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Research Advances

New Discovery of Upper Crustal High- and Low-Velocity Belts and High-Velocity Core in the Tarim Basin

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WANG Tengfei[1, 2], JIN Zhenkui[1, *], YU Xiaoxia[1], CHENG Rihui[2], SONG Xue[3], YANG Baojun[4], LI Shuo[1] and SHI Shuting[1]

[1] *College of Geosciences, China University of Petroleum (Beijing), Beijing 102249, China*
[2] *College of Earth Sciences, Jilin University, Changchun 130061, China*
[3] *Shandong Lunan Geological Engineering Investigation Institute, Jining 272100, Shandong, China*
[4] *College of Geo-Exploration Science and Technology, Jilin University, Changchun 130026, China*

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Objective

The Tarim Basin is the biggest oil- and gas-bearing basin in China, which has undergone long-term and complicated evolutionary history. During each evolutional stage and in different sub-basins in the same stage, the Tarim Basin has different proto-types, and it is thus named a composite and superimposed basin. A study on the basement nature of such a complex but significant to the national oil and gas strategy basin is of great significance (Huang Chenjun et al., 2017). Based on earthquake data, detailed velocity structure of deep basin can be obtained in order to research the basement nature.

Methods

Earthquake events within 74°–90°E longitude and 35°–42°N latitude detected by at least three seismic stations with more than six seismic phases are chosen. A total of more than 14000 P-wave records are selected to obtain the three-dimensional P-wave velocity (*V*p) structure through tomography (Tromp et al., 2010).

A total of 29 *V*p profiles have been imaged throughout the entire Tarim Basin with a depth of 100 km and a total length of 52592 km, i.e., nine profiles along the latitude (35°–42°N), 17 profiles along the longitude (74°–90°E), and four profiles along the seismic sections.

Results

Velocity anomalies exist in the depth of 20km beneath the Tarim Basin on all profiles. In this paper, the basic characteristics of the *V*p profiles are discussed, and the profile along the 80°E longitude (hereinafter referred to as "P80") is as an example (Fig. 1a).

P80 covers 30°–45°N, and range of the Tarim Basin is ca. 35.2°–41.7°. The most obvious features along the P80 is the uplift and concave of the Moho surface, which is uplifted in the basin and sunk in the mountains. The uplift in the middle of P80 is responding to the Tarim Basin, and the concaves in the southern and northern are responding to the Qinghai–Tibet Plateau and Tianshan Mountain, respectively. Near the Moho surface, the velocity contours are dense. And in the range of 20 km under the Moho surface, the velocity contours are more complex, i.e. the other velocity anomaly, which is characterized by the horizontal and vertical complexity. This anomaly changes slowly in the northern and changes rapidly in the southern P80.

Within the Tarim Basin on P80, the upper crust and lower crust are separated by a velocity contour of 6.7 km/s. The velocity distribution in the lower crust is rather even and corresponding to the Moho surface. The velocity distribution in the upper crust is more complicated and the high-velocity belt (H), low-velocity belts (namely L1 in the north and L2 in the south) and high-velocity core (C) exist. The high-velocity belt is the higher part of *V*p than the same depth, which is shown as the uplifts of the contours. And the low-velocity belt is the lower part of the *V*p, which is the lower concaves of the contours. On P80, L1 encompasses 42.2°–44.0° N, and L2 encompasses 37.5°–38.9°N. H is cut by L2 in the south, and its range is 36.0°–37.5°N and 38.1°–42.2°N. It is suggested that the distribution range of the high- and low- velocity belts can be intersecting horizontally. The high- velocity core is highlighted by steeply raised contours and do not cover low value of *V*p. On P80, H encompasses 31.5°–41.4°.

Ranges of the high- and low- velocity belts and high-velocity core along the longitude lines are marked (Fig. 1b). The high-velocity core shapes regularly, and is located to the north of 39°N. The range of high-velocity belt is almost corresponding to the Tarim Basin, but extends beyond the basin boundary in the middle of the north.

