

GEOLOGICAL FEATURE OF YUNKAI RIFT^①

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ABSTRACT The Yunkai area, which spreads along the boundary between Guangdong and Guangxi, is a terrain with independent structure unit and evolution history. The features of the rigid basement, edge faults, sedimentary formation, alkalic basic volcanism, metamorphic facies series and geophysical anomalies of this area indicate that the Yunkai terrain was formed in the geosynclinal-type rift caused by the rigid crust extension at Sinian period of upper Proterozoic subera.

Key words Yunkai rift edge faults sedimentary formation evolution history

1 INTRODUCTION

Since the founding of the rift theory, it is found that many internal or external large, super large deposits relate to rifting. For example, the famous superlarge Yunfu troilite deposit, known as submarine exhalative deposit, is located in volcanic rocks in rift. Therefore, the extensive and depressive environment in rift region and on the submarine exhalative mineralization controlled by it, has been paid more and more attention by geologists^[1, 2]. In Yunkai area, the geotectonic environment at Sinian period of later Proterozoic era was an intracontinental geosynclinal-type rift. Its approximate range was that the deep faults zone Wuchuan-Sihui and Bobai-Cenxi were bordered to east and to west respectively, and the region between them extended from Zhanjiang to northern region beyond Yingyangguan at the boundary of Hunan, Guangxi and Guangdong provinces/autonomous region as seen in Fig. 1.

2 BASEMENT

Yunkai area is located on the southern edge of Yangzi terrain at later Proterozoic eon. The terrain's nucleus is the Chuanshong terrain, whose basement emerges only a few. And only in Huangling of west Hubai province does

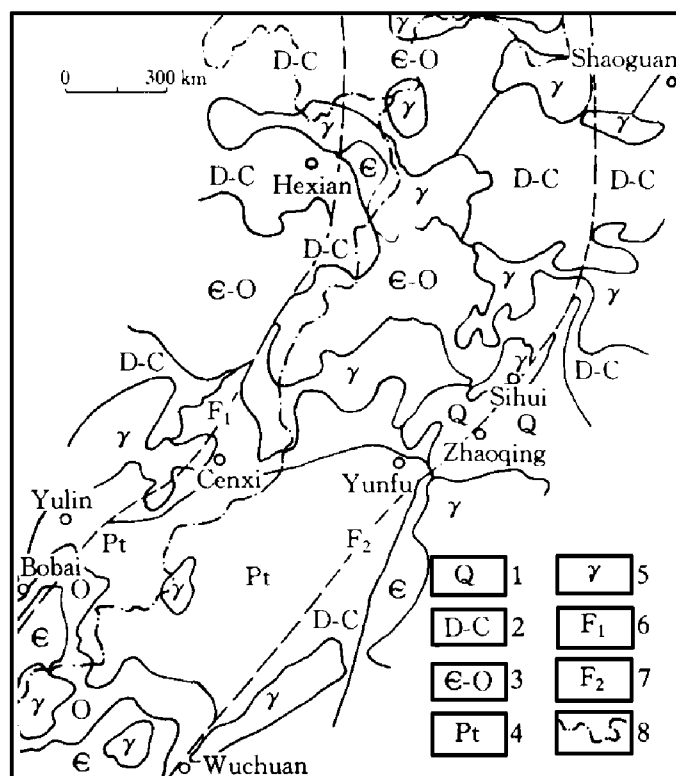


Fig. 1 Geological sample map of Yunkai rift

1—Quaternary system; 2—Devonian system-Carboniferous system; 3—Cambrian system-Ordovician; 4—Proterozoic group; 5—Granitic intrusive; 6—Cenxi-Bobai Faulted Zone (Rift boundary); 7—Wuchuan-Sihui Faulted Zone (Rift boundary); 8—Province boundary

Kongling group emerge, which is primarily made up of biotite plagioclase-gneiss, migmatite and hornblende. Its age (K-Ar) is 1 000~800 Ma, and it is in the metamorphic age of later

① Received Dec. 23, 1996; accepted Oct. 13, 1997

stage obviously. Therefore, it is very possible that Kongling group belongs to later Proterozoic group. Recently, in Shilu region of Hainan province, there discovers biotite hornblende schist, whose age(Sm-Nd) is 1 200~ 1 700 Ma, and the age of metamorphic rocks in north Yunnan is 2 700 Ma. These show that it is an ancient metamorphic basement from the central of Sichuan through Guizhou, Guangdong provinces and Guangxi autonomous region to north Yunnan. And at the boundary of Hunan, Guangdong provinces and Guangxi autonomous region, the southeast edge of Yangzi terrain, there emerge large area middle-upper Proterozoic group of which the middle is Sibao group or Fanjingshan group and the upper is Panchi group of later Proterozoic group. The Panchi group which emerges at Longsheng, Hexian of Guangxi autonomous region has volcanic comination feature similar to island curve. Therefore, Sibao (or Fanjingshan) group and Panchi group (or their equivalent layer) are the rigid basement of Yunkai rift^[3].

