SOUTHAMPTON OCEANOGRAPHY CENTRE

CRUISE REPORT No. 59

RRS *CHARLES DARWIN* CRUISE CD166
29 OCT - 22 NOV 2004

Sedimentary processes and deposits
in the Agadir Basin and Gulf of Cadiz

Principal Scientists
R B Wynn[1] & B.T. Cronin[2]

2005

[1]Challenger Division for Seafloor Processes
Southampton Oceanography Centre*
University of Southampton
Waterfront Campus
European Way
Southampton
Hants SO14 3ZH
UK

Tel: +44 (0)23 8059 6553
Email: rbw1@noc.soton.ac.uk

[2]University of Aberdeen, UK

**Renamed* National Oceanography Centre, Southampton
May 2005

DOCUMENT DATA SHEET

AUTHOR

WYNN, R B & CRONIN, B T et al

PUBLICATION DATE 2005

TITLE

RRS *Charles Darwin* Cruise CD166, 29 Oct – 22 Nov 2004. Sedimentary processes and deposits in the Agadir Basin and Gulf of Cadiz.

REFERENCE

Southampton Oceanography Centre Cruise Report, No. 59, 31pp.

ABSTRACT

The primary aim of CD166 was to undertake intensive coring in the Agadir Basin on the Northwest African margin, with the intention of characterising deep-water gravity flow processes and deposits at a basin-wide scale. In addition, it was hoped that sampling of volcaniclastic turbidites derived from Canary Islands landslides would provide insights into landslide processes and aid assessment of potential tsunami hazards. In addition, the first two days of the cruise were assigned to piston coring of a small, deep-water sand lobe in the Gulf of Cadiz, off southern Spain.

In the event, CD166 proved to be a highly successful cruise. In the Agadir work area a total of 50 piston cores was collected, up to 8 m in length. Most of the cores successfully penetrated through the target turbidite units 1-14, providing sedimentological and stratigraphical data for the last 200,000 years. The piston coring mechanism was extremely reliable throughout this extensive coring effort. In the Speculobe work area, a total of 11 piston cores was collected, up to 7.7 m in length. The seabed environment in this region was highly challenging for coring, although several of the cores did recover crucial sediment sequences. The insights gained from these two datasets are likely to substantially alter current thinking on large-scale deep-water gravity flows.

Wildlife observations were dominated by a variety of disoriented migrant landbirds and even a Migratory Locust arrived on board. Of scientific interest was the unusually large number of Leach's Storm-petrels *Oceanodroma leucorhoa* recovered on the deck of the ship at night.

KEYWORDS

Agadir Basin, *Charles Darwin,* cruise166 2004, Gulf of Cadiz, multibeam bathymetry, sediment cores, submarine channels

ISSUING ORGANISATION

National Oceanography Centre, Southampton
University of Southampton, Waterfront Campus
European Way
Southampton SO14 3ZH UK

Copies of this report are available from: **National Oceanographic Library, NOCS** *PRICE*:
Tel: +44(0)23 80596116 Email: nol@noc.soton.ac.uk

CONTENTS

CRUISE PERSONNEL

WYNN, R.B. (Principal Scientist)	Southampton Oceanography Centre, UK
MASSON, D.G.	Southampton Oceanography Centre, UK
FRENZ, M.	Southampton Oceanography Centre, UK
GEORGIOPOLOU, A.	Southampton Oceanography Centre, UK
AKHMETZHANOV, A.	Southampton Oceanography Centre, UK
KENYON, N.H.	Southampton Oceanography Centre, UK
CRONIN, B.T. (Co-Principal Scientist)	University of Aberdeen, UK
MAZZINI, A.	University of Aberdeen, UK
TALLING, P.J.	University of Bristol, UK
HOLZ, C.	University of Bremen, Germany
DALLMEIER-THIESSEN, S.	University of Bremen, Germany
GARCIA, M.	CSIC Barcelona, Spain
GAULD, P.D.	Master
REYNOLDS, P.	Chief Officer
HOOD, M.	2nd Officer
KIRKALDY-WILLIS, A.	3rd Officer
HOLT, J.M.	Chief Engineer
GREENHORN, A.	2nd Engineer
BELL, S.	3rd Engineer
JACKSON, A.	4th Engineer
HURREN, D.	ETO
LUCKHURST, K.	CPO (D)
ALLISON, P.	PO (D)
CRABB, G.	S1A
PEARCE, A.	S1A
DICKINSON, R.	S1A
MOORE, M.	S1A
HARRISON, M.	CPO (Sci)
MOORE, C.	ERPO
PERRY, C.	SCM
HAUGHTON, J.	Chef
LINK, W.	Asst. Chef
ORSBORN, J.	Steward
EVANS, J.	Technical Liaison Officer (TLO)
COOPER, J.	Technician
LLOYD, R.	Technician
TURNER, D.	Technician
WHITTLE, S.	Technician

ITINERARY

Departed Lisbon, Portugal on Oct 29th 2004
Arrived Funchal, Madeira on Nov 22nd 2004

OBJECTIVES

Understanding the internal architecture of large deep-water turbidite systems is currently of great importance to both science and industry. The aim of this cruise was to undertake an intensive coring programme in the Agadir Basin on the Northwest African margin, so that the detailed depositional architecture of a turbidite sequence emplaced in the last 200 ka could be assessed. The dataset was intended to provide a unique opportunity to investigate how turbidite deposits vary laterally over a distance of >450 km, and this in turn would provide new insights into flow processes. In addition, sampling of volcaniclastic turbidites derived from Canary islands landslides was intended to investigate landslide processes and aid assessment of associated potential tsunami hazards. The cruise was run by UK-TAPS as part of the Agadir Project, and was supported by NERC as part of SOC's core research, and also by a consortium of four oil companies, ExxonMobil, Shell (Morocco), ConocoPhillips and BHP Billiton.

The work programme consisted of three coring transects across the Agadir Basin using a standard piston corer in ~4.5 km water depth. A total of about 50 cores was planned, with 3.5-kHz profiles collected continuously across all transects. Detailed multibeam bathymetry surveys would be carried out at the input and exit points either end of the basin, and one or more mega-cores would provide data on recent activity inside the Agadir Canyon-Channel.

In addition, the first two days of the cruise were assigned to the UK-TAPS Speculobe project, involving piston coring of a small, deep-water sand lobe in the Gulf of Cadiz, off southern Spain.

CRUISE NARRATIVE

Oct 25th

Immediately before departure from SOC we heard that, due to inclement weather, the ship had been delayed during its transit from Glasgow to Lisbon, and instead of arriving on the 26th it was predicted on 27th/28th. We had also received no diplomatic clearance for any of the three countries whose waters we intended to operate in! The scientific party was itself delayed for an hour upon arriving at Lisbon airport, as one of the scientists had their luggage damaged on the flight and needed a replacement.

Oct 26th

Scientific party waiting in Lisbon. Our bad luck continues as one of the scientists had their wallet stolen by a pickpocket! No diplomatic clearance yet received.

Oct 27th

Scientific party waiting in Lisbon. Diplomatic clearance finally received for Portugal and Spain.

Oct 28th

Scientific party waiting in Lisbon. The ship was further delayed due to bad weather on passage.

Oct 29th (Day 303)

Ship arrived in Lisbon late morning. The planned boat transfer was abandoned and a port call used instead, due to a heavy swell. The agent arranged to transfer the scientific party to the ship at 1030 hrs. Once on board, the scientific party had a safety briefing at 1230 hrs, and the ship finally departed Lisbon at 1330 hrs, heading to the first coring site in the Gulf of Cadiz.

Oct 30th (Day 304)

Passage to the first coring site continued up to 1130 hrs. A science meeting for the cruise leaders took place at 0900 hrs. One issue that arose was the presence of numerous submarine cables in the work area; after some discussion with the Captain, we agreed to avoid coring sites within a half-mile of any marked and active cables. Fortunately, all selected targets were outside of this zone.

As we approached the first station at 1130 hrs the EM12 multibeam bathymetry system was switched on and the 3.5kHz and 10kHz fish deployed. We arrived on station **CD16601-01** at 1155 hrs. This station was at 1480 m water depth and the target was an area of background sediments beyond the edge of the 'Speculobe' sand lobe. We deployed an XBT at this site to calibrate the multibeam bathymetry data. The first one failed to work correctly but the second was successful. However, the computer engineer lost the data from this deployment so yet another XBT was required, which was successful. After a software crash and further 'teething troubles' the multibeam bathymetry was deemed to be successfully calibrated. The USBL probe was also deployed prior to coring. The 12 m piston corer was in the water at 1236 hrs and the USBL transmitter was clamped to the wire 100 m above the core head. The corer hit seabed at 1310 hrs with 1494 m wire out (location $35^{o}45.379$'N/$07^{o}40.019$'W). Pullout was reasonable at 4.6 tonnes. USBL records indicated that the corer was about 70 m west of the ship (260^{o}) during penetration (later deployments showed a similar deviation distance). The corer was recovered at 1355 hrs, and showed sediment halfway up the barrel to about 6 m. Sand had apparently got between the barrel and the liner as extracting the core

was difficult, requiring the hydraulic pusher. Even this failed to extract the whole liner, but a 4 m core was eventually recovered and the remaining liner left in the barrel as a new rig with a new barrel was set up. On splitting, it looked as if sand had also run up alongside the core liner and the sediment itself, and some of this loose sand had accumulated at the top of the core. Overall, the core showed a sequence of about 2.5 m of fine-grained background sediments (with one obvious silt-mud turbidite) overlying a thick massive sand at the base that was either debrite or liquefied through disturbance. The colour change in the background sediments indicated that the thick basal sand was probably in glacial age sediments. The lower part of these was rich in blackish sulphide flecks.

