CHINA KARST TYPES

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ABSTRACT; The diverse karst landscape of China is the result of a number of different factors, forming the largest and most interesting karst areas in the world.

Although exposed carbonatite strata only cover an area of 910,000 Km over one third of China's territory has the distribution of carbonate on which various types of karst developed under the different conditions of geology, topography and climate (Figure 1.) China Karst is the most important and the most widely distributed karst in the world.

The development of China Karst is controlled and affected by the following factors.

1. The lithological character, the thickness and the stratigraphic combination types of carbonatite strata.
2. The geological structure and the feature of neotectonic movement.
3. Climatic conditions.
4. Terrain conditions.

The main types of karst developed in China are controlled by the above-mentioned factors respectively.

There is an obvious regularity of karst distribution from south to north in Eastern China.

(1) Fenglin karst, with a total distribution area of 200,000 Km is widely dispersed over the tropics and the subtropics south of latitude 27^{o} N. (See Area A of Figure 1.) The minimum annual precipitation of 1,000 mm and high temperatures are available for the chemical corrosion of karstification. Topographically constructed by the Peak Cluster - Depression Landform and the Peak Forest - Pain Landform, Fenglin Karst is in fact a sort of Holekarst. Caves are extensively developed, but particularly those modern underground rivers of large scale in the Peak Cluster - Depression Area. Further information about this field could be obtained from the paper of "Fenglin Karst in China".

(2) Karst Low - Hills mainly distributed on the Second - Step Topographic Staircase of China which is located between 27^{o} and 35^{o} of north latitude and on the eastern coastland of North China, namely, the bankland of the Three - Gorges Segment of the Yangtse River, the Qinling Mt., the south edge of the Taihangshan Mt., the Shandong Peninsula and the Liaodong Peninsula. (Area B, Figure 1.) Developed under the climatic conditions of 600 - 1,000 mm annual rainfall and 10^{o} C mean annual temperature, Karst Low - Hills are topographically characterised by the following surfacial karst landforms: gentle low - hills, dolines, dry valleys and stone - teeth. Caves and subterranean streams in Area B are much less than those in the Fenglin Karst area but are still the dominant landscape of underground karst.

(3) Normal Karst Terrains, developed in Area C on Figure 1, are chiefly distributed in the Nuliangshan Mt. Area and the north part of the Taihangshan Mt. of Shanxi Prov. and in the Erduosi District. The karst regions in Area C, with the annual precipitation of less than 500 mm are characterised by the development of normal surface water systems and by the shortage of closed negative relief such as doline and depression. Shallow karrens usually developed instead of stoneteeth on the surface of carbonate rocks. To the formation of the aforementioned changes of karst landscape from south to north in Eastern China, it seems that the variation of climate is much more important than the lithologic factor. For example, Ordovician limestone exposed in Shanxi and Devonian limestone exposed in Guilin are all pure and thick - bedded and have little difference in lithography but have great difference in geomorphologic display - the former displays normal karst terrains and the latter displays Fenglin Karst Landforms. The preliminary conclusion we draw from this point is that, karst landscape is chiefly affected by climatic factor on condition that there is no change in lithology. Surely the great change in morphology among karst landforms developed under the same climatic condition (As we see in the Fenglin Karst Area near Guilin) are due chiefly to the difference in lithology.

When there are thick - bedded interbed or interlayer of carbonatite existed in noncarbonate rocks, independent karst units of anticline, syncline and flaut block may be formed by the folding and developed further into "Tectonic Karst". Tectonic karst is the dominant landscape in the south-bank area of the Three - Gorge Section of the Yangtse River on the east edge of Sichuan Basin and the linear-fold region which is situated within the Sichuan Basin. (Area D, Figure 1.)

The south-bank area of the Three - Gorge Section consists of the western Hubei, the western Hunan and a small piece of the eastern Sichuan. With the interlayers of thick sandshale of Silurian & Devonian, the main carbonatite strata of Cambrian, Permian and Triassic usually formed independent anticlinal karst systems or

