

National Oceanography Centre, Southampton

Cruise Report No. 6

RRS *Charles Darwin* Cruise 169

17 FEB - 19 MAR 2005

Hydrothermal exploration of the
southern Mid-Atlantic Ridge

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2006

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ABSTRACT <p>The principal objective of this cruise was to identify the first site or sites of high temperature hydrothermal venting anywhere on the southern Mid-Atlantic Ridge, to characterize their geological setting, preliminary chemical nature and to identify, where possible, the nature of any vent-endemic species that might inhabit such vents to investigate whether this ridge system might represent a new biogeographic province. Initially we used the TOBI deep-tow sidescan system equipped with a CTD system and optical backscatter sensors, together with Miniature Autonomous Plume Recorders (MAPRs) to identify two new sites in which diagnostic chemically- and particle-laden plumes indicated the presence of high-temperature hydrothermal venting. Subsequently, we used the ABE autonomous underwater vehicle to (1) locate the core of one of these hydrothermal plumes, (2) obtain a detailed map of the underlying seafloor and (3) photograph three discrete hydrothermal sites (2 black-smoker systems, 1 diffuse-flow) and their associated ecosystems. A series of CTD stations were occupied for water column investigations and a number of rock-coring and dredging stations were also undertaken to provide groundtruthing of sidescan sonar images of the Mid-Atlantic Ridge seafloor.</p>	
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SCIENTIFIC PERSONNEL

			Leg 1	Leg 2
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Dr. R..Prien	(SOC, UK)		√	√
Dr. D.Connelly	(SOC, UK)		√	√
Mr A.Evans	(SOC, UK)		√	√
Ms S Bennett	(SOC, UK)		√	√
Dr. E.Ramirez	(SOC, UK)		√	
Dr. G.Fones	(SOC, UK)			√
Dr. T.Shank	(WHOI, USA)			√
Dr. D.Yoerger	(WHOI, USA)			√
Dr. A.Bradley	(WHOI, USA)			√
Mr. M.Jakuba	(WHOI, USA)			√
Mr. A.Billings	(WHOI, USA)			√
Mr. D.Turner	(SOC, UK)	PTO	√	√
Mr. P.Keen	(SOC, UK)		√	√
Mr. J.Cooper	(SOC, UK)		√	√
Mr. I.Rouse	(SOC, UK)		√	√
Mr. L.Fowler	(SOC, UK)		√	
Mr. M.Bridger	(SOC, UK)			√
Mr. D.White	(SOC, UK)			√

ITINERARY

Departed:	Mindelo, Cape Verdes	17 Feb 2005
Port-call:	Georgetown, Ascension	04 Mar 2005
Arrived:	Georgetown, Ascension	18 Mar 2005

OBJECTIVES

The objectives of the cruise were three-fold:

- (1) To locate and investigate the geologic setting of hydrothermal vent-plumes along the southern Mid-Atlantic Ridge, 2-7°S using TOBI equipped with in situ sensors.
- (2) To precisely locate the first sites of venting to be found anywhere on the Southern MAR, using the ABE autonomous underwater vehicle equipped with in situ sensors.
- (3) To obtain first geochemical, petrological and biological sampling and characterization of any new hydrothermal field and its surrounding environment.

NARRATIVE

Leg 1

The SOC scientific party for RRS *Charles Darwin* Cruise 169 arrived in Mindelo, Cape Verdes on 15th February 2005. Upon arrival in port, the ship was boarded (Feb 16th) ready to sail next day. With all gear and scientific party on board, the ship departed Mindelo, Cape Verdes at 09:30 (GMT) on 17 Feb (Julian Day 048) bound for the South Atlantic. After 24 hours of transit a preliminary test deployment of the CTD was conducted, to 500m, to aid with cleaning of the rosette's 10-L Niskin bottles (JD 49). As soon as this was completed, the TOBI deep-tow cable was streamed with a 450kg weight attached – an operation planned for the transit from Lisbon to the start of CD168 but which had not yet been completed. Once back inboard, full transit speed was resumed and at 11:32z on JD 050, multibeam mapping was commenced in international waters close to the Sierra Leone Rise. A total of ca.6.25 days transit was required to reach our planned study area, with the Equator being crossed at 16:23z on Julian Day 053. Due to high surface water temperatures close to the equator (often >30°C), ineffective operation of the ship's engines' cooling system required that transit speeds were often reduced significantly below 10kts during the course of the transit south, significantly delaying our initially-predicted arrival in the work area.

Scientific operations commenced on JD 054 (14:14z) with a multi-beam swath bathymetric survey along the length of the Mid-Atlantic Ridge axis from 02°34.20'S, 12°30.00'W as far as 05°07.85'S, 12°18.54'W. Rather than complete our original multibeam survey plans, this swath mapping was interrupted at 10:00z on JD 55 when it was decided, for efficiency, to commence TOBI operations. Our goal was to survey this section of the ridge crest as efficiently available in the reduced time available using a single pass of the TOBI deep-tow sidescan vehicle rather than a double-swath as has more traditionally been used when investigating the Mid-Atlantic Ridge rift-valley.

Deployment of the TOBI deep-tow vehicle was commenced at 11:00z on JD 055 at 05°11.40'S, 12°17.80'W. Full deployment of TOBI + 6 MAPRs was complete by 12:26z and by 12:56z the TOBI vehicle was on course (ship's position 05°12.00'S, 12° 17.52'W) and being lowered to the seafloor to commence its northward survey. Acquisition of survey data commenced at 15:20z when TOBI arrived at 800m above the seafloor. Ship's position at this time was 05°06.23'S, 12° 18.19'W. TOBI continued north with two minor computer failures at 18:45 on JD 055 and at 01:14 on JD 056. In the second case, no CTD etc data were acquired for ca.2 hours until 03:00z on JD 056. The TOBI survey continued north as far as ship's position 03° 58.61'S, 12° 11.68'W when, at 00:30z on JD 057 the TOBI system suffered a significant failure. The vehicle was recovered to 1000m wire-out by 04:56z and recovered in-board under daylight between 06:30 and 08:11z.

Next, a first scientific CTD station (CTD-01) was occupied at 04° 04.60'S 12° 16.19'W to a water depth of 4858m. The CTD station commenced at 09:54 on JD 057 and was recovered in-board at 13:15z. Following a brief test of the TOBI umbilical cord (13:53-14:08z) a first rock-core station was occupied at 04° 11.31'S 12°18.05'W in 3131m water depth. The rock corer was deployed at 15:10z on JD 057 and recovered at 18:30z. This station was not without mishap – it included a brief delay (17:52-18:05z) due to winch failure. Once the problem with the winch was confirmed resolved together with news that the TOBI system was not yet ready for further testing, a 2nd CTD station was occupied at 04° 00.34'S, 12° 13.05'W in 4222m. CTD-02 was deployed at 21:45z on JD 057 and recovered in-board at 01:27 on JD 058. Following this, a series of three further rock-core stations were occupied (RC-02, -03 and -04) at 04°6.10'S, 12°18.10'W; at 04°08.70'S, 12° 18.11'W and at 04°13.88'S, 12° 17.18'W respectively. Deployment times for these stations, in water depths of 3535m, 3350m and 2962m were 02:25-04:55z, 06:05-08:04z and 08:52-10:33z. By the end of this sequence the TOBI engineering team had completed their repairs and were ready to redeploy. To ensure overlap in our acquired sonar surveys – including re-interception of a hydrothermal plume revealed by MAPR data during the previous TOBI recovery, the ship was transitted SW from 04°13.77'S, 12°17.06'W at 10:40z on JD 058 to 04°05.49'S, 12°19.56'W (10:40-11:45z) prior to TOBI redeployment.

TOBI Leg 2 deployment was commenced at 13:02z on JD 058 and the complete system, including 6 MAPRs strung below and above the depressor weight that connects via the umbilical to TOBI itself were successfully deployed by 14:22z and data acquisition was commenced by 17:00z. The rest of this TOBI survey was conducted successfully, continuing until 15:00z on JD 059 when recovery of the vehicle at the northern limit of our detailed studies ended. The full TOBI + MAPR system was recovered in-board at 18:25z on JD 059 at ship's position 03°14.60' 12° 10.05'S. From 18:35z on JD059 the ship transmitted almost due south until 08:00z on JD060 ready for our third and final TOBI deployment.

TOBI leg 3 was commenced at 08:30z on JD 060 at 04°55.85'S 11°38.36'W. Full deployment of the TOBI + MAPR system was completed at 09:28z and TOBI was on course by 11:33z and acquiring sidescan sonar data before 12:00z. With the exception of some intermittent problems with the TOBI phase bathymetry system (06:18-07:12z on JD 061 and 05:16-05:21z on JD 062) the majority of TOBI leg 3 was conducted very successfully. At 06:52z on JD 062, however, Ship's power was lost completely while TOBI was still deployed to a wire out of >6,500m, surveying ca.350m above the seafloor approximately 6km astern of the ship. At 07:08z (16 minutes later) power was restored and the ship's speed increased to 2.9kts to prevent TOBI colliding with the seafloor. A further 25 minutes later (07:33z) winch power was obtained once more and TOBI operations recommenced. Approximately 80 minutes later, regrettably, all ship's power was lost once more (08:50z, JD 062). On this occasion TOBI was deployed with almost 7,000m of wire out, surveying 350- 400m above the seabed ca.6km behind the vessel. Although ship's power was restored very promptly on this occasion (08:53z) it still took a further 5 minutes to restore power to the scientific winches and hauling of the vehicle was commenced at 09:00z. At 09:02z communication was regained with the vehicle. During 12 minutes the vehicle had descended from

380m above the seafloor to 274m up at a rate of >8m/minute. Rather than fail to complete all aspects of our survey, the TOBI vehicle was now raised to >500m above the seafloor to complete our final period of survey (from 09:10z onward) – sufficiently deep to continue geophysical mapping but too shallow to have any merit for hydrothermal operations. Recovery of the TOBI vehicle was commenced at 10:32z on JD 062, enabling a complete single-swath sidescan survey to be completed all the way to the Ascension Fracture Zone. The full system of TOBI+MAPRs was recovered inboard between 13:01 and 14:05z on JD 062 at 06°48.63'S, 11°13.84'W. At that time course was made directly for Georgetown, Ascension Island (07° 54.00'S, 14° 25.02'W) where Leg 1 of cruise CD 169 ended (09:15z, JD 063).

Leg 2

Having embarked the 5-person ABE team from WHOI, USA, Leg 2 of Cruise CD 169 commenced with departure from our position anchored off Ascension Island at 17:00z on JD 063. Our target for Leg 2 of the cruise was the southern of two new hydrothermal plume sites located in the 2nd-order volcanically active ridge-segment at 5°S. During transit we attempted an off-axis background CTD station, CTD-03. The CTD rosette was deployed at 07:15z and lowered to 3390m at 06° 06.27'Sm 13°14.78'W. However, a fault was identified with the rosette CTD system that prevented any Niskin bottles from being fired and, hence, from any water samples being collected. The system was recovered inboard at 10:04z and transit continued toward the work area. At 13:18z a test station was occupied (5°41.90'S, 13°00'W) and the CTD-rosette lowered to 500m. Upon recovery in-board (14:05z) all 24 Niskin bottles were tripped successfully and it was decided to conduct a full background station immediately before proceeding. Station CTD 04 (5° 42.52'S, 12° 59.56'W) was commenced at 14:30z. The CTD-rosette was lowered to 3481m depth and recovered in-board at 17:26z after all 24 bottles had been fired.

At 23:45z on JD 064, the ship arrived back at the MAR ridge-crest and two rock-core stations were occupied. RC-05 (5° 06.91'S, 12° 19.17'W) was commenced at 23:55z, deployed to 3380m and recovered in-board at 01:39z on JD 065. RC-06 (5° 04.02'S, 12° 17.29'W) was commenced at 03:40z, deployed to 3599m and recovered in-board at 05:51z. From 05:57z until 08:15z an additional line of swath bathymetric mapping was conducted to provide a more comprehensive coverage of the segment prior to ABE deployment, between 4°54.05'S, 12° 25.90'W and 4° 43.93'S 12° 28.26'W and demarcating the western boundary of the segment-centre's rift-valley. Upon completion of this swath survey, the first ABE transponder (TX-01) was deployed at 10:04z at 4° 47.91'S 12° 24.72'W. Transponder 'D' reached the seabed at 10:51z and the required navigation survey was completed approximately 1 hour later at 11:55z.

At 13:09z on JD 065, station CTD-05 was occupied at 04° 45.98'S, 12° 23.01'W. The deployment was commenced at 13:09z but a fault was detected at 13:19z after lowering to just 50m depth. The vehicle was hauled out of the water but not recovered in-board at 13:27z and redeployed at 13:33z after being re-set. At 13:44z the CTD computer system failed again (CTD @ 100m water depth) and was re-set. With no visual display but digital data available it was decided to continue with the cast and the CTD was deployed to 3146m at 14:51z. Immediately upon attempting to fire Niskin bottles through the rosette command system, however, the CTD suffered a major system failure and was recovered in-board at 15:54z with no water samples taken. At 16:45z, the first BRIDGET tow-yo of the cruise was attempted. Deployment of BGT-01 commenced at 17:10z at 4° 43.26'S, 12° 25.07'W. The vehicle was lowered to the proposed survey depth of 2720m at 19:01z having reported numerous operating errors throughout the deployment. Test firings of the BRIDGET rosette were continued until 19:28z and the vehicle was recovered inboard at 20:55z at 4° 44.95'S, 12°23.05'S still north of the segment centre and without any useable data recorded. At this stage

neither the CTD-rosette nor the BRIDGET deep-tow vehicle were operational to guide our hydrothermal exploration programme as intended.

At 22:20z on JD 065, our second transponder (transponder 'B') was deployed at 4° 47.28'S, 12° 21.33'W (TX-02) followed by the third and final transponder (transponder 'A') which was deployed at 4° 49.53'S, 12° 22.47'W (TX-03) at 02:40z on JD 066.

In the continuing absence of either operational system from RSU intended for conducting hydrothermal plume detection and location it was decided to improvise by deploying a series of self-recording MAPR plume-instruments at fixed intervals along the TOBI deep-tow cable attached to the depressor weight. Deep Underwater MAPR deployments (DUM-01) was commenced at 05:30z on JD 066 at 4° 48.80'S, 12° 26.14'W, south of the segment centre. A series of way-points were selected for the ship to sail a grid although the only navigational aid on the DUM instrument-package as deployed was a pinger to detect height off-bottom. After multiple attempted passes across the breadth of the seafloor, from south to north, the DUM-01 system was recovered in-board at 05:46z on JD 067 at 04° 45.72'S 12° 28.71'W, north of the segment centre.

Following the DUM-01 recovery, two rock-core stations were occupied. RC-07 (4° 48.64'S, 12°23.24'W) was commenced at 07:34z but recovered at 07:52z and only re-deployed in the correct location at 08:37z on JD 067. The package was deployed to 3129m at 09:24z and recovered inboard at 11:19z after further delay due to a winch failure encountered during recovery of the rock-corer. RC-08 (4° 46.24'S, 12° 22.62'W) was less troublesome. After arriving on station at 11:33z, the rock-corer was deployed at 12:02z, deployed to 3143m by 12:57z and recovered in-board at 14:00z.

Following a brief transit, a CTD test-deployment was conducted to 500m at 4° 48.50'S 12° 21.17'W (15:00-15:42z) and then preparations were made for first deployment of the ABE autonomous underwater vehicle. Dive ABE-150 commenced with deployment at 4° 48.50'S, 12° 21.10'W – launch operations commenced at 16:20z and the vehicle was released at 16:35z. Tracking of the vehicle was continued until 18:00z and transit was then made to the next CTD station.

Station CTD 06 was occupied at 4° 49.74'S, 12° 21.82'W. The system was deployed at 18:30z on JD 067, lowered to 2890m at 19:45z and recovered in-board at 21:25z. A further station, CTD 07, was then occupied at 4° 46.95'S, 12° 23.55'W. This station was commenced at 23:15z on JD 067. The CTD-rosette reached a maximum depth of 2995m at 00:17z on JD 068 and was recovered in-board at 01:42z. Following these two CTD stations, three rock-cores were collected. RC-09 (4° 48.89'S, 12° 22.91'W) was commenced at 03:00z. The rock-corer was deployed to 3034m at 03:44z and recovered in-board at 04:40z. RC-10 (4° 47.67'S, 12° 22.00'W) was commenced at 05:45z, deployed to 3086m at 06:33z and recovered in-board at 07:32z. Rock core RC-11 (4° 50.93'S, 12° 22.25'W) was commenced at 08:43z, deployed to 3155m at 09:40z and recovered in-board at 10:45z.

Following stem-down (for ABE tracking) transit, station CTD 08 (4° 48.65'S, 12° 21.81'W) was commenced at 11:50z deployed to 2852m at 12:57z and recovered in-board at 14:45z. At this time a problem was found with the hydrowire and all science operations had to be suspended for a further ca.4.5 hours from 15:00 until 19:25z until the problem was resolved.

CTD 09 (4° 47.68'S, 12° 22.03'W) was commenced at 19:31z on JD 068, deployed to 2985m at 20:40z and recovered in-board at 21:55z. At this stage it was considered incautious to commence any further over-the-side operations prior to ABE recovery. Instead, the ship was transitted to the AEB recovery position, arriving on-location at 22:45z at 4° 47.44'S, 12°24.58'W. ABE surfaced at 23:40z on JD 068 and dive ABE 150 was completed with recovery in-board at 00:32z on JD 069.

A series of four rock-cores were occupied next. RC-12 (4° 45.97'S, 12° 23.84'W) was commenced at 01:42z on JD 069 but only reached the seafloor at 3062m at 04:35z due to a hydraulic pipe rupture that interrupted operations from 01:52z to 03:40z – a further 2 hours of lost science time. The station was finally completed at 05:40z. RC-13 (4° 47.44'S, 12° 24.66'W) was commenced at 06:18z, deployed to 2831m at 07:15z and recovered in-board at 08:11z. RC-14 (4° 49.59'S 12° 24.05'W) was commenced at 0907z, deployed to 2884m at 10:02z and recovered in-board at 11:05z. Finally, RC-15 (4° 50.18'S, 12°23.23'W) was commenced at 11:31z, deployed to 3051m at 12:30z and then recovered in-board at 13:40z. Over-the-side science operations were then interrupted to proceed to the ABE 151 launch site.

Having arrived on station at 4° 48.53'S, 12° 48.53'W, ABE was not yet ready for deployment. Instead a further CTD test-deployment was conducted to 500m (1705-1736z, 4° 48.68'S, 12° 23.01'W). ABE deck-testing was completed at 18:04z and at 18:53z on JD 069, dive ABE 151 was commenced at 4° 48.57'S, 12° 22.95'W. Following monitoring of ABE's descent to the seafloor, station CTD 10 was occupied close by at 4° 47.95'S, 12° 22.51'W. The system was launched at 19:50z, deployed to a maximum depth of 2985m at 20:54z and recovered in-board at 22:28z. At that time the USBL navigation pod was raised and transit commenced to the north leaving ABE Dive 151 in progress at the segment centre.

At 01:30z on JD 070, the ship arrived on station to commence dredge DR-01. This station commenced at 4° 38.27'S, 12°25.46'S, deployed to the seafloor at 3596m between 03:00 and 05:35z and was recovered in-board at 07:35z at 4° 39.11'S, 12° 24.80'W. The ship then returned south conducting two further swath survey lines in the northern portion of the ridge segment (08:17z-09:35z) before re-deploying the USBL stem ready for station CTD-11 (4° 48.57'S, 12° 22.33'W) followed by ABE recovery. Deployment for CTD-11 was commenced at 10:48z, reached a maximum depth of ca.2980m at 11:46z and was recovered inboard at 13:21z. A 3.5 hour delay then resulted while awaiting ABE's return from the seafloor.

At 17:00z, dive ABE 151 was completed with recovery of the AUV inboard at 4° 47.50'S, 12° 23.20'W. A further period of swath mapping was conducted next, north of the segment centre once more (17:25-19:50z) en route to a further dredge station. Station DR-02 was commenced at 4°44.33'S, 12° 23.41'W at 20:10z on JD 070. The dredge was deployed to the seafloor at 3247m between 21:50 and 22:50z and recovered in-board at 00:43z on JD 071 at 4°45.33'S, 12° 21.90'W.

Returning to the segment centre, the ship arrived on station for CTD 12 at 01:25z on JD 071. Upon arriving on station, however, a further problem with the CTD-rosette was encountered. Station CTD 12 was attempted again at 04:14-04:37z (4° 47.86'S, 12° 22.56'W) but immediately upon entering the water significant errors were encountered. At 07:01z the CTD system was ready for re-deployment once more but, again, significant problems were encountered with the system and the station was abandoned at 07:13z. Once again, we were without any mechanism for meaningful water column hydrothermal plume investigations and over-the-side water column operations were brought to a complete stop. Fortunately AUV operations continued.

At 1030z on JD 071 ABE passed its deck-test for dive 152 and was ready for launch at 1100z when the ship's crane suffered an untimely failure. Dive ABE 152 was subsequently initiated at 12:52 with the vehicle launched at 4° 48.69'S, 12° 22.51'W. The vehicle was tracked to the seafloor and confirmed to have started its mission successfully at 15:30z. In the continuing absence of an operational CTD system it was decided, next, to attempt a further operational test of the BRIDGET system previously deployed on JD 065.

BRIDGET tow-yo BGT-02 commenced at 17:24 on JD 071 at 4°45.80'S, 12° 23.70'W. The vehicle was deployed to ca.2800m by 19:44z although by that time it had suffered multiple system

crashes starting at 18:11z with the instrument at less than 1500m depth (i.e. ca. half desired operational depth for this cruise). At depth operations were continued, with multiple system resets required until 20:39z at which point recovery was commenced. The BGT-02 deployment was concluded at 22:49z on JD 071 at 4° 50.13'S, 12° 21.89'W. Although the tow-yo conducted had approached and ended directly above hydrothermally active centre of this second-order ridge segment, no useable data had been acquired. This vehicle was supposed to operate as the instrument of choice for Leg 2 of cruise CD169 to guide subsequent ABE operations. Instead, half of the shiptime available for this leg had now expired, ABE was already conducting its first near-bottom vent-location dive, but the BRIDGET vehicle was still inoperational, as was the conventional CTD-rosette.

For the next operation, rock core station RC-16 was occupied at 4° 48.28'S, 12° 21.51'W. The corer was deployed at 01:30z on JD 072, deployed to 2898m at 02:29z and recovered inboard at 03:40z. The ship then transited to the recovery position for ABE arriving on station at 04:05z. ABE surfaced at 05:45z and was recovered in-board at 05:15z at 4° 48.64'S, 12° 23.03'W. A series of swath survey lines were then occupied extending through the southern portion of the segment between 4° 49.8'S and 5° 08.2'S and then extending along the eastern and western boundaries of the previously mapped segment centre, 4° 32-49'S. This swath survey was conducted between 06:45z and 18:06z including brief interruption for a CTD test-deployment to 1000m (CTD-14) at 5° 8.17'S, 12° 11.71'W, 10:30-11:20z.

At 20:00z, rock-core station RC-17 (4° 48.65'S, 12° 22.65'W) was commenced. The corer reached 3054m at 20:59z and was recovered inboard at 22:05z. The ship was then repositioned for a further rock-core station but the sudden availability of the CTD-rosette again at 22:25z meant that the next rock-core station was postponed and the ship re-positioned for station CTD-15 at 4° 48.58'S, 12° 22.41'W. This station was commenced at 23:21z on JD 072 and reached a maximum water depth of 2975m at 00:25z on JD 073. The CTD-rosette was recovered in-board at 03:19z.

The next operations were a series of three closely spaced rock-core deployments. RC-18 (4° 47.78'S, 12° 22.53'W) was deployed at 05:28z, reached 3020m at 06:24z and was recovered at 07:25z. RC-19 (4° 48.04'S, 12° 22.60'W) was deployed at 07:44z, reached 3010m at 08:48z and was recovered in-board at 09:50z. RC-20 (4° 47.25'S, 12° 22.85'W) was deployed at 10:10z, reached 3094m at 11:11z and was recovered in-board at 12:11z.

Following these operations the ship was re-positioned ready for launch of dive ABE 153 and the USBL stem was lowered accordingly (13:23z). Prior to commencement of this ABE dive, however, station CTD-16 was occupied (4° 47.80'S, 12° 22.61'W). Deployment commenced at 14:25z, a maximum depth of 2991m was reached at 15:47z and the instrument was recovered in-board at 17:19z. After passing deck-tests, dive ABE 153 was successfully launched at 4° 48.08'S, 12° 22.76'W some 2.5 hours later, at 19:59z.

After confirming that ABE had descended safely to the seafloor and begun its survey as planned, the ship transited south for rock core station RC-21 at 4° 50.16'S, 12° 21.97'W. The corer was deployed at 21:30z, reached 3012m depth at 22:32z and was recovered in-board at 23:30z. The ship then returned north for dredge station DR-03. This dredge was initiated at 00:57z on JD 074 at 4° 46.35'S 12° 23.19'W. After deployment along the seabed from 02:02-03:16z the dredge was recovered in-board at 04:50z at 4° 47.45'S 12° 21.87'W. When all was secure transit was made to the ABE recovery site. Despite initial problems with communication with the vehicle confirmation was received that the vehicle was ascending through the water column at 10:50z. Dive ABE 153 was eventually completed at 13:55z when the vehicle was recovered in-board at 4° 49.80'S 12° 22.04'W.

Although it was intended that ABE should be re-deployed as soon as possible following dive ABE 153, the opportunity was taken to occupy a further CTD station (CTD 17, 4° 48.34'S, 12° 22.30'W) while ABE was being prepared for redeployment. CTD 17 was deployed at 14:45z, reached a maximum depth of 2952m at 16:04z and was recovered inboard at 17:46z. The ship then proceeded to the Dive ABE 154 deployment site, arriving on-station at 19:00z. Dive ABE 154 was initiated at 20:39z when the vehicle was released at 4° 48.63'S 12° 22.71'W.

After deployment the vehicle was monitored during descent to the seafloor and commencement of its pre-programmed survey and then, at 21:31, transit was made to our final dredge station. DR-04 was deployed at 21:56z at 4° 47.63'S 12° 22.69'W. The dredge was lowered to the seafloor and remained on-bottom from 23:29z on JD 074 to 01:10 on JD 075. It was recovered in-board at 4° 44.96'S, 12° 20.85'W at 02:45z on JD 075.

The final rock-sampling station of the cruise followed – rock-core RC 22 located at 4° 49.28'S 12° 21.89'W. The rock core was deployed at 03:35z, lowered to the seafloor at 2927m at 04:31z and recovered inboard at 05:28z. During lowering of the rock-core, confirmation was received from ABE that it had finished the mission for Dive ABE 153 and was returning to the surface. The ship arrived at the ABE recovery position at 06:00z, ABE surfaced at 06:33z and was recovered in-board at 4° 48.39'S, 12° 22.45'W at 06:51z on JD 075 approximately 10 hours after launching.

As soon as ABE was recovered, a final CTD station was occupied. CTD-18 (4° 48.61'S, 12° 22.39'W) was deployed at 07:12z, lowered to a maximum depth of 2959m at 08:20z and recovered in-board at 09:53z. Following rapid downloading of data and recharging of batteries, the ship then repositioned for final dive ABE 155. The ship arrived on-station, above the Red Lion vent-site, at 11:40z. There was a 60 minute delay in deployment to guard against ABE's camera over-heating and the vehicle was launched at 4° 48.02'S 12° 22.68'W at 12:51z.

Our penultimate over-the-side operation was a vertical cast of 4 stand-alone pumps (SAP02) at 4° 48.5'S, 12°22.3'W. Deployment started at 13:35z and concluded at 20:13z. Pump operations were conducted from 16:16-18:16z. Following recovery of the SAPs in-board the ship transited north for a third and final attempt at use of the BRIDGET vehicle. Tow-yo BGT-03 commenced at 21:40z on JD 075 at 4° 44.97'S 12° 24.44'W but had to be recovered inboard at 21:53 and the ship repositioned for re-deployment at 23:58z, JD 075, at 4° 45.77'S 12° 23.83'W. From 01:30-03:34z on JD 076, BRIDGET reportedly operated very successfully at the required depths, between 2700m and the seafloor detecting nephelometer and Eh anomalies and closing Niskin bottles upon demand. This performance sadly came too late to be of any benefit to the cruise and, further, none of the data displayed in real time was logged in a manner that could be accessed during the remainder of the cruise – although the data were subsequently recovered from the logging computer and restored to the PSO, post-cruise. At 04:53z, JD 076, BRIDGET was recovered in-board at 4° 48.55'S 12° 21.78'W having been tow-yo'ed directly across the 5°S MAR vent-sites.

At 05:55z ABE returned to the surface for the last time and transponder "B" was released at 05:56z. Dive ABE 155 was concluded at 06:22z when the vehicle was recovered in-board at 4° 48.30'S 12° 27.25'W. The remaining navigation transponders were released and recovered between 07:06z and 09:30z. At this time, science operations were broken off from 4° 49.71'S 12° 22.53'W and passage made direct to Ascension Island.

Leg 2 and, hence, the entire scientific operations of RRS *Charles Darwin* Cruise CD 169 were completed with the disembarkation of the scientific party by pilot boat at Ascension Island at 08:50z on JD 077.

The ship's track followed by RRS *Charles Darwin* during CD 169 is shown in Figure 1. A diary of events is given as Appendix A and Science Logs for Legs 1 & 2 are given as Appendices B & C.

(C.German)

SCIENTIFIC REPORTS

1. EM-12 Multi-beam Bathymetry.

1.a) Introduction

The Simrad EM-12 is a 13kHz multibeam echo sounding system, designed to operate in water depths from 50m to 11,000m (full ocean depth), using 81, 1.5° equidistant beams providing 120° coverage. The theoretical swath width in deep water recording mode is up to 7.4 times water depth, although this coverage is restricted by speed of advance of the ship, character of the seafloor and weather conditions. Typical value for the coverage during CD169 was approximately three times water depth.

The EM12 is composed of transducer arrays, a transmitter subsystem, a receiver subsystem, including beam-forming and special digital signal processors, a Bottom Detection Unit (BDU), and an Operator Unit (OPU) with external interfaces for data input and output on serial line and Ethernet. Also included are the Quality Assurance Unit (QAU) and Sonar Imaging Unit (SIU).

