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NEAREST

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D22b: high-resolution seismic and core sampling cruise report

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PU	Public	**PU**
PP	Restricted to other programme participants (Including Commission Services)	
RE	Restricted to a group specified by the Consortium (Including Commission Services)	
CO	Confidential, only for members of the Consortium (Including Commission Services)	

WP6 - Paleotsunami and Paleoseismic records

D22b: High-resolution seismics and core sampling cruise report

Leader Task 6.2: CSIC

Task 6.2 responsible: Dr. Eulàlia Gràcia i Mont

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Abstract

A total of 12 sediment cores were acquired in the Gulf of Cadiz to complete the turbidite paleoseismology objective of Task 6.2. The cores were collected during the JC27 cruise (August - September 2008) on board the RRS *James Cook* (United Kingdom) in the deep depositional basins and sedimentary pathways of the SW Iberian Margin (i.e. Seine Abyssal Plain, Horseshoe Basin and Abyssal Plain, and Tagus Abyssal Plain). We present the JC27 cruise report corresponding to the core acquisition in the SW Iberian Margin area. The NEAREST-CORE cruise, planned to collect the new sediment cores out onboard the new Spanish RV *Sarmiento de Gamboa,* was delayed and has been finally scheduled for May 2010.

1. Introduction

The NEAREST-CORE cruise, initially planned to acquire new marine sediment cores for Task 6.2, could not be carried out at the start of the project due to schedule delays on the new Spanish RV *Sarmiento de Gamboa*. The cruise has been finally programmed for May 2010, at the end of the NEAREST project. To collect additional sediment cores, we established a collaboration agreement with Drs. R. Wynn and D. Masson from the National Oceanography Centre (NOC), Southampton (UK), in order to participate in their piston coring cruise on board the RRS *James Cook* in August 2008 (Wynn et al., 2009). The research agreement included planning new core sites in the SW Iberian Margin, participation in the JC27 cruise and post-cruise sampling and analysis (grain-size, physical properties, carbonate and dating) of the cores from the Gulf of Cadiz area (see results in report D22). The new JC27 cores together with cores previously obtained (PRIME-2003, SWIM-2004 and NEAREST-07) allowed us to obtain a complete sedimentary record for marine paleoseismology purposes and successfully accomplish Tasks 6.2 and 6.3.

The JC27 sediment coring cruise was carried out on board the RRS *James Cook* along the northeast Atlantic Margin, from the 5 August to 3 September 2008, Santa Cruz de Tenerife (Spain) to Portland (United Kingdom). The chief Scientist was Russell Wynn (NOCS, United Kingdom) and Zoraida Rosselló and Graziella Bozzano sailed as WP6 CSIC participants. The primary aim of JC27 was to collect sediment cores from a series of deep-water basins along the northeast Atlantic continental margin, in order to determine the character, frequency and potential geohazard of landslides and gravity flows in the basins from the Canary Islands to the north Biscay margin.

Target areas included the submarine slopes north of the Canary Islands, the Agadir Basin, the Seine, Horseshoe, Tagus, Iberia and Biscay Abyssal Plains, and a series of feeder canyons and channels. In addition, Autosub6000 was deployed on its first scientific missions in order to investigate the erosive power of large-scale gravity flows in canyon mouth environments. A total of 63 stations were visited, with deployments including five Autosub6000 dives, five megacores and 55 piston cores. Cruise highlights included 1) recovery of sufficient core data to allow development of a detailed chrono-stratigraphy for all of the major basins between the Canary Islands and the UK, aiding identification of areas where landslides and gravity flows may pose a potential geohazard to European coastlines, 2) collection of a series of spectacular high-resolution multibeam bathymetry

images of giant erosional scours (using Autosub6000), which are providing new insights into scour formation and the flows that formed them, and 3) new data illustrating the complexity of sedimentary processes and deposits in deep-water environments, including flow transformation

