Along-strike segmentation of tremor and its relationship with the hydraulic structure of the subduction zone

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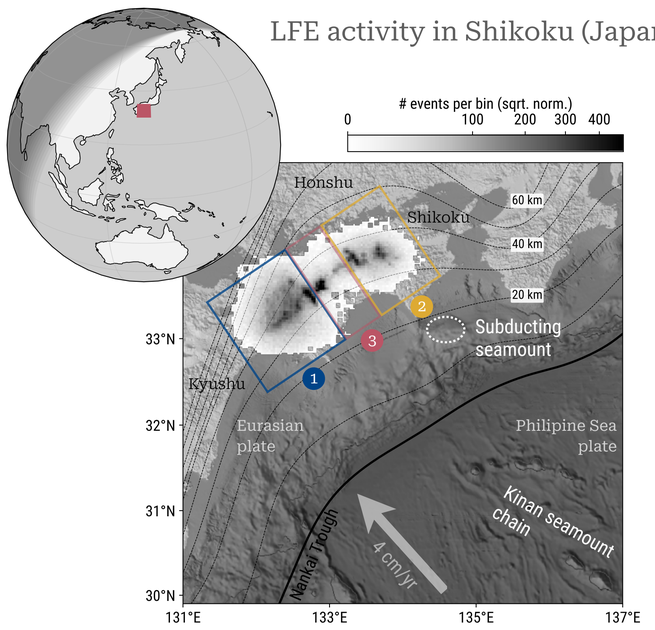
Slow-earthquakes are associated with fluid overpressure and transient hydraulic processes, such as fault-valving.

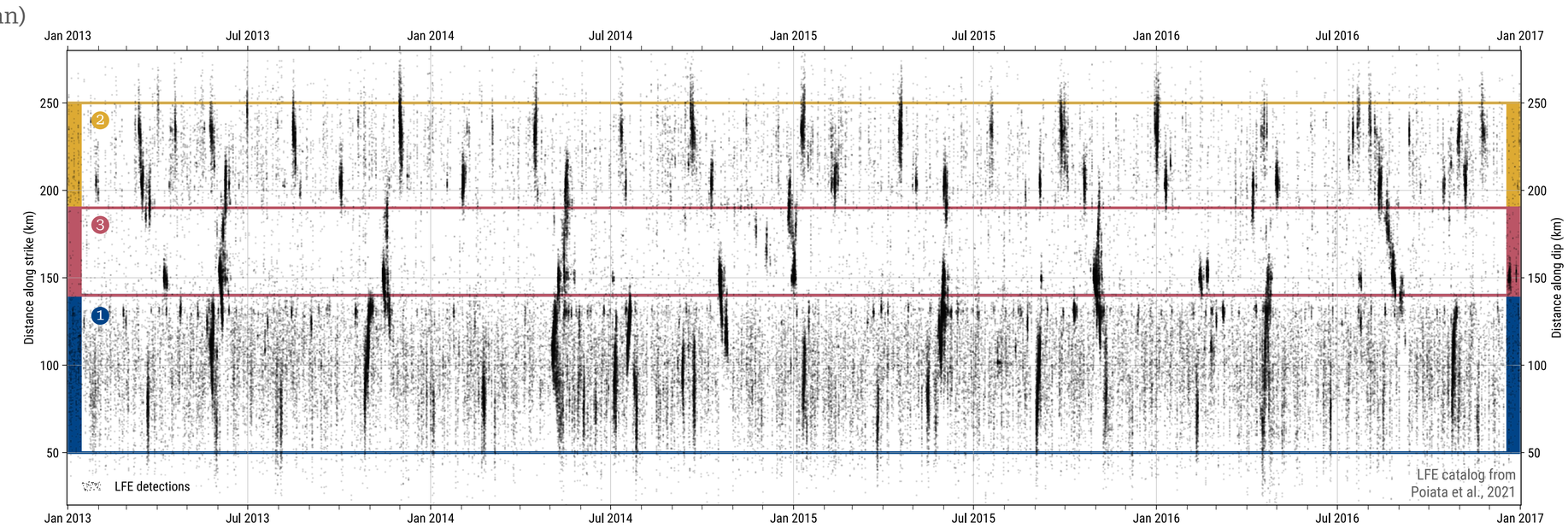
Using a simplified model of fluid circulation and tremor generation, we investigate what characteristics of the dynamics of fluid pressure and permeability could be involved in shaping tremor intermittence.

