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Do submarine landslides and turbidites provide a faithful record of large magnitude earthquakes in the Western Mediterranean?

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Large earthquakes and associated tsunamis pose a potential risk to coastal communities. Earthquakes may trigger submarine landslides that mix with surrounding water to produce turbidity currents. Recent studies offshore Algeria have shown that earthquake-triggered turbidity currents can break important communication cables. If large earthquakes reliably trigger landslides and turbidity currents, then their deposits can be used as a long-term record to understand temporal trends in earthquake activity. It is important to understand in which settings this approach can be applied. We provide some suggestions for future Mediterranean palaeoseismic studies, based on learnings from three sites.

Two long piston cores from the Balearic Abyssal Plain provide long-term (<150 ka) records of large volume turbidites. The frequency distribution form of turbidite recurrence indicates a constant hazard rate through time and is similar to the Poisson distribution attributed to large earthquake recurrence on a regional basis. Turbidite thickness varies in response to sea level, which is attributed to proximity and availability of sediment. While mean turbidite recurrence is similar to the seismogenic El Asnam fault in Algeria, geochemical analysis reveals not all turbidites were sourced from the Algerian margin. The basin plain record is instead an amalgamation of flows from Algeria, Sardinia, and river fed systems further to the north, many of which were not earthquake-triggered. Thus, such distal basin plain settings are not ideal sites for turbidite palaoeseimology.

Boxcores from the eastern Algerian slope reveal a thin silty turbidite dated to ~700 ya. Given its similar appearance across a widespread area and correlative age, the turbidite is inferred to have been earthquake-triggered. More recent earthquakes that have affected the Algerian slope are not recorded, however. Unlike the central and western Algerian slopes, the eastern part lacks canyons and had limited sediment input in the Holocene. This indicates the eastern part is less sensitive to earthquake-triggered slope failures and is less suitable for future palaeoseismology investigations.

Landslide events identified from contourite drift and mound sequences in the Tyrrhenian Sea indicate a regular temporal spacing. No landslides are identified over the last 10,000 years, however, and the inferred recurrence between events is in the order of tens to hundreds of thousands of years. The preconditioning agents and triggers for failures are interpreted to be related to oversteepening of depositional mounds, current-related erosion and geotechnical properties of contourite sediments, rather than earthquake effects. Major hiatuses (up to 2 Myr) result in local incompleteness of the depositional record. Therefore this setting is also unlikely to yield useful palaeoseismological records.

This is not intended as a pessimistic tale, however, but instead aims to provide guidance for the future. Efforts should focus on sites that ideally feature: sediments that can be dated accurately from proximal to distal sites; near-constant sediment accumulation rates through time, that provide high enough sensitivities to failure; limited modification by bottom-currents; and, known historical earthquake events to correlate with dated deposits from box or multicoring.