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2008年汶川 M_S 8.0地震前龙门山—岷山构造带的地震活动性参数与地震视应力分布

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Distributions of seismicity parameters and seismic apparent stresses on the Longmenshan-Minshan tectonic zone before the 2008 M_S 8.0 Wenchuan earthquake

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摘要

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摘要 本文利用四川区域台网最近30多年的地震资料, 计算了2008年四川汶川 M_S 8.0地震前沿龙门山—岷山构造带的多个地震活动性参数(包括震级-频度关系中的 a 、 b 与 a/b 值, 复发间隔 T_r 值), 同时, 计算了震前2年多的时间内 $M_L \geq 3.5$ 地震的视应力。在此基础上分析了地震活动性参数值和地震视应力的空间分布与汶川主震破裂范围、 $M_S \geq 5.0$ 余震分布的关系。主要结果表明: ①汶川地震前, 沿龙门山—岷山构造带的地震活动性参数与地震视应力的分布均存在显著的空间差异。其中, 龙门山断裂带中-北段的绵竹—茂县段与江油—平武段具有远低于区域平均值的显著异常低 b 值、低 a 值、相对较高 a/b 值以及较小复发间隔 T_r 值的参数值组合, 反映这两个断裂段在汶川主震之前已处于高应力闭锁状态, 且发生强震的概率明显高于其他段落。这两个段落成为汶川主震破裂的中心段落和破坏严重的地段; ②汶川地震前, 位于前述两断裂段之间的龙门山断裂带北川段具有较高的 b 值与 a 值、较低 a/b 值的参数值组合, 显示出应力积累水平不高的状态。汶川主震后, 北川断裂段的余震强度与频度均偏低, 缺少 $M_S \geq 5.0$ 的余震; ③地震活动性参数与视应力显示汶川地震之前龙门山断裂带南西段的应力积累水平明显低于中-北段, 这种差异可能与汶川主震破裂沿断裂带中-北段呈北东向单侧扩展有关。另外, 地震活动性参数值组合也反映龙门山断裂带南西段近期发生大地震的可能性较小。

关键词: 龙门山—岷山构造带 汶川地震 地震活动性参数 视应力 余震

Abstract: Using the seismic data from the Sichuan Seismic Network, we calculate several seismicity parameters (including the a and b values in the frequency-magnitude relationship, the ratio of a and b , and the recurrence interval T_r) on the Longmenshan-Minshan tectonic zone for the last 30 years before the 2008 M_S 8.0 Wenchuan, Sichuan, earthquake. We also calculate the apparent stresses of $M_L \geq 3.5$ earthquakes in the study area for the last over 2 years just before the Wenchuan earthquake. Based on the calculations, we analyze the relationships between the distributions of the seismicity-parameters and the apparent stresses and both the extent of the Wenchuan mainshock's rupture and the distribution of the $M_S \geq 5.0$ aftershocks. The result mainly shows that, (1) Before the Wenchuan earthquake, the spatial distributions of seismicity parameters and the apparent stresses were significantly heterogeneous on the Longmenshan-Minshan tectonic zone. The sections of Mianzhu-Maoxian and Jiangyou-Pingwu of the central and northern segments of the Longmenshan fault zone were of anomalously low b -values that were much lower than the regional mean one, low a -values, relatively high a/b values and relatively short recurrence intervals T_r . Such a parameter combination suggests that these two fault-sections seemed to have been locked under high stress and to have higher probability for strong or major earthquakes occurring than the other segments before the Wenchuan earthquake. Actually, these two fault sections have become the central segment of the rupture and suffered severe damage during the Wenchuan mainshock. (2) Before the Wenchuan earthquake, the Beichuan fault section, that is between the above mentioned two fault sections, had the parameter combination of relatively high b and a values, as well as relatively low a/b values, implying that it was a fault section with not-high stress level. Following the Wenchuan mainshock, this section has shown relatively low level of aftershock activity without $M_S \geq 5.0$ aftershock events. (3) From the distributions of the seismicity parameters and the apparent stresses it has been suggested that the stress level cumulated on the southwestern segment of the Longmenshan fault zone seemed to be lower than that on the central and

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northern segments of the fault zone before the Wenchuan earthquake. This difference of the background stress levels on the southwestern and the central to northern segments could be related with the unilateral and northeastward rupture propagation of the Wenchuan mainshock. In addition, the seismicity parameter value combination also suggests that there may be little chance for a major earthquake occurring on the southwestern segment of the Longmenshan fault zone in the near future.

Keywords: Longmenshan-Minshan tectonic zone Wenchuan earthquake Seismicity parameters Apparent stress Aftershocks

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