S031-0011
Intermittence and Migration of Low Frequency Earthquakes Explained by Fast Fluid Pressure Transients in the Permeable Subduction Interface

Thursday, 10 December 2020
Poster

Gaspard Farge[1]*, Claude P Jaupart*[1] *and Nikolai M Shapiro*[2]*, (1)Institut de Physique du Globe de Paris, Paris, France, (2)Institut des Sciences de la Terre, Université Grenoble Alpes, CNRS (UMR5275), Grenoble, France*

Abstract:
In some parts of the world, the subduction process is accompanied by intermittent, low-frequency seismic activity. As example, in Guerrero, Mexico, low frequency earthquakes in a 30–50 km depth interval occur in cascades and migrate along the fault plane, at fast rates over short distances and at a slower rate over large distances. This is reminiscent of a diffusive process and has been attributed to transient fluid pressure pulses in a permeable subduction interface. We develop a simple model of source triggering and interaction in a 1D permeable channel saturated with fluid, that contains a number of elementary fault valves. This model is in part inspired by geological observations from exhumed subduction fault interfaces showing that deformation is intrinsically coupled to transient high fluid pressure pulses leading to vein opening and pressure-solution creep.

In our model, metamorphic fluid is injected downdip of the channel and rises by buoyancy. Low-permeability valves impede the flow, leading to a local increase of fluid pressure gradient that eventually triggers valve opening: valve permeability suddenly increases and fluid pressure heterogeneities rapidly diffuse back to base level. This mechanism is akin to erosive bursts that have been documented in porous media when clogged pores are re-opened. The rapid pressure release and/or mechanical fracturation associated with valve opening acts as the source of low frequency earthquakes. The valve/source then heals, permeability closes, and a new cycle of fluid pressure accumulation and release resumes. In such a system, sources interact constructively: events are triggered by the pressure pulse generated by the activation of a nearby source. With many sources, this behavior results in cascades of events and generates intermittent activity. Following the build-up of activity in a transient initial phase, two different steady-state regimes can be observed, quasi-periodic or quiescent. In the first case, we observe short and fast migrations on a small scale, and longer and slower migrations on a larger scale, which is strongly reminiscent of activity at Guerrero, Mexico. This simple model of fluid/fault coupling generates realistic patterns of seismic activity and can provide constraints on the physical conditions that lead to such activity.

<< Previous Abstract | Next Abstract >>