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中国大陆与各活动地块、南北地震带实测应力特征分析

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Analysis of the characteristics of measured stress in Chinese mainland and its active blocks and North-South seismic belt

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摘要

本文以"中国大陆地壳应力环境基础数据库"为基础,补充了迄今为止查阅到的中国大陆水压致裂法与应力解除法的实测地应力数据,在1474个测点上得到3586条数据,研究区经度范围75° E—130° E,纬度范围18° N—47° N,深度范围0~4000 m,基本覆盖了中国大陆的各活动地块与南北地震带各段等研究区.本文采用等深度段分组归纳的方法解决了实测地应力数据样本数量沿深度分布的不均匀问题,给出了中国大陆与各研究区地壳浅层测量深度范围内应力量值、方位特征.结果显示:(1)中国大陆地壳浅层最大水平应力、最小水平应力、垂直应力随深度呈线性增加;(2)中国大陆地区侧压系数随深度的变化特征为:浅部离散,随着深度增加而集中,并趋向0.68,D=465 m是水平作用为主导向垂直作用为主导的转换深度,K_{av}=1;(3)中国大陆水平差应力在地表为3 MPa左右,随深度增加以5.8 MPa/km的梯度增大;(4)在测量深度范围内,中国大陆各研究区最大水平应力中间值(深度为2000 m时的统计回归值)从大到小的顺序是:青藏地块63.6 MPa、南北带北段57.3 MPa、华南地块51.4 MPa、华北地块50.5 MPa、南北带中段47.9 MPa、西域地块47.5 MPa、南北带南段45.4 MPa、东北地块44.8 MPa,总体表现为"西强东弱"的基本特征,反映了印度板块与欧亚板块的强烈碰撞是中国大陆构造应力场强度总体特征的主要来源;(5)与其他研究区相比较,青藏地块地壳在从南向北的挤压作用下呈现出明显的"浅弱深强"特点;(6)最大水平应力方向的总体特征,基本以青藏高原为中心,呈辐射状展布,由西向东,从近N-S方向逐步顺时针旋转至NNE-SSW、NE-SW、NEE-SWW、NW-SE方向,与深部的震源机制解研究结果有一致性.

关键词 中国大陆, 地应力测量, 回归分析, 活动地块, 地震带

Abstract:

The latest hydraulic fracturing and stress relief measurement data of Chinese mainland was collected and supplemented to the "Database of Crustal Stress in China and Adjacent Area" which was established in 2003. The entries of in situ stress data measured at 1474 points are 3586. The longitude, latitude, and depth range is 75° E—130° E, 18° N~47° N and 0~4000 meters respectively. Every active block and each section of north-south seismic belt have data more or less. Depth-grouping analysis was used in this paper to solve the problem caused by uneven distribution of measurement data along the depth. The magnitude and direction characteristics of stresses measured in the shallow crust of Chinese mainland and each study area were given. The result is summarized as follows. (1) The magnitudes of maximum horizontal stress, minimum horizontal stress, and vertical stress all increase linearly with depth; (2) The characteristics of the lateral pressure coefficient with depth can be described as follow. The distribution of K_{av} is scattered in superficial crust, becomes more concentrated in the deeper crust and trends to 0.68. At a depth of 465 m K_{av} equals to 1 which indicates the transition from horizontal to vertical stress domination. (3) The magnitude of horizontal differential stress equals to 3 MPa at surface. The growth gradient is 5.8 MPa/km. (4) In the middle depth range of measurement data in Chinese mainland (i.e. depth equals to 2000 meters), the descending order of stress magnitudes in various blocks is: 63.6

MPa in Qinghai-Tibet, 57.3 MPa in north section of north-south seismic belt, 51.4 MPa in south China, 50.5 MPa in north China, 47.9 MPa in middle section of north-south seismic belt, 47.5 MPa in northwestern China, 45.4 MPa in south section of north-south seismic belt, and 44.8 MPa in northeast China. Generally, the basic characteristic of magnitude is high in west and weak in east. This indicates that the strong collision of Indian plate and Eurasian plate determines the general strength characteristics of tectonic stress field in Chinese mainland. (5) Compared to most other study regions, the crustal stress magnitude feature of the Qinghai-Tibet block under northward compression is lower in the shallow and higher in the deep. (6) The general direction characteristics of maximum horizontal stress basically spread radially from the center of Tibetan Plateau. The directions of maximum horizontal stress gradually rotate clockwise from N-S to NNE-SSW, NE-SW, NEE-SWW, NW-SE and are consistent with the result of focal mechanism solution.

Keywords Chinese mainland, In-situ stress measurement, Regression analysis, Active block, Seismic belt

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