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Karst Development Models of Early Palaeozoic Carbonate Rocks on the Southern Margin of North China Platform

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Abstract. This paper analyzes the formation and karst development process of early paleozoic carbonate rocks in the southern margin of North China platform from the aspects of regional stratigraphy distribution, crustal movement and evolution and groundwater recharge and drainage conditions. It is concluded that the karst in the study area is multi-level developed and affected by lithology. Under the control of tectonic movement and groundwater flow, there are three main types of karst development models: bedding karst, water erosive karst, fault zone karst and erosive mining karst.

1. Introduction

Karst workers at home and abroad have done a lot of analysis and research on the characteristics of karst development of carbonate rocks, especially on the inland areas of the south and north of China ^[1-5]. However, as the southern margin of the North China platform, which is the boundary between the south and the north of China, the development of karst has its particularity, which is not only different from the erosive karst in the south, but also different from the tectonic karst in the inland area of the North. The main reason for the development of karst in the area is not due to the chemical changes of water, but mainly due to the physical factors such as fracture, collapse, erosion and scour of flowing water. There are many small and medium-sized karst forms, such as karst dry valley, dissolved hole, dissolved ditch, karst cave, dissolved gap and so on. Most of the previous studies in this area are aimed at the study of "point source" such as karst water inrush and surface karst collapse in mining area ^[6-11]. In this paper, the characteristics and models of karst development in the study area will be systematically carried out, and the regional "non-point source" will be analyzed and discussed.

2. Basic situation

The study area is located on the north-south geography and geological boundary of China, the middle reaches of Huaihe River and the development of water system. The regional area is connected with Bengbu uplift in the north, Hefei sag in the south, North China fault depression in the west and Tanlu fault zone in the east. The geographical coordinates are 116 °38 '117 °46 E and 32 °35 '52 N. The average annual precipitation is 969mm and the average annual temperature is 16 °C. It is four distinctive seasons and belong to the typical continental temperate and semi-humid monsoon climate zone. (Figure 1)



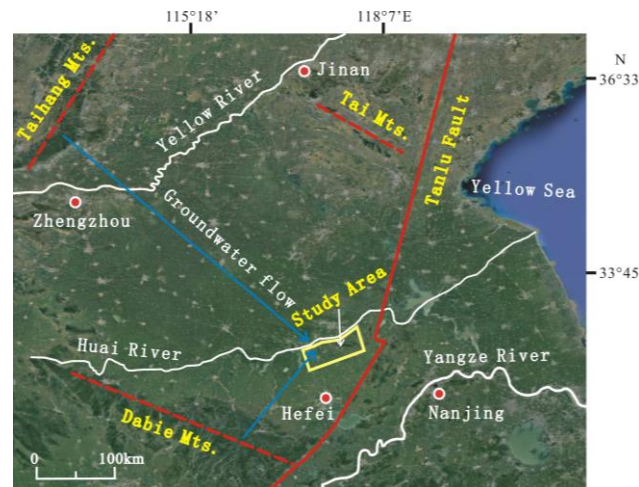


Figure.1 The location map of study area

3. Karst distribution characteristics

The study area is located on the edge of the platform, controlled by deep faults between the north and south, the main structural traces of the study area are distributed in NWW direction, the Shouxian-Dingyuan fault located at the south of the study area runs to the Dingyuan County from the west to east and converges on the Tanlu fault zone which is distributed in NWW direction. In Shouxian County in the south, reaching Dingyuan eastward and intersecting with the Tanlu fault zone in the direction of NNE. The intensity of karst development at the intersection of water diversion fault is larger than that at the tip of fault. In the area where the fault structure is not well developed, the aquifer in the same layer has a unified water level line, and the hydraulic connection tends to along the strike of rock strata be closer than tends to along the inclination of strata. The karst develops strongly in the shallow area and the ground of reverse and rapidly inclined strata, and a large number of bedding split karst collapse pits and karst fissures appear in the strata (Figure. 2A).

The karst topography, geomorphology and hydrogeological conditions in the area are strictly controlled by strata, lithology, geological structure and so on. Although the thickness of Ordovician carbonate rocks is large, limestone and dolomite are distributed between each group, and the rock composition and solubility have significant difference, which affects the uniformity of karst development in the area, and mainly geomorphology are dissolved trench, dissolved pore, dissolved hole and so on (Figure.2B).