The transmit fan is split into several individual sectors with independent active steering according to vessel roll, pitch and yaw. This places all soundings on a “best fit” to a line perpendicular to the survey line. The sectors are frequency coded (12.7, 13.0 and 13.3kHz) to avoid interference (the outer beams have the lower frequency to optimise coverage). The steering is fully taken into account when the position and depth of each sounding is calculated, as is the refraction due to the sound speed profile, vessel attitude and installation angles. The ping rate is only limited by the round trip travel time in the water.

The transceiver unit uses a combination of phase and amplitude detection, resulting in measurement accuracy on the order of 50cm or 0.2% of depth RMS (whichever is greater), practically independent of beam pointing angle.

At the beginning of survey the BDU is configured with the relevant settings required, i.e. mode (deep or shallow), beam coverage and weather conditions, for example. The BDU determines the range to the bottom in every beam using data from the transceiver unit, and transfers the ranges to the OPU. The OPU, is the operator interface of the EM12, does the final conversion from beam ranges to position and depth on the seafloor, and interfaces with other systems in the ship, e.g. gyro, DGPS. The OPU also uses the sound velocity information to calculate the beam ranges into depths.

Both BDU and OPU are located in the ship’s plot. From here it is possible to quality assure the data as it is acquired.

The Mermaid software, housed on the Mermaid UNIX workstation, also in the plot, is where the swath data is stored. Here the cruise identification, CD169, is logged and all acquired data transferred to that ID directory. The Mermaid UNIX workstation also houses the Merlin software. This allows visualisation of data acquisition, where if any loss of data should occur, adjustments could be made to the BDU/OPU settings. A Merlin slave display unit was also available in the main scientific laboratory for watch keepers to keep an eye on data quality.

The swath data is initially processed on the OPU and logged as a line number. These line numbers have to be manually incremented on the OPU, in order to assure no loss of data should the system fail. Upon line number change the raw data is automatically copied to the Mermaid system where it is stored.

1.b) Data acquisition and system performance

In order to acquire accurate swath data two operations may need to be performed. Firstly a sound velocity profile (SVP) is required in order that the OPU can accurately calculate true depths. Second it may be necessary to run a calibration survey, in order to check the roll and pitch bias.

The EM12 was activated soon after departure from Cape Verde, but due to the fact that for cruise CD169 swath data was not required until we reached our survey area, which was 6 days transit, we did not acquire a SVP, as this was intended to be done shortly before the swath survey commenced, or perform a calibration survey. However, once the system was logging and using the SVP installed, following cruise CD168, it was found that the quality of the data was good and did not merit a calibration check. Although with increasing distance from Cape Verde, some deterioration of the data could be seen as a result of not applying a SVP relevant to the region of transit.

Upon arrival at the start of the survey area, time constraints, due to a slower than expected transit, meant that no SVP was acquired. However SVP information taken from an Expendable Bathy Thermograph (XBT), acquired during a previous cruise to the region (JR65, 1991), was input to the OPU.

The Swath survey began at 17:37 on the 23rd February 2005 at 2° 55.98'S 12° 14.12'W. The intended use of the survey was to fill-in gaps in existing swath data and to locate a ridge axis where no swath data existed. This was necessary in order to produce a "road map" by which the TOBI (Towed Ocean Bottom Instrument) sidescan sonar instrument could be flown. Due to the time constraints generated by the slow transit, the swath survey was cut short. The survey ended at 10:04 on the 24th February 2005 at 5° 08.43'S 12° 18.39'W.

Data quality throughout was good with very little deterioration, other than some noise in the outer 5 to 10 beams on either side. The new data was processed and merged with the existing data (see later). This new data set was then used to generate bathymetry plots by which TOBI could be navigated during TOBI's first two deployments.

Due to the reduced swath survey area, the EM12 was also used during TOBI survey 03. This survey was to "fly" over a section of the ridge where our existing data had some data gaps. As the TOBI vehicle is towed up to 4km behind the ship, it was possible to print off a screen dump of the swath, which was several kms ahead of the TOBI vehicle and fill in the gaps on our printed swath plots. This data was again of good quality and processed to be merged with the existing data.

At the end of TOBI survey 03, just prior to our transit into Ascension, for a crew change, the ship lost all electrical power resulting in the EM12 shutting down. Once the ships power problems were rectified, the EM12 was re-started. However during the 19hr transit to Ascension, there were problems with the EM12 data, where a time error between the OPU time and DGPS input time occurred. All the raw data for this period is currently inaccessible for processing.

During the crew change at Ascension the EM12 was re-booted. This involved the powering down of the system. Upon re-start the time problem had seemingly been rectified and logging was again resumed.

EM12 data was acquired during the transit out to the designated working area, approximately 200M north of Ascension, for CD169, leg2. Although no specific swath surveying was required during leg 2, wherever possible the EM12 was left on to acquire data in an ad-hoc fashion. This proved to be valuable in that during transit from one station to another additional data could be added to that which previously existed.

Also during leg 2, where time allowed between other instrumentation down times, swath data was acquired along the flanks of part of the ridge section that had never been swathed, prior to leg 1. This allowed an increased understanding of the regional setting of the survey area where all work during leg 2 occurred. (It was necessary to set the transmit mode of the EM12 to “off” when close to the ABE survey areas, as the 13kHz frequency of the EM12 affected their transponder signals. This resulted in the EM12 being switched on and off frequently and for varying periods of time.)

During one of the ad-hoc ridge flank surveys, the problem, which occurred after the power loss, recurred. This resulted in abandoning the survey. It was established that the clock on the OPU was 7min different to that on the DGPS. Once the problem was identified it was simply a case of manually setting the time on the OPU to tie-in with the DGPS input signal. (The error manifested itself by displaying the message “Time dif -378570 millisecc between pos and ping to big” on the Merlin consol as well as there being no data visual on the Merlin window.)

A total of 85 swath lines were logged and processed (line numbers not incremented by any fixed time period). Of these 85 lines 17 were not available due to the OPU time problems (a total of 21hrs worth of swath data).

A full list of swath survey data is logged at Appendix D.

(A.Evans)

2. TOBI Operations.

The Towed Ocean Bottom Instrument (TOBI) deep tow vehicle was deployed and recovered three times during CD169, between 1030z (JD 055) – 0811z (JD 057), 1314z (JD 058) – 1825 (JD 059), and 0814 (JD060) – 1405 (JD062).

The proposed survey plan was to use the EM12 multibeam bathymetry data acquired during the earliest part of the cruise to design the acquisition of two parallel, marginally overlapping sonar swaths, occupying reciprocal tracks through the axial valley of a least four of the second order ridge segments closest to the Ascension Fracture Zone. Due to time constraints, however, only a single pass was made, covering a six-kilometre swath central to the axis. Approximately 2700 square kilometres of ridge axis were insonified producing high quality images of extensive fresh-looking sheet flow packages and more MAR-typical, constructional volcanic ridges. Heavily sedimented, broad non-transform discontinuities linking the segments appear to host localised volcanic activity in intermediate ‘relay’ pull-apart basins.

Additional instrumentation carried by TOBI also produced key results for the cruise. A nephelometer on the vehicle forming part of the hydrothermal particulate monitoring suite (see Science Report 5 on MAPRs, below), confirmed in real time the presence of hydrothermal plumes at a number of sites within the segments studied. Phase difference sonar data were continuously collected for post-cruise processing into interferometric bathymetry. Finally, chirp seismic profiler and three component magnetometer data acquired will constrain high resolution topographic and magnetic field variations, respectively, for comparison with ABE AUV data in the focus study area (see Science Report 6, below).

It is worth noting that the complementarity of the imagery acquired using the 30kHz TOBI sidescan and both the SMS2000 multibeam and 675 kHz scanning altimeter on ABE produced a very powerful integrated dataset for analysis of neovolcanism and neotectonic processes at mid-ocean ridge systems.

(I.Rouse, L.Parson)

3. BRIDGET Operations.

The BRIDGET deep-tow system is a deep-tow CTD+sensor unit for the identification, investigation and sampling of hydrothermal plumes. The instrument was a joint development, under the NERC's BRIDGE programme, between the University of Cambridge and the former Institute of Oceanographic Sciences Deacon Laboratory (1993-1995). In 2001, BRIDGET was formally transferred into UKORS ownership to become part of the National Marine Equipment Pool.

The BRIDGET deep-tow carries the following sensors and samplers:

- FSI Micro CTD Ser. No. 1327 (BRIDGET CTD)
- FSI Micro CTD Ser. No. 1359 (TOBI CTD borrowed as a spare)
- Chelsea Instruments Alphatracka Transmissometer 25 cm. pathlength.
- Chelsea Instruments Aquatracka nephelometer.
- SeaTech Light Scattering Sensor (LSS)
- General Oceanics 12 position rosette pylon (modified)
equipped with 12 x 2.5 litre Niskin bottles.
- Simrad Mesotech Acoustic Altimeter (500 metre range).
- Dual clinometer attitude sensor and flux gate magnetometer compass unit

For the second cruise running (following CD128 to the Central Indian Ridge in 2001) this was not a happy cruise for BRIDGET. A major limitation for most of the cruise was that there were significant teething problems with the new version of software that had been developed to interface the vehicle subsequent to transfer into UKORS. As the very final operation of the cruise, however, a successful CTD tow-yo was completed and, although the stored data could not be accessed at sea, real-time success was apparent during the cast, as projected onto the controlling computer's display scheme and the recorded data was successfully recovered from the relevant hard-drive post cruise. After some years in the wilderness, it is to be hoped that BRIDGET will once again be ready to serve again as an international state-of-the-art survey vehicle in years to come.

(C.German, D.White)

4. CTD operations

4.a) CTD sensor configuration

CTD configurations and calibration factors are listed in Appendix E reflecting changes as they occurred during the course of the cruise. Main system sensors are given in Table 4.1. In addition to those listed below an experimental E_h sensor was deployed for all casts, physically attached to the stabilising fin and giving direct, voltage, readout to Voltage channel 5 (V5), while external Mn and Fe sensors were attached to the frame on an occasional basis. These latter sensors did not contribute to the Sea Bird data stream.

SENSOR / SYSTEM TYPE	SERIAL No	REMARKS
Sbe 9+ CTD	09p-1987-0528	Main ctd, 24 way st st frame
Digiquartz pressure sensor	73299	
Sbe 03p temperature sensor	03p-4489	primary
Sbe 03p temperature sensor	03p-4490	secondary
Sbe 04c conductivity sensor	04c-3052	primary
Sbe 04c conductivity sensor	04c-3054	secondary
Breakout box	B019109T	
Sbe 5T pump	2793	primary
Sbe 5T pump	3607	secondary
Sbe dissolved oxygen	43-0709	
Sbe 32 carousel	32-19817-0243	
Deck unit	11p34173-0676	spare
Deck unit	11p23680-0587	Main unit
BBRTD scattering meter	169	
Transmissometer	161/2642/002	
Fluorometer	88/2360/108	
seapoint OBS	10491	

Table 4.1 : CTD main system sensors

4.b) CTD Deployments

22 individual CTD casts were conducted during the course of the cruise. Of these, 5 were test casts to 500 or 1000 meters to test system performance after faults developed (see later in text) or to fill the Niskin bottles with water from depth to leach contaminants. Two casts, casts 012 and 013, were aborted at 70 metres and 30 metres respectively and are not included in cast records but do influence the total cast number.

The arrangement of sensors differed during the CTD programme in an attempt to rectify performance issues. These changes are given in Table 4.2; configuration files with relevant changes are included in Appendix D.

CTD cast logging was always begun on deck. The instrument package was lowered into the water with minimal pause at the surface, taken to 3 meters and held there for 5 minutes. This was to allow the Mn, and Fe (if present), sensors to prime their pumps, and to allow the Sea Bird T/C pumps to start and stabilise readings. Following this wait the package was lowered directly to a predetermined depth calculated to be approximately 50 meters above the seafloor. At this point a decision was made to continue the downcast depending on the output of the Beam Transmission, Optical Backscatter Sensors and E_h sensor (V5) as indicators of hydrothermal plumes in that vicinity. Bottle firing sequences were decided at the lowest point of the cast on the basis of this

same information but including any temperature anomaly information if observed. If conditions were appropriate and indicated the close proximity of fresh vent fluids, for instance the presence of a buoyant plume or temperature anomaly, the instrument package was “Tow-yo’d” up and down through the plume for more comprehensive sampling.

Station Number	Cast Number	System Changes
Test 2 006	005	Seapoint OBS removed for this cast
	008	Deck Unit and Logging computers swapped. New *.con file in accordance.
010	014	Seapoint OBS to V3, Fluorometer to V4, BBRTD to 2. New *.con file in accordance.

Table 4.2: CTD configuration changes

4.c) CTD Performance

The CTD system suffered a number of problems during the course of the cruise. In retrospect these may be related to the same cause though, at the time, they manifested themselves in such a way that other causes were indicated.

Issues first arose on cast 004 (Station 003) when, at the end of the downcast, the Deck Unit registered an error, the modem link to the SBE 32 carousel was lost and bottles could not be fired either via software or manually. The unit was examined on deck and no problems could be found after cycling the power. A test dip was conducted, cast 005 (station “Test 2”) to 500 metres and all bottles were fired successfully though modulo error counts, indicating communication errors, were higher than expected. It was decided to continue the CTD programme and cast 006 (Stn. 004) was successful in all respects. The problems recurred on cast 007 (Stn. 005) when on start up the Deck Unit failed to initiate until the third attempt. Logging computers were extremely unstable with a propensity to hang at the NMEA (GPS) acquisition stage and the main overlay display was not responding. Attempts to refresh the display caused the software to crash. This first occurred at 50 metres and the instruments were brought to the surface and restarted. The second occurrence was at 100m and the system was reset and the downcast was continued from there. Upon firing the first bottle the software running on the data collection computers once more crashed. Subsequent attempts to fire a bottle via software also cause the same effect and the Deck Unit modem status light was out. Attempts to fire the bottles manually from the Deck Unit were unsuccessful. The Deck Unit was left running and the package brought to the surface with no water samples being taken. Upcast instrument data was still logged under the new name of cast 005A on the backup computer only. Further investigation on deck indicated modem communication problems and the Deck Unit was replaced with the spare unit (s/n 11p34173-0676). Data logging computers were also swapped at this point as the Sea Bird software, during modem communication periods, seemed more stable on the Windows 2000 operating system than under Windows XP. Continued tests of the rosette firing mechanism indicated difficulty firing some positions on a regular basis. The trigger mechanism was removed and thoroughly cleaned. This appeared to fix the problem.

Problems next arose in the set up for casts 012 and 013 when the Deck Unit failed to start up completely when powered on. Over the course of these two casts various remedies were applied to what was a very intermittent problem but which appeared, at least in part, temperature related. Sometimes the system would appear to be stable only to crash an hour later. A new pigtail was attached to the CTD wire termination, the sea cable extension to the SBE9+ was replaced, cables to the temperature and conductivity probes were replaced and the breakout box was opened and inspected for leaks. A test cast to 1000 metres was conducted successfully and once more the CTD programme was resumed. The system failed again on the set up for the next cast. The SBE9+ unit

was removed at this point since metering of the auxiliary channel power supply pins indicated that the unit was not supplying power to the outboard sensors. On inspection of the power board two screws that hold a large heat sink onto the bottom of the power switching unit were found to be loose and in intermittent contact with the modem board directly below them. Additionally a power output regulation transistor was found to be faulty. These issues were rectified and stable power was stored to the unit. Some contacts on the power supply board were re-soldered at the same time. The unit was reassembled and secured back into the frame. All subsequent casts were conducted without incident.

4.d) Data Processing

Data for each cast (upcast and downcast) was first converted from the raw data file to ASCII using the SBE Data Processing software under the following configuration;

Depth (sea water, m)
Pressure (digiquartz)
Voltage 4
Beam Transmission
User Polynomial (BBRTD)
Temperature 1 (ITS-90, Deg C)
Temperature 2 (ITS-90, Deg C)
Potential Temperature (ITS-90, Deg C)
Conductivity 1 (mS/cm)
Conductivity 2 (mS/cm)
Density (kg/m³)
Salinity (PSU)
Voltage 5
Voltage 3

Subsequently this converted data was corrected for conductivity cell thermal mass effects within the same suite of software running the sub routine Cell Thermal Mass configured as follows:

Thermal anomaly amplitude (α) = 0.03
Thermal anomaly time constant ($1/\beta$) = 7
(for both primary and secondary temperature sensors).

On completion the data was corrected for heave and roll fluctuations using the Loop Edit subroutine. Casts 001 to 011 were compensated for loops below 0.25 metres per second (15 m/min) and Casts 014 to 018 were compensated for loops less than 0.10 metres per second (6 m/min) since these casts involved slow up and down casts above the plume site.

All converted files after and including the cell thermal mass correction procedures were then averaged over 10 second time intervals.

(P.Keen)

5. Miniature Autonomous Plume Recorders (MAPRs)

Six MAPR units were provided for cruise CD169 from Dr Ed Baker, NOAA-PMEL in the USA. These MAPRs were deployed extensively throughout both legs of the cruise - 40 stations in total. On the first leg all 6 MAPRs were deployed for each of TOBI runs 1 to 3. Two sensors were deployed at heights of 1 m and 50 m above the depressor weight and the remaining 4 were

suspended from a wire that hung directly below the depressor weight with instruments deployed at 50, 100, 150 and 200 m below the depressor.

All Rockchip stations (1-22) were run with a MAPR 20 m above the rock chipper.

A MAPR was attached to the CTD frame on CTD stations 6, 8, 9, 11, 15, 16, 17 and 18 as a fallback for the unreliable optical backscatter sensor on the CTD (see earlier).

On all dredge stations (1-4) a MAPR was attached to the wire 10 m above the pinger.

On the deep undulating MAPR station (DUM1), 6 MAPRs were attached at an equal spacing of 50 m to the wire, weighted down by a bottom weight. The string was then towed behind the ship at different depths to search for plume signals.

On the Stand Alone Pump stations SAPS 1 and 2 four MAPRs were attached on the wire at the same depth as each of the pumps.

The data for all MAPR deployments were recovered successfully. Only a part of the downcast for station CTD 11 was missed, due to a programming error.

(R. Prien)

6. ABE (Autonomous Benthic Explorer)

6.a) Overview

The ABE vehicle from WHOI (USA) was used extensively during Leg 2 of cruise CD169 in three modes – *i*) to map non-buoyant hydrothermal plumes; *ii*) to conduct detailed swath mapping of the seafloor and intercept buoyant hydrothermal plumes; *iii*) to investigate and photograph new hydrothermal fields on the deep seafloor. During the course of the cruise, 5 ABE dives were conducted ABE 150 to ABE 155 – one Phase I, two Phase II, one partially failed Phase III (sensors operational but no photographs recorded), and two further Phase III dives.

6.b) ABE Dive 150.

ABE150 was a phase 1 dive. The dive tracks were based on clues obtained from an earlier TOBI tow on leg 1 of this cruise. The depths were refined before the ABE dive from CTDs and the tow of an array of MAPRs (DUM-1). The dive was very successful, we found E_h and OBS (optical back-scatter) anomalies at two different depths nearly at the center of the survey grid.

These data did not constrain the search nearly as well as the MAPR data from our past experience with AEB in the Lau Basin so we had to cover a larger area and use significantly larger track spacings (1km for ABE150 versus 200m on the phase 1 Lau dives).

The dive tracks made up a grid with lines 4.5km long spaced at 1 km. The dive started at a spot about 2 km away, the start point was chosen based on considerations of total water depth, LBL (long base-line) net coverage, and terrain. The inefficiency of the long connector leg was accepted since the chosen starting spot reduced some uncertainty for the first dive. Tracklines alternated depths between 2750 m and 2875 m depth.

The 3 element LBL worked very well and coverage was solid - only one flyer was crunched for the entire dive. The vehicle DR'd (dead reckoned) when expected based on maximum transponder range (set to 7 seconds, changed to 8 after testing it during the abort phase of this dive).

The DVL (Doppler velocity log) performed well also. It maintained bottom-lock out to ranges of up to 250 meters (the maximum setting). Mike Jakuba noticed some strange segments when it lost bottom lock and water track simultaneously.

Summary: ABE150

Start time: 2005/03/08 16:27:19

Survey start: 2005/03/08 19:16:15

Survey end: 2005/03/09 20:04:53

Surface time: 2005/03/09 23:38:33

Recovery time: 2005/03/10 00:33:39

descent: 0.23 kwhr over 2.81 hrs, ave pwr: 80.1 w

survey: 4.65 kwhr over 24.80 hrs, ave pwr: 187.4 w over 43.3km 2810 m depth

ascent: 0.13 kwhr over 4.72 hrs, ave pwr: 28.1 w

surface: 0.05 kwhr over 0.92 hrs, ave pwr: 49.8 w

Total energy use: 5.01 kwhr

Min cell voltages

1: 3.65 3.63 3.66 3.66 3.63 3.65 3.65 3.65 3.65 3.66 3.64 3.66 3.65 3.66

2: 3.65 3.67 3.66 3.67 3.65 3.67 3.65 3.66 3.65 3.66 3.64 3.67 3.65 3.66

3: 3.65 3.65 3.64 3.66 3.65 3.67 3.66 3.67 3.65 3.67 3.64 3.66 3.63 3.66

energy from pack 1: 1.660 2: 1.675 3: 1.673 kWhrs

ABE150 DVL stats

119125 pings over 24.7 hour survey

beam 1, 82.4 pct max range: 240.4

beam 2, 82.9 pct max range: 240.4

beam 3, 79.9 pct max range: 240.4

beam 4, 83.1 pct max range: 240.4

0 beams 15.4 pct

1 beams 1.0 pct

2 beams 0.8 pct

3 beams 5.9 pct

4 beams 77.0 pct

average ping rate: 1.34 pings/sec

Mean speeds u: -0.405 v: 0.004 w: -0.022

6.c) ABE Dive 151

ABE151 was a phase 2 dive based on the data from ABE150, CTD, and MAPR data. Tracklines, each 600m long, ran ENE-WSW with 30 meter spacing at 50 meters height. We ran the SM2000 for bathymetry along with the Imagenex (the latter data were not very useful, ABE altitude too high). The dive identified two vent sites. On the first few lines at the southern end of the survey, the data showed a vent site with temperature rises of about 150 mdeg and OBS hits of just over 100 mV. At the northern end we saw solid temperature hits (200 mdeg increase) and an OBS signal over 100 mV lasting for over a minute on the last trackline.

Our choice of the survey area was critical for the success of this dive, as the vent signals were seen on the first and last lines only.

The vehicle performed well, LBL and DVL nav were excellent. The dive ended when the end-of-mission time was reached, although low battery warnings were being generated on every climb and descent and it probably would not have made it more than a few minutes more.

Summary: ABE151

Start time: 2005/03/10 18:45:06

Survey start: 2005/03/10 21:24:39

Survey end: 2005/03/11 12:49:18

Surface time: 2005/03/11 16:35:21

Recovery time: 2005/03/11 16:55:22

descent: 0.42 kwhr over 2.65 hrs, ave pwr: 157.4 w

survey: 4.71 kwhr over 15.40 hrs, ave pwr: 305.8 w over 35.2km 2930 m depth

ascent: 0.21 kwhr over 4.28 hrs, ave pwr: 48.0 w

surface: 0.02 kwhr over 0.33 hrs, ave pwr: 57.5 w

Total energy use: 5.33 kwhr

Min cell voltages

1: 3.58 3.52 3.58 3.60 3.58 3.59 3.59 3.59 3.58 3.60 3.57 3.61 3.58 3.62

2: 3.59 3.61 3.60 3.60 3.61 3.61 3.58 3.62 3.57 3.60 3.58 3.60 3.60 3.61

3: 3.59 3.59 3.57 3.60 3.60 3.61 3.61 3.61 3.58 3.61 3.59 3.60 3.56 3.60

energy from pack 1: 1.778 2: 1.781 3: 1.776 kWhrs

ABE151 DVL stats

89804 pings over 15.3 hour survey

beam 1, 100.0 pct max range: 237.7

beam 2, 100.0 pct max range: 240.4

beam 3, 100.0 pct max range: 219.0

beam 4, 100.0 pct max range: 240.4

0 beams 0.0 pct

1 beams 0.0 pct

2 beams 0.0 pct

3 beams 0.0 pct

4 beams 100.0 pct

average ping rate: 1.63 pings/sec

Mean speeds u: -0.626 v: -0.001 w: -0.016

6.d) ABE Dive 152

Close, but no cigar. ABE flew great tracklines at 5 meters height through the vent field. The survey track started with a large box (250 x 200) then two 100 meter boxes over the spot determined by the adaptive algorithm. Track spacing was 5 meters. All went very well except that the camera failed after about 100 bottom images. All other data were good, including the SOC manganese sensor (see Science Report 7).

LBL tracking and bottom following worked very well. The vehicle hit bottom a few times, including once when it hung up for 9 minutes, but it timed out and freed itself. Vehicle came up with one very strong burn mark on the stbd pod fwd and some muck on the nose. In the case of the big hangup, none of the ranging devices (fwd looking Robertson at 60 deg up, DVL, Imagenex) saw the obstacle coming.

OBS, temperature and E_h data look great. The E_h data clearly outline the smoker field in the NW corner (identified by the IPT algorithm) and a lower temperature area (diffuse flow?) in the southeast quadrant.

Summary: ABE 152

Start time: 2005/03/12 12:42:47

Survey start: 2005/03/12 15:16:16

Survey end: 2005/03/13 03:04:51
Surface time: 2005/03/13 05:49:32
Recovery time: 2005/03/13 06:12:05
descent: 0.35 kwhr over 2.55 hrs, ave pwr: 137.3 w
survey: 2.22 kwhr over 11.80 hrs, ave pwr: 188.0 w over 17.0km 2967 m depth
ascent: 0.20 kwhr over 3.36 hrs, ave pwr: 58.9 w
surface: 0.03 kwhr over 0.38 hrs, ave pwr: 75.0 w
Total energy use: 2.77 kwhr
Min cell voltages
1: 3.74 3.64 3.74 3.75 3.74 3.75 3.74 3.75 3.74 3.75 3.75 3.75 3.75 3.76
2: 3.75 3.76 3.75 3.76 3.75 3.77 3.74 3.76 3.74 3.76 3.74 3.75 3.74 3.76
3: 3.74 3.75 3.73 3.75 3.75 3.75 3.74 3.75 3.74 3.76 3.73 3.75 3.73 3.74
energy from pack 1: 0.959 2: 0.957 3: 0.953 kWhrs

ABE152 DVL stats
147431 pings over 11.8 hour survey
beam 1, 99.9 pct max range: 240.4
beam 2, 99.8 pct max range: 240.4
beam 3, 99.7 pct max range: 240.4
beam 4, 99.5 pct max range: 240.4
0 beams 0.0 pct
1 beams 0.0 pct
2 beams 0.0 pct
3 beams 1.1 pct
4 beams 98.9 pct
average ping rate: 3.48 pings/sec
Mean speeds u: -0.379 v: 0.002 w: -0.004

6.e) ABE Dive 153

ABE153 was a phase 2 dive. We had planned a phase 3 dive, but the failure of the camera on deck made us change plans. In hindsight, the failure on deck was a blessing since the camera had a major problem, a short in the oil-filled cable. This had caused the problem on dive 152, but we danced (frantically) around the problem (more in another document). We had the camera working fine on the bench, but not with the full vehicle cabling. So the camera setup we were about to launch for the phase 3 version of 153 was doomed to failure. We removed the camera and computer and ran a phase 2 (no sm2000, since the same computer runs both the sm2000 and the camera). Camera repairs continued while the vehicle ran the phase 2 ABE153 survey.

The tracklines for ABE153 consisted of a 600x600 m block north of the area surveyed in ABE151 with EW lines, then long lines running NS to the east expanding the 151 survey. Since we were relying on the imagenex for bathy, we ran at 40m height with 25m spaced lines.

The tracklines north of the ABE151 lines closed the vent field that we spotted on the northernmost line of ABE151. On ABE153, this field showed OBS hits on the order of 200 mV and temperature increases of about 200 mdeg (similar to the hits seen on ABE151). The 4 lines run expanding the 151 survey area to the east did not show any large excursions of temperature or OBS.

The dive ended with an abort command issued from the surface, since the camera was now working and we decided to start the next camera dive as soon as possible. We tried at about 0600 with no success. Al's theory, verified by the data, was that the replacement thruster was noisy and prevented the 10.5 interrogations from being received at the vehicle. I (DY) kept trying throughout

the morning. On a northbound line whenever I noticed a few 13.0 responses I switched the ducer to the command box and sent some codes. I did this a few times, finally getting through. The data showed that when the code was received, the vehicle was hill climbing and had slowed its aft thrusters (including the noisy one). After the thrusters shut down, reception of the 10.5 interrogations was very consistent, as opposed to nearly zero when they were running.

Summary: ABE 153

Start time: 2005/03/14 18:52:21

Survey start: 2005/03/14 22:31:37

Survey end: 2005/03/15 10:39:00

Surface time: 2005/03/15 13:24:14

Recovery time: 2005/03/15 13:47:17

descent: 0.26 kwhr over 3.65 hrs, ave pwr: 72.6 w

survey: 3.09 kwhr over 12.12 hrs, ave pwr: 255.1 w over 26.1km 2990 m depth

ascent: 0.07 kwhr over 3.31 hrs, ave pwr: 21.3 w

surface: 0.01 kwhr over 0.38 hrs, ave pwr: 34.8 w

Total energy use: 3.43 kwhr

Min cell voltages

1: 3.67 3.61 3.67 3.70 3.67 3.68 3.68 3.69 3.66 3.70 3.68 3.70 3.68 3.70

2: 3.69 3.70 3.69 3.69 3.69 3.71 3.68 3.70 3.68 3.69 3.67 3.70 3.67 3.70

3: 3.68 3.69 3.68 3.70 3.69 3.69 3.69 3.70 3.68 3.70 3.67 3.69 3.67 3.69

energy from pack 1: 1.141 2: 1.146 3: 1.144 kWhrs

ABE 153 DVL stats

80268 pings over 12.0 hour survey

beam 1, 100.0 pct max range: 226.1

beam 2, 100.0 pct max range: 240.5

beam 3, 100.0 pct max range: 288.6

beam 4, 99.9 pct max range: 253.3

0 beams 0.0 pct

1 beams 0.0 pct

2 beams 0.0 pct

3 beams 0.2 pct

4 beams 99.8 pct

average ping rate: 1.86 pings/sec

Mean speeds u: -0.586 v: 0.002 w: -0.009

6.f) ABE Dive 154

ABE 154 was a phase 3 dive (close up survey including camera) at the southern of the two vent sites. It was a short run to get essential data and to make sure all was well with the camera. The vehicle ran a 5m-spaced block over the site identified by the adaptive algorithm on ABE152 with lines 80m long. Then it ran a 100m x 100m block over a presumed diffuse vent field to the southeast.

