ON THE ORIGIN OF CONE KARST AND ITS MORPHOLOGY

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In the subtropical monsoon karst regions uplifted in the Quaternary, the cone karst coexists with many kind of topography, such as plains, valleys, depressions, poljes, bank slopes and terraces. This is the major difference between the distribution of the cone karst and the tower karst. The latter is observed only on plains or basins. This situation brings about the idea that there are different origins for cone karst and tower karst. Moreover, the main aspects of cone karst morphology is illustrated in this paper, through which an overall conception of the cone karst may be figured out.

FLUVIAL ORIGIN OF THE CONE KARST AND THE PROOFS

The axiom from which the inference of cone karst morphogenesis is made could be stated as:" positive topography and negative one nearby are spatially complementary". Through the logical comparision between fluvial landforms and cone karst landforms, it is revealed that the slopes of cones are also sculptured by fluvial gulleys. The number of cones and first order gulleys both increase nearly in direct ratio with the extension of areas where the cones and gulleys exist. But the gulleys are "conjugate" in the cone karst and "alternate" in the fluvial landform. That is to say, the process of dissolution makes big joints exposed and along them further erosion takes place. Consequently, the conjugate gulleys controlled by joints occur along with cone karst.

CONTROL OF CLIMATE ON THE DEVELOPMENT OF THE CONE KARST

What would happen if we removed a type of landform in a region to another one where the climate is different? Though it is impossible for us to do so we can investigate landforms in several karstic regions where the climates are different but the lithological, tectonic features and morphologic history are the same. The analysis shows that climate is one of the important factors which control the development of cone karst, although the threasholds are not the same under different structural and lithological background. In Guizhou plateau, for complete synclines underlain by the middle Triassic carbonate rocks, the climate condition in which the cone karst can develop is temperature T>12° or precipitation R>1100mm, which is actually in the area to

the south of 27° in latitude or with altitude<1300m.

EFFECT OF GEOLOGICAL STRUCTURE ON THE DEVELOPMENT OF CONE KARST

According to the experiences in Guizhou, the most important structural feature which strongly affects the development of cone karst is the type of fold. We have two sample areas A and B in Guizhou at about altitude 2000m and latitude 27° N with limestone of the lower Permian. In area A (syncline) the drainage network satisfies Horton's law: $\log Nu=2.07-0.52\mu$, $r=0.99$, where μ is the stream order and Nu number of streams. The density of peaks in this area is $0.5/km^2$ so that the landform is fluvial one. The area B is on an anticline, where the drainage network has already been disintegrated by caves and depressions. The river system has become dry valleys and the density of peaks>$6/km^2$, i.e., it is a typical cone karst region.

THE SHAPE OF CONES IS DETERMINED BY LITHOLOGICAL FEATURE

The shape of cones differ to each other for their different size and angles of slopes. For a typical cone, its basic shape can be described by $ctg\alpha$, where α is the angle of slope determined by the strength of the rock. Taking a horizontal circular section at definite level of a cone, then the average pressure on the section is $1/3\ h\sigma$, where h is the height of the cone above the section and σ the specific gravity of the rock. The less the strength of rock, the less the pressure which the rock can support. Thus h is a main variable if σ changes not much and the angle of slope α is a regulator of h. Many evidences have been founded to show that the mechanical character of the rock is an important factor determining the morphology of cone karst.

APPROACHES FOR DATING THE CONE KARST

All geomorphologists pay attention to the scale of time in which a definite type of topography was formed or remained unchanged basically. In karst regions, chemical depositional process provide us geological and geochemical records for dating. In the middle of Guizhou, a stream tufa is found on an eroded terrace which is 80m higher than the modern river. The isotopic age of the tufa is 169 ka B.P. from the U-series disequilibrium approach, which indicates the cones on the terrace has remained at least 170 ka. A hanging flow stone which is attached to the roof of a cave in an isolated peak of a peak-forest plain was dated back to 15296±556 a B.P. with ^{14}C method.The cave is 12m higher than the dissolution plain. Accordingly, the

water flow which removed the deposits beneath the flowstone should have been existed before the peak-forest plain was formed. So it is considered that the peaks in this region developed in the late of the Late Pleistocene to the Holocene.

A DISCUSSION ON THE DIFFERENCE BETWEEN ORIGIN OF TOWER KARST AND THE CONE KARST

The morphogenesis of the tower karst differs from that of the cone karst which is due to the dissolution and erosion of gulley flow. The irregular shape and cliff of towers should be due to the collapse of water table caves. The tower karst distributes in plains or basins where the overburden is thick with stable neotectonism or subsidence. Yushan, a hill with cliffs and footcaves. in Zhijin, Guizhou is also a typical tower, which illustrates that tectonism is not a direct cause for the formation of tower karst. Many dissolutional features such as scallops in the caves of towers and the notches on the cliffs of towers indicate that stable water table and its slowly descending should be the basic hydrodynamic conditions for the forming of tower. The process is that hard limestone strata with gentle dip angle and vertical joints has bedding plane caves formed near the water table and followed by the callapse of caves. This idea has been supported by the statistics on the relationship between projected area and the cavernization degree of tower (Zhu Xuewen et al, 1985).

THE RELATIONSHIP BETWEEN CONE KARST AND TOWER KARST IN A CATCHMENT

The cone karst is always in the vadose zone which has no continuous horizontal flows. The main hydrologic process in it is to produce slope flows, well characterized by dynamic equilibrium. The base of cone karst constitutes the lower part of vadose zone with continuous horizontal flows, where ground water moves in various directions. In the area with deep dissection cone karst with higher base will develop, whereas in those areas with shallow dissection, cone karst will develop with lower base. If the base level in an area is stable for a long period, then the thickness of vadose zone as an effective relief will diminish gradually, and finally become zero. Under such situation, the cone karst will change into tower karst. But the cone karst will not change into tower karst where rejuvenation process happens. They will be uplifted as a whole on a slope or platform with their base keeping on a quasiplane, nevertheless, there are sinkholes and leakage occurring on the slope or platform.