

引用本文(Citation):

郑勇, 李永东, 熊熊. 华北克拉通岩石圈有效弹性厚度及其各向异性. 地球物理学报, 2012, 55(11): 3576-3590, doi: 10.6038/j.issn.0001-5733.2012.11.007

ZHENG Yong, LI Yong-Dong, XIONG Xiong. Effective lithospheric thickness and its anisotropy in the North China Craton. Chinese J. Geophys. (in Chinese), 2012, 55(11): 3576-3590, doi: 10.6038/j.issn.0001-5733.2012.11.007

华北克拉通岩石圈有效弹性厚度及其各向异性

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Effective lithospheric thickness and its anisotropy in the North China Craton

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摘要

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摘要 华北克拉通是典型的克拉通破坏的区域, 研究该区域的岩石圈有效弹性厚度(T_e)及其各向异性特征有助于了解华北克拉通的强度构造及破坏机制. 我们根据空间分辨率为 $30'' \times 30''$ 的地形数据和由自由空气异常解算得到的完全布格重力异常数据, 利用Fan小波分析方法计算了两者之间的相关性, 并基于Forsyth理论和正交各向异性薄板模型计算了华北克拉通地区的岩石圈 T_e 和其各向异性分布情况. 结果表明: (1) 从各向同性 T_e 分布来看, 华北克拉通岩石圈在东部、中部和西部存在着明显的差异. 鄂尔多斯地块、河淮盆地的 T_e 值均较高; 中华克拉通、南北重力梯度带及鲁西隆起 T_e 值较低, 约10~25 km; 郑庐断裂带两侧 T_e 有非常大的差异, 西侧的 T_e 明显小于东侧, 推测郑庐断裂带在华北克拉通破坏过程中起着非常重要的作用. (2) 从 T_e 的各向异性来看, 不同块体 T_e 各向异性的大小或方向存在差异, 并且研究区内地震大多分布在 T_e 各向异性大小或方向转变的区域. (3) 从地震波SKS各向异性和 T_e 各向异性的比较来看, 在华北克拉通西部阿拉善块体岩石圈变形趋于垂直连贯变形模式; 鄂尔多斯地区各向异性源自历史构造事件的“化石”各向异性; 山西裂谷带地区 T_e 的弱轴方向和SKS的快波方向平行, 而在山西裂谷带南部的秦岭一大别区域, SKS快波方向和 T_e 弱轴方向相垂直, 这可能与地幔热物质上涌等作用有关. 此外, T_e 各向异性与现今构造应力场间的相关性不明显, 体现出华北克拉通复杂的构造应力特征.

关键词 有效弹性厚度, 各向同性, 各向异性, 华北克拉通

Abstract: The North China Craton (NNC) is a typical rejuvenated craton in the world. For this reason, the lithospheric effective elastic thickness (T_e) and its anisotropy are important to understand the deformation mechanism of the NNC as well as its tectonic structures. In this work, we apply the Fan wavelet method to compute the coherence between the topography data with spatial resolution of $30'' \times 30''$ and the Bouguer gravity anomalies derived by free air gravity anomalies, and further calculate the effective lithospheric thickness and its anisotropy based on Forsyth's theory and a orthogonal 2D thin plate model. The results show that: (1) Big isotropic T_e variations can be observed between the eastern, central and western parts of the NNC: high T_e regions mainly concentrate in the Ordos Block and Huanghe-Huaihe Basin; in central NNC, the North-South Gravity Lineament and west part of Shandong province, T_e is relatively low, with typical value of 10~25 km; across the Tanlu fault, T_e varies dramatically, the T_e value in the west side of Tanlu fault is much smaller than that in the east side. Based on this phenomenon, we speculate that the Tanlu fault may play an important role during the deformation process of the North China Craton. (2) The pattern of T_e anisotropy distribute unevenly between different regions inside of the NNC, and the earthquakes mainly occurred in the areas where the directions and the magnitudes of T_e change dramatically. (3) Based on the comparison between the SKS seismic anisotropy and the T_e anisotropy, we argue that the deformation of the Alashan block in the western NNC is coupled from the deeper depth to the surface, and the T_e anisotropy in the Ordos block is belong to the fossil anisotropy which is originated from the historic tectonic movements. In the Shanxi rift, the directions of the weak T_e axis is parallel to the fast axes of SKS splitting data, and in the south end of the Shanxi rift zone and the Qinling-Dabie orogen, the two kinds of axes are perpendicular, based on the tectonic environment of these regions, we think this kind of coherency and discrepancy may due to the upwelling of the hot materials under the Shanxi rift zone. Generally speaking, the pattern of T_e anisotropy is not in good consistent with the tectonic stress field at present, which is an strong evidence that the tectonics in the NNC is very complex.

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