After a short transit, site **CD16602-01** was reached at 1653 hrs. This site was at 1478 m water depth and the target was the outer fringe of the Speculobe. A 12 m piston core was again attempted, and the corer was in the water at 1713 hrs. The USBL was deployed and appeared to be functioning successfully. The corer hit seabed at 1755 hrs (location 35°45.203'N/07°39.283'W). Pullout was 4.5 tonnes. Upon recovery, sediment could be seen halfway up the barrel to about 6 m. The core was easily removed from the barrels and was about 4 m in length. The overall sequence was very similar to CD16601-01, with about 2.5 m of dominantly background sediments on top of about 1.3 m of massive sand debrite with mud clasts near the top.

Another short transit saw us arrive at site **CD16603-01** at 1952 hrs. This site was at 1456 m water depth and was located in the thick, middle section of the Speculobe near to an obvious channel. The 3.5kHz record suggested a hard, sandy seafloor. A 12 m piston core was again attempted, and the corer was in the water at 2013 hrs. The USBL was deployed and appeared to be functioning successfully. The corer hit the seabed at 2051 hrs (location 35°45.999'N/07°37.204'W). Pullout was 4.8 tonnes and showed a curious stepped signal, suggesting only part penetration of the corer and/or an over-tight piston. Upon recovery at 2128 hrs, the core barrels were bent and the core head was half-covered in surficial mud, suggesting the corer had hit a hard layer and fallen over on the seabed. This was confirmed when a large sample of loose medium sand was recovered from inside the otherwise empty barrel. The trigger core was empty.

Oct 31st (Day 305)

A second deployment was attempted at site **CD16603-02** using a 6 m piston core. The USBL was deployed and functioned successfully. The corer was in the water at 0023 hrs and hit the seabed at 0101 hrs (35°46.160'N/07°37.215'W). Pullout was 3.12 tonnes. When the corer arrived on deck at 0135 hrs the core barrel was severely bent and no core was recovered in either the piston core or the trigger core. It then took two hours to break down the corer as the piston was jammed inside the barrel.

While a new corer was being rebuilt we then moved to a station nearby on the lobe surface (**CD16604-01**), which showed slightly more penetration on 5kHz deep-tow and 3.5kHz records. A 6 m piston core was attempted and the corer was in the water at 0526 hrs. The USBL was deployed and functioned successfully. The corer was in the seabed at 0601 hrs (35°46.215'N/07°37.165'W) and recorded a pullout of 3.1 tonnes, however, the signal indicated that the attempt was probably unsuccessful. The corer arrived on deck at 0638 hrs and had clearly fallen over on the seabed as one of the fins on the core head was deflected inwards and covered in surficial mud. An 84 cm core was recovered which contained a compressed 10 cm layer of surficial mud isolated in black sand that was probably a result of flow-in.

After the series of failures on the hard lobe surface we decided to attempt another site on the lobe fringe at a water depth of 1457 m (**CD16605-01**). The 5kHz deep-tow record showed good penetration with stratified sediments. A 12 m piston core was therefore attempted and the corer was in the water at 0844 hrs. The USBL was deployed and functioned successfully. The corer reached the seabed at 0935 hrs and showed a 'classic' pullout of 4.9 tonnes (35°46.392'N/07°37.205'W). The corer returned on deck at 1021 hrs. The trigger core only contained a small sample of surficial mud. The piston core contained about 8 m of sediment. The top 1 m showed a sequence of interbedded sandy debrites and compressed distorted background sediments, while below this was a thick sequence of dark sulphide-rich background muds.

After a short transit, station **CD16606-01** was reached at 1202 hrs. The target here was a section of the distal 'Speculobe' at a water depth of 1455 m. As we were becoming short of 110 mm diameter piston core barrels we decided to an attempt a 6 m piston core using a 90 mm diameter barrel. The corer was in the water at 1220 hrs, and the USBL was deployed and functioned successfully. The corer reached the seabed at 1257 hrs and showed a pullout of just 3.3 tonnes (35°46.210'N/07°36.588'N). Upon arrival on deck at 1339 hrs it was clear that the corer hadn't fully penetrated the seafloor, and only about 1.5 m of sediment was recovered (dominantly 'flow-in' sand).

Station **CD16607-01** was reached at 1457 hrs. The target was the fringe of the youngest part of 'Speculobe' at a water depth of 1464 m. Another 6 m piston core with 90 mm diameter barrels was used, and was in the water at 1521 hrs. The USBL was deployed and functioned successfully. The corer was in the seabed at 1554 hrs (35°45.155'N/07°37.254'W) and showed a pullout of just 2.9 tonnes, again suggesting limited penetration into the seabed. The core was on board at 1630 hrs and when opened contained 1.5 m of 'flow-in' sand.

Station **CD16608-01** was reached at 1810 hrs. The target was an area just beyond the edge of "Speculobe' at a water depth of 1462 m. A 9 m piston core was attempted using 90 mm barrels. The corer was in the water at 1825 hrs. The USBL was deployed and functioned successfully. The corer reached the seabed at 1858 hrs and had a pullout of 3.5 tonnes (35°45.218'N/07°37.149'W). The core was on board at 1947 hrs and contained about 3 m of muddy background sediments, with a thin sand layer towards the base hinting at a deeper sandier sequence that presumably prevented further penetration.

Station **CD16609-01** was reached at 2040 hrs, with the lobe fringe as the target. Water depth was 1454 m. The corer was in the water at 2110 hrs. The USBL was deployed and functioned successfully. The corer reached the seabed at 2151 hrs and showed a pullout of 3.1 tonnes (35°45.163'N/07°36.223'W). The corer returned on deck at 2236 hrs.

<u>Nov 1st (Day 306)</u>

The target for station **CD16610-01** was a braided 'flow pathway' feeding into the proximal lobe at a water depth of 1412 m. A 6 m piston core was attempted using 90 mm barrels. The corer was in the water at 0000 hrs and the USBL was deployed but failed to function so the deployment continued without it. The corer reached the seabed at 0043 hrs and recorded a pullout of 4.0 tonnes (35°46.666'N/07°34.163'W). When the corer returned on deck at 0127 hrs the barrels were bent.

A short transit to station **CD16611-01** saw us arrive at 0255 hrs. The target was the fan fringe at a water depth of 1477 m. The corer was in the water at 0308 hrs and this time the USBL functioned successfully when deployed. The corer reached the seabed at 0343 hrs and recorded a pullout of 3.1 tonnes (35°45.205'N/07°39.630'W). When the corer arrived on deck at 0420 hrs the barrels were again bent, but a 1.2 m core was recovered using the hydraulic pusher.

At 0448 hrs the hull-mounted USBL receiver was raised and passage commenced to the second work area in the Agadir Basin. Passage time estimated to be just over two days.

Nov 2nd (Day 307)

Clocks went back one hour overnight. Passage continued to the Agadir Basin in excellent weather conditions. There was a brief stop at 0900 hrs to allow for a change of the damaged piston core head, as the hydro fins had buckled during a previous deployment when the corer had fallen over on the seabed. An XBT profile was also collected while the ship was stationary at 33°23.49'N/12°23.02'W, in the SW corner of the Seine Abyssal Plain. This would provide calibration for the multibeam bathymetry in the upper 1800 m of the water column. Multibeam bathymetry logging commenced at 1300 hrs at 33°01.5'N/13°05.4'W, on the eastern margin of the Agadir Basin. The 3.5kHz and 10kHz tow-fish were deployed in the evening in preparation for commencement of work tomorrow morning.