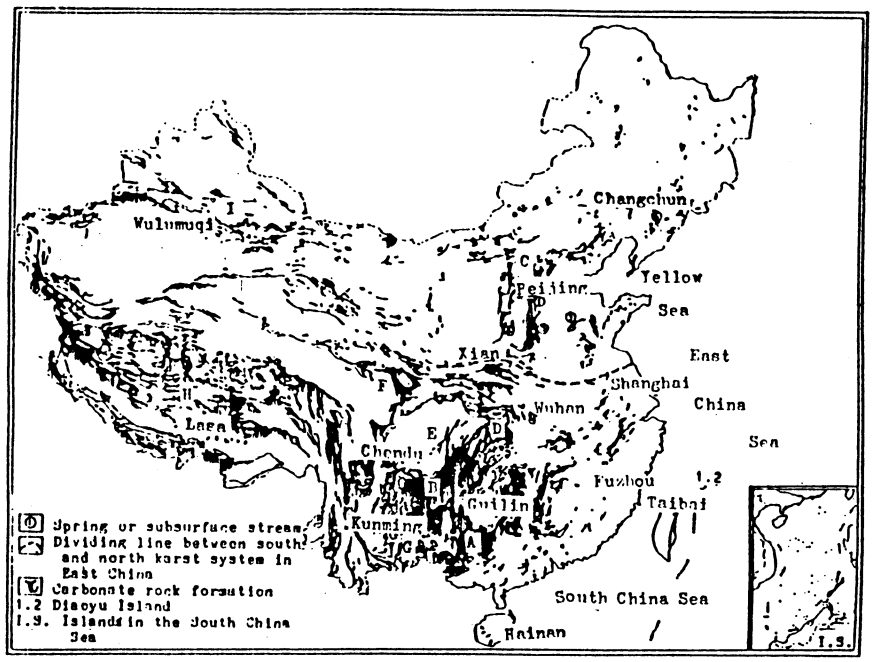

Fig.1 The map showing distribution of carbonate rocks and karst types in China

A--Fenglin Karst(Guilin-Type)

B--Remnant hill with shallow depression Karst(North Guizhou Plateau-Type)

C--Normal landform Karst(Shanxi-Type) D--Tectonic Karst(SanXia-Type)

E--Trough Karst(East Sichuan-Type)

F--High mountain-deep valley karst (Mianchan-Type)

G--Faulted basin Karst(Yunnan-Type)

H--High mountain Karst(Qing-Zang plateau-Type)

I--Arid Karst(East Tianshan-Type)

synclinal karst systems in the area under the structural control of anticline or syncline. (Figure 2.) Karst low - hills and dolines are the main surfacial karst landforms, and sinkholes extensively developed at the bottom of the dolines. Polje sometimes formed in the karst area with anticlinal structure, while karst synclinal mountains formed under the conditions of synclinal structure. The most attractive "Tectonic Karst" is formed in the fold zone which is situated on the east limb of the Sichuan Basin. The anticlines of the area totalled over 40 and each anticline is about 5 - 8 km in width and 40 - 250 km in length. (Figure 3 and Figure 1,E) Stratigraphically the anticlinal limbs are constituted by sand stones of the Upper Triassic with the dip angle changing from 20^{o} - 80^{o}, while the anticlinal axes are taken up by limestones of the Lower Triassic and thus formed karst trough eventually in process of karstification. Topographically the karst trough is constituted by low hills and depressions. There are many sinkholes and deep shafts developed at the bottom of the depression. (Figure 4.) Under some other circumstances polje may develop instead of karst trough. When the drainage system of a polje gets clogged or is not able to drain away the water efficiently, polje will fill with water and form a "Heavenly Lake" such as Qingmuguan Heavenly Lake near Chongqing City and Guangan Heavenly Lake in Huayinshan Mt.

Tectonic Karst developed in Eastern Sichuan also has two important phenomena in hydrogeology and speleology: the emergence of thermal springs and salt springs and the development of longitudinal phreatic caves. The thermal spring is in fact sulphate spring with the water temperature of 35^{o}C - 47^{o}C and the total dissolved solids of 2 - 2.9 g/l, and the salt spring is sodium-chloride spring with the water temperature of lower than 35^{o}C and the total dissolved of 4 - 43 g/l.

Under the structural condition of rake anticline, the longitudinal phreatic caves could form and develop along the buried anticlinal axis - Haidigoudong cave developed in the Longwangdong Anticline Area is the typical example. (Figure 5.) The cave was discovered by a coal mining tunnel on August 27, 1966. The discharge of the cave was 90,000 Cubic Mtrs/Hr at the beginning then declined to 3,400 Cubic Mtrs/Hr after 72 days, and the

total discharge of the cave during this period was 16,800,000 Cubic Metres. The recharge source of the cave is in the Hauyinshan Multiple - Fold Area of 20 Km away, and the water quality of the cave is calcium sulfate-type (the content of sulphate ion was 700 - 900 mg/l, the total dissolved solid was 1.1 - 1.3 g/l, the total hardness was 43 - 53 German deg. and the water temperature was 19°C.) With the discharge of the cave water, the previous surfacial springs in the area disappeared gradually and the underground collapse happened.