The vehicle and camera system performed well. LBL navigation worked fine and most fixes used all 3 transponders. The DVL performed well also, although the output was not used in realtime. Bottom-following worked very well. We had made a few changes after the crashes on ABE152. We lowered the forward looking sonar from 30 degrees down to 45 degrees down and changed how that data was weighted in the bottom following algorithm. This time the vehicle did not hit the structures, although in looking at the pictures there were a few close calls. The vehicle made

several passes over structures on the order of 5 m tall without incident and it flew through clouds of black smoke on several occasions.

The bottom-following was set to 5m, and the vehicle held this pretty well even when flying up over the structures. Another change made after the crashes on 152 was to make the vehicle less aggressive when flying down.

Summary: ABE 154

Start time: 2005/03/15 20:30:19

Survey start: 2005/03/15 23:06:01

Survey end: 2005/03/16 03:40:12

Surface time: 2005/03/16 06:30:21

Recovery time: 2005/03/16 06:47:22

descent: 0.33 kwhr over 2.59 hrs, ave pwr: 129.4 w

survey: 0.85 kwhr over 4.57 hrs, ave pwr: 186.0 w over 5.7km 2968 m depth

ascent: 0.16 kwhr over 3.26 hrs, ave pwr: 49.8 w

surface: 0.02 kwhr over 0.28 hrs, ave pwr: 60.4 w

Total energy use: 1.35 kwhr

Min cell voltages

1: 3.81 3.70 3.81 3.81 3.80 3.81 3.79 3.81 3.81 3.82 3.80 3.81 3.80 3.83

2: 3.81 3.83 3.81 3.82 3.82 3.83 3.80 3.81 3.79 3.82 3.80 3.82 3.81 3.82

3: 3.80 3.81 3.79 3.80 3.81 3.82 3.80 3.80 3.80 3.82 3.78 3.81 3.78 3.80

energy from pack 1: 0.457 2: 0.448 3: 0.445 kWhrs

ABE 154 DVL stats

31327 pings over 4.6 hour survey

beam 1, 99.9 pct max range: 288.6

beam 2, 99.8 pct max range: 288.6

beam 3, 99.6 pct max range: 288.6

beam 4, 99.6 pct max range: 288.6

0 beams 0.0 pct

1 beams 0.0 pct

2 beams 0.1 pct

3 beams 0.8 pct

4 beams 99.1 pct

average ping rate: 1.90 pings/sec

Mean speeds u: -0.353 v: 0.009 w: -0.00

6.f) ABE Dive 155

ABE155 was a longer photo run over the northern vent site (4° 47.84'S 12° 22.65'W). We planned a long, complex mission involving visits to several other sites after completing an adaptive survey on the main site. But the vehicle ran slower than expected and the abort time occurred at the end of the first adaptive survey.

The vehicle made a reasonable survey of the site, but the LBL navigation was poor. A number of factors contributed to the low quality: a) the vehicle was moving very slowly with strong current; b) the survey area was directly on the BD transponder baseline, so if A was not received a fix could not be computed; c) transponder B showed clear clipping by terrain - only at the closest (eastern) end of the survey could the vehicle hear B; d) transponder A showed some unexplained directional effect, the vehicle did not hear it well when driving away; e) the returns from D were a bit ratty. These results are in contrast to the other vent site to the south, where the acoustic tracking was nearly perfect.

We have been having trouble with our doppler velocity log (DVL), so we did not have it connected into the vehicle's navigation processing in real time. The problems now seem fixed, but we were shy to use it in real time given the quality of our previous LBL results. With the benefit of hindsight, that decision was clearly wrong: the DVL works fine and would have helped enormously in this case.

The dive achieved some very good results despite the LBL problems and slow/incomplete progress of the programmed survey. The adaptive algorithm properly identified the best site, and the vehicle returned there for more survey lines at a different orientation. The strongest plume hits and best photos were obtained during the adaptive survey. We made a quick mosaic of one of the approaches to the large structures, and it looks good.

Summary: ABE 155

Start time: 2005/03/16 12:42:12

Survey start: 2005/03/16 15:30:36

Survey end: 2005/03/17 03:01:43

Surface time: 2005/03/17 05:53:30

Recovery time: 2005/03/17 06:22:03

descent: 0.41 kwhr over 2.80 hrs, ave pwr: 147.1 w

survey: 1.93 kwhr over 11.51 hrs, ave pwr: 167.2 w over 12.0km 3029 m depth

ascent: 0.19 kwhr over 3.52 hrs, ave pwr: 54.1 w

surface: 0.05 kwhr over 0.48 hrs, ave pwr: 96.0 w

Total energy use: 2.53 kwhr

Min cell voltages

1: 3.76 3.65 3.76 3.77 3.75 3.77 3.75 3.77 3.76 3.77 3.75 3.77 3.76 3.78

2: 3.77 3.78 3.76 3.78 3.77 3.78 3.75 3.77 3.75 3.77 3.75 3.77 3.76 3.77

3: 3.76 3.76 3.75 3.77 3.77 3.77 3.76 3.77 3.75 3.77 3.75 3.76 3.74 3.76

energy from pack 1: 0.846 2: 0.844 3: 0.842 kWhrs

ABE 155 DVL stats

141840 pings over 11.5 hour survey

beam 1, 99.9 pct max range: 288.6

beam 2, 99.8 pct max range: 287.0

beam 3, 99.9 pct max range: 288.6

beam 4, 98.8 pct max range: 288.6

0 beams 0.0 pct

1 beams 0.0 pct

2 beams 0.0 pct

3 beams 1.6 pct

4 beams 98.4 pct

average ping rate: 3.42 pings/sec

Mean speeds u: -0.314 v: 0.000 w: -0.003

(D.Yoerger, A.Bradley, M.Jakuba, A.Billings)

7. *In situ* Chemical Sensors

7.a) E_h sensors.

In addition to the E_h sensor mounted on the ABE vehicle, two further E_h sensors were provided by Dr Koichi Nakamura (Japan). These sensors were deployed, one on the CTD, and one on the BRIDGET deep-tow vehicle. Both sensors worked reliably on all deployments (all CTD stations and BRIDGET tow-yo 3) without any failures. Drops in the output signal of the E_h sensor routinely coincided with signals in other parameters (optical backscatter, temperature anomalies, in situ Mn/FeII)

7.b) *In situ* Fe and Mn analysers.

Two *in situ* analysers were deployed on this cruise. Both analysers can be set up as manganese or iron II analysers by changing the reagents and standards accordingly.

Both analysers were installed on the CTD frame for 2 CTD casts. On the first cast both analysers showed inconclusive results with a high noise on the baseline and no discernible effect of standard and blank when these were switched on instead of the sample input. After an adjustment of pump parameters both analysers showed a more stable baseline and easily identifiable steps when switching to blank or standard. For the following CTD deployments (CTD 15-18) the analyser worked without failure, apart from a problem with the internal flash memory card on CTD 18, leading to the loss of in situ Mn data for the first hour of measurements on CTD 18.

On ABE dives 150 to 152 the analyser installed on the vehicle was set up to measure Mn, all deployments were successful. On ABE dives 153 & 154 the analyser was set up to measure Fe II. These deployments also were successful.

On dive 150 the internal data logging of ABE did not record the Mn analyser data and they had to be recovered from the internal flash memory of the analyser's electronics. All dives yielded data sets that showed Mn and Fe II signals coinciding with other sensors on board ABE (optical backscatter, E_h , temperature anomalies).

The second analyser was deployed on CTD stations 3, 5 and 15 to 18 and on BRIDGET run 3, set up for the measurement of manganese in all cases. For CTD stations 3 and 5 on the first leg, the first analyser (later installed on ABE) was also run on the CTD, set up for Fe II.

(R.Prien, D.Connelly)

8. Hydrothermal Plume Water-Column Sampling

8.a) Sampling for total dissolvable metals, methane and nutrients

A total of 13 CTD casts were made. Samples from all casts were taken for total dissolvable metals (Mn, Fe) and methane. Half of the methane samples were collected for shipboard analysis and half for storage for analysis back at SOC. Nutrient samples were collected from those CTD casts that showed strongest evidence of hydrothermal impact. In addition to the CTD casts, 2 sets of samples were collected using the sampling rosette on BRIDGET, for a total of 15 samples.

CTD 16 was collected in the buoyant portion of a hydrothermal plume and so extra samples were collected for all analytes.

Methane samples were collected immediately the CTD arrived back on deck. In general, duplicate samples were collected into 100 ml borosilicate glass bottles, preserved with 100ml of mercuric chloride and crimp sealed with Teflon lined caps.

TDMn/Fe samples were collected into acid cleaned 1 litre LDPE bottles and acidified in the clean laboratory with 1ml of quartz distilled concentrated nitric acid. The samples are double bagged and packed.

Nutrient samples were collected into 30ml polycarbonate bottles and frozen.

Due to unforeseen problems with the standards for the GC, samples were not analysed on board for methane. Initial runs on the GC showed that there was methane in the samples that had a high nephel reading but the decision was made to save all of the samples and collect a better data set back at SOC.

Table 8.1: numbers of water column samples taken for shore analyses.

CTD #	Metals	Nutrient	Methane	Other
1	15		48	
2	12		24	
3	Failed			
4	12		24	Labelled CTD3!!!
6	12		24	
7	8		16	
8	6		15	
9	6		12	
10	12	12	24	
11	11	11	24	
12	Failed			
13	Failed			
14	Failed			
15	15	14	30	
16	48 (24*2)	24	96	Buoyant Plume!
17	7	7	14	
18	14	14	28	
BGT01	5		10	
BGT02	10			
Totals	204	82	389	

(D.Connelly)

8.b) Filtration of Niskin Samples

Selected samples from CTD-rosette Niskin bottles were filtered through 0.4µm cyclopore membrane filters as soon as the bottles were brought on deck. The volume of seawater filtered was recorded and the membrane filters retained.

From CTD 3, a background station, 6 samples were filtered. From CTDs 6 – 11 and from CTD 15, a total of 50 samples (500 – 1500mL) were filtered. These samples all came from the non buoyant plume, as revealed by optical sensors on the CTD: an increase in nephelometry and/or a decrease in transmissometer reading.

CTD 16 collected 18 samples in the buoyant plume and all the remaining water in the Niskin bottle (approx 6000mL) after methane, TDMn/TDFe and nutrient samples had been taken was filtered. These filter membranes were observed to have black/brown precipitate present. Above the buoyant plume 2 background samples and 4 non-buoyant plume samples were filtered (1000mL each).

CTDs 17 and 18 collected 5 samples from the edge of a buoyant plume and in each case all the remaining water in the Niskin bottle was filtered, as before (approx 7000mL). There were no non-buoyant plume samples from these CTD casts.

(S.Bennett)

8.c) Stand Alone Pump Sampling

Two SAPS stations were carried out. The location was chosen using the CTD optical back scatter data that showed a strong (max 34mV) broad signal from 2725 – 2925m on the down cast and from 2800 – 2925m on the up cast. Out of all the CTD data this station had the broadest plume with the strongest signal.

A 450 kg weight, pinger and 4 SAPS along with a MAPR each, were attached to a plastic coated wire at 25m intervals and lowered (30m/min) into the ocean. The wire was stopped with the pinger 60m off the sea floor (weight 35m off bottom) putting the first SAPS at 2900m. Three more SAPS continued up the wire at 25m increments with the top station at 2825m. The filters used were 293mm 1 μ m nuclepore membrane filters.

SAPS01 had to be aborted after 2.5 hours, but as the pumps had already started, the filters were kept as background samples. COSAP04, 03, 02 and SN005 pumped 373.5, 28, 146 and 170L respectively.

SAPS02 was completed and the pumps switched on at the correct depth for 2 hours and then returned to the surface (hauling @ 40m/min). COSAP04, 03, 02 and SN005 pumped 1299, 1534, 532 and 1246L respectively. Precipitate was observed on the filter membrane and the MAPR data showed positive optical back scatter signals compared to the background signals during the time the pumps were switched on. This precipitate can be inferred to be hydrothermal plume precipitate.

(S.Bennett)

9. Electrochemical Measurements

9.a) Background

Although abundant in the Earth's crust iron (Fe) is relatively insoluble in oxygenated sea water resulting in concentrations that are known to limit phytoplankton growth and nitrogen fixation rates over large areas of the ocean. For marine geochemists, one of the most important aspects of iron is that it precipitates rapidly in hydrothermal plumes, modifying the gross flux from vents to the oceans. But if only a small proportion of dissolved Fe escapes from hydrothermal plumes it could dominate the budget for deep-ocean dissolved Fe. It is therefore essential to understand the biogeochemical cycling of Fe in hydrothermal systems and their influence throughout the deep ocean. Our knowledge of Fe speciation in seawater, however, is severely limited due to a lack of measurements of Fe concentrations and its degree of organic complexation in seawater. The few existing electrochemical measurements of Fe speciation demonstrate that greater than 99% of the operationally defined "dissolved" Fe that passes through a 0.4 micron filter is strongly bound to organic ligands of presumed biological origin. Our knowledge of Fe speciation in deep waters is also severely lacking due to lack of data, while our knowledge of Fe speciation in hydrothermal plumes is virtually zero except for limited studies on size fractionation. Organic complexation has been measured on deep samples collected in the Sub-Arctic North Pacific and shown to be also highly complexed. However the origin of these ligands is completely unknown. Colloidal (0.4 micron - 0.02 microns molecular diameter) Fe and binding ligands may be the driving force in Fe hydrothermal inputs into the deep ocean keeping the Fe in solution long enough for hydrothermal inputs to play an important role in the Fe deep-ocean budget.

This study aims to investigate Fe organic complexation in deep water samples in distil and plume samples from a newly discovered vent site close to Ascension Island in the South Atlantic. Major goals of the study are to elucidate the dominant size fraction, concentration and binding strength of

these ligands along with determining the concentration of free iron available and ultimately the organically bound fraction.

9.b) Electrochemistry equipment.

This system is used for on-board measurements of Fe-organic complexation. This data can be used with total Fe data to model the ligand concentrations, the different class of ligand (L1, L2), the conditional stability constants of these different ligand classes, and Fe(III)' (soluble inorganic Fe(III) hydrolysis species). The instrumentation used consists of a PAR303A hanging mercury drop electrode connected to an Ecochemie 303 Interface and an Ecochemie μ Autolab 3 voltammeter; the system was run using GPES software. During D286 major problems were encountered with the system. However after servicing and air-freighting out to Ascension in time for CD169 the 303A electrode was found to be in full working order and preliminary studies were undertaken on collected samples.

9.c) Methodology.

Seawater was collected using the CTD at stations and depths in the plume and in the background (Table 9.1). Samples were pressure filtered using research grade nitrogen through an acid washed 0.4 micron polycarbonate filter and collected in Teflon bottles. Samples for immediate analysis were placed in the fridge while the majority of the samples were frozen for subsequent analysis at SOC. Previous studies have shown that immediate freezing of the samples retains the integrity of the sample for future speciation studies. Analysis will be undertaken at SOC using the technique of CLE-ACSV (Competitive ligand exchange – adsorptive cathodic stripping voltammetry) with the added ligand TAC. Complexing capacity titrations will be undertaken on the samples to determine the Fe-TAC response over a series of increasing Fe concentrations (0.1 to 20 nM). Total dissolved Fe will be measured in the laboratory at Southampton Oceanography Centre. The seawater will be subjected to UV irradiation and analysed using CSV with DHN as the added ligand. Total Fe values will also be determined using high-resolution isotope dilution inductively coupled plasma mass spectrometry after Mg(OH)₂ coprecipitation or solvent extraction and determination by GFAAS (graphite furnace atomic absorption spectroscopy). After the total values have been measured, the numbers combined with the complexing capacity titrations can then be used to yield the ligand concentrations, the different class of ligand, the conditional stability constants of these different ligand classes, and Fe(III)' (soluble inorganic Fe(III) hydrolysis species).

Table 9.1 CTD stations sampled for Fe speciation studies during CD169.
(Fridge samples in italics)

CTD #	Sample #	OTE Bottle #
3	<i>1</i>	<i>24</i>
	<i>9</i>	<i>8</i>
5	3	10
7	3	8
8	5	14
9	2	6
10	6	12
	<i>6</i>	<i>12</i>
	7	14
	<i>7</i>	<i>14</i>
	8	16
	9	18
	10	20

11	4	8
	5	10
	6	12
15	3	11
	4	12
	5	13
	6	14
16	15	15
	16	16
	17	17
	18	18
	22	22

9.d) Preliminary Results.

Only a limited number of samples were run on-board ship due to the time constraints and length required for each titration (~ 4 hours). Initial data from samples analysed on ship showed evidence for organic complexation. Figure 2 shows a complexing capacity titration for Niskin Bottle #14 from CTD cast 10. Linear analysis of this data yields a ligand concentration of 2.10 nM with a logKL of 11.9. This is consistent with deep ocean ligand concentrations and depths, comparing favourably with data from the tropical deep Pacific (2.5 nM and 11.2 log KL) and the sub-Arctic North Pacific (1.76 nM and 12.1 Log KL).

9.e) Future Work.

All frozen samples collected will be air freighted to SOC and analysed using the same equipment in the SOC clean electrochemistry laboratory. Totals will be determined and speciation calculations undertaken using the linear approach and compared with a non-linear modelling programme.

(G.Fones)

10. Petrological Sampling

10.a) Deployments

Rock chipper stations were made by the ship maintaining a constant position and deploying the chipper over the starboard side on a 6mm hydro-wire at a rate of ≤ 60 m/minute. The chipper hit the seafloor at this speed, after which it was withdrawn at 5m/min until 5 m above the bottom and then recovered at 60m/min.

Rock dredge stations were made by the ship maintaining a constant position and deploying the dredge over the aft at a rate of ≤ 60 m/minute on the 16mm coring warp. Once on the seafloor, the ship made for an end way-point at a rate of 1kt. (30m/min) over the ground, and the dredge wire was veered at a rate of 10-15m/min. The pinger was kept to 50-100m off bottom. At the end of the haul, the package was recovered, stowed and the dredge samples sorted and bagged.

10.b) Problems encountered during deployments

Difficulties arose with the rock-chipper when, on station RC07, the package encountered resistance on pulling off the bottom. There was no sediment at the location, and the chipper probably snagged on a loose rock. The crew operating the winch used the recommended technique for dealing with this situation, and at no time exceeded the safe working load as displayed on the CLAM system. However, on being informed of the incident later, by the scientist on watch at the time, it was explained that the maximum load had been 1800 kg. Recognising this to be close to the maximum load-bearing of the 6mm hydro-wire, I enquired why this was inconsistent with the CLAM system display. On investigation, it was found that the CLAM had displayed parameters inappropriate to the hydro-wire. This caused a potentially dangerous situation. As a result of the incident, officially reported as a “near miss” by the TLO, elsewhere, >3000m of damaged wire was removed and stowed on deck.

The winch drivers’ consoles, both inside the Main lab. and at the winch driving stations, display incorrect operational data. For example, the brake light is on, even when the brake is off. The speed control knob does not correlate with the positions marked on the consol, e.g. when the control is set to the neutral position the winch still either hauls or veers. This is unsafe and must be rectified.

A hydraulic pipe on the starboard gantry burst through corrosion. The duty engineer immediately repaired it, but the repair took about two hours. Luckily the chipper was stopped at 28m and the weather fair at the time.

10.c) Scientific Samples Obtained

On the basis of available bathymetry (SIMRAD EM12 and ABE-derived SM2000) and TOBI-derived sidescan sonar imagery, the active Southern Mid-Atlantic Ridge axis was located for sampling by rock chipping and dredging. Twenty two chipper sites and 4 dredge sites were chosen (see Appendix F). In addition, MAPRs (Mini Autonomous Plume Recorders) were attached to the chipper (20m above) and dredge wire (beside the pinger at 150m above the dredge) and recorded depth, pressure, temperature and particulate backscatter – see Section 7, above.

Much of the central part of segment 2 (5°S) was sampled, including multiple stations across the area of sheet flows, the hydrothermal sources and the surrounding older hummocky lava terrain. The ends of the segment were also sampled, but with rather poor recovery.

10.d) Preliminary Scientific Highlights:

Station RC07, central north segment 2, recovered abundant iron oxide sediment, fresh glass and small fragments of sulphide. The station was chosen on the basis of two criteria: it is directly below the strongest, and depth extensive plume signal obtained by the MAPRs during the Leg 1 TOBI survey. There also appears at this position an unusual-shaped feature (resembling a 'Mexican's Hat') on the TOBI imagery that overlays and buries fissures in the unsedimented and young sheet flow. The MAPR profile from RC07 showed a tall and dense particulate plume that extended to the seafloor. Combined with the sulphide fragments, this site appears to support an active, high-temperature hydrothermal vent.

Dredge 02, on the central sheet flows and Mexican's Hat area, recovered a variety of extremely fresh lavas, including frozen wave-like structures of glass, several centimetres thick. These structures indicate extremely rapid flow rates for this sheet flow, an inference supported by frozen eddies on the surface on the sheet flow, seen on ABE photographs of the area.

Dredge 04, on the central axial sheet flow and areas with Eh and positive temperature anomalies, recovered extremely fresh glassy sheet flows, several to tens of centimetres thick. Also recovered was a small white crab (10cm x 5cm), a gastropod shell (6mm long) and fragments of mussel shell. These are vent fauna and were observed *in situ* on ABE photographs.

(B.Murton)

11. Biological Investigations

11.a) Overview

Hypothesis-driven investigations of ecosystems in different oceanic regions can provide immediate insights into the processes controlling regional biogeographic patterns and the evolution of chemosynthetic fauna. Understanding how biogeographic processes shape faunal evolution can be achieved through the identification of key ridge localities like the South Atlantic that will yield large first order "jumps" in our knowledge of faunal evolution and biogeography. Hypotheses for the South Atlantic are founded on this premise, as well as on the finding that the recently-discovered Central Indian Ridge faunal province hosts fauna that are distinct (with only one species exception) from the biologically characterized vent ecosystems of the northern Mid-Atlantic Ridge. The overarching hypothesis is that the Equatorial Atlantic Fracture Zones act as a large-scale barrier or species-specific filter to along-axis dispersal and dispersion of species in two ways:

H1) the physical displacement of adjacent segments of the volcanically-active MAR axis, across the Romanche and Chain Fracture Zones, leads to a prohibitively large geographic separation (order 1,000km) between adjacent active high-temperature hydrothermal fields.

H2) strong regional-scale currents flow across the MAR axis, from West to East, through both the Romanche and Chain Fracture Zones. The oceanographic currents of the Fracture Zones as well as their geological structure inhibit along-axis transport of larvae (and species).

To address these hypotheses, my goal during this cruise was to: 1) determine the structure and distribution of vent faunal communities and their associated geological setting on the Southern Mid-Atlantic Ridge via detailed digital imaging surveys, mosaic-mapping, and faunal sampling (via complementary De-Ridge remotely operated vehicle programs) in areas that span the diversity of observed habitats, and 2) to elucidate the distribution of venting activity and habitat diversity through detailed photo-characterization of constituent communities for future detailed biological studies, and demonstrate the utility of AUV technology, (specifically ABE) for hydrothermal

biological research through nested Phase II to Phase III approaches.

11.b) Autonomous characterization of venting activity, biological communities and habitat distribution using ABE.

Phase III overlapping image surveys acquired 12bit images every 5 seconds during 2 ABE dives employing 5m trackline spacing and speeds of 0.4 to 0.6 m/sec. A trigger feature was enabled that upon completion of an initial broad survey, ABE would center the next grid based on binning, within a spatially discrete area, the highest average temperature and Eh anomalies. The tracklines for the trigger surveys were 100 x 100 meters in the opposite direction and diagonal from the initial survey box. The imaging surveys were conducted from 4 to 5 meters altitude to permit the mosaic mapping of spatial relationships and associations among biological, hydrothermal, and geological phenomena.

Table 11.1. ABE biological image statistics

ABE Dive #	Area	Total # of images / dive
154	Southern	6421
155	Northern	11374

Southern Phase II area: Based on E_h and Temperature anomalies during ABE dive 153 (a Phase III survey in which the digital black and white camera system did not work), an 80 x 80 meter box located at the northern end of a north-south collapsed pit, and an 80 x 100m box, 25 meters to the southeast. ABE images revealed a broad spectrum of lava morphologies surrounding a series of linear collapsed lava pits with several sulfide chimneys constructed from the base of the pits. Images of the southeastern area revealed extensive and discrete mussel communities hosting gastropods, shrimp, clams, and barnacles in cracks and crevices associated with sheet and hackly lava flows.

Northern Phase II area: ABE images revealed at least one black smoker and the presence of abundant shrimp, resembling *Rimicaris*. No live mussels were observed.

11.c) Biological Collections

One brachyuran crab was collected during Dredge 04. This specimen was preserved and transported to the Woods Hole Oceanographic Institution.

Table 11.2. Biological sample and dredge location.

Dredge #	Julian Day	Time	Lat' Start	Lon° Start	Depth (m)
DR04			End	End	
On bottom	074	21:56	4 47.63	12 22.69	3043
Off bottom	075	01:10	4 48.98	12 12.83	3276

SUMMARY

RRS *Charles Darwin* Cruise CD169 enjoyed remarkable success. We were able to systematically survey approximately 200km of the Mid-Atlantic Ridge crest south of the Equator (ca.3-7°S) and

investigate the interplay of volcanic, tectonic and hydrothermal activity. Evidence for high-temperature hydrothermal venting was discovered in two locations, one of which had not even been mapped by multi-beam swath bathymetry before the cruise began. Using SOC's TOBI deep-tow sidescan vehicle, equipped with NOAA-PMEL MAPRs we were able to identify particle laden plumes and using a CTD-rosette water samples were taken from these plumes to confirm, geochemically, that they were hydrothermal in nature. One of these sites was in a non-transform discontinuity between two adjacent 2nd order ridge segments. The other was at the very centre of a spreading ridge segment which, TOBI revealed, hosted an area of ca.15km² of geologically fresh, unfaulted lava flows. By the end of the 2nd Leg of our cruise, the ABE autonomous underwater vehicle had managed to precisely locate and photograph the first vent-sites ever to be found in the South Atlantic Ocean and reveal the dominant fauna inhabiting the area. The data gathered was sufficient to guide a complementary ROV cruise by the German Ridge Program, aboard RV *Meteor*, directly to these sites less than one month after they were found. As well as proving an extremely efficient mode of hydrothermal exploration, the TOBI/ABE combination also allowed a full program of CTD and rock-sampling operations to be undertaken while ABE was operating autonomously at the seabed.

Although RRS *Charles Darwin* Cruise CD169 enjoyed considerable success, it was not without disappointments, too. To be fair, the ship itself was in much better condition when the PSO last sailed on her in 2001 (CD127, CD128) when a number of failures led to near collapse of the science programme. Nonetheless, it should be recognized that a "near-miss" in complete power failure of the vessel came close to causing the loss of TOBI which was being towed some kilometers behind the ship and only 350m above the seafloor at the time. The ship's engineers deserve particular credit for averting that problem as promptly as they did – with only minutes to spare! Another continuing setback was with the BRIDGET deep-tow. Ian Rouse and Dave White struggled committedly throughout the cruise to render the vehicle useful for science which they achieved during the last 12 hours of station work. It was fortunate that the rest of the science programme managed without the BRIDGET data but it would have been much higher quality had that been available from the outset. Perhaps the most disappointing outcome for the cruise, however, was from the CTD. During 20 years of seagoing this has routinely been considered the most reliable piece of equipment that one can turn to when all else fails. Instead, during much of the cruise it was questionable how reliable the system was and, throughout, it proved impossible to obtain reliable optical back-scatter data from the UKORS instrument – something that has been a mainstay of such research in the UK since at least 1988 (*Discovery* 176). For this cruise, however, the only safe approach was to attach a NOAA-PMEL MAPR to all CTD deployments to ensure that reliable results were obtained.

(C.German)

ACKNOWLEDGEMENTS

I am pleased to have the opportunity to thank Capt.P.Sarjeant and the Officers and Crew of the RRS *Charles Darwin* for the efficacy with which the cruise was conducted. Everyone made their contributions, from the officers of the watch with their ship handling and station keeping skills to the deck hands helping with novel ABE deployments; from the galley crew who did so much to keep spirits high to the engineers who so narrowly averted the demise of TOBI at the end of Leg 1 – all overseen by the watchful eye of a Master who takes pride in a safely run vessel.

Our science party also enjoyed great support from our Technical support team from UKORS. Particular thanks go to Dave Turner, TLO, for helping organize our way through some rather trying times – at one point we had NO operating instrumentation that was fit to be deployed over the side of the ship – and to Ian Rouse who worked tenaciously during Leg 1 to trouble-shoot and repair TOBI on the sole occasion when that instrument encountered problems. With support like that, UK Marine Science should only continue to prosper.

RRS *Charles Darwin* Cruise CD169 would have been impossible without the financial support of NERC through core strategic funding to the Fluid Fluxes Group and the Ocean Crust Group of the Challenger Division for Seafloor Processes, Southampton Oceanography Centre, UK. In addition, essential funding to enable participation of the Woods Hole Oceanographic Institution's science team and their ABE autonomous underwater vehicle was provided through the NOAA Ocean Exploration program in the USA. Additional funding was also provided by NERC via a PhD studentship to Ms.Sarah Bennett and by the Census of Marine Life "ChEss" program (Chemosynthetic Ecosystems) for which location of the first vents and vent-ecosystems on the Southern Mid-Atlantic Ridge had been a very high priority.

