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Prediction of seismic moment release of aftershocks by a kinetic law

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We modelled the temporal behaviour of the cumulative seismic moment releases of aftershock sequences by a kinetic approach of the fracture mechanism. This approach considers that the relation between applied stress and time-to-break is conditioned by two competing phenomena occurring in the fracture zone: the breakage of unbroken elements and the reformation of broken elements. With respect to the familiar log-linear relation between stress and fracture time of static fatigue, the present approach also considers the damage evolution of the material during the fracture process. From a math point of view it means a modification of the log-linear relation by the introduction in the equation of a new factor that represents the fraction of integrity of the materials: the result is a better fit of experimental data. The aftershock model we derived has been applied to seven aftershock sequences of Californian earthquakes selected from the SCEC database: the mainshocks range from M=5.45 to M=7.3. We considered a total time interval of 120 days following the mainshock, but for Whittier Narrows (110 days), with the same magnitude threshold (M=1.8) for all the sequences. The total number of events considered ranges from the 470 of Whittier Narrows (October 1, 1987) to the 12573 of Landers (June 28, 1992). To check the predictive validity of the model we analysed the forecast of the cumulative seismic moment release as a function of time: we defined τ as the elapsed time, since the mainshock, required to evaluate the costants of the equation sufficient to obtain predictions of the cumulative seismic moment with maximum error of 3 days for the whole remaining sequence. We obtained τ = 2.8 days for Whittier Narrows, τ = 3 days for Landers, τ = 15 hours for Northridge (January 17, 1994), τ = 9 days for North Palm Springs (July 8, 1986) and τ = 6 days for Hector Mine (October 16, 1999). Unfortunately two sequences, Ridgecrest (September 20, 1995) and Oceanside (July 13, 1986) showed very unsatisfactory results.