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青藏高原东缘上地幔顶部Pn波速度结构及各向异性研究

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Velocity and anisotropy structure of the uppermost mantle under the eastern Tibetan plateau inferred from Pn tomograph

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摘要 本研究使用中国地震局地壳应力研究所2010—2011年期间在云南地区布设流动地震台站以及青藏高原周边地区固定地震台站记录到的波形资料,提取了大量高质量Pn波到时资料.联合中国地震台网观测报告,我们获得了一个新的青藏高原东缘上地幔顶部Pn波速度和各向异性结构模型.结果显示,研究区内上地幔顶部存在明显横向不均匀性.古老盆地和稳定地台区如四川盆地、柴达木盆地、拉萨地块和阿拉善块体呈现为明显高波速异常,而祁连山至西秦岭褶皱带和川滇菱形块体北部等为相对弱高波速异常.在龙日坝断裂带以东的松潘—甘孜地块往南沿安宁河—则木河断裂至川滇菱形块体南部显示为一条近南北向明显低波速异常.三江褶皱系、缅甸弧俯冲带以及四川盆地东南等地区为明显低波速异常.地壳强震多发生在高波速异常边缘或高低波速异常过渡带上,表明地壳强震的孕育可能还与地幔构造作用存在一定相关性.青藏高原东构造结的各向异性快波方向呈顺时针旋转分布,与印度—欧亚碰撞密切相关.龙门山断裂带东西两侧的各向异性快波方向发生明显变化,由其西侧松潘—甘孜地块下方的NE向转变为四川盆地下方的近EW向,说明青藏高原物质流动遇四川盆地后分为NE和SW向两支.在川滇地区26° N以南地区上地幔顶部各向异性呈现近NS向与地表GPS观测相一致,但与SKS分裂结果存在较大差异,可能表明地壳与上地幔顶部形变表现为耦合现象,而上地幔顶部至岩石圈内部则存在解耦现象.

关键词 Pn波, 上地幔顶部, 速度不均匀性, 各向异性, 青藏高原东缘

Abstract: In the present study a large number of high-quality Pn arrival times were hand-picked from seismograms recorded by the portable seismic stations, deployed from 2010 to 2011 in the Yunnan region by the Institute of Crustal Dynamics, CEA and recorded by Chinese permanent seismic stations around the eastern Tibetan plateau. Combining with the data from the observational bulletins of Chinese provincial seismic networks, we obtained a new model of seismic velocity and anisotropy of the uppermost mantle under the eastern Tibetan plateau. Our results show obvious lateral heterogeneities in the study region. The old basins and stable blocks, such as the Sichuan and Qaidam basins and Lhasa and Alashan blocks, show prominent high-velocity anomalies, while the Qilian-Qinling fold zone and northern Chuan-Dian diamond-shaped block exhibit relatively weaker high-velocity anomalies. A pronounced north-south trending low-velocity anomaly zone exists from the Songpan-Garz? block east of the Longriba fault, southward through the Anning-Zemu fault zone to the southern Chuan-Dian diamond-shaped block. In the Sanjiang fold system, Burma-subduction zone and the region southeast of the Sichuan basin, there are three obvious low-velocity anomalies. Most of crustal major earthquakes occur on the edges of high-velocity anomalies or the transition zone from high to low velocities, suggesting that crustal earthquakes may be somewhat related to the mantle structure. The fast direction of Pn propagation around the eastern Himalayan syntaxis rotates in a clockwise manner, suggesting that it is related to the Indo-Asian collision. The fast direction changes sharply across the Longmenshan fault zone from NE under the Songpan-Garz? block in the west to EW under the Sichuan basin in the east, implying that the material flow of the Tibetan plateau is divided into the NE and SW braches when it meets the Sichuan basin. To south of 26癗, in the Chuan-Dian region the Pn fast direction is in an approximate N-S direction, which is consistent with the GPS observations but different from SKS splitting results, suggesting the mechanically coupling of the crust and the uppermost mantle but decoupling at certain depths between the uppermost and lithospheric mantle.

Keywords Pn-wave, Uppermost mantle, Velocity heterogeneity, Anisotropy, Eastern Tibetan plateau

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