(C.German)

Figure 1: RRS *Charles Darwin* CD169 Cruise Track

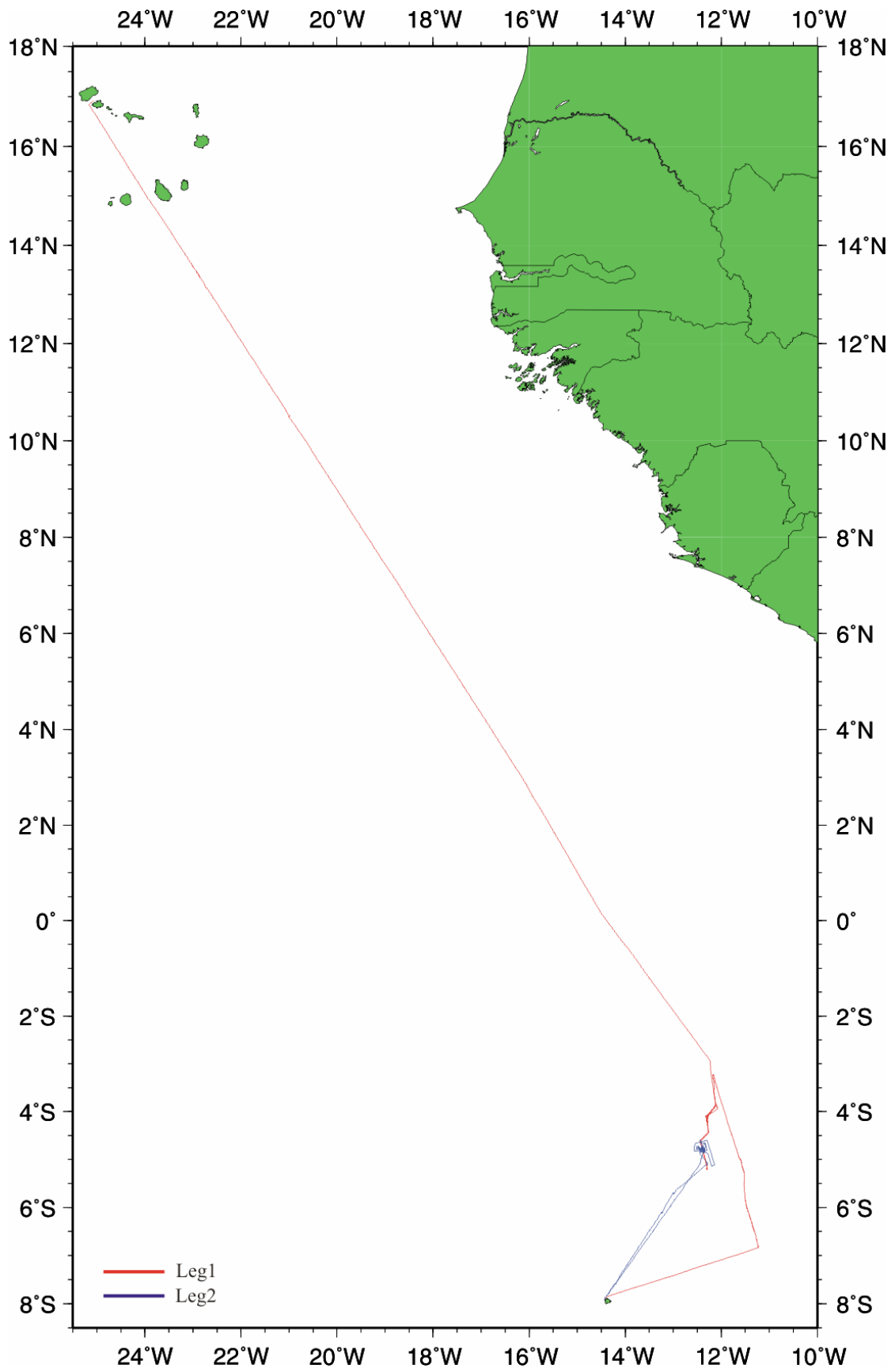
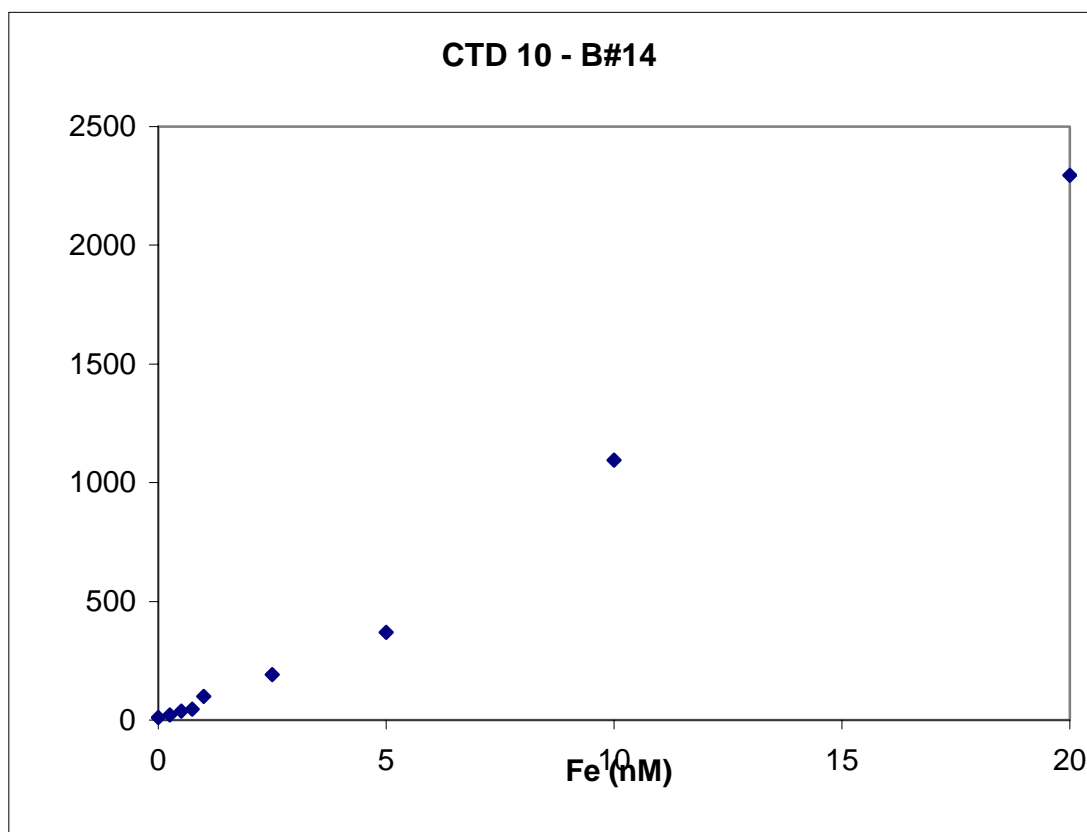


Figure 2: Fe complexing capacity titration

(see Science Report 9: Electrochemical Measurements)



APPENDIX A – DIARY OF EVENTS

Times in text are UTC-1 'til 0100, 22nd February, thence UTC

2005-02-16

0900 Scientific & Technical staff for CD 169 join vessel. Minor mobilisation work underway.
Vessel bunkering and taking FW & fresh provisions this day. RSU Crew reliefs.
1500 Sign on of Scientific & Technical party + Safety Briefing & Familiarisation Tour.

2005-02-17

0800 Completing alongside tasks.
0855 Complete tests of ME, Bow Thrust & Steering Gear – all satisfactory.
0912 ERSB
0923 Last line
0930 Clear of breakwater
0936 RFA on passage; B'water 120 degs @ 0.6nm
1200 16 37.8N 25 01.5W Wind NE 20 knots
1615 Emergency & Boat Stations muster

2005-02-18

0001 14 55.8N 23 55.3W
0925 V/I heaving-to for CTD test deployment
0934 13 35.9N 23 00.9W CTD01 deployed
1010 CTD recovered
1030 13 35.3N 23 00.8W Resume transit @ 2 knots; streaming deep tow cable
1200 13 29.6N 22 56.8W Continue streaming deep tow; v/l speed 6 knots; Wind NE 22 knots
1318 13 23.8N 22 53.1W Commence hauling deep tow
1606 13 11.7N 22 45.5W Deep tow cable recovered; resume transit @ 125 rpm

2005-02-19

0001 12 05.3N 22 01.7W
1037 10 33.4N 21 01.7W Commence Swath recording on passage
1200 10 25.5N 20 57.5W Wind NExN 10 knots

2005-02-20

0001 08 40.1N 19 48.2W
1200 06 52.8N 18 38.2W Wind NE 10 knots

2005-02-21

0000 05 08.2N 17 31.2W
1200 03 28.2N 16 27.0W Wind Light & Variable
1424 03 07.6N 16 13.9W Reduce to 118rpm @ ER request due to high LT circuit temps
1600 02 55.5N 16 05.6W Adj. co. to 150 degs (T&G)
1610 02 53.3N 16 04.9W Further reduction to 113rpm
1920 02 27.3N 15 50.1W Further reduction to 105rpm

2005-02-22

0100 01 47.7N 15 27.1W Clocks advanced 1hr to GMT
1200 00 32.4N 14 43.6W Wind SSE 15 knots
1447 00 11.6N 14 31.7W Adj. co. to 144 degs (T&G)
1510 00 08.9N 14 30.0W Incr. to 123rpm

2005-02-23

0001 00 55.8S 13 41.6W
1200 02 19.8S 12 40.5W Wind SE 20 knots; v/l pitching heavily @ times
1742 02 56.5S 12 14.0W Commence Swath survey proper; adj co. to 176 degs (T&G)
1936 03 13.3S 12 12.8W Adj. co to 171 degs (T&G)

2005-02-24

0006 03 52.8S 12 07.1W A/c to 219 degs (T&G)
0200 04 06.3S 12 17.9W A/c to 175 degs (T&G)
0415 04 26.0S 12 16.8W A/c to 224 degs (T&G)

0600 04 37.2S 12 27.0W A/c to 166 degs (T&G)
0625 04 41.0S 12 26.0W A/c to 150 degs (T&G)
0728 04 48.4S 12 21.8W A/c to 165 degs (T&G)
0735 04 49.5S 12 21.5W A/c to 195 degs (T&G)
0745 04 51.2S 12 21.9W A/c to 180 degs (T&G)
0810 04 54.3S 12 22.0W A/c to 165 degs (T&G)
1000 05 08.1S 12 18.4W Slowing at termination of s-bound Swath run
1033 05 10.9S 12 17.8W 10kHz sonar fish deployed
1036 3.5kHz PES deployed
1111 05 11.4S 12 18.0W Commence TOBI deployment; streaming MAPR string
1139 MAPR string streamed & stoppered-off
1148 TOBI outboard
1150 TOBI umbilical streamed
Wind SE 10 knots
1218 Depressor wt connections complete & tested
1221 05 12.1S 12 18.0W Depressor wt outboard; MAPRs attached @ 0 & 50 metres; veering
deep tow cable
1237 05 12.3S 12 17.9W Cease veer @ 300m; commence turn @ 10 degs/min & 3 knots
1257 05 12.0S 12 17.5W Turn completed & resume veering cable
1400 onwards Adjustments of co & speed as necessary to meet track requirements

2005-02-25

0025 04 49.0S 12 23.0W A/c to 349 degs (T&G)
0618 04 36.6S 12 25.3W Commence turn to stbd @ 1 degree/min
0730 04 34.6S 12 24.3W Settled on new co. 048 degs (T&G)
1151 04 27.6S 12 16.5W Commence turn @ 2 degs/min to 352 degs
1200 04 27.3S 12 16.3W Wind SSE 15 knots
1615 Emergency exercises/familiarisation
1630 04 15.7S 12 17.3W A/c to 000 degs (T&G)
2015 04 06.2S 12 17.2W Commence turn @ 2 degs/min
2104 04 04.7S 12 16.4W Settled on new course, 038 degs (T&G)

2005-02-26

0001 03 59.4S 12 12.3W
0037 03 58.3S 12 11.5W TOBI signal fails; commence hauling
0410 03 52.0S 12 07.2W Slow course change towards recovery heading
0500 03 51.8S 12 06.1W Cease hauling @ 1000m wire out
0630 03 55.0S 12 04.9W Resume hauling
0722 Depressor wt recovered & MAPR string stoppered-off
0737 Prop stop – heading & forward way maintained by bow thrusters
0747 TOBI landed on deck
0811 03 56.4S 12 04.9W MAPR string recovered; securing deck
0900 Repositioning for CTD station
0955 04 04.6S 12 16.1W CTD02 deployed
1105 CTD near bottom
1200 04 04.6S 12 16.2W Wind SE 15 knots
1315 CTD recovered
1352 Streaming TOBI umbilical for test purposes
1431 04 06.2S 12 16.5W Umbilical recovered; repositioning to Rock Chipper (RC) site
1510 04 11.0S 12 17.5W Hove-to on station
1603 RC deployed; RC01
1830 04 11.6S 12 18.6W RC recovered
1940 04 06.1S 12 16.6W A/c to 288 degs (T&G)
2011 04 05.7S 12 19.5W Hove-to awaiting TOBI repairs
2044 Decision to continue other work o'night; v/l heading for CTD statn.
2157 04 00.3S 12 13.0W CTD03 deployed
2317 Hauling from 4120m

2005-02-27

0128 04 00.3S 12 13.1W CTD recovered; repositioning to RC02
0246 04 06.0S 12 18.1W RC deployed; RC02
0500 04 06.5S 12 18.0W RC recovered
0612 04 08.7S 12 18.1W RC deployed; RC03
0803 04 08.5S 12 18.0W RC recovered; repositioning to RC04

0858 04 13.8S 12 17.1W RC deployed; RC04
 1032 04 13.7S 12 17.0W RC recovered
 1041 Set co. for TOBI deployment position
 1143 04 05.5S 12 19.2W Hove-to @ position; Wind SE 15 knots
 1316 04 05.8S 12 19.3W Commence deploying MAPR string
 1352 TOBI streamed
 1414 Depressor wt streamed
 1424 04 06.2S 12 19.4W Commence veering Deep Tow cable; slow turn onto track (038 degs)
 2124 03 56.4S 12 10.0W A/c to 031 degs (T&G)
 2359 03 51.9S 12 07.2W A/c to 351 degs (T&G)

2005-02-28

0630 03 35.6S 12 09.2W A/c to 002 degs (T&G)
 0900 03 29.8S 12 09.0W Hauling Deep Tow & running ahead on Bow Thrust due to fan failure
 in SCR cabinet of propulsion system
 1000 TOBI 800m off bottom; prop system off for repairs
 1130 03 25.1S 12 08.9W Main propulsion back on line; veering TOBI to preferred depth
 1200 03 24.3S 12 08.8W Wind SE 12 knots
 1431 03 19.0S 12 10.0W Commence hauling for TOBI recovery prior relocation
 1620 03 14.8S 12 10.9W Altering course, head-to-wind
 1720 03 14.7S 12 09.7W Recovering Depressor wt & hanging-off MAPR string
 1800 TOBI landed on deck
 1825 03 15.0S 12 09.3W MAPR string recovered; set co 163 degs for new deployment site

2005-03-01

0001 03 54.2S 11 57.9W
 0832 04 55.8S 11 38.3W V/I @ 0.5 knot; Commence deploying MAPR string
 0855 04 55.8S 11 38.4W Streaming TOBI
 0927 04 55.8S 11 38.5W Depressor wt outboard & commence veering Deep Tow cable
 1124 04 58.6S 11 37.4W A/c to 135 degs (T&G)
 1200 04 59.4S 11 37.2W Wind SSE 15 knots
 1242 05 00.3S 11 35.7W A/c 170 degs (T&G)
 1645 05 09.3S 11 33.9W A/c 162 degs (T&G)
 2054 05 18.0S 11 31.1W A/c 182 degs (T&G)

2005-03-02

0001 05 25.3S 11 31.2W
 0304 05 32.7S 11 31.6W A/c 176 degs (T&G)
 0948 05 49.0S 11 30.3W A/c 169 degs (T&G)
 1200 05 54.0S 11 29.5W Wind SExE 20 knots
 1407 05 59.0S 11 28.6W A/c 163 degs (T&G)

2005-03-03

0001 06 20.8S 11 21.6W
 0234 06 26.5S 11 19.8W A/c 161 degs (T&G)
 0655 06 36.2S 11 16.4W V/I suffers total loss of power
 0700 Propulsion restored; v/I heading 190 degs; rpm increased to 100+
 initially to re-tension TOBI tow.
 0740 06 38.1S 11 16.6W Co restored to 164 degs; speed 2 – 2.5 knots
 0855 06 41.4S 11 15.9W Second loss of power
 0858 Propulsion restored
 1033 06 44.4S 11 14.9W Commence hauling TOBI
 1200 06 47.5S 11 14.0W Wind ExS 17 knots
 1258 06 49.6S 11 13.5W Reduce rpm to < 1 kn thro' water
 1320 06 49.8S 11.13.7W Depressor wt recovered & MAPR string hung-off
 1341 06 49.9S 11 15.9W TOBI recovered to deck
 1400 3.5 & 10 kHz fish inboard
 1405 MAPR string recovered
 1406 06 50.1S 11 14.0W Set co for Ascension Is.

2005-03-04

0001 07 23.1S 12 54.2W
 0600 07 41.9S 13 54.6W
 0855 A/c 180 degs, NW of Ascension Is

0900 07 52.8S 14 24.7W EoP; ERSB
0906 Comp satisfactory ME, BT & steering gear tests
0933 Commence walking back anchor
0943 Cease veer @ 6 sh in water; Bates Pt brng 115 degs x 0.72nm
0948 RFWE
1015 1st boat transfer completed; Joiners onboard; Medical cases ashore
1138 Baggage exchange completed via pontoon. Wind SExS 12 knots
1218 Launch a'side with Agent & medical cases.
1248 Ship's business completed; Agent & leavers away
Vessel completing equipment shifts & essential generator maintenance

1630 ME, steering gear & BT tested & satisfactory
1636 ERSB
1639 Comm heaving anchor
1655 4 sh on deck
1710 Anchor's aweigh; v/l manoeuvring clear of anchorage
1724 RFAoP; Bates Rock brng 139 degs x 1.8nm; set co 033 for work area 1940 07
35.2S 14 13.0W Heave to for ABE maintenance
2008 Resume passage

2005-03-05

0003 07 04.1S 13 52.9W
0655 06 06.4S 13 15.0W Heave to on station
0720 06 06.3S 13 14.9W CTD04 deployed
0830 USBL spar lowered
1005 USBL spar recovered
1010 06 06.7S 13 14.2W CTD recovered; resume passage
1317 05 42.0S 13 00.0W Heave to for CTD test dip. Wind SExS 15 knots
1339 05 42.1S 13 00.0W CTD05 deployed
1405 CTD recovered; repositioning to avoid longlines
1431 05 42.5S 12 59.6W CTD06 redeployed
1508 USBL spar lowered
1615 05 42.4S 12 59.4W Emergency muster & exercises
1728 05 42.6S 12 59.3W CTD recovered
1750 05 42.7S 12 59.3W USBL spar recovered; set co 050 degs for next work area
2355 05 06.8S 12 19.1W RC deployed; RC05

2005-03-06

0140 05 06.8S 12 19.4W RC recovered; commence Swath survey
0340 05 04.0S 12 17.3W RC deployed; RC06
0550 05 04.0S 12 17.2W RC recovered; resume Swath survey
0810 04 44.3S 12 28.4W Cease swath survey; v/l bound for first transponder deployment
0907 04 47.1S 12 25.5W USBL spar lowered
1005 04 47.9S 12 24.6W Transponder #1 released
1053 04 47.3S 12 24.1W 'Boxing-in' transponder
1158 Transponder position fixed; repositioning to CTD station
1200 Wind SExS 18 knots
1312 04 46.0S 12 23.1W CTD07 deployed
1534 04 45.6S 12 23.7W CTD recovered – unsuccessful; v/l repositioning for BRIDGET deployment
1710 04 43.3S 12 25.0W Bridget streamed
1800 04 43.6S 12 24.6W Co 120 degs @ 0.8 knots; veering deep tow
1820 Co 100 degs @ 0.4 knots
1930 04 44.1S 12 23.6W Hauling Bridget due technical problems
2046 Commence recovery
2055 04 44.9S 12 23.9W BRIDGET on deck
2117 Aft deck secure; proceeding for second transponder deployment
2210 04 47.2S 12 21.4W Commence deployment
2220 04 47.2S 12 21.3W Transponder #2 released; repositioning for #3
2315 04 49.5S 12 22.4W Transponder #3 released; 'listening' during descent

2005-03-07

0110 04 46.8S 12 20.9W 'Boxing-in' #2 transponder
0241 04 49.53S 12 22.46W #3 transponder not detected. #4 transponder released in adjacent

position

0329 04 48.9S 12 22.0W 'Boxing-in' #4 transponder
0455 04 50.7S 12 33.9W USBL spar recovered; set co for MAPR string deployment area
0525 04 48.9S 12 26.2W Heave-to & commence deployment
0608 04 49.7S 12 26.4W MAPRs all attached – continue veering deep tow cable
0703 04 50.5S 12 26.4W 2300m wire out; commence MAPR survey conducting cross tracks
Mid-Atlantic ridge.
1200 04 48.3S 12 21.3W Wind SExE 5 knots
1409 04 47.1S 12 26.8W Aborted turn to stbd due wire angle; shortening cable
1523 04 44.6S 12 28.2W Slow turn to port to resume survey
1541 04 43.6S 12 28.6W USBL spar lowered
1700 04 45.0S 12 30.5W Co 098 degs @ 3 knots thro' water
2330 04 46.2S 12 21.2W Slow turn onto W'ly heading

2005-03-08

0324 04 46.3S 12 26.1W Commence hauling MAPR string
0507 First of MAPRs at surface
0615 04 47.0S 12 30.8W MAPR string recovered & USBL spar retracted
0735 04 46.8S 12 23.4W Hove-to & RC (07) deployed
0816 04 47.0S 12 23.4W RC recovered; v/l repositioning
0832 04 46.6S 12 23.1W V/l repositioned; deployment resumed
0925 04 46.8S 12 23.2W RC on bottom
1120 04 47.0S 12 23.4W RC recovered; proceeding to RC08
1206 04 46.1S 12 22.5W RC08 deployed; Wind SSE 18 knots
1258 04 46.25S 12 22.61W RC on bottom
1404 04 46.3S 12 22.6W RC recovered; v/l repositioning
1444 04 48.5S 12 21.1W USBL spar lowered
1514-1541 CTD08 test dip; thence preparing for ABE deployment
1635 04 48.4S 12 21.2W ABE released (ABE150); v/l hove-to for monitoring
1810 04 48.9S 12 21.2W Re-locating for CTD deployment
1844 04 49.5S 12 21.9W CTD09 deployed
2125 04 49.9S 12 21.5W CTD recovered; v/l re-locating
2315 04 46.9S 12 23.6W CTD10 deployed

2005-03-09

0144 04 47.0S 12 23.4W CTD recovered; v/l re-locating
0236 04 48.8S 12 22.9W RC09 deployed
0445 04 48.8S 12 22.9W RC recovered; v/l re-locating
0540 04 47.7S 12 22.0W RC10 deployed
0733 04 47.6S 12 22.1W RC recovered; v/l repositioning
0848 04 50.9S 12 22.2W RC11 deployed
1045 04 51.2S 12 22.1W RC recovered; v/l repositioning for CTD station
1152 04 48.6S 12 21.7W CTD11 deployed; Wind SExE 14 knots
1414 04 48.5S 12 21.9W CTD recovered; v/l repositioning
1620 04 46.8S 12 22.1W Hove-to; reeling off & cropping Hydro Wire
1920 04 47.7S 12 22.0W CTD12 deployed
2156 04 47.7S 12 21.8W CTD recovered
2300 04 47.3S 12 24.9W Hove-to awaiting surfacing of ABE
2341 04 47.3S 12 24.8W ABE sighted on surface; range approx 7 cables

2005-03-10

0030 04 47.4S 12 24.6W Lifting line hooked-on ABE
0040 04 47.4S 12 24.8W ABE clear of water & landed on cradle
0056 04 47.3S 12 24.8W USBL pole retracted & gate valve closed
0134 04 45.6S 12 23.7W RC12 deployed
0139 Hydraulic failure; 28m wire out
0339 Resume veering
0540 04 45.8S 12 24.0W RC recovered; v/l repositioning
0620 04 47.4S 12 24.6W RC13 deployed
0823 04 47.2S 12 24.4W RC recovered; v/l repositioning
0902 04 49.5S 12 24.0W RC14 deployed
1104 04 49.5S 12 24.0W RC recovered; v/l repositioning
1130 04 50.1S 12 23.3W RC15 deployed; Wind SE 19 knots
1339 04 50.2S 12 23.2W RC recovered; v/l repositioning

1414 04 48.5S 12 23.0W USBL spar lowered
 1700 CTD deployed for cleaning purposes
 1736 CTD recovered
 1810 04 48.6S 12 23.0W Re-positioning for ABE deployment
 1852 04 48.6S 12 22.9W ABE released; v/l hove-to for monitoring
 1908 Re-positioning for CTD#10
 1925 04 48.0S 12 22.5W CTD13 deployed
 2230 04 47.9S 12 22.4W CTD recovered
 2245 USBL spar retracted; v/l relocating for rock dredge

2005-03-11

0113 04 38.3S 12 25.4W Commence streaming Dredge #1
 0300 04 38.3S 12 25.3W Dredge on bottom
 0535 04 39.1S 12 24.8W Off bottom
 0735 04 40.1S 12 25.1W Dredge recovered; courses various (Swath?)
 0950 04 48.2S 12 22.4W USBL spar lowered
 1020 Repositioning for CTD#11
 1045 04 48.5S 12 22.3W CTD14 deployed
 1322 04 48.6S 12 22.4W CTD recovered; Wind SExE 18 knots
 1446 04 47.3S 12 23.3W Hove-to awaiting ABE recovery
 1640 04 47.6S 12 23.0W ABE on surface
 1658 'Hooked & tagged'
 1700 04 47.4S 12 23.2W ABE 'cradled'
 1728 04 47.7S 12 23.1W USBL spar retracted; v/l repositioning for Swath survey run
 1812 04 48.6S 12 17.9W Commence Swath survey; co 345 degs
 1915 04 39.9S 12 21.0W Complete survey & a/c for Dredge start pt.
 2008 04 44.3S 12 23.4W Commence streaming Dredge #2
 2251 04 44.4S 12 22.2W Dredge off bottom

2005-03-12

0044 04 45.3S 12 21.9W Dredge recovered; repositioning for CTD
 0136 04 47.8S 12 22.6W CTD failed @ deployment
 0710 04 47.8S 12 22.6W CTD 'downtime' continues
 0854 04 47.8S 12 22.5W USBL spar lowered
 1105 04 48.6S 12 23.3W Hove-to for ABE deployment
 1236 Commence ABE deployment; Wind SExS 10 knots
 1252 04 48.7S 12 22.5W ABE released; monitoring to bottom
 1600 04 48.8S 12 22.5W Hove-to awaiting instructions
 1620 Repositioning for BRIDGET deployment
 1722 04 45.9S 12 23.7W Commence streaming BRIDGET
 1900 04 46.5S 12 23.2W Cease veer at 2900m wire out
 1920 04 46.8S 12 23.0W Towing BRIDGET – CMG 162 degs; speed 1.0 knots
 2116 04 48.7S 12 22.3W Commence hauling BRIDGET
 2248 04 50.3S 12 21.8W BRIDGET on deck
 2307 Relocating to RC site

2005-03-13

0125 04 48.5S 12 21.3W RC16 deployed
 0223 04 48.48S 12 21.25W RC at bottom
 0326 04 48.6S 12 21.1W RC recovered; v/l relocating for ABE recovery
 0550 04 48.4S 12 22.7W ABE on surface
 0618 04 48.5S 12 23.0W 'Hooked & tagged'
 0620 'Cradled'
 0642 USBL spar retracted; v/l relocating for Swath survey
 0748 04 53.3S 12 16.6W Commence Swath survey; CMG 163 degs; speed 9.5 knots
 0832 04 59.0S 12 14.8W Hove-to @ Watch leader's request
 0903 Resume Swath survey
 1020 05 08.2S 12 11.6W Hove-to for CTD test dip
 1125 CTD recovered; resume Swath survey
 1200 05 06.9S 12 08.2W Hdg 343 degs; Wind SExS 20 knots
 1522 04 35.9S 12 17.8W A/c 254 degs
 1700 04 40.4S 12 32.6W A/c 198 degs
 1735 04 45.5S 12 34.1W A/c 168 degs
 1807 04 49.8S 12 33.0W A/c 082 degs – bound for RC station

1937 04 48.6S 12 22.4W RC17 deployed
 2100 04 48.5S 12 22.4W RC at bottom
 2205 04 48.5S 12 22.3W RC recovered; v/l repositioning
 2326 04 48.5S 12 22.3W CTD15 deployed

2005-03-14

0320 04 48.6S 12 22.5W CTD recovered; v/l repositioning
 0525 04 47.7S 12 22.5W RC18 deployed
 0722 04 47.6S 12 22.4W RC recovered
 0750 04 48.1S 12 22.7W RC19 deployed
 0850 04 48.04S 12 22.59W RC at bottom
 0949 04 48.2S 12 22.6W RC recovered
 1009 04 47.2S 12 22.8W RC20 deployed
 1115 04 47.27S 12 22.83W RC at bottom
 1212 04 47.4S 12 22.9W RC recovered; Wind ESE 15 knots
 1324 USBL spar lowered
 1426 04 47.8S 12 22.6W CTD16 deployed
 1718 04 47.8S 12 22.7W CTD recovered
 1831 04 48.2S 12 22.7W Re-positioned for ABE deployment
 1959 04 48.13S 12 22.71W ABE released
 2052 04 48.1S 12 22.7W Re-positioning for RC station
 2129 04 50.2S 12 22.0W RC21 deployed
 2234 04 50.16S 12 21.95W RC on bottom
 2334 04 50.2S 12 21.8W RC recovered; re-locating for dredge station

2005-03-15

0046 04 46.4S 12 23.1W Dredge03 outboard
 0202 04 46.36S 12 23.10W Dredge on bottom (3235m); incr to 1 knot OTG
 0450 04 48.1S 12 21.6W Dredge recovered
 0540 – 0600 Checking acoustic response from ABE
 0745 04 48.5S 12 22.5W Heave-to @ SAPs deployment position
 0836 04 48.6S 12 22.3W Commence streaming SAPs & MAPRs string
 0917 String completed; continue veering
 1030 ABE inadvertently released; commence heaving SAPs string
 1216 04 48.6S 12 22.3W Complete SAPs string recovery; re-positioning for ABE recovery
 1336 04 47.6S 12 22.0W ABE sighted on surface; Wind SE 15 knots
 1348 'Hooked & tagged' and clear of water
 1353 04 47.7S 12 22.1W ABE cradled; v/l repositioning for CTD
 1452 04 48.3S 12 22.3W CTD17 deployed
 1745 04 48.1S 12 21.9W CTD recovered; v/l lying a-hull to provide lee for work on ABE
 1830 Re-positioning to launch site
 1900 04 48.6S 12 22.7W Hove-to awaiting launch
 2040 04 48.63S 12 22.69W ABE released; v/l monitoring & then re-locating for dredge
 2200 04 47.6S 12 22.7W Dredge04 outboard
 2330 04 47.67S 12 22.68W Dredge on bottom

2005-03-16

0247 04 49.9S 12 20.9W Dredge recovered; re-positioning for RC
 0333 04 49.3S 12 21.9W RC22 deployed
 0530 04 49.3S 12 21.7W RC recovered
 0600 04 48.3S 12 22.8W Hove-to for ABE recovery
 0635 04 48.4S 12 22.6W ABE on surface
 0647 'Hooked & tagged'
 0650 04 48.4S 12 22.4W ABE cradled
 0715 04 48.6S 12 22.4W CTD18 deployed
 0951 04 48.6S 12 22.4W CTD recovered; v/l re-positioning for ABE release
 1145 04 48.1S 12 22.7W Hove-to awaiting deployment; Wind SE 18 knots
 1250 04 48.0S 12 22.6W ABE released; v/l re-positioning for SAPs deployment
 1334 04 48.5S 12 22.3W Commence streaming SAPs 02 string
 1403 All SAPs clamped to wire; continue veering to reqd depth
 1830 04 48.5S 12 22.2W Commence hauling SAPs
 2013 04 49.3S 12 22.4W All SAPs gear recovered; v/l re-positioning for BRIDGET deployment
 2141 04 44.8S 12 24.6W Commence BRIDGET deployment
 2156 Recovering due to technical problems

2358 04 45.7S 12 23.8W Re-deploying

2005-03-17

0320 04 47.9S 12 22.3W Commence hauling BRIDGET
0455 04 48.7S 12 21.8W BRIDGET recovered to deck
0545 04 47.6S 12 23.5W In position for ABE recovery
0600 ABE on surface
0620 04 47.7S 12 23.4W 'Hooked & tagged'
0625 'Cradled'; v/l re-locating for transponder recoveries
0715 04 47.0S 12 22.0W NE transponder recovered
0812 04 47.6S 12 25.2W NW transponder recovered
0835 USBL spar retracted & gate valve closed
0908 04 48.6S 12 23.8W S'ly transponder recovered
0933 04 49.9S 12 22.6W 'Dead' transponder not located; commence Swath run towards
Ascension Island
1118 05 06.0S 12 22.1W A/c to 214 degs (T&G); complete Swath run & science for cruise
1200 05 12.0S 12 31.3W Wind SE 18 knots
1800 06 02.3S 13 06.4W

2005-03-18

0001 06 52.3S 13 41.7W
0600 07 51.0S 14 23.7W
0715 Critical bridge gear tests completed & satisfactory
0718 RSBE; EoP Pyramid Pt brng 147 degs x 1.23 nm
0742 Comm walking back port anchor
0748 Holding on at 5 sh on deck. 'CB' anchorage, Clarence Bay; RFWE.

