D. B a l á z s

RELIEF TYPES OF TROPICAL KARST AREAS

The difference in the phenomena of tropical karst landforms caused the geographers to give them peculiar names. Mostly the names given by German geographers /Lehmann, H., Wissmann, H./ are used: "Kegelkarst" and "Turmkarst" and their English /cone karst and tower karst/ and French /karst à pitons, karst à tourelles etc./ versions. In the course of study of the Caribbean Archipelago a number of new concepts were adapted by the scientific literature /cockpit karst, "mogote karst, haystock karst, morne karst, etc/ causing many misunderstandings.

In our view the concepts of "Kegelkarst" and "Turmskarst" are not suited for the determination of the type of tropical karst regions. The "Kegel" /cone/ and "Turm" /tower/ shapes often occur within the same karst region, in another's vicinity. The cones may develop in time into towers and the towers into cones. It is extremely difficult to determine for instance ot the region shown in Figure 1, wether it is of Turmkarst or Kegelkarst type, since both formations are present in compact and isolated full forms.

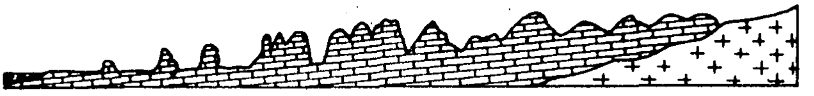

FIG. 1.

It seems more reasonable to consider a continuous karst region as an independent morphogenetical unit and to attempt to typity it on the basis of the complex geological development of the region. However this task is made more difficult by the circumstance that each tropical karst region is the result of individual development and many factors contribute to the trend of development /lithologic, tectonic, orographical and conditions, etc./. The subjects of our investigations are solely the plain- and plateau - like, thus approximately horizontal, karst regions and they do not extend over karst regions of high mountainous or specific character.

Similarly to the volcano experts who marked out certain characteristic volcanos as head-types /i.e. Stromboli type, Vesuvio type, etc./ it is possible to select characteristic types of tropical karst, though the steps of development follow a substantially slower course than in volcano morphology. The selection of tropical morpho-genetical karst types is made possible by the peculiar full forms characteristic of each karst region, forming about 70-80 % of the karst region in question.

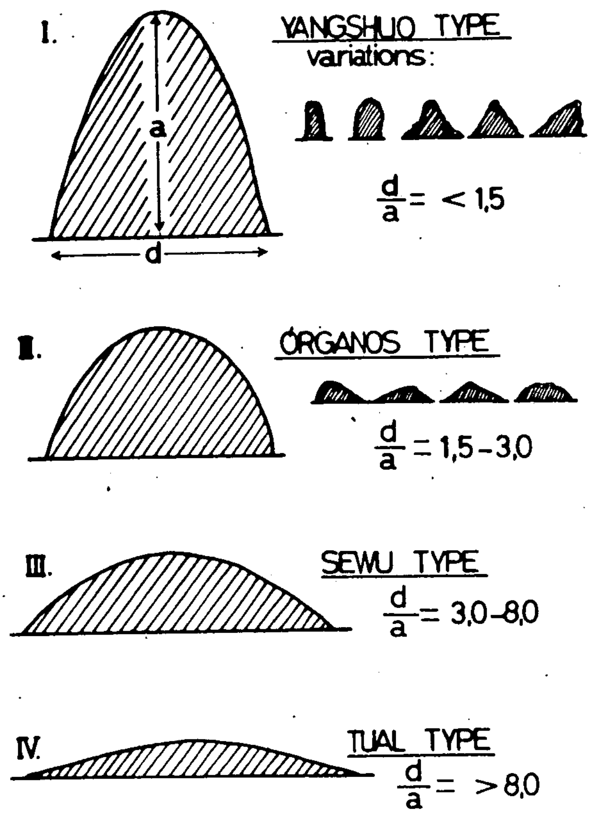

FIG. 2.

