Characteristic of Fault Structures in the south coastal Zone of Taizhou Based on High-Precision Aeromagnetic Data

Ming Wang1,2, Xiaoxing Lin1,2, Jiaojiao Li1,2, Yongjun Zhang1,2

1 China Aero Geophysical Survey and Remote Sensing Center for Natural Resources, Beijing, China
2 Key Laboratory of Airborne Geophysics and Remote Sensing Geology of MNR, Beijing, China;
Email: hushuanggui808@csu.edu.cn

Abstract. The south coastal zone of Taizhou lies on the magmatic rock belt of southeast coast of China, which has complex regional geological structure, intense tectonic movement and frequent magmatic activities. Based on the latest high-precision aeromagnetic data, integrated interpretation was completed, combining with regional geology, regional gravity and magnetic susceptibility information. According to the block features in different zones of the RTP aeromagnetic data, the magnetic field characteristics and the relationship with the structure division were described in detail. It showed that the different characteristics of magnetic field is the concentrated reflection such as tectonic movement, magmatic activity and stratigraphic distribution, and the fault structure was inferred and studied, especially the deep and large fault structures. The fault structures were mainly distributed in NE, NNE and NW direction, with approximately equal spacing distribution. The magnetic anomaly is mainly characterized by the boundary, gradient zones and beaded anomalies in different magnetic field. The faults act not only as the important tectonic boundaries in this region, but also the important tectonic belts, controlling the distribution of mineralization. Under the interaction of these faults, they form the basic structural pattern of East-West zone and North-South block; Among them, the NE faults have the largest scale and obviously control over different magnetic field and magmatic activity. The results presented in the paper can provide reference for further study on the distribution and activity characteristics of magmatic rocks in the coastal zone.

1. Introduction

Compared with other geophysical measure, Aeromagnetic survey, as one of the important geophysical measures to perspective the geological deep structure information, not only covers well-distributed, but also is subjected to the minimum interference from the surface topography and has a strong penetration ability [1]. These characteristics make it possible to study the geological structure by using the regional aeromagnetic data. Many scholars at home and abroad have widely used regional aeromagnetic data to study the fault structure features, and obtained a series of research results [2-14].

The southeastern coastal magmatic belt of China is an important part of the coastal Pacific magmatic belt, which is the focus and hotspot of Geosciences [15-22]. At present, Many scholars at home and abroad still have great differences on the formation of the belt's dynamic mechanism, tectonic environment and evolution [23-34]. Using aeromagnetic data to delineate the magmatic belt can provide important clues for further study of the corresponding geological problems [35-36].
2. Regional Geological Outline
The study area is located in the southeast coastal magmatic rock belt of China, which is generally distributed in NE direction and parallel to the coast, covering an area of 320,000 square kilometers. The southeast coast is located in the southeast of South China plate, which is located at the junction of South China plate, India plate and Pacific plate. It evolved from the Cathaysian Old Land, and experienced the formation and breakup of the Cathaysian Old Land, the collision and amalgamation of the Yangtze and the Cathaysian plate, and the interaction stage between the Pacific plate and the Eurasian plate [37], which has undergone multiple-epoch structural movements as a result of regional geologic structure complexity, intense tectonic activity and magmatism frequency, of which the Mesozoic Magmatic Activity is the largest in scale.

Magmatic activity is closely related to the collision of Yangtze plate and Cathaysian plate in Jinning, Caledonian and Indosinian epoch, and the subduction of the Pacific plate during the Mesozoic; magmatic activity is closely correlated with tectonic movement, and magmatic rocks of different ages and origins are obviously zoned. From the Proterozoic Era to the Cainozoic Era, the intensity of magmatic activity gradually strengthened, reaching the peak in Yanshanian period, becoming weak in Cenozoic, and very active in Mesozoic Magmatic Activity and tectonic activity, most of which are distributed in coastal areas of Zhejiang, Fujian and Guangdong, with complete rock types, ranging from ultrabasic-ultraacidic and alkaline rocks, with intermediate acid rocks as the main body, and granite as the intrusive rock [38].

