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Gravity distribution characteristics and their relationship with the distribution of earthquakes and tectonic units in the North–South seismic belt, China

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ABSTRACT

The North–South Seismic Belt (NSSB) is a Chinese tectonic boundary with a very complex structure, showing a sharp change in several geophysical field characteristics. To study these characteristics and their relationship with the distribution of earthquakes and faults in the study area, we first analyze the spatial gravity anomaly to achieve the Bouguer gravity anomaly (EGM2008 BGA) and the regional gravity survey Bouguer gravity anomaly. Next, we ascertain the Moho depth and crustal thickness of the study area using interface inversion with the control points derived from the seismic and magnetotelluric sounding profiles achieved in recent years. In this paper, we summarize the relief, trend, Moho gradient, and crustal nature, in addition to their relationship with the distribution of earthquakes and faults in the study area. The findings show that earthquakes with magnitudes greater than Ms7.0 are mainly distributed in the Moho Bouguer anomaly variation belt and faults. The results of the study are important for future research on tectonic characteristics, geological and geophysical surveys, and seismicity patterns.

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1. Introduction

The North–South Seismic Belt (NSSB) is located on the eastern margin of the Tibetan Plateau, known as the third pole and the roof of the world. It is a tectonic boundary of China and its structure is very complex, involving a sharp change in several geophysical field characteristics. Since the 1980s scholars have undertaken numerous geological and geophysical surveys and achieved fruitful results [1–6]; however, the structural properties, focal mechanisms and other issues of the NSSB still need to be explored. Bai Zhiming, Wang Chunyong et al. [7,8] conducted research on the NSSB using tomography DSS profiles and found that the fault zone trends north–east in the upper crust, intersecting and converging with the Jianshui fault, the Qujiang fault, the Xiongchu–Tonghai fault, and then veering south–west in the lower crust. It is vertical or slightly reversed, extending into the upper mantle in the middle lower crust at the edge of high and lower velocity anomaly bodies, and displays the characteristics of a thrust nappe structure. The study conducted by Huang Jianli, Zhang Zhongjie, Ma Hongsheng, and Huang Jing [9–12] has shown that, at depth of 26–30 km, velocity is significantly lower than that in the surrounding area of the Sichuan–Yunnan rhombic block, which is surrounded by the Xiaojiang and Honghe faults. Furthermore, on the basis of seismic first arrival P wave and S wave travel time data, they determined the 3-D velocity structure of both crust and upper mantle. In terms of the three periods of survey data across the crustal movement observation network of China and others, Wang Yanzhao et al. [13] mapped the velocity field image of GPS and inversed the activity rate of the main active faults in the Sichuan Yunnan region. Huang Zhongxian et al. [14] using natural seismic surface wave records and tomographic imaging methods, studied the lithosphere S wave velocity structure and anisotropy characteristics in the NSSB and adjacent regions. Their results not only show that the eastern boundary of NSSB is a crustal thickness upheaval boundary, but also show that it is a significant crustal velocity boundary. Xiong Xiong [15] simulated the eastern Tibetan Plateau and the results show that the image matched the GPS and geological survey. The Qilian Mountain area mainly exhibits crustal shortening, which has a north–northeast trend. Furthermore, the crustal movement in Yunnan exhibits a clockwise rotation, a characteristic of the trend of plateau material flow.

These achievements were mainly in the context of natural earthquakes or an artificial source of deep seismic reflection, and large-scale remote sensing and GPS measurements. There are relatively few findings on regional gravity, mainly concentrated in the Honghe fault zone [16–20], and studies have neither focused on Moho depth nor discussed in detail the relationship between gravity fluctuations and tectonic units.

This study is based on previous work using spatial gravity data of the NSSB and the adjacent area, combining DEM terrain, gravity profile and electromagnetic sounding profile data from recent years and constructing the Bouguer anomaly map, the Moho depth map, and the crustal thickness map for the research region. To further our understanding of the relationship between different tectonic units and the distribution of the Moho surface, a section of gravity profile was analyzed. The results obtained in this paper provide the basis for further inference of the characteristics of the gravity field, the geological structure, and the focal mechanism of the NSSB.

2. Sources of data on gravity field

2.1. *Data sources and processing method*

The study area ranges from 95°E–110°E to 22°N–38°N (Fig. 1). Fig. 2 shows the spatial gravity anomaly data; its grid size is 1′ × 1′. Fig. 3 displays the Bouguer gravity anomaly data of EGM2008, while Fig. 4 is the regional gravity Bouguer anomaly data.

To reduce multiplicity, the Moho depth map is compared with previous NSSB results while simultaneously integrating the principles of geological and geophysical interpretation [21] by modifying the geological model using seismic sounding and section data of the gravity inversion obtained Moho depth as the constraint. Since the 1980s there have been international geological and geophysical investigations of the NSSB, yielding many outputs including core multiple reflection data [1], seismic tomography data [4], surface wave data over an extended time period [5,6] and DSS profile data [7,8,22]. In this study, we digitize these results as the inversion constraint to obtain the Moho depth map of the study area. The main ideas for the research were to:

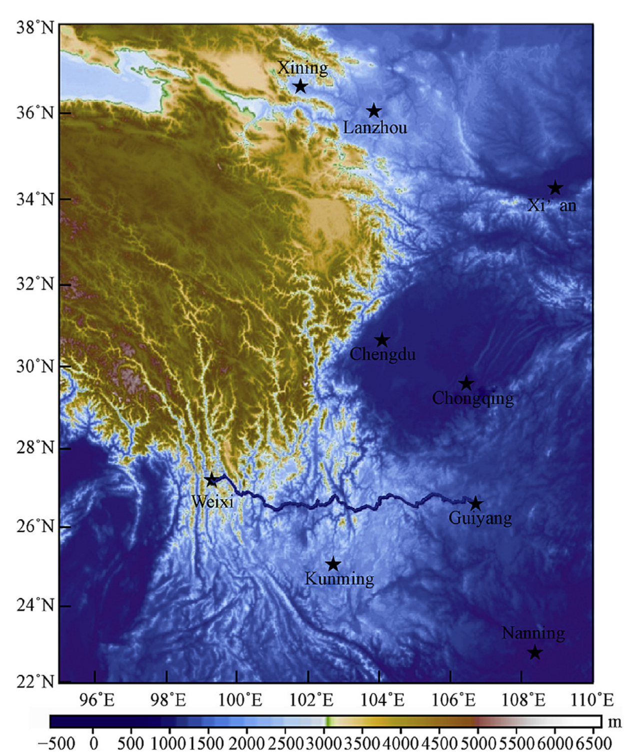

Fig. 1 – Topographic map. (The blue line is the Weixi–Guiyang gravity sounding profile and the black stars indicate cities).