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21 MAR-19 APR 1997

Geological processes in the Strait of Hormuz, Arabian Gulf:
a contribution to the Scheherezade Programme

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1997

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ABSTRACT

The second leg of the Scheherezade multidisciplinary environmental cruise to the entrance to the Arabian Gulf is concerned with superficial geology, geoacoustics and geotechnics.

Preliminary interpretation of the digitally recorded sidescan sonar, seismic profiles and the 206 sediment samples showed that the area can be divided into two types, one where strong currents sweep the seafloor and the other where currents are weaker. In the strong current area, bed load transport paths have been determined from asymmetrical bedforms and a number of bedform zones have been identified. The sediments here are mainly shelly sands and gravels. In the weaker current areas there are large numbers of pockmarks, believed to be due to gas venting at the seabed. The sediments here are muddier but shelly sands are still present. Two very high resolution sidescan surveys of selected areas were made and at each survey area video photographs of the seabed and dredge samples were obtained.

Measurements of shear waves were made with the newly developed SAPPA device at nine sites. Further work is needed before P waves can be measured.

KEYWORDS

ARABIAN GULF, BEDFORMS, *CHARLES DARWIN*/RRS, CRUISE 104 LEG 2 1997, POCKMARKS, SAPPA, SCHEHEREZADE, SEDIMENT SAMPLING, SEISMIC PROFILES, SIDE SCAN SONAR, STRAIT OF HORMUZ, VIDEOTAPE RECORDING

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2. SCIENTIFIC ACHIEVEMENTS

a. This survey is the second leg of the Scheherezade multidisciplinary environmental cruise to the entrance to the Arabian Gulf. It is concerned with superficial geology, geoacoustics and geotechnics. Leg 1 was concerned with the study of hydrography, pelagic biology and meteorology and is the subject of a separate report (Roe et al, 1997).

b. A geophysical survey of the superficial geology in the area around the Musandam Peninsula, within Omani and UAE waters, was carried out. Digitally recorded sidescan sonar with a swath width of about 800m was obtained along approximately 2500km of track, high resolution sidescan with about 200m range along 150km of track and high resolution seismic profiles along approximately 2000km of track.

c. A sampling programme was completed over the entire area of the geophysical survey. 206 stations were occupied. Cores were taken where possible and failing that grab samples or dredge samples. Preliminary sieving of a portion of sediment, to retain the larger constituents, was completed.

d. Preliminary interpretation of the sidescan sonar, seismic profiles and sediment samples showed that the area can be divided into two types, one where strong currents sweep the seafloor and the other where currents are weaker. In the strong current area bed load transport paths have been determined from asymmetrical bedforms and a number of identified bedform zones should, by analogy with work in other areas e.g. Belderson et al 1982, give an estimate of the peak current speed at the seabed. The sediments here are mainly shelly sands and gravels. In the weaker current areas there are large numbers of pockmarks, believed to be due to gas venting at the seabed. The sediments here are muddier but shelly sands are still present.

e. Two detailed sidescan surveys of selected areas were made and at each video photographs of the seabed and dredge samples were obtained. One survey was from a zone where gas was suspected to be at or near the seabed and is characterised by a particular type of pockmark pattern, the "pitted ground". In the other detailed survey area there appeared to be relict bedforms, shaped by a different current regime from the present one.

f. Measurements of shear waves were made with the SAPPA device at nine sites. Further work is needed before P waves can be measured. The SAPPA is a new instrument which was being used for the first time and, in the circumstances, performed well. Shear strength measurements were made on cores from the SAPPA sites and from all other samples where possible. Cores were retained for laboratory measurements with the multi-sensor core logger.

3. INTRODUCTION

(Neil Kenyon)

3.1. Background

There are special conditions controlling the physical oceanography and hence the current regime and the sedimentation patterns in regions of straits. The Arabian Gulf is an important commercial and strategic sea area, in a warm, low latitude, setting that is partially closed at the Strait of Hormuz. A major aim of the cruise was to first determine the sedimentation patterns in and adjacent to the Strait, prior to finding out what controls their character and distribution. A reconnaissance was planned in order to find out the extent of the area most directly affected by the constriction at the Strait and to cover that area with a geophysical survey and a sediment sampling programme.

The Arabian Gulf lies in a low between the relatively undeformed continental crust of the Arabian Shield and the highly compressional Zagros Mountains to the north. It is shallow with a median depth of only 35m. The northerly plunging and tilting Musandam Peninsula, with its high mountains, constricts the mouth of the Arabian Gulf. The deepest part of the area, > 200m, lies within the Strait of Hormuz at the tip of the Peninsula. During the last regression of sea level the Gulf area was a large river valley with streams flowing in from surrounding higher ground (Kassler, 1973). A relict of the drainage from the high mountains of the Musandam Peninsula is seen as inlets with a pattern of shoreline that resemble tributary drainage patterns. They are present at the northernmost tip of the Peninsula. It is presumed that these were once wadis, formed on land by flash floods, that have been drowned by the sea. There is at the present time a remarkably rapid rate of subsidence at the northern end of the Peninsula, estimated to be as much as 60m over the last 10,000 years (Vita-Finzi 1973).

