

Thermal pressurization and fluidization of pulverized cataclastic rocks formed by coseismic slipping in seismogenic fault zones

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Pulverized cataclastic rocks, including fault gouge and microbreccia, can be injected into coseismic fractures as vein networks within seismogenic fault zones by thermal pressurization and fluidization of ultrafine- to fine-grained materials during large earthquakes (e.g., Lin, 1996, 2008; Rowe et al., 2012). This fluidization has been suggested to occur in a gas–solid–liquid system (Lin, 2011, 2017). The fractures that form during coseismic faulting represent void spaces that generate suction, thereby leading to the rapid intrusion of ultrafine- to fine-grained materials, with or without frictional melt, from the slip zone on the source fault. Thus, the physics of earthquakes can be strongly affected by thermal pressurization and fluidization within seismogenic fault zones.

This study focuses on the formation mechanisms of thermal pressurization of liquids and the fluidization of ultrafine- to fine-grained materials sourced from pulverized ultracataclastic rocks in seismogenic fault zones during faulting. Vein networks of pseudotachylite (Pt) and ultracataclastic rocks are composed mainly of ultrafine- to fine-grained materials, including fault gouge and microbreccia, and are widely considered indicators of past seismic faulting events. I show that such vein networks of Pt with both melt and crush origins, as well as ultracataclastic rocks, form by the rapid injection of ultrafine- to fine-grained material sourced from pulverized ultracataclastic rocks in seismogenic fault zones under thermal pressurization and fluidization during seismic events. The thermal expansion of seismic slip zones caused by frictional heating results in the rapid fluidization of ultrafine- to fine-grained materials along with expanded fluids and gases (e.g., water vapor and melt) that are injected under pressure into fracture void spaces within fault zones in a gas–solid–liquid system during large earthquakes. I propose that the thermal expansion of water vapor and ultrafine- to fine-grained materials caused by frictional heating in the fault slip zone is the main mechanism responsible for the dramatic increase in pore pressure that results in the dynamic coseismic weakening of faults.

Reference

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