Basen on the development of the full forms characteristic of the tropical plateau karstlands <u>four head types</u> could be established. The schematic diagram of these is illustrated <u>in Figure 2</u>. The quotient of the diameter /d/ measured at the base of the hills and their altitude /a/ is the main characteristic of each type /morpho-genetical index, herafter: m.g.i./.

For the morpho-genetical classification of the tropical plateau karstlands the following four head types are suggested:

1. Yangshuo type: Yangshuo or Jangso is a small town in the Kwangsi province of China, south of the town Kweilin. As a part of the Kwei-kiang karst region the karst "island mounts", the most imposing formations of their kind are to be found near to Yangshuo. /Figure 3./

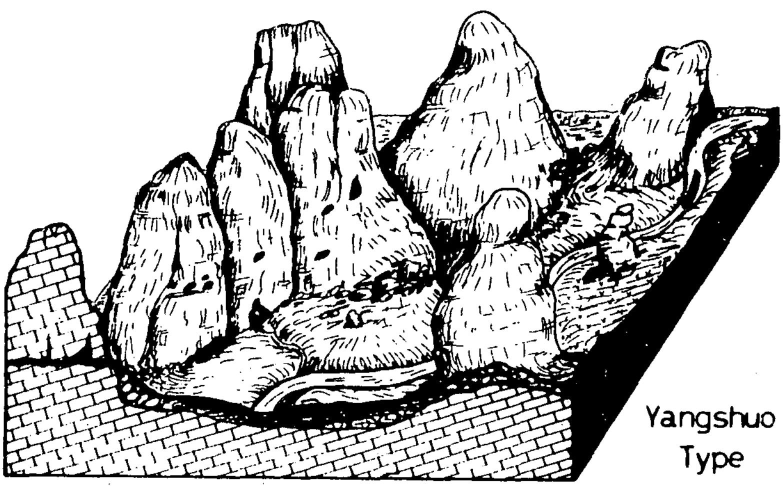

FIG. 3.

2. Órganos type: The name-giving type is to be found in the Sierra de los Órganos, Cuba, slightly to the north from the small town of Vinales, where the mogote karsts are. /Figure 4./

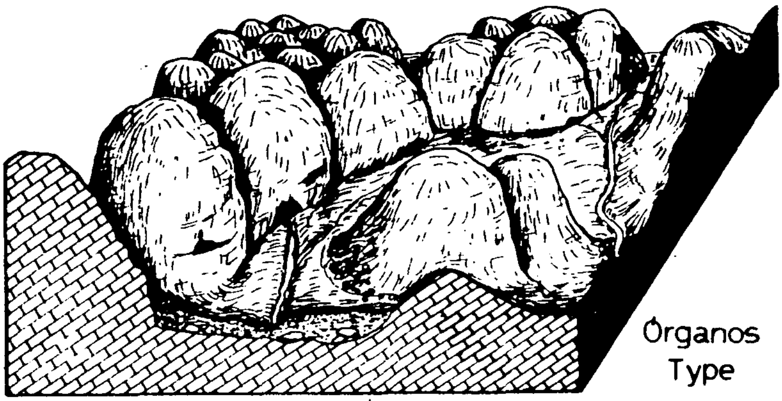

FIG. 4.

3. Sewu type: Gunung Sewu /"Thousand hills"/ karstic plateau is in Indonesia, in the Southern middle of Java, south-east of Jogjakarta. The area between the Wonosari Basin and the Baron Spring served for the more exact type determination. /In the geographical literature this area is mentioned as a typical specimen of "Kegelkarst" though the full forms to be found there do not resemble at all geometrical cones. That is why D. Pfeiffer renamed them "sinoids", and the karst-type "sine-karst"/. /Figure 5./

FIG. 5.