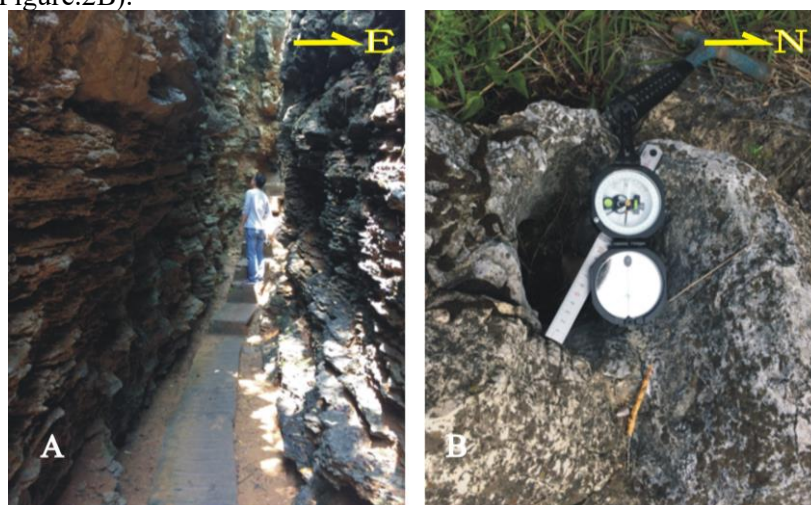


Figure.2 Field karst geological photos of corroded ditch

The Cambrian Gushan formation is a light gray thick layer siliceous dolomite and khaki thin layer muddy limestone irregular interlayer, the former lithology is strong and brittle, the latter structure is loose and easy to be weathered, at the junction of hard and soft strata, Shun Geng mountain south slope. It has been developed bedding cracks and falling holes (Figure.3A). There are many caves in carbonate rocks of Maozhuang formation. Mt. Jiu Cave with east and west spread in strips is developed in this group of strata. attitude of bed of rock strata is $180^{\circ} \angle 20^{\circ}$. It was originally the east extension of the north wing of Huainan complex slope under the Huaibei plain(Figure.3B). Due to the influence of the NNE trending Wu dian normal fault, the top of a rock formation in the west fell and the bottom of a rock formation in the east was revealed by the rise.

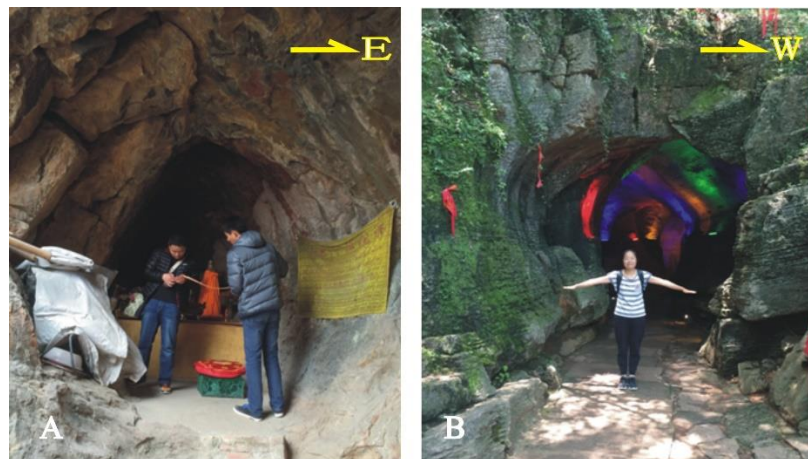


Figure.3 Field karst cave photos of cambrian

4. Karst development model

The development of karst in this area is mainly controlled by the distribution of strata lithology, the evolution of crustal movement and the condition of groundwater recharge and drainage. There are three types of karst development models: bedding karst, water erosive karst and fault zone karst.

4.1. Bedding karst

The Cambrian Gushan formation, Maozhuang formation and Man tou formation are irregular interbeds of carbonate, mudstone and shale(Figure.4). In the early stage of karst development, the karst develops along the limestone plane, with the expansion of the cave, the lower mudstone and shale strata are also eroded, and the overlying strata collapse, which leads to the further expansion of the scale of the caverns. The joint cracks in the cave are dense, and the gap filling is dark purple debris, which is mainly filled with mud sand and calcareous.

