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Thermal effects on the time occurrence of earthquake failures: a deterministic approach.

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Understanding the complexity of the fault dynamics and the seismicity recurrence may help to improve the earthquake prediction and can give significant advances in seismic hazard assessment. Numerical models of chemical and physical phenomena occurring during faulting represent a valuable tool to explore realistic configurations that are very often far from being fully reproduced in laboratory experiments, due to intrinsic and technical limitations. The time recurrence of earthquakes has been frequently modeled through an analog fault system known as the spring-slider model (a damped harmonic oscillator), which simulates the interaction between slip surfaces and the surrounding elastic medium. On the basis of several experiments conducted on the spring-slider system, laboratory-derived constitutive laws have been carried out in order to describe the time evolution of the friction. In the present study we have considered different analytical formulations of the rate- and state- dependent friction laws, the Dieterich-Ruina (DR), the Ruina-Dieterich (RD) and the Chester and Higgs (CH). Our numerical simulations clearly show that the duration of the seismic cycle (i.e. the time range separating two subsequent instabilities) depend on the specific analytical formulation of the constitutive law assumed to govern the seismogenic fault. In particular, our results have showed that a spring-slider system governed by the CH constitutive law requires a lower time interval to undergo to a seismic instability. Moreover, we want to highlight that the present results clearly demonstrate that the deterministic prediction of the earthquake occurrence, even in the simplest case of a single isolated fault, is markedly affected by the non-obvious choice of the constitutive law.