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REPORT AND PRELIMINARY RESULTS OF R/V METEOR CRUISE M65/3, LAS PALMAS - LAS PALMAS (SPAIN), JULY 31st - AUGUST 10th, 2005

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2. Research Program

2.1 MeBo

A mobile sea floor drill rig was developed at the Research Center Ocean Margins (University of Bremen) in order to improve the possibilities to get high quality samples from the deep sea floor. This drill rig is called “MeBo” (Abbreviation of the German expression for sea floor drill rig – **Me**eresboden-**Bo**hrgerät). The MeBo is tested during the RV METEOR cruise M65-3 for the first time in deep water (water depth between 1000 and 1700 m). The goals of the tests are to examine the handling of the drill on deck and during its deployment, to test the functionality of the drill in deep water and to check the core quality for soft and consolidated sediments.

2.2 The cephalopod *Spirula*

Morphological hints indicate that the cephalopod *Spirula* could be a useful model organism for approaching the embryonic development of the extinct ammonoids. However, studies and material of *Spirula* are rare, despite the dead shells found on beaches. An Isaacs-Kidd midwater trawl is used during RV METEOR cruise M65-3 in order to catch *Spirula* and other midwater cephalopods. One goal is to catch a pair of adult *Spirula* and to fertilisate the eggs. DNA analyses will be performed on tissue of *Spirula* and other cephalopods in order to investigate the phylogenetic position of the order Spirulida within the cephalopods. Additionally, shells of *Spirula* will be collected to describe a fragile structure of the shell, which cannot be found in the stranded shells.

3. Narrative of the Cruise

On 27 July 2005 the five containers of the sea floor drill rig (MeBo) stood ready for embarkation at the pier, and workers from a local shipyard, together with the crew and Mr. Burzeia (inspector of the RF), installed the deployment rack. This work required reinforcement of the covered stern ramp and of the deck of the METEOR. The containers were brought on board on 28 July 2005, and setup of the drilling rig could begin. Operations tests and training for deployment and recovery were carried out on the 29th and 30th of July under the quiet conditions within the harbor (Fig.1). Based on this experience the crew made additional minor modifications to the deployment frame, particularly working to prevent the drilling rig from catching on the frame during deployment and recovery. At the same time that work was being done on the MeBo, plankton nets were being prepared to trawl for the cephalopod *Spirula*.

Figure 1: Test of the launching and recovery procedure of the sea floor drill rig MeBo in the harbour of Las Palmas.

The morning of July 31 was spent with further testing and modification of the MeBo. At 2:00 p.m. the Meteor left the Las Palmas harbor and made an easterly course toward the first station at a water depth of about 1,070 meters (Fig.2), and arrived there during the night of Sunday to Monday (July 31/Aug. 01). This position was chosen because of its high sedimentation rates, providing a high-resolution and continuous documentation of climate history. First there was a test to see how well the Meteor could be held on position, within 50 m, and if possible with a precision of 25 meters. This was admirably achieved under manual control because of favorable wind and current conditions, and because of the skill of the steering crew. We used the remainder of the night for plankton fishing with the Isaacs Kidd midwater trawl.

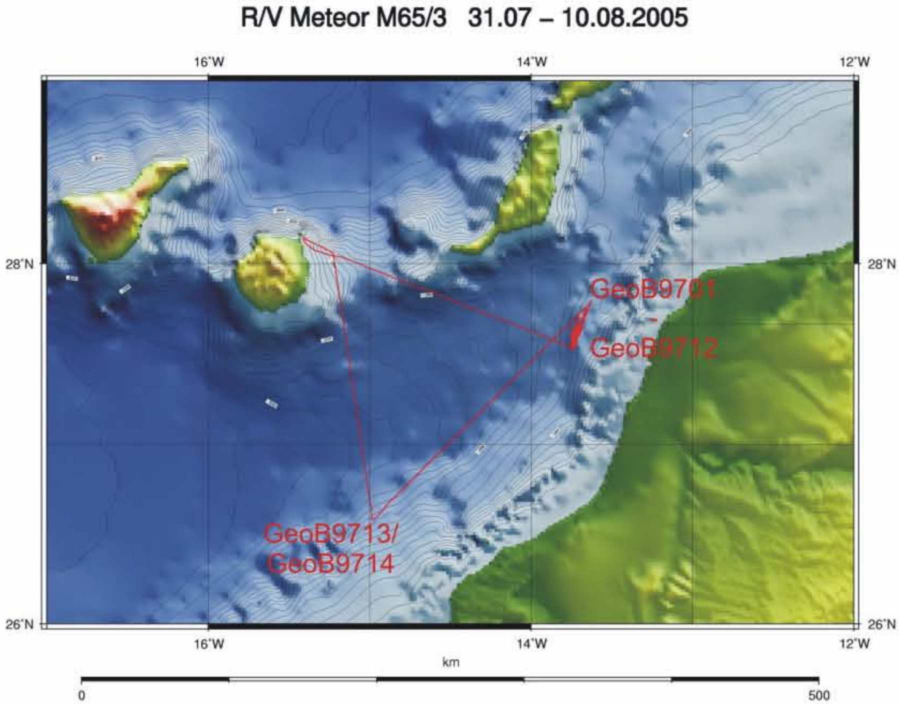

Figure 2: Cruise track from the Canary Islands to the continental slope off Morocco during METEOR cruise M 65/3.

We deployed the MeBo for the first time on the morning of August 1. The deployment frame developed by RF and Prakla Bohrtechnik and built in Bremerhaven for this purpose performed very well, and the MeBo sat softly down on the seafloor after about an hour. The MeBo was deployed three times through August 5, retrieving short cores in order to acquire experience in coring and operation of the equipment. After each coring operation modifications were carried out on the rig, software and drilling pipe. The rig was retrieved on deck each time without problems, which was made easier by favorable weather conditions. The frame design proved to be very successful and is critical for the secure deployment and retrieval of the rig, particularly under somewhat harsher conditions. The hydraulic winch with its 32 mm cable also performed very well and worked without problems.