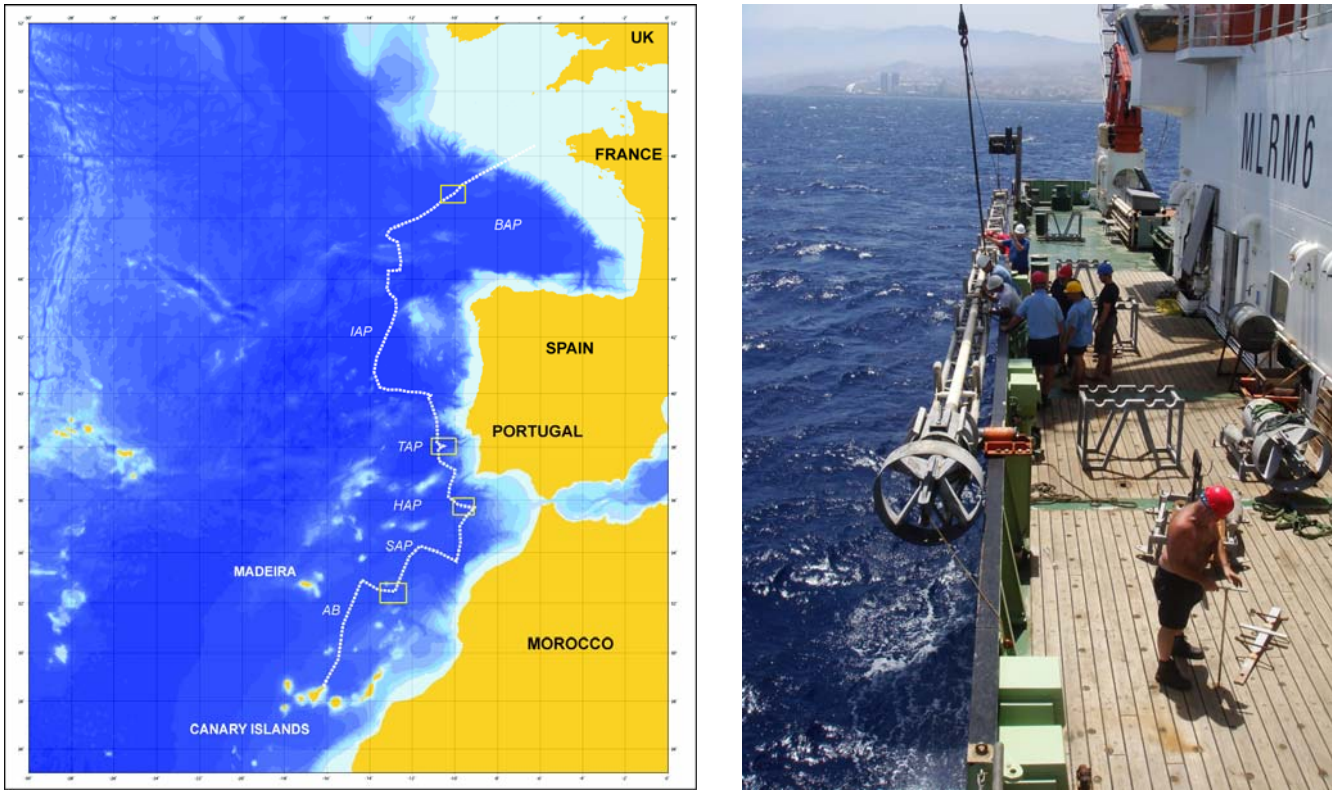

Fig. 1*. Left: Shiptrack of the JC27 cruise from the Canary Islands to United Kingdom. Right: Preparing the piston coring gear on board the RRS James Cook at the start of the cruise.*

During the cruise, two days were devoted to sample sediments in the area of interest for NEAREST WP6: Tagus Abyssal Plain, Gorringe Bank slide, Horseshoe Abyssal Plain and scours, and Seine Abyssal Plain (Fig. 1). A total of 12 sediment cores were collected for Task 6.2. They have been analyzed by the CSIC team in collaboration with NOCS Team and are integrated in the turbidite paleoseismology model of the Gulf of Cadiz. A preliminary description and photograph was taken on board, and further work will include joined work with the NOCS team and measurement of MST, lightness, grainsize, facies determination and radiocarbon dating. In addition, the AUV Autosub was used in selected

locations (Setubal Canyon scours, Portimao Channel scours, etc) to map the topography of the seafloor in a resolution of few centimetres.

