

Seismic evidence for the Collision tectonic of North China Block and Yangtze Block beneath Tongbai-Dabie Orogenic belt

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The Tongbai-Dabie Orogenic belt is formed in the Middle-to-Late Triassic through a continental collision between the Yangtze Block (YB) and North China Block (NCB). We have applied the teleseismic tomography method to determine a 3D P-wave velocity structure down to 400 km depth beneath Tongbai-Dabie orogenic. Our images show the south-dipping high velocity anomalies beneath the Tongbai-Dabie orogenic belt, which represent the southward subducted NCB in Mesozoic. While a huge high velocity anomaly beneath the Wudang Moutin region extending down to 250 km is possible the ancient lithosphere of the Yangtze Craton remnant since the Paleoproterozoic. The northward subducted YB is only limited in the Eastern Dabie terrane and Yangtze foreland. Break-off retained Paleo-Tethyan oceanic slab are revealed at depths from the upper mantle 250 to 400 km.

1. Introduction

The Tongbai-Dabie Orogenic belt, a key component of the Central Orogen of China, is formed in the Middle-to-Late Triassic through a continental collision between the Yangtze Block (YB) and North China Block (NCB) (Hacker et al., 1998, 2000; Zheng et al., 2013; Zhang and Dong, 2019) (Figure 1), which is famous on the most extensive high and ultrahigh pressure (HP/UHP) metamorphic zone in the world (Hacker et al., 2006; Zhang et al., 2009). It is an ideal place to study the ancient orogenic processes between collided continents (Liou et al., 2009; Zhang et al., 2009; Zheng et al., 2012; Wu and Zheng, 2013).

The widely approved view about the collision orogeny is that the YB northward subducted into the NCB in the Triassic (Li et al., 1993; Ames et al., 1996; Hacker et al., 1998; Zheng et al., 2005). Even though, there are still many scientific challenges about the only YB subduction existing beneath the NCB during the convergence in Triassic. This led to propose another opinion that the NCB southward subducted into the YB (Jahn and Chen, 2007; Li et al., 2017). However, this only NCB subduction model is imperfect because it is difficult to explain the northward dipping Moho beneath the Dabieshan. We are troubled by these contradictory phenomena.

In this study, we report the velocity structures explored by recent 45 portable broadband seismic stations and 54 permanent seismic stations around Tongbai-Dabie orogenic belt (Figure 2). Our aim is to produce a detailed image of the crustal and upper mantle velocity structure beneath the Tongbai-Dabie Orogen and use it to assess possible collision relationship between the NCB and the YB.