Nov 3rd (Day 308)

Passage continued at full speed until 0650 hrs when the first coring station was reached. When we were about two miles off the site the ship speed was reduced to 6 knots and the 3.5kHz profiler switched on. Station **CD16612-01** was reached at 0735 hrs and showed an uncorrected water depth of 4396 m. The target was a sequence of sheet-like interbedded turbidites and hemipelagites in the thickest part of the Agadir Basin sediment fill. An SVP probe was deployed to determine water column character down to the seabed; this would then be used to calibrate multibeam bathymetry across the whole work area. The SVP was recovered at 1015 hrs and appeared to have worked successfully. A 12 m piston core using a 1.5 tonne head weight and 110 mm barrels was then deployed at 1057 hrs. It was sent to the seabed at ~50 m/min and reached the bottom at 1231 hrs at location 31°29.99'N/16°12.014'W. Pullout looked very good and reached 7.1 tonnes. The corer returned on board at 1359 hrs and we departed from the station at 1420 hrs to undertake a 3.5kHz survey on passage at 6.5 knots to the next core site. The recovered core was 8 m in length and contained a full sequence of turbidites from 1-14. There was an imploded liner in section 2 but this did not affect the overall excellent quality of the core.

Station **CD16613-01** was reached at 1627 hrs. The 3.5kHz record during the transit to this station showed a completely flat seafloor with parallel strata. A 12 m piston corer with the same set-up as at the previous station was deployed and was in the water at 1641 hrs. Uncorrected water depth was 4397 m. The corer reached the seabed at 1803 hrs and recorded a pullout of 6.3 tonnes (31°38.981'N/16°20.989'W). The corer returned on deck at 1936 hrs and showed evidence of having hit a hard sand layer due to reduced penetration and shearing off of the nails holding the core cutter. We departed from the station at 1958 hrs and proceeded to the next core site at 6.5 knots. The recovered core was 4 m long and contained turbidites 1-8.

Station **CD16614-01** was reached at 2125 hrs. This site was at an uncorrected water depth of 4383 m, some 14 m shallower than the previous site. A very gentle slope break was noted

halfway between this and the previous site. A 12 m piston core was deployed and was in the water at 2146 hrs. It reached the seabed at 2309 hrs and recorded a pullout of 6.1 tonnes (31°45.994'N/16°28.000'W). The corer returned on deck at 0033 hrs, and by 0104 hrs we had departed for the next core site at 6.5 knots. The recovered core was only 1.4 m long and contained a sequence of turbidites that were not obviously correlatable with the previous two cores. For this reason, we decided not to attempt another site at 30 m above the basin floor, and instead turned and headed SW on a 3.5kHz survey line.

Nov 4th (Day 309)

The 3.5kHz survey line across the distal Agadir Basin continued until 0800 hrs, and crossed two small channels in the SW of the basin at about 31°15'N/16°50'W. We then turned onto the next line heading to the NW, and soon crossed the same two channels. Another pair of broad shallow channels were also crossed slightly to the north at about 31°25'N/16°55'W. At 1140 hrs we turned and passed through WP1 at 31°29'N/16°54'W onto Line 1 of a dedicated multibeam bathymetry and 3.5kHz survey. The target was to map the northern channel system as it passed out of the distal Agadir Basin and headed west across the rise to the Madeira Abyssal Plain. We continued mapping the channel westwards and reached the end of Line 5 at 2330 hrs.

Nov 5th (Day 310)

We continued on the geophysical survey until 0920 hrs at the end of Line 9. The first look at the data showed that the multibeam bathymetry worked extremely well, and the channel was very well defined on the backscatter data. A nice series of 3.5 kHz profiles were also collected showing how the channel (named as the Madeira Channel) evolves downstream. We then proceeded to a series of selected cores sites on Line 5, where we intended to take four piston cores in a transect across the channel. Station **CD16615-01** was reached at 1255 hrs, with the target being the southern channel margin at 4475 m (uncorrected) water depth. A 12 m piston core with 110 mm barrels was deployed and was in the water at 1313 hrs. It reached the seabed at 1427 hrs and showed a pullout of 6.3 tonnes (31°26.783'N/17°13.229'W). When the corer arrived on deck at 1556 hrs it showed sediment up the side of the barrel to at least 6 m, but the core catcher was missing and some sediment appeared to have been lost out of the bottom of the corer. However, an 8 m core was recovered that contained a sequence of dominantly background sediments and our missing core catcher!

We then proceeded the short distance to station **CD16616-01** and arrived at 1642 hrs. The target here was a small 'terrace' on the southern edge of the channel at an uncorrected water depth of 4480 m. The corer was set-up the same way as at the previous site and was in the water at 1710 hrs. It reached the seabed at 1838 hrs and showed a pullout of 6.9 tonnes (31°27.167'N/17°13.133'W). When the corer returned on board at 2013 hrs the core catcher was turned inside out and the liner was empty – it appears that the corer had penetrated to a significant depth but the sediment was unfortunately lost.

While the corer was being rebuilt we proceeded to station **CD16617-01** and arrived at 2058 hrs. The target was the deepest part of the channel at a water depth of 4486 m. The 12 m corer was in the water at 2121 hrs and reached the seabed at 2243 hrs, showing a pullout of 7.1 tonnes (31°27.808'N/17°12.736'W). The corer returned on deck at 0018 hrs and contained about 3.5 m of sediment, although the core catcher was again severely damaged.

Nov 6th (Day 311)

The next deployment was a second attempt at the channel terrace station **CD16616-02**, and again a 12 m piston core was attempted. After arriving on station at 0111 hrs the corer was in the water at 0127 hrs. Water depth was 4480 m. The corer reached the seabed at 0245 hrs and showed a pullout of 7.0 tonnes (31°27.11'N/17°13.15'W). Upon arrival back on deck at 0412 hrs the core catcher appeared to be inverted, and only a 2.7 m core was recovered.

Station **CD16618-01** was reached at 0533 hrs with the intended target being the northern channel margin at a water depth of 4475 m. The corer was in the water at 0610 hrs and reached the seabed at 0733 hrs, recording a pullout of 8.1 tonnes (31°28.85'N/17°12.33'W). The corer returned on deck at 0857 hrs and also showed another inverted core catcher. About 5 m of core was recovered, and contained a nice sequence of 'bypass' turbidites interbedded with background sediments.

Station **CD16619-01** was reached at 1020 hrs and was aimed at an area of reduced 3.5kHz penetration ~3 km to the north of the channel. Water depth was 4467 m. A single 6 m barrel was used at this site in an attempt to overcome the problem of inverted core catchers, which appeared to be the result of particularly stiff ooze layers. The corer was in the water at 1034 hrs and reached the seabed at 1157 hrs, showing a pullout of 6.3 tonnes (31°30.794'N/17°11.777'W). It returned on deck at 1320 hrs and contained a 4.3 m core with a series of volcanic 'bypass' turbidites. The core catcher was undamaged on this deployment.

At 1403 hrs we departed to the SSE with the aim of crossing the southern channel system with two 3.5kHz profiles before selecting two coring sites. At 1839 hrs the two lines had been completed and we headed for station **CD16620-01**, which was aimed at the deepest section of the channel. We arrived on station at 1924 hrs and deployed a 6 m piston corer. Water depth was 4478 m. The corer was in the water at 1940 hrs and reached the seabed at 2103 hrs, showing a pullout of 6.5 tonnes (31°13.979'N/17°09.609'W). A 3 m core was recovered on deck at 2236 hrs, and contained a nice sequence of both volcanic and Moroccan margin 'bypass' turbidites.

Nov 7th (Day 312)

Station **CD16621-01** was reached at 2340 hrs, and the target was the northern margin of the channel at an uncorrected water depth of 4453 m. A 6 m corer was deployed and was in the water at 0003 hrs. It reached the seabed at 0120 hrs and showed a pullout of 6.2 tonnes (31°15.181'N/17°09.289'W). The corer arrived back on deck at 0245 hrs and contained a 3.75 m core with another nice sequence of turbidites from both sources.

At 0325 hrs we departed to the east to start a multibeam survey where the intention was to fill in two data 'holes' between previous survey lines. After this was completed we arrived at station **CD16622-01** at 1121 hrs, where the target was the gather zone of the northern channel system. Water depth was recorded as 4420 m. A 12 m piston core was deployed at 1137 hrs and reached the seabed at 1254 hrs, showing a pullout of 6.6 tonnes (31°26.392'N/16°42.716'W). It returned on deck at 1423 hrs and contained about 5.2 m of sediment.

We then started another geophysical survey, with the aim of tracing the origin of the southern channel system. The survey began at 1440 hrs and ended at 2100 hrs. The target for coring site **CD16623-01** was a very shallow depression just upstream of the southern channel system, which showed reduced penetration on 3.5kHz profiles and a hard surface reflector. Water depth was 4412 m. After arriving on station at 2124 hrs a 12 m piston core was

deployed at 2145 hrs and reached the seabed at 2308 hrs, showing a pullout of 6.8 tonnes (31°16.811'N/16°41.661'W). The corer returned on deck at 0043 hrs and contained about 7 m of sediment. We departed from the station at 0053 hrs.