2. Cruise Personnel

Scientific Party

WYNN, R.B.	(Principal Scientist) National Oceanography Centre, UK
MASSON, D.	National Oceanography Centre, UK
HUVENNE, V.	National Oceanography Centre, UK
TROFIMOVS, J.	National Oceanography Centre, UK
JACOBS, C.	National Oceanography Centre, UK
MARKETOS, G.	National Oceanography Centre, UK
STEVENSON, C.	National Oceanography Centre, UK
MCPHAIL, S.	National Oceanography Centre, UK
STEVENSON, P.	National Oceanography Centre, UK
FURLONG, M.	National Oceanography Centre, UK
SUMNER, E.	University of Bristol, UK
MACDONALD, H.	University of Leeds, UK
WILKINSON, J.	University of Liverpool, UK
***ROSELLO, Z.**	**CSIC Barcelona, Spain**
***BOZZANO, G.**	**CSIC Barcelona, Spain**
RODRIGUES, L.	University of Lisbon, Portugal
PONYAEV, M.	Moscow State University, Russia
LUKMANOV, B.	Moscow State University, Russia
YURCHENKO, I.	Moscow State University, Russia
SHAW, K.	Marine Wildlife Observer

*Participants from the EU NEAREST project (WP6).

3. Scientific objectives

The main scientific objective was to investigate the recurrence rate of large Holocene events, such as the Lisbon Earthquake. For this purpose we applied the “turbidite paleoseismology” concept in the low-convergence SW Iberian Margin to determine past seismic activity and to obtain a recurrence rate for great magnitude Holocene earthquakes (Mw ≥ 8.0).

Piston coring in deep basins produces the best record of recent (<50 kyrs) turbidite events on adjacent margins, but the availability of pre-existing data from the study area was patchy. Consequently, a key aim of JC27 cruise was to recover cores from plains and slope basins of the SW Iberian Margin where data was not obtained yet, such as the Seine

Abyssal Plain, and sedimentary pathways to the HAP and TAP. The methodology involved analysis of event timing and frequency in the recent geological record. A total of 12 piston cores were obtained in the SW Iberian Margin (Fig. 2, Table 1).

