Identification and determination of the boundary between the Cathaysian and Yangtze blocks: a preliminary understanding of gravity and magnetic fields

Jiayong Yan[1,2],Kun Zhang[1,2],Guangming Fu[3,1],Fan Luo[3,1],Hao Wang[1,2],Guang Qi[1,2]

[1]China Deep Exploration Center (SinoProbe Center), Chinese Academy of Geological Sciences, Beijing, 100037, China, yanjy@163.com

[2]MLR Key Laboratory of Metallogeny and Mineral Assessment, Institute of Mineral Resources,CAGS，Beijing, 100037, China

[3]School of Geophysics and Measurement-control Technology，East China Institute of Technology，Nanchang 330013, China

1 Introduction

The South China continent has undergone a multiphase tectonic evolution since its formation. Many important basic problems are still debated because of the superposition and reconstruction of many tectonic-magmatic events in later periods. However, views are sharply divided on the problem of suture zones in the Yangtze and Cathaysia block. The focus is on the existence of oceanic basins. Where is the Cathaysian Block (remnant)? Since Yangtze and Cathaysia are mostly covered by strata since the late Paleozoic, direct contact is rare (Hu Z., 2010), and in spite of long-term research there is still controversy. The focal point is whether the ancient South China Ocean and the Cathaysian ancient land existed. Shuitou et al. (1988) considered that the Jiangxi-Hunan-Guangxi-Guangdong basin between the Cathaysian and Yangtze blocks was a residual oceanic basin. Jin WS et al. (1997) suggested that there may not have been an oceanic basin between Cathaysia and the Yangtze block, and that since the Paleoproterozoic the tectonic framework of South China has generally been dominated by intracontinental rifting or the tectonic setting of the Inner Silicon-Aluminum Basin. In recent years, the Jiangshan-Shaoxing-Pingxiang fault zone has been generally recognized as the collision zone between Yangtze and Cathaysia. However, the Jiangshan-Shaoxing-Pingxiang fault zone, which extends to the southwest of Hunan and Guangxi, has a zonal distribution with at least three faults of similar scale and lacks ophiolite markers and is not typical as the joint zone of blocks. Some authors believe that there has never been an ancient Chinese continent (Pan GT et al., 2009). Some authors admit that there is an old basement, but do not think there is an ancient land mass. Yang MG et al. (2009) suggested that there was a Cathaysian paleoblock, but for a long time no remnant was found because the remnant was fragmented shortly after its formation. After investigation and study in recent years, Yang MG et al. (2012) proposed that the Xinjiang-Qiantang landmass and Guangfeng micro-landmass were the large-scale remnants of the Cathaysian landmass, the core of the Jinning Cathaysian block.

The above understanding of the block tectonic framework depends largely on the interpretation of deep seismic sounding profiles and magnetotelluric profiles in the 1980s-1990s. However, due to the limitation of instruments and equipment, technical methods and costs at that time, the resolution of these old deep-seated data is relatively low, and there are also great uncertainties in themselves, which need to be verified by high-resolution seismic observations. In order to define the boundary, scope and structure of the Qin-Hang junction zone, the boundary of the Cathaysia-Yangtze junction zone was studied and determined by comprehensive processing and analysis of regional large-scale satellite gravity and magnetic data with the support of deep geological survey.

2 Data & method

Because land gravity is difficult to carry out in difficult areas such as waters and high altitudes, the land gravity in mainland China has not yet been fully covered and can not provide a complete dataset for large-scale research. Satellite gravity is a free-air anomaly with a wide coverage area and convenient data acquisition. By adding topographic correction and subtracting the correction value of the middle layer, the ground Bouguer can be solved (Huang ZG ,2016). The results show that the accuracy of the satellite gravity anomaly is equivalent to 1:500,000 scale of the ground gravity anomaly. Through the calculation of satellite gravity, most of the Bouguer gravity anomalies in South China are obtained, which make up for the blank area (water area and sea area) of ground gravity surveys and provide complete data support for large-scale gravity field research in South Chian. The magnetic anomaly is based on the global magnetic anomaly data set EMAG2, which was compiled by satellite, ship and aeromagnetic survey. EMAG2 is the world's first satellite magnetic anomaly

DEEP-2018

grid EMAG 3 upgrade, mesh spacing from 3 (radian) (about 5.5 km) to 2 (about 3.7 km), height from 5 km to 4 km, merging time for 2009.

