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孤立したアスペリティでの複雑な地震サイクル
Complicated recurrence of slip events on a uniform circular asperity

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Numerical simulation of repeated occurrence of slip events on a fault patch (asperity) is conducted to understand the mechanism of irregular sequence of slip events. The fault is uniformly shear loaded at a constant rate, and frictional stress acting on the fault is assumed to obey a rate- and state-dependent friction (RSF) law. A circular patch with velocity-weakening frictional property is embedded in a fault with velocity-strengthening frictional property elsewhere. A numerical simulation is conducted by varying the characteristic slip distance L of the RSF law. Slip behavior changes as L increases. When L is small, seismic slip events (earthquakes) repeatedly occur at a constant time interval. As L increases, recurrence of slip events becomes complex. Period doubled slip pattern, where seismic and aseismic slip events alternately occur, multiperiodic pattern, and aperiodic patterns occur. At the same time, slip tends to be aseismic with increasing L. The distributions of shear stress on the fault before the slip events are variable because of variations of the residual stress in the preceding slip event and aseismic sliding during an interseismic period. This variation in shear stress causes the complex sequence of slip events. Iteration maps of the recurrence intervals of slip events are examined by taking a plot of Ti versus Ti+1, where Ti denotes the time interval between the ith and (i+1)th slip events. Each iteration map for aperiodic sequence of slip events is expressed by a simple curve, suggesting that the occurrence time of the next event is predictable from the previous time interval and the slip event sequence exhibits deterministic chaos. To compare the simulation result of sequence of slip events on a velocity-weakening patch embedded in a velocity-strengthening region, a numerical simulation of slip on a velocity-weakening patch enclosed by unbreakable barrier. In this case, no complex recurrence of slip events is observed. When L is smaller than a critical value, seismic slip events repeatedly occur at a constant interval. On the other hand, stable sliding occurs when L is larger than the critical value. This result indicates that the complex slip behavior for a velocity-weakening patch embedded in a velocity-strengthening region comes from the interaction between the velocity-weakening and velocity-strengthening regions.

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