3 BORDER

Yunkai rift is strictly controlled by Wuchuan-Sihui deep faulted zone at east side of the "Old land" and Boab-Cenxi deep faulted zone at west side of the "Old land". The deep faulted zone have features as follows^[4]:

(1) Belongs to deep faulted zone of large scale and deep cutting.

Bobai-Cenxi faulted zone consists of the faulted zone Bobai-Tengxian as the northern branch and Luchuan-Cenxi as the southern branch. It starts from Hebu in south and stretches right north of Hexian, and extends along northeast as a whole. The linear feature of the faulted zone on landsatellite images is quite clear, and along the faulted zone, there are not only warm spring as linear distribution but also frequent seismic motion of modern time^[5]. Wuchuan-Sihui faulted zone also is made up of a series of deep faults, and it has feature of "Three in one" (deep fault, basic or ultrabasic rock belt, Skarn-type ore belt of iron ore, porphyry Cu, Mo ore). Many augite rockbodies are found nearby Yangchuan-Xinxing faulted zone, there

are V, Ti and platinum group elements in them. In addition, Gangwei Skarn-type iron ore, Yangchuan porphyry copper ($\delta S^{34} \times 10^{-3}$ is close to meteorite) and Xinxing porphyry copper all distribute along deep fault. It is obvious that they are products come from upper mantle.

(2) On two sides, morphology and geological tectonic are different.

Bobai-Cenxi deep faulted zone is distributed among Mt. Liuwan, Mt. Darong and Mt. Yunkai and is a narrow and long trough valley. In this narrow and long banded region, there often emerge zone of progressive metamorphism or zone of migmatite as kinetic genesis, which were caused by kinetic metamorphism or thermometamorphism, of which the extensive direction agree to the regional tectonic line.

(3) On both sides of the faulted zone, the geophysical feature is obviously different.

In the west side of Bobai-Cenxi faulted zone, there is gentle negative anomaly of aeromagnetic survey, but complexed positive anomaly in the east. Magnetic intensity of faulted zone is great and changes violently. The anomaly shows linear distribution. But on the regional gravity image, the gravity value outside the two faulted zones of Bobai-Cenxi and Wuchuan-Sihui is high, and inside where it is negative anomaly with low gravity value.

4 SEDIMENTARY FORMATION

The sedimentary formation of Yunkai rift, from old to new in order, are as follows: (1) Katametamorphic terrigenous clastic flysch formation, in which, there is ceratophyre formation in Yingyangguan region, and neutral basic volcanic formation in Xinyi, Yunfu region; (2) Peaty carbonatite, sabulous pelitic volcanic clastic formation; (3) Black charcoal pelitic volcanic tuff formation; (4) Black siliceous rock formation. The deposit of rift at initial and middle period generally went through three sedimentary stage: terrigenous clastic facies, continental-oceanic alternating deposits facies, marine facies. During this process, there were often associated volcanic activities. These show that succession of strata of this area coincides completely with the

three sedimentary stages of rift in initial and middle periods. Therefore, the flysch, flyschoid formation, the spilite ceratophyre formation and the neutral acid tuff, carbonaceous shale, siliceous ferruginous rock formation just are the characteristic construction combinations of rift^[6].

5 MAGMATIC ACTIVITY

At northern end of Yunkai rift, the boundary region of Hunan, Guangdong provinces and Guangxi autonomous region, there emerge a series of spilite and ceratophyre formation of Sizhoushan group at later Proterozoic group, of which the epimetamorphic marine volcanic rock series typical. According to the volcanic-sedimentary combined feature, the marine volcanic activity at rifting period expresses two cycles^[7]. Explosive facies characterizes the lower cycle, and it primarily forms volcanic fragmental rock and volcanic breccia lava, also including the eruption of basic spilite; frequent eruption characterize the upper cycle, and it forms basic, neutral basic volcanic complexed rocks. Basic spilite and ceratophyre and also their interbedding are typical. The extensive directions of hypabyssal, ultrahypabyssal rock are almost northeast, and completely coincide with the entire directions of rift and large fault inside, and strictly controlled by rifting. At the same time, in volcanic cycle from lower to upper and even to hypabyssal and ultrahypabyssal rock, the products of volcanic activity show the tendency of evolution from spilite to ceratophyre to diorite. And it reflects the magmatic differential series, of which the volcanic activity of rift from mantle is from ultrabasic and basic to neutral acid. The primitive rocks of quartz sericite schist in metamorphic rock in Yunkai area are equal to liparite. Therefore, from north to south, there appears the symbol of volcanic rock which is typical to rift.