The first test for a deeper hole was carried out on the 6th and 7th of August 2005. Using the pushcore technique we reached a sediment depth of 23.5 m, changing the sediment barrel and drill rods 37 times in a period of 17 hours. The system functioned perfectly and the METEOR was able to hold position with an accuracy of 25 m for the entire time. This was monitored with the GAPS navigational system, which was lowered through the hydrographic shaft.

The setup and breakdown times, as well as the changing of the drill pipe and making modifications, was used to trawl for the elusive squid *Spirula* near the station GeoB 5546 (27°32’N, 13°44’W). These efforts were begun on July 31, 2005 at 11:00 p.m. *Spirula* is the only modern squid that has a well developed internal shell, and because of particular morphological features (e.g., egg size, construction of the initial chamber of the shell) it represents a good model for the embryonic development of ammonites, which became extinct in the Cretaceous. However, it is not even known in what form the spawn of *Spirula* are laid, at what depth or location, nor what the freshly hatched animals look like. The objective of the fishing haul was, therefore, to catch adult animals and carry out an artificial fertilization procedure on board the ship. A pelagic net (Isaacs Kid midwater trawl, mesh size 6-10 mm) was used. Depending on depth, the hauls lasted from three to six hours. After several adult female *Spirula* and one adult male were caught, the animals were killed and eggs and sperm removed, and the artificial fertilization was carried out.

On Monday, August 8 at 10:00 a.m. the MeBo was deployed at DSDP Site 369 off the coast of Morocco, at a water depth of 1700 m. Because the slope was relatively steep, the MeBo drilling rig had to be oriented and stabilized before drilling could begin. We took two push cores and set casing before rotary drilling could begin at a sediment depth of 5 m. The position was chosen in order to drill indurated sediments or rocks in addition to coring the soft sediments. According to the drilling records of the DSDP hole, we could expect to encounter Tertiary rocks here, which were near to the surface because of a slide. We drilled to a depth of 20.5 m through calcareous claystones and various indurated limestones. Except for a few hard spots, we were able to drill at a rate of 3 m in about 15 minutes. The liners were full, so the recovery was excellent. On the morning of August 9 we ended the MeBo operations and began with the breakdown and packing up of equipment. The time up until the transit back to Las Palmas was used for further plankton hauling. According to plan, we tied up to the pier in Las Palmas at 7:00 a.m. on 10 August 2005.

In summary it can be said that the MeBo functioned as planned and worked dependably in its first deployment. All the planned functions were carried out. The control program developed by MARUM worked perfectly. Some individual work steps will have to be further automated to take some of the burden off the operating personnel. With MeBo, a new sampling tool is available to the marine geosciences that fills the gap between the use of gravity/piston cores and the use of a drilling ship.

4. Preliminary Results

4.1 Test of the MeBo System during METEOR Cruise M65/3

(T. Freudenthal, M. Bergenthal, S. Buhmann, R. Düßmann, G. Engemann, H. Kalweit, S. Klar, H.-O. Könnecker, T. Lunk, J. Renken, W. Schmidt, U. Rosiak, G. Wefer)

4.1.1 Introduction

One major goal of the M65/3 cruise was the operational testing of the seafloor drill rig MeBo (Fig.3), developed at the Research Center Ocean Margins in cooperation with Prakla Bohrtechnik, Peine, and Schilling Robotics, Davis (California). These tests included the launch and recovery procedure, suitability of winch and umbilical for deep water deployments of the MeBo (between 1000 and 2000 m), and test of the functions of MeBo including push coring, rotary drilling, and setting of casing. The recovered cores were sealed for opening and description on shore. However, clear liners allowed a rough estimate on core recovery on board. Material of the core catchers was used for a preliminary description of the recovered sediments.

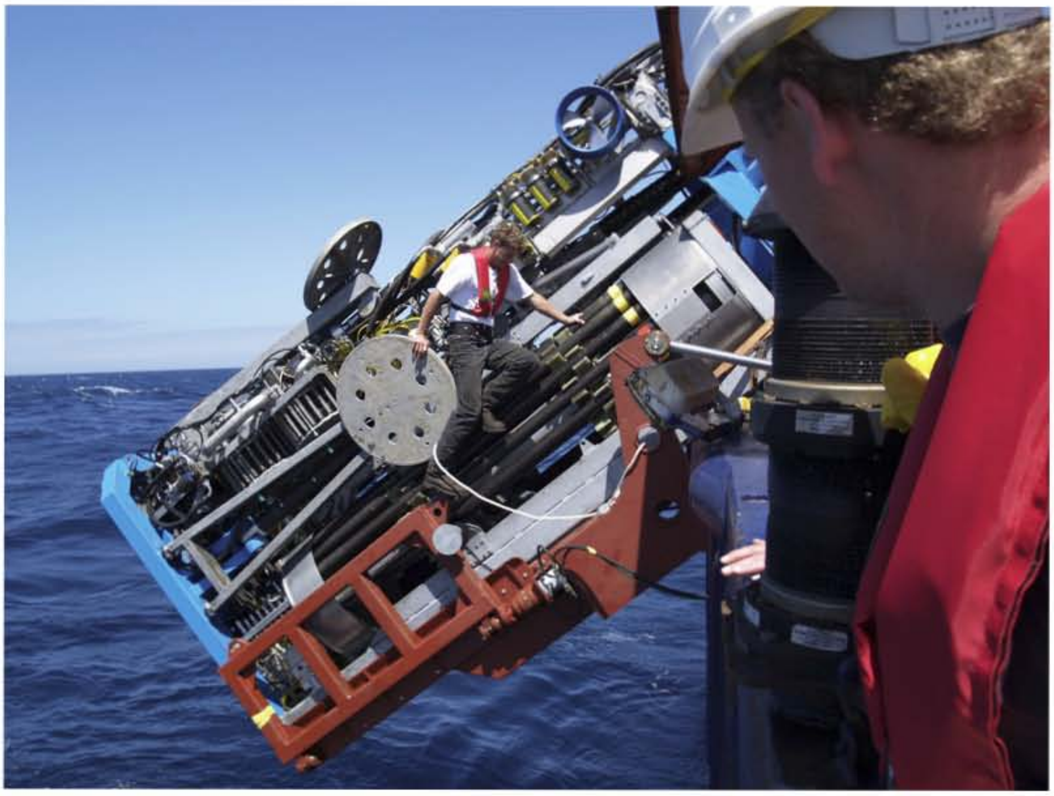

Figure 3: Last preparations on the sea floor drill rig before the first deep water test.