Nov 8th (Day 313)

After a short passage station **CD16624-01** was reached at 0337 hrs. The target here was to have a linking core in the middle of a triangle of sites (12, 22 and 23), and was at a water depth of 4400 m. A 12 m piston core was deployed at 0338 hrs and reached the seabed at 0512 hrs, showing a pullout of 7.3 tonnes (31°24.94'N/16°16.28'W). The corer returned on deck at 0637 hrs and contained a good quality core some 5.2 m in length. At 0719 hrs we left the station and headed eastwards towards site CD16612-01, before turning to the SE at 0912 hrs for a geophysical survey of the southern distal strike transect.

After the geophysical survey was completed, we selected our first core site at ~15 m above the deepest part of the basin floor. Station **CD16625-01** was reached at 1457 hrs and showed a water depth of 4383 m. A 12 m piston core was deployed at 1515 hrs and reached the seabed at 1643 hrs, recording a slightly irregular pullout of 6.3 tonnes (31°17.550'N/16°00.85'W). The corer returned on deck at 1816 hrs and contained a 5.5 m core that showed some evidence of compression in the top section. The core contained several Moroccan margin turbidites so we decided to go higher up the slope to follow the pinch-out.

Station **CD16626-01** was reached at 2045 hrs, and was ~30 m above the basin floor at a water depth of 4365 m. A 12 m piston core was deployed at 2126 hrs and reached the seabed at 2248 hrs, recording a pullout of 6.6 tonnes (31°13.827'N/15°57.291'W). It returned on deck at 0017 hrs and we left the station at 0111 hrs.

Nov 9th (Day 314)

Station **CD16627-01** was reached at 0312 hrs and the target was the southern basin margin at a water depth of 4390 m. A 12 m piston core was deployed at 0321 hrs and reached the seabed at 0445 hrs, showing a pullout of 6.7 tonnes (31°20.99'N/16°03.56'W). The core returned on deck at 0611 hrs and contained about 8 m of sediment.

Station **CD16628-01** was reached at 0837 hrs, and the target was the pinch-out of the Bed 5 'debrite' between sites 12 and 24 at a water depth of 4398 m. A 12 m piston core was deployed at 0855 hrs and reached the seabed at 1019 hrs, recording a pullout of 7.3 tonnes (31°28'N/16°17.5'W). The core returned on deck at 1146 hrs and contained 4.75 m of sediment. The work area in the distal Agadir Basin was then left at about 1200 hrs.

We then moved east into the central Agadir Basin to start our axial transect and arrived at station **CD16629-01** at 1500 hrs, where water depth was 4389 m. A 12 m piston core was deployed at 1507 hrs and reached the seabed at 1623 hrs, recording a pullout of 7.2 tonnes (31°35.16'N/15°58.03'W). The core returned on deck at 1828 hrs and contained about 7 m of sediment. We then departed at 1915 hrs and headed NE.

Station **CD16630-01** was reached at 2041 hrs, at a water depth of 4381 m. A 12 m piston core was deployed at 2059 hrs and reached the seabed at 2223 hrs, showing a pullout of 6.5 tonnes (31°41.01'N/15°44.03'W). The core returned on deck at 2356 hrs and contained 4 m of sediment.

Nov 10th (Day 315)

Station **CD16631-01** was reached at 0230 hrs, at a water depth of 4375 m. A 12 m piston core was deployed at 0249 hrs and reached the seabed at 0407 hrs, recording a pullout of 6.8 tonnes (31°47.51'N/15°31.01'W). The core returned on deck at 0544 hrs and contained about 7 m of sediment. The Bed 5(d) turbidte-debrite sandwich bed had transformed into a pure turbidite in this core, so we decided to run a short survey line to the NW to find the deepest part of the central basin and constrain the turbidite-debrite transformation.

The survey found that the basin floor in the central basin was essentially flat, so we took just one core at station **CD16632-01** at a water depth of 4375 m. A 12 m piston core was deployed at 0958 hrs and reached the seabed at 1120 hrs, showing a pullout of 7.2 tonnes (31°54.52'N/15°34.64'W). The core returned on deck at 1251 hrs and contained about 6 m of sediment. Bed 5(d) consisted of turbidite so, satisfied that we had defined the boundary of the sandwich bed, we proceeded back to station CD16631-01 and resumed our axial transect to the NE.

In the afternoon a fax arrives detailing correspondence between RSU and the FCO regarding our Moroccan permissions clearance, which is yet to be granted. It appears that the main hold up is with the Moroccan military, and we are assured that all is being done at 'our' end to ensure it is sorted before we enter the Agadir Channel work area at the weekend.

Station **CD16633-01** was reached at 1728 hrs, at a water depth of 4369 m. A 12 m piston core was deployed at 1740 hrs and reached the seabed at 1914 hrs, recording a pullout of 7.1 tonnes (31°52.115'N/15°14.955'W). The core returned on deck at 2055 hrs and contained 7 m of sediment. The top section showed some evidence of core disruption but otherwise the core was in good condition.

Nov 11th (Day 316)

After a two hour passage, station **CD16634-01** was reached at 2346 hrs. However, due to further deterioration in the weather it was decided that coring was not possible and instead a geophysical survey line was chose that headed in to the wind in a NE direction. After five hours passage at ~7 knots the ship turned 180° and returned at full speed to the core site. At 0938 hrs the sea had died down sufficiently for a 12 m piston corer to be deployed, with water depth showing as 4368 m. The corer reached the seabed at 1108 hrs, recording a pullout of 6.4 tonnes (31°59.9'N/15°00.12'W). The core returned on deck at 1239 hrs and contained 7 m of sediment.

After another two hour passage towards the next core site, a further increase in sea state meant that we had to resume geophysical surveying, so a couple of lines were chosen running NE-SW that would constrain the bathymetry of the southern proximal basin.

Nov 12th (Day 317)

By 0800 hrs we had completed our survey of the southern proximal basin and there was still no improvement in the weather, so we decided to head east to the mouth of the Agadir Channel where the intention was to continue surveying around the channel mouth. However, we received a welcome boost after lunch with the news that Moroccan permissions had finally been granted, enabling us to plan a multibeam and 3.5kHz survey in Moroccan waters which would cover the channel itself. By 2100 hrs we had reached a position just south of the Casablanca seamount and were heading towards WP1 of the survey.

Nov 13th (Day 318)

WP1 of the geophysical survey was reached at 0219 hrs, and we then proceeded to run a series of lines across the distal Agadir Channel. Although the wind had died down a little, conditions were still not suitable for coring. However, by mid-evening the wind had dropped sufficiently for coring, so a site in the axis of the main Agadir Channel was chosen. We arrived at station **CD16635-01** at 2200 hrs, with water depth showing 4113 m. The 3.5kHz record suggested a hard seafloor. A 6 m piston corer was in the water at 2218 hrs, and a USBL was deployed on the wire 1000 m above the corer. However, the USBL appeared to have difficulty with tracking and the data returned was not thought to be reliable. Consequently, the USBL was not used again in this work area. The corer reached the seabed at 2339 hrs and showed a negligible pullout of ~5.7 tonnes, suggesting the corer had failed to penetrate the hard channel floor (32^{o}22.32'N/12^{o}34.13'W). However, when the corer returned on deck at 0125 hrs it appeared to have gone in to a depth of at least 3 m. Unfortunately, the lowermost metre or so of sediment was lost, probably as most of it was sandy material that flushed through the core catcher during the journey to the surface. Eventually, just 40 cm of sediment was recovered, and showed evidence for flow-in and disruption. A small 30 cm long sample was also recovered from the trigger core that contained one turbidite a few cm below the surface.

Nov 14th (Day 319)

As there seemed to be some mud near the seafloor in the base of the channel, it was decided to deploy the megacorer at the same site to assess the level of recent turbidity current activity. At station **CD16635-02** we used a four-tube megacorer and this was in the water at 0233 hrs. It reached the seabed at 0405 hrs at a water depth of 4113 m (32^{o}22.29'N/12^{o}34.05'W). It returned on deck at 0537 hrs and two of the tubes contained good samples. A few cm of background sediment at the seafloor indicated that the lower Agadir Canyon has not been fed by large flows in the last few thousand years.

During the night a fault developed on the 3.5kHz profiler and no data were recorded for several hours. Eventually the recording unit was patched up but could only operate with reduced power, so although a record was achieved the quality was slightly reduced.

We then moved to station **CD16636-01** which was located on the left-hand levee of the main Agadir Channel at a water depth of 3894 m, about 220 m above the channel floor. We arrived on station at 0715 hrs and a 12 m piston core was deployed at 0726 hrs. The corer reached the seabed at 0843 hrs and recorded a 7 tonne pullout (32^{o}20.52'N/12^{o}38.79'W). It returned on deck at 1005 hrs and contained about 6.5 m of dominantly fine-grained sediment.

We then crossed the channel and proceeded to station **CD16637-01**, which was located on the right-hand bank of the channel at a water depth of 3904 m, some 210 m above the channel floor. A 12 m piston core was deployed at 1420 hrs and reached the seabed at 1536 hrs, recording a pullout of just 6.1 tonnes (32^{o}32.67'N/12^{o}37.09'W). The corer returned on deck at 1659 hrs and contained about 1 m of sediment. Once split, the core seemed to show a major erosional hiatus, which was confirmed when the 3.5kHz records were analysed.

