Dynamics of Aseismic Slip on San Andreas Fault and Underlying Mechanisms

Understanding the evolution of aseismic slip enables constraining the fault's seismic budget and provides insight into dynamics of creep. Inverting the time series of surface deformation measured along the Central San Andreas Fault obtained from interferometric synthetic aperture radar in combination with measurements of repeating earthquakes, we constrain the spatiotemporal distribution of creep during 1992–2010. We identify a new class of intermediate- term creep rate variations that evolve over decadal scale, releasing stress on the accelerating zone and loading adjacent decelerating patches. We further show that in short- term (<2 year period), creep avalanches, that is, isolated clusters of accelerated aseismic slip with velocities exceeding the long- term rate, govern the dynamics of creep. The statistical properties of these avalanches suggest existence of elevated pore pressure in the fault zone, consistent with laboratory experiments. To further investigate the underlying mechanism of creep avalanches, using a rate and state friction model we show that effective normal stress is temporally variable on the fault, and support this using seismic observations. We propose that, compaction-driven elevated pore fluid pressure in hydraulically isolated fault zone and subsequent frictional dilation cause the observed creep avalanche episodes.