4.1.2 The MeBo System - Functional Description

MeBo operates on the sea floor and is thus unaffected by vessel movements due to wind, waves or currents. It is controlled via an umbilical from the research vessel (Fig.4). All operations are surveyed from the vessel by video cameras and different kind of sensors. The feeding system, the drill head, chucks and flushing pump are essential parts of the drill (Fig.4) that allow coring both by simple pushing in soft sediments and by rotary drilling in hard rocks. The core length for each push and rock barrel is 3 m. When the barrel has finished sampling it is recovered out of the drilled hole and stored by the loading arm in a magazine. Afterwards another barrel is lowered into the drill hole, a 3 m rod is added and the next 3 m can be sampled. This is a highly flexible procedure that allows immediate changes of the coring procedures for example in case of a sudden change in lithology. With a maximum magazine loading of 17 core barrels and 16 rods, MeBo has the capacity to sample the sea floor down to 50 m. The drilled hole can be stabilised with another set of 15 casing rods down to 40 m.

The MeBo system is transported within six 20’ transport containers. Next to the drill the system consists of a control van, a workshop container, a drill tool container, a winch and a launch and recovery system. This concept of a containerised support system allows world wide operation on vessel of opportunity.

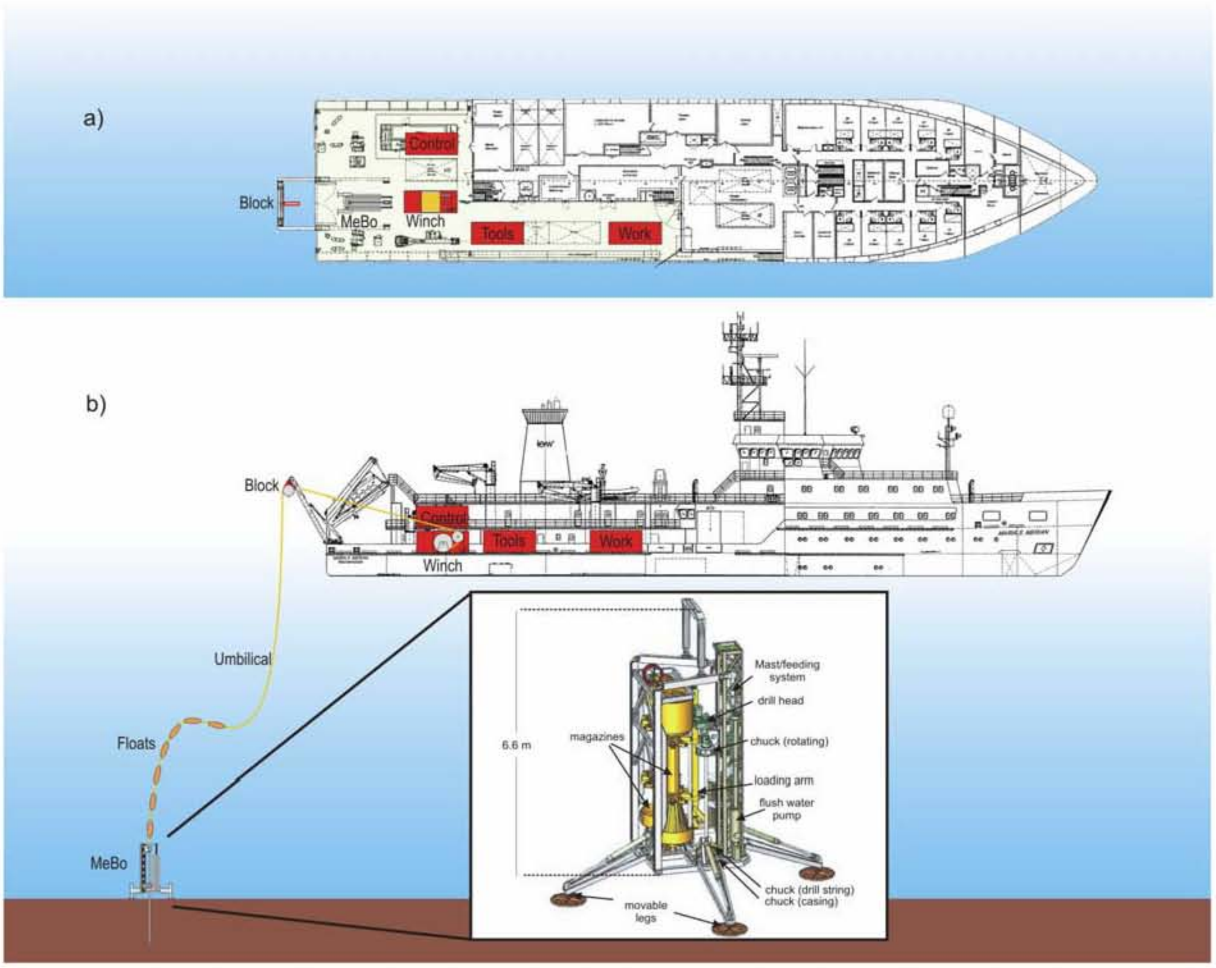

Figure 4: Schematic illustration of the deployment of MeBo from a research vessel (in this example RV Celtic Explorer). The enlargement of the drill rig shows the principal components.

4.1.3 Launch and Recovery

The launch and recovery of this 10 t-load from a movable platform are critical phases where the risk for personnel, vessel and the MeBo-system has to be minimized. With combined effort of the Leitstelle METEOR, RF-Forschungsschiffahrt-GmbH, Prakla Bohrtechnik GmbH, Motorenwerke Bremerhaven and the Marine Center for Environmental Sciences Marum a Launch and Recovery System (MeBo-LARS) was developed that allows

- horizontal storage of MeBo on deck; this is favorable for fixation of MeBo during transfer time, for loading and unloading the magazines with the heavy drill tools, and for maintenance and repair on MeBo;
- controled movement of the drill on rails between the maintenance position on deck and the vertical position behind the stern; this prevents the drill from swinging during this critical maneuver;
- takink the load of the drill by the A-frame and the umbilical only in vertical position; this minimizes the risk of bends and snap loads on the umbilical during the launch and recovery procedure;
- easy capture of the drill with the Launch and Recovery while it is carried by the umbilical at the sea surface in order to minimize the risk of damages on the vessels stern or on the drill.