The southeast coastal area has complex geological structure and well-developed faults which is mainly EW direction, NE direction and NW direction. In the period of neotectonic movement, they all have different levels of activity, forming the tectonic active belt of the continental margin in the southeast coastal area. The main faults in the area are Lishui-Zhenghe-Dapu fault zone and Changle-Nan'ao fault zone. These two major faults established the basic pattern of regional structure. They are both the boundary faults of Pre-Mesozoic basement and the regional division faults of structural units. Because of the deep dissecting depth of the faults, they can provide favorable pathways for the underplating of upper mantle basaltic magma and the induced migration of granitic magma, which controls the distribution, scale and occurrence of the regional Mesozoic and Cenozoic magmatic rocks [39,40].

On the aeromagnetic anomaly field map, the magmatic rock belt in the southeast coast is a large-scale strong magnetic anomaly belt distributed in NE direction. The local anomalies in the belt is mainly NE direction, with many anomalies and large intensity. It is an important part of the active continental-margin of East Asia in Late Mesozoic. The magnetic field with different characteristics is a comprehensive reflection of geological structure, magmatic activity and stratigraphic distribution.

3. Regional Aeromagnetic Characteristics
Throughout the 1:500000 aeromagnetic anomaly map of the coastal zone in the south of Taizhou, the magnetic field is characterized by rich information, clear appearance, obvious characteristics and strong regularity, showing a number of different magnetic field background and the division of the magnetic anomaly; Compared with the characteristics of the adjacent magnetic field, the overall magnetic field in the studying area is strong and peculiar. Taking Heyuan-Huilai as the boundary, the magnetic anomaly difference on the north and south sides of the studying area is very different. In the north of the boundary, the magnetic field intensity of local magnetic anomalies is generally 50~200nt, and the maximum is 350nt. The gradient is steep, and the intensity is also high. The regional anomaly is banded, and the anomaly trend is mainly NE and NW, followed by EW; The magnetic anomalies were belt-like distributed, the trend is mainly NE and NW, locally EW magnetic field pattern; The stratas exposed in this area are completely developed and magmatism is violent. The stratas and igneous rocks are mainly distributed in NE and NW directions, The depth of the magnetic basement is shallow, and the positive magnetic field background is the reflection of weakly-magnetic acid igneous rocks and epimetamorphic rocks, the NE and NW trending high-strength aeromagnetic anomaly zones are the reflection of intermediate-acidity igneous rock body with magnetism or the basic igneous rock body with strong
magnetism. But on the other side, the overall magnetic field changes smoothly, and the magnetic anomalies associated with positive and negative appear in the appearance of groups and belts correspond to the well-developed granites. The main trend of magnetic anomaly zone is NE direction, NEE direction and near EW direction, and it is mainly affected by the weakly magnetic granites or rock bodies contact zone where alteration and mineralization. The minority rock bodies are associated with positive and negative magnetic anomalies, corresponding to the lower gravity anomalies, forming gravity and magnetic homologous anomalies; However, most of the rock bodies surrounding rock contact zone have local magnetic anomaly response, some of which are characterized by circular distribution. There are distinct differences between the complex magnetic anomaly area in the southeast and the gentle variations magnetic anomaly area in the west, which reflects the differences in the developing degree of basement and magmatic rock between the structural units I of the Yangtze plate and the Cathaysian plate.

Hainan is located in the southern end of the studying area, with complex magnetic anomalies; Based on the analysis of the distribution characteristics of the deep magnetic field, the magnetic field area to the west of Hainan reflects the small-scale crustal block formed by the dissecting of multiple groups of faults; In the composite part of multiple groups of faults, the strong granitization of the crust leads to the low magnetic anomaly. On the other side, the magnetic field shows that the structure is dominated by NE and EW directions, and the strong activity of the faults leads to the strong granitization of the crust from Tunchang to Wanning area [41]. Therefore, the aeromagnetic anomaly has the characteristics of zonal block, varied form and great difference in strength and weakness.