P. Sarjeant
Master

Appendix B: CD169 Science Log Leg 1

CD169 leg1: science log										Swath/		Plotted Position										Comments		
SHIP										TOBI		(m) Lat											Lon	
Operation	JD	Time	deg min	deg min	Dec.Lat	Dec.Lon	CMG	SMG	Depth	Line	#	W/o	Alt	z(m)	HDG	Dec.Lat	Dec.Lon	L-bck	Jeg.	Min	Lon	Deg	Min	
	048	09:30	16 55.00	25 00.00																				Depart Mindelo
CTD Test	049	10:36	13 35.91	23 00.94	13.599	23.016																		CTD in water
CTD Test	049	10:53	13 35.87	23 01.07	13.598	23.018																		Firing bottles @ 500m
CTD Test	049	11:10	13 35.82	23 01.10	13.597	23.018																		CTD on deck, all bottles fired - probs with Salinity?
Stream Cable	049	10:55	13 35.17	23 00.80	13.586	23.013	147	6.0																Cable in water + 450kg weight
Stream Cable	049		13 11.65	22 45.35	13.194	22.756																		Cable & weight inboard
Start EM12	050	11:32	10 34.21	21 02.20				10.9		01														Begin EM12 mapping nr Sierra Leone Rise
Swath	054	14:14	02 34.20	12 30.00			149	8.2	2884	Transit	14													
Swath	054	14:32	02 36.20	12 28.60			143	8.9	3062	Transit	14													
Swath	054	14:59	02 39.05	12 26.70			149	7.9	3058	Transit	14													
Swath	054	15:29	02 42.40	12 24.20			150	8.0	3046	Transit	14													
Swath	054	16:00	02 45.75	12 21.80			141	7.7	2872	Transit	14													
Swath	054	16:30	02 48.80	12 19.20			142	8.0	2387	Transit	14													
Swath	054	17:00	02 51.90	12 17.00			142	7.9	2608	Transit	14													
Swath	054	17:30	02 55.10	12 14.70			141	8.0	2299	Transit	14													
Swath	054	17:37	02 55.90	12 14.10			142	8.0	2060	Transit	14													
Swath	054	17:41	02 56.50	12 14.00			176	8.2	1787	01	15													End transit, Alter course
Swath	054	18:00	02 59.10	12 13.80			174	8.4	2776	01	15													On course- Line 1
Swath	054	18:30	03 03.40	12 13.50			177	8.5	3500	01	15													
Swath	054	19:00	03 08.00	12 13.10			176	8.7	4020	01	15													
Swath	054	19:30	03 12.32	12 12.90			176	9.1	4058	01	15													
Swath	054	19:36	03 13.40	12 12.80			171	7.7	3932	01, 02	5, 16													WP3: EOL1 & on course SOL2
Swath	054	20:00	03 16.66	12 12.26			172	9.3	3865	02	16													
Swath	054	20:30	03 20.98	12 11.57			171	9.2	3166	02	16													
Swath	054	21:00	03 25.20	12 10.94			173	8.6	3012	02	16													
Swath	054	21:30	03 29.56	12 10.26			178	7.7	3588	02	17													
Swath	054	22:00	03 33.91	12 09.62			175	8.6	3619	02	17													
Swath	054	22:30	03 38.25	12 08.90			169	8.5	3608	02	17													
Swath	054	23:00	03 42.72	12 08.34			171	8.9	3642	02	17													
Swath	054	23:30	03 47.09	12 07.63			171	7.3	3571	02	17													
Swath	054	00:00	03 51.76	12 06.90			174	8.4	3662	02	17													
Swath	055	00:02	03 52.25	12 06.84			183	9.4	3800	03	18													
Swath	055	00:30	03 55.60	12 09.40			225	8.4	4209	03	18													
Swath	055	01:00	03 59.15	12 12.20			223	9.0	4075	03	18													
Swath	055	01:30	04 02.50	12 14.90			217	9.3	4272	03	18													
Swath	055	01:59	04 06.19	12 17.88			189	8.5	3587	03	19													
Swath	055	02:29	04 10.55	12 17.59			175	8.5	3164	04	19													
Swath	055	03:00	04 14.89	12 17.26			175	8.5	3016	04	19													
Swath	055	03:30	04 19.35	12 16.87			175	8.1	3343	04	19													
Swath	055	04:00	04 23.71	12 16.45			175	8.5	3569	04	19													
Swath	055	04:12	04 25.80	12 16.79				8.7	3529		20													
Swath	055	04:16	04 26.07	12 16.79			216	9.0	3418	05	20													
Swath	055	04:30	04 27.49	12 18.16			226	9.5	3387	05	20													
Swath	055	05:00	04 30.79	12 21.26			220	9.0	3392	05	20													
Swath	055	05:30	04 34.04	12 24.39			228	9.0	3572	05	20													
Swath	055	05:50	04 36.55	12 26.80			228	9.0	3430		20													
Swath	055	06:00	04 37.40	12 26.90			166	9.0	3392	06	21													
Swath	055	06:24	04 40.70	12 26.10			150	9.0	3288	07	22													
Swath	055	06:32	04 41.78	12 25.62			152	9.1	3363	07	22													
Swath	055	07:00	04 45.02	12 23.71			151	8.1	3296	07	22													
Swath	055	07:25	04 48.30	12 21.80			165	8.1	2946	08	23													
Swath	055	07:30	04 48.80	12 21.70			165	9.3	2930	08	23													
Swath	055	07:35	04 49.30	12 21.60			195	9.4	2914	09	23													
Swath	055	07:44	04 50.70	12 21.90			180	8.6	3040	10	23													

Appendix B: CD169 Science Log Leg 1

Operation	JD	Time	deg	min	deg	min	Dec.Lat	Dec.Lon	CMG	SMG	Depth	Line	#	W/o	Alt	z(m)	HDG	Dec.Lat	Dec.Lon	L-bck	Deg.	Min	Deg	Min			
Swath	055	08:00	04	52.90	12	21.90			184	7.8	3252	10	23														
Swath	055	08:10	04	54.16	12	22.01			181	7.6	3328	11	23												a/c to 165		
Swath	055	08:30	04	56.70	12	21.45			164	7.6	3444	11	23														
Swath	055	09:00	05	00.41	12	20.40			165	6.8	3345	11	23														
Swath	055	09:30	05	04.12	12	19.46			162	8.1	3311	11	23												END OF SWATH EOL 11		
Swath	055	10:00	05	07.85	12	18.54			168	7.8	3454	11	23												Continue line for TOBI deployment		
Transit	055	10:07																								Underway to TOBI start	
Transit	055	10:20	05	10.50	12	17.80			170	3.5	3658	-													Reducing speed to deploy 10 KHz, 3.5 KHz fish		
TOB-01	055	10:30	05	10.80	12	17.80			170	3.5	3632	-															
TOB-01	055	10:40	05	11.10	12	17.80			174	1.5	3467	-														2 Fish in	
TOB-01	055	11:00	05	11.40	12	17.87			286	1.2	3280	-															
TOB-01	055	11:07																								Bat fish + 1st mapper in (M12)	
TOB-01	055	11:13																								2nd mapper in (M13)	
TOB-01	055	11:20																								3rd mapper in (M6)	
TOB-01	055	11:28																								4th mapper in (M29)	
TOB-01	055	11:50																								TOBI in th water	
TOB-01	055	12:10																								TOBI electronics ok - ready to deploy	
TOB-01	055	12:20																								Bomb in water	
TOB-01	055	12:23																								5th mapper in (at 0m W/O)	
TOB-01	055	12:26																								6th mapper in (at 50m W/O)	
TOB-01	055	12:34	05	12.27	12	17.98			151	1.0																	
TOB-01	055	12:36	05	12.33	12	17.93																					
TOB-01	055	12:56	05	12.00	12	17.52	5.200	12.292	351	3.7	3281			300	217	357	5.203	12.292	379						Commencing turn at 10 degrees per minute		
TOB-01	055	13:00	05	11.83	12	17.54	5.197	12.292	337	2.2	3300			462	231	349	5.202	12.291	590							TOBI deployed - on course	
TOB-01	055	13:27	05	10.50	12	17.63	5.175	12.294	359	2.8	3675			1661	801	355	5.190	12.293	1645								
TOB-01	055	14:00	05	09.12	12	17.76	5.152	12.296	356	2.7	3662			2795	1282	348	5.176	12.291	2674								
TOB-01	055	14:29	05	08.10	12	17.90	5.135	12.298	347	3.0	3293			3953	2144	359	5.167	12.298	3511	5	10.00	12	17.05				
TOB-01	055	14:48	05	07.43	12	18.05	5.124	12.301	331	1.9	3517														Reduced W/O to 20m/min		
TOB-01	055	14:55												4837												Stop winch	
TOB-01	055	15:01	05	07.05	12	18.15	5.118	12.303	337	2.0	3554			4837	2789	352	5.155	12.297	4142	5	9.40	12	17.45				
TOB-01	055	15:20	05	06.23	12	18.19	5.104	12.303	347	2.0	3501			4837	2637	351	5.142	12.297	4245							TOBI 800m of bottom - sol 12	
TOB-01	055	15:30	05	06.01	12	18.24	5.100	12.304	350	2.0	3548			4836	850	2632	351	5.138	12.298	4247	5	8.30	12	17.80			
TOB-01	055	16:00	05	05.01	12	18.51	5.084	12.309	000	2.8	3607			4835	765	2643	354	5.122	12.304	4239	5	7.40	12	17.90			At WP 9
TOB-01	055	16:30	05	04.02	12	18.79	5.067	12.313	357	1.9	3452	12		5050	738	2786	354	5.107	12.309	4402	5	6.45	12	18.20			
TOB-01	055	17:00	05	03.09	12	19.04	5.052	12.317	338	2.0	3425	12		5200	449	2944	350	5.092	12.310	4476	5	5.50	12	18.45			
TOB-01	055	17:30	05	02.17	12	19.31	5.036	12.322	343	2.3	3479	12		5158	447	3428	353	5.073	12.317	4044	5	4.55	12	18.80			
TOB-01	055	18:00	05	01.27	12	19.54	5.021	12.326	351	1.7	3534	12		5117	323	3405	353	5.057	12.321	4010	5	3.50	12	19.00			
TOB-01	055	18:30	05	00.28	12	19.79	5.005	12.330	349	1.9	3615	12		5074	438	3516	354	5.039	12.326	3848	5	2.40	12	19.30			
TOB-01	055	18:45	04				4.000																			TOBI glitch, rebooted successfully at 18:55	
TOB-01	055	19:00	04	59.31	12	20.11	4.989	12.335	334	1.8	3454	12		5146	455	3469	354	5.032	12.331	3991	5	1.50	12	19.60			
TOB-01	055	19:30	04	58.29	12	20.38	4.972	12.340	345	1.9	3575	12		5353	492	3135	350	5.012	12.333	4529	5	0.80	12	19.75			
TOB-01	055	20:00	04	57.35	12	20.67	4.956	12.345	347	1.9	3466	12		5474	439	3033	350	4.998	12.337	4747	5	0.00	12	19.90			
TOB-01	055	20:30	04	56.36	12	20.94	4.939	12.349	357	2.2	3552	12		5522	390	3088	348	4.982	12.340	4768	4	58.80	12	20.20			
TOB-01	055	21:00	04	55.44	12	21.20	4.924	12.353	339	2.1	3512	12		5523	369	3122	346	4.966	12.343	4746	4	57.85	12	20.35			
TOB-01	055	21:05												5523													
TOB-01	055	21:11												5446	374											Haul 10m/m	
TOB-01	055	21:30	04	54.51	12	21.47	4.909	12.358	338	1.9	3380	12		5446	386	3118	345	4.949	12.347	4655	4	57.25	12	20.60			Winch stopped
TOB-01	055	21:37												5446													
TOB-01	055	21:50												5321	400											Haul10m/m	
TOB-01	055	22:00	04	53.67	12	21.71	4.895	12.362	334	1.6	3290	12		5321	406	3082	344	4.934	12.350	4528	4	56.00	12	21.00			Winch stopped
TOB-01	055	22:15												5240													
TOB-01	055	22:22												5240													Increase haul to 15 m/m
TOB-01	055	22:30	04	52.83	12	21.93	4.881	12.366	336	2.2	3284	12		5158	303	3061	345	4.919	12.355	4342	4	55.00	12	21.20			
TOB-01	055	22:55												4743	481												
TOB-01	055	23:00	04	51.82	12	22.20	4.864	12.370	354	2.2	3131	12		4743	521	2781	351	4.900	12.364	4032	4	54.00	12	21.60			Winch stopped
TOB-01	055	23:30	04	50.90	12	22.46	4.848	12.374	338	1.9	3106	12		4744	580	2691	349	4.885	12.367	4097	4	53.20	12	21.80			Veer 5m/m, Increase veer to 10m/m

CD169 leg1: science log

SHIP Latitude (S) Longitude (W)

Swath/

TOBI

Appendix B: CD169 Science Log Leg 1

TOB-01	055	23:59	04	49.89	12	22.73	4.832	12.379	326	1.3	3015	12	4962	467	2706	350	4.870	12.372	4349	4	52.00	12	22.05	Winch stopped	
TOB-01	056	00:30	04	48.89	12	23.04	4.815	12.384	356	1.8	2964	12	4910	352	2677	349	4.853	12.376	4306	4	51.20	12	22.50	WP10 passed	
TOB-01	056	01:00	04	47.87	12	23.23	4.798	12.387	333	1.8	2994	13	4889	350	2659	347	4.836	12.378	4293	4	50.05	12	23.00		
TOB-01	056	01:03											4889												Haul 5m/min
TOB-01	056	01:14																							TOBI CTD locked out
TOB-01	056	01:22																							Winch stopped
TOB-01	056	01:30	04	46.86	12	23.39	4.781	12.390	334	2.0	3129	13	4707			347	4.816	12.382	3894	4	48.85	12	22.85	! No TOBI altitude. Layback est'd from past values	
TOB-01	056	02:00	04	45.85	12	23.60	4.764	12.393	344	2.0	3070	13	4706			354	4.799	12.390	3893	4	47.75	12	23.40	! No TOBI altitude. Layback est'd from past values	
TOB-01	056	02:30	04	44.84	12	23.77	4.747	12.396	338	2.0	3220	13	4705			353	4.782	12.392	3892	4	46.80	12	23.40	! No TOBI altitude. Layback est'd from past values	
TOB-01	056	02:45											4705												start veering at 8m/sec
TOB-01	056	02:57											4802												Winch stopped
TOB-01	056	03:00	04	43.86	12	23.97	4.731	12.400	333	2.3	3251	13	4802			355	#####	#####			4	46.00	12	23.55	! No TOBI altitude. Layback est'd from past values
TOB-01	056	03:10																							nephel 0.038
TOB-01	056	03:30	04	42.68	12	24.16	4.711	12.403	347	2.5	3300	13	4964	475	2640	356	4.751	12.400	4394	4	45.00	12	24.00		
TOB-01	056	04:00	04	41.54	12	24.40	4.692	12.407	329	2.5	3427	13	5458	355	2875	425	4.711	12.446	4829	4	44.10	12	23.95	Pay out @ 8	
TOB-01	056	04:30	04	40.44	12	24.59	4.674	12.410	357	1.7	3528	13	5597	433	2887	354	4.719	12.405	4985	4	43.15	12	24.20	veer @ 7	
TOB-01	056	05:00	04	39.37	12	24.78	4.656	12.413	355	1.9	3583	13	5788	357	3029	356	4.703	12.410	5122	4	41.90	12	24.45		
TOB-01	056	05:30	04	38.31	12	25.00	4.639	12.417	335	2.1	3627	13	5787	367	3039	357	4.685	12.414	5115	4	41.20	12	24.40		
TOB-01	056	06:00	04	37.26	12	25.20	4.621	12.420	357	1.8	3648	13	5791	421	3057	355	4.667	12.416	5108	4	40.50	12	24.50	Veer @ 8	
TOB-01	056	06:18	04	36.61	12	25.31	4.610	12.422	326	2.4	3620	13												turn to WP started: 1°/min. Should take 1 hr to WP.	
TOB-01	056	06:30	04	36.24	12	25.33	4.604	12.422	347	2.1	3650	13	5748	347	3095	355	4.650	12.418	5034	4	39.20	12	24.60	Haul @ 15. WP11 eol.	
TOB-01	056	07:00	04	35.37	12	24.94	4.590	12.416	031	1.0	3521		5695	397	3172	357	4.634	12.413	4920	4	38.10	12	24.80	Turning	
TOB-01	056	07:30	04	34.60	12	24.32	4.577	12.405	031	2.3	3727	14	5648	415	3203	9.4	4.620	12.413	4842	4	36.85	12	24.95	o/c on line 1, veer @ 8	
TOB-01	056	07:39											5648												Winch haul @ 10
TOB-01	056	07:42											5635												Winchstop
TOB-01	056	07:47											5636												Veer @ 8
TOB-01	056	08:00	04	33.79	12	23.48	4.563	12.391	054	2.9	3751	14	5761	460	3133	28.1	4.603	12.413	5025	4	35.90	12	25.50		
TOB-01	056	08:30	04	33.08	12	22.69	4.551	12.378	051	2.6	3671	14	6020	417	3167	39.3	4.589	12.409	5310	4	35.10	12	25.00	NB "PlottedPos" = estimated TOBI posn from map	
TOB-01	056	09:00	04	32.32	12	21.85	4.539	12.364	050	2.3	3470	14	6400	421	3232	44	4.576	12.400	5714	4	34.40	12	24.10	winch stopped	
TOB-01	056	09:30	04	31.54	12	20.98	4.526	12.350	049	3.0	3393	14	6401	544	3146	47	4.561	12.388	5765	4	33.60	12	24.40		
TOB-01	056	10:00	04	30.73	12	20.04	4.512	12.334	066	2.0	3395	14	6401	523	3025	51.2	4.545	12.375	5831	4	32.90	12	23.10		
TOB-01	056	10:30	04	29.89	12	19.12	4.498	12.319	058	3.1	3455	14	6401	377	2984	53.2	4.530	12.361	5853	4	32.00	12	21.80		
TOB-01	056	11:00	04	29.11	12	18.24	4.485	12.304	058	2.0	3242	14	6401	367	2954	53.3	4.517	12.347	5869	4	31.20	12	20.15		
TOB-01	056	11:30	04	28.25	12	17.28	4.471	12.288	043	3.0	3335	14	6402	506	2943	52.9	4.503	12.331	5875	4	30.20	12	19.50		
TOB-01	056	11:51																							Start turn for WP13 (bridge late informing)
TOB-01	056	11:57	04	27.41	12	16.40	4.457	12.273	038	2.0	3234	14	6402	326	2917	53	4.489	12.316	5889	4	29.60	12	18.75	Haul at 5m/min	
TOB-01	056	12:00											6389												Increase haul to 10m/min
TOB-01	056	12:05											6339												Winch stopped
TOB-01	056	12:25											6339												Veering 5m/min
TOB-01	056	12:30	04	26.04	12	15.97	4.434	12.266	344	2.8	3331	14	6372	567	2871	51.5	4.467	12.308	5879	4	28.80	12	17.50		
TOB-01	056	12:32											6374												Stopped winch
TOB-01	056	12:46											6374												Haul at 5m/min
TOB-01	056	12:51											6354												Stopped winch
TOB-01	056	13:00	04	24.78	12	16.09	4.413	12.268	355	3.2	3450	14	6354	367	2938	38.7	4.454	12.301	5824	4	27.70	12	16.80		
TOB-01	056	13:30	04	23.42	12	16.28	4.390	12.271	359	2.5	3450	14	6354	422	2840	17.8	4.441	12.288	5874	4	26.55	12	16.00		
TOB-01	056	13:38																							Veering 10m/min
TOB-01	056	14:00	04	22.08	12	16.45	4.368	12.274	357	2.8	3565	14	6643	600	2888	5.8	4.424	12.280	6172	4	25.40	12	15.80		
TOB-01	056	14:19																							Winch stopped
TOB-01	056	14:30	04	20.83	12	16.64	4.347	12.277	352	2.5	3474	14	###	6956	379	3050	359	4.406	12.276	6442	4	24.60	12	16.20	
TOB-01	056	15:00	04	19.58	12	16.79	4.326	12.280	354	2.6	3300	14	###	6956	420	3065	359	4.385	12.279	6434	4	23.10	12	16.30	
TOB-01	056	15:22											00	6956											Haul at 10m/min
TOB-01	056	15:30	04	18.32	12	16.99	4.305	12.283	350	2.5	3200	14	###	6871	440	3053	358	4.363	12.281	6345	4	21.80	12	16.45	still hauling at 10m/min.
TOB-01	056	16:00	04	16.96	12	17.17	4.283	12.286	356	2.5	3153	14	###	6721	371	2966	358	4.339	12.284	6221	4	20.50	12	16.80	
TOB-01	056	16:04	04				4.000						6721												Haul @ 5
TOB-01	056	16:14																							Haul @ 10
TOB-01	056	16:16																							Haul @ 15.
TOB-01	056	16:30	04	15.68	12	17.30	4.261	12.288	000	2.8	3096	14	6459	355	2865	355	4.315	12.284	5979	4	19.25	12	16.50		

CD169 leg1: science log

Swath/

Plotted Position

Operation	JD	Time	deg	min	deg	min	Dec.Lat	Dec.Lon	CMG	SMG	Depth	Line	#	TOBI	W/o	Alt	z(m)	HDG	Dec.Lat	Dec.Lon	(m)	Lat	Lon	Comments	
TOB-01	056	16:32													6459									haul @ 20	
TOB-01	056	16:56																						Haul at 10m/min	
TOB-01	056	17:00	04	14.40	12	17.30	4.240	12.288	357	2.7	2954	15		5933	395	2675	356	4.290	12.285	5486	4	17.40	12	16.80	Stop winch

Appendix B: CD169 Science Log Leg 1

CD169 leg1: science log																	Swath/		Plotted Position										Comments
SHIP																	TOBI		(m)										
Operation	JD	Time	deg min	deg min	Dec.Lat	Dec.Lon	CMG	SMG	Depth	Line	#	W/o	Alt	z(m)	HDG	Dec.Lat	Dec.Lon	L-bck	deg	Min	Lon	Deg	Min						
TOB-01	056	17:05																						Haul at 10m/min					
TOB-01	056	17:06																						Haul at 20m/min					
TOB-01	056	17:15																						Haul at 10m/min					
TOB-01	056	17:30	04	13.31	12	17.31	4.222	12.289	040	1.7	2952	15																	
TOB-01	056	17:31																						winch stopped					
TOB-01	056	17:34																						Haul at 10m/min					
TOB-01	056	17:38																						Haul at 15m/min					
TOB-01	056	17:42									2914													winch stopped					
TOB-01	056	17:50									2899													Veer at 10					
TOB-01	056	17:53									2897													winch stopped					
TOB-01	056	18:00	04	12.00	12	17.30	4.200	12.288	000	2.0	2925													Haul at 10m/min					
TOB-01	056	18:21									3060													Haul at 5m/min					
TOB-01	056	18:24									3094													winch stopped					
TOB-01	056	18:28									3108													veer 10m/min					
TOB-01	056	18:30	04	10.77	12	17.31	4.180	12.289	001	2.4	3128	15												veer 15m/min					
TOB-01	056	18:33									3128													Stopped winch					
TOB-01	056	18:46									3118													Veer 10m/min					
TOB-01	056	18:58									3207													Stopped winch					
TOB-01	056	19:00	04	09.47	12	17.27	4.158	12.288	356	1.7	3214	15												veer 10m/min					
TOB-01	056	19:11	04				4.000				3324	15												veer 15m/min					
TOB-01	056	19:15									3399														Chris changed time delay to 4.5sec on 3.5KHz				
TOB-01	056	19:20																											
TOB-01	056	19:30	04	08.23	12	17.28	4.137	12.288	358	2.3	3470	15												5746 440 2584 2.4 4.186 12.290 5322 4 10.50 12 17.05					
TOB-01	056	19:45									3574														Winch stopped				
TOB-01	056	20:00	04	06.95	12	17.22	4.116	12.287	346	2.9	3631	15												5979 363 2657 1.3 4.166 12.288 5546					
TOB-01	056	20:09																							veer 15m/min				
TOB-01	056	20:17	04	06.22	12	17.27	4.104	12.288	351	2.2	3697	15												start turn at w/p 14					
TOB-01	056	20:30	04	05.81	12	17.18	4.097	12.286	050	1.7	3738	15												veer reduce to 10m/m					
TOB-01	056	20:32																							Winch stopped				
TOB-01	056	20:47																							veer 10m/min				
TOB-01	056	21:00	04	04.89	12	16.58	4.082	12.276	039	2.5	3801	15												6430 412 3067 2.5 4.135 12.279 5841 4 8.00 12 17.00					
TOB-01	056	21:07	04	04.67	12	16.41	4.078	12.274	033	2.2	3895	16													6511 343 3146 4.5 4.131 12.278 5891				
TOB-01	056	21:20																							Winch stopped				
TOB-01	056	21:30	04	03.99	12	15.91	4.067	12.265	052	2.4	4105	16													6631 302 3264 13.4 4.119 12.278 5962 4 7.30 12 16.80				
TOB-01	056	21:52																							veer 10m/min				
TOB-01	056	22:00	04	03.05	12	15.18	4.051	12.253	052	2.6	4222	16													6714 406 3249 26.5 4.100 12.278 6066 4 6.20 12 16.80				
TOB-01	056	22:16																							Winch stopped				
TOB-01	056	22:30	04	02.18	12	14.48	4.036	12.241	055	3.4	4231	16													6879 396 3325 33.1 4.084 12.272 6212 4 5.00 12 16.20				
TOB-01	056	22:32																							Veer 10m/m				
TOB-01	056	22:50																							Increase veer to 15m/m				
TOB-01	056	23:00	04	01.22	12	13.72	4.020	12.229	056	3.0	4208	16													7203 637 3446 36.4 4.068 12.264 6515 4 4.40 12 16.00				
TOB-01	056	23:15																							Decrease veer to 10m/m				
TOB-01	056	23:18																							Winch stopped				
TOB-01	056	23:24																							Veer 10m/m				
TOB-01	056	23:30	04	00.33	12	13.01	4.006	12.217	036	2.5	4272	16													7522 495 3653 39.8 4.053 12.256 6765 4 3.20 12 15.50				
TOB-01	056	23:50																							Winch stopped				
TOB-01	057	00:00	03	59.54	12	12.39	3.992	12.207	036	1.8	4311	16													7692 377 3809 41.3 4.039 12.248 6873 4 2.50 12 14.70				
TOB-01	057	00:26																							Hauling @ 20 m/min				
TOB-01	057	00:28																							On board computer crashed				
TOB-01	057	00:30	03	58.61	12	11.68	3.977	12.195	047	2.2	4193	16													CTD gone, Reboot - All bad: short in umbilical?				
TOB-01	057	00:38																							Hauling for recovery @ 25 m/min. ETA 5AM				
TOB-01	057	02:55	03	56.02	12	09.70	3.934	12.162	035	2.3	4310														5428 3.969 12.186 4709				
TOB-01	057	03:06	03	53.82	12	08.38	3.897	12.140	012	23.0	4164														3660 3.897 12.140				
TOB-01	057	04:00	03	52.39	12	07.52	3.873	12.125	042	1.9	3982														2358				
TOB-01	057	04:39	03	51.57	12	06.60	3.860	12.110	087	1.1	3582														1340				