MeBo acts at no time as hanging load over the decks area with this Launch and Recovery Systems.

The MeBo-LARS was transported in one 20’ open top container to Las Palmas. Installation on deck took about two and a half days since the deck had to be prepared with extra bars for taking the load of it. A test of the system in the harbour of Las Palmas proved the functionality of the system. During the cruise we were able to launch and recover MeBo at sea states of up to 2.5 m without major difficulties. Only slight modifications were suggested to improve the handling when capturing MeBo at the start of the recovery procedure. This modifications will be realized, when the MeBo-LARS is transported back to Germany.

4.1.4 Winch and umbilical operation, catenary management

The MeBo is lowered to the sea bed with an umbilical that has a diameter of 32 mm and a breaking strength of 55 t. The MeBo winch stores 2500 m of this umbilical on its drum. During the first deployment we stopped the winch each 100 m in order to control if its pulling force can compensate the weight of the MeBo and umbilical. During the descent of the drill its legs were extended. After landing another 30 m of umbilical were paid out while 35 floats attached to the first 100 m of the umbilical hindered it from laying on the sea floor. By building up this catenary we ensured that ship movements due to waves, wind or currents didn’t affect the drill rig. The vessel was able to navigate within a 25 m radius above the drill rig almost over the entire operation time. The relative position of MeBo, catenary and vessel was monitored by a GAPS-USBL-system.

The load on the umbilical was measured by a load pin at the level wind of the winch. The maximum tension that was measured at 1700 m deployment depth was 18 t (Fig.5). This includes the weight of the MeBo and umbilical and a dynamic factor of about 1.5. The safety factor of the umbilical was at no time during the deployment below 3. The winch was operated near to its limit of pull force.

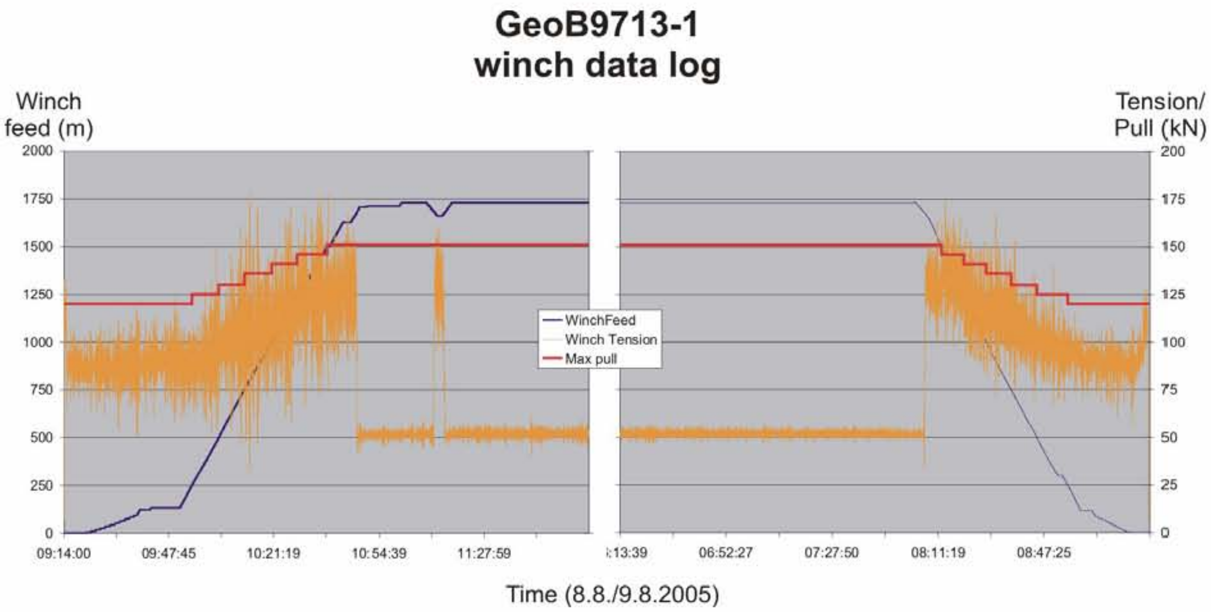

Figure 5: Tension and pay out of umbilical during the deployment of the MeBo in 1700 m water depth.

4.1.5 MeBo Operations during M65/3 Cruise - Test Results

The MeBo was deployed 7 times during cruise M65-3 (Table 1). The first 6 deployments were conducted in 1070 m water depth at 27°32N and 13°44W. Late quaternary hemipelagic nannofossil oozes were sampled. The last deployment was conducted at 26°35N and 14°59W in 1700 m water depth. At this site Pliocene consolidated marls are covered by a thin layer of quaternary sediments.

1.Test (GeoB 9702-1):

The focus of this first test was the functionality of the MeBo functions in deep water (1000 m water depth). Telemetrie-system and power were switched on when the MeBo was lowered down to 150 m. The cameras, lights and pan & tilts, sensors and the hydraulic driven functions (magazines, loading arm, feeding system, drill head, chucks, flush water pump, legs) worked properly. MeBo was launched on the sea floor with extended legs. After the catenary was built up we lifted the legs until the load of the MeBo was equally distributed among the four feet and the bottom plate. In order to test repeatedly all hydraulic functions (besides of the casing chuck) we drilled down to 8.65 m with push core technique. After these successful tests the MeBo was recovered. The core recovery was about 30%.

2nd test (GeoB 9704-1):
This test had to be stopped due to a low isolation signal in the high voltage system that occurred when the telemetry system and power where switched on at 170 m water depth.