In an attempt to core a more conformable sequence we moved upslope a short distance to station **CD16638-01** at a water depth of 3779 m, some 335 m above the channel floor. The 3.5kHz record indicated a moderately soft seafloor with well-stratified sediments. A 12 m piston core was deployed at 1918 hrs and reached the seabed at 2033 hrs, recording a classic

pullout of 7.2 tonnes (32°34.97'N/12°36.41'W). The corer returned on deck at 2157 hrs and contained 3 m of sediment that also included a significant hiatus.

At 2220 hrs we headed west with the aim of running a single survey line across the channel mouth, and then coring along this line to calibrate a series of targets identified on TOBI sidescan sonar.

Nov 15th (Day 320)

The survey line was completed at 0704 hrs and the first station selected was on the lower rise just to the south of the channel mouth. Station **CD16639-01** was reached at 0725 hrs and showed a water depth of 4191 m, about 60 m above the deepest part of the channel mouth. A 12 m piston core was deployed at 0742 hrs and reached the seabed at 0914 hrs, recording a pullout of 6.4 tonnes (32°23.09'N/13°31.96'W). The corer returned on deck at 1043 hrs and showed an inverted core catcher and a partially imploded liner, suggesting that some sediment may have been lost during pullout. A 3 m core was recovered that contained a similar sequence to CD16636-01.

We then moved to station **CD16640-01**, which was located at the southern edge of the channel mouth at a water depth of 4236 m. The target was an area of high backscatter with longitudinal streaking, interpreted as sand patches with some reworking. A 6 m piston core was deployed at 1302 hrs and reached the seabed at 1411 hrs, recording a pullout of 6.1 tonnes (32°27.04'N/13°29.11'W). The corer returned on deck at 1546 hrs and contained about 2 m of sediment. The top of the core was highly compressed, but the lower section was good quality.

Station **CD16641-01** was reached at 1643 hrs, with the target being a zone of chevron-shaped scours in an area of high backscatter. Water depth was 4247 m. A 6 m piston core was deployed at 1701 hrs and reached the seabed at 1832 hrs, recording a pullout of 6.2 tonnes (32°29.47'N/13°27.52'W). The corer returned to the surface at 2018 hrs and had failed due to the main wire wrapping around the corer. Nothing was recovered from the piston core although a trigger core was collected. A second attempt was made at the same site (station **CD16641-02**) and a 6 m piston core was deployed at 2055 hrs. This reached the seabed at 2223 hrs but showed negligible pullout of 5.9 tonnes, suggesting the corer had failed to penetrate far into the hard seafloor (32°29.46'N/13°27.46'W). The corer returned on deck at 2355 hrs but only contained about 1.5 m of sediment.

Nov 16th (Day 321)

Station **CD16642-01** was aimed at the deepest part of the channel mouth, adjacent to the northern margin. Water depth was 4253 m. A 6 m piston core was deployed at 0150 hrs and reached the seabed at 0259 hrs, recording a pullout of 5.8 tonnes (32°33.49'N/13°24.52'W). A 2.6 m core was recovered once the corer returned on deck at 0431 hrs.

The next station was **CD16643-01**, located on the northern margin of the channel mouth at a water depth of 4187 m, some 65 m shallower than the previous site. We arrived on station at 0537 hrs and a 12 m piston core was in the water at 0556 hrs. It reached the seabed at 0719 hrs, recording a pullout of 6.9 tonnes (32°34.98'N/13°24.48'W). The corer returned on deck at 0848 hrs and contained 2.6 m of sediment.

Several of the previous deployments had recovered unexpectedly short cores, given that the sediment was not particularly sandy or stiff. The problem was thought to be the clamp fixing

the trigger arm to the main coring wire. This had worn smooth leading to slippage of the trigger arm during its journey to the seabed. The resulting alteration to wire lengths affected the coring process, resulting in a series of short or disrupted cores. Consequently a new trigger arm clamp was attached and we returned to station **CD16641-03** to test the new equipment at a previous site, and also in the hope of gaining a longer core at that location. We arrived on station at 1055 hrs and a 6 m piston core was deployed at 1106 hrs. It reached the seabed at 1231 hrs, recording a pullout of 6 tonnes (32°29.51'N/13°27.51'W). Unfortunately, when the corer returned on deck it only contained about 50 cm of sediment, which was compressed relative to the previous core at that location. Before departing for the next station the amount of wire used to account for rebound was halved in an attempt to alleviate the problem of compression.

We then moved south to station **CD16640-02** in the hope of recovering a better quality core (the previous attempt here also resulted in a highly compressed top section). We arrived on station at 1459 hrs and deployed a 6 m piston core at 1516 hrs. It reached the seabed at 1633 hrs and recoded a pullout of 6 tonnes (32°26.98'N/13°29.08'W). The corer returned on deck at 1755 hrs and contained an identical sequence to CD16640-01, so it appeared that the apparent compression in the top section was actually a series of erosional surfaces in the core.

The next target was a site on the northern margin of the channel mouth between stations CD16642-01 and CD16643-01. Station **CD16644-01** was reached at 2041 hrs and showed a water depth of 4209 m. A 6 m piston core was deployed at 2101 hrs and reached the seabed at 2226 hrs, recording a pullout of 5.8 tonnes (32°34.31'N/13°24.48'W). The corer returned on deck at 0001 hrs but was completely empty, despite appearing to have fully penetrated into the seabed.

Nov 17th (Day 322)

The cause of the previous coring failure was not obvious, so we decided to go again at the same site. At station **CD16644-02** we again deployed a 6 m piston corer, which entered the water at 0207 hrs. It reached the seabed at 0331 hrs and recorded a pullout of 6.3 tonnes (32°34.37'N/13°24.51'W). Water depth was 4212 m. When the corer returned on deck at 0458 hrs it contained 3.6 m of sediment.

The next target was the bottom of a large erosional scour in the proximal channel mouth zone. Station **CD16645-01** was reached at 0655 hrs and showed a water depth of 4247 m. A 6 m piston core was deployed at 0713 hrs and reached the seabed at 0843 hrs, recording a pullout of 6.4 tonnes (32°29.74'N/13°15.90'W). When the corer returned on deck at 1013 hrs it appeared to have over-penetrated the seafloor, and unfortunately the barrel was empty. The likely conclusion was that the core catcher had again failed to hold in the sediment and/or the piston was not creating a sufficient seal. The over-penetration presumably meant that the scour was filled with a substantial thickness of soft sediment. The trigger core contained a 50 cm core that correlated very well with the top sections of CD16641 and CD16642.

At 1110 hrs we moved west to the outer channel mouth and towards station **CD16646-01**, which was attempting to hit a high backscatter patch within an area of reworked transverse bedforms. Water depth was 4255 m. We arrived on station at 1316 hrs and deployed a 9 m piston corer at 1330 hrs. It reached the seabed at 1458 hrs and showed a weak pullout of 5.9 tonnes (32°32.48'N/13°38.00'W). The corer returned on deck at 1640 hrs and appeared to have only penetrated a couple of metres into the seabed. This was confirmed when the core was removed and only about 75 cm of sediment was present, with the top few beds again

correlating very well with sites CD16641 and CD16642. There was evidence of minor sand flow-in at the base.

We then continued our transect down the proximal basin and arrived at station **CD16647-01** at 1835 hrs. Water depth was 4293 m. A 12 m piston core was deployed at 1856 hrs and reached the seabed at 2020 hrs, recording a pullout of 6 tonnes (32°27.48'N/13°51.99'W). The pullout trace suggested that the corer had fallen over on the seabed after hitting a hard sand layer. When the corer returned on deck at 2156 hrs the bottom barrel was bent and the head fins were distorted. About 50 cm of heavily distorted sediment were recovered, with sand flow-in at the base.

Nov 18th (Day 323)

Station **CD16648-01** was reached at 0010 hrs. The 3.5kHz record was still indicating a fairly hard seafloor at this location so a 9 m piston core was deployed. Water depth was 4322 m. The corer was in the water at 0104 hrs and reached the seabed at 0238 hrs, recording a pullout of 6 tonnes (32°21.01'N/14°08.01'W). The corer returned on deck at 0408 hrs and contained just over 5 m of sediment.

We arrived at station **CD16649-01** at 0637 hrs, with water depth showing as 4345 m. A 9 m piston core was deployed at 0659 hrs and reached the seabed at 0830 hrs, recording a pullout of 6.7 tonnes (32°14.49'N/14°22.50'W). The corer returned on deck at 1010 hrs and contained 4.5 m of sediment.

Station **CD16650-01** was reached at 1231 hrs and showed a water depth of 4361 m. A 12 m piston core was deployed at 1247 hrs and reached the seabed at 1407 hrs, recording a pullout of 6.1 tonnes (32°09.00'N/14°38.01'W). A 4.5 m core was recovered, however, due to the piston being set particularly tight in an attempt to stop cores slipping through the catcher, the upper section was severely imploded.

