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The Alboran Sea earthquake (Mw 6.3) of 25 January 2016: A consequence of the 1994-2004 Al Hoceima seismic events?

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The 25 January 2016 earthquake (Mw 6.3) follows in sequence the 26 May 1994 earthquake (Mw 6.1) and the 24 February 2004 earthquake (Mw 6.5) in the Rif Mountains and Alboran Sea. The earlier two seismic events were destructive because inland and the third event occurred offshore but all three events have 10 – 15-km-depth and occurred within a period of 22 years. The three events have similar strike-slip focal mechanisms with NNE trending left lateral faulting for the 1994 and 2016 events and NW trending right-lateral faulting for the 2004 event. This shallow seismic sequence offers the possibility to understand the fault-rupture interaction, to model the Coulomb Failure Function (CFF with μ' = 0.4), to analyze the pore-fluid effect on the rupture mechanism, and to infer the clock-time advance. The CFF shows a direct impact of the 1994 mainshock and aftershocks and related positive lobes on the 2004 earthquake rupture with a stress change increase of 0.6 bar. Similarly, the 2004 mainshock and aftershocks indicate loading zones with stress change (> 0.25 bar) that includes the 2016 earthquake rupture. The tectonic loading 15.2 nanostrain/yr obtained from the GPS data are comparable to the 0.5 10^{18} N.m/yr seismic strain release in the Rif mountains. The seismic sequence is apparently controlled by the poroelastic properties of the seismogenic layer that depends on the undrained condition of fluid circulation. The pore-fluid physical condition implies a higher rate of aftershocks with relatively larger magnitudes (4<Mw <5.5) that requires a drained condition for a short interseismic period between mainshocks. The stress-rate being ∼370 Pa/yr with a ΔCFF of 0.6 bar, combined with the estimated 190 ±10 years recurrence time for Mw 6 – 6.5, the computed clock-time advance reaches 163 ±10 years in agreement with the ∼10 years delay between mainshocks. The calculated stress transfer with 0.25 bar ΔCFF, under pore-fluid stimulus added with well-constrained geodetic and seismic strain rates are critical for any seismic hazard assessment.