4. Tual Type. Tual is unknown as yet in the literature of karst morphology: it is a small settlement on the Kai-Ketjil island belonging to the Indonisian Maluku Archipelago. The island is built up of plio-pleistocene coral limestone and has undeveloped karstic phenomena /Figure 6./.

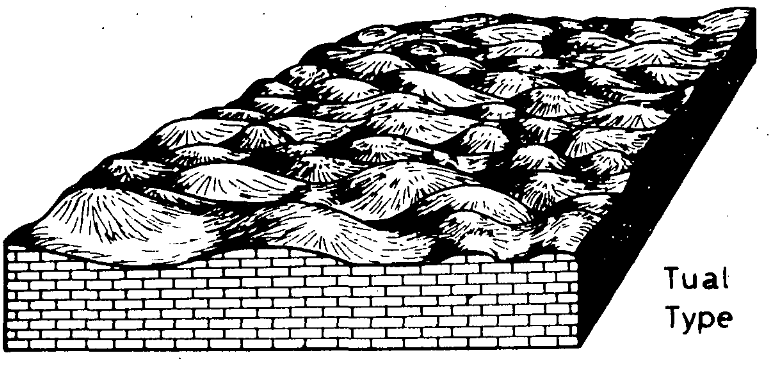

FIG. 6.

Comparative data of the four tropical head types:

	Morpho-genetic index	Relative height of full forms, meter	Number of full forms per km²
1. Yangshuo type	<1,5	100-300	5-10
2. Órganos type	1,5 - 3,5	50-200	10-20
3. Sewu type	3,0 - 8,0	30-120	15-30
4. Tual type	>8,0	10-50	0-50

The four head types do not indicate stages of denudation /see: Corbel/, but morpho-genetic units formed under different geological, climatological, hydrogeological conditions, during different periods. For instance it is obvious that the formation of the Yangshuo karstland took a substantially longer time than that of the Sewu type. Generally there is no genetic correlation between these types. For instance the Tual type will never develop into Yangshuo type.

In some cases it is difficult to decide of a certain karst region to which of the four types it stands nearest. In North-Vietnam and Laos for instance, there are many karst regions which form a transitory type between Yangshuo and Órganos. In such cases "Yangshuo-Órganos transitory type" is the suitable designation. Or in other cases: Órganos-Sewu transitory type, or again Sewu-Tual transitory type.

Within every head type of karst region it is possible to define sub-types.

Based on the correlation of the full forms two sub-types may be distingished:

1. Compact karst in which the full forms are in close connection /often enclosing depressions/, or close

2. Karst region with "island mounts", where the karst hills, because of progressed denudation, are isolated.

Further peculiar phenomena may be caused within one and the same morpho-genetic type by hydrogeological conditions:

a. the karst block lay near the receiving level /surface and underground drainage/, or

b. the karst is in an uplifted situation /mainly underground drainage/.

The characteristics enumerated may be demonstrated on the geomorphological map of the region.

To classify into the four head types some of the tropical karst regions, a table was prepared.

In the experience of the author there exist a few plateau karsts which cannot be classified in any for the head types or transitory types. These exeptional cases are not treated in this paper.

Classification of some tropical karstlands

Karst regions	Yearly preci-pitati-on	Average peadk height, meters a.s.l.	Age of limes-tone	Relative height of full forms, meters
I. Examples of the Yangshuo type karst				
Kwei-kiang and He-kiang Karst Regions, Kwangsi, China	1914	300-500	Carboniferous	100-300
Li-kiang Karst Region, Kwangsi, China	1472	300-500	Carboniferous	100-250
Lu-kiang Karst, SW of Nanning, Kwangsi, China	1322 –	300-600	Permian, Carboniferous	50-150
Middle Si-kiang Karst, Kwangsi, China	1200	80-200	Carboniferous	10-80
Tunnang-ho Karst, S. of Kwei-yang, Kweichow, China	1202	600-900	Permian, Carboniferous	80-200
SE Yunnan Karst Region, China	981	1500-2000	Triassic Permian	100-250
Bac-son Karst, Vietnam	1400	200-600	Permian-Carboniferous	100-200
Cao-bang Karst, Viet-nam	1350	200-600	Permian, Carboniferous	100-200
Ha-long Bay Karst Region, Vietnam	1775	100-300	Permian, Carboniferous	50-200

