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首都圈地区精细地壳结构——基于重力场的反演

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Fine crustal structure beneath Capital area of China derived from gravity

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摘要 本文以地质与地球物理资料作为约束条件,利用小波多尺度分析方法,对首都圈地区重力场进行了有效分离,应用Parker位场界面反演法及变密度模型对莫霍界面进行了反演分析,并构建了两条地壳密度结构剖面模型,对该区精细地壳结构进行了深入研究.研究结果表明首都圈地区受多期构造运动的改造,形成坳、隆相邻,盆、山相间,密度非均匀性,壳内结构与莫霍面埋深相差比较大的地壳分块构造格局.受华北克拉通岩石圈伸展、减薄以及岩浆的上涌底侵作用,首都圈地区莫霍面起伏比较大,莫霍面区域构造方向呈NE—NNE方向,在盆地向太行山、燕山过渡地带形成了莫霍面陡变带;盆地内部莫霍面形成东西向排列、高低起伏的框架,最大起伏约5 km,但平均地壳厚度比较小,北京、唐山地区地壳厚度最小约29 km,武清凹陷地壳厚度最大约34 km.在重力均衡调整作用下,西部太行山区地壳厚度较大,但地壳密度小于华北裂谷盆地内部;中上地壳重力场特征与地表地形及地貌特征具有很大的相关性.受新生代裂谷作用影响,首都圈中上地壳结构非常复杂,形成了NNE方向为主体的构造单元,断层多下延至中地壳;下地壳发生明显的褶曲构造,表现出高低密度异常相间排列的典型特征;首都圈地区地壳密度具有明显的非均匀性.研究认为首都圈地区地震的发生与上地幔顶部及软流层物质的上涌有一定关系.

关键词 首都圈地区, 地壳结构, 布格重力异常, 密度界面, 重力建模

Abstract: In this paper the multi-scale wavelet method is used to separate gravity field. Moho topography of Capital area is determined using 3D Parker density interface inversion method and variable density model, constrained by deep seismic data. And at last, two typical gravity profiles are modeled. The results indicate that the crustal structure of Capital area rebuilded by multiple tectonic movements is very complicated, with adjoining depressions and uplifts, alternating basins and hills, and inhomogeneous density. Influenced by strong extension, thinning and erosion of North China Craton lithosphere, Moho topography around Capital area fluctuates greatly. The dominating tectonic direction of the Moho topography strikes from NE to NNE. Two steep slopes exist between North China Basin and Western Taihang uplift and Northern Yanshan uplift, respectively. Moho depth in North China Basin varies greatly, with the largest difference of 5 km, but the average thickness of crust in the basin is small. The thinnest is about 29 km, beneath Beijing and Tangshan area. The thickest crust is about 34 km in Wuqing depression. Adjusted by gravity equilibrium, crust thickness of western Taihang uplift area increases greatly. However, the density of western area is lower than the eastern basin. Gravity anomalies in upper and middle crusts are related to surface relief and topographic features. Affected by Cenozoic rifting, crustal structure of Capital area is very complicated in upper and middle crusts. Many geological tectonic units striking NNE are formed in different tectonic movements. Most faults cut through to the middle crust. Fold structures are formed in lower crust. High and low density anomalies are distributed alternatevely. Crustal density in Capital area is remarkably inhomogeneous. Research concludes that occurrences of strong earthquakes in Capital area are probably related to upwelling of asthenosphere and uppermost mantle high density materials.

Keywords Capital area, Crustal structure, Bouguer gravity anomaly, Density interface, Gravity modeling

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