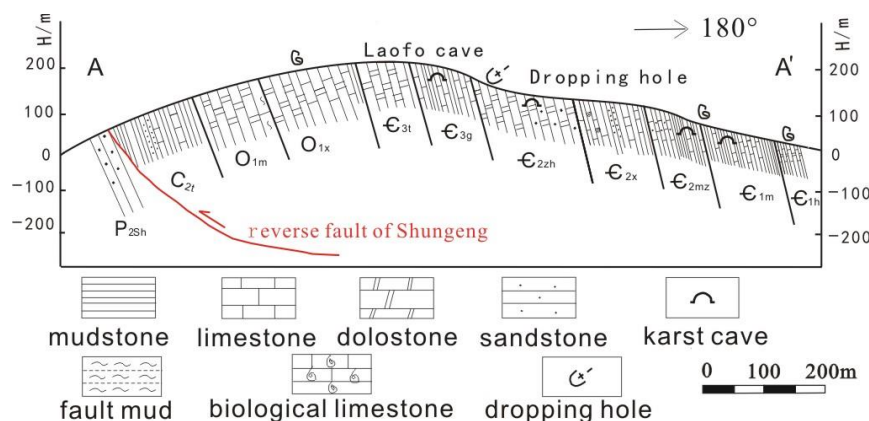


Figure.4 Geological profile of Shungenshan

4.2. Water erosive karst

The carbonate rocks in the deep buried area were formed from Cambrian to Middle Ordovician, and from late Ordovician to Middle Devonian for a Long-term intermittent deposition, and paleo karst developed strongly, but it was filled during late deposition. Coal-bearing strata with a thickness of nearly kilometer were deposited from late Carboniferous to Permian. The lithology was carbonate-bearing coal-bearing clastic rock. Organic matter in coal measures produced a large number of CO₂ during hydrocarbon generation and pyrolysis and formed acidic groundwater, which aggravates dissolution, as can be seen from Figure.5.

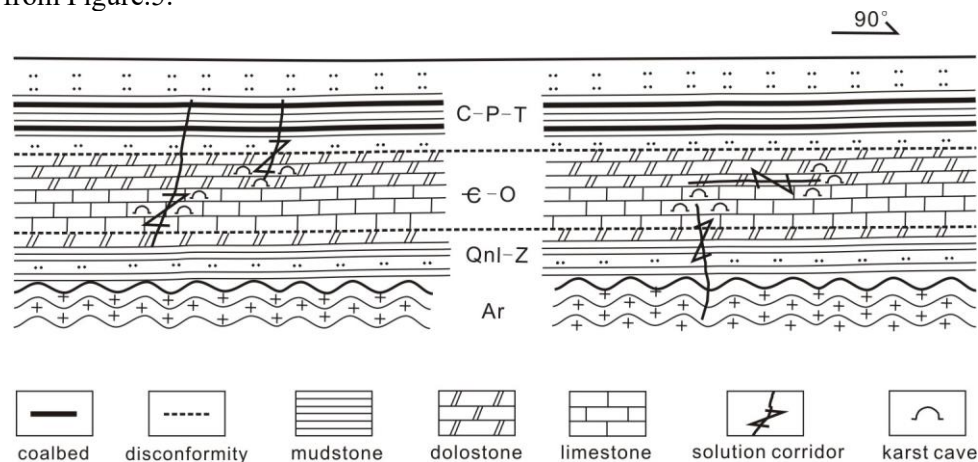


Figure.5 Water erosive karst formation profile before Triassic period

4.3. Fault zone karst

During the Indian movement that began in the Triassic, The earth's crust folded and rose in this area by the north-south tectonic stress, and this had produced the NWW trending Shungeng mountain, Fufeng and other thrust faults. The Jurassic Yanshan movement resulted in the formation of a large number of NNE trending fault systems in the area, which provided conditions for karst water activity. All kinds of Karst channels criss-cross and form a mesh or maze of morphological systems, for example, the Wolf Lane Valley in Fengyang Mountain(Figure.6).

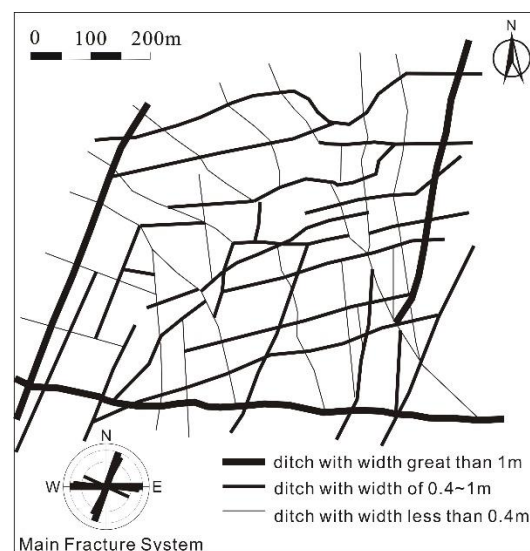


Figure.6 The surface distribution of groove in the valley Karst area of Wolf Lane

5. Conclusion

1. Rock properties, geological structure and climatic conditions are the basic factors to control the development of Karst, while hydrogeological conditions and topography are mainly the result of karstification. The Karst in the area is concentrated in the contact zone between carbonate rock and non-carbonate rock, the cross convergence zone of two or more groups of fault joints and the low mountain valley zone.

2. The faults with small angle dip angle in carbonate strata are beneficial to the development of small dissolved pores and caverns, and the faults with high angle dip angle are beneficial to the development of caverns and trenches. When interlayer karst fissures are developed in the gently inclined monoclinic structural area and the filling material of joints is clay, it is beneficial to the development of karst when the surface and shallow parts of steeply inclined strata are inversely turned to the surface and shallow parts of steeply inclined strata.

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