3rd test (GeoB 9706-1):
After localisation of the isolation problem in the 3000V transformers we tried to get rid of the water penetrated into the system by replacing it under pressure by oil. Due to an improvement of the isolation values we decided to launch the MeBo. However, after switching on the power at 170 m water depth the electric resistance decreased again and the test was stopped. After the recovery the transformers where dried out at about 60°C for 24 hrs.

4th test and 5th test (GeoB 9709-1 and GeoB 9709-2):
The aim of theses tests was to investigate if the pressure inside the core barrel, that builds up while the sea water inside the core barrel is replaced by the sediment core, was responsible for the fairly low core recovery of 30% during the first test. We repeated the first test with modified barrel heads of the push core barrels. These barrelheads have two different non-return valves. These valves

- allow flushing down of the core barrel within a collapsed drill hole without sampling of the collapsed materials; flush water is switched off before sampling starts
- allow water inside the core barrel to be replaced by the sediments during the coring procedure
- generate suction if the core tries to escape out of the core barrel during recovery.

One problem identified was the overpressure that is generated if the water inside the barrel can't escape fast enough during coring. A variety of modifications of both valves were tested. However, the limited possibilities on board allowed only modifications on cost of the ability to generate suction to prevent the core from escaping out of the core barrel during recovery. Only a slight increase of the recovery rate was reached by these modifications (GeoB 9709-1: 32%; GeoB 9709-2: 40%). Modifications of the barrel head will be developed after cruise M65/3. With these modifications less pressure during coring shall be generated without reducing the suction during barrel recovery.

6th test (GeoB9711-1):
A 24 hrs endurance test of the MeBo-system was conducted at about 1000 m water depth. A drilling depth of 23.55 m was reached by simple push coring. Most of the time was required for building the drill string down and up (about 4 hrs at a drill string length of 21 m) between each sampling of a 3 m section. No system failure occurred during this endurance test. Core recovery was about 23%. Investigation of the core barrels revealed that the used core catchers were too weak to hold the sediment cores in the barrels, especially in the deeper and more consolidated part of the sediments.

7th test (GeoB9713-1):
At this site we used strengthened core catchers for the push core barrels. At a depth of about 5 m below sea floor a maximum push force of 4 t was reached and penetration stopped. The push core barrel was recovered and one casing tube was installed in order to stabilise the

drilled hole. We continued sampling by rotary drilling. We drilled down to 20.65 m before we stopped the test program for this cruise. The time required was overall about 20 hrs. Rotary drilling in the consolidated Pliocene marls took about 5 min/m. Like at the previous site, most time was required for building up and down the drill string repeatedly. Core recovery both by push coring in the upper 5 m with the modified core catchers and by rotary drilling below was nearly 100% (Fig.6).

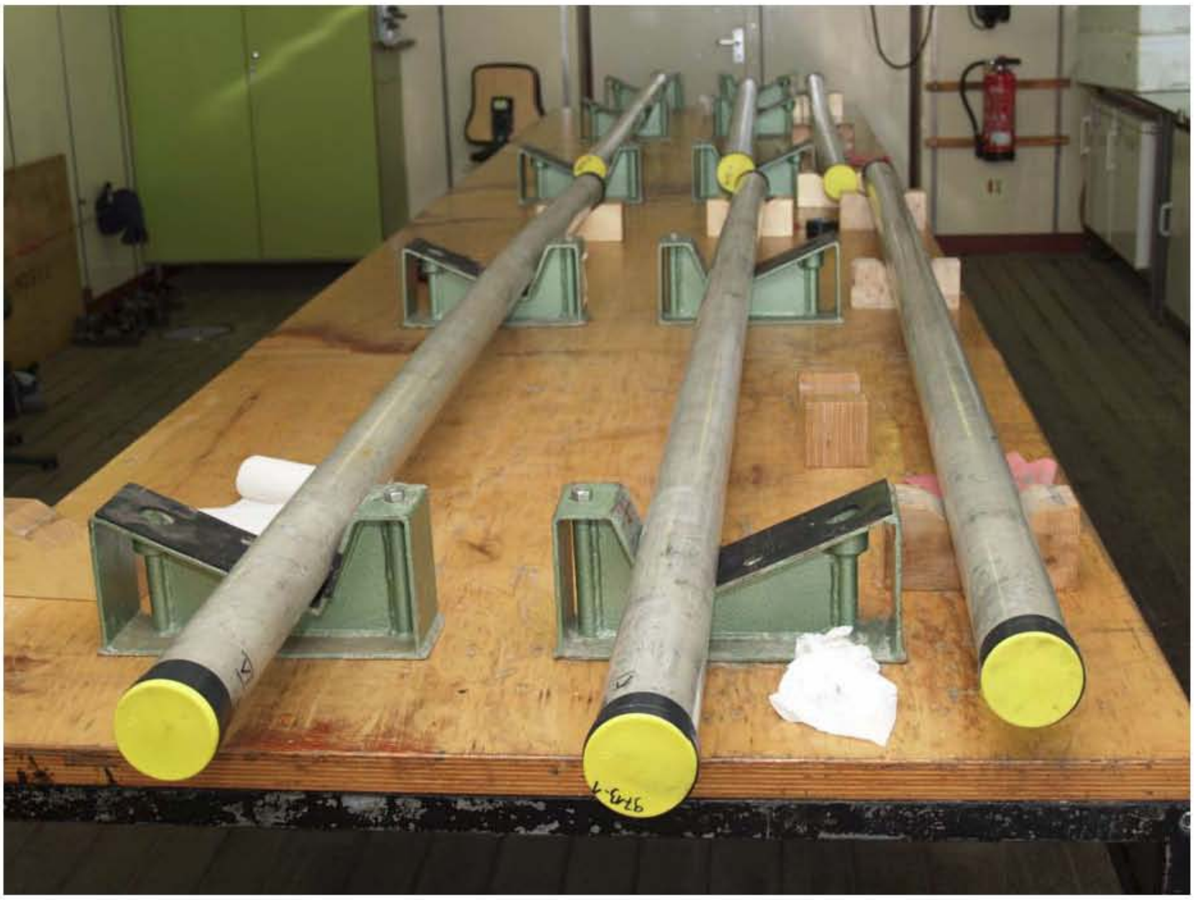

Figure 6: Sediment cores recovered at site GeoB9713-1 in 1700 m water depth.