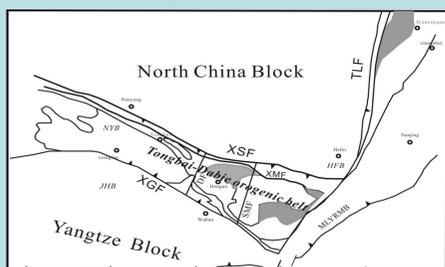


Fig. 1. Tectonic background map of the Tongbai-Dabie orogenic belt

3. Results and discussion

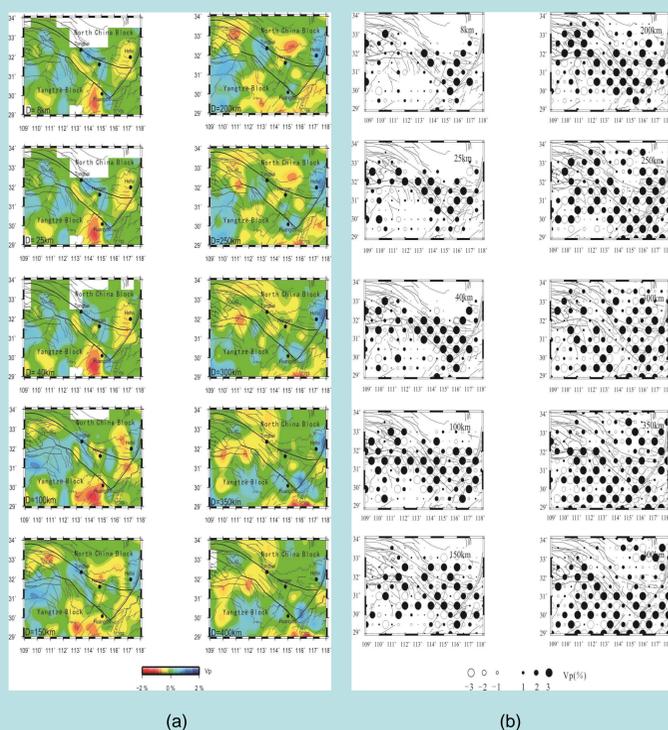


Fig. 3. (a) P-wave velocity images at every depth slices. The layer depth is shown below each map. The velocity perturbation scale is shown at the bottom. The black lines denote the major tectonic boundaries. (b) Results of checkerboard resolution test.

4. conclusion

In this study, we used a large number of P-wave arrival times recorded by portable and permanent seismic stations to reveal the structure of the crust and upper mantle beneath the Tongbai-Dabie orogenic belt and its adjacent region. Our images show the south-dipping high velocity anomalies beneath the Tongbai-Dabie orogenic belt, which represent the southward subducted NCB in Mesozoic. While a huge high velocity anomaly beneath the Wudang Moutin region extending down to 250 km is possible the ancient lithosphere of the Yangtze Craton remnant since the Paleoproterozoic. The northward subducted YB is only limited in the Eastern Dabie terrane and Yangtze foreland. Break-off retained Paleo-Tethyan oceanic slab are revealed at depths from the upper mantle 250 to 400 km. The tomographic images also show the low velocity anomalies spread widely under the MLYRMB, which is mainly attributed to that the gap between the lithospheric mantle subduction frontier of NCB and YB locates in the south of the Tongbai-Dabie orogenic belt.

Based on our tomography images of both NCB southward subduction and YB northward subduction, we propose two stages unsimultaneous subduction model (Fig. 6.) that YB and NCB subducted beneath the Tongbai-Dabie orogenic belt in Triassic and Jurassic period respectively. Our model can reconcile the apparent Yangtze surface geology and the isotope signatures of the Dabieshan post-tectonic Cretaceous magmatic rocks bearing a genetic relation with the NCB lithosphere. Although our model is not perfect, we intend to shed light on an unresolved tectonic problem that deserves further investigation.

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2. Data and method

In the present study, we hand-picked 39,384 first P-wave arrival-time data from high-quality seismograms of 1643 teleseismic events (Fig. 2) recorded by 99 seismic stations. The data spans the time interval from July 2014 to May 2015 and June to October 2017. These stations include one temporary seismic network and four provincial seismic networks of China. We deployed 45 portable temporary broadband seismic stations with an average station spacing of 5~10 km along the Tongbai-Dabie orogenic belt and southward across the middle and lower reaches of Yangtze River metallogenic belt in the YB. These four provincial networks have a total of 54 permanent seismic stations, which belong to Anhui, Henan, Jiangxi, and Hubei provinces.

We used the tomographic method of Zhao et al. (1992, 1994) to determine the 3-D P-wave velocity structure beneath the study area.

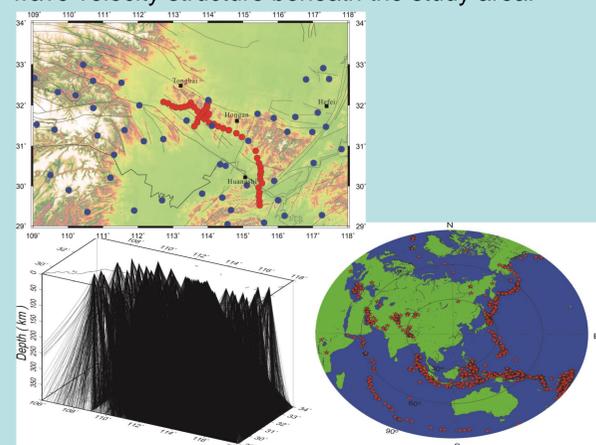


Fig. 2. The 99 seismic stations, distribution of seismic ray paths in the model space and distribution of teleseismic events used in this study.

