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Age constraints and sediment properties of Ana Slide (Balearic Sea, Western Mediterranean) and implications on age dating of submarine landslides

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The Eastern Ibiza Channel (Western Mediterranean) is an area of widespread seafloor instability as highlighted by recent multibeam and geophysical surveys. Ana Slide is the submarine landslide with the clearest morphological expression over an area of about 6 km2, showing the headwall in 635 m water depth and the toe of the deposit in 790 m, with an average bathymetric slope of 1.6°. Seafloor morphology and direct observations of sediment cores support the interpretation of Ana Slide as resulting from limited displacement mass wasting: the upper part of the landslide deposit shows an intact stratigraphy and/or the presence of sediment blocks with intact stratigraphy. Recent results in geotechnics based on additional sediment cores and CPTU data allowed to identify a remoulded unit (landslide deposit) buried under about 2.5 m of undisturbed sediment, and to propose, based on numerical modeling, that the triggering mechanism could be linked to sediment strength degradation due to the presence of shallow gas. We propose here a re-evaluation of the available data from two campaigns to reconstruct the age of Ana Slide with AMS radiocarbon dating and planktonic foraminifer assemblages.

The evaluation of the age of the submarine landslide, also when the mass accumulation is evident in seafloor morphology, sediment cores and geotechnical tests, remains a delicate issue, because it requires to compare and summarize data of different types and to consider the extreme lateral and vertical variability of landslide deposits. Coupled sedimentological and micropaleontological evidences, supported by seismic reflection profiles, indicate that above the Ana Slide area there is a sediment drape of hemipelagic deposit at least 0.8 m thick and Holocene in age, based on AMS radiocarbon dates and faunal assemblages. This hemipelagic unit drapes also the landslide headwall and the surrounding seafloor unaffected by the landslide and it is correlatable by means of paleontological observations and magnetic susceptibility measurements. A sediment core reaching below the glide plain within the landslide headwall area sampled warm foraminifera fauna of MIS 5 that could be considered the lower boundary for the age of the landslide. Estimates of the age of landslide deposit and the underlying strata suggest that the mass wasting process did occur in the Late Pleistocene in times of MIS 2/3 or older. The largest uncertainty in age determination concerns the interpretation of the ‘post landslide’ unit, whose base could best approach the age of the sediment failure. This unit, interpreted from CPTU at 2.5 m, was correlated with regional oxygen isotopes curves thanks to measured XRF elemental profiles and suggests an age around 61.5 kyr BP. Alternatively, the undeformed section of the CPTU tests could include both a post landslide drape and a sedimentary unit carried for a limited distance during the failure without appreciable sediment deformation which would be thus older than the age of the landslide event.

An acoustically transparent body buried below Ana Slide demonstrates that recurrent mass wasting occurred in the area during the Pleistocene. Beside fluid expulsion supported by the presence of numerous pockmarks, sea level fluctuations and variations in sediment supply during the Middle and Late Pleistocene could have played an important role as predisposing factors for mass wasting in the Ibiza Channel. The case of Ana Slide represents an excellent example of how subtle can be the attribution of an accurate age to a sediment failure event, and suggests to proceed by multiple hypotheses supported by integrated datasets.