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地幔岩石圈热结构差异与中国大陆岩石圈均衡分析

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摘要 观测表明，大陆地区存在很多传统均衡模型无法解释的现象，其根本原因在于传统均衡理论中没有考虑地幔岩石圈部分由于热结构差异导致密度差异的影响.本文基于岩石圈尺度的质量平衡模型研究了中国大陆20个构造单元地壳及地幔岩石圈对地形海拔的贡献，以及各块体的均衡状态.计算结果表明，在一些地区，如塔里木盆地、北山和柴达木盆地，尽管岩石圈均衡模型和Airy模型得到了一致的海拔值，但岩石圈均衡模型更能体现均衡过程的物理本质；除青藏高原造山带外的多数块体，岩石圈均衡模型的计算结果更接近观测海拔和地表垂直运动状态；总体上，考虑地幔岩石圈热结构影响后，中国大陆各地区的均衡结果普遍优于传统的均衡模型.通过对均衡状态分析，我们得到以下主要结论：(1)构造稳定地区均衡程度较高；(2) 青藏高原及周边造山带现今地壳运动主要为区域构造过程及深部动力学过程所控制，均衡调整过程不是主要控制因素；(3) 现今地壳垂直运动比较明显的块体处于均衡调整阶段，地表垂直运动的大小反映了该区所受的均衡力作用的程度；(4) 构造稳定地区基于岩石层均衡的理论计算海拔与观测海拔之差值和现今地壳垂直运动速率有较好的相关性，据此我们可以通过均衡分析研究构造块体的运动趋势和动力学性质；(5) 地幔热结构对现今地形、海拔及地壳垂直运动有显著影响，在处理均衡问题时，地幔岩石圈热结构是我们必须考虑的重要因素.

关键词 地幔岩石圈 均衡 质量平衡模型 海拔 垂直形变

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Analysis of the thermal structure of lithospheric mantle and lithospheric isostasy in China Continent

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Abstract It is shown that there are several phenomena in continental areas which can not be explained by traditional isostacy models. The essential reason for this problem comes from the thermally-caused lithospheric mantle density variation effects on the isostacy models: in traditional isostasy models, the effects from mantle lithosphere are excluded. Incorporating lithospheric mantle effect into isostasy model, we analyzed the isostasy state of 20 tectonic units in China continent. It is shown that, in some areas, such as Tarim Basin, Beishan and Qaidam Basin, although the results derived from traditional Airy model and lithospheric isostasy model are close, the lithospheric isostasy model can explain the nature of the mass balance in a more reasonable way. Except for Tibetan Plateau and its surrounding regions, the results derived from lithospheric isostasy model are closer to observed elevations and consistent with vertical velocities of crustal movement in most tectonic units. In general, the lithospheric isostasy model, which takes into account the effects of mantle density variations, is always better than the traditional crustal isostasy models. Based on the analysis of isostatic states, the following conclusions can be derived. (1) The degree of isostatic state is relatively higher in stable areas; (2) The present-day crustal movement of Tibetan Plateau and its surroundings is mainly controlled by regional tectonics and deep dynamic processes. The isostatic adjustment plays just a minor role for the current crustal vertical movement; (3) The tectonic units in which significant vertical movements are observed are in the stage of isostatic adjustment. The magnitudes of isostasy forces are represented by the amount of crustal vertical movement. (4) There is a good correlation between the rate of present-day crustal vertical movement and the differences between the observed elevations and those calculated with lithospheric isostasy model in stable areas. Based on this relationship, we can obtain the information of the kinematic and geodynamic characteristics by analyzing isostasy states; (5) Mantle contribution to lithospheric isostasy is so important that it should be taken into account in isostasy analysis.

Key words Lithospheric mantle; Isostasy; Mass balance; Elevation; Crustal vertical movement

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