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Clogging and un-clogging of the subduction plumbing system may generate tremor-like patterns

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Many subduction zones host intermittent, low-frequency, low-magnitude seismic activity emitted from the vicinity of the plates' interface. For instance, in Guerrero, Mexico, deep (30--50 km) low-frequency earthquakes (LFEs) occur in bursts, and migrate in cascades along the subduction interface. Those patterns are often attributed to episodic pulses of fluid pressure and slow slip that travel within the fault zone. However, the dynamic behavior of the permeable system in which fluid-pressure circulates remains a blindspot in most models of tremor generation, even as geological observations report pervasive imprint of strong, localized fluid pressure and permeability variations in its source region.

In order to analyze the role of such processes in generating tremor, we design a simple model of how fluid pressure and permeability can interact within the subduction interface, and generate realistic, tremor-like patterns. It is based on seismic source triggering and interaction in a permeable channel. The latter contains a number of low-permeability plugs acting as elementary fault-valves. In a mechanism akin to erosive burst documented in porous media, valve permeability abruptly opens and closes in response to the local fluid pressure. The brutal pressure transient and/or mechanical fracturing associated with valve opening acts as the seismic source of an LFE-like event. The strong fluid pressure transient that it triggers allows valves to interact constructively: as a valve breaks open, neighbor valves are more likely to break. This interaction therefore leads to cascades and migrations of synthetic seismicity along the model fault channel, that can synchronize into larger bursts of activity that migrate more slowly along the channel. In our model, valve activity draws patterns of that closely resemble tremor patterns in Guerrero and other subduction zones.

The input metamorphic fluid flux at the base of the channel exerts a key control on the occurence of and distribution of synthetic tremor in space and time. A weak input flux will not allow valves to open, conversely a strong flux will not allow them to close. In both cases, no activity will occur. However when the value of the fluid flux is intermediate, permanent regimes of sustained activity arise. Depending on its value, activity can be strongly time-clustered, quasi-periodic or random but constant in time.

Our model is based on a simple yet powerful and realistic description of the permeability and its dynamics in fault zones. It allows for new interpretations of low-frequency seismicity in terms of

effective flux and fault-zone permeability, both for long-term regimes and finer scale, transient dynamics. Eventually, it could lead to deep enhancements of our understanding of fault-zone hydraulic processes and how they are coupled with fault-slip.