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Paleoseismology under sea: First evidence for irregular seismic cycles during Holocene off Algeria from turbidites

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According to simple models, stress build-up along a given fault is proportional to the time elapsed since the previous earthquake. Although the resulting « seismic gap » hypothesis suits well for moderate magnitude earthquake (Mw 4-5), large events (Mw>6) are hardly predictable and show great variation in recurrence intervals. Thus, models based on stress transfer and interactions between faults suggest that an earthquake may haste or delay the occurrence of next earthquake on adjacent fault by increasing or lowering the level of static stress.

Here, we show that meaningful information of large earthquakes recurrence intervals over several seismic cycles may be obtained using turbidite record offshore the Algerian margin (Mediterranean Sea), an area prone to relatively large (M∼7) earthquakes in historical times. Indeed, as evidenced on the Cascadia subduction zone, synchroneous turbidites over a large area and originated from independent sources, are most likely triggered by an earthquake. To test the method on this slowly convergent margin, we analysed turbidites in 3 sediment cores collected off the area shaken by the 1980 Ms 7.3 El Asnam and 1954 M6.7 Orléansville earthquakes. We used X-ray radioscopy, XRF major elements counter, magnetic susceptibility, and grain-size distribution to accurately discriminate turbidites (∼instantaneous deposit) from hemipelagites (continuous background sedimentation). We dated turbidites by calculating hemipelagic sedimentation rates obtained with AMS radiocarbon ages, and applied the rates between turbidites. Finally, the age of events was compared to the only paleoseismic investigation available onland.

We found that 10 to 25 turbidites deposited as single or multiple pulses over the last ∼8ka. Once correlated from site to site, they support 14 seismic events. Most events are correlated with the paleoseismic record of the El Asnam fault, but uncorrelated events support that other faults were active. Only the first of the two major events of 1954 and 1980 triggered a turbidity current, implying that the sediment buffer on the continental shelf could not be reloaded in 26 years thus giving information on the minimum time resolution of our method. The new paleoseismic catalog shows a recurrence interval of 300-700 years for most events, but also a great interval of >1200 years without any major earthquake. This result suggest that the level of static stress may have drastically dropped as a result of three main events occurring within the 800 years prior the quiescence period. The quiescent period also supports a stress transfer and interaction between neighbouring faults.