Table 1: MeBo deployments during R/V METEOR cruise M65/3.

Stat.-No.	Lat. (°N)	Long. (°W)	WD (m)	Bar.-No.	Device	Start (cm bsf)	End (cm bsf)	Sect. No.	Sect. depth
9702-1	27°32.19	13°44.20	1076	1	P	0	255	1	0-40
				2	P	255	555	1	0-60
				3	P	555	855	1	0-80
								2	80-160
9704-1	27°32.20	13°44.20	1077	Test stopped due to low resistance in high voltage transformator					
9706-1	27°32.16	13°44.27	1080	Test stopped due to low resistance in high voltage transformator					
9709-1	27°32.18	13°44.23	1079	1	P	0	255	1	0-104

								2	104-204
				2	P	255	555	1	0-70
				3	P	555	855	-	-
9709-2	27°32.18	13°44.23	1079	1	P	0	255	1	0-88
								2	88-176
				2	P	255	555	1	0-101
								2	101-168
				3	P	555	855	-	-
9711-1	27°32.20	13°44.21	1078	1	P	0	255	1	0-90
								2	90-188
				2	P	255	555	1	0-94
				3	P	555	855	-	-
				4	P	855	1155	1	0-144
								2	144-261
				5	P	1155	1455	-	-
				6	P	1455	1755	-	-
				7	P	1755	2055	-	-
				8	P	2055	2355	-	-
9713-1	26°34.99	14°58.98	1695	1	P	0	255	1	0-141
								2	141-288
					casing	0	250	-	-
				2	P	255	ca. 500	1	0-143
								2	143-240
				3	R	500	565	1	0-146
				4	R	565	865	1	0-147
								2	147-291
				5	R	865	1165	1	0-150
								2	150-300
				6	R	1165	1465	1	0-147
								2	147-297
				7	R	1465	1765	1	0-145
								2	145-294
				8	R	1755	2055	1	0-148
								2	150-298

4.2 Embryology and phylogeny of *Spirula*

(K. Warnke, V. Diekamp, V. Hemsing)

With its unique chambered shell, *Spirula* is one of the most unusual of all recent cephalopods. Shape and composition of the early *Spirula* shell resembles very much that of Ammonoidea (Bandel & Boletzky 1979, Doguzhaeva 1996). Indeed, there are many morphological hints indicating that *Spirula* could be a useful model organism for approaching the embryonic development of the extinct ammonoids. Thus, *Spirula* is likely to provide interesting insights concerning both biology and paleontology. But studies and material of *Spirula* are rare, despite the dead shells found on beaches. Though at present time nothing is known about spawning of *Spirula*. Especially it is not clear how the laid egg masses look like or where egg laying takes place in the water colum. If *Spirula* eggs will not be found in the sea, the outcomes of artificial fertilisation could fill many gaps in the knowledge especially with regard to cleavage patterns and shell sac differentiation (Boletzky 1998). For example Arnold & O´Dor (1990) got interesting data on the embryonic development of rare oceanic squids with help of artificial fertilisation.

Therefore one important aim on the Meteor cruise was to catch a pair of adult *Spirula* and to fertilisate the eggs. Further tissue of *Spirula* and other cephalopods will be needed to perform DNA analysis regarding the phylogenetic position of the order Spirulida within the cephalopods. Additionally, shells of *Spirula* are needed to describe a fragile structure of the shell, which cannot be found in the stranded shells.

With help of the Isaacs-Kidd midwater trawl (IKMT) the mesopelagic *Spirula* was caught (Fig.6). The IKMT has a mash size of 6 to 10 mm, mouth opening of 6 m^2 and a length of 10 m. Because *Spirula* migrates vertically, fishing was performed in daytime between 500 and 1000 m and at night between 100 and 300 m to the surface. The fishing time depends on the fishing depth. A significant difference between effort of day and night catch could not be found. An improvement of fishing with light at night could not be detected. The ship was steaming with a speed between 2- 2.5 knots.

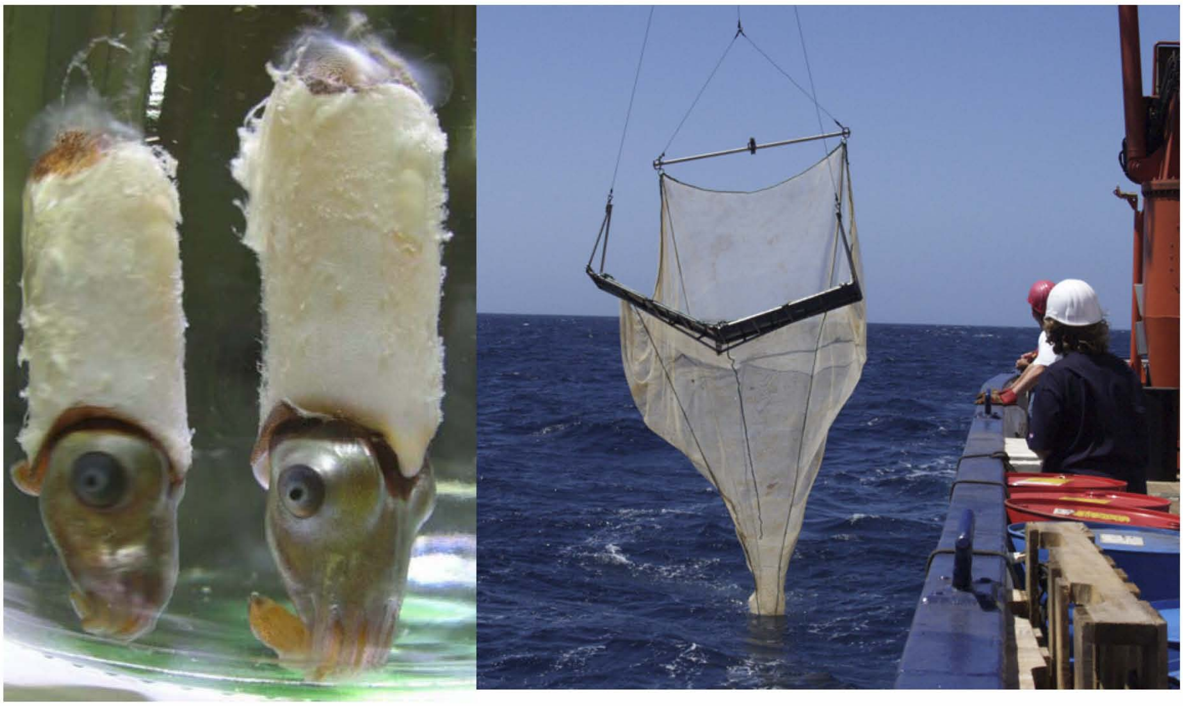

Figure 6: Photograph of living Spirula spirula (left female, right male) caught with an Isaacs Kidd Deepwater Trawl (left photo).