Segmentation of tremor intermittence could reveal structural properties of the fault interface

- Temporal clustering and recurrence timescales vary along-strike, defining segments
- The scale of segments is ~1—10 km, possibly coherent with a large-scale structural control
- Within segments, activity timescales could be linked to a shorter spatial scale, a structural property, characteristic of the tremor-generating process

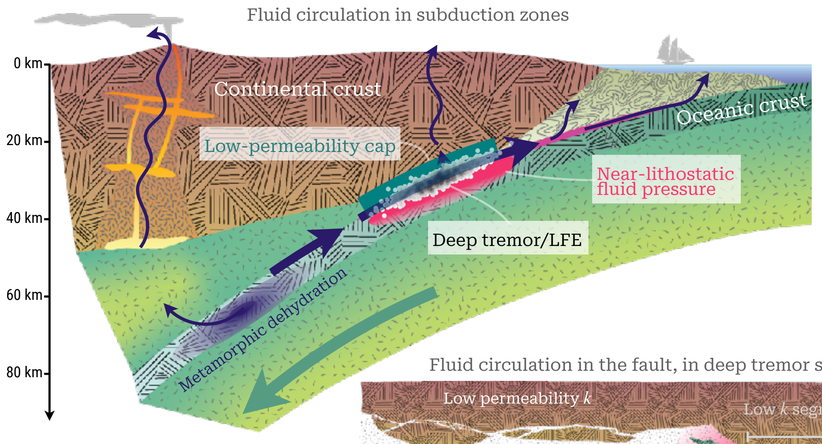
LFE activity in Shikoku (Japan)



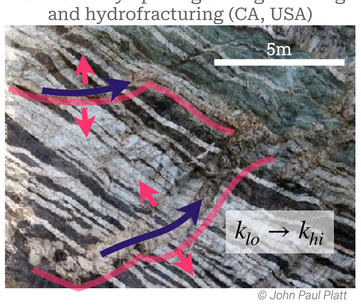


We model how transient, spatially-heterogeneous fluid transport processes could shape tremor intermittence

Fluid circulation in subduction zones



Permeability opening through veining and hydrofracturing (CA, USA)



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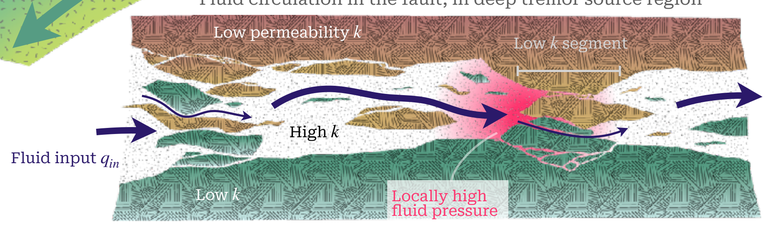
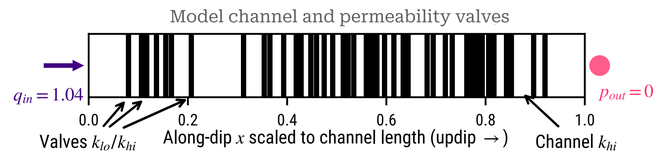
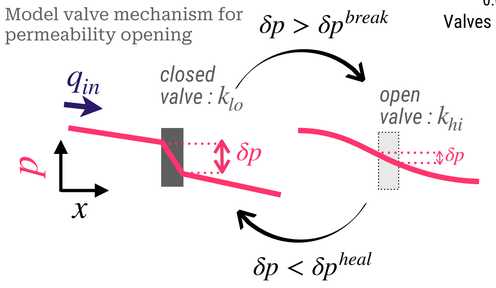
Fluid circulation in the fault, in deep tremor source region



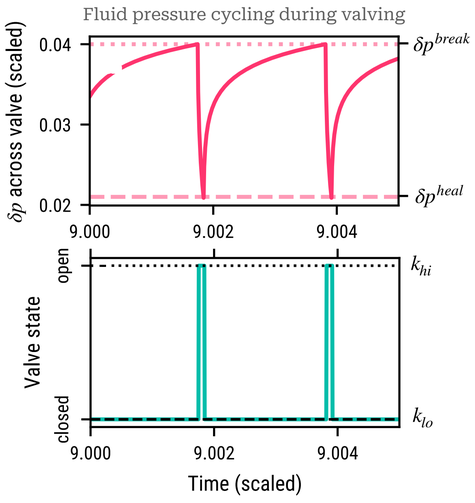
Model channel and permeability valves



Model valve mechanism for permeability opening



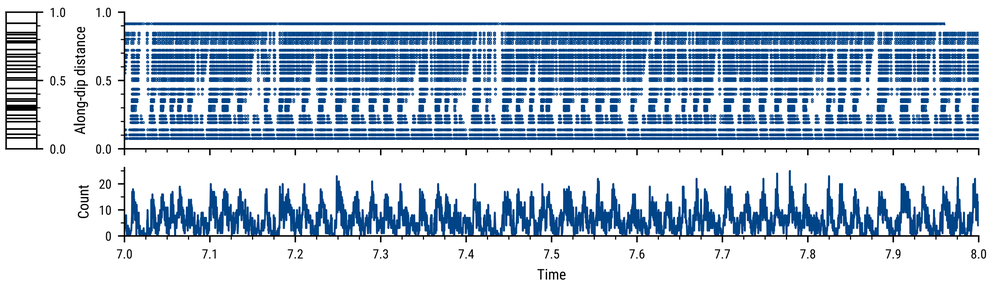
Fluid pressure cycling during valving



- We model fluid pressure diffusion in a 1D permeable channel in the fault zone
- Permeability heterogeneity in space is represented by a distribution of low-permeability segments
- Low-permeability segments open and close in a valve mechanism, simulating permeability changes in the fault
- Each valve opening is associated with an elementary tremor event

