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Hydraulic anomalies triggered close to an active fault by far field earthquakes

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This study focuses on records from a set of pressure transducers inserted in a 1000m-deep borehole that intersects, at a depth of 760m, the moderately active 10 km long, Aigio fault, Gulf of Corinth, Greece. They exhibit a few short transients, two of which are coincidental with the arrival of seismic waves generated by far field large magnitude earthquakes.

The hydraulic system in which are inserted the sensor is relatively simple : below the upper 700m deep cased section, the well intersects only two artesian aquifers separated by the fault. The upper aquifer is fully hydraulically decoupled from surface aquifers and is developed in tectonized platy limestone. It supported a 0.5 MPa original overpressure before drilling. Below the fault, the limestone is heavily karstified and the artesian overpressure reaches about 0.85MPa. Hence, prior to drilling, the fault supported a 0.35 MPa differential pressure through the 5m thick radiolarite clay layer that has been smeared along the 150 m fault offset. The Aigio fault appears thus to be impervious.

In September 2003, the borehole was plugged with a packer set at the top of the casing resulting in a direct connection between both aquifers. Since the well closure, the pressure has been monitored by sensors set just below the packer. Sensitivity of the experimental setting enables to record tidal waves with a resolution better than 1/100.

A 60Pa drop in pore pressure has been recorded at the onset of S waves generated by the $M_w = 7.8$ Rat Island Earthquake of November, 17th 2003. It is followed by a slow recovery that lasted about 30 minutes. This anomaly is compatible with a minor movement along the fault with a seismic moment of 10^9 Nm. A very similar behaviour also occurred on the aftermath of the December, 26th $M_w = 9$ Sumatra earthquake. The drop is then 50Pa with a similar recovery time.

These striking similarities suggest a similar mechanism for both events. Given that an extensometer located on the other shore of the Gulf did not detect any anomaly, this effect is local to the fault and aquifers system. However, for the Rat Island earthquake (2003) the pressure drop started with the S waves arrival, whereas for the Sumatra earthquake, the pressure drop occurs when surface waves are recorded. Precise mechanisms for both these pressure drops are still under investigation.