According to the characteristics of zonal block, gradient change and the spatial distribution, trend, shape, property of the RTP aeromagnetic data, combined with regional geologic data and geophysical characteristics, the great deep fault belt confirmed by geology or the gradient belt, variation belt and linear anomaly belt reflected by gravity and magnetic are taken as the boundary, the studying area is divided into five areas with different magnetic characteristics from north to South (Figure 1): (I) positive and negative changing magnetic field area of Zhejiang-Fujian-Guangdong; (II) negative magnetic field area of Huilai-Shanwei-Longmen; (III) flat-increasing magnetic field area of Sanshui-Gaozhou-Fangcheng; (IV) the positive and negative changing magnetic field area along the south coast of Guangdong; (V) complex magnetic field of Hainan.

![Figure 1](image_url)

**Figure 1.** Magnetic field of the coastal zone in the south of Taizhou based on aeromagnetic data (RTP)
4. Fault structures reflected by Aeromagnetic

The studying area is located in the Mesozoic-Cenozoic volcanic rock belt along the southeast coast of China. The fault structure reflected by aeromagnetic is relatively obvious, mainly distributed in the boundary line and magnetic anomaly gradient belt of different magnetic field divisions.

According to the principle of fault delineation, magnetic anomaly indication and magnetic anomaly characteristics, based on aeromagnetic characteristics, combined with gravity and geological data, through comprehensive analysis and research, 26 large-scale faults are inferred, including 7 regional large and deep faults (Figure 2).

![Image of fault structures](image)

**Figure 2.** Main faults distribution inferred from aeromagnetic data of the coastal zone in the south of Taizhou

In this paper, the overall fault structure is mainly distributed in NE, NNE and NW directions, and the faults with approximately equal spacing distribution are reflected as linear abnormal zones and there are some relatively small faults in SN, EW directions and arcuate faults between them; Under the interaction of this series of faults, the basic structural pattern of East-West zoning and South-North blocking is formed.

The large and deep faults of aeromagnetic inference have obvious characteristics not only in the original magnetic field map, but also in the magnetic field conversion and processing map and the gravity anomaly map, which have the characteristics of long extension and deep dissection. The NE faults have the largest scale and have obvious control over the magnetic field division, sedimentary formation, magmatism and metamorphism; The NW faults control the magmatic activity to a certain extent; the other faults are small in scale, limited in extension and controlled by NE and NW faults in spatial distribution.

The main large and deep faults are Yongtai-Wenling fault, Xiamen-Dongshandao fault, Fangchen fault, Wuchuan-Sihui fault, Qiongzhou Strait fault, Haifeng-Hongkong fault and Sanya fault.

5. Conclusions

Aeromagnetic data of the coastal zone in the south of Taizhou, the magnetic field is characterized by rich information, clear appearance, obvious characteristics and strong regularity, showing a number of different magnetic field background and the division of the magnetic anomaly. The magnetic field with different characteristics is a comprehensive reflection of geological structure, magmatic activity and stratigraphic distribution. Using aeromagnetic data to study the characteristics of magnetic field and the fault structure provides an important geophysical basis for the further study of the dynamic mechanism, tectonic setting and evolution law of the formation of the coastal magmatic belt.
Acknowledgments
Supported by the National Key Research and Development Program of China (2017YFC0602204-05). Investigation and application of airborne geophysical remote sensing in Bohai Coastal Zone (DD20160150).

