Geological record of thermal pressurization and earthquake instability of subduction thrusts

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During an earthquake, fault strength decreases with slip over the slip-weakening distance, Dc, to a residual strength. The estimation of Dc is crucial for the evaluation of fault instability during earthquakes; however, it has been difficult to determine Dc from natural faults. We found a geological evidence of thermal pressurization from the on-land analog of a subduction thrust exhumed from seismogenic depths, which is represented by fluidization of the comminuted material and increase in volume of fluid inclusions by frictional heating. Numerical analysis of thermal pressurization with the constraints on the thickness of the seismic slip zone, the temperature range of frictional heating, and ambient conditions of subduction thrusts indicates that the Dc of subduction thrusts ranges between 0.03 and 0.22 m, which is independent on the initial pore-fluid pressure on subduction thrusts. The short Dc associated with the effect of thermal pressurization on subduction thrusts indicate the occurrence of rapid stress relief and high radiated energy during subduction earthquakes.