地球物理学报 » 2012, Vol. 55 » Issue (12) :4126-4137 doi:10.6038/j.issn.0001-5733.2012.12.025

引用本文(Citation):

张乐天, 金胜, 魏文博, 叶高峰, 段书新, 董浩, 张帆, 谢成良.青藏高原东缘及四川盆地的壳幔导电性结构研究. 地球物理学报, 2012,55(12): 4126-4137,doi: 10.6038/j.issn.0001-5733.2012.12.025

ZHANG Le-Tian, JIN Sheng, WEI Wen-Bo, YE Gao-Feng, DUAN Shu-Xin, DONG Hao, ZHANG Fan, XIE Cheng-Liang.Electrical structure of crust a upper mantle beneath the eastern margin of the Tibetan plateau and the Sichuan basin.Chinese J.Geophys. (in Chinese),2012,55(12): 4126-4137,doi: 10.6038/j.issn.0001-5733.2012.12.025

青藏高原东缘及四川盆地的壳幔导电性结构研究

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Electrical structure of crust and upper mantle beneath the eastern margin of the Tibetan plateau and the Sichuan basin

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摘要

自从2008年M_S8.0级汶川大地震发生以来,青藏高原东缘便成为地质与地球物理研究的热点区域.该区域的龙门山断裂带标志着青藏高原东缘与四川盆地的边界.汶川地震即发生于龙门山断裂带内的映秀—北川断裂上.该地区现有的研究工作多集中于青藏高原东缘及四川盆地的西部,对四川盆地东部构造情况的研究目前较少.在SinoProbe项目的资助下,完成了一条跨越青藏高原东缘及整个四川盆地的大地电磁测深剖面.该剖面自西北始于青藏高原内部的松潘—甘孜地块,向东南延伸穿过龙门山断裂带、四川盆地内部及四川盆地东部的华蓥山断裂,最终止于重庆东南的川东滑脱褶皱带附近.维性分析表明剖面数据整体二维性较好,通过二维反演得到了最终的电性结构模型.该模型表明,从电性结构上看,沿剖面可分为三个主要的电性结构单元,分别为:浅部高阻、中下地壳低阻的松潘—甘孜地块,浅部低阻、中下地壳相对高阻的四川盆地,以及华蓥山以东整体为高阻特征的扬子克拉通地块.龙门山断裂带在电性结构上表现为倾角较缓、北西倾向的逆冲低阻体,反映了青藏高原东缘相对四川盆地的推覆作用.其在地下向青藏高原内部延伸,深度约为20 km左右.在标志逆冲推覆滑脱面的低阻层下存在一电性梯度带,表征着低阻的青藏高原中下地壳与高阻的扬子地壳之间的电性转换.位于四川盆地东边界的华蓥山断裂在电性结构上表现为一倾向为南东向的低阻体插入高阻的扬子克拉通结晶基底,切割深度约为30 km左右.这一结构反映出华蓥山向西的推覆作用.在电性结构模型的基础上,进一步讨论了青藏高原东缘的壳内物质流、青藏块体与扬子块体的深部关系以及青藏高原东部的隆升机制等构造问题.

关键词 大地电磁测深, 青藏高原东缘, 四川盆地, 壳幔电性结构, 龙门山断裂带, 华蓥山断裂

Abstract:

Studies on the geology and tectonics of the eastern margin of the Tibetan Plateau have increased over recent years since the M_S8.0 Wenchuan earthquake happened in 2008. The Longmenshan fault zone located in this region marks the boundary between the plateau and the Sichuan Basin. The Wenchuan earthquake happened on the Yingxiu-Beichuan fault in this fault zone. Previous studies in this region are mostly focused on the eastern margin of the Tibetan Plateau and the western Sichuan Basin, while studies on tectonics of the eastern Sichuan Basin are still very limited. Under the auspices of the SinoProbe Project, a long magnetotelluric (MT) profile was acquired across the eastern margin of the Tibetan Plateau and the whole Sichuan Basin. The profile starts within the Songpan-Ganze block of the plateau in the northwest, extends southeastward across the Longmenshan fault zone, Sichuan Basin and the Huayingshan fault in the eastern basin, and ends around the East Sichuan decollement fold belt southeast of Chongqing. Dimensionality analysis has shown a good 2D character along the profile, and subsurface electrical structure was obtained through 2D inversions. Electrical structure along the profile could be divided into three major blocks: The Songpan-Ganze block with conductive mid to lower crust and a relatively resistive shallow region, the Sichuan Basin with conductive shallow sediments and relatively resistive mid to lower crust, and the highly resistive part of the Yangtze craton east of Huayingshan fault. The Longmenshan fault presents as a northwestward dipping conductor with a low dip angle, which reflects the overthrusting between the eastern margin of the plateau and the Sichuan Basin. The fault extends beneath the plateau to the depth around 20 km. Below the conductive layer which marks the detachment surface under the Longmenshan nappe structure is an electrical gradient zone within the range of mid to lower crust, which presents the boundary between the conductive Tibetan crust and the resistive Yangtze crust. The Huayingshan fault in the eastern margin of the Sichuan Basin performs as a southeastward dipping conductor which cuts into the resistive basement of the Yangtze craton to the depth of about 30 km. This structure reflects the westward overthrusting of the Huayingshan Mountains. Based on the electrical model, we further discussed some important tectonic issues in this study area, such as the crustal flow, the relationship between Tibetan and Yangtze blocks, and the uplift mechanism of eastern Tibet.

Keywords Magnetotellurics, Eastern margin of the Tibetan Plateau, Sichuan Basin, Electrical structure, Longmenshan fault zone, Huayingshan fault

Received 2012-04-06;