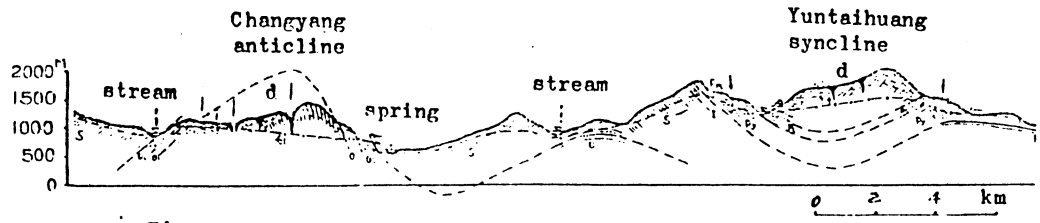

Fig. 2 tectonic control of karst in west Hubei

limestone shale sandstone

€--Cambrian O--Odovician S--Silurian D--Devonian
P--Permian d--depression and sinkhol

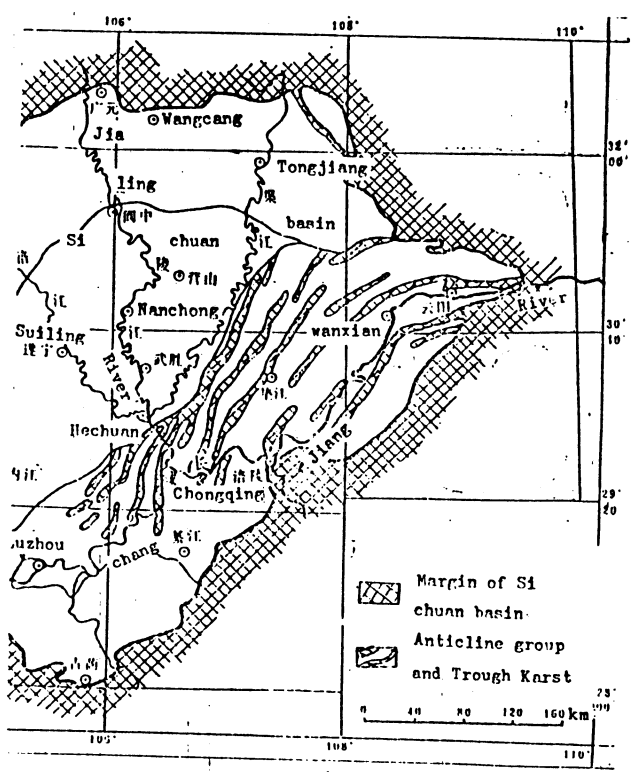

Fig. 3 The anticline group and the Trough Karst (along anticlinal axis) in East Sichuan

The vertical variation of karst landscapes in the same area is evidently affected by the terrain conditions and the most typical example is the "Mianshan Mt. - Type Karst" which is situated on the western edge of the Sichuan Basin. (Area F, Figure 1.) The Mianshan Mt. - Type Karst is constituted by two different subsystems in vertical section: the upper zone of mountain paramos karst and the lower zone of gorge temperate karst. The boundary line of the two subsystems is about 3,700 - 4,000 metres above sea level.

The mountain paramos karst subsystem, developed under the climatic conditions of 800 mm - annual precipitation and 1.0°C - annual temperature in the area whose elevation is higher than 3,700 - 4,000 metres can by subdivided by the altitude of 4,800 metres into two parts: the upper zone and the lower zone. The upper zone is covered by ice & snow all the year round and by the desert vegetation, and is mainly recharged by the summer meltwater. The lower zone is meadow-grass land where the karst landforms formed by corrosional action is not prominent because of the intense physical weathering and the gravitational collapse. There are lots of tooth-peaks, residual stone columns and natural bridges formed by weathering agent in the lower zone. According to the determination, the precipitate water of the lower zone has very strong solvent power of carbonatite. (SIc = -1.61, SId = -3.61, $\log(pco_2)$ = -4.21.) Karstic springs of the lower zone has a higher value of the total dissolved solids (0.3 - 0.78g/l) and the temporary hardness (21 - 36.4 German deg) than the karst springs of Northern China because of the severe karstification.

The gorge temperate karst subsystem and the forest zone have the same upper limit. With the mean annual temperature of 3 - 7.3°C and the yearly rainfall of 600 - 800mm, the biology of the gorge temperate karst zone is prosperous and biokarstification exists anywhere at any time. Numbers of karst springs and the relevant tufa deposits on the zone are the most marvellous natural landscapes.

