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## 强震前的“加速矩释放”(AMR)现象: 对一个有争议的地震前兆的回溯性震例研究

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### Accelerating Moment Release (AMR) before strong earthquakes: A retrospective case study of a controversial precursor

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摘要

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摘要 近年来,国际上对于强震前的加速矩释放(AMR)现象是否可作为一种可靠的、带有普遍性的地震前兆现象争议较大.本文以2008年3月21日新疆于田 $M_S7.3$ 地震为例,试图从前兆存在的客观性和与地震发生的物理相关性两方面考察本次地震前的AMR现象.用“破裂时间分析”方程中的幂指数 $m$ 作为描述震前加速矩释放“程度”的参量,在时间-空间-地震序列截止震级组成的三维参数空间 $(T, R, M_c)$ 内考察AMR现象存在的客观性.考虑了多种因素对 $m(T, R, M_c)$ 分布图像可能的影响,其中,余震是否删除和 $M_c$ 对计算影响不大,但 $M_L6.0$ 以上“干扰”事件的影响则较大.结果表明,于田地震前的确存在AMR现象,但得到的 $m(T, R, M_c)$ 分布图像较为复杂,可观测到两个明显的AMR集中分布区.此外,在以实际震中为圆心的多个圆形区域内,使用固定时间窗向实际发震时刻滑动逼近,可观测到 $m$ 值逐渐减小,即加速特征逐渐明显的过程.对震前矩释放程度 $m$ 值的时-空扫描结果显示,出现AMR现象的空间区域与震中位置似有较好的对应,但其时-空演化图像与滑动时-空窗的选取有关.这表明,本次 $M_S7.3$ 地震前的确存在AMR现象,并与其孕震过程在物理上相关.但本文仅是一个震例的研究,无法给出具有统计显著性的结论,此外,用AMR来约束地震发生的时间看来是困难的.

关键词 新疆于田 $M_S7.3$ 地震, 加速矩释放(AMR)现象, 地震的类临界点模型, 地震矩释放程度扫描

Abstract: Since recent years there has been the controversy on whether accelerating moment release (AMR) can be regarded as a reliable intermediate-term precursor of strong earthquakes with generality. Taking the March 21, 2008, Yutian, Xinjiang,  $M_S7.3$  earthquake as an example, we conducted a case study focusing on the reliability and physical relevance of AMR. We investigate the generality of AMR by mapping  $m$ , the exponent in the power-law-like ‘time-to-failure’ function describing the moment release, in the  $(T, R, M_c)$  space, where  $T$  and  $R$  are the scales of temporal and spatial window, respectively, and  $M_c$  is the cutoff magnitude of earthquake catalogue in use. Various factors potentially affecting the result are considered. It is observed that declustering of catalogues has less influence on the distribution of  $m(T, R, M_c)$ , while the ‘interfering events’ with magnitude larger than  $M_L6.0$  have more influence. AMR can be observed before the earthquake, albeit the pattern is complicated. The distribution of  $m(T, R, M_c)$  in the  $(T, R, M_c)$  space shows two clusters of accelerating-like  $m$ . Furthermore, when the spatial range is taken as a fixed circle centered at the epicenter of the main shock,  $m$  value is found to decrease gradually with the time window approaching the earthquake, implying the strengthening of AMR behavior before the quake. Spatio-temporal mapping of  $m$  value shows that the region with accelerating moment release correlates well with the source region, but such correlation depends on the sliding window selected. It turns out that AMR does exist before the Yutian earthquake, and such AMR behavior may have physical relevance in the process of earthquake preparation. Being only a retrospective case study, however, statistical significance of AMR cannot be confirmed by the present result. Moreover, constraint of failure time by AMR analysis is shown to be difficult, at least for this case.

Keywords Yutian  $M_S7.3$  earthquake, Accelerating Moment Release (AMR), Critical-point-like model of

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