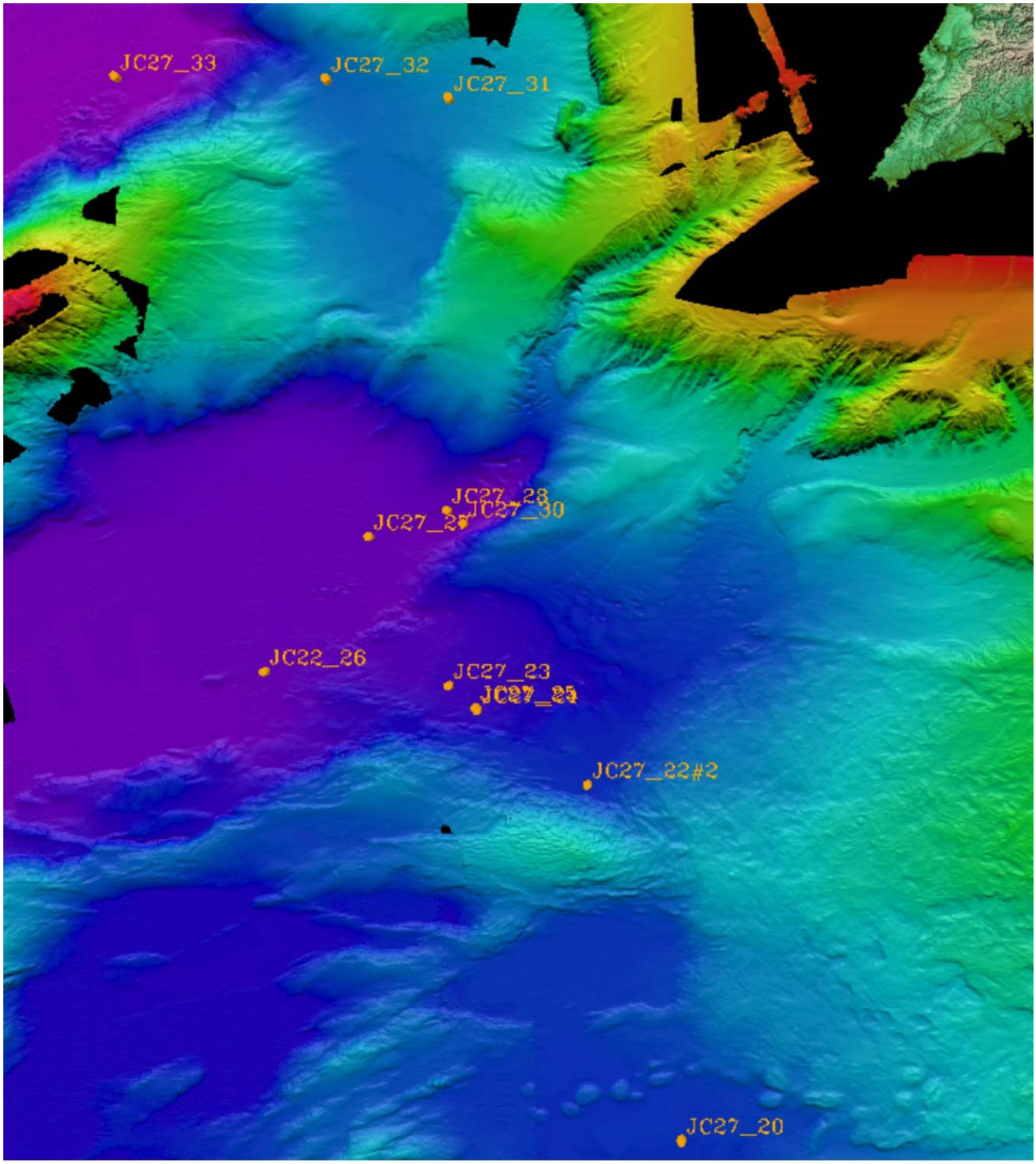

Fig. 2. *Location map of the 12 piston cores acquired in the SW Iberian Margin during the RRS James Cook-27 cruise, which are presented in D22.*

4. Cruise narrative

4 Aug.

The planned arrival of the ship in Tenerife was delayed due to a limiting speed of 10 knots (to conserve fuel). Consequently, the 15-strong scientific party was required to stay in Tenerife for a further night. On the upside, diplomatic clearance was received for France, Spain, Portugal and Morocco prior to sailing.

5 Aug.

Scientific party boarded the vessel at ~0900 hrs. Departure delayed while the ship took on fuel. Scientific party signed on and attended H&S meeting. Ship departed at ~1400 hrs and, after a brief test of the 3.5kHz system, headed towards the first coring site. Hull-mounted EM120 and SBP120 were run continuously, and the sub-bottom profiler at least appeared to be working well.

6 to 12 Aug.

Core sampling sites from Canaries-Selvage sub-basin and the Agadir Basin to central Seine Abyssal Plain

13 Aug.

The final core site in the Seine Abyssal Plain was located in an eastern sub-basin, just beyond the mouth of the Rharb Valley. A 12 m piston core was deployed at 2237 hrs and the pullout was 6.4 tonnes (location 34º40.00'N/09º27.45'W at 4285 m WD). The corer returned on deck at 0137 hrs and core JC027-20 contained 7.5 m of sediment, including two well-developed foram-rich turbidites presumably sourced via the Rharb Valley.

14 Aug.

A USBL test drop was undertaken at 0302 hrs, and the ship then headed north to an area of giant scours within the lower Lagos-Portimao Fairway. Autosub6000 was to survey one of the scours, and complete a 6 x 4 km multibeam bathymetry survey box, centred on 35º45.2'N/09º59.5'W. Station JC027-21 was reached at 1526 hrs and Autosub was in the water at 1742 hrs. The deployment went smoothly and no problems were reported. The USBL was working well and tracked the vehicle throughout its descent.

