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Omori Law and fluid driven aftershocks: A non-linear diffusion process

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The aftershock sequences following different earthquakes are investigated to test the hypothesis that aftershocks are triggered by the co-seismic release of high-pressure fluids derived from depth. The data suggests that high a pressure source drives the fluid through the crust, triggering events along the flow path. The positive feedback between fluid-pressure-driven faulting, and the subsequent large-scale change hydraulic properties due to slip, allows the pressure pulse to travel at high rates. Coupling large co-seismic permeability changes with an effective-stress-dependent permeability results in a highly non-linear diffusion process. Models of this scenario show that it consequently generates Omroi´s Law. The decay rate, described by the p-value, is shown to be controlled by the orientation of the mainshock rupture relative to the regional stress field. The rate of aftershocks decays rapidly when the rupture is mis-aligned from that optimal for failure relative to the regional stress field, and decays more slowly when the rupture is optimally aligned with the regional stress field. That is, high effective normal stress for non-optimally oriented planes restricts permeability, subsequently shutting down the permeable pathways and suppressing aftershocks. Conversely, the high permeability of optimally oriented faults allows flow paths to remain open for longer periods and thus contribute to longer aftershock sequences.