References
[1] Crawford B, Betts P and Laurent A 2010 An aeromagnetic approach to revealing buried basement structures and their role in the Proterozoic evolution of the Wernecke Inlier, Yukon Territory, Canada *Tectonophysics* **490** 28-46
[2] Gilder S, Gill J and Coe R 1996 Isotopic and paleomagnetic constraints on the Mesozoic tectonic evolution of south China *Journal of Geophysical Research* **101** 137-154
[3] Guo F and Yuan, K 1996 Geotectonic Background and Metamorphic Phases of the Formation of the Changle-Nan'ao Metamorphic Belt *Journal of Guilin Institute of Technology* **16** 102-108
[4] He R, Gao R and Zheng H 2007 Matched-filter analysis of aeromagnetic anomaly in mid-western Tibetan Plateau and its tectonic implications *Chinese Journal of Geophysics* **50** 1131-1140
[5] He R, Gao R and Zheng H 2007 Aeromagnetic Anomaly of Subtle East-West Striking Faults in the Central Tibet and Its Significance *Journal of Jilin University(Earth Science Edition)* **37** 1002-1008
[6] Huang H, Guo K and Li S 1993 Study on the Basic Characteristics of the Changle-Nan'ao Faulted Belt and Pingtan- Dongshan Folded Belt in Fujian Province *Geological of Fujian* **12** 48-67
[7] Hsü K, Li J 1998 Mesozoic overthrust tectonics in south China *Geology* **16** 418-421
[8] Jahn B, Zhou X and Li J 1990 Formation and tectonic evolution of southeastern China and Taiwan: Isotopic and geochemical constraints *Tectonophysics* **183** 145-160
[9] Jahn B 1974 Mesozoic thermal events in Southeast China *Nature* **248** 480-483
[10] Li X 2000 Cretaceous magmatism and lithospheric extension in Southeast China *Journal of Asian Earth Sciences* **18** 293-305
[11] Li Z, Li X and Lin J 1999 On the Meso-Cenozoic Mantle Plume Tectonics, Its Relationship to Uranium Metallogenesis and Prospecting Directions in South China *Uranium Geology* **15** 9-34
[12] Li Z and Li X 2007 Formation of the 1300 km-wide intracontinental orogen and postorogenic magmatic province in Mesozoic South China- A flat-slab subduction model *Geology* **35** 179-182
[13] Li Z, Li X and Chung S 2012 Magmatic switch-on and switch-off along the South China continental margin since the Permian: Transition from an Andean-type to a Western Pacific-type plate boundary *Tectonophysics* **532** 271-290
[14] Ling M, Wang F and Ding X 2009 Cretaceous ridge subduction along the lower yangtze river belt, eastern china *Economic Geology* **104** 303-321
[15] Liu Y, Yu X and Li J 2007 Magnetic Characteristics of Different Types of Granite in Southeast Coastal area of China *Geophysical & Geochemical Exploration* **31** 526-528
[16] Mao J, Tao K and Xing G 1999 Petrological Records of the Mesozoic-Cenozoic Mantle Plume Tectonics in Epicontinental Area of Southeast China *Acta Geophysica Sinica* **20** 254-259
[17] Mao J, Yutaka T and Li Z 2009 Correlation of Meso-Cenozoic tectono-magmatism between SE China and Japan *Geological Bulletin of China* **28** 844-856
[18] Mao J 2013 Meso-Cenozoic Magmatism and Mineralization in Southeast China and its adjacent areas Science Publishing. Okuma S, Stotter C and Supper R 2009, Aeromagnetic constraints on the subsurface structure of Stromboli Volcano, Aeolian Islands, Italy: *Tectonophysics* **478** 0-33
[19] Osinowo O, Akanji A and Olayinka A 2014 Application of high resolution aeromagnetic data for basement topography mapping of Siluko and environs, southwestern Nigeria *Journal of African Earth Sciences* **99** 637-651
[20] Qu G and Wang S 1997 Aerial magnetic anomaly-tectonic interpretations in mainland continent
and their adjacent seas of China *Scientia Geologica Sinica* 32 455-464