15 Aug.

A core site to the southeast, on the southern edge of the fairway, was targeted next. A megacore was deployed first to identify any recent events. After a three-hour passage an eight-barrel megacore was deployed at 0050 hrs and the pullout was 5.0 tonnes (location 35º33.28'N/09º41.92'W at 4306 m WD). All eight barrels recovered ~20 cm of sediment: three were sub-sampled for sedimentology, two for biology and two for geochemistry. These were labelled as core JC027-22-1.

A 9 m piston core was then deployed at the same site at 0555 hrs and the pullout was 7.1 tonnes (location 35º33.28'N/09º41.92'W at 4306 m WD). The core returned on deck at 0819 hrs and core JC027-22-2 contained five sections. These were dominated by turbidites with organic-rich mud tops affected by blackish sulphide development. There was evidence for significant bypass.

There was still sufficient time for a further core before Autosub had to be recovered, so a core site just downstream of the surveyed scour was selected. After a three-hour passage a 9m piston core was deployed at 1224 hrs and the pullout was 6.9 tonnes (location 35º48.07'N/10º03.35'W at 4614 m WD). The corer returned on deck and core JC027-23 contained about 7 m of sediment. A large number of sand-mud turbidites were sampled, and a low proportion of hemipelagite indicated a fairly rapid accumulation rate. The bottom ~60 cm of the core were heavily compressed. In addition, the winch was still having spooling problems.

Autosub was recovered at 1906 hrs with no problems, and the data indicated that the survey was partially successful. However, the data recorder had cut out halfway through the run, meaning that only the upper half of the selected scour (including the headwall) had been surveyed. Fortunately, this was sufficient for core planning purposes.

Two core sites were then selected around the surveyed scour. The first was targeting an area of grooved seafloor just upslope of the scour headwall. A 9 m piston core was deployed at 2200 hrs and the pullout was 7.6 tonnes (location 35º44.38'N/09º59.00'W at 4571 m WD). The corer returned on deck at 0128 hrs and core JC027-24 contained about 5 m of sediment. The core appeared to contain relatively few turbidites, probably due to local bypass.

16 Aug.

The next core site was the floor of the erosional scour. A 9 m piston core was deployed at 0302 hrs and the pullout was 6.4 tonnes (location 35º44.75'N/09º59.27'W at 4633 m WD). The corer returned on deck at 0620 hrs and core JC027-25-1 contained about 3 m of sediment. However, due to a coring fault, the liner had shattered and sand had penetrated between the liner and the core barrel. This meant the liner had to be hammered out, and the core was therefore destroyed.

An eight-barrel megacore was then deployed at the same site with the aim of sampling recent events passing through the area. The corer was deployed at 0734 hrs and the pullout was 4.7 tonnes (location 35º44.75'N/09º59.27'W at 4633 m WD). The corer returned on deck at 1114 hrs and core JC027-25-2 comprised five sub-sampled cores about 30 cm in length (two for geology, one for chemistry, one for biology and one for geotechnics).

A 9 m piston core was deployed for the second time inside the scour at 1216 hrs, and the pullout was 6.8 tonnes (location 35º44.75'N/09º59.27'W at 4633 m WD). The corer returned on deck at 1615 hrs and core JC027-25-3 contained about 6.5 m of sediment. The core was composed of about seven turbidites, with surprisingly thin sandy bases and thick mud caps.

The ship then headed downslope to the Horseshoe Abyssal Plain, to a site on the basin floor immediately downstream of the Lagos-Portimao Fairway. A 12 m piston core was deployed at 2047 hrs and the pullout was 7.0 tonnes (location 35º50.94'N/10º32.05'W at 4834 m WD). The corer returned on deck at 0145 hrs and core JC027-26 contained 3.5 m of sediment, mostly sand-mud turbidites. Some of the core had probably fallen out of the core catcher upon recovery.

17 Aug.

The next site was in the southeast Horseshoe Abyssal Plain, midway between the two entry points. A 12 m corer was deployed at 0519 hrs and the pullout was 7.35 tonnes (location 36º10.17'N/10º15.92'W at 4849 m WD). The corer returned on deck at 0855 hrs and core JC027-07 contained 9 m of sediment. Core quality was excellent, even though the metal core catcher was lodged in the core at 1.8 m depth! Two local debrites were present, underlying 14 well-developed sand-mud turbidites, suggesting they may have

been earthquake-triggered events. One of the thickest turbidites is probably correlative with the H13 turbidite of Lebreiro.