Appendix B: CD169 Science Log Leg 1

Operation	JD	Time	deg min	deg min	Dec.Lat	Dec.Lon	CMG	SMG	Depth	Line	#	W/o	Alt	z(m)	HDG	Dec.Lat	Dec.Lon	L-bck	deg. Min	Lon	Deg Min	Comments	
TOB-01	057	07:13																					6th MAPR inboard (M9)
TOB-01	057	07:19																					5th MAPR inboard (M8)
TOB-01	057	07:22																					Depressor weight on deck
TOB-01	057	07:35	03	56.30	12 04.70	3.938	12.078	180	1.7	3458													TOBI on deck
TOB-01	057	07:48	03	56.30	12 08.84	3.938	12.147	264	0.5	3466													4th MAPR inboard (M29)
TOB-01	057	08:00	03	56.35	12 04.89	3.939	12.082	222															3rd MAPR inboard (M6)
TOB-01	057	08:03																					2nd MAPR inboard (M13)
TOB-01	057	08:07																					1st MAPR and BAT fish inboard (M12)
TOB-01	057	08:11																					
Transit	057	08:25	03	57.17	12 05.64	3.953	12.094	234	10.0														transit to CTD station (2 knots until TOBI is tied up)
Transit	057	09:00	04	00.68	12 10.62	4.011	12.177	233	12.0	3980													Transit to CTD position (speed up to 9 knots)
Transit	057	09:30	04	03.98	12 15.52	4.066	12.259	240	11.2	4049													Transit to CTD position
Transit	057	09:39	04	04.47	12 16.01	4.075	12.267																Slowing down
CTD-01	057	09:42	04	04.52	12 16.06	4.075	12.268	281		3910													On station
CTD-01	057	09:54	04	04.60	12 16.18	4.077	12.270	189	0.6	4005													CTD in water
CTD-01	057	10:30	04	04.61	12 16.22	4.077	12.270	232	0.5			1680											Not picking up bottom on bathymetry screen.
CTD-01	057	11:00	04	04.57	12 16.18	4.076	12.270	133	0.2			3382											
CTD-01	057	11:01	04	04.58	12 16.18	4.076	12.270	186	0.2			3384	3500										Small particle peak. Red = CTD in Db not TOBI in m.
CTD-01	057	11:08	04	04.60	12 16.19	4.077	12.270			4858		3726	3800										On Bottom- Bottle 1
CTD-01	057	11:15	04	04.60	12 16.19	4.077	12.270	165	0.2	4858													Winch up 100m
CTD-01	057	11:19	04	04.61	12 16.19	4.077	12.270	002	0.6	4858		3627	3700										Bottle 2
CTD-01	057	11:24	04	04.60	12 16.21	4.077	12.270	321	0.5			3530	3600										Bottle 3
CTD-01	057	11:28	04	04.60	12 16.21	4.077	12.270	146	0.7			3481	3550										Bottle 4
CTD-01	057	11:31	04	04.62	12 16.20	4.077	12.270	114	0.2			3458	3525										Bottle 5
CTD-01	057	11:34	04	04.63	12 16.20	4.077	12.270	141	0.6			3432	3500										Bottle 6
CTD-01	057	11:39	04	04.64	12 16.20	4.077	12.270	251	0.1			3408	3475										Bottle 7
CTD-01	057	11:42	04	04.64	12 16.20	4.077	12.270	064	0.0			3383	3450										Bottle 8
CTD-01	057	11:46	04	04.64	12 16.21	4.077	12.270	072	0.7			3335	3400										Bottle 9
CTD-01	057	11:50	04	04.63	12 16.21	4.077	12.270	357	0.4			3237	3300										Bottle 10
CTD-01	057	11:54	04	04.63	12 16.22	4.077	12.270	344	0.4			3140	3200										Bottle 11
CTD-01	057	12:00	04	04.62	12 16.23	4.077	12.271	184	0.3			2945	3000										Bottle 12
CTD-01	057	12:08	04	04.65	12 16.23	4.078	12.271	194	0.1			2700	2750										Bottle 13
CTD-01	057	12:17	04	04.70	12 16.23	4.078	12.271	101	0.7			2457	2500										Bottle 14
CTD-01	057	12:25	04	04.69	12 16.26	4.078	12.271		1.1			2204	2250										Bottle 15
CTD-01	057	12:35	04	04.66	12 12.27	4.078	12.205		0.2			1970	2003										Bottles 16-24
CTD-01	057	13:15	04	04.81	12 16.29	4.080	12.272																CTD on deck
CTD-01	057	13:53	04	05.15	12 16.40	4.086	12.273																
TOBI TEST	057	13:53	04	05.10	12 16.40	4.085	12.273																hove to
TOBI TEST	057	14:08	04	05.50	12 16.40	4.092	12.273																umbilical streaming test
Transit	057	14:28	04			4.000																	SAPS weight in water
Transit	057	15:02	04	10.80	12 17.50	4.180	12.292	198	4.9	4076													test end
RC-01	057	15:10	04	11.10	12 17.40	4.185	12.290			3055													On station RC01.Hove to.s
RC-01	057	16:02	04	11.10	12 17.40	4.185	12.290			3055													
RC-01	057	16:05						300	1.5														Chipper in water
RC-01	057	16:10	04	11.10	12 17.50	4.185	12.292																MAPR in water
RC-01	057	16:30	04	11.11	12 17.70	4.185	12.295																
RC-01	057	17:10	04	11.31	12 18.05	4.189	12.301			3131		3235											Chipper on bottom. Start recovery
RC-01	057	17:52	04			4.000																	Stop recovery. Winch problem.
CD169 leg1: science log																							
SHIP												Swath/ TOBI				Plotted Position							
			Latitude (S)		Longitude (W)				TOBI		(m)		Lat		Lon						Comments		
Operation	JD	Time	deg min	deg min	Dec.Lat	Dec.Lon	CMG	SMG	Depth	Line	#	W/o	Alt	z(m)	HDG	Dec.Lat	Dec.Lon	L-bck	deg. Min	Lon	Deg Min	Comments	
RC-01	057	18:05	04	11.70	12 18.40	4.195	12.307		3142			1215										Restart winch. Continue recovery	
RC-01	057	18:25	04	11.70	12 18.50	4.195	12.008															MAPR on deck	
RC-01	057	18:30	04	11.65	12 18.56	4.194	12.309	272	1.1	3111												RC01 on deck	
Transit	057	18:32																					Transit to RC02
Transit	057	19:25	04	08.90	12 17.40	4.148	12.290	019	8.9	3387													
Transit	057	20:00	04	05.43	12 19.26	4.091	12.321	287	8.4	3659													

Appendix B: CD169 Science Log Leg 1

TOB-02	058	23:30	03	52.55	12	07.59	3.876	12.127	053	2.2	3993	18	7733	450	3828	38.9	3.925	12.166	6909	3	55.90	12	9.80	Haul 10m/m		
TOB-02	058	23:36											7654												Increase haul to 15m/m	
TOB-02	058	23:50	03	51.93	12	07.21	3.866	12.120	055	2.5	3888	18	7446												A/C for W/P 16	
TOB-02	059	00:00	03	51.59	12	07.06	3.860	12.118	033	2.6	3806	19	7260	399	3624	37	3.907	12.153	6481	3	54.70	12	8.90			
TOB-02	059	00:12									4216		7033												reduce to 10m/min	
TOB-02	059	00:15	03	50.93	12	07.98	3.849	12.133	350	2.5	4206		7013	610	3483	36.7	3.895	12.167	6277	3	53.68	12	10.03		stop hauling	
TOB-02	059	00:29	03	50.42	12	07.06	3.840	12.118	337	2.4	3601	19	7013	526	3509	35.9	3.886	12.151	6262	3	53.70	12	8.30			
TOB-02	059	00:35											7013												Haul 10 m/min	
TOB-02	059	00:40											6941												Haul 20 m/min	
TOB-02	059	00:50											6728												stop hauling	
TOB-02	059	01:00	03	49.20	12	07.23	3.820	12.121	354	2.5	3300	19	6728	563	3338	26	3.869	12.145	6032	3	52.50	12	7.80			
TOB-02	059	01:15											6728													Veer at 10 m/min
TOB-02	059	01:25											6821													
TOB-02	059	01:29	03	48.03	12	07.42	3.801	12.124	345	2.4	3548	19	6821	510	3308	11.6	3.855	12.135	6155	3	41.30	12	7.30			
TOB-02	059	01:39											6821													Haul 10 m/min
TOB-02	059	02:00	03	46.81	12	07.61	3.780	12.127	347	2.0	3556	19	6631	516	3103	1.4	3.835	12.128	6050	3	50.10	12	7.00			
TOB-02	059	02:08											6555													Winch stopped
TOB-02	059	02:30	03	45.57	12	07.80	3.760	12.130	330	2.5	3380	19	6555	480	3004	358	3.814	12.128	6016	3	48.80	12	7.10			
TOB-02	059	02:51											6555													Veering at 10m/min
TOB-02	059	03:00	03	44.37	12	07.97	3.740	12.133	347	2.2	3545	19	6645	429	3014	358	3.795	12.131	6112	3	47.80	12	7.40			
TOB-02	059	03:02											6661													Stopped winch
TOB-02	059	03:14											6661													Veering at 10m/min
TOB-02	059	03:30	03	43.01	12	08.18	3.717	12.136	351	2.5	3490	19	6830	504	3024	358	3.774	12.134	6314	3	46.30	12	7.70			
TOB-02	059	03:31											6835													Veering at 20 m/min
TOB-02	059	03:42											7068													Stopped winch
TOB-02	059	03:45											7068													Hauling @ 15 m/min
TOB-02	059	03:46											7050													Increase hauling to 25 m/min
TOB-02	059	03:58	03		12		3.000	12.000					6806													Stopped winch
TOB-02	059	04:00	03	41.71	12	08.40	3.695	12.140	001	2.5	3500	19	6806	500	2981	356	3.752	12.136	6308	3	45.00	12	8.00			
TOB-02	059	04:04											6827	564	2980	358	#####	#####	6332							veer 15m/min
TOB-02	059	04:26											7163													winch stopped
TOB-02	059	04:30	03	40.44	12	08.55	3.674	12.143	355	2.8	3500	19	7164	479	3130	358	3.734	12.140	6634	3	43.90	12	8.25			
TOB-02	059	04:48											7164													Engine speed dropped 5rpm
TOB-02	059	04:56											7164	460												haul at 5m/min
TOB-02	059	05:00	03	39.32	12	08.80	3.655	12.147	332	1.2	3542	19	7147	450	3189	359	3.715	12.146	6586	3	42.90	12	8.30			
TOB-02	059	05:02											7139													haul at 15m/min
TOB-02	059	05:03											7123													Haul at 20m/min, engine speed back up by 5 rpm
TOB-02	059	05:09											7000													haul at 25m/min
TOB-02	059	05:12											6917													Haul at 10m/min
TOB-02	059	05:14											6894													winch stopped
TOB-02	059	05:30	03	38.14	12	08.91	3.636	12.149	328	2.2	3530	19	6894	394	3186	394	3.683	12.181	6304	3	41.80	12	8.20			
TOB-02	059	05:46											6894													haul 20m/min
TOB-02	059	05:47											6880													
TOB-02	059	05:55											6687													Iss>0.038, haul 10m/min
TOB-02	059	05:58											6677													winch stopped
TOB-02	059	06:00	03	36.89	12	09.14	3.615	12.152	252	2.2	3598	19	6677	406	3088	359	3.670	12.151	6110	3	40.50	12	8.25			
TOB-02	059	06:12											6677													haul 10

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Swath/

Plotted Position

Operation	SHIP		Latitude (S)		Longitude (W)		Dec.Lat	Dec.Lon	CMG	SMG	Depth	Line	#	TOBI		Plotted Position (m)						Comments				
	JD	Time	deg	min	deg	min								W/o	Alt	z(m)	HDG	Dec.Lat	Dec.Lon	L-bck	deg		Min	Lon	deg	Min
TOB-02	059	06:15														6651										winch stopped
TOB-02	059	06:24														6651										veer 10m/min
TOB-02	059	06:28														6695										veer 15m/min
TOB-02	059	06:31	03	35.54	12	09.27	3.592	12.155	017	2.9	3566	19	6738	508	3046	359	3.649	12.154	6200	3	39.25	12	8.80			
TOB-02	059	06:35											6797													At WP 17, winch stopped
TOB-02	059	06:58											6797													haul 15m/min
TOB-02	059	07:00	03	34.41	12	09.23	3.574	12.154	005	1.8	3515	20	6782	293	3138	0.6	3.630	12.154	6202	3	38.00	12	8.75			
TOB-02	059	07:04											6697													haul 20m/min
TOB-02	059	07:13											6483													haul 25m/min
TOB-02	059	07:27											6483													Winch stopped
TOB-02	059	07:30	03	33.31	12	09.18	3.555	12.153	013	2.2	3611	20	6443	291	3106	4.4	3.608	12.157	5835	3	38.20	12	8.30			
TOB-02	059	07:32											6438													haul 15m/min
TOB-02	059	07:45											6231													winch stopped

Appendix B: CD169 Science Log Leg 1

TOB-03	061	15:30	06	01.96	11	27.69	6.033	11.462	150	1.8	3047	27	5092	511	2594	169	5.992	11.469	4572	5	59.50	11	28.20	
TOB-03	061	16:00	06	03.14	11	27.35	6.052	11.456	162	2.3	2950	27	5093	442	2581	164	6.012	11.467	4581	6	1.00	11	27.85	
TOB-03	061	16:11											5093											haul 10m/min
TOB-03	061	16:22											4987											winch stopped
TOB-03	061	16:30	06	04.15	11	27.03	6.069	11.451	164	1.8	2963	27	4987	405	2591	171	6.029	11.457	4451	6	1.85	11	27.50	
TOB-03	061	16:45											4986											haul 10m/min
TOB-03	061	17:00	06	05.21	11	26.65	6.087	11.444	170	2.2	2964	27	4852	396	2551	169	6.048	11.452	4317	6	3.00	11	27.20	
TOB-03	061	17:13											4852											veer 10m/min
TOB-03	061	17:26											4957											winch stopped
TOB-03	061	17:30	06	06.32	11	26.27	6.105	11.438	158	2.6	3001	27	4958	411	2551	166	6.066	11.448	4441	6	3.70	11	26.70	
TOB-03	061	17:44											4957											haul 15m/min
TOB-03	061	18:00	06	07.44	11	25.91	6.124	11.432	160	2.3	3043	27	4736	406	2410	162	6.087	11.444	4267	6	5.20	11	26.50	Stop winch
TOB-03	061	18:23											4736											veer 10m/min
TOB-03	061	18:30	06	08.55	11	25.55	6.143	11.426	160	3.2	3070	27	4790	488	2420	165	6.105	11.436	4324	6	5.90	11	26.25	veer 15m/min
TOB-03	061	18:39											4923											winch stopped
TOB-03	061	19:00	06	09.67	11	25.20	6.161	11.420	167	2.7	3254	27	4923	440	2463	168	6.122	11.429	4453	6	7.10	11	25.95	
TOB-03	061	19:26											4923											veer 15m/min
TOB-03	061	19:30	06	10.84	11	24.83	6.181	11.414	166	3.4	3232	27	4988	553	2445	170	6.140	11.421	4538	6	8.60	11	25.55	
TOB-03	061	20:00	06	11.98	11	24.47	6.200	11.408	150	2.8	3364	27	5440	465	2638	171	6.155	11.415	4948	6	9.50	11	25.15	
TOB-03	061	20:21											5741											winch stopped
TOB-03	061	20:30	06	13.12	11	24.09	6.219	11.402	150	2.1	3070	27	5741	428	2759	169	6.172	11.411	5225	6	10.30	11	24.70	
TOB-03	061	21:00	06	14.16	11	23.78	6.236	11.396	156	1.5	3254	27	5739	417	2788	171	6.189	11.404	5206	6	11.30	11	24.60	
TOB-03	061	21:20											5739											Haul 10 m/min
TOB-03	061	21:30	06	15.30	11	23.36	6.255	11.389	158	1.8	3321	27	5624	289	2782	168	6.210	11.399	5078	6	12.70	11	24.30	
TOB-03	061	22:00	06	16.44	11	23.03	6.274	11.384	167	2.0	3293	27	5464	452	2676	168	6.230	11.393	4954	6	13.90	11	23.80	
TOB-03	061	22:05											5464											Veer 10 m/m
TOB-03	061	22:30	06	17.54	11	22.70	6.292	11.378	168	2.5	3342	27	5724	461	2777	168	6.246	11.388	5195	6	14.90	11	23.50	
TOB-03	061	22:40											5831											winch stopped
TOB-03	061	23:00	06	18.59	11	22.36	6.310	11.373	157	2.8	3472	27	5832	245	2905	172	6.263	11.379	5247	6	15.80	11	23.20	
TOB-03	061	23:05											5832											haul 15m/min
TOB-03	061	23:13											5714											decrease haul 10 m/m
TOB-03	061	23:19											5658											winch stopped
TOB-03	061	23:30	06	19.68	11	21.96	6.328	11.366	160	2.0	3355	27	5658	441	2838	170	6.282	11.374	5085	6	17.20	11	23.00	
TOB-03	062	00:00	06	20.78	11	21.64	6.346	11.361	173	2.6	3361	27	5803	397	2904	172	6.299	11.367	5214	6	18.00	11	22.80	
TOB-03	062	00:30	06	21.86	11	21.29	6.364	11.355	158	2.6	3564	27	5802	355	2950	172	6.318	11.361	5186	6	18.90	11	22.20	
TOB-03	062	01:00	06	22.85	11	20.98	6.381	11.350	155	1.7	3546	27	5801	431	2989	167	6.335	11.360	5162	6	20.10	11	21.80	
TOB-03	062	01:17											5801											haul at 25 m/min

CD169 leg1: science log

Operation	JD	Time	SHIP		Latitude (S)		Longitude (W)		Swath/		Plotted Position											Comments			
			deg	min	deg	min	Dec.Lat	Dec.Lon	CMG	SMG	Depth	Line	#	W/o	Alt	z(m)	HDG	Dec.Lat	Dec.Lon	L-bck	Jeg		Min	Lat	Lon
TOB-03	062	01:26											5547												haul at 10 m/min
TOB-03	062	01:27											5538												stopped winch
TOB-03	062	01:30	06	23.94	11	20.60	6.399	11.343	155	2.5	3552	27	5538	539	2862	171	6.355	11.350	4931	6	21.35	11	21.47		
TOB-03	062	01:51											5538												Chucking out at 15m/min
TOB-03	062	02:00	06	25.11	11	20.23	6.419	11.337	171	2.4	3521	27	5675	653	2830	164	6.374	11.350	5109	6	22.50	11	21.00		
TOB-03	062	02:28											6106												stopped winch
TOB-03	062	02:30	06	26.37	11	19.87	6.440	11.331	168	2.7	3525	27	6106	378	2954	173	6.390	11.337	5534	6	23.70	11	20.65		
TOB-03	062	03:00	06	27.48	11	19.47	6.458	11.325	153	1.8	3504	28	6105	475	2923	167	6.409	11.336	5550	6	24.70	11	20.30		
TOB-03	062	03:18											6105											veer 10 m/min	
TOB-03	062	03:27											6189											stopped winch	
TOB-03	062	03:33	06	28.79	11	19.00	6.480	11.317	159	2.6	3544	28	6189	493	2959	169	6.430	11.326	5626	6	26.00	11	19.90		
TOB-03	062	04:00	06	29.80	11	18.60	6.497	11.310	162	2.1	3629	28	6198	513	2958	162	6.448	11.326	5637	6	26.60	11	20.20		
TOB-03	062	04:04											6198											veer 15m/min	
TOB-03	062	04:18											6405											winch stopped	
TOB-03	062	04:30	06	31.00	11	18.22	6.517	11.304	164	2.2	3747	28	6406	407	3036	169	6.465	11.314	5831	6	28.05	11	19.20		
TOB-03	062	04:52	06										6406											veer 10m/min	
TOB-03	062	05:02	06	32.23	11	17.84	6.537	11.297	156	2.6	3773	28	6518	460	3066	168	6.484	11.308	5942	6	29.20	11	18.75		
TOB-03	062	05:21																						5 mins TOBI swath lost, then back on its own again.	
TOB-03	062	05:30	06	33.26	11	17.45	6.554	11.291	152	2.2	3781	28	6786	398	3206	172	6.499	11.299	6171	6	30.30	11	18.55	winch stopped	
TOB-03	062	05:39																						ship slowed to around 2.2	
TOB-03	062	05:54																						veer 10m/min	
TOB-03	062	06:00	06	34.40	11	17.04	6.573	11.284	161	2.1	3708	28	6847	485	3230	168	6.518	11.296	6227	6	31.30	11	18.20		
TOB-03	062	06:07											6910											winch stopped	

Appendix C: CD169 Science Log Leg 2

CD169 Leg2: science log														
Operation	Jday	Time	Lat. (South)		Long. (West)		CMG	SMG	Wat. dept	BRIDGET etc		Layback	Altitude	Comments
			Deg	Min	Deg	Min				Wire Out	Depth			
	063	17:00												
Transit	063	17:00	7	54.59	14	25.28	272	5.4						Under way from Ascension
Transit	063	17:30	7	53.39	14	25.82	035	8.3						On way to CTD 03
														On way to CTD 03
	064	05:30	6	18.13	13	22.45	031	10.2						transit to CTD station
	064	06:00	6	13.26	13	19.37	035	10.5						
	064	07:00	6	6.40	13	14.93	195	1.0						10kHz fish in water, on station
CTD03	064	07:15												Waiting for CTD winch
CTD03	064	07:21												plug in sensors
CTD03	064	07:23	6	6.33	13	14.93			3447					CTD in water
CTD03	064	08:28	6	6.27	13	14.78	131	1.0	3440					CTD on bottom
CTD03	064	08:32												Error = no bottle fire confirmation
CTD03	064	08:40								3390	3400			attempt manual fire (Bottles 1 & 2)
CTD03	064	08:55								3000	3017			attempt manual fire (Bottles 3 & 4)
CTD03	064	09:05								2500	2513			attempt manual fire (Bottles 5 & 6)
CTD03	064	09:17								2000	2004			attempt manual fire (Bottles 7 & 8)
CTD03	064	09:38								1000	1003			attempt manual fire (Bottles 9 & 10)
CTD03	064	09:58								10	15			attempt manual fire (Bottles 11 & 12)
CTD03	064	10:02	6	6.75	13	14.31								CTD on deck, no bottles fired
CTD03	064	10:04												Fe & Mn sensors unplugged
Test 2	064	13:18	5	41.90	13	0.00	103	3390.0						
Test 2	064	13:27												Re-positioning to avoid fishing buoy
Test 2	064	13:35	5	42.06	12	59.98	153	3392.0						On station - CTD04
Test 2	064	13:38												CTD in water
Test 2	064	13:40												start pay-out to 500m for test firing 50m/m
Test 2	064	13:50												All stop 500m
Test 2	064	13:51	5	42.07	13	0.01								firing all bottles successfully
Test 2	064	13:52												bringing CTD up to surface
Test 2	064	14:05												CTD on deck - all fired
CTD04	064	14:30	5	42.48	12	59.56	145	1.0	3401	0	0	190		CTD in water
CTD04	064	15:31	5	42.52	12	59.56	140	1.3	3481	3340				CTD on bottom
CTD04	064	15:32							3481	3340	3360			Fire bottles 1 & 2
CTD04	064	15:40								3180	3200			Fire bottles 3 & 4
CTD04	064	15:49								2981	3000			Fire bottles 5 & 6
CTD04	064	15:58								2782	2800			Fire bottles 7 & 8
CTD04	064	16:07							3399	2584	2600			Fire bottles 9 & 10
CTD04	064	16:17								2389	2400			Fire bottles 11 & 12
CTD04	064	16:25								2192	2200			Fire bottles 13 & 14
CTD04	064	16:34								1990	1999			
CTD04	064	16:47								1492	1502			Fire bottles 17 & 18
CTD04	064	17:00								990	1000			Fire bottles 19 & 20
CTD04	064	17:14								491	500			Fire bottles 21 & 22
CTD04	064	17:26								3	10			Fire bottles 23 & 24
CTD04	064	17:29	5	42.57	12	59.31	177	0.5	3397					CTD on deck
transit	064	18:23	5	37.50	12	56.10	052	10.0	3425					In transit to seg 2 RC05
transit	064	19:03	5	34.50	12	52.10	056	10.8	3430					In transit to seg 2 RC05
transit	064	19:30	5	31.90	12	48.50	057	10.7	3268					In transit to seg 2 RC05
transit	064	20:00	5	29.20	12	44.80	057	11.0	3283					In transit to seg 2 RC05
transit	064	20:30	5	26.11	12	40.84	053	10.9	3126					In transit to seg 2 RC05
transit	064	21:00	5	22.79	12	33.43	050	10.9	3156					In transit to seg 2 RC05
transit	064	21:31	5	19.34	12	33.60	052	10.7	2748					In transit to seg 2 RC05
CD169 Leg2: science log														
Operation	Jday	Time	Lat. (South)		Long. (West)		CMG	SMG	Wat. dept	BRIDGET etc		Layback	Altitude	Comments
			Deg	Min	Deg	Min				Wire Out	Depth			
transit	064	22:02	5	16.00	12	29.81	052	10.8	3109					In transit to seg 2 RC05
transit	064	22:32	5	12.83	12	26.19	055	10.7	2678					In transit to seg 2 RC05
transit	064	23:03	5	9.58	12	22.45	057	10.9	3646					In transit to seg 2 RC05
RC05	064	23:30	5	7.04	12	19.36	070	6.3	3365					Slowing down for RC05
RC05	064	23:45	5	6.88	12	19.18	137	1.2	3371					on station rc05
RC05	064	23:55								0	3411			chipper in water
RC05	064	23:59								26	3362			MAPR in water

Appendix C: CD169 Science Log Leg 2

RC05	065	00:10	5	6.88	12	19.19			3381	700	3381				75m/min		
RC05	065	00:10	5	6.89	12	19.22			3375	1500	3375				80m/min		
RC05	065	00:30	5	6.92	12	19.21			3396	2340	3396				82m/min		
RC05	065	00:40	5	6.92	12	19.18			3394	3106	3394				80m/min		
RC05	065	00:42	5	6.91	12	19.17			3380	3464	3380	948			HIT- tension .47 to .31		
RC05	065	00:47	5	6.92	12	19.17			3400	3464	3400	853			off bottom		
RC05	065	00:55	5	6.93	12	19.17			3336	2966	2966	190			75m/min		
RC05	065	01:10	5	6.88	12	19.22			3425	1960	3425				80m/min		
RC05	065	01:23	5	6.83	12	19.26			3339	732	3339				86m/min		
RC05	065	01:33	5	6.79	12	19.30			3342	55	3342				35m/min		
RC05	065	01:37	5	6.79	12	19.35			3415	20	3415				MaPR on board		
RC05	065	01:39	5	6.79	12	19.35									RCO5 on deck- few specks- soft btm		
transit	065	02:00	5	6.54	12	18.24			3549	0	3549				in transit to seg 2 RC06		
transit	065	02:15	5	6.14	12	16.81			3683	0	3683				in transit to seg 2 RC06		
transit	065	02:20	5	6.00	12	16.35			3754	0	3754				Simrad line 55 started- lmbear went off		
transit	065	02:30	5	6.12	12	16.12			3695		3695				multibeam run over target area		
transit	065	02:25	5	6.23	12	17.21			3599		3599				changing course for northern high target		
transit	065	02:45	5	5.57	12	17.67			3505		3505				in transit to seg 2 RC06		
transit	065	03:00	5	4.25	12	17.84			3641		3641				in transit to seg 2 RC06		
transit	065	03:25	5	3.99	12	17.37			3642		3642				in transit to seg 2 RC06 (arriving)		
RC06	065	03:37	5	3.99	12	17.29			3629		3629				RC06 on station		
RC06	065	03:40	5	3.98	12	17.29			3629		3629				Chipper in water		
RC06	065	03:43	5	4.00	12	17.29			3625		3625				MAPR in water, 20 up cable		
RC06	065	04:00	5	4.00	12	17.28			3646		3646				65m/min		
RC06	065	04:40	5	4.02	12	17.29			3602		3602				60m/min		
RC06	065	04:42	5	4.02	12	17.29			3599	3753	3599	1254			Hit, rc06 up to 3700m then back down for 2nd hit		
RC06	065	04:48	5	4.03	12	17.29			3599	2753	3599				2nd hit		
RC06	065	05:47	5	4.07	12	12.23			3614	20					MAPR off		
RC06	065	05:51													RC06 on deck		
Transit	065	05:57							LINE						Transit to WP 29, line 29		
Transit	065	06:02	5	4.16	12	17.83	334	9.1	3634						Transit to WP 29		
Transit	065	06:30	5	4.41	12	20.35	323	11.1	3312								
Transit	065	07:00	4	56.07	12	24.18	321	11.0	2848								
Transit	065	07:13	4	54.05	12	25.90	a/c	11.0	2794						a/c at WP 29 sol 29		
Swath	065	07:17	4	53.53	12	26.15	352	11.1	2798	29					o/c line 29		
Swath	065	07:30	4	51.26	12	26.70	350	11.0	2620	29							
Swath	065	08:00	4	46.40	12	27.90	351	11.1	2681	29							
transit	065	08:15	4	43.93	12	28.26	110	8.4	3054						A/C at W/P 30 - transit to trans stn		
transit	065	08:30	4	45.65	12	27.18	132	9.5	3012								
TX01	065	08:51	4	1.96	12	25.55	134	1.6	2773						slow to deploy USBL		
TX01	065	09:15	4	47.13	12	25.52	128	1.4	2780						slow transit to transponder deployment		
TX01	065	09:30	4	47.54	12	25.08	132	5.7	2807						who knows!!!		
TX01	065	09:38													transponder D in water		
TX01	065	10:00	4	47.91	12	24.72	130	2.2	2859								
TX01	065	10:04	4	47.96	12	24.69	131	2.4	2874						weight in water - eventually!!!!		
TX01	065	10:51	4	47.29	12	24.16	134	1.6	2937						Transponder D on bottom		
TX01	065	11:00	4	47.42	12	24.09	135	2.8	2909								
TX01	065	11:30	4	48.48	12	24.16	183	2.3	2959								
CD169 Leg2: science log																	
BRIDGET etc																	
Operation	Jday	Time	Lat. (South)	Long. (West)													
			Deg	Min	Deg	Min	CMG	SMG	Wat. depth	Wire Out	Depth	Layback	Altitude	Comments			
TX01	065	11:55	4	48.55	12	25.30	312	2.1	2624					end of transponder test survey			
transit	065	12:00	4	48.42	12	1.07	045	2.1	2622					transit to CTD05 (at 5knts)			
	065																
CTD05	065	13:09	4											sensor plugged in			
CTD05	065	13:12	4	45.98	12	23.01	296	0.5	3209					CTD in water			
CTD05	065	13:19												stopped @ 50m CTD software problems			
CTD05	065	13:24												CTD coming up			
CTD05	065	13:27												CTD suspended to restart and reset software			
CTD05	065	13:33												CTD back in water, to 5m			
CTD05	065	13:39												CTD going down 20m/min to 100m			
CTD05	065	13:44												CTD at 100m hold for computer restart, now lost graphical interface			
CTD05	065	13:56												CTD going down, no plots but digital data, background nephels are 90.379-90.352			
CTD05	065	14:04												Off position by .5 miles, we are drifting back that way, ship wil do it			
CTD05	065	14:15	4	45.95	12	23.11								Drifting to station			
CTD05	065	14:30	4	45.94	12	23.20	119	1.1	3165					Drifting to station			
CTD05	065	14:45	4	45.36	12	23.41	124	1.0	3127					Drifting to corect position			
CTD05	065	14:51												Winch stopped at bottom of cast			