15 hauls (Table 2) were performed and 13 *Spirulas* were captured. Further 15 cephalopods from five families of the orders Sepiolida and Teuthoida were caught and fixed in 70% ethanol for DNA analysis. This analysis will be performed later in the laboratory of palaeontology of the “Freie Universität Berlin”. The by-catch containing typical members of nektonic deep-sea fauna (like stomiatoids, myctophids, euphausiids and others) was frozen. These samples will be determined later by specialists for taxonomy of crustaceans and fishes from a canaries institute (Instituto Ciencias Canarias Marinas, Gran Canaria).

Three juvenile, two subadult and eight adult animals were caught. The size of the captured *Spirula* ranged between one and four centimetres dorsal mantle length. The sex of the caught *Spirula* was determined, and the adult animals were reared on board at 10°C for some days. To carry out the artificial fertilisation (after ARNOLD & O´DOR 1990) four adult females and two adult males were killed. The mantle caves of the animals were ventrally opened and the gonads were collected. Mature eggs were placed in petri dishes and washed three times with filtered seawater. The sperm was gently dragged over the eggs, a few drops of seawater were added. Filtered seawater was mixed with lyophilized, powdered, oviductal gland (from *Sepia*) until a barely detectable increase in viscosity was noted. This water was added to the eggs and sperm so that a thin layer of this fluid covered the eggs. After 5 minutes filtered seawater was added to fill the petri dishes. The petri dishes were placed in a storage room with 10°C. After some hours some successfully fertilised eggs were recognised under a dissecting microscope. However, to evaluate the success of this procedure is not possible at the moment, because the time on board was even too short to recognize first development stages. The complete embryonic development will need several months.

Tissue samples from all *Spirula* were fixed in ethanol for later DNA analysis. Additionally to the phylogenetic investigations concerning the position of *Spirula* within the Cephalopoda the structure of the *Spirula* population around Canary Islands will be checked.

Table 2: Hawls with the Isaacs-Kidd midwater trawl. The catching depth was estimated using rope length and wire angel measured with a clinometer.

Haul no.	Date 2005	GeoB code	Water depth [m]	Start/stop station [UTC]	Start/stop gear on depth [UTC]	Catching depth [m]	Latitude [N]	Longitude [W]	Amount of caught *Spirula*
1	01.08.	9701	1168	1:00			27°34.03’	13°45.00’	
			1174		1:17	200	27°34.43’	13°44.98’	
			1244		3:45		27°38.63’	13°44.57’	
			1252	5:15			27°39.16’	13°44.48’	1
2	02.08.	9703	1084	7:11			27°32.34’	13°44.29’	
			1168		9:43	600-700	27°38.25’	13°43.05’	
			1187		10:05		27°39.21’	13°42.86’	
			1227	11:25			27°42.11’	13°42.02’	-
3			1107	12:50			27°31.71’	13°44.76’	
			1125		14:14	900-1000	27°34.39’	13°44.21’	
			1208		16:30		27°39.66’	13°43.08’	
			1257	18:23		.	27°42.90’	13°42.35’	1
4			1097	23:46			27°32.16’	13°44.47’	
	03.08.		1074		0:15	300	27°33.19’	13°43.84’	
			1070		2:45		27°38.24’	13°41.07’	
			1083	3:12			27°39.08’	13°40.71’	-
5			1084	4:12			27°32.22’	13°44.30’	
			1079		4:54	400	27°33.74’	13°43.73’	
			1113		6:55		27°38.45’	13°41.78’	
			1151	7:42			27°40.65’	13°41.05’	2
6			1076	9:04			27°32.47’	13°44.15’	
			1118	9:56		700	27°34.48’	13°43.88’	
			1146	11:15			27°37.57’	13°43.07’	
			1224	12:44		.	27°41.38’	13°42.33’	1
7	04.08.	9705	1070	2:49			27°32.51’	13°44.01’	
			1061		3:13	300	27°33.44’	13°43.55’	
			1063		4:14		27°35.88’	13°42.51’	
			1086	4:45			27°37.00’	13°42.23’	-
8			1087	5:29			27°32.25’	13°44.32’	
			1083		6:06	500-700	27°33.71’	13°43.77’	
			1150		8:51		27°40.42’	13°41.17’	
			1197	10:18			27°43.76’	13°39.76’	-
9		9707	1134	17:24			27°31.64’	13°45.09’	
			1121		18:40	800	27°34.62’	13°43.07’	
			1145		20:41		27°39.46’	13°41.73’	
			1192	22:45			27°44.33’	13°39.14’	2
10	05.08.	9708	1110	3:04			27°32.87’	13°44.50’	
			1110		3:30	300-400	27°34.08’	13°44.03’	
			1164		6:31		27°41.07’	13°41.06’	
			1190	7:23			27°43.02’	13°40.16’	2

