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南北地震带岩石圈S波速度结构面波层析成像

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Lithospheric S-wave velocity structure of the North-South Seismic Belt of China from surface wave tomography

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摘要

本文利用天然地震面波记录和层析成像方法,研究了南北地震带及邻近区域的岩石圈S波速度结构和各向异性特征.结果表明南北地震带的东边界不但是地壳厚度剧变带,也是地壳速度的显著分界.其西侧中下地壳的S波速度显著低于东侧,强震大多发生在低速区内部和边界.青藏高原东缘中下地壳速度显著低于正常大陆地壳,在松潘甘孜地块和川滇地块西部大约25～45 km深度存在壳内低速层;这些低速特征与高原主体的低速区相连,有利于下地壳物质的侧向流动.地壳的各向异性图像与下地壳流动模式相符,即下地壳物质绕喜马拉雅东构造结运动,东向的运动遇到扬子坚硬地壳阻挡而变为向南和向北东的运动.面波层析成像结果支持青藏高原地壳运动的下地壳流动模型.南北地震带的岩石圈厚度与其东侧的扬子和鄂尔多斯地块相似但速度较低.川滇西部地块上地幔顶部(莫霍面至88 km左右)异常低速;松潘甘孜地块上地幔盖层中有低速夹层(约90～130 km深度).岩石圈上地幔的速度分布图像与地壳显著不同,在高原主体与川滇之间存在北北东向高速带,可能会阻挡地幔物质的东向运动.上地幔各向异性较弱且与地壳的分布图像显然不同.因此青藏高原岩石圈地幔的构造运动具有与地壳不同的模式,软弱的下地壳提供了壳幔运动解耦的条件.

关键词 南北地震带, 岩石圈, 速度结构, 面波, 层析成像

Abstract:

This paper uses surface wave data from natural earthquakes and a tomographic method to study the S-wave velocity structure and anisotropy of the lithosphere of North-South Seismic Belt and adjacent regions. The result indicates that the east margin of the seismic belt is not only a zone of rapid change of crustal thickness, but also a remarkable boundary between different crustal velocities. To its west the S-wave velocity of the middle and lower crust is obviously lower than that on the east side, and strong earthquakes generally occur within or at the border of the low velocity regions. The S-wave velocity of middle-lower crust in the east margin of Tibetan Plateau is obviously lower than that of normal continental crust; low velocity zones (LVZ) exist at depths about 25～45 km in the crust of Songpan-Garzê block and the western part of Chuan-Dian block. These low velocity features are connected with the low velocities of the plateau proper, which facilitates the lateral flow of lower crustal material. The anisotropy patterns of the crust is consistent with the lower crust flow model, that is, the lower crust material moves around the eastern Himalayan syntaxis and the eastward movement is diverted to south and northeast when blocked by the rigid Yangtze crust. The result of our surface wave tomography supports the lower crust flow model for crustal movement of Tibetan Plateau. The lithosphere of the North-South Seismic Belt has similar thickness with that of Erdos and Yangtze on its east, but with relatively lower velocity. At the top of upper mantle in the west Chuan-Dian block (from Moho to about 88 km) the shear velocity is abnormally low; in the upper mantle lid of Songpan-Garzê block there is a low velocity layer between about 90 and 130 km depth. The velocity pattern of the upper mantle is remarkably different from that of the crust; there is an

NNE-trending high velocity zone between the plateau proper and western Sichuan-Yunnan region, which may hamper the eastward movement of mantle material. The anisotropy of upper mantle is weaker and exhibits an obviously different pattern from the crustal anisotropy. Therefore, it is considered that the modes of tectonic movement of crust and upper mantle of Tibetan Plateau are different, and the weak lower crust provides the condition for decoupling of crust and mantle movement.

Keywords North-South Seismic Belt, Lithosphere, Velocity structure, Surface wave, Tomography

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