Appendix C: CD169 Science Log Leg 2

CTD05	065	14:53	4	45.89					3146											Fire bottles 1 and 2	
CTD05	065	14:53	4	45.89	12	23.46														Software crash as tried to fire	
CTD05	065	14:58																		CTD coming up, BROKEN!	
CTD05	065	15:30	4	45.98	12	23.57	122	1.5	2712											CTD coming up	
CTD05	065	15:52																		on surface one bottle fired	
CTD05	065	15:54																		On deck	
CTD05	065	15:55																		unplug sensor	
Transit	065	16:06																		in transit to BGT01	
Transit	065	16:30	4	43.82	12	24.62	355	3.7	3205											in transit to BGT01	
BGT01	065	16:45	4	43.01	12	24.99	129	0.8	3249											On station BGT01	
BGT01	065	17:10	4	43.26	12	25.07	129	1.7	3237	21										BGT in water	
BGT01	065	17:13							3056	70										nB Clock on bgt is ship +30 minutes	
BGT01	065	17:30	4	43.42	12	24.97	117	2.5	3113	383	392									Excursions on all analog traces(Trans, neph and alt0	
BGT01	065	18:00	4	43.56	12	24.62	112	2.1	3207	1051	1054									bGTstill malfunctioning	
BGT01	065	18:12					110	1.8	3292	1310	1302	335								Veer increaseto 30 m/min	
BGT01	065	18:30	4	43.70	12	24.30	112	2.1	3291	1856	1865										
BGT01	065	18:32																		Reboot BRIDGET, try to kickstart analogue Tx/Rx. No A value	
BGT01	065	18:35																		No change. Reboot logging.	
BGT01	065	18:36																		No result. Proceed to fuldepth, then recovery.	
BGT01	065	19:01	4	43.80	12	23.90	112	2.1	3238	2750	2720	595								Winch stop	
BGT01	065	19:05								2750										Fire bottle no.1 - confirmed	
BGT01	065	19:07																		veer at 30m/m	
BGT01	065	19:13								2923										stop winch	
BGT01	065	19:15																		haul at 45m/m to targeth depth 2800m	
BGT01	065	19:17								2802										fire bottle no.2 - confirmed - haul at 45m/m	
BGT01	065	19:19								2751										fire bottle no. 3 - confirmed	
BGT01	065	19:21								2701										fire bottle no. 4 - confirmed	
BGT01	065	19:23								2651										fire bottle no. 5 - confirmed	
BGT01	065	19:26								2599										fire bottle no. 6 - confirmed	
BGT01	065	19:28								2545										fire bottle no. 7 - confirmed	
BGT01	065	20:00	4	44.42	12	23.12	116	2.6	3234	1238										resume recovery	
BGT01	065	20:05								1024										fire bottle no. 8 - confirmed	
BGT01	065	20:06								1024										fire bottle no. 9 - confirmed	
BGT01	065	20:07								1024										fire bottle no. 10 - confirmed	
BGT01	065	20:08								1024										fire bottle no. 11 - confirmed	
BGT01	065	20:16																		Resume haul 35m/m	
BGT01	065	20:31	4	44.73	12	23.05	114	1.7	3189	450											
BGT01	065	20:55								-12										BRIDGET on deck	
CD169 Leg2: science log																					
												BRIDGET etc									
Operation	Uday	Time	Lat. (South)	Long. (West)																Comments	
			Deg	Min	Deg	Min	CMG	SMG	Wat. depth	Wire Out	Depth	Layback	Altitude								
transit	065	21:00	4	44.95	12	23.05	120	1.0	3145												
TX02	065	21:30	4	45.97	12	22.48	124	4.4	3097												
TX02	065	22:00	4	47.07	12	21.53	116	2.1	2977												
TX02	065	22:08	4	47.19	12	21.42	119	1.5													
TX02	065	22:10																			
TX02	065	22:20	4	47.28	12	21.33	116	1.9													
transit	065	22:30	4	47.60	12	21.49	188	5.0													
TX03	065	23:00	4	49.45	12	22.50	189	2.9													
TX03	065	23:16	4	49.53	12	22.50	099	2.5													
TX03	065	23:21	4	49.53	12	22.47	107	3.0													
transit	065	23:30	4	49.43	12	22.38	056	3.4													
hove-to	065	23:32																			
hove-to	065	00:00	4	48.96	12	0.95	117	2.1													
TX02	066	00:24	4	49.16	12	22.41	100	2.4													
TX02	066	02:00	4	48.20	12	22.27	103		2978												
TX03	066	02:23	4	49.46	12	22.57	105		2977												
TX03	066	02:40	4	49.53	12	22.47	108		2977												
	066	04:15	4	50.34	12	23.70	152		2918												
Transit	066	04:50																			
Transit	066	05:00	4	50.70	12	24.30	316	7.2	2621												
DUM1	066	05:24	4	48.80	12	26.14															
DUM1	066	05:30																			
DUM1	066	05:37																			
DUM1	066	05:40								58											
DUM1	066	05:45								108											
DUM1	066	05:50								158											
DUM1	066	05:54								208											

Appendix C: CD169 Science Log Leg 2

Operation	Jday	Time	Lat. (South)	Long. (West)	CMG	SMG	Wat. depth	Wire Out	Depth	Layback	Altitude	Comments
DUM1	067	04:30	4	45.72	12	28.71	282	2.7			1106	
DUM1	067	04:55										Manoever ship for MAPR recovery
DUM1	067	05:17									330	MAPR inboard (308 m ref. Wire out)
DUM1	067	05:22									270	MAPR inboard (258 m ref. Wire out)
DUM1	067	05:28									219	MAPR inboard (208 m ref. Wire out)
DUM1	067	05:33									170	MAPR inboard (158 m ref. Wire out)
DUM1	067	05:38									120	MAPR inboard (108 m ref. Wire out)
DUM1	067	05:43									69	MAPR inboard (58 m ref. Wire out)
CD169 Leg2: science log												
BRIDGET etc												
DUM1	067	05:46									61	MAPR inboard (50 m ref. Wire out)
DUM1	067	05:55										
transit	067	06:04	4	46.87	12	30.74	152	1.1	2778			In transit to RC07
transit	067	06:15										USBL pod retracted, transit to station RC07
transit	067	06:30	4	47.13	12	29.73	087	9.2	2652			
transit	067	07:00	4	41.86	12	25.31	085	10.7	2854			
RC7	067	07:29	4	46.78	12	23.37	113	1.1	3070			Onstation RC07
RC7	067	07:34	4	46.80	12	23.38						RC07 in water
RC7	067	07:38	4	46.85	12	23.40			3070	50		MAPR in water
RC7	067	07:52										Stopwinch recover RC and reposition
RC7	067	08:00	4	47.15	12	23.40						
RC7	067	08:13	4	47.04	12	23.43			3029			MAPR out of water
RC7	067	08:16	4	47.05	12	23.42						RC07 on deck
transit	067	08:17										Reposition to RC07
RC7	067	08:37	4	46.63	12	23.20			3055			Onstation RC07 - In water
RC7	067	08:40	4	46.64	12	23.20			3055			MAPR in water
RC7	067	09:00	4	46.76	12	23.23			3058	1410		paying out at 74 m/min
RC7	067	09:15	4	46.82	12	23.24			3069	2390		
RC7	067	09:24	4	46.84	12	23.24			3129	3141		chipper on bottom
RC7	067	09:27							3045	3148		chipper on bottom again - recovering
RC7	067	09:35										chipper possibly lodged
RC7	067	09:40										problems with winch
RC7	067	10:00	4	46.93	12	23.33				3082		still problems with winch
RC7	067	10:30	4	46.99	12	23.38				3082		winch brake problems
RC7	067	10:35										winch repaired
RC7	067	11:00	4	46.98	12	23.44				1155		recovering chipper
RC7	067	11:16										MAPR on deck
RC7	067	11:19										chipper on deck
RC7	067	11:30	4	46.97	12	23.29	045	3.8	3129			Transit to RC08
RC8	067	11:33	4	46.03	12	22.51						onRC08 station
RC8	067	12:02	4	46.06	12	22.55	264	0.4				RC08 in water
RC8	067	12:09	4	46.11	12	22.55	165	0.1				mapr on wire at 20m
RC8	067	12:35	4	46.24	12	22.55	122	0.9	3125	1760		down at 67m/min
RC8	067	12:45	4	46.22	12	22.60	128	1.1	3114	2888		70m/min
RC8	067	12:57	4	46.24	12	22.62	133	1.3	3143	3231		Hit on bottom tension 50 to 32
RC8	067	13:02	4	46.27	12	22.61	063	0.5	3118	3231		2nd hit on bottom tension 50 to 32
RC8	067	13:30	4	42.27	12	22.62	124	1.5	3102	1766		60m/min
RC8	067	13:45	4	46.27	12	22.61	124	1.2	3108	838		60m/min
RC8	067	14:00	4	46.25	12	22.60	239	0.9	3123	0		mapr off and rc8 on deck
transit	067	14:14	4	47.06	12	22.17	142	9.1	3002			transit to ABE launch site
transit	067	14:30	4	48.46	12	21.26	129	2.6	2884			transit to ABE150 launch site
transit	067	14:45	4	48.49	12	21.16	126	1.1	2883			on station; stem down
CTD3	067	15:00	4	48.50	12	21.15	131	1.3	2883			CTD test with mapr- set up
Test3	067	15:14	4	48.53	12	21.14	223	0.5	2880			CTD in water
Test3	067	15:25	4	48.51	12	21.17	285	1.0				CTDat 500m
Test3	067	15:42										on deck
ABE-01	067	16:20	4	48.50	12	21.10	289	1.1	2879			on station ABE-01. Deployment prep.
ABE-01	067	16:25										Start ABE-01 launch
ABE-01	067	16:32										weight in water
ABE-01	067	16:34										ABE in water
ABE-01	067	16:35	4	48.41	12	21.17	090	0.7	2879			Release pin out. ABE on descent
ABE-01	067	17:00	4	48.43	12	21.20	097	1.1				
ABE-01	067	17:30	4	48.43	12	21.21	216	0.2	2880			ABE descending
ABE-01	067	18:00	4	48.87	12	21.25	007	0.4	2934			transit to ctd station 06
CD169 Leg2: science log												
BRIDGET etc												
			Lat. (South)	Long. (West)								

Appendix C: CD169 Science Log Leg 2

Operation	Jday	Time	Deg	Min	Deg	Min	CMG	SMG	Wat. dept	Wire Out	Depth	Layback	Altitude	Comments
CTD06	067	18:30	4	49.43	12	21.89	166	0.4	2923					on station ctd 06
CTD06	067	18:43	4	49.50	12	21.87	181	0.9	2973					CTD06 inn water
CTD06	067	19:12	4	49.74	12	21.82			2962		1200			V4 (OBS) dead
CTD06	067	19:45								2880	2890			Bottles 1&2 fired Neph 0.040
CTD06	067	19:49								2840	2845			Bottles 3&4 fired Neph 0.039
CTD06	067	19:53								2800	2804			Bottles 5&6 fired Neph 0.042
CTD06	067	19:58								2760	2766			Bottles 7&8 fired Neph >0.051
CTD06	067	20:00								2750	2759			Bottles 9&10 fired Neph >0.06
CTD06	067	20:03								2740	2749			Bottles 11&12 fired Neph 0.049
CTD06	067	20:08								2720	2730			Bottles 13&14 fired Neph 0.049
CTD06	067	20:14								2680	2692			Bottles 15&16 fired Neph 0.040
CTD06	067	20:18								2640	2653			Bottles 17&18 fired Neph 0.039
CTD06	067	20:24								2500	2512			Bottles 19&20 fired Neph 0.039
CTD06	067	20:39								1988	2000			Bottles 21&22 fired Neph 0.038
CTD06	067	21:20								5	10			Bottles 23&24 fired Neph 0.078
CTD06	067	21:25	4	49.91	12	21.57			2977					CTD06 on deck
CTD07	067	23:15	4	46.98	12	23.64			3079					CTD 06 in water
CTD07	068	00:16	4	46.95	12	23.55			3049					CTD on bottom
CTD07	068	00:17								2980	2995			fire bottles 1 & 2, neph 46mv
CTD07	068	00:20								2960	2975			fire bottles 3+4, neph 50mv
CTD07	068	00:25								2910	2924			fire bottles 5+6, neph 55mv
CTD07	068	00:28								2862	2875			fire bottles 7+8, neph 56mV
CTD07	068	00:34								2810	2825			fire bottles 9+11, neph 60mV
CTD07	068	00:37								2760	2775			fire bottles 13+15, neph 40mV
CTD07	068	00:50								2487	2500			fire bottles 17+18, neph 40mV
CTD07	068	01:02								1987	2000			fire bottles 19, 20, 21, 23, 24 neph 40mV
CTD7	068	01:42	4	46.98	12	23.61			3049					CTD on deck
transit	068	02:30	4	48.13	12	23.40	156	2.0	2930					transit to RC9
RC9	068	03:00	4	48.04	12	22.95	258	0.3	2962	60				RC9 and mapr in water
RC9	068	03:35	4	48.89	12	22.92	126	0.6	2959	2291				70m/min
RC9	068	03:44	4	48.89	12	22.91	169	0.4	2959	3034				Hit bottom, then up 100m at 10m/min
RC9	068	03:50	4	48.89	12	22.90	144	0.4	2960	3034				2nd Hit, recovering chipper
RC9	068	04:40												Chipper inboard
Transit	068	04:45												Start transit to RC10
Transit	068	05:00	4	48.80	12	22.70	030	4.0	2984					
Transit	068	05:30	4	47.60	12	27.00	035	3.5	3021					
RC10	068	05:35												On station RC10. Start chipper deployment
RC10	068	05:40												Chipper in water
RC10	068	05:43	4	47.67	12	22.00			2999					mAPR 13 on wire. Deployment at 70m/min
RC10	068	06:24												Tension off wire (0.4 to 0.1, then back to 0.4)
RC10	068	06:28												Tension off wire (0.425 to 0.125, then back to 0.425)
RC10	068	06:33							3011	3086				1st hit bottom at 70 m/min(wire reading at 'pull-out')
RC10	068	06:37												2nd hit bottom at 40 m/min. Recovering chipper
RC10	068	07:00	4	47.70	12	22.04			3005	1851				
RC10	068	07:32												chipper on deck - in transit RC11
RC11	068	08:00	4	48.60	12	22.10	177	3.1	2939					
RC11	068	08:30	4	50.45	12	22.17	166	4.2	3018					
RC11	068	08:43	4	50.93	12	22.25								on station RC11
RC11	068	08:48							3025	0				chipper in water
RC11	068	08:51							3025	20				MAPR in water
RC11	068	08:55								504				spike on load monitor
CD169 Leg2: science log														
BRIDGET etc														
Operation	Jday	Time	Lat. (South)	Long. (West)										Comments
RC11	068	09:40								3155				chipper on bottom
RC11	068	09:43								3155				wire under tension
RC11	068	09:44								3155				on bottom again - recovering
RC11	068	10:00	4	51.02	12	22.16			3031					
RC11	068	10:30	4	51.10	12	22.16			3039	535				
RC11	068	10:39								19				MAPR on deck
RC11	068	10:45								1				chipper on deck
transit	068	11:01	4	50.84	12	21.95	352	4.4	3054					

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transit	068	11:30	4	48.70	12	21.88	003	2.9	2907										
CTD08	068	11:36	4	48.60	12	21.82			2910										On station CTD08
CTD08	068	11:50							2898	0									CTD in water
CTD08	068	12:15	4	48.64	12	21.77	256	0.1	4074	1025									60m/min
CTD08	068	12:47	4	48.65	12	21.81			2893										CTD on bottom
CTD08	068	12:52								2852									fire 1+2
CTD08	068	12:57							2811	2825									fire 3 + 4 No neph so use trans 90.01
CTD08	068	13:00							2786	2800									fire 5 + 6 89.988
CTD08	068	13:03							2761	2775									fire 7 + 8 trans 89.988
CTD08	068	13:06							2751	2765									fire 9+10, trans 89.988
CTD08	068	13:09							2736	2750									fire 11+ 12, trans 89.963
CTD08	068	13:13							2711	2725									fire 13 + 14, trans 89.939
CTD08	068	13:16							2626	2700									fire 15 + 16, trans 90.012
CTD08	068	13:32							2000	2010									fire 17 + 22
CTD08	068	14:11	4	48.52	12	21.85			2923										CTD on deck
CTD08	068																		
CTD08	068	14:45																	finish ctd sampling ,hydrowire fix
DEAD	068	15:00																	hydrowire operations
CTD09	068	19:25																	resume science
CTD09	068																		
CTD09	068	19:31	4	47.63	12	22.08			2998										CTD in water
CTD09	068	19:52																	stop winch to test things
CTD09	068	19:53																	winch going again
CTD09	068	20:32	4	47.68	12	22.03			3129	2950	2965								CTD on bottom
CTD09	068	20:40								2970	2985								fire bottles 1 + 2 trans 89.817
CTD09	068	20:45								2936	2951								fire 3 and 4, trans 89.792
CTD09	068	20:48								2911	2929								fire 5 and 6,trans 89.68
CTD09	068	20:51								2911	2929								fire 7 and 8, trans 89.792
CTD09	068	20:53								2861	2875								fire 9 and 10, trans 89.917
CTD09	068	20:57								2811	2825								fire 11 and 12, trans 89.817
CTD09	068	21:13								2000	2011								fire bottles 13-24, trans 89.841
CTD09	068	21:55	4	47.67	12	21.90				-4									CTD on deck
transit	068	22:31	4	47.61	12	23.68	292	4.9											transit to ABE recovery
recovery	068	22:45	4	47.44	12	24.58	192	1.5											slowing down at ABE recovery location
recovery	068	23:00	4	47.33	12	24.93	141	1.1											awaiting ABE to surface
recovery	068	23:30	4	47.36	12	24.85	136	1.0											
recovery	068	23:40																	ABE on surface
recovery	068	23:46																	manouvering towards ABE
recovery	069	00:32																	ABE on deck, end of dive150
RC12	069	01:42	4	46.02	12	23.71				20									Chipper in water, Mapr 13 attached
RC12	069	01:52	4	46.02	12	23.71													hydraulic pipe rupture- standing by
RC12	069	03:40	4	46.00	12	23.71	136	1.1	3066										starting back down 30m/min then 60m/min
CD169 Leg2: science log																			
		Lat. (South)		Long. (West)				BRIDGET etc											
Operation	Jday	Time	Deg	Min	Deg	Min	CMG	SMG	Wat. dept	Wire Out	Depth	Layback	Altitude	Comments					
RC12	069	04:35	4	45.97	12	23.84	135	1.3	3062	3237									1st hit at 60m/min
RC12	069	04:39																	2nd hit at 40m/min. Recovering chipper
RC12	069	05:40																	Chipper inboard. Start transit
	069	06:00	4	46.83	12	24.92	200	5.4	2917										confirmed on BRIDGET that USBL pob retracted
RC13	069	06:18																	On station RC13 - hove-to
RC13	069	06:32	4	47.44	12	24.66			2837										RC13 chipper deployed at 60m/m
RC13	069	07:15							2831	2947									1st hit at 60m/min
RC13	069	07:19	4	47.36	12	24.65													2nd hit at 40m/min. Recovering chipper
RC13	069	08:11																	MAPR on deck
transit	069	08:15																	Chipper on deck -transit to RC14
RC14	069	09:00	4	49.59	12	24.05			2916										on station RC14 - chipper in water
RC14	069	09:07							2916										MAPR in water
RC14	069	10:02							2884	3030									chipper on bottom
RC14	069	10:03							2886	3025									tension back on wire
RC14	069	10:06							1898	3027									chipper on bottom again
RC14	069	11:00																	MAPR on deck
transit	069	11:05																	Chipper on deck - transit to RC15
RC15	069	11:28	4	50.15	12	23.71			3048										on station RC15
RC15	069	11:31								0									Chipper in water

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RC15	069	11:34								3001	20					MAPR in water
RC15	069	12:00	4	50.20	12	23.25	133	1.2		3051	1660					down at 60m/min
RC15	069	12:30	4	50.13	12	23.12	134	0.9		3051						hit bottom and then upto 3100wire out
RC15	069	12:38	4	50.13	12	23.12	135	0.8		3046						2nd hit
RC15	069	13:40	4	50.18	12	23.23	129	1.0		3029						rc15 on ndeck
transit	069	13:50	4	49.34	12	23.12	092	9.4		2991						transit to abe launch site/stem check
	069	14:00	4	48.53	12	48.53										
	069	14:30	4	48.52	12	48.52	136	1.6		2992						have to near abe launch site. Stem down
	069	15:15	4	48.69	12	48.69	128	1.1		2983						will dunk ctd to 500m for cleaning
	069	16:00	4	48.78	12	48.78	124	1.6		2985						setting up for abe deck test
	069	16:30	4	48.57	12	48.57	147	1.3		2979						conducting abe deck test
	069	16:30	4	48.57	12	48.57	147	1.3		2979						still doing abe deck tests
test 4	069	17:05	4	48.76	12	23.00										CTD in water
test 4	069	17:20	4	48.68	12	23.01	121	1.4		2977						CTD at 500 m to fire all bottles
test 4	069	17:36	4	48.60	12	23.03	119	1.0		2988						CTD on deck
	069	18:04	4	48.45	12	22.95										
ABE 02	069	18:04	4	48.45	12	22.95										ABE passed deck test
ABE 02	069	18:53	4	48.57	12	22.95	125	1.6		2986						ABE in water
	069	19:50	4	48.02	12	22.48				3003						CTD in water
CTD10	069	20:54	4	47.95	12	22.51				2970	2985					CTD on bottom, Bottles 1 & 2
CTD10	069	20:58								2945	2960					Bottles 3 & 4
CTD10	069	21:02								2925	2940					Bottles 5 & 6
CTD10	069	21:06								2883	2900					Bottles 7 & 8
CTD10	069	21:10								2835	2850					Bottles 9 & 10
CTD10	069	21:14								2810	2825					Bottles 11 & 12
CTD10	069	21:18	4	47.96	12	22.50				2785	2800					Bottles 13 & 14
CTD10	069	21:21								2760	2775					Bottles 15 & 16
CTD10	069	21:26								2745	2760					Bottles 17 & 18
CTD10	069	21:31	4	47.96	12	22.49				2725	2740					Bottles 19 & 20
CTD10	069	21:35								2685	2700					Bottles 21 & 22
CTD10	069	21:39								2585	2600					Bottles 23 & 24
CTD10	069	22:28	4	47.98	12	22.45				3006						CTD on deck
CTD	069	22:31														Stem Up
CD169 Leg2: science log																
				Lat. (South)		Long. (West)										BRIDGET etc
Operation	Jday	Time	Deg	Min	Deg	Min	CMG	SMG	Wat. depth	Wire Out	Depth	Layback	Altitude	Comments		
Transit	070	00:50	4	37.06	12	25.94	148	8.0	3386					transiting to Dredge 01 position		
DR01	070	01:30	4	38.27	12	25.46	116	0.4						DR-01 in water, mapr and pinger on at 150m		
DR01	070	01:45	4	38.29	12	25.46	112	0.4		600				DR-01down at 50m/min		
DR01	070	02:08	4	38.29	12	25.30	262	0.4	3596	1700				50m/min		
DR01	070	02:45	4	38.30	12	25.35	248	0.0		3255				50m/min switched controls to lab		
DR01	070	03:00	4	38.33	12	25.35	319	0.2		3646				DR01 on bottom- forward at 0.5 knots		
DR01	070	03:15	4	38.40	12	25.26	065	0.3		3744				50m pinger altitude		
DR01	070	03:30	4	38.51	12	25.18	118	0.8		3729				Nibbles		
DR01	070	03:55	4	38.73	12	24.18	196	0.8		3857				Bites at 50m off		
DR01	070	04:13	4	38.96	12	24.77	119	0.7		4013				Paying out at 15m/m		
DR01	070	04:47	4	39.13	12	24.73	120	0.7						small bites		
DR01	070	05:35	4	39.08	12	24.77	120	0.7		3481				off bottom- very slow coming up- bottom followed		
DR01	070	05:44	4	39.05	12	24.70	090	0.1	3477	3400				Hauling at 30 m/min		
DR01	070	06:00	4	39.11	12	24.80	160	1.0	3471					Hauling at 35 m/min		
DR01	070	07:35												Dredge on deck. Set course for WP 41 (No. TBC)		
	070	08:00	4	39.84	12	23.19	076	8.7	3605							
Swath	070	08:17	4	39.46	12	20.61	110	8.5	2669					A/C onto survey line		
Swath	070	08:54	4	44.20	12	19.12	174	9.1	2229					EM12 logging bad data. Logging off. Abandon survey. A/C to ABE 2 site		
Swath	070	09:35	4	48.10	12	22.51	178	1.1	2999					EOT to ABE2. USBL deployment		
Swath	070	09:50												USBL deployed		
Swath	070	10:00	4	48.17	12	22.52	311	0.3	2002							
	070	10:48	4	48.52	12	22.33	311	0.3	2983					CTD in water		
CTD 11	070	11:46	4	48.57	12	22.33	256	0.1	2979					CTD on bottom		
CTD 11	070	11:49												fire 1 + 2, V3=.026, trans=89.963		
CTD 11	070	11:54												Bottles 3 & 4, v3 .027, trans 89.963		
CTD 11	070	11:58												Bottles 5 & 6, v3 .028, trans 89.915		
CTD 11	070	12:03												Bottles 7 & 8, v3 .031, trans 89.719		

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CTD 11	070	12:07															Bottles 9 & 10, v3 .031, trans 89.744			
CTD 11	070	12:10																Bottles 11 & 12, v3 .031, trans 89.817		
CTD 11	070	12:13																Bottles 13 & 14, v3 0.024, trans 89.988		
CTD 11	070	12:16																Bottles 15 & 16, v3 .026, trans 89.988		
CTD 11	070	12:20	4	48.53	12	22.38										2984		Bottles 17 & 18, v3 .024, trans 89.988		
CTD 11	070	12:28																Bottles 19 & 20, v3 .024, trans 90.012		
CTD 11	070	12:39																Bottles 21 & 22, v3 0.024 trans 90.012		
CTD 11	070																	Bottles 23 & 24		
CTD 11	070	13:21	4	48.55	12	22.45												CTD on deck		
	070	17:00	4	47.50	12	23.20												ABE on deck. USBL transponder up.		
Swath	070	17:25					105	8.1										In transit to swath survey. E Seg 2.		
Swath	070	18:00	4	48.72	12	19.17	103	9.1												
Swath	070	18:14	4	48.52	12	17.89	345	9.7												
Swath	070	18:32	4	45.60	12	18.70	348	10.1											A/C at WP41	
Swath	070	19:11	4	39.33	12	20.20		8.9											A/C at WP42 for Dredge station 2	
Swath	070	19:16					204	8.9											O/C	
Swath	070	19:45	4	43.50	12	22.90	204	9.1												
DR02	070	19:50	4	44.19	12	23.20	204	0.4												
DR02	070	20:10	4	44.33	12	23.41	156	0.4											Hove to on station	
DR02	070	20:20	4	44.37	12	23.46	213	1.6											DR02 in water	
DR02	070	21:50	4	44.29	12	22.97	243	1.6											Pinger and mapr on, then down at 30m/min	
DR02	070	21:54																	dredge on bottom - winch stop - speed to 1knts	
DR02	070	22:05																	veer 10m/m	
DR02	070	22:10																	winch stop	
DR02	070	22:13																	3247	3449
DR02	070	22:13																	3449	veer 5m/m
CD169 Leg2: science log																				
BRIDGET etc																				
Operation	Jday	Time	Lat. (South) Deg	Min	Long. (West) Deg	Min	CMG	SMG	Wat. depth	Wire Out	Depth	Layback	Altitude	Comments						
DR02	070	22:20							3249	3500									winch stop	
DR02	070	22:21							3249	3475									haul 10m/m	
DR02	070	22:24								3475									winch stop	
DR02	070	22:25								3446									haul 10m/m	
DR02	070	22:28							3241	3480									stop winch - veer 10m/m	
DR02	070	22:31																	increase veer 15m/m	
DR02	070	22:36							3232	3555									stop veer - haul 10m/m	
DR02	070	22:45																	increase haul 15m/m	
DR02	070	22:50							3227	3395									dredge off bottom increase haul 50m/m	
DR02	071	00:20	4	45.05	12	21.87	088	0.9		3238	336								hauling in at 38m/min	
DR02	071	00:35	4	45.25	12	21.86			3220	144										
DR02	071	00:43	4	45.33	12	21.90													DR02 on deck	
Transit	071	00:50																	In transit to CTD 12	
CTD 12	071	01:25	4	47.83	12	27.50	262	0.1		3009									On station CTD broken	
CTD 12	071	02:00																	CTD broken still	
CTD 12	071	03:30																	CTD fixed b but leave for 30 mins to confirm	
CTD 12	071	04:14																	sensor plugged in	
CTD 12	071	04:19	4	47.86	12	22.65				3022									CTD in water	
CTD 12	071	04:31																	CTD modular errors, broken, bringing back	
CTD 12	071	04:37																	CTD on deck and sensor off	
CTD 12	071	07:01	4	47.76	12	22.56				3005									sensor on	
CTD 12	071	07:04																	CTD at 3m	
CTD 12	071	07:08																	CTD ? on CTD stopped	
CTD 12	071	07:09																	haul 30m/m	
CTD 12	071	07:13																	on deck - sensor off	
hove to	071	10:10																	ABE deck testing	
ABE3	071	10:30																	ABE passed deck test	
ABE3	071	11:00																	ABE ready - winch broken	
ABE3	071	11:45	4	48.61	12	22.44													Stand down - ABE probs	
ABE3	071	12:52	4	48.69	12	22.51				2988									ABE in water	
ABE3	071	14:00	4	48.96	12	22.28													ABE at 1430m depth	
ABE3	071	15:10	4	48.78	12	22.31													ABE 6min from starting line 1	
ABE3	071	15:30	4	48.74	12	22.41													ABE is off the mooring	
ABE3	071	16:10	4	48.86	12	22.56													On way to BGT-02	
ABE3	071	17:00	4	46.25	12	23.44	346	4.0		2002										
BGT2	071	17:12	4	45.61	12	23.62		0.5											On station BGT-02, manoeuvring ship	
BGT2	071	17:24	4	45.80	12	23.70	110	0.8		3225									Bridget in water	

