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２００４年スマトラ島沖地震による遠隔誘発された中国雲南省の地震活動
Remotely triggered seismicity in Yunnan, Southwestern China following the 2004 Mw9.3 Sumatra earthquake

雷 興林[1*], 解　朝 DI[2], 傅　碧宏[3]
Xinglin Lei[1*], Chaodi Xie[2], Bihong Fu[3]

[1] 産業技術総合研究所, [2] 雲南大学地球物理学科, [3] 中国科学院地質地球物理研究所
[1]Geological Survey of Japan, AIST, [2]Department of Geophysics, Yunnan Univers, [3]Institute of Geology and Geophysics, Aca

Following the 2004 Mw9.3 Sumatra earthquake, seismicity increased sharply over a wide area of up to ˜2,500 km away in Yunnan province, southwestern China. Raised seismicity lasts for approximately 14 days. During this period, more than 800 events having a magnitude of >=1.5 were observed, including at least 7 M4 class events and a M5.1 event. This is perhaps the most impressive example of remotely triggered seismicity yet observed. Major events were clustered at several sites that exhibit complex fault geometries, such as step-overs and junctures. We use statistic approaches including the Beta-statistics to examine the statistical significance of the seismic rate increases associated with the Sumatra mainshock and conclude that there is a reasonable probability that the raised seismicity was remotely triggered by the Sumatra earthquake.

Both rapid-onset dynamic triggering and delayed response were well established. During the first hour of event time (time from the origin time of the Sumatra earthquake), we can identify and locate at least 7 M1.5+ earthquakes. These events are embedded in the body waves and surface waves from the Sumatra earthquake. However, clear records at some stations are obtained by applying a high-pass filter to the original seismograms. The first identified event is a M4.6 earthquake occurred during the passage of the surface waves from the Sumatra earthquake. However, major clusters likely demonstrate significant delays in the onset of triggering seismicity, with the dominant energy releasing a few hours to a few days after the surface wave passed.

We use the epidemic-type aftershock sequence (ETAS) model to examine seismicity in the study in 2004 through 2005. Two major changing points and thus three phases (I through III) of activity pattern, are well determined. The second phase (II) corresponds to the period of seismic activity remotely triggered by the Sumatra earthquake. The ETAS models show great p0 (>30%) and small Alfa, which are 1.368, 0.804, and 1.328 for phases I, II, and III, respectively. Therefore, the triggered activities show earthquake swarm-like characteristics such as that indicated by the epidemic-type aftershock sequence (ETAS) modeling results (large percentage of random components and less magnitude dependence in Omori law type self triggering).

Multiple sources of evidence, including intensive hydrothermal activities, and low velocity and high Vp/Vs zones in the lower to middle crust suggests that magma/mantle-generated fluids have a role in the region. High fluid pressure in branched fault zones weakened the faults, making them sensitive to external disturbances and leading to fluid-driven seismicity.

キーワード: 遠隔誘発, ETAS, 流体駆動地震活動, 雲南, スマトラ島沖地震
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