[21] Shu L, Yu J and Wang D 2000 Late Mesozoic Granitic Magmatism and Its Relation to Metamorphism-Ductile Deformation in the Changle-Nan’ao Fault Zone, Fujian Province *Geological Journal of China Universities* 6 368-377
[22] Shu L and Wang D 2006 A Comparison Study of Basin and Range Tectonics in the Western North America and Southeastern China *Geological Journal of China Universities* 12 1-13
[23] Sun W, Ling M and Yang X 2010, Ridge subduction and porphyry copper-gold mineralization—An overview *Science China(Earth Sciences)* 53 475-484
[24] Tzanis A, Kranis H and Chailas S 2010 An investigation of the active tectonics in central-eastern mainland Greece with imaging and decomposition of topographic and aeromagnetic data *Journal of Geodynamics* 49 55-67
[25] Wang D, Zhou J and Qiu J 2000 Characteristics and petrogenesis of Late Mesozoic granitic volcanic-intrusive complexes in southeastern China *Geological Journal of China University* 6 487-498
[26] Wang Y, Jiang M and Xiong S 2006 Delamination of the lithosphere below the West Kunlun and its tectonic implications—evidence from Seismic tomographic images and aeromagnetic anomalies *Geology in China* 33 299-308
[27] Wang T, Xu M and Wang L 2007 Aeromagnetic anomaly analysis of Ordos and adjacent regions and its tectonic implications *Chinese Journal of Geophysics* 50 163-170
[28] Wu G, Zhang D and Peng R 2014 Study on The Evolution Regularity of Mineralization Ages in Southeastern China *Earth Science Frontiers (China University of Geosciences)* 11 237-247
[29] Xie D, Ma R and Zhang Y 1997 Crustal growth process and mantle plume structure in Southern China continent *Volcanic Geology and Mineral Resource* 94
[30] Xie D, Mao J and Peng W 1997 The Rock Strata of South Chian and Continental Dynamics *Acta Geophysics Sinica* 153-163
[31] Xie G, Hu R and Zhao J 2001 Matle Plume and The Realntship Betewen It and Mesozoic Large-Scale Metallogenesis in Southeastern China-A Preliminary Discussion *Geotectonica et Metallogenia* 25 179-186
[32] Xiong S, Fan Z and Huang X 2013 A report on the application of magnetic data for the national mineral resources potential assessment project *China Aero Geophysical Survey and Remote Sensing Center for Land and Resources*
[33] Xiong S, Ding Y and Li Z 2015a Map of Magnetic Basement Depth in Chinese Continent (1:2,500,000) *Geological Publishing House (in Chinese)*
[34] Xiong S, Ding Y and Li Z 2015b Map of Regional Structure in Chinese Continent (1:2,500,000) *Geological Publishing House (in Chinese)*
[35] Xiong S, Tong J and Ding Y 2016 Aeromagnetic data and geological structure of continental China-A review *Applied Geophysics* 13 227-237
[36] Xiong S, Yang H and Ding Y 2018 Subdivision of tectonic units in China based on aeromagnetic data *Geology in China* 45 658-680
[37] Yang H, Liang Y 2013 Nationwide aeromagnetic ΔT anomalies and China's geoscience block structures *Geophysical and Geochemical Exploration* 37 957-967
[38] Zhang Y, Lao Q and Li Y 1999 Tectonic implication of aeromagnetic anomaly and evolution of Huabei-South Tarim- Yangtze superlandmass *Earth Science Frontiers* 6 379-390
[39] Zhou X 2003 My thinking about granite geneses of South China *Geological Journal of China Universities* 9 556-565
[40] Zhou X and Li W 2000 Origin of Late Mesozoic igneous rocks in Southeastern China: Implications for lithosphere subduction and underplating of mafic magmas *Tectonophysics* 326 269-287.
[41] Zhu Y 2013 Tectonic and Deep Structure of China and Its Adjacent Area-preliminary Interpretation of Aeromagnetic Map of China(1:1000,000) *Geological Publishing House*