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Transient ductile strain localization triggered by fluid-enhanced microfracturing and sealing: a possible analogue to Episodic Tremor and Slip

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A combination of seismic (non-volcanic tremors) and transient aseismic (slow slip events) behaviours is now commonly observed at plate interfaces in subduction zones, between locked/seismogenic zone at low depths and stable/ductile creep zone at higher depths. This association defines Episodic Tremor and Slip, systematically highlighted by over-pressurised fluids and near failure shear stress conditions. A microstructural study of exhumed rocks deformed at 400°C and 35-40 km allows us to propose a new ductile rheological approach that relates microstructures evolution with pore fluid pressure fluctuations. In contrast with more classical rate-and-state models, this approach is based on ductile rheology with grain size sensitivity, fluid-driven micro-fracturing and sealing (e.g. grain size reduction and grain growth) and related pore fluid pressure fluctuations. 1D numerical models reproduce slow slip events by transient ductile strain localisation as a result of fluid-enhanced micro-fracturing and sealing for near lithostatic initial conditions. The occurrence of macrofracturing during transient strain localisation and a local increase in pore fluid pressure well reproduced non-volcanic tremors. Our model provides, therefore, a geological explanation of episodic tremor and slips and moreover predicts the depth and temperature ranges of their occurrence.