In this study, the multi-scale edge detection method was used to extract gravity and magnetic boundaries and to identify fault structures within the study area. Multi-scale edge detection of gravity and magnetic data (Hornby et al., 1999) is also known as WORMS as it took the shape of worms, and several studies have been conducted based on the theories and applications of WORMS by Archibald et al. (1999), Holden et al. (2000) and Austin et al. (2008). The result of WORMS is composed of the maximum value of horizontal derivatives of gravity and magnetic data with different prolongation heights. The location and intensity of the gradient field are constrained by the analysis, and the result can be interpreted as the 3D distributions of geological structures. Lines, the so called WORMS lines or wiring harness, are created by the connection of points with different prolongation height using certain logic rules. The accuracy of the boundary locations represented by WORMS decreases as the prolongation height increases (Archibald et al. 1999).The magnetic anomalies are used as the initial input data. The continuation height can be set based on the scale of the study area and the maximum value. The maximum continuation heights are given by the upward continuation of the initial data at different heights. The shape of anomalies will change as the continuation height changes. When the height reaches the maximum continuation height values, anomalies will stop changing or have slight changes. The minimum up continue height changes according to the research purpose. Logarithm spacing is used to distribute the continuation heights uniformly. The maximum value detection can be carried out using the Blackly rule or the Canny rule. Comparison between every point and its surrounding points will be conducted by using a slicing windows algorithm. When the value of the point is larger than all the values of the surrounding points, the point will be preserved. After detection of all maximum points, lines will be created by connecting these points based on their logical topologies (such as the minimum distance between adjacent point and the minimum points to create a line). These lines represent geological boundaries at various depth scales.

3 Result & discussion

Multiscale edge detection of gravity and magnetic data in South China is shown in Figs 1 and 2. They reflect abundant information on structure and rock mass in South China. Linear detection lines are mostly the reflection of fault and block boundaries, and ring detection lines are mostly the boundaries of rock mass and basin. This paper mainly focuses on the block boundary. As can be seen from Fig. 1, there is a continuous and obvious line bundle along Ningbo-Jinhua-Shangraonan-Ganzhou North-Chenzhou-Linwu-Wuzhou-Yulin East-Beihai East. The north-east section of the line is consistent with the Jiangshao fault and the middle section of the Chenzhou-Linwu fault. We think that the fault F1 should be the southern boundary of the Qinhang junction zone. Crack. There is a continuous line harness along the Suzhou-Huzhou-Hangzhou-Quzhou-North-Yingtan-Linchuan-Xinyu-Pingxiang-Hengyang-Leiyang-Yongzhou-Guilin-Wuzhou-West-Yulin-Qinzhou line. From the angle of wire harness amplitude strength, the cutting depth of F1 is greater than that of F2, and the shape is more complete, which indicates that F1 may be the main boundary representing subduction of Cathaysian block beneath the Yangtze block. Along Nanjing-Xuanzhou-Huangshan-Jiujiang-Xianning-Yiyang-Huaihua-Liuzhou-Nanning, there is also an obvious line bundle, which is staggered by a NW-striking fault near Nanning. We believe that the line bundle is a boundary fault F3 composed of several faults. According to the results of magnetic anomaly edge detection, the trend of the magnetic anomaly on the north side of F3 is mostly NW, and on the south side is mostly NNE and N-S, reflecting the different magnetic background of the two blocks. A comprehensive analysis shows that the F1 and F3 are the Jiangnan orogenic belt, that is, the combined boundary of the Cathaysia and Yangtze blocks.

Acknowledgments

DEEP-2018

This study is supported by the National Key R&D Program of China (NO. 2016YFC0600101), the China Geological Survey Project (NO. DD20160082) and the National Natural Science Foundation (No. 41574133 , No.41630320)

