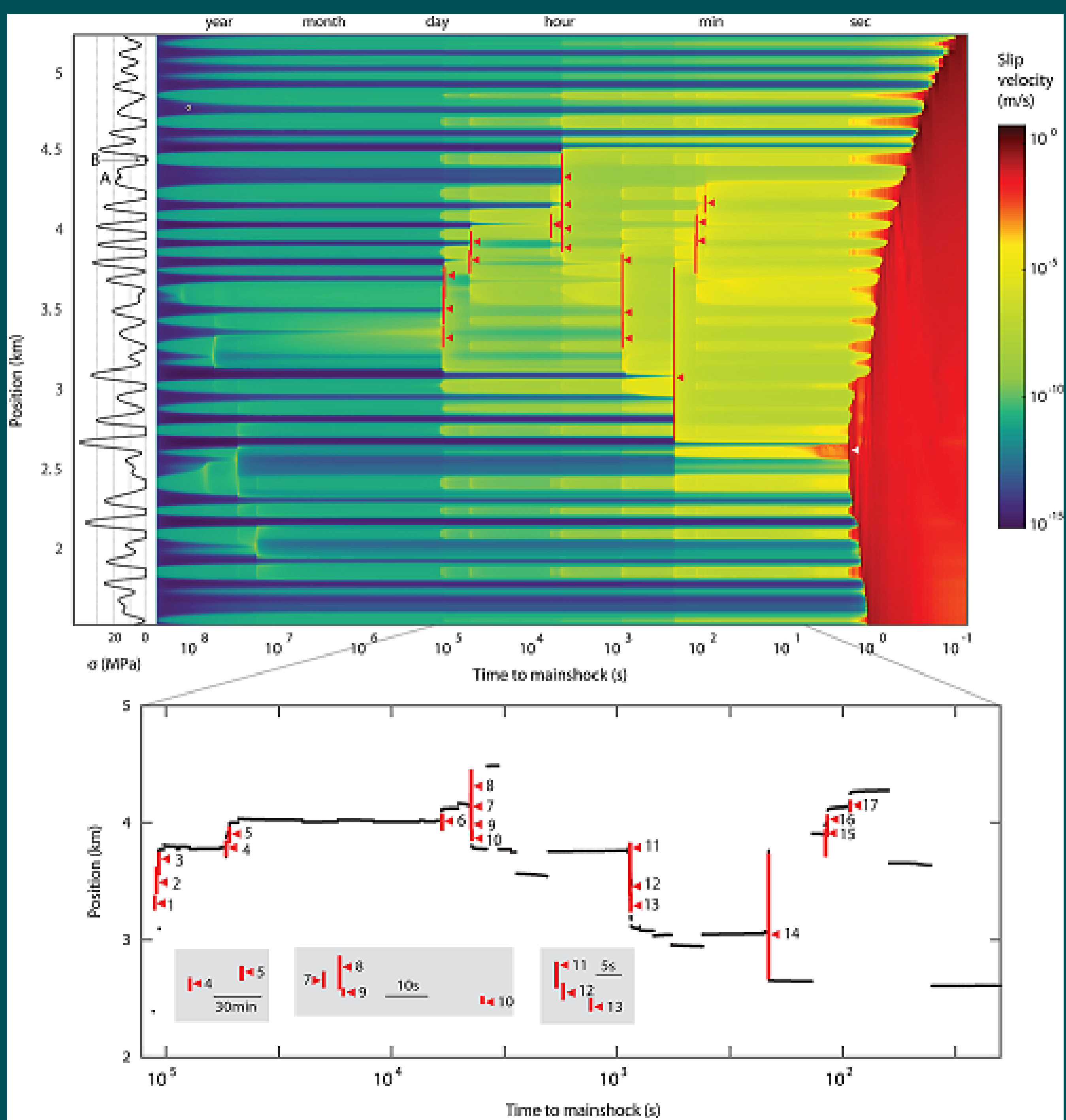
Chemical & Physical Sciences
UNIVERSITY OF TORONTO
MISSISSAUGA

COLLOQUIUM SEMINAR SERIES

HOW DO EARTHQUAKES BEGIN? NUMERICAL AND THEORETICAL INSIGHTS INTO THE NUCLEATION PROCESSES OF SMALL AND LARGE EARTHQUAKES



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Theoretical considerations and numerical studies predict a slow nucleation phase leading up to large earthquakes. This gradual acceleration provides a physical basis for earthquake precursors, including foreshock sequences and preseismic transients inferred geodetically. However, the conditions controlling nucleation on natural faults, and the significance of the (rarely) observed precursory signals, remain poorly understood.

Here I will present numerical and theoretical results on earthquake nucleation at different scales, exploring the role of geometrical complexity (fault roughness). I will argue that classical nucleation models are appropriate at small scales and short time intervals (tens of meters and seconds, respectively); while on larger scales, geometrical complexity facilitates a different style of precursory slip, described below. Slip behavior on a rough fault is controlled by heterogeneity in normal stress σ induced by roughness: regions with low σ begin to slip aseismically early in the cycle, loading high σ regions (asperities) which eventually fail seismically generating foreshocks. Since normal stresses modulate fault stability, the precursory phase comprises both foreshocks and preslip, but it is markedly different from classical nucleation predicted by the elasto-frictional response of uniform faults. Preslip on a rough fault is characterized by migratory seismicity; creep over an extended area (order of magnitudes larger than the nominal nucleation dimension); mainshocks nucleating on strong asperities at the edge of the preslip areas. These features are consistent with a number of observations at different scales, including laboratory experiments, sub-glacial slip events, and foreshock sequences of megathrust earthquakes.

Colloquium Seminar Series

Wednesday, February 16, 2022

Join us on Zoom at 3:10pm

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