

2013 年 7 月 22 日岷县漳县 6.6 级地震前 地震相关长度增长现象^①

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摘要:利用单键群分析方法研究了 2013 年 7 月 22 日岷县漳县 6.6 级地震前地震空间相关长度增长现象。结果表明,从 2011 年下半年开始主震周围区域地震空间相关长度明显增长。利用这种特征对可能的大震危险区进行网格式搜索,至少可以对未来强震发生的地点进行初步预测。

关键词:岷县—漳县 6.6 级地震;地震空间相关长度;单键群方法(SLC)

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Analysis of the Growth Phenomenon of Seismic Correlation Length Prior to Minoxian—Zhangxian Earthquake

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Abstract: The seismic correlation lengths prior to the Minoxian—Zhangxian earthquake occurring on July 22, 2013, have been studied using the single-link cluster analysis (SLC) method. The catalogs used were downloaded from the China Earthquake Data Center (CEDC; <http://data.earthquake.cn/data/>). Earthquakes that occurred during the five years prior to the main shock until its origin time were located in an area centered on the main shock (34.5°N , 104.11°E) with a range of $32^{\circ}\sim 37^{\circ}$, $102^{\circ}\sim 107^{\circ}$. We selected 2.5 (M_L) as the minimum magnitude and verified the completeness of the catalogs prior to the mainshock using the Gudengberg formula, which showed good results above magnitude $M_L=2.5$. The result shows that an increase in correlation length for moderate-sized earthquakes was observed nearly 1.5 years before the main shock and can be fitted well by the power law. For the preparation and occurrence stage of the earthquake process characterized as a self-organized critical phenomenon, direct testing for the increase in spatial correlation lengths prior to large earthquakes is an independent approach used to detect critical point behavior in observed seismicity. The results of this study show that the self-organized critical point characteristic was been observed prior to the Minoxian—Zhangxian $M_s 6.6$ earthquake. The results from the many earthquake examples indicate that the increase in seismic correlation length by the power law represents a physical process of critical-point characteristics in the source area in preparation of the main earthquake. In a future work, the grid search technique is

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applied to systematically extract a region of increased correlation length from a dataset. Estimates for the epicenter of an expected mainshock may be then obtained from the results of the grid search.

Key words: Minxian—Zhangxian $M_s 6.6$ earthquake; seismic spatial correlation length; single-link cluster analysis (SLC)

1 资料和研究结果

2013 年 7 月 22 日在甘肃岷县漳县发生了 6.6 级地震。本文利用单链群分析方法^[1]研究岷县漳县 6.6 级地震前地震空间相关长度增长现象。

地震目录: 从国家地震科学数据共享中心 (CEDC) 下载 (<http://data.earthquake.cn/data/>)。

时间范围: 2009-01-01 至 2013-07-22 主震发生。

空间范围: 以主震为中心 (北纬 34.5° , 东经 104.18°), 大致 5° 的范围 (北纬 $32^\circ \sim 37^\circ$, 东经 $102^\circ \sim 107^\circ$)。