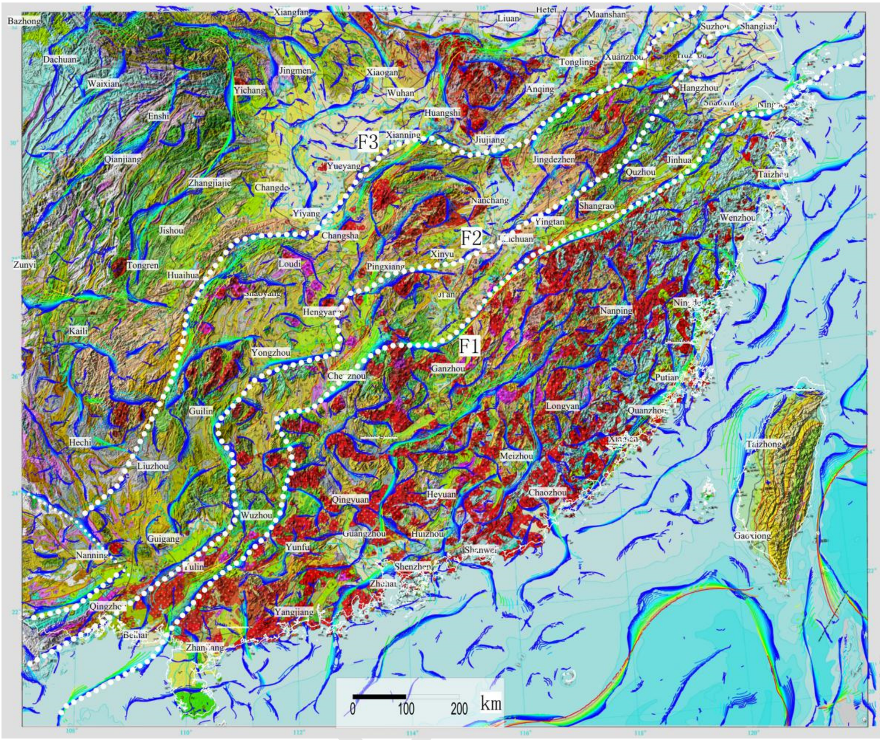

Figure 1. Multi-scale edge detection result of gravity anomalies of South China (the color change of lines from blue to red means the changing of structural depth from shallow to deep).

DEEP

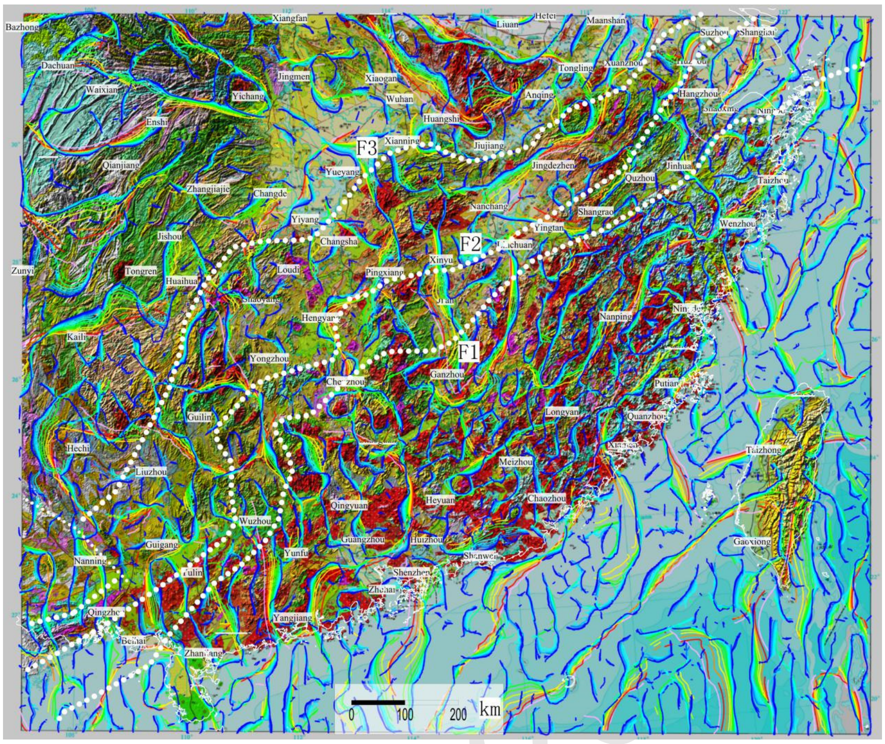

Figure 2. Multi-scale edge detection result of reduction to the pole magnetic anomalies of South China (the color changing of lines from blue to red means the changing of structure depth from shallow to deep)

DEEP-2