A site on the northern levee of the lower Sao Vicente Canyon was targeted next, and a 9 m piston core was deployed at 1247 hrs. The pullout was 7.0 tonnes (location 36º14.69'N/10º03.82'W at 4825 m WD). The corer returned on deck at 1700 hrs and core JC027-28 contained 6 m of sediment. Most of the core was composed of thin-bedded turbidites, but a locally-derived debrite was also present.

A survey line was the run to the southeast across the canyon axis, to identify a suitable site for megacoring. The canyon appeared to be filled with one or more debris flows, so it was decided that a piston core should also be attempted. The megacore was deployed first in the canyon axis, at 1834 hrs, and the pullout was 5.0 tonnes (location 36º13.07'N/10º01.82'W at 4878 m WD). The corer returned on deck at 2250 hrs and five tubes contained samples. A spectacular range of shelly and woody debris was noted in the base of the core, which was labelled as core JC027-29-1.

18 Aug.

A piston core was deployed a short distance away on a slight rise in the canyon axis, and was apparently targeting a series of stacked debris flows visible on profiler data. A 12 m piston core was deployed at 0000 hrs and the pullout was 8.0 tonnes (location 36º12.67'N/10º01.33'W at 4878 m WD). The corer returned on deck at 0359 hrs and core JC027-30 contained a fairly regular series of mud-dominated turbidites, with a length of 5.2 m.

After a lengthy transit of several hours the ship arrived in the northern Infante d'Henrique sub-basin, where the target was the northern sub-basin floor. A 12 m piston core was deployed at 1215 hrs and the pullout was 6.3 tonnes (location 37º15.74'N/10º02.84'W at 3786 m WD). The corer returned on deck at ~1600 hrs and core JC027-31 contained a thick sequence of apparently hemipelagic muds with one muddy sand debris flow unit.

The second target in the sub-basin was the gather zone where the northern and southern subbasins merged prior to plunging down the slope to the Tagus Abyssal Plain. A 12 m piston core was deployed at 1840 hrs and the pullout was 6.9 tonnes (location 37º18.80'N/10º21.70'W at 3994 m WD). The corer returned on deck at 2242 hrs and core JC027-32 contained another thick sequence of apparently hemipelagic muds, with some

thin turbidite layers and potential evidence for a debris flow in at least the bottom of the core.

19 Aug.

The ship then undertook a survey across the toe of the Gorringe Bank landslide, on the floor of the southeast Tagus Abyssal Plain. This debris avalanche appeared to be a few hundred thousand years old, as it showed a significant sediment drape. Consequently, a target was chosen off the toe of the landslide, to recover the basinal sequence. Debris flows coming from the Infante d'Henrique sub-basin were widespread on the acoustic profile. A 12 m piston core was deployed at 0424 hrs and the pullout was 7.9 tonnes (location 37º20.50'N/10º55.54'W at 5120 m WD). The corer returned on deck at 0822 hrs and core JC027-33 contained a thick sequence of fine-grained turbidites, some with sandy bases. Blackish iron sulphide banding was abundant.

The next core site was on the eastern margin of the Tagus Abyssal Plain. A 12 m piston corer was deployed at 1306 hrs and the pullout was 7.0 tonnes (location 37º43.10'N/10º49.89'W at 5065 m WD). The corer returned on deck at 1720 hrs and core JC027-34 contained a nice sequence of sand-mud turbidites with some well-developed coarse sand bases.

19 Aug. to 3 Sep.

Survey north from the Tagus abyssal Plain until Whittard Channel. The ship arrived in Portland Harbour in the morning of September 3rd, marking the end of cruise JC027.

5. Data Obtained

A piston corer was used to collect sediment cores during the JC27 cruise. The core barrels used were 9 and 12 m long, which allowed to obtain cores of slightly more of 9 m long. The cores obtained from this system are of very high quality as sedimentary structure is well preserved with no visible structure deformation.