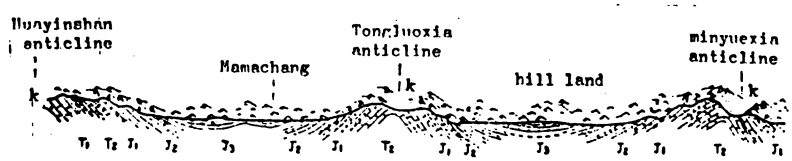

Fig. 4 Topographic and geological profile between anticlines Huayinshan and Minyuexia

k—Trough karst J—Jurassic T—Triassic

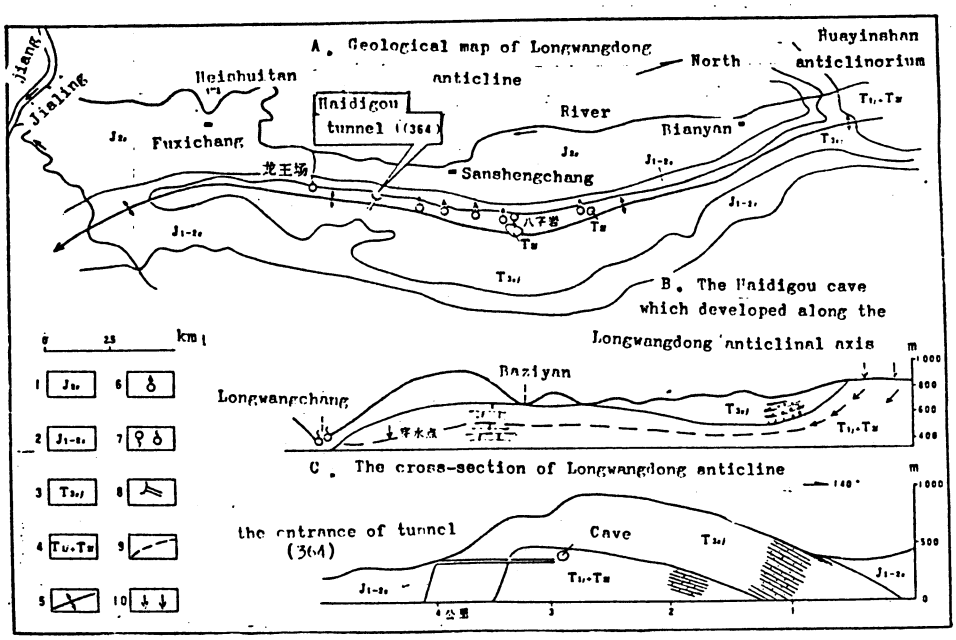

Fig.5 The Haidigou cave which developed along the Longwangdong anticlinal axis

1,2--Jurassic sandstone 3--Triassic sandstone 4—Triassic limestone

5—Anticlinal axis 6-- Flowing well 7-- Spring 8-- Tunnel 9--Caves

10--Water flowing deraction

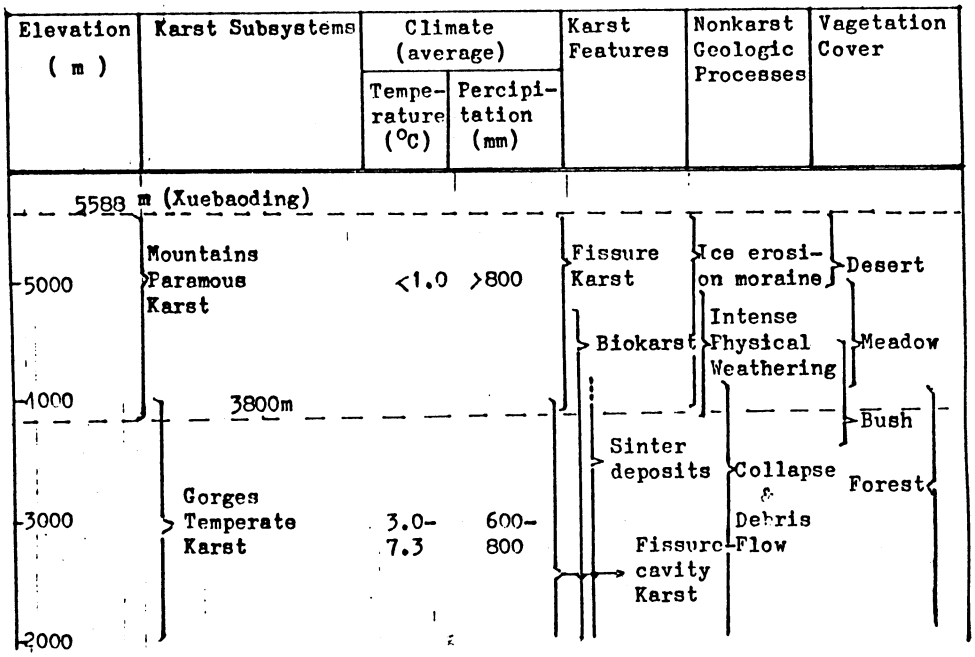

Fig. 6 The basic features of Mianshan Karst systems

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