11		9710	1087	23:15			27°32.90’	13°44.35’	
	06.08.		1129		23:30	200-250	27°32.53’	13°44.55’	
			1138		1:30		27°33.58’	13°44.13’	
			1154	1:59			27°38.78’	13°42.40’	1
12			1081	3:00			27°32.19’	13°44.22’	
			1096		3:28	300-400	27°33.34’	13°44.11’	
			1153		6:38		27°40.77’	13°41.02’	
			1183	7:32			27°42.79’	13°40.20’	1
13	07.08.	9712	1073	6:47			27°32.40’	13°44.11’	
			1076		8:06	1000	27°35.56’	13°42.89’	
			1138		10:05		27°40.22’	13°41.02’	
			1211	12:03			27°44.85’	13°39.33’	-
14			1053	13:42			27°32.08’	13°43.80’	
			1051		15:05	900-1000	27°35.33’	13°42.57’	
			1167		18:21		27°43.05’	13°39.45’	
			1206	20:08			27°47.31’	13°37.76’	-
15	09.08.	9714	2506	11:39			27°40.10’	13°59.71’	
			2533		13:21	1100-1300	27°44.03’	13°59.94’	
			2763		15:50		27°49.56’	13°00.82’	
			2890	18:05		.	27°54.90’	13°01.31’	2

5. Ship's Meteorological Station

At the time of departure of RV "Meteor" from Las Palmas on the 31st July the general synopsis over the Eastern Atlantic was dominated by the subtropic high near the Islands of Azores and a stationary low over the western part of Sahara. According to this distribution of surface pressure the transit to the operation area at about 27.6N 13.7W (and later at 26.8N 15.0W) was characterized by northeasterly winds force 5 to 6 Bft. with gusts reaching 7 Bft. and sea state of about 2 m. These had been the prevailing conditions during the first two days at the working position of "Meteor". On the 3rd August the subtropic high started to move into northeasterly direction which caused a weakening of the pressure gradient at the working area with decreasing northeasterly winds of about 4 Bft. which had been the prevailing conditions until 6 th August. The remaining days of the cruise were characterized by a wedge of high pressure, extending to the sea area of the Canary Islands and a slightly westward move of the Sahara Low which caused again an increasing northeasterly airflow with winds force 5 to 6 Bft., reaching 7 Bft. at times and sea state of about 2.5 m. These had been the prevailing conditions during the transit back to Las Palmas which had been arrived on the 10 th August at morning.

6. Concluding Remarks and Acknowledgements

The aims of the RV METEOR cruise M65-1 were almost fully achieved. The test results of the complex drill system during its first deep water deployments where overwhelming. It was proven, that the MeBo has full functionality. Deployment and recovery, landing on the sea bed, cable management, remote control, push coring in soft sediments, rotary drilling in consolidated sediments, stabilizing the drilled hole by casing, drill string handling, and long term operation were all successfully carried out. With MeBo, a new sampling tool is available to the marine geosciences that fills the gap between the use of gravity/piston cores and the use of a drilling ship.

The downtimes of the MeBo due to tests on deck, maintenance and small repair work where successfully used to catch the remarkable and rare cephalopod Spirula (13 individuals). Besides the first success of an artificial fertilization of Spirula further captured cephalopods provided useful samples for a complex DNA analysis of the phylogenetic position of the taxon Spirula.

The success of the cruise was only possible because of the good prearrangement by the Leitstelle METEOR and by Reederei Forschungsschiffahrt. We profited from the excellent teamwork with the ship’s crew which was highly competent. Captain Jakobi and his crew offered perfect technical assistance and the convenient atmosphere to run all scheduled tasks successfully.

7. References

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8. Station List M 65/3

Date	*Stat.-No.*	*WD*	*Device*	*Lat*			*Lon*			*Remarks*
		[m]		[°]	min	N	[°]	min	W	
31.07.2005	9701-1		Bongo-Netz	27	32.04		013	44.25		480 m, 0:10h
	9701-2		IKMT	27	34.46		013	44.97		200 m, 2:30h
01.08.2005	9702-1	1076	MeBo	27	32.19		013	44.2		Drill depth 855 cm, 46% core recovery (test stopped due to leakage of hydraulic oil into Comp2)
02.08.2005	9703-1	1080	IKMT	27	32.28		013	44.16		600 + 700 m, 2h
	9703-2	1132	IKMT	27	31		013	44		1000 + 900 m, 2h
03.08.2005	9703-3	1070	IKMT	27	32		013	44		300 m, 2:30h
	9703-4	1086	IKMT	27	33		013	44		2h
	9703-5	1085	IKMT	27	32		013	44		2:19h
03.08.20053	9704-1	1077	MeBo	27	32.20		013	44.20		Test stopped due to water in deck transformer
	9704-2	1077	GAPS	27	32.20		013	44.20		Test
04.08.2005	9705-1	1067	IKMT	27	32.20		013	44.00		300 m, 1h
	9705-2	1086	IKMT	27	33		013	44		450 + 690 m, 1:35h
04.08.2005	9706-1	1080	MeBo	27	32.16		013	44.27		Test stopped due to water in deck transformer
04.08.2005	9707-1	1117	IKMT	27	31.26		013	45.05		800m, 2h
05.08.2005	9708-1	1107	IKMT	27	32.46		013	44.29		300 + 400m, 2:50h
05.08.2005	9709-1	1079	MeBo	27	32.18		013	44.23		Drill depth 555 cm, 49% core recovery (Test stopped due to loss of compensation oil)
	9709-2	1077	MeBo	27	32		013	44		Drill depth 555 cm, 63% core recovery (Test stopped due to release of emergency pump)
05.08.2005	9710-1	1087	IKMT	27	35.17		013	43.66		200 + 250m, 1:50h
06.08.2005	9710-2	1101	IKMT	27	32		013	44		330 + 400m, 3h
06.08.2005	9711-1	1078	MeBo	27	32.20		013	44.21		Drill depth 2355 cm, 24% core recovery (Test stopped due to a thread that could not be disconnected)
07.08.2005	9712-1	1071	IKMT	27	32.34		013	44.24		1000 m, 2h
	9712-2	1054	IKMT	27	32		013	44		850m + 950m, 3h
08.08.2003	9713-1	1693	MeBo	26	34.99		014	58.98		Drill depth 2055 cm, 106% core recovery
09.08.2003	9714-1	2496	IKMT	26	39.49		014	59.38		1000 + 1200 m, 2h

Abbreviations:

Bongo	Bongo-Net
GAPS	Ultrashort Baselength measurement with the GAPS-system
IKMT	Isaacs Kidd Midwater Trawl
MeBo	Sea floor drill rig MeBo