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YANG Feng, HUANG Jin-Li, YANG Ting. Upper mantle structure beneath the Chinese capital region from teleseismic finite-frequency tomography[J]. Chinese Journal Geophysics, 2010, V53(8): 1806-1816

应用远震有限频率层析成像反演首都圈上地幔速度结构

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Upper mantle structure beneath the Chinese capital region from teleseismic finite-frequency tomography

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摘要

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摘要 本文选用首都圈数字地震台网2003年9月~2005年12月记录的300多个远震事件的波形资料,采用分频带多道互相关方法得到三个不同频段的P波相对走时数据共18499个,计算了每个频段的走时灵敏度核,应用有限频率层析成像反演得到首都圈地区的上地幔三维P波速度结构模型.利用检测板估计了反演结果的分辨率,并与射线层析成像方法的结果进行了比较,说明了反演结果的可靠性.研究表明,各构造单元具有明显不同的速度结构特征,其差异可到150 km深:燕山隆起区表现高速;太行山隆起区整体以低速为主并存在小范围高速块体;华北盆地、渤海湾下浅层上地幔中存在大范围的强低速异常,其顶面在50~70 km,可视为软流圈顶面的埋深,这一结果说明华北盆地、渤海湾下岩石圈明显减薄;张家口—蓬莱断裂带是上地幔浅部速度结构的变异带,也是岩石圈减薄的边界带,区内大部分强震都发生在该构造带上,由此看来该带上强震的发生不仅与地壳结构的不均匀性有关,还可能有较深的构造背景.

关键词: 首都圈 有限频率层析成像 灵敏度核 远震波形 上地幔速度结构

Abstract: We selected waveform data from more than 300 teleseismic events recorded by the digital Capital Seismic Network during the period from September 2003 to December 2005, obtained 18499 P-wave relative travel-times by dividing these waveform data into three different frequency bands and multi-channel cross correlation measurement, calculated travel-time sensitivity kernels for each frequency band, applied the finite-frequency tomography to determine 3-D P-wave velocity structure model of the upper mantle under the Chinese capital region. We also analyzed the reliability of inversion results by using checkerboard resolution test and comparing present model with ray tomographic model. Our results show that there are distinct differences of deep velocity structure down to 150 km depth under three tectonic units. The Yanshan uplift exhibits the high velocity (high-V) features. Under the Taihangshan uplift, a broad low velocity (low-V) is visible, but there are also small high-V anomalies. A large scale prominent low-V anomaly is revealed in the shallow upper mantle under the North China basin and Bohai bay, and it extends up to the depth of 50~70 km which can be regarded as the top of asthenosphere. This result suggests lithospheric thinning in the North China basin and Bohai bay. Zhangjiakou-Penglai fault zone is a variation belt of velocity structure in the shallow upper mantle and a boundary of lithospheric thinning, most of large earthquakes has occurred in this belt. We consider that large earthquakes occurred in this belt are not only related to the crustal heterogeneity but also affected by the deeper velocity structure.

Keywords: Chinese capital region Finite-frequency tomography Sensitivity kernel Teleseismic waveform Velocity structure of the upper mantle

Received 2009-09-30; published 2010-08-20

Fund:

国家自然科学基金项目(40774040)及研究所业务专项(2007-13)资助.

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