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双层黏弹介质模型条件下地震应力扰动的时空特征

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The spatio-temporal features of earthquake stress perturbation based on the simplified two-layer viscoelastic medium model

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摘要 基于简化双层黏弹介质模型及其变形过程的时间属性,考虑震后地壳上层(黏滞性相对较弱)短时间的弹性扰动及后续较长时间内下层(黏滞性相对较强)黏性变形对上层应力扰动的联合作用,研究地震应力扰动的时空变化.结果显示,地震应力扰动在震后一段时间内逐渐增大,之后缓慢衰减.并且模型参数越接近真实地体,应力扰动增大及衰减过程就越缓慢,持续时间越长,即地震活动具有较长时期的时间"记忆"特性.因而,在地震活动及库仑应力变化研究中,长时期的应力扰动影响不宜忽略.地震应力扰动有一定的空间作用范围,在此范围内应力扰动随距离衰减明显,距离震源较近处衰减较快、距离震源较远处衰减相对较慢,此范围之外应力扰动可忽略不计.在本文所取与实际地壳相对较为接近的模型参数条件下,应力扰动的空间作用范围大体是震源线性破裂尺度的2.5倍.地震应力扰动随震级增大而逐渐增大,在本文模型参数条件下,震级大于6级之后,应力扰动随震级快速增加.地震破裂尺度测量误差所导致的应力扰动计算误差的相对大小,与时间无关,与破裂尺度(震级)及震源距有关,随震源距的增大而增大,但对应力扰动的总体变化趋势及变化范围影响甚微.当距离足够远时,应力扰动计算误差的相对大小趋于常数,就6、7、8级地震而言,最大应力扰动计算误差分别小于应力扰动值本身的22%、30%及38%.

关键词 双层黏弹介质地壳模型, 地震应力扰动, 持续时间, 作用范围, 主震震级

Abstract: Based on the simplified two-layer viscoelastic medium model and its temporal characteristics of the deformation process, considering the joint action of the instantaneous elastic stress perturbation in the upper layer (more elastic) and the delayed and long-term load on upper layer due to the viscous relaxation deformation in lower layer (more viscous), the spatio-temporal variation of the earthquake stress perturbation has been studied. The results show that the stress perturbation increases quickly during a short time since the earthquake and then decays slowly for a long time. And when model parameters approach to real data more and more, the increasing and decay process of the stress perturbation is slower, and the duration becomes gradually longer. In another word, the earthquake activity has a long-term 'memory' feature. Therefore, the long-term influence of stress perturbation could not be ignored in the study of earthquake activity or Coulomb stress changes. The stress perturbation has a limited acting range in space. It decreases obviously with distance inside the range, the decay is quick nearby the epicenter and is slow far away from the epicenter. The stress perturbation could be ignored outside the range. For the model parameters used in this paper, which approach to the real status for some extent, the effective acting range of the stress perturbation is about 2.5 times of the linear fracture size of the earthquake. The stress perturbation increases gradually with the mainshock magnitude, for the assumed model parameters in this paper, it increases more quickly when magnitude is larger than *M*6. The relative error of stress perturbation, resulting from the measurement errors of the fracture size, is relational to the fracture size (magnitude) and epicenter distance, and there is no relationship with the time. The relative error increases with the epicenter distance, but its total influence on changing tendency and numerical range of the stress perturbation are very small, it tends to constant when distance is large enough. For earthquake with magnitude *M*6, *M*7 and *M*8, the maximum relative errors of stress perturbation are smaller than 22%, 30% and 38%.

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