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Glacial-interglacial sedimentation in the deep continental margin off Portugal

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West of Portugal are a number of well-spaced but large submarine canyons that extend up to 200 km in length from the continental shelf to the abyssal plain. Sedimentary processes through two of the largest canyons, Nazaré and Setúbal/Lisbon, have been investigated using swath bathymetry, sidescan sonar imagery, high-resolution seismic profiling, sediment cores and video imaging. Sediment cores have been used to document late Quaternary sediment transport through these canyons.

We have collected a number of piston and trigger cores from within the canyon mouths and from the lower rise adjacent to the canyon mouths. These consist mainly of olive-grey mud with occasional coarser layers, and most include an orange-brown surface layer. These cores show very low magnetic susceptibility values throughout except for some sharp peaks. Some of these peaks correlate with the coarser layers, but several do not appear visually. Analysis of the mineral grains from these layers shows them to be ice-rafted Heinrich layers. The most prominent layer on the magnetic susceptibility records is confirmed by radiocarbon dating to be Heinrich Layer (HL) 4 (38 ka), which always shows high magnetic susceptibility values. HL 6 (60 ka) is also apparent, and two weakly developed magnetic susceptibility peaks may represent HL1 and HL2 (16.8 and 24 ka respectively).

It can be inferred that the Holocene is reduced to a thin layer less than 50 cm thick, whilst the glacial isotope stages 2-4 are relatively thick. This conclusion is borne out by core CD56427, which was located on the lower continental rise south of the mouth of the Nazaré Canyon. We have performed oxygen isotope and planktonic foraminiferal analyses of this core. Both analyses are limited by the strong dissolution in some core intervals associated with the water-depth of this core being 5040 m.

Nevertheless, it appears that this core extends to oxygen isotope stage 7. The magnetic susceptibility record for this core shows a series of broad peaks within isotope stage 5 and these appear to correlate with the colder substages 5b and 5d. This is commonly observed in cores with dissolution and is due to loss of calcium carbonate, which leads to an increase in the non-carbonate percentage within which the magnetisable material lies, hence causing a peak in the magnetic susceptibility profile. The same pattern, however, is not observed in this core's glacial stages 2-4 and 6 even though there is very strong dissolution here. These stages also show high accumulation rates indicating significant input of detrital material. The most likely origin for this material is from low magnetic susceptibility turbidity currents that have travelled through the Nazaré Canyon and deposited on the adjacent Iberia Abyssal Plain, leaving a fine-grained component to accumulate on the continental rise that dilutes the magnetic susceptibility signal.

The depositional pattern seen in core CD56427 can also be observed in other cores from the Nazaré lower rise and canyon mouth (e.g. CD56423 and CD56428), although none have penetrated so far back in time. The same pattern can also be seen in cores CD56409, CD56410 and D155-6 from the mouth of the Setúbal Canyon. This scenario shows that both the Nazaré and Setúbal Canyons have been much more active during low sea-levels than high sea-levels.

Evidence of sediment destabilisation caused by the 1755 Lisbon earthquake has not been found in either canyon, even though a relatively large turbidite of this age is known to cover the Tagus Abyssal Plain, which lies beyond the mouth of the Setúbal Canyon.