We then moved to a site between stations CD16649 and CD16650 in an attempt to pin down the transition in Bed 5 from a gravel lag deposit to a thick turbidite-debrite sandwich bed. We arrived at station **CD16651-01** at 1823 hrs and deployed a 12 m piston corer at 1835 hrs, with water depth showing 4355 m. There was then a short delay as, after paying out about 1000 m of wire, a spike on the wire tension meter indicated that the trigger arm may have slipped as had happened previously. However, once this was checked out it was found to be just a jolt related to the wire scrolling on the winch. The corer eventually reached the seabed at 2058 hrs and recorded a pullout of 6.6 tonnes (32°11.99'N/14°30.03'W). It arrived back on deck at 2244 hrs and contained 3.5 m of sediment.

Nov 19th (Day 324)

The next two cores were aimed either side of the axial transect to constrain the lateral extent of the Bed 5 turbidite-debrite sandwich bed. Station **CD16652-01** was reached at 0118 hrs and showed a water depth of 4360 m. A 12 m piston core was deployed and reached the seabed at 0306 hrs, recording a pullout of 6.2 tonnes (32°02.49'N/14°30.04'W). The corer returned on deck at 0435 hrs and contained 4.5 m of sediment.

Station **CD16653-01** was reached at 0651 hrs and showed a water depth of 4356 m. A 12 m piston core was deployed at 0713 hrs and reached the seabed at 0845 hrs, recording a pullout of 6.5 tonnes (32°17.5'N/14°37.99'W). The corer returned on deck at 1025 hrs and contained 3.5 m of sediment.

At 1059 hrs we headed southwest to the start of a survey line across the southern proximal basin margin. The start of the survey line (WP1) was reached at 1226 hrs and we arrived at the end of the line (WP2) at 1714 hrs and then selected a coring site 25 m above the basin floor at a water depth of 4341 m. At station **CD16654-01** a 12 m piston core was deployed at 1730 hrs, and reached the seabed at 1905 hrs (31°44.49'N/14°34.50'W). Recorded pullout was 7.4 tonnes. The corer returned on deck at 2050 hrs and contained 6 m of sediment.

Nov 20th (Day 325)

Station **CD16655-01** was reached at 2216 hrs and showed a water depth of 4360 m, about 5 m above the deepest part of the basin on this transect. There was a short delay before coring commenced due to a problem with the wire scrolling on the winch. A 12 m piston corer was deployed at 0020 hrs and reached the seabed at 0130 hrs, recording a pullout of 7.2 tonnes (31°46.83'N/14°36.18'W). The corer returned on deck at 0253 hrs and contained 2.5 m of sediment.

We arrived on station **CD16656-01** at 0520 hrs, with water depth showing as 4364 m. A 12 m piston core was deployed at 0542 hrs and reached the seabed at 0658 hrs, recording a pullout of 6.2 tonnes (31°53.50'N/14°38.34'W). The corer returned on deck at 0828 hrs and contained an excellent quality core with 7.5 m of sediment.

A wrap-up meeting for the cruise leaders was held at 0900 hrs. Items discussed included the supply of submarine cable data to the PSO, delays in receiving diplomatic clearance, reliability of the NIOZ coring system and dual ship position displays in the main lab and on the bridge. Overall, everyone agreed that the cruise had been a great success.

Station **CD16657-01** was located in the deepest part of the transect at a water depth of 4365 m. We arrived on station at 1048 hrs and deployed a 12 m piston core at 1105 hrs. The corer reached the seabed at 1230 hrs and recorded a pullout of 6.5 tonnes (32°04.14'N/14°43.89'W). The corer returned on deck at 1403 hrs and contained 6.8 m of sediment.

Station **CD16658-01** was reached at 1606 hrs and showed a water depth of 4362 m. A 12 m piston core was deployed at 1627 hrs and reached the seabed at 1753 hrs, recording a pullout of 6.3 tonnes (32°12.47'N/14°50.99'W). The corer returned on deck at 1923 hrs and contained 5.6 m of sediment.

We arrived at station **CD16659-01** at 2135 hrs with water depth showing as 4361 m. A 12 m piston core was deployed at 2150 hrs and reached the seabed at 2323 hrs, recording a pullout of 6.4 tonnes (32°22.01'N/15°00.03'W). The corer returned on deck at 0057 hrs and contained 4.2 m of sediment. We then headed north to the basin margin and the final two core sites.

Nov 21st (Day 326)

Station **CD16660-01** showed a water depth of 4337 m, some 25 m above the deepest part of the basin. We arrived at 0508 hrs and a 12 m piston core was deployed at 0532 hrs. It reached the seabed at 0657 hrs and recorded a pullout of 6.4 tonnes (32°36.69'N/15°15.10'W). The corer returned on deck at 0837 hrs and contained 5.5 m of sediment.

The final station, **CD16661-01**, was reached at 1032 hrs, at a water depth of 4354 m. A 12 m piston core was deployed at 1049 hrs and reached the seabed at 1219 hrs, recording a pullout of 6.1 tonnes (32^{o}33.00'N/15^{o}10.35'W). The corer returned on deck at 1357 hrs and contained 3 m of sediment.

At 1530 hrs we left the station and headed for port in Madeira. Multibeam and 3.5kHz was switched off prior to leaving the final station.

Nov 22nd (Day 327)

Arrival in Funchal, Madeira. Scientific party disembarked and transferred to the airport for the journey home.

WILDLIFE OBSERVATIONS

Oct 30th (35°45'N/07°40'W)
165 km SW of Cadiz, Spain
Wildlife observations began with single Grey Wagtail, Meadow Pipit and Goldfinch on or over the ship, and one Great Skua, two storm-petrel sp., and several Gannets and Lesser Black-backed Gulls.

Oct 31st (35°46'N/07°37'W)
165 km SW of Cadiz, Spain
A Leach's Storm-petrel was picked up on deck overnight, and single Goldfinch and Pied/White Wagtail flew over the ship. A Gannet and up to 15 'Scandinavian' Lesser Black-backed Gulls were also seen.

Nov 1st (35°45'N/07°39'W to 34°10'N/10°45'W)
Transit from 165 km SW of Cadiz, Spain to 225 km off NW Morocco
A good passage of migrant passerines took place between 0800-1400 hrs in good conditions (a light NW wind and sun with scattered light cloud). At least 700 birds were logged moving south from Europe into Africa in flocks of up to 100 birds. Skylarks appeared to be the dominant species, with four White/Pied Wagtails, three Serins, one Grey Wagtail, one Goldfinch and one Meadow Pipit also noted. Single Skylark, Starling and a 1st-winter male Black Redstart touched down briefly on the ship. Seabirds were scarce but included about 100 Gannets moving south, single 1st-winter Mediterranean Gull and Great Skua, and about five immature Lesser Black-backed Gulls. A single hoverfly sp. was noted on deck.

Nov 2nd (34°10'N/10°45'W to 32°05'N/14°55'W)
Transit from 225 km off NW Morocco to 160 km ESE of Madeira
A Spotted Flycatcher was on board early morning before departing to the SE. A Chiffchaff or Willow Warbler briefly alighted early afternoon. Other birds noted included single 1st-winter Yellow-legged and Lesser Black-backed Gulls, and at least two storm-petrel sp.

Nov 3rd (32°05'N/14°55'W to 31°30'N/16°12'W)
Transit from 160 km ESE of Madeira to 110 km SE of Madeira
A Grey Wagtail circled the ship briefly mid-morning and a Sooty Shearwater flew SW. Up to eight storm-petrel sp. were also noted. A small brownish turtle sp. was seen. Another three Leach's Storm-petrels crash-landed on the deck overnight and were boxed until dawn.

Nov 4th (31°15'N/16°50'W)
135 km S of Madeira
The three Leach's Storm-petrels were released successfully after breakfast.

Nov 5th (31°26'N/17°13'W)
115 km SSE of Madeira
An adult *atlantis* race Yellow-legged Gull was seen in the afternoon and two Skylarks flew over in the early evening. Two more Leach's Storm-petrels were found on the deck overnight, and were boxed until morning. Another that was dazzled by the ship lights was seen to fly into the ships' hull, but flew off apparently unhurt. Several small passerines were also seen flying around the ship at night, with both Starling and Skylark noted.

Nov 6th (31°30'N/17°11'W)

110 km SSE of Madeira
Another Leach's Storm-petrel was found inside the main lab in the morning and was boxed for a few hours to recuperate. It was slightly oiled from walking around on deck, so after a quick clean it was returned to its box to dry off before being released in the afternoon. However, it had difficulty flying and appeared to become rapidly waterlogged, so its chances of surviving were unfortunately slim. The two birds from the previous night were released successfully in the morning. In the afternoon a small arrival of sub-Saharan migrants on the ship included single Wheatear, Turtle Dove and Chiffchaff. After dark, another four Leach's Storm-petrels were picked up on deck and boxed overnight.

