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汶川地震区地壳速度相对变化的环境噪声自相关研究

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Crustal velocity changes associated with the Wenchuan M8.0 earthquake by auto-correlation function analysis of seismic ambient noise

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摘要

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摘要 2006年中国地震局地质研究所地震动力学国家重点实验室在川西地区(100° E~105° E, 26° N~32° N)布设了由297个宽频带地震台组成的密集流动地震观测台阵. 本文利用川西流动地震台阵29° N以北地区的137个台站2007年1月至2008年10月的连续三分量地震环境噪声记录, 研究了汶川地震震前震后地壳速度变化特征. 借助川西台阵的密度优势, 我们针对单台三分量噪声自相关函数和单台不同分量间的互相关函数, 利用互谱移动窗技术, 在0.33~1 Hz频带范围内测量了经过50天滑动平均的相关函数与长时间平均参考相关函数的走时变化率, 进而求得地壳浅部速度随时间的相对变化, 并得到其空间分布特征. 本文结果表明, 利用环境噪声自相关方法可以得到与互相关方法基本一致的同震速度变化分布图像, 同震速度变化分布与同震体应变具有明显相关性. 具有更高空间分辨率的噪声自相关研究进一步发现, 在鲜水河断裂和龙门山断裂交汇区存在同震速度增加区, 这个区域与同震库伦应力变化和地表形变观测预测的周边断层库伦应力增加区一致. 我们的研究发现, 同震库伦应力增加效应的持续时间大约为2个月左右, 在此之后, 区域应力场逐渐恢复为普遍的应力下降.

关键词 环境噪声, 自相关函数, 地震波速变化, 汶川地震, 川西台阵

Abstract: A temporal seismic array consisted of 297 broadband seismographs was deployed in Western Sichuan (100° ~105° E, 26° ~32° N) in 2006, and the observation covered the great 2008 Wenchuan earthquake. We used the continuous three-component ambient noise data from January, 2007 to October, 2008, recorded at the 137 stations north of 29° N, to study the crust seismic velocity changes before and after the earthquake. For every single station, three autocorrelation functions (ACF) and three cross correlation functions (CCF) are calculated and stacked in 10 days for three components of noise data respectively. Then we estimated the relative velocity changes by measuring travel time shifts between the 50-day-moving-average stacks and the reference correlation functions. We obtained the characteristic of spatial distribution of relative velocity changes caused by Wenchuan earthquake. Our results indicate that ACF analysis can get similar coseismic velocity changes pattern with the CCF method, and the distribution of coseismic velocity changes is closely correlated with the volumetric strain changes during the Wenchuan earthquake. We also found an area of velocity increase in the region where the Longmenshan Fault zone adjoins the Xianshuihe Fault zone. This area is consistent with the faults that the Coulomb stress increased by the occurrence of the Wenchuan earthquake as predicted by the source mechanism and surface deformation. We also found that the crustal velocity increase lasted for about 2 months and then decreased with ubiquitous stress release in the studying region.

Keywords Ambient noise, Auto-correlation function, Seismic velocity change, Wenchuan earthquake, Western Sichuan seismic array

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