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Effects of dynamic stress transfer on fault zone by fluid injection-induced fracture activation: relationships between slow slip, seismicity and fluid leakage.

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Here we present a fluid-injection field experiment where we nucleated various types of seismic events within a natural and critically stressed fractured zone at 250 meters depth by artificial pressurization of a passive normal fault. Continuous high accuracy monitoring of strain, pore pressures and seismicity revealed that slow slip, occurring along the injected fracture, nucleates after a drastic decrease of fault friction directly related to the fault fluid-pressurization. Moreover, slow slip is associated to the main seismic energy production (80% of the total seismic energy measured). Two main types of seismic signals were observed during this phenomena, such as episodic micro-ruptures and tremor-like-signal events. We show that episodic ruptures observed were caused by poroelastic stressing of the fault inducing a pressure decrease, and both permeability and porosity variations related to shear dilation and a re-activation of the secondary surrounding fracture network. Tremor-like-signals appear during the inter-slip period immediately before fluid-pressure drops within the injected fault. They seem to be good indicators of dynamic fluid migration and could be seen as precursors of the fault slip activation. The inversion of the waveforms of these complex signals could be of interest to estimate the spatial extend of the reactivated fracture network, and then mechanical softening of the off-fault zone. We suggest that these phenomena can be triggered in natural active faults by transient active fluid migrations.