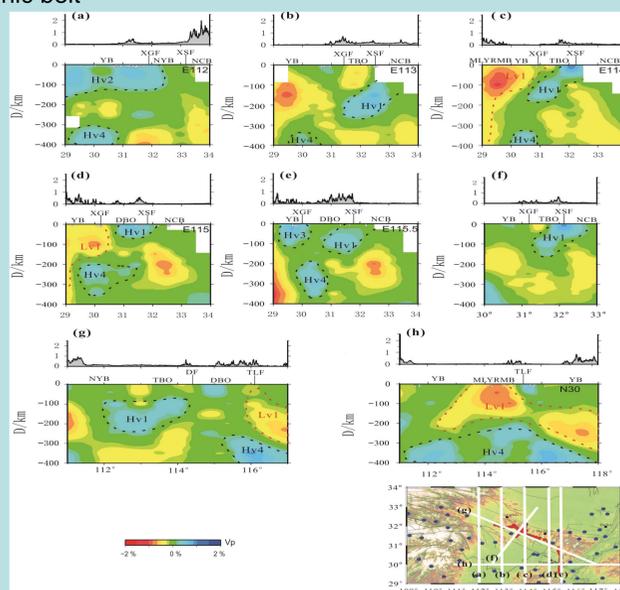


Fig. 4. Vertical cross-sections of P-wave tomography along the eight profiles shown on the inset map. Red and blue colors denote slow and fast velocities, respectively. The surface topography is shown atop each cross-section. The velocity perturbation scale is shown at the base of the figure. TBO: Tongbai orogenic belt; DBO: Dabie orogenic belt.

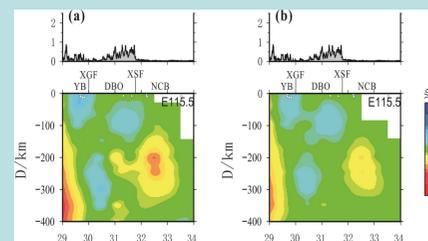


Fig. 5. A results of the restored test along 115.5° E. (a) Input model; (b) Result of restored test. The velocity perturbation scale is shown on the right.

Our seismic tomographic results display the clear southward subducting NCB lithospheric images under the Tongbai-Dabie orogenic belts in some vertical cross-sections profiles (Fig.3 and Fig. 4). The NCB has subducted toward the south along the Tongbai-Dabie Orogenic belt and extends down to 150 km depth and even more. Its frontier is located along the southern margin of the Tongbai-Dabie orogenic belt.

The northward subducted YB is only limited in the Eastern Dabie terrane and Yangtze foreland along the 115.5° E profile. We made a restored test in order to further verify the reliability of NCB and YB high velocity anomalies (Fig. 5).

Because of the NCB southward subduction, the deep suture between NCB and YB is located in the south of Dabie orogenic belt. The gap was formed between the lithosphere subduction frontier of NCB and YB. Therefore, we believe that the position of the plate deep suture is one of the important causes leading to the surface Mesozoic mineralization distribution along MLYRMB.

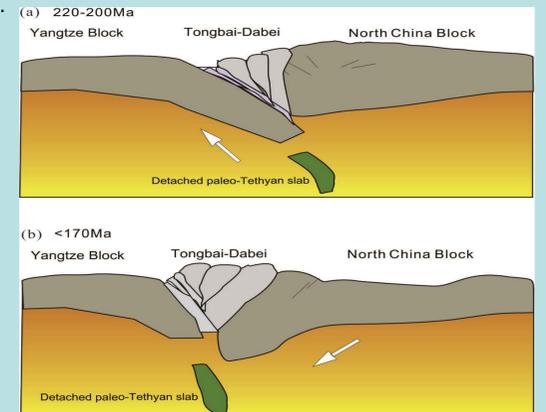


Fig. 6. A proposed tectonic scenario for the Tongbai-Dabie orogenic belt. (a) 220 – 200 Ma, subduction of the YB and detachment of the Paleo-Tethyan slab beneath the Tongbai-Dabie orogenic belt; (b) After 170 Ma, subduction of the NCB.