Karst regions	Yearly precipitation mm	Average peak height, meters a.s.l.	Age of limestone	Relative height of full forms meters
II. Examples of the Órganos type karst				
Sierra de los Órganos N of Viñales, W-Cuba	1700	200–500	Cretaceous, Jurassic	50–200
Northern Littoral Mogote Karst, Puerto Rico	1200	50–200	Aymamon limestone /Middle--Tertiary/	50–100
Internal Cockpit Karst, Puerto Rico	1800	200–500	Lares limestone /Middle-Tertiary/	50–150
Cockpit Country, Jamaica	2500	300–600	White limestone /Upper Eocene-L. Miocene/	80–150
Sinamar-Kvantan-Takung Karst Region, Middle-W-Sumatra, Indonesia	2032	500–900	Carboniferous	100–200
Western Gunung Sewu, Middle Java, SE of Jogjakarta, Indonesia	1849	300–500	Miocene	50–120
Pangkadjene Karst, SW-Sulawesi, Indonesia	3545	100–300	Eocene	80–200
Maros Karst Region, SW-Sulawesi, Indonesia	3175	200–550	Eocene	80–200
Ajamaru Karst Region, Doberai Peninsula, W. Irian, Indonesia	4819	300–500	Miocene	100–200
Southern Yucatan Karst Mexico-Guatemala	2500	200–500	Oligocene-Cretaceous	100–200
Tabasco Karst Region, S. Mexico	4000	100–500	Cretaceous	50–150

Karst regions	Yearly precipitation mm	Average peak height, meters a.s.l.	Age of limestone	Relative height of full forms meters
III. Examples of the Sewu type karst				
Middle Gunung Sewu, Middle Java, Se of Jogjakarta, Indonesia	1809	200–400	Miocene	30–80
Kalapanunggal Karst, W. Java, Indonesia	3705	300–500	Miocene	50–150
Gunung Sewu of Karangbolong, Middle Java, Indonesia	3720	300–400	Miocene	50–120
Nusa Barung, Island of SE Java, Indonesia	1311	150–300	Miocene	50–120
Blambangan, SE Peninsula of Java, Indonesia	1367	250–350	Miocene	50–120
Bukit Badung /Tafelhuk/, S. Peninsula of Bali, Indonesia	1645	150–200	Miocene	50–80
Nusa Penida, island between Bali and Lombok, Indonesia	963	200–500	Miocene	50–150
Northern Sumba, Sumba Island, Indonesia	1895	500–600	Miocene	50–150
Middle Yucatan Karst, Mexico	1500	100–200	Miocene	50–100

Karst regions	Yearly precipitation mm	Average peak height, meters a.s.l.	Age of limestone	Relative height of full forms, meters
IV. Examples of the Tual type karst				
Kai-Ketjil Island, SE. Maluku Islands, Indonesia	2437	20-50	Plio-Pleistocene	10-30
Tanimbar Islands, SE Maluku Islands, Indonesia	1951	20-80	Plio-Pleistocene	10-50
Western Kobroör, Aru Islands, SE Maluku, Indonesia	2177	20-50	Plio-Pleistocene	10-30
North Bone Karst, SW Sulawesi, Indonesia	1642	250-500	Pliocene	30-80
Hitu Karst, Ambon Island, Maluku, Indonesia	3475	200-400	Plio-Pleistocene	50-100
North Yucatan Karst, Mexico	1000	100-200	Plio-Pleistocene	20-50
Middle and Southern Florida	1300	20-60	Miocene, Pliocene	10-30

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