震级下限: $M_L 2.5$ 。

以上区域和地震分布如图 1。

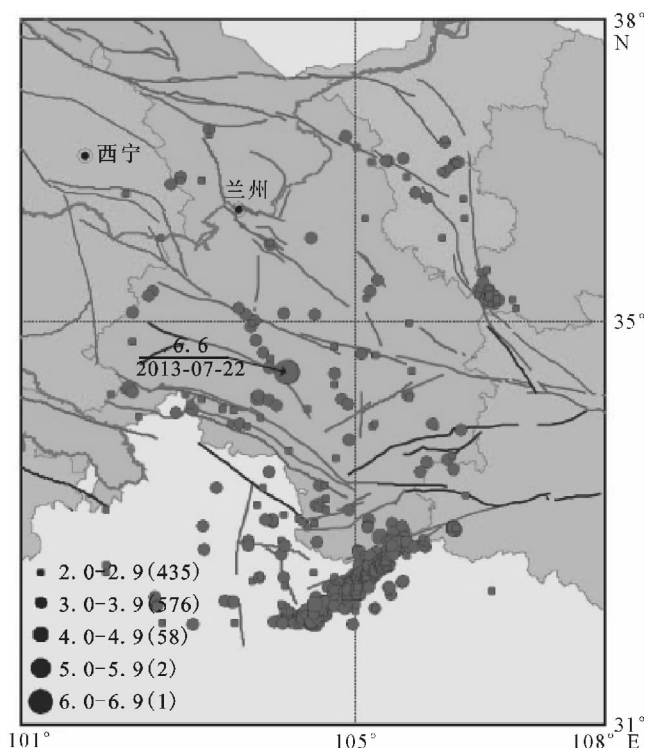


图 1 以主震震中为中心, $5^\circ \times 5^\circ$ 范围内地震分布

Fig. 1 Distribution of earthquakes in the area centered at the epicenter of main shock with $5^\circ \times 5^\circ$ range

根据中国地震局发布的甘肃岷县漳县 6.6 级地震烈度图^[2], 地震极震区烈度为Ⅷ度, 等震线长轴呈 NW 走向分布。因此在计算中选择以主震为中心, 长

轴方向大致与等震线长轴走向一致的椭圆为临界区域。

用古登堡公式对所用的主震前的地震目录进行了完备性检验, 其震级—频度图如图 2, 可以看出所用的地震目录在 $2.5 (M_L)$ 以上是完备的。

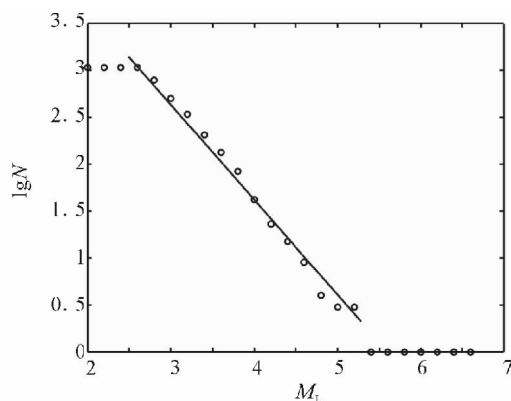


图 2 所用地震目录的震级—频度图

Fig. 2 The magnitude-frequency plots for the used catalog

主震前相关长度计算结果如图 3。

2 讨论

从 2009 年至主震发生时的整体资料 (图 3(a)) 来看相关长度的幂指数拟合不是很好, 但是从图中可以看到, 从 2011 年下半年开始地震空间相关长度增长比较显著。从 2011 年开始的资料和结果如图 3(b), 可以清楚地看到在主震发生前大致一年半开始主震周围区域的地震空间相关长度明显增长。

大地震之前地震空间相关长度的增长是地震孕育和发生具有自组织临界特征的表现^[3]。迄今为止已经有许多震例研究表明在中强地震发生前大致一至两年的时间孕震区域会出现中小地震空间相关长度增长的现象, 例如美国加州北纬 $32^\circ \sim 40^\circ$ 之间 1952 年来发生的 9 次 $M \geq 6.5$ 地震^[4]、近 17 年来发生在甘肃及邻近地区的数次 6 级左右地震^[5]、日本 9.0 级地震 (2011 年 3 月 11 日)^[6]、汶川 8.0 级地震 (2008 年 5 月 12 日)^[7]、2004 年以来苏门答腊北部海域两次强震 (分别是 2004 年 12 月 26 日 $M_w 9.1$ 和 2012 年 4 月 11 日 $M_s 8.6$)^[8]、芦山 7.0 级地震 (2013 年 4 月 20 日)^[9] 等。本文的研究结果进一

