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Searching for the seafloor signature of the May 21, 2003 Boumerdès earthquake offshore central Algeria

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Catastrophic events such as earthquakes and the genetically linked submarine failures and turbidity current flows can rarely be observed in real time in the submarine realm. Also their sedimentary signature remains quite elusive, because it is often represented by erosional features rather than by deposits, especially on continental slopes. In some cases, it is possible to have some hints about catastrophic process, for examples when submarine cables breaks mark the timing and the area of impact of one of such events.
Several submarine cable breaks occurred in distinct sectors of the Algerian margin after major earthquakes (e.g., 1954, 1980, 2003 AD). In particular, the May, 21st 2003 event followed a magnitude 6.8 earthquake with the epicenter offshore Boumerdès, central Algeria. The 2003 earthquake caused a coastal uplift of up to 0.7 m along several tens of km of coastline, triggered a tsunami wave that impacted the Balearic islands, and coincided with the formation of a sediment plume in superficial waters visible in satellite images. This earthquake likely generated sediment instabilities and turbidity flows responsible of 28 ruptures of 5 submarine cables along 150 km of the central Algerian margin, from the continental slope to the abyssal plain, where several sediment transport conduits (canyons) are present. A sixth cable about 75 km away from the coastline was unaffected by the event.
Deep-towed side scan sonar images (SAR) acquired at the base of the continental slope offshore Algiers show marks of seafloor erosion and submarine landslides, but it is difficult to link seafloor morphology and the timing of cable breaks based on morphological studies alone. Furthermore, canyon flanks, continental slope tectonic scarps and landslides scars all represent potential multiple sources for sediment failure triggered by the 2003 earthquake. The pattern of the cable breaks is not fully exploitable to calculate turbiditic flow velocities, and numerical modeling was used to reconstruct the turbiditic flow paths in the Algiers canyon. Modeling result confirmed the complex path of turbidites with significant levee overspill, a patchy distribution of areas of erosion/deposition along the turbiditic flow path and the need of multiple flows to explain the numerous and scattered cables breaks linked to the 2003 event also within the Algiers canyon sector alone.
Five interface sediment cores were retrieved in 2005 in the Algiers submarine valley to search for a turbidite deposit of recent age and possibly linked with the Boumerdès earthquake. Interface core IMDJ-03, in particular, was recovered in 2404 m water depth within the upper portion of the Algiers submarine valley. It shows a good preservation of recent deposition with a 20-cm thick silty and sandy layer interpreted as a turbidite deposit. The downcore activity profile of 210Pb shows that the uppermost 0.48 m of the core is younger than 100 yr, and include the sandy turbidite which has a sharp base at 0.45 m downcore. Grain size distribution of 17 levels within the uppermost 0.5 m of the core and the analysis of the fraction >63 micron allow to interpret part of the mud layer on top of the sand (0.15 to 0.25 m) as belonging to the turbidite. Also the uppermost part of the core (0 to 0.15 m) would not represent hemipelagic sedimentation because of the absence of foraminifera (present at 0.5 m and in deepest levels) and the presence of vegetal remains. This study shows that the deposition pattern and flows trajectories from modeling helps deciphering the complex and elusive sedimentary record of a known catastrophic event by comparison with the observed features in the backscatter dataset and the sedimentary record observed in sediment cores.