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CTD15	073	00:31	4	48.58	12	22.41			2985	2880	2902				B# 3 & 4
CTD15	073	00:35	4	48.57	12	22.41			2984	2830	2850				B# 5 & 6
CTD15	073	00:45	4	48.56	12	22.40			2984	2780	2801				B# 7 & 8
CTD15	073	00:52	4	48.58	12	22.42									
CTD15	073	00:58	4	48.59	12	22.42				2925	2947				B# 9 & 10
CTD15	073	01:08	4	48.60	12	22.41				2830	2852				B#11
CTD15	073	01:14	4	48.59	12	22.42				2800	2820				B#12
CTD15	073	01:17	4	48.59	12	22.42				2782	2803				B#13
CTD15	073	01:18			12										Calibration
CTD15	073	01:19	4	48.59	12	22.41				2782	2802				B#14
CTD15	073	01:34	4	48.59	12	22.42					2800				
CTD15	073	01:37	4	48.60	12					2925	2946				winch stop
CTD15	073	01:42	4	48.60	12										WS
CTD15	073	01:48	4	48.59	12										B# 15 & 16
CTD15	073	01:52	4	48.59	12										B# 17 & 18
CTD15	073	01:55	4	48.59	12										B# 19 & 20
CTD15	073	02:01	4	48.59	12										B#21
CTD15	073	02:14	4	48.59	12										B#22
CTD15	073	02:17	4	48.59	12										B#23
CTD15	073	02:27	4	48.59	12										B#24
CTD15	073	02:28	4	48.59	12										Hauling
CTD15	073	03:19	4	48.59	12	22.55									CTD in ==> 7 not closed, 8 ==> rope
CTD15	073	03:20													Mn sensor off
RC18	073	03:25													EMI2 line 081 started for RC18 survey
RC18	073	05:28	4	47.73	12	22.45			3020						RC18 in water with MAPR 13
RC18	073	06:24	4	47.78	12	22.53			3020	3109					Chipper hit bottom
RC18	073	07:25	4												Chipper on deck. Transit to RC19
RC19	073	07:44	4	48.07	12	22.67			3019						On station RC19
RC19	073	07:48													in water
RC19	073	08:48	4	48.04	12	22.60			3010	3091					chipper on bottom - recovery
RC19	073	09:50													chipper on deck - transit to RC20
Transit	073	10:00	4	47.69	12	22.59	328	6.5	3011						transit to RC20
RC20	073	10:10	4	47.25	12	22.23	133		3100						RC20 in water
RC20	073	10:12	4	47.25	12	22.23	246	0.4	3100	21					MAPR on wire
RC20	073	11:11	4	47.25	12	22.85			3094	3174					chipper on bottom - wire on tension
RC20	073	12:08													MAPR on deck
RC20	073	12:11													Chipper on deck - transit to ABE153
ABE153	073	13:10	4	48.57	12	22.76	214	0.5	2980						on station for ABE 153
CTD16	073	13:23													stem down
CTD16	073	14:23													Mn Sensor power on
CTD16	073	14:25	4	47.82	12	22.61			3012						CTD in water
CTD16	073	15:22	4	47.80	12	22.61			3023	2950	2962				winch stop - at bottom
CTD16	073	15:32	4	47.80	12	22.61			3037	2700	2712				winch stop
CTD16	073	15:45	4	47.79	12	22.59					2980				bottle 1 & 2 fired
CTD16	073	15:47									2991				bottle 3 fired
CTD16	073	15:47									2989				bottle 4 fired
CTD16	073	15:48									2988				bottle 5 fired
CTD16	073	15:51	4	47.81	12	22.59				2960	2973				winch stop
CTD16	073	15:53									2997				bottle 6 fired
CD169 Leg2: science log															
BRIDGET etc															
Operation	Jday	Time	Lat. (South)	Long. (West)	CMG	SMG	Nat. dept	Wire Out	Depth	Layback	Altitude	Comments			
CTD16	073	15:54						2990	3003						bottle 7 fired
CTD16	073	15:54							3008						bottle 8 fired
CTD16	073	15:54	4	47.81	12	22.59			3014						bottle 9 fired
CTD16	073	15:56							3009						bottle 10 fired
CTD16	073	15:57							3006						bottle 11 fired
CTD16	073	15:57							3002						bottle 12 fired
CTD16	073	15:57							2996						bottle 13 fired
CTD16	073								2992						bottle 14 fired
CTD16	073	15:58							2990						bottle 15 fired
CTD16	073	15:58							2985						bottle 16 fired
CTD16	073	15:58			0.06				2981						bottle 17 fired

Appendix C: CD169 Science Log Leg 2

ABE155	075	11:40	4	48.06	12	22.70			3010								On station ABE155
ABE155	075	11:53															suspension of deployment 30/60mins - camera overheating
ABE155	075	12:51	4	48.02	12	22.68	290	0.9	3025								ABE155 launched
SAP 02	075	13:17	4	48.49	12	22.34			2980								On station for SAP 02
SAP 02	075	13:35	4	48.51	12	22.29			2967								Weight in water
SAP 02	075	13:41	4						2985								Pinger in water
SAP 02	075	13:47	4														SN0004 and MAPR12 in water
SAP 02	075	13:53															SN0203 and MAPR8 in water
SAP02	075	13:57															SN2002 and MAPR29 in water
SAP02	075	14:02	4	48.48	12	22.34											SN005 and MAPR 9 in water
SAP02	075	15:49	4	48.53	12	22.33			2700				140				winch stop
SAP02	075	15:55	4	48.53	12	22.32			2770								In position - weight at 50m
SAO02	075	16:16	4	48.54	12	22.33											Pumps started
SAP02	075	17:00	4	48.54	12	22.26	293	0.8									
SAP02	075	17:16	4	48.54	12	22.27	356	0.1	2770								
SAP02	075	18:00	4	48.51	12	22.35	325	0.1	2769								
SAP02	075	18:16	4	48.53	12	22.31	125	0.4	2769								pumps finished
SAP02	075	18:26															winch haul @ 40m/m
SAP02	075	19:50															MAPR & SAP 1 on deck
SAP02	075	19:55															MAPR & SAP 2 on deck
SAP02	075	19:59															MAPR & SAP 3 on deck
SAP02	075	20:05															MAPR & SAP 4 on deck
SAP02	075	20:08															pinger on deck
SAP02	075	20:13															weight on deck
CD169 Leg2: science log																	
BRIDGET etc																	
Operation	Jday	Time	Lat. (South) Deg	Min	Long. (West) Deg	Min	CMG	SMG	Wat. dept	Wire Out	Depth	Layback	Altitude	Comments			
transit	075	20:30															transit to BRIDGET03
transit	075	21:05	4	47.03	12	23.95	345	4.0									
BGT03	075	21:30	4	44.85	12	24.62	044	1.7									manouvering on station
BGT03	075	21:40	4	44.79	12	24.58	130	1.4									Deploying BRIDGET03
BGT03	075	21:45															BRIDGET in water
BGT03	075	21:53															BRIDGET recovery
BGT03	075	22:15															BRIDGET on deck
BGT03	075	22:31	4	44.97	12	24.44											Hove-to
BGT03	075	23:00	4	45.03	12	24.42											New start poss 1 mile down the line
BGT03	075	23:58	4	45.77	12	23.83											BRIDGET in water
BGT03	076	00:22	4	46.08	12	23.61	130	0.9	3110	1328	1335	#NUM!					big rita going down
BGT03	076	01:00	4	46.18	12	23.63	130	1.1	3131	1840	1836	311					big rita going down
BGT03	076	01:30	4	46.44	12	23.38	131	1.1	3087	2733	2715	503	212				Mn, eh signal, no nephs
BGT03	076	01:46	4	46.65	12	23.19	141	1.4	3135	2990	2980	434	100				fire bottle 1- nephs plume
BGT03	076	02:00	4	46.78	12	23.12	140	1.2	3068	3013	2937	862	75				fire bottle 2- nephs plume
BGT03	076	02:05	4	46.83	12	23.08	140	1.3	3100	2996	2975	544	75				fire bottle 3 - neph plume
BGT03	076	02:19	4	46.99	12	22.96	140	1.2	3096	3188	3010	1240	70				fire bottle 4 - nephs plume
BGT03	076	02:24	4	#REF!	12	#REF!	140	1.3	3096	3148	3030	1044	50				fire bottle 5 - nephs plume
BGT03	076	02:30	4	47.20	12	22.80	140	1.3	3095	2974	2819	1138	143				fire bottle 6 - nephs plume
BGT03	076	02:38					140	1.3	3095	3120	2950	1206	95				fire bottle7 - nephs + Mn plume
BGT03	076	02:55							3085	3122	2937	1249	100				fire bottle 8 - neph + Mn plume
BGT03	076	03:00	4	47.60	12	22.50	140	1.3	3042	3284	3081	1327	27				bottom of neph plume negative delta T
BGT03	076	03:24	4	47.90	12	22.30	140	1.3	3006	3180	2966	1337	73				fire bottle 9 - neph plume. Then started hauling at 40m/min
BGT03	076	03:34	4	48.00	12	22.20	140	1.2	2908	2800	2597	1237	245				fire bottle 10 - 160m above plume top.
BGT03	076	04:04								1500							
BGT03	076	04:23															Chem sensor switched off
BGT03	076	04:29	4	48.55	12	21.78	144	1.0	2918	560							BRIDGET switched off
BGT03	076	04:53															BRIDGET on deck and secure
transit	076	05:12	4	48.30	12	27.25	002										In transit to ABErecovery
ABE	076	05:55															ABE on surface
ABE	076	05:56															Transponder B popped
ABE	076	06:22															ABE on deck
TX recov	076	07:00															Transponder B spotted
TX recov	076	07:06															Transponder D popped
TX recov	076	07:17															Transponder B on deck
TX recov	076	08:05															USBL recovery start
TX recov	076	08:11															Transponder D on deck
TX recov	076	08:38															USBL raised
TX recov	076	09:05															Transponder A on deck
transit	076	09:30	4	49.71	12	22.53		7.0									Search for transponder A(orig) Aborted - to Ascension

Appendix D: Swath Survey Data List

Time (GMT)	Date	J day	Lat	Lon	EM12 Line No.	CMG	SMG	Water Depth	SVP	Comments		
11:32	19/02/2005	50	10	34.21	-21	2.2	1	10.9		started logging/no SVP/no gyro		
11:40	19/02/2005	50					1			gyro on		
12:00	19/02/2005	50					1			slowed down to do 360 turn to empty sewer pipes		
12:36	19/02/2005	50	10	28.65	-21	0.76	2	141	9	5159	finished flushing	
17:37	19/02/2005	50	9	45.48	-20	30.48	3	147	11.12	4947		
23:05	19/02/2005	50	8	57.78	-19	59.32	4	143	11	3438	data deterioration - no SVP	
08:56	20/02/2005	51	7	29.32	-19	2.11	5	142	11	4490		
15:03	20/02/2005	51	6	34.56	-18	26.96	6	148	11	4881		
22:01	20/02/2005	51	5	33.25	-17	47.53	7	146	11	5009		
09:19	21/02/2005	52	3	58.73	-16	46.7	8	146	10.6	4986		
14:48	21/02/2005	52	3	12.72	-16	17.2	9	150	10.8	4899		
20:04	21/02/2005	52	2	29.39	-15	51.5	10	150	9.6	5000		
08:16	22/02/2005	53	1	00.05	-14	59.67	11	146	10.3	3926		
14:52	22/02/2005	53	0	11.05	-14	31.3	12	141	10.7	3314		
16:23	22/02/2005	53									crossed the equator	
09:01	23/02/2005	54	-2	00.33	-12	54.91	13	140	10.3	3941		
10:22	23/02/2005	54	-2	9.25	-12	48.53	14	140	10.6	3277	log off to apply SVP - derived from JR65 XBT	
10:35	23/02/2005	54	-2	10.71	-12	47.47	14	140	10.3	2840	1	
17:37	23/02/2005	54	-2	55.98	-12	14.12	15	153	10.5	1881	1	at WP2 - start of work
19:37	23/02/2005	54	-3	13.48	-12	12.79	16	164	9.9	3907	1	at WP3
21:30	23/02/2005	54	-3	29.48	-12	10.27	17	162	10	3620	1	line no. change
00:02	24/02/2005	55	-3	52.23	-12	6.84	18	168	9.8	3688	1	at WP4
01:59	24/02/2005	55	-4	6.31	-12	17.91	19	176	9	3569	1	at WP5
04:11	24/02/2005	55	-4	25.39	-12	16.36	20	178	9.4	3528	1	at WP6
06:00	24/02/2005	55	-4	37.43	-12	26.94	21	157	8.6	3287	1	at WP7
06:25	24/02/2005	55	-4	40.9	-12	26.09	22	152	9.4	3300	1	change course, 15deg port
	24/02/2005	55	-4	48.35	-12	21.8	23	147	9.4	2947	1	change course
10:04	24/02/2005	55	-5	8.43	-12	18.39	24	155	8.7	3454	1	end of swath survey - TOBI deployment
13:02	24/02/2005	55	-5	11.69	-12	17.55	25	14	3.7	3345	1	start TOBI survey 01
19:28	24/02/2005	55	-4	58.37	-12	20.35	26	16	2.5	3591	1	
00:08	25/02/2005	56	-4	49.56	-12	22.84	27	10	2.6	3008	1	
07:30	25/02/2005	56	-4	34.57	-12	24.3	28	55	3.4	3726	1	
21:10	25/02/2005	56	-4	4.56	-12	16.33	29	61	2.9	3935	1	
07:34	26/02/2005	57	-3	56.29	-12	4.73		126	0.8	3477		log off - TOBI recovery
08:22	26/02/2005	57	-3	56.92	-12	5.27	30	226	8.5	3487	1	transit to CTD01
09:35	26/02/2005	57	-4	4.33	-12	15.99		192	3.8	4050		log off at CTD01
19:11	26/02/2005	57	-4	10.56	-12	17.97	31	25	9.7	3207	1	transit to TOBI 02 - re-deployment
20:00	26/02/2005	57	-4	5.64	-12	19.48		105	1.3	3714		hove-to for deployment
14:40	27/02/2005	58	-4	6.52	-12	19.23	32	118	2.7	3731	1	TOBI survey 02
07:31	28/02/2005	59	-3	33.25	-12	9.18	33	24	2.5	3678	1	
14:59	28/02/2005	59	-3	17.97	-12	10.19		5	2.5	3693	1	log off - TOBI recovery
18:35	28/02/2005	59	-3	15.07	-12	9.34	34	167	4.7	2988	1	log on - Transit to TOBI03
08:10	01/03/2005	60	-4	55.06	-11	38.65		154	5	3420		log off - TOBI deployment
10:27	01/03/2005	60	-4	57.08	-11	38.03	35	138	2.7	4464	1	log - TOBI03 survey
08:48	02/03/2005	61	-5	46.78	-11	30.58	36	160	3.3	3703	1	
16:36	02/03/2005	61	-6	4.38	-11	26.47	37	153	3.2	2970	1	
00:15	03/03/2005	62	-6	21.33	-11	21.47	38	144	3	3407	1	
06:52	03/03/2005	62										Ship lost power
08:02	03/03/2005	62	-6	38.97	-11	16.32	39					EM12 started
08:07	03/03/2005	62	-6	39.14	-11	16.27	39			3933		data flowing
09:38	03/03/2005	62	-6	42.14	-11	15.5	40			3292		logging resumed

Appendix D: Swath Survey Data List

15:12	17/03/2005	76	-5	38.63	-12	49.85	84	207	8.9	3312	1	
18:15	17/03/2005	76	-6	4.01	-13	7.51	85	207	8.9	3396		

Appendix E: CTD Configuration Files for CD 169

D.1) Original Configuration File

Date: 03/16/2005

ASCII file: C:\Program Files\Sea-Bird\Seasave-Win32\CD169\CD169_main.con

Configuration report for SBE 911/917 plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Scans to average : 1
Surface PAR voltage added : No
NMEA position data added : Yes
Scan time added : Yes

1) Frequency, Temperature

Serial number : 4489
Calibrated on : 12/29/04
G : 4.36985005e-003
H : 6.45644119e-004
I : 2.27228210e-005
J : 1.99064966e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency, Conductivity

Serial number : 3052
Calibrated on : 12/30/04
G : -1.01167697e+001
H : 1.41046907e+000
I : 1.40888638e-004
J : 6.06099170e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency, Pressure, Digiquartz with TC

Serial number : 73299
Calibrated on : 8 may 2002
C1 : -5.087539e+004
C2 : -2.199664e-002
C3 : 1.589010e-002
D1 : 3.721700e-002
D2 : 0.000000e+000
T1 : 3.011152e+001
T2 : -2.857091e-004
T3 : 4.528990e-006
T4 : -5.484500e-011
T5 : 0.000000e+000
Slope : 1.00000000
Offset : 0.00000
AD590M : 1.282874e-002
AD590B : -9.075593e+000

- 4) Frequency, Temperature, 2
 Serial number : 4490
 Calibrated on : 12/28/04
 G : 4.40572536e-003
 H : 6.48538846e-004
 I : 2.30142379e-005
 J : 2.02318152e-006
 F0 : 1000.000
 Slope : 1.00000000
 Offset : 0.0000
- 5) Frequency, Conductivity, 2
 Serial number : 3054
 Calibrated on : 12/22/04
 G : -9.90666069e+000
 H : 1.36319852e+000
 I : -2.43252028e-004
 J : 8.05596827e-005
 CTcor : 3.2500e-006
 CPcor : -9.57000000e-008
 Slope : 1.00000000
 Offset : 0.00000
- 6) A/D voltage 0, Oxygen, SBE 43
 Serial number : 0709
 Calibrated on : 6 aug 2004
 Soc : 3.8260e-001
 Boc : 0.0000
 Offset : -0.4858
 Tcor : 0.0010
 Pcor : 1.35e-004
 Tau : 0.0
- 7) A/D voltage 1, Free
- 8) A/D voltage 2, Altimeter
 Serial number :
 Calibrated on :
 Scale factor : 1.000
 Offset : 0.000
- 9) A/D voltage 3, Fluorometer, Chelsea Aqua 3
 Serial number : 88/2360/108
 Calibrated on : 17 nov 2004
 VB : 0.287100
 V1 : 1.978300
 Vacetone : 0.331500
 Scale factor : 1.000000
 Slope : 1.000000
 Offset : 0.000000
- 10) A/D voltage 4, OBS, Seapoint Turbidity
 Serial number : 10491
 Calibrated on : 1 june 2004
 Gain setting : 100 x
 Scale factor : 1.000
- 11) A/D voltage 5, Free

- 12) A/D voltage 6, User Polynomial
 Serial number : 169
 Calibrated on : 9 nov 04
 Sensor name :
 A0 : 0.00021513
 A1 : 0.00300000
 A2 : 0.00000000
 A3 : 0.00000000
- 13) A/D voltage 7, Transmissometer, Chelsea/Seatech/Wetlab CStar
 Serial number : 161/2642/002
 Calibrated on : 4 sept 1996
 M : 20.0000
 B : 0.0000
 Path length : 0.250

D.2) Configuration File after Deck Unit Swap, Cast 006.

Date: 03/16/2005

ASCII file: C:\Program Files\Sea-Bird\Seasave-Win32\CD169\CD169_main_SHIFT.con

Configuration report for SBE 911/917 plus CTD

 Frequency channels suppressed : 0
 Voltage words suppressed : 0
 Computer interface : RS-232C
 Scans to average : 1
 Surface PAR voltage added : No
 NMEA position data added : No
 Scan time added : Yes

1) Frequency, Temperature
 Serial number : 4489
 Calibrated on : 12/29/04
 G : 4.36985005e-003
 H : 6.45644119e-004
 I : 2.27228210e-005
 J : 1.99064966e-006
 F0 : 1000.000
 Slope : 1.00000000
 Offset : 0.0000

2) Frequency, Conductivity
 Serial number : 3052
 Calibrated on : 12/30/04
 G : -1.01167697e+001
 H : 1.41046907e+000
 I : 1.40888638e-004
 J : 6.06099170e-005
 CTcor : 3.2500e-006
 CPcor : -9.57000000e-008
 Slope : 1.00000000
 Offset : 0.00000

3) Frequency, Pressure, Digiquartz with TC

Serial number : 73299
Calibrated on : 8 may 2002
C1 : -5.087539e+004
C2 : -2.199664e-002
C3 : 1.589010e-002
D1 : 3.721700e-002
D2 : 0.000000e+000
T1 : 3.011152e+001
T2 : -2.857091e-004
T3 : 4.528990e-006
T4 : -5.484500e-011
T5 : 0.000000e+000
Slope : 1.00000000
Offset : 0.00000
AD590M : 1.282874e-002
AD590B : -9.075593e+000

4) Frequency, Temperature, 2

Serial number : 4490
Calibrated on : 12/28/04
G : 4.40572536e-003
H : 6.48538846e-004
I : 2.30142379e-005
J : 2.02318152e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency, Conductivity, 2

Serial number : 3054
Calibrated on : 12/22/04
G : -9.90666069e+000
H : 1.36319852e+000
I : -2.43252028e-004
J : 8.05596827e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

6) A/D voltage 0, Oxygen, SBE 43

Serial number : 0709
Calibrated on : 6 aug 2004
Soc : 3.8260e-001
Boc : 0.0000
Offset : -0.4858
Tcor : 0.0010
Pcor : 1.35e-004
Tau : 0.0

7) A/D voltage 1, Free

8) A/D voltage 2, User Polynomial

Serial number : 169
Calibrated on : 11/04
Sensor name : BBRTD
A0 : 0.00000000
A1 : 1.00000000
A2 : 0.00000000

A3 : 0.0000000

9) A/D voltage 3, Fluorometer, Chelsea Aqua 3

Serial number : 88/2360/108
Calibrated on : 17 nov 2004
VB : 0.287100
V1 : 1.978300
Vacetone : 0.331500
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

10) A/D voltage 4, OBS, Seapoint Turbidity

Serial number : 10491
Calibrated on : 1 june 2004
Gain setting : 100 x
Scale factor : 1.000

11) A/D voltage 5, Free

12) A/D voltage 6, Free

13) A/D voltage 7, Transmissometer, Chelsea/Seatech/Wetlab CStar

Serial number : 161/2642/002
Calibrated on : 4 sept 1996
M : 20.0000
B : 0.0000
Path length : 0.250

D.3) Configuration File after Sensor Re-Configuration, Cast 010.

Date: 03/16/2005

ASCII file: C:\Program Files\Sea-Bird\Seasave-Win32\CD169\CD169_main_SHIFT.con

Configuration report for SBE 911/917 plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Scans to average : 1
Surface PAR voltage added : No
NMEA position data added : No
Scan time added : Yes

1) Frequency, Temperature

Serial number : 4489
Calibrated on : 12/29/04
G : 4.36985005e-003
H : 6.45644119e-004
I : 2.27228210e-005
J : 1.99064966e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

- 2) Frequency, Conductivity
 Serial number : 3052
 Calibrated on : 12/30/04
 G : -1.01167697e+001
 H : 1.41046907e+000
 I : 1.40888638e-004
 J : 6.06099170e-005
 CTcor : 3.2500e-006
 CPcor : -9.57000000e-008
 Slope : 1.00000000
 Offset : 0.00000
- 3) Frequency, Pressure, Digiquartz with TC
 Serial number : 73299
 Calibrated on : 8 may 2002
 C1 : -5.087539e+004
 C2 : -2.199664e-002
 C3 : 1.589010e-002
 D1 : 3.721700e-002
 D2 : 0.000000e+000
 T1 : 3.011152e+001
 T2 : -2.857091e-004
 T3 : 4.528990e-006
 T4 : -5.484500e-011
 T5 : 0.000000e+000
 Slope : 1.00000000
 Offset : 0.00000
 AD590M : 1.282874e-002
 AD590B : -9.075593e+000
- 4) Frequency, Temperature, 2
 Serial number : 4490
 Calibrated on : 12/28/04
 G : 4.40572536e-003
 H : 6.48538846e-004
 I : 2.30142379e-005
 J : 2.02318152e-006
 F0 : 1000.000
 Slope : 1.00000000
 Offset : 0.0000
- 5) Frequency, Conductivity, 2
 Serial number : 3054
 Calibrated on : 12/22/04
 G : -9.90666069e+000
 H : 1.36319852e+000
 I : -2.43252028e-004
 J : 8.05596827e-005
 CTcor : 3.2500e-006
 CPcor : -9.57000000e-008
 Slope : 1.00000000
 Offset : 0.00000
- 6) A/D voltage 0, Oxygen, SBE 43
 Serial number : 0709
 Calibrated on : 6 aug 2004
 Soc : 3.8260e-001
 Boc : 0.0000
 Offset : -0.4858

Tcor : 0.0010
Pcor : 1.35e-004
Tau : 0.0

7) A/D voltage 1, Free

8) A/D voltage 2, User Polynomial

Serial number : 169
Calibrated on : 11/04
Sensor name : BBRTD
A0 : 0.00000000
A1 : 1.00000000
A2 : 0.00000000
A3 : 0.00000000

9) A/D voltage 3, Fluorometer, Chelsea Aqua 3

Serial number : 88/2360/108
Calibrated on : 17 nov 2004
VB : 0.287100
V1 : 1.978300
Vacetone : 0.331500
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

10) A/D voltage 4, OBS, Seapoint Turbidity

Serial number : 10491
Calibrated on : 1 june 2004
Gain setting : 100 x
Scale factor : 1.000

11) A/D voltage 5, Free

12) A/D voltage 6, Free

13) A/D voltage 7, Transmissometer, Chelsea/Seatech/Wetlab CStar

Serial number : 161/2642/002
Calibrated on : 4 sept 1996
M : 20.0000
B : 0.0000
Path length : 0.250

Appendix F: Rock Sampling Stations

CD169 Rock Sample Stations and descriptions

Station	Target	Lat. (S) °	Long. (W) °	Depth m	Wire m	Rock grammes, type, crystallinity	Sediment type
RC01	Central seg. 3: volcano	4 11.31	12 18.05	3131	3235	1g altered glass	calcareous
RC02	North Seg. 3 hummock	4 6.00	12 18.10	3550	3689	none	yellow calc.
RC03	Mid-north Seg. 3 volcano	4 8.75	12 18.10	3350	3470	5g glass	calcareous
RC04	Central Seg. 3 sheet flow	4 13.00	12 17.18	2900	3032	12g glass	calcareous
RC05	South Seg. 2: volcano	5 6.88	12 19.19	3362	3464	0.1g of glass	calcareous
RC06	Mid-south Seg. 2: volcano	5 4.02	12 17.29	3599	3573	10g glass	calcareous
RC07	Centre Seg. 2, plume max. (Mexican's Hat)	4 46.84	12 23.24	3129	3129	8g glass, 0.5g sulphide	Fe-oxides
RC08	Centre Seg. 2, mottled valley in sheet flow	4 46.24	12 22.62	3145	3231	4g glass	Fe-oxides
RC09	Centre Seg. 2, hummocks NE of central sheet flow	4 48.89	12 22.91	2959	3080	3g pl.-f glass	calcareous
RC10	Central Seg. 2: speckled area (on TOBI image), eastside sheet flow	4 47.67	12 22.00	3010	3080	12g v-fresh glass	none
RC11	South central Seg. 2, southside sheet flow	4 50.97	12 22.25	3025	3153	10g pl.-phyric glass	Fe-oxides
RC12	Central-northern Seg. 2: hummocky volcano	4 46.00	12 23.70	3175	3190	5g alt. glass	Fe-oxides
RC13	Central westside Seg. 2: hummocky ridge	4 47.45	12 24.60	2900	3080	10g glass	Fe-oxides
RC14	Central westside Seg. 2: hummocky ridge	4 49.60	12 24.05	2910	2980	.1g glass	calcareous
RC15	Centre Seg. 2, southwest side of sheet flow	4 50.24	12 23.20	3100	3180	0.1g of glass	calcareous
RC16	Central-east flank Seg. 2, seamount	4 48.48	12 21.25	2911	2998	2g alt. glass	calcareous
RC17	Centre Seg. 2, collapse pits in sheet flow and Eh hotspot	4 48.65	12 22.65	2988	3054	20g v-fresh glass	none
RC18	Central Seg. 2: mound central north side of sheet flow Parson's Nose)	4 47.77	12 22.47	2980	3020	5g v-fresh glass	Fe-oxides
RC19	Central Seg. 2: Central-northside of sheet flow	4 48.07	12 22.61	2990	3020	20g v-fresh glass	none
RC20	Central Seg. 2, mound just north of centre of sheet flow	4 47.30	12 22.80	2970	3012	3g pl.-phyric alt. glass	none
RC21	Central Seg. 2, south-middle of sheet flow	4 50.19	12 21.98	3010	1050	50g v-fresh glass	none
RC22	Central Seg. 2, hummocky ridge within south-middle of sheet flow	4 49.28	12 21.90	2960	3015	3g pl.-phyric alt. glass	Fe-oxides
DR01	North Seg. 2 hummocky ridge and volcano	4 38.27	12 25.46	3686		250kg mixed plag-phyric basalt	calcareous
01-end		4 39.08	24.7 23.41	3481			
DR02	Mid-north Seg. 2 hummocky AVR	4 44.33	12 23.41	3288		50kg mixed plag-phyric basalt	calcareous
02-end		4 45.05	12 21.83	3238			
DR03	Central Seg. 2, below TOBI plume max. (Mexican's Hat)	4 46.37	12 23.12	3000		150kg of mixed sheet flow and pillows	calc & FeOx
03-end		4 47.02	12 22.84	3100	3400		
DR04	Centre Seg. 2, Parson's Nose to collapse pits: sheet flow area	4 47.64	12 22.70	3020		200kg of glassy sheet and pillow flows	calc & FeOx
04-end							