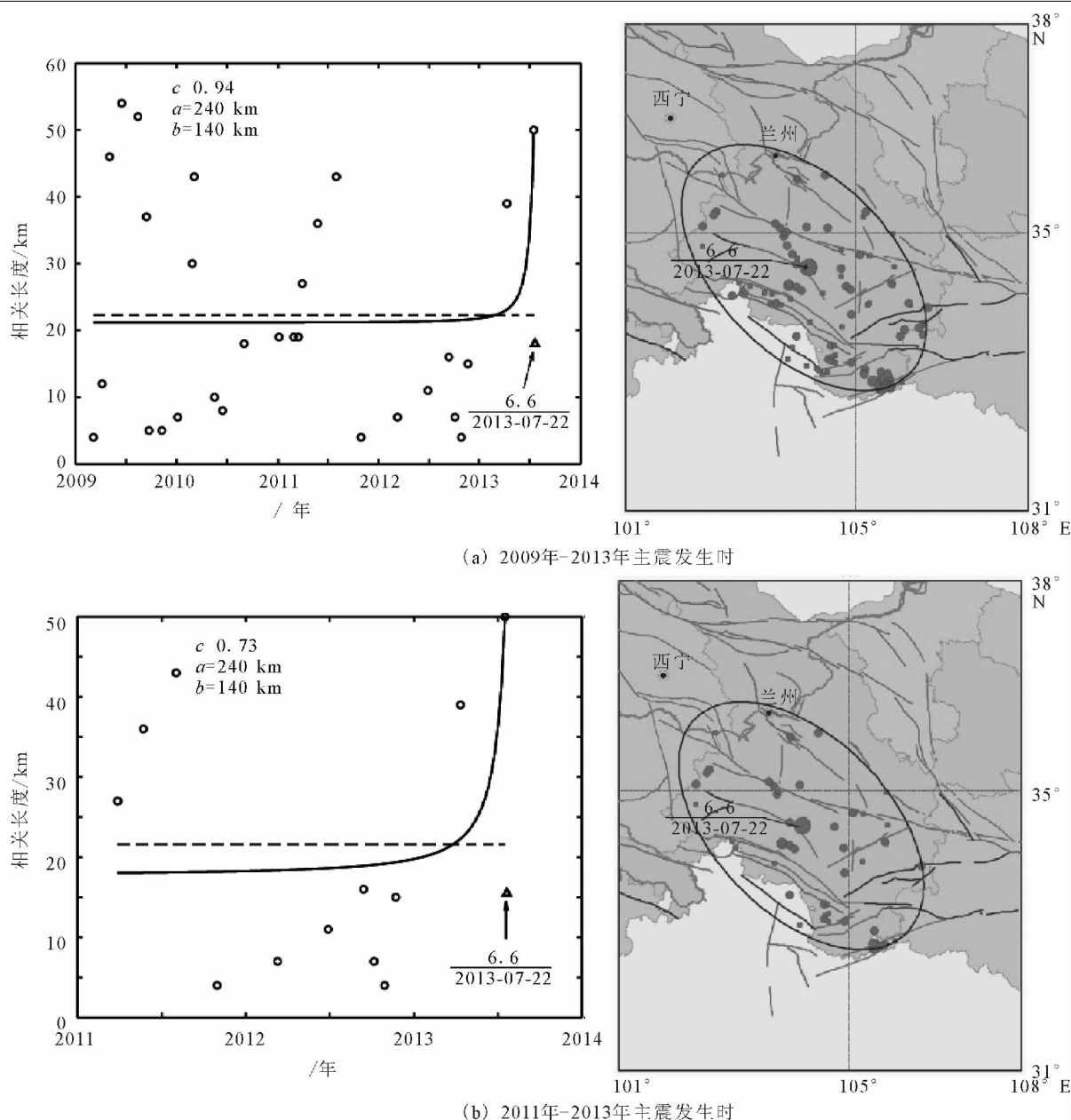


图 3 相关长度变化结果(左图为地震相关长度变化图(实线为幂指数拟合,虚线为常数拟合),右图为对应的临界区域和地震分布)

Fig. 3 The result of correlation length changing

步验证了这种现象,观察到了强震前明显的地震活动的临界点特征。同时表明利用这种特征对可能的大震危险区进行网格搜索,至少可以对未来强震发生的地点进行初步预测。

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