The structure of the northern Qin-Hang belt from 3D gravity inversion

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There is a metallogenic belt from Qinzhou Bay to Hangzhou Bay, often referred to as the Qin—Hang metallogenic belt, which is a famous tectonic unit in South China and is also important because it is rich in mineral resources. According to a tectonic pattern, the Qin—Hang metallogenic belt roughly corresponds to the Yangtze plate in the northwest and the Cathaysian plate in the southeast, and the two major tectonic plates play a great role in continental crust reconstitution and searching for mineral resources. Therefore, many scholars have been attracted to this area (Yang e*t al.,* 2009; Zhang e*t al.*, 2009; Zhou *et al.*, 2012). Based on the integrity and internal heterogeneous structure, this metallogenic belt has been divided into three segments namely north, middle and south by Yongzhang Zhou (2012). In fact, due to strong magmatic activity, a complex tectonic and dynamic evolution, and stacked sheets in this region, vegetation coverage is also very extensive. Consequently, the overall geological background of the Qin-Hang metallogenic belt is not clearly understood. As a density anomaly model by 3D inversion can serve to extend our knowledge about the Moho topography and crustal density structure across the margin and provide a better framework for understanding the geodynamics of rifting (Williams e*t al.*, 2004; Oldenburg e*t al.*, 2007; Welford e*t al.*, 2007; Lü, e*t al.*, 2015), we have undertaken 3D gravity inversion of the bouguer anomaly data to generate a 3D density anomaly model of the region. This study chooses the northern section of the Qin-Hang belt at 27.6°N-31°N, 116.4°E-121°E as our research area.

According to regional geology and other data, including surface geology, magnetotelluric (MT) and seismic reflection results, we have a general knowledge of the lithology, structure, physical properties, chronology of major rock units, and distribution of major ore deposits. Distinct strata belong to the Yangtze and southeast China, whose lithology involves metamorphic volcanic and sedimentary rocks, and the basement consists of ancient Mesoproterozoic strata. Major metamorphic facies are greenschist or low-grade amphibolite. Magmatic rocks are abundant and widely distributed. Here volcanic rocks are mainly early Cretaceous felsic rocks, and intrusive rocks mostly consists of early Yanshan granites (I). The depth of basement is about 8 km, and the surface of Moho lies around 32 km deep. There are some basic—ultrabasic magmatic rocks emplaced in the 220 ~ 250 Ma period, and granites in the Yanshan period provide certain information on their mantle source. This information can provide a powerful basis for subsequent inversion interpretation.

With gravity observation data to obtain a subsurface 3-D density anomaly distribution (relative to a background density of 2670 kg/m^{-3}) below the observation locations, the method of physical property inversion is popular, which has two algorithms, one unstructured and one structured. They are similar but different, since the unstructured algorithm adopts a tetrahedral mesh unit, and the structured algorithm uses a hexahedron rectangle mesh grid. Details can be found in the literature (Li, *et al.*, 1998; Farquharson, *et al.*, 2008, 2009; Lelièvre, *et al.*, 2012, 2013). In our study the unstructured method of Peter G. Lelievre (2013) from the Department of Earth Sciences, Memorial University of Newfoundland and the structured method with the GRAV3D modelling algorithm developed by Li and Oldenburg (1998) from the Geophysical Inversion Facility, University of British Columbia (abbreviation UBC - GIF) have both been used. The unstructured inversion parameters are as follows: the space of observation data is 5000 meters, and weighting factor lambda is 1.0×10^{-5}. The maximum lambda step is 1000 and we take constant boundary constraints. First, the mesh units were determined with some nodes, surfaces and blocks. The final mesh was constructed from many tetrahedrons with lateral dimensions of 350×345 km and 40 km deep. The structured inversion parameters are as follows: the space of observation data is also 5000 meters. The final mesh was constructed from cubes with lateral dimensions of 350×345 km and 45 km deep, including 20 km deep as the centre and 25 km deep as a neighbor. These two methods both consider local topography.

Analyzing the two inversion results, they look very similar in their main characteristics. Five parts can be discriminated from the gravity anomalies, including three high anomaly value areas lying in the west, the north and the east; two low anomaly value areas, one is in the Jiangnan uplift belt in the middle of the research area and the other lies in the southern Wuyi Mountains. This reflects the structural style of the study area from the southern sag to a smooth transition, finally uplifted around three sides, which demonstrates the typical characteristics of the Cathaysia plate diving into the Yangtze plate, and further can be divided into five geological blocks. Furthermore, the main fractures can be identified with inversion results. Particularly, the Jianshan—Shaoxing (JS) fault between the Yangtze plate and the Cathaysian plate can be clearly defined. The JS fault begins at Pingxiang, passes through Jiangshan, and ends in Shaoxing, which also goes through the upper crust and basement, extending to the Moho, its depth is roughly 40 km. There are two control faults in the JS fracture, one is a high angle fault in the north and the other is a low angle fault in the south. This matches the regional geological tectonic evolution on Cathaysia plate subduction, first division, then thrust on the Yangtze plate. Additionally, since the JS fault zone is developed in different rocks on the north and south sides, and there is a widespread distribution of magmatic rocks, this is caused by tectonic movements and large-scale magmatic activity. Overall, the results provide a unique perspective of the regional structure and present further constraints for future tectonic deformation and metallogenic dynamics.

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