The 12 cores collected in the SW Iberian Margin studied during WP6 of the NEAREST project are: JC27-20, JC27-22#2, JC27-23, JC27-25, JC27-26, JC27-27, JC27-28, JC27-30, JC27-31, JC27-32, JC27-33 and JC27-34. Core JC27-20 was collected in the NE sub-

basin of the Seine Abyssal Plain, just beyond the mouth of the Rharb Valley (Fig. 2, Table 1).

Cores JC27-22#2, JC27-23 and JC27-25 are located on the Horseshoe Basin, between 4300 and 4600 m deep on the drainage pathway to the HAP. Cores JC27-26, JC27-27, JC27-28 and JC27-30 were acquired at the NE part of the HAP at around 4800 m depth. Core JC27-26 is located downstream of the Lagos-Portimao pathway, bounded from the Horseshoe Basin by the Horseshoe Fault and JC27-27 is located at the northern HAP, down the slope from the MPF block. Cores JC27-28 and JC27-30 are located on the mouth of the Sao Vicente Canyon at the foot of the Horseshoe Fault Cores (Figs. 2, 3, Table 1).

Cores JC27-30 and JC27-31 were collected in HITS basin, at the gather zone prior to plunging down the slope to the Tagus Abyssal Plain. Core JC27-33 is the core closer to the North Gorringe debris avalanche and JC27-34 is located at the foot of the Sines Spur. Both were collected at the TAP at more 5000 m depth (Figs. 2, 3, Table 1).

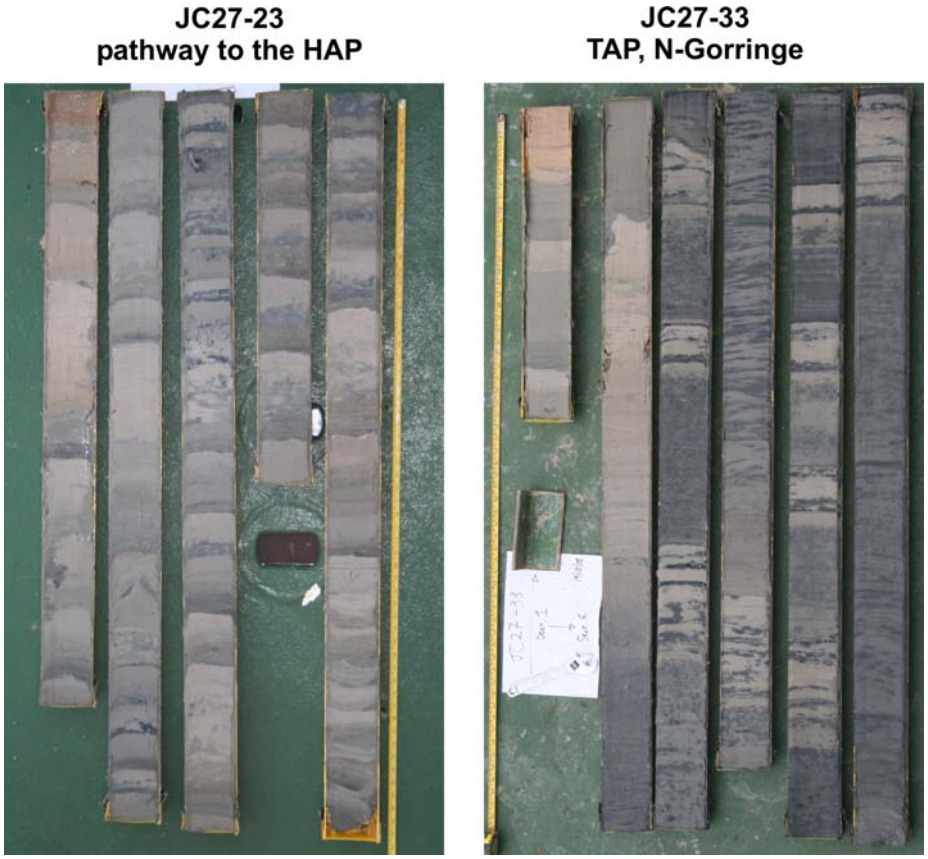

***Fig. 3**. Pictures of the sediment cores JC27-23 (5.7 m long) and JC27-33 (8 m long) acquired in the Horseshoe Basin and Tagus Abyssal plains during the JC-27 cruise.*

The 12 sediment cores are stored in the British Ocean Sediment Core Facility (BOSCORF) at the National Oceanography Centre, Southampton (NOCS). Analysis of piston cores included visual (graphic) logging and Multi-Sensor Core Logging (MSCL) for all the cores, and sediment dating (^{14}C and micropaleontological), and grain-size analysis for selected samples.