6 REGIONAL METAMORPHIC FACIES AND HEAT FLOW FIELD

In Yunkai area, the metamorphic facies belt, from gneissose facies in under part, is

transferred to green chist facies in the upper part. In metamorphic rock, there are not only middle-level metamorphic minerals (formative temperature is 510~ 710 °C) such as garnet, staurolite, cordierite, but also high-level metamorphic minerals (formative temperature is 700~ 800 °C) such as sillimanite and potash feldspar. Therefore, the range of formative temperature of these metamorphic rocks should be 500 °C to 800 °C. According to differentiation of regional metamorphism of Ducheng Xinsui, it belongs to low pressure type where there emerge the metamorphic facies of constitutes including biotite, cordierite, staurolite and sillimanite. The temperature gradient of its formative process is high and generally is 25~ 60 °C/km. Such a high earth temperature and temperature gradient reflect that this area belongs to high temperature heat flow region. And such a low pressure and high temperature heat flow anomaly region is just one symbol of rifting region.

7 REGIONAL GEOPHYSICAL FIELD

Yunkai area is low gravity anomaly region. Along Zhanjian, Xinyi, Luoding, Fengkai, Huaiji and Lianxian, there have several obvious negative value belts. According to the relation that the low gravity anomaly belt corresponds to seg of upper mantle, these several segs of upper mantle are distributed paternosterly along northeast direction, and form the seg belt of mantle. It approximately reflects the extensive direction and range of rift. In addition, the Wuchuan-Sihui mantle-slope belts correspond to gravity gradient, and they are just where the Wuchuan-Sihui deep fault are. Therefore, the gravity anomaly belt, the distribution of sedimentary formation, edge faults and so on, are completely identical, and all reflect the existence of old rift.

8 MINERALIZATION

The sedimentary center of Yunkai rift must be in Yunkai-Luoding region between the two rifts of Shonggu-Jiayi and Wuchuan-Sihui. The famous Yunkai tourmaline deposit as the marine exhalative genesis is just formed under this envi-

ronment. There are volcanic clastic rocks of explosive facies formed due to the regmagensis of step basement in rift belt, and associated with limestone, sand-mud stone formation of bathyal facies. In some region, exhalative deposit happened in the third-level basin which is caused by multidirectional syngenetic rift, and formed the pyritic carbonaceous shale formation and the pay siliceous rock formation concerned to marine exhalation^[8, 9].

9 EVOLUTIONAL HISTORY

During the early development phase of rift, the earth crust grew thinner for the uplifting of the mantle bottom, and the extensive rift was formed. Then a series of NE deep fault were formed on geosynclinal rigid basement of Proterozoic era, especially the two typical faulted zones of Wuchuan-Sihui and Bobai-Cenxi. The lateral extension produced by opposing flow of mantle made the two faulted zones moved at opposite direction and settled differentially, and formed asymmetric fault through basin. It was the beginning of Yunkai rift.

During middle rifting period, at the beginning of Palaeozoic era, the rift was completely mature. The whole earth crust descended and then happened quite great ingression. The narrow long rift changed into "Extensive sea basin". The rift itself and its two sides accepted deposit of early Palaeozoic group at the same time. But at last stage of Cambrian period, some local region (for example, Luoding) had once emerged above the water, which is called Yunkai movement, and formed the parallel unconformity between Cambrian system and Ordovician system.

By the last stage of early Palaeozoic era, the development of Yunkai rift entered last stage. This time the lateral compression caused by reversing of rift led to intense compression and cut-

ting (correspond to Caledonian movement) in the rifting region and on its two sides. Sinian system and later Palaeozoic system happened tight fold, nonaffine elevation and subsidence at the same time, then are sustained denudation. While nearby the edge fault of rift, the strata often were associated with violent kinetic metamorphism, even the migmatite formed. By middle Devonian epoch, the strata of later Palaeozoic group nearby the rifting region had been disintegrated locally, while the strata of early Palaeozoic group of rift itself had completely disintegrated. By that time, this region entered platform stage, the earth crust settled down two times and accepted deposit of strata after Devonian, and Yunkai rift had completely closed and finished its history of birth, development and ending.

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(Edited by He Xuefeng)