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How the changes of fault zone material properties influence earthquake nucleation and rupture

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Abstract Text:

The fault damage zone is a well-known structure of localized deformation around faults. Its material properties evolve over earthquake cycles due to coseismic damage accumulation and interseismic healing. We will present fully dynamic earthquake cycle simulations to show how the styles of earthquake nucleation and rupture propagation change as fault zone material properties vary temporally. First, we will focus on the influence of fault zone structural maturity quantified by near-fault seismic wave velocities in simulations. The simulations show that immature fault zones promote small and moderate subsurface earthquakes with irregular recurrence intervals, whereas mature fault zones host pulse-like earthquake rupture that can propagate to the surface, extend throughout the seismogenic zone, and occur at regular intervals. The interseismic healing in immature fault zones plays a key role in allowing the development of aseismic slip episodes including slow-slip events and creep, which can propagate into the seismogenic zone, and thus limit the sizes of subsequent earthquakes by releasing fault stress. In the second part, we will discuss how the precursory changes of seismic wave velocities of fault damage zones may affect earthquake nucleation process. Both laboratory experiments and seismic observations show that the abrupt earthquake failure can be preceded by accelerated fault deformation and the accompanying velocity reduction of near-fault rocks. We will use earthquake cycle simulations to systematically test the effects of timing and amplitudes of such precursory velocity changes. Our simulations will provide new insights into the interplay between fault zone structure and earthquake nucleation process, which can be used to guide future real-time monitoring of major fault zones.

Session Selection:

MR016. Pre-, Co-, and Post-Rupture Processes Across Multiple Scales

Invited Author?:

Yes

Submitter's E-mail Address:

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Abstract Title:

How the changes of fault zone material properties influence earthquake nucleation and rupture

Requested Presentation Type:

Assigned by Program Committee (oral, eLightning or poster discussion session)

Previously Published?:

Yes

Previously Published Material:

The first part of the presentation will focus on the influence of fault zone structural maturity in earthquake cycles. This work is currently being considered for publication in Geophysical Research Letters.

AGU On-Demand:

Yes

Abstract Payment:

Paid (agu-fm21-792472-1536-6106-1348-0067)

For non-students only: I would like to volunteer as an OSPA judge.

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