6. Acknowledgments

This report been completed by Eulàlia Gràcia in collaboration with Graziella Bozzano and Zoraida Roselló (UTM-CSIC). It corresponds to a summary of the JC27 cruise report (Wynn et al., 2009) focusing on the coring stations from the SW Iberian Margin. We deeply thank Russell Wynn and Douglas Masson (NOCS, United Kingdom) for their invitation to collaborate in planning, acquiring and working on the sediment cores collected during the JC27 cruise in the Gulf of Cadiz.

7. Reference

Wynn, R B et al., (2009). RRS *James Cook* Cruise JC27, 05 Aug – 03 Sep 2008. Investigating landslide and gravity flow geohazards along the northeast Atlantic continental margin. National Oceanography Centre, Southampton, Cruise Report, No. 36, 25pp.

Table 1: Geographical location, characteristics and brief description of the 12 studied cores.

Core Name	Lat N	Long W	Depth m	Gear	Core length m	Study area	Brief core description
JC27-20	34º 40.0'	9º 27.45'	4285	PC (12m)	7.43	NE Seine Abyssal Plane	two well-developed foram-rich turbidites presumably sourced via the Rharb Valley
JC27-22	35º 33.28'	9º 41.91'	4306	PC (9m)	5.52	South Portimao-Lagos Canyon	dominated by turbidites with organic-rich mud tops affected by blackish sulphide development. There was evidence for significant bypass
JC27-23	35º 48.07'	10º 03.35'	4614	PC (9m)	5.78	Portimao-Lagos Canyon	A large number of sand-mud turbidites were sampled, and a low proportion of hemipelagite indicated a fairly rapid accumulation rate. The bottom ~60 cm of the core were heavily compressed
JC27-25	35º 44.75'	9º 59.27'	4635	PC (9m)	6.41	Portimao-Lagos Canyon	composed of about seven turbidites, with surprisingly thin sandy bases and thick mud caps
JC27-26	35º 50.93'	10º 32.05'	4834	PC(12m)	3.36	HAP	mostly sand-mud turbidites. Some of the core had probably fallen out of the core catcher upon recovery
JC27-27	36º 10.17'	10º 15.92'	4849	PC(12m)	8.7	SE HAP, midway between SVC and LP entry	Two local debrites were present, underlying well-developed sand-mud turbidites, suggesting they may have been earthquake-triggered events. One of the thickest turbidites is probably correlative with the H13 turbidite of Lebreiro
JC27-28	36º 14.69'	10º 3.82'	4825	PC (9m)	5.66	Levee on N side of SVC (outflow of the canyon)	Most of the core was composed of thin-bedded turbidites, but a locally-derived debrite was also present
JC27-30	36º 12.67'	10º 01.33'	4878	PC (12m)	5.22	Outflow of Sao Vicente Canyon	contained a fairly regular series of mud-dominated turbidites
JC27-31	37º 15.73'	10º 02.84'	3787	PC (12m)	8.23	Northern HITS basin gather zone	contained a thick sequence of apparently hemipelagic muds with one muddy sand debris flow unit
JC27-32	37º 18.80'	10º 21.70'	3994	PC (12m)	9.04	Nothern HITS basin	contained another thick sequence of apparently hemipelagic muds, with some thin turbidite layers and potential evidence of a debris flow in at least the bottom of the core
JC27-33	37º 20.50	10º 55.54'	5120	PC (12m)	8.05	Toe of Gorringe Bank Landslide (TAP)	contained a thick sequence of fine-grained turbidites, some with sandy bases. Blackish iron sulphide banding was abundant
JC27-34	37º 43.09''	10º 48.89'	5066	PC (12m)	4.76	Eastern margin of TAP	contained a nice sequence of sand-mud turbidites with some well-developed coarse sand bases.