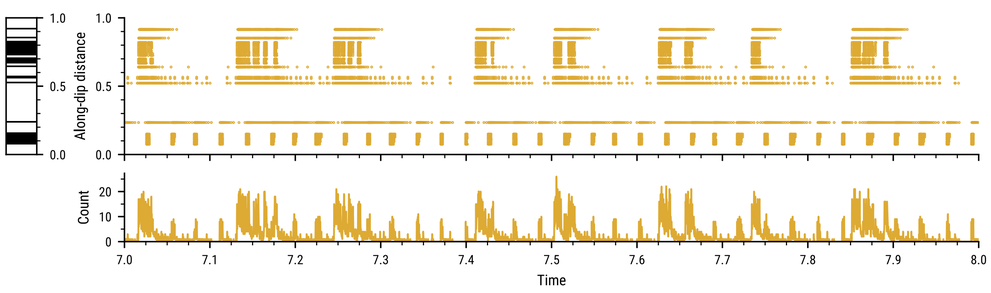
Permeability structure controls time/space scales of fluid pressure transients and synchronization of tremor activity

Synthetic valve activity for various permeability structures



*Random, **homogeneous** valve distribution*

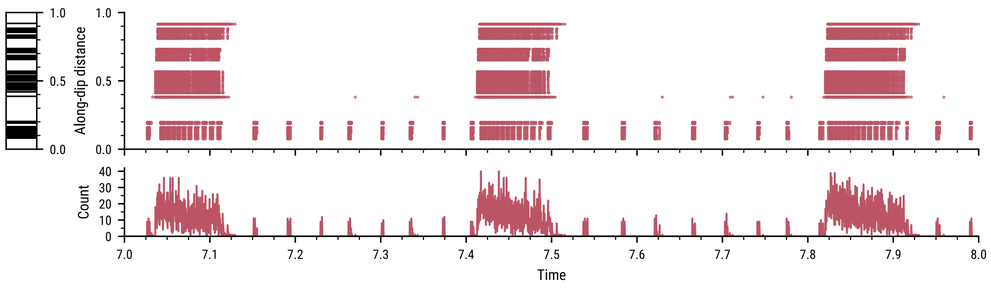
➡ Intermittent, quasi-periodic activity



***More clustered**, equally dense valve distribution*

➡ Stronger spatial and temporal clustering of activity

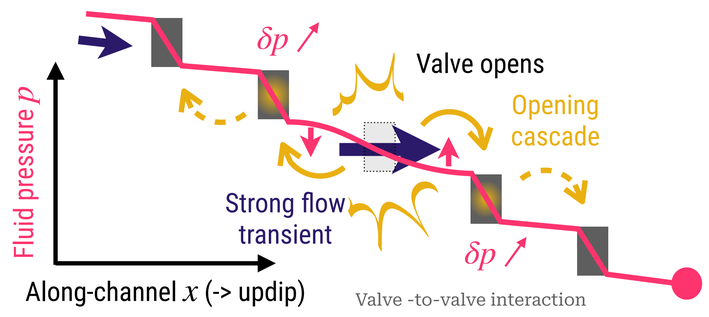
➡ Longer recurrence timescales of activity bursts



*Equally clustered, **denser** valve distribution*

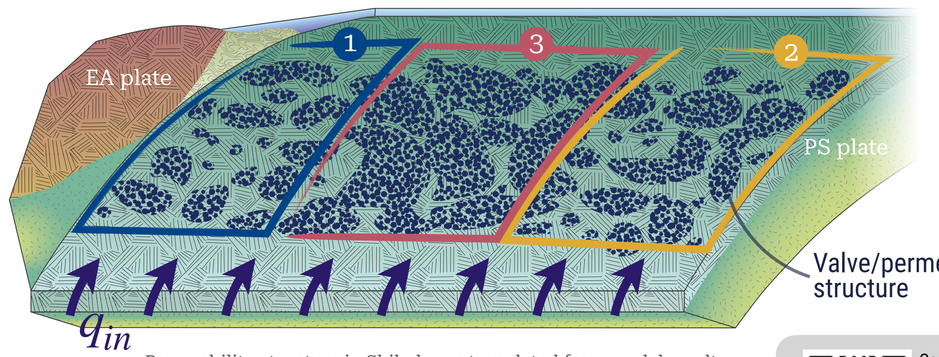
➡ Even stronger synchronization: emergence of large-scale valving

➡ Even longer recurrence timescales of activity bursts



- Valve (= tremor sources) synchronize through fluid pressure transients.
- The shorter the distance between low-permeability valves d_v, the stronger their interaction
- Systems in which permeability elements are more strongly coupled produce the most temporally clustered and long period activity, with more spatial coherence

In Shikoku, the central segment (3) could behave as a subduction-scale low-permeability valve, made up of a dense, coupled population of valves. It opens more episodically, generating large-scale, long-period seismicity transients during subduction-scale valving events.



Permeability structure in Shikoku, extrapolated from model results

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