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Anomalous stress diffusion, Omori's law and Continuous Time Random Walk in the 2010 Efpalion aftershock sequence (Corinth rift, Greece)

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Efpalion aftershock sequence occurred in January 2010, when an M=5.5 earthquake was followed four days later by another strong event (M=5.4) and numerous aftershocks (Karakostas et al., 2012). This activity interrupted a 15 years period of low to moderate earthquake occurrence in Corinth rift, where the last major event was the 1995 Aigion earthquake (M=6.2). Coulomb stress analysis performed in previous studies (Karakostas et al., 2012; Sokos et al., 2012; Ganas et al., 2013) indicated that the second major event and most of the aftershocks were triggered due to stress transfer. The aftershocks production rate decays as a power-law with time according to the modified Omori law (Utsu et al., 1995) with an exponent larger than one for the first four days, while after the occurrence of the second strong event the exponent turns to unity. We consider the earthquake sequence as a point process in time and space and study its spatiotemporal evolution considering a Continuous Time Random Walk (CTRW) model with a joint probability density function of inter-event times and jumps between the successive earthquakes (Metzler and Klafter, 2000). Jump length distribution exhibits finite variance, whereas inter-event times scale as a q-generalized gamma distribution (Michas et al., 2013) with a long power-law tail. These properties are indicative of a subdiffusive process in terms of CTRW. Additionally, the mean square displacement of aftershocks is constant with time after the occurrence of the first event, while it changes to a power-law with exponent close to 0.15 after the second major event, illustrating a slow diffusive process. During the first four days aftershocks cluster around the epicentral area of the second major event, while after that and taking as a reference the second event, the aftershock zone is migrating slowly with time to the west near the epicentral area of the first event. This process is much slower from what would be expected from normal diffusion, a result that is in accordance to earthquake triggering in global scale (Huc and Main, 2003) and aftershocks diffusion in California (Helmstetter et al., 2003). While other mechanisms may be plausible, the results indicate that anomalous stress transfer due to the occurrence of the two major events control the migration of the aftershock activity, activating different fault segments and having strong implications for the seismic hazard of the area.

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