Comparing with the lower crust, the upper crust of the Tarim Basin is of a large heterogeneity, and the existence of these anomalies is evidence. The lower crust is obviously thicker than the upper crust. And with its high-velocity, high density and high rigidity, the lower crust is the main and direct cause of the rigidity of the Tarim basement. The existence of these velocity anomalies is of great significance for the study of the natures of the Tarim

* Corresponding author. E-mail: jin.zk@hotmail.com

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basement and the development of the basin. As for the origin of the high-velocity core, it is likely that the crystalline rock mass gathered before the Tarim Movement. It is mainly distributed in the north of the basin and could provide evidence for the collage of the South and North Tarim Terranes.

Conclusion

In the upper crust of the Tarim Basin, high- and low- velocity belts and high-velocity core exist. The high-velocity core appears only in the northern basin. The distributional range of high-velocity belt is corresponding to the basin range. The discovery of these velocity anomalies is of great significance for the study of the natures of the Tarim basement and the development of the basin.

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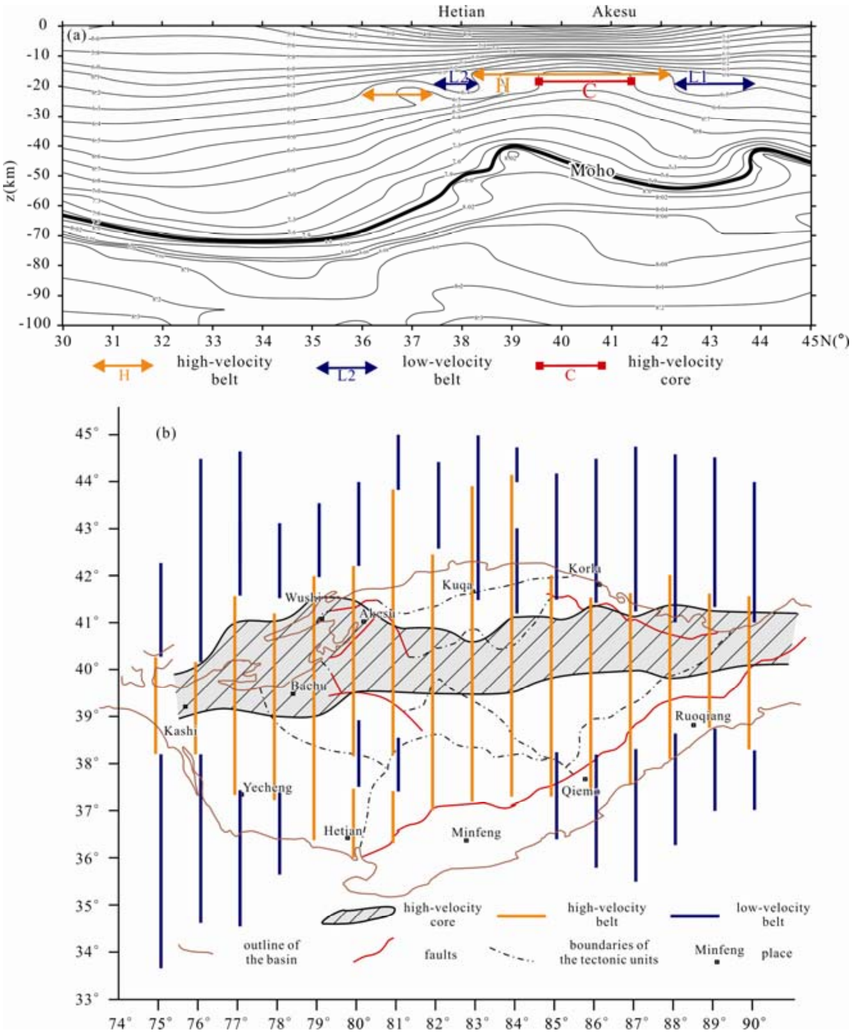

Fig. 1. P-wave velocity distribution of the 80°E profile (a) and distributions of velocity anomalies (b).