Nov 7th (31°16'N/16°41'W)
130 km S of Madeira
The four Leach's Storm-petrels were released successfully in the morning. A distant Sperm Whale was seen after lunch, and single Pied/White Wagtail, Chiffchaff and Spotted Flycatcher visited the ship. Two Leach's Storm-petrels and a Cory's Shearwater were also noted in the afternoon. After dark, a Meadow Pipit was found roosting at the back of the ship and another four Leach's Storm-petrels were found and boxed overnight, while an additional bird was seen clattering into the after deck A frame but apparently flew off unscathed.

Nov 8th (31°17'N/16°00'W)
160 km SE of Madeira
The four Leach's Storm-petrels were released successfully in the morning. A Whitethroat and a Blackcap were seen on board mid-morning, and a Short-eared Owl gave good views as it passed low over the ship on its passage to the SE. Its heading would suggest arrival in the Canary Islands later in the day. At least two Leach's Storm-petrels and up to ten distant storm-petrel sp. were seen, and a Spotted Flycatcher and a tired-looking Reed Warbler arrived mid-afternoon. However, highlight of the day was a Fea's Petrel seen late afternoon and photographed passing by the ship. At night a severe downpour dumped a bizarre collection of land birds onto the deck, including a Cattle Egret, a 1st-winter Night Heron, two Grey Herons, three White Wagtails, a Skylark, a Redwing, a Starling and two Leach's Storm-petrels, while at least another two Leach's Storm-petrels, a Lapwing, a Grey Plover, 15 Knot, two small waders and several other unidentified land birds were seen circling around. These birds were apparently displaced by a large high pressure system to the NW of Iberia, producing east winds across west Iberia.

Nov 9th (31°35'N/15°58'W)
115 km SE of Madeira
The Cattle Egret from the previous night was still on deck in the morning, as were two Starlings and single White Wagtail, Black Redstart, Skylark, male Blackcap and Chiffchaff (which later died). Up to ten storm-petrel sp. were noted in the morning, some of which were definitely identifiable as Leach's Storm-petrel. The two Leach's Storm-petrels from the previous night were successfully released. At night, single Dunlin, Skylark, Meadow Pipit and female Blackcap were seen on or around the ship and another two Leach's Storm-petrels were observed approaching the ships' lights but did not land.

Nov 10th (31°54'N/15°34'W)
120 km SE of Madeira
A Chiffchaff arrived on deck in the early afternoon.

Nov 13th (32°22'N/12°34'W)

320 km off NW Morocco
A White/Pied Wagtail was seen on board in the early afternoon.

Nov 14th (32°32'N/12°37'W)
325 km off NW Morocco
A Scandinavian Lesser Black-backed Gull flew over late morning and a small orange-brown turtle was seen at close range in the early afternoon.

Nov 15th (32°27'N/13°29'W)
360 km off NW Morocco
A 1st-winter Yellow-legged Gull was the only bird noted. A Pearly Underwing (a migrant moth) was captured in the evening.

Nov 20th (32°04'N/14°43'W)
210 km ESE of Madeira
At least three distant storm-petrel sp. were seen in the early afternoon and a Migratory Locust arrived on deck in the early evening, the sole representative of a major influx into the Canaries region. A single Leach's Storm-petrel crash-landed on the deck at night; the weather was calm with bright moonlight in between scattered cloud and showers, which fits the earlier pattern of occurrence.

Nov 21st (32°33'N/15°10'W)
115 km E of Madeira
The Leach's Storm-petrel was successfully released in the morning. A Chiffchaff arrived on deck in the late afternoon as we began the passage to port in Madeira.

CORING EQUIPMENT REPORT

Piston corer: On CD166 a modified NIOZ piston corer was used with a 1.5 tonne head weight. Most cores were recovered in 110 mm barrels, although in the Speculobe work area we switched to the slimmer 90 mm barrels for a time. The trigger mechanism generally worked well and in most cases high-quality cores were recovered. Some of the coring difficulties are outlined as follows: In the Speculobe work area the sandy seabed sediments led to several cores bouncing off the surface, or bending after partial penetration. In once case, the corer fell over on the seabed and buckled the hydro fins on the core head. In addition, those cores that did part-penetrate were often affected by sediments being sucked into the bottom of the barrel, as the piston continued moving towards the core head. In one case, sand trapped between the plastic liner and the metal core barrel meant that the core had to be extracted with a sledgehammer, with an obvious negative effect on core quality! Another general problem was that the plastic liners were frequently imploded; although this only had a minor effect on core quality, it frequently hindered extraction of the core from the core barrels, necessitating use of the hydraulic pusher. The core catchers generally worked well, although there was occasionally reduced or no recovery in areas where very stiff calcareous oozes were penetrated. It was thought that the cohesion of the sediments prevented them breaking at the core cutter, and as the core was pulled out of the seabed the sediment slipped back out as the catcher fingers failed and inverted.

Megacorer: The single deployment worked successfully, with two out of the four tubes containing a well-reserved surface sediment sequence.

SUMMARY OF RESULTS

CD166 was a highly successful cruise, and although the ship departed late from Lisbon, there was very little weather downtime and an extra day was provided before the cruise finished in Funchal.

In the Agadir Project work area a total of 50 piston cores was collected, up to 8 m in length. Most of the cores successfully penetrated through the target turbidite units 1-14, providing sedimentological and stratigraphical data for the last 200,000 years. The piston coring mechanism was extremely reliable throughout this extensive coring effort, with only relatively minor problems such as imploding liners and core catcher failures. Core quality was excellent in most cases. A single megacore deployment in the Agadir Channel successfully recovered the surface sediment sequence. Multibeam bathymetry surveys using the hull-mounted EM12 system were also successfully completed, and initial processing showed the data to be of high quality. 3.5 kHz profiles were collected along all ship's tracks in paper and digital form.

In the Speculobe work area, a total of 11 piston cores was collected, up to 7.7 m in length. The seabed environment in this region was highly challenging for coring, with sand-rich sediments leading to a number of failed attempts, mostly due to the corer bouncing off the surface or bending after only part-penetrating. In addition, many of the recovered cores were disrupted by flow in. However, cores recovered away from the sandy lobe surface were of good quality. 3.5kHz profiles were again collected along all ship's tracks in paper and digital form.

Wildlife observations were dominated by a variety of disoriented migrant landbirds. Of scientific interest was the unusually large number of Leach's Storm-petrels *Oceanodroma leucorhoa* recovered on the deck of the ship at night.

STATION LOG

Core number	Type	Latitude			Longitude			Water depth / m (corr)	Core length / m
		deg	min		deg	min			
CD166/01-01	Piston	35	45	N	7	40	W	1501	3.25
CD166/01-01	Trigger	35	45	N	7	40	W	1501	?
CD166/02-01	Piston	35	45	N	7	39.4	W	1485	4.24
CD166/02-01	Trigger	35	45	N	7	39.4	W	1485	?
CD166/03-01	Piston	35	46	N	7	37.4	W	1463	4.99
CD166/03-01	Trigger	35	46	N	7	37.4	W	1463	0
CD166/03-02	Piston	35	46	N	7	37.2	W	1464	0
CD166/03-02	Trigger	35	46	N	7	37.2	W	1464	0
CD166/04-01	Piston	35	46	N	7	37.2	W	1463	0.59
CD166/04-01	Trigger	35	46	N	7	37.2	W	1463	0
CD166/05-01	Piston	35	47	N	7	37.3	W	1463	7.7
CD166/05-01	Trigger	35	47	N	7	37.3	W	1463	0
CD166/06-01	Piston	35	46	N	7	37	W	1461	1.43
CD166/06-01	Trigger	35	46	N	7	37	W	1461	0
CD166/07-01	Piston	35	45	N	7	37.3	W	1471	1.51
CD166/07-01	Trigger	35	45	N	7	37.3	W	1471	0
CD166/08-01	Piston	35	45	N	7	37.2	W	1469	2.86
CD166/08-01	Trigger	35	45	N	7	37.2	W	1469	?
CD166/09-01	Piston	35	45	N	7	36.4	W	1460	2.08
CD166/09-01	Trigger	35	45	N	7	36.4	W	1460	0
CD166/10-01	Piston	35	47	N	7	34.2	W	1418	3.71
CD166/10-01	Trigger	35	47	N	7	34.2	W	1418	0
CD166/11-01	Piston	35	45	N	7	39.1	W	1484	1.2
CD166/11-01	Trigger	35	45	N	7	39.1	W	1484	0
CD166/12-01	Piston	31	30	N	16	12.01	W	4430	8
CD166/12-01	Trigger	31	30	N	16	12.01	W	4430	0.2
CD166/13-01	Piston	31	39	N	16	20.98	W	4431	4
CD166/13-01	Trigger	31	39	N	16	20.98	W	4431	0.29
CD166/14-01	Piston	31	46	N	16	28.00	W	4417	1.4
CD166/14-01	Trigger	31	46	N	16	28.00	W	4417	0.18
CD166/15-01	Piston	31	27	N	17	13.22	W	4511	7.9
CD166/15-01	Trigger	31	27	N	17	13.22	W	4511	0.75
CD166/16-01	Piston	31	27	N	17	13.13	W	4516	0
CD166/16-01	Trigger	31	27	N	17	13.13	W	4516	0
CD166/16-02	Piston	31	27	N	17	13.15	W	4516	2.7

