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云南地区地壳速度结构的层析成像研究

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Tomographic study of crustal velocity structures in the Yunnan region southwest China

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摘要

利用地震波到时和体波层析成像方法反演了云南地区的P波速度结构,根据不同深度的速度异常分析了主要断裂和区域动力作用的深部效应,揭示出壳内低速层的分布范围以及与下地壳流动的联系.研究结果表明,哀牢山—红河断裂两侧的地壳速度结构存在明显的差异,滇中地区的速度异常分布与小江断裂、元谋断裂、程海断裂等南北走向的断裂一致,反映了青藏东部地壳块体顺时针旋转产生的构造效应;滇西南的速度异常分布与哀牢山—红河断裂、无量山断裂、澜沧江等断裂的走向平行,显示了印支块体朝东南方向挤出产生的影响;沿着南汀河断裂分布的低速异常则与印缅块体侧向挤压引起的构造活动有关.壳内低速异常具有分层和分区特征:在哀牢山—红河断裂西侧和澜沧江之间主要分布在地壳中上部,在小江断裂和元谋断裂附近分布在地壳中下部,在滇中地区则广泛分布于地壳底部至莫霍面附近,东、西两侧分别受到小江断裂和哀牢山—红河断裂的限制.其中攀西地区的低速异常与小江断裂和元谋断裂在此附近交汇形成的热流传输通道以及张裂时期强烈的壳幔热交换有关;在哀牢山—红河和澜沧江地区,除了印支块体向东南方向的挤出之外,印缅块体的侧向挤压和向东俯冲也对地壳深部的构造变形产生了一定的影响,由此引发的地幔上涌将导致热流物质沿着断裂通道进入地壳形成低速层.因此,哀牢山—红河断裂不仅在地壳浅部是分隔印支块体和华南块体的地质界限,也是控制两侧区域深部构造变形和壳内韧性流动的分界.

关键词 云南地区, 地震层析成像, 地壳速度结构, 哀牢山&mdash, 红河断裂

Abstract:

We studied P-wave velocity structures of the Yunnan region through a seismic tomography using arrival data from permanent and temporary stations. Our objective is to analyze velocity anomalies that can reflect fault shearing and regional dynamic process at depths. We also like to locate low-velocity zones within the crust that are associated with lower crustal flows. The results reveal a prominent difference of crustal velocity structures across the Ailao Shan-Red River Fault. Bordered by the fault zone, velocity anomalies in the central Yunnan are parallel to the N—S trending faults like the Xiaojiang fault, the Yuanmou Fault and the Chenghai Fault, which reflect the deep effect of the clockwise rotation of the eastern Tibetan crust. Velocity anomalies in the southeastern Yunnan are parallel to the NW—SE trending faults like the Ailao Shan—Red River Fault, the Wuliang Shan Fault and the Lancang River Fault, which show the effect of the southeastward extrusion of the Indochina Block; whereas low-velocity anomalies along the Nanting River Fault are related to tectonic activities of the eastward motion of the Indo-Burma Block. The low-velocity anomalies within the crust are distributed at various depths and in different regions. They are observed in the upper-mid crust between the Ailao Shan—Red River Fault and the Lancang River Fault, and in the mid-lower crust near the Xiaojiang Fault and the Yuanmou Fault. In the lowermost crust and near the Moho, they are distributed throughout the central Yunnan, but limited by the Xiaojiang Fault to the east and by the Ailao Shan-Red River Fault to the west. We estimate that the low velocities in the Panxi region is related to the intersection of the Xiaojiang Fault and the Yuanmou Fault, that would provide heat flow channels for the crust-mantle thermal exchange in the rifting period. In the Ailao Shan-Red River region, besides the

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southeastward extrusion of the Indochina Block, the collision and eastward subduction of the Indo-Burma Block has also played a certain role in deep crustal deformation. The induced mantle upwelling would lead to a penetration of heat flows into the crust through the fault systems and to create the low-velocity layers within the crust. Therefore, the Ailao Shan-Red River Fault is not only a simple geological boundary between the Indochina Block and the South China Block, but also a border to control the deep crustal deformation and the ductile flow in the eastern and western sides.

Keywords Yunnan region, Seismic tomography, Crustal velocity structure, The Ailao Shan—Red River fault