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华北地区勒夫波噪声层析成像研究

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Love wave tomography from ambient seismic noise in North-China

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摘要

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摘要

利用华北地震科学台阵200个流动地震台站、14个月的连续波形数据,通过互相关方法提取了勒夫波的经验格林函数,使用多重滤波方法测量了5229条勒夫波的群速度频散曲线,采用噪声层析成像方法得到了研究区域4~30 s的勒夫波群速度分布图像,横向分辨率在多数区域可以达到 $0.25^\circ \times 0.25^\circ$. 层析成像结果显示,短周期的群速度分布特征与地表地质和构造特征基本一致,华北盆地和山西断陷带内的盆地呈现低速异常,燕山隆起和太行山隆起表现为高速异常;中周期的群速度分布图揭示了华北盆地内部隆起和拗陷的空间分布范围及沉积层的厚度差异. 勒夫波频散曲线具有明显的分区特征,太行山隆起、燕山隆起和鄂尔多斯块体东北缘的频散曲线形态基本一致,和其它典型克拉通相似;张渤地震带和山西裂谷盆地的频散曲线基本一致,接近于埃塞俄比亚裂谷. 中西部块体的平均频散曲线和其它典型克拉通相似,而东部块体的频散曲线和中西部块体存在较大差异,且低于其它典型克拉通,表明东部块体的地壳受到了强烈的破坏和改造,而中西部块体受改造的程度较低,仍具有稳定克拉通的物理性质. 太行山重力梯度带的东西两侧在地形地貌、速度结构、频散特征、地壳厚度、岩石圈厚度以及地幔过渡带厚度均存在显著差异,是划分华北克拉通破坏空间范围的一条重要界线,推测华北克拉通的破坏范围主要在太行山重力梯度带以东.

关键词 噪声层析成像, 勒夫波, 华北克拉通, 互相关, 频散

Abstract:

We present the results of Love wave group velocity tomography in North China using ambient seismic noise observed at 200 portable seismic stations from North China Seismic Array. 14-month continuous data have been cross-correlated to yield estimated empirical Love wave Green's functions. 5229 group velocity dispersion curves were measured by applying multiple filter method. Group velocity maps between 4 s and 30 s are reconstructed. Checkerboard tests indicate that the lateral resolution is estimated to be $0.25^\circ \times 0.25^\circ$ for most of the study area. The tomography maps at short periods agree well with the surface geological structure. North China basin and Shanxi rift are mapped as low velocity anomaly, while Yanshan uplift and Taihangshan uplift are mapped as high velocity anomaly. The tomography maps at intermediate periods outline the shapes of the basins and reveal the relative thickness of sedimentary cover. Dispersion curves show clear regional characteristics. The dispersion curves of Taihangshan uplift, Yanshan uplift and northeastern margin of Ordos block are consistent and are similar with those of typical craton. The dispersion curves of Zhang-Bo seismic zone are in agreement with Shanxi rift, and are close to Ethiopia rift. The dispersion curves of middle and western block are similar with other typical cratons. The dispersion curves of eastern block differ greatly with middle and western block and are lower than other cratons, which implies that the crust of eastern block suffers strong damage and alteration. The middle and western block are less affected by North China craton destruction and still keep the physical properties of stable craton. Great differences in topography, velocity structure, dispersion characteristics, crust thickness, lithosphere thickness and mantle transition zone thickness are observed between the western and eastern sides of Taihangshan gravity lineament. We infer the lineament is an important borderline to determine the destruction area of North China Craton and the destruction of North China craton is confined to the eastern part.

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