CD166/16-02	Trigger	31	27	N	17	13.15	W	4516	0.75
CD166/17-01	Piston	31	28	N	17	12.73	W	4522	3.5
CD166/17-01	Trigger	31	28	N	17	12.73	W	4522	0.53
CD166/18-01	Piston	31	29	N	17	12.33	W	4511	5
CD166/18-01	Trigger	31	29	N	17	12.33	W	4511	0.61
CD166/19-01	Piston	31	31	N	17	11.77	W	4502	4.3
CD166/19-01	Trigger	31	31	N	17	11.77	W	4502	0.75
CD166/20-01	Piston	31	14	N	17	9.60	W	4514	3.1
CD166/20-01	Trigger	31	14	N	17	9.60	W	4514	0.55
CD166/21-01	Piston	31	15	N	17	9.28	W	4488	3.7
CD166/21-01	Trigger	31	15	N	17	9.28	W	4488	0
CD166/22-01	Piston	31	26	N	16	42.71	W	4454	6.4
CD166/22-01	Trigger	31	26	N	16	42.71	W	4454	0.13
CD166/23-01	Piston	31	17	N	16	41.66	W	4446	7
CD166/23-01	Trigger	31	17	N	16	41.66	W	4446	0.51
CD166/24-01	Piston	31	25	N	16	26.28	W	4434	5.3
CD166/24-01	Trigger	31	25	N	16	26.28	W	4434	0.34
CD166/25-01	Piston	31	18	N	16	0.85	W	4417	5.5
CD166/25-01	Trigger	31	18	N	16	0.85	W	4417	0.24
CD166/26-01	Piston	31	14	N	15	57.29	W	4398	5.8
CD166/26-01	Trigger	31	14	N	15	57.29	W	4398	0.18
CD166/27-01	Piston	31	21	N	16	3.56	W	4424	7.7
CD166/27-01	Trigger	31	21	N	16	3.56	W	4424	0
CD166/28-01	Piston	31	28	N	16	17.50	W	4432	4.75
CD166/28-01	Trigger	31	28	N	16	17.50	W	4432	0.38
CD166/29-01	Piston	31	35	N	15	58.03	W	4421	7.7
CD166/29-01	Trigger	31	35	N	15	58.03	W	4421	0.2
CD166/30-01	Piston	31	41	N	15	44.03	W	4415	4
CD166/30-01	Trigger	31	41	N	15	44.03	W	4415	0.37
CD166/31-01	Piston	31	48	N	15	31.01	W	4408	6.5
CD166/31-01	Trigger	31	48	N	15	31.01	W	4408	0.46
CD166/32-01	Piston	31	55	N	15	34.64	W	4408	5.6
CD166/32-01	Trigger	31	55	N	15	34.64	W	4408	0.48
CD166/33-01	Piston	31	52	N	15	14.95	W	4402	6.8
CD166/33-01	Trigger	31	52	N	15	14.95	W	4402	0.42
CD166/34-01	Piston	31	60	N	15	0.12	W	4401	7
CD166/34-01	Trigger	31	60	N	15	0.12	W	4401	0
CD166/35-01	Piston	32	22	N	12	34.13	W	4141	0.4
CD166/35-01	Trigger	32	22	N	12	34.13	W	4141	0.3

CD166/35-02	Mega	32	22	N	12	34.05	W	4141	~0.3
CD166/36-01	Piston	32	21	N	12	38.79	W	3917	6.3
CD166/36-01	Trigger	32	21	N	12	38.79	W	3917	0.75
CD166/37-01	Piston	32	33	N	12	37.09	W	3928	1.1
CD166/37-01	Trigger	32	33	N	12	37.09	W	3928	0
CD166/38-01	Piston	32	35	N	12	36.41	W	3801	2.8
CD166/38-01	Trigger	32	35	N	12	36.41	W	3801	0.69
CD166/39-01	Piston	32	23	N	13	31.96	W	4220	3.1
CD166/39-01	Trigger	32	23	N	13	31.96	W	4220	0.5
CD166/40-01	Piston	32	27	N	13	29.11	W	4266	1.9
CD166/40-01	Trigger	32	27	N	13	29.11	W	4266	0.15
CD166/40-02	Piston	32	27	N	13	29.08	W	4266	1.5
CD166/40-02	Trigger	32	27	N	13	29.08	W	4266	?
CD166/41-01	Piston	32	29	N	13	27.52	W	4277	0
CD166/41-01	Trigger	32	29	N	13	27.52	W	4277	?
CD166/41-02	Piston	32	29	N	13	27.46	W	4277	1.3
CD166/41-02	Trigger	32	29	N	13	27.46	W	4277	?
CD166/41-03	Piston	32	30	N	13	27.51	W	4277	0.5
CD166/41-03	Trigger	32	30	N	13	27.51	W	4277	0.3
CD166/42-01	Piston	32	33	N	13	24.52	W	4284	2.6
CD166/42-01	Trigger	32	33	N	13	24.52	W	4284	0.17
CD166/43-01	Piston	32	35	N	13	24.48	W	4216	2.6
CD166/43-01	Trigger	32	35	N	13	24.48	W	4216	0.48
CD166/44-01	Piston	32	34	N	13	24.48	W	4239	0
CD166/44-01	Trigger	32	34	N	13	24.48	W	4239	?
CD166/44-02	Piston	32	34	N	13	24.51	W	4242	3.6
CD166/44-02	Trigger	32	34	N	13	24.51	W	4242	0.57
CD166/45-01	Piston	32	30	N	13	15.90	W	4277	0
CD166/45-01	Trigger	32	30	N	13	15.90	W	4277	0.5
CD166/46-01	Piston	32	32	N	13	38.00	W	4286	0.75
CD166/46-01	Trigger	32	32	N	13	38.00	W	4286	0.24
CD166/47-01	Piston	32	27	N	13	51.99	W	4324	0.5
CD166/47-01	Trigger	32	27	N	13	51.99	W	4324	0.37
CD166/48-01	Piston	32	21	N	14	8.01	W	4354	5.1
CD166/48-01	Trigger	32	21	N	14	8.01	W	4354	0.59
CD166/49-01	Piston	32	14	N	14	22.50	W	4378	4.6
CD166/49-01	Trigger	32	14	N	14	22.50	W	4378	0.63
CD166/50-01	Piston	32	9	N	14	38.01	W	4394	4.5

CD166/50-01	Trigger	32	9	N	14	38.01	W	4394	0
CD166/51-01	Piston	32	12	N	14	30.03	W	4388	3.7
CD166/51-01	Trigger	32	12	N	14	30.03	W	4388	0.75
CD166/52-01	Piston	32	2.5	N	14	30.04	W	4393	4.2
CD166/52-01	Trigger	32	2.5	N	14	30.04	W	4393	0
CD166/53-01	Piston	32	18	N	14	37.99	W	4389	3.7
CD166/53-01	Trigger	32	18	N	14	37.99	W	4389	0.23
CD166/54-01	Piston	31	44	N	14	34.50	W	4374	6.1
CD166/54-01	Trigger	31	44	N	14	34.50	W	4374	0.52
CD166/55-01	Piston	31	47	N	14	36.18	W	4393	2.6
CD166/55-01	Trigger	31	47	N	14	36.18	W	4393	0
CD166/56-01	Piston	31	54	N	14	38.34	W	4397	7.5
CD166/56-01	Trigger	31	54	N	14	38.34	W	4397	0.36
CD166/57-01	Piston	32	4.1	N	14	43.89	W	4398	6.7
CD166/57-01	Trigger	32	4.1	N	14	43.89	W	4398	0.31
CD166/58-01	Piston	32	12	N	14	50.99	W	4396	5.6
CD166/58-01	Trigger	32	12	N	14	50.99	W	4396	0.6
CD166/59-01	Piston	32	22	N	15	0.03	W	4394	4.2
CD166/59-01	Trigger	32	22	N	15	0.03	W	4394	0.69
CD166/60-01	Piston	32	37	N	15	15.10	W	4369	5.5
CD166/60-01	Trigger	32	37	N	15	15.10	W	4369	?
CD166/61-01	Piston	32	33	N	15	10.35	W	4387	3
CD166/61-01	Trigger	32	33	N	15	10.35	W	4387	0.25

CD166 TRACK CHART