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Numerical Simulations of Mechanical Erosion from below by Creep on Rate-State Faults

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The aim of this study is to increase our understanding of how earthquakes nucleate on frictionally-locked fault patches that are loaded by the growing stress concentrations at their boundaries due to aseismic creep. Such mechanical erosion from below of locked patches has previously been invoked by Gillard et al. (1996) to explain accelerating seismicity and increases in maximum earthquake magnitude on a strike-slip streak (a narrow ribbon of tightly clustered seismicity) in Kilauea's East rift, and it might also play a role in the loading of major locked strike-slip faults by creep from below the seismogenic zone. Gillard et al. (1996) provided simple analytical estimates of the size of and moment release within the eroding edge of the locked zone that matched the observed seismicity in Kilauea's East rift. However, an obvious, similar signal has not consistently been found before major strike-slip earthquakes. Here, we use simulations to determine to what extent the simple estimates by Gillard et al. survive a wider range of geometric configurations and slip histories. The boundary between the locked and creeping sections at the base of the seismogenic zone is modeled as a gradual, continuous transition between steady-state velocity-strengthening at greater depth to velocity-weakening surroundings at shallow depth, qualitatively consistent with laboratory estimates of the temperature dependence of (a-b). The goal is to expand the range of possible outcomes to broaden our range of expectations for the behavior of the eroding edge of the locked zones.