Very little work on the superficial sediments from the area of operations has been published. There are two lines from a reconnaissance using a 3.5 kHz profiler, on a cruise of the RV Atlantis II, that pass through the area (Ross et al 1986: Uchupi et al 1996). Most of the preexisting sedimentary data is from the notations on Admiralty charts, which show that shell sands are common. In addition there are 4 cores taken by Atlantis II from just outside the area and a few grab samples from the study of the superficial Gulf sediments made by Sarnthein (1972).

3.2. Aims and Objectives

3.2.1. Basin Filling Processes

An overall aim was to look at the nature of the recent (Last Glacial to Present) basin filling processes. Controls on sedimentation were expected to include:

a) Input of terrigenous, dominantly siliciclastic, sediment compared with the production of carbonates. The main input of terrigenous muds during the Holocene probably comes from the Tigris-Euphrates and from the Iranian margin, which has a higher rainfall than the Arabian margin. A terrigenous mud layer, seen as a transparent blanket on seismic profiles (Ross et al 1986; Uchupi et al 1996), is present in the deeper parts of the Gulf, which are mainly on the northern, Iranian, side. Carbonates form a major proportion of the sediment and are expected to be of several origins.

b) Sea level. The last period of lower sea level is thought to have resulted in a subaerial erosional surface on which the mud blanket formed during the Holocene. It was hoped that the programme would reveal something of the nature of this erosion surface and of the history of the last transgression. The shelf margin at the time of low sea level stand is postulated to be found near the Strait of Hormuz by Sarnthein (1972), who also interprets groups of low parallel ridges from within the Gulf as possible seif dunes.

c) Tectonics. It was hoped that we could determine the impact of the active vertical tectonics on the sedimentary patterns.

d) Currents. Very little is known about the current regime at the Strait of Hormuz. There is inflowing surface water, due to the evaporation within the Gulf area, and outflowing deeper more saline water. The effect of Coriolis force is that the surface inflow is deflected toward the Iranian coast and the subsurface outflow (which has the most influence on bed load sediment distribution) is deflected toward the Arabian coast. Wave action is also significant, causing winnowing of finer sediments from the shallower areas near the coast and leaving higher energy carbonate sands. Tidal currents are strongest in the Strait and are probably maintaining the deep trough to the north of the Musandam Peninsula. The current information obtained by ADCP during the first leg of Cruise 104 (Roe et al 1997) together with long term mooring data obtained by the Louisiana State University from two sites within our area will be combined with the sedimentary data.

e) Carbonate producing organisms. There have been relatively many studies in the Gulf of carbonate sedimentation and the formation and diagenesis of evaporitic minerals, e.g. papers in Purser (1973). The carbonate processes will be studied and especially the interaction of sediments with shelly faunas. Useful information is expected on the relation between bed stress and faunal associations (as in the study of the Bristol Channel by Warwick and Uncles 1980).

3.2.2. Acoustics/Geotechnics

Acoustic methods are often the only practical way of gaining information on the spatial distribution and the in-situ properties of seafloor sediments. Not surprisingly, the relationships between acoustic properties (velocity, attenuation, backscatter strength) and more applicable sediment parameters (e.g. grainsize, porosity, mineralogy, degree of cementation) are of considerable interest to marine geologists. A large amount of acoustic data has been collected on siliciclastic sediments, but there are relatively few data on carbonate sediments (e.g. Hamilton 1987). There is no reason to suspect that the two groups of sediments behave in the same way in response to acoustic waves. Detailed studies are needed on carbonate sediments to test the validity of sediment acoustics models, such as the Biot-Stoll model (Stoll 1989), developed for granular materials.

The geophysical survey using digitally recorded sidescan sonar images and subbottom profiles, together with a sampling programme, will be supplemented by a laboratory based programme of acoustic, geotechnical and sedimentological measurements on the collected samples.

It is intended that this programme will:

a) provide high quality data on the acoustic properties of carbonate sediments. This will be achieved through in-situ measurements using compressional and shear waves.

b) establish the relationships between acoustic and carbonate sediment properties. This will involve a geostatistical analysis of the collected datasets.

c) relate the experimental data to sediment acoustic models and hence ascertain the nature of wave propagation in carbonate sediments. In-situ acoustic velocity and attenuation measurements will be compared with the Biot-Stoll model predictions.

4. CRUISE NARRATIVE

(Neil Kenyon)

(Times are local, which is 4 hours ahead of GMT)

Thursday 20 March (Day 079)

Scientific party arrive to join RRS Charles Darwin at the Freeport, Abu Dhabi. Install Seistech Boomer and Widescan sonar.

Friday 21 March (Day 080)

Sail at 1200 after late delivery of water. Test Widescan and Boomer in shallow water outside approaches to Abu Dhabi. Boomer is found to be affecting ship's electric supply. The solution is judged to be acquisition of an isolating transformer. Proceed at full speed to area of operations near entrance to the Arabian Gulf.

Saturday 22 March (Day 081)

Start geophysics survey at 4 knots. The speed was limited by the Boomer and until the Boomer survey stopped at the end of the first two weeks this was the operating speed, after which sidescan surveys were run at about 5 knots. Running the Boomer off scientific supply is found to be acceptable, without need for transformer. First two lines are a reconnaissance, designed to determine types of ground present and establish operating restrictions.

[SOME OPERATING RESTRICTIONS

The area imposes a number of unusual restrictions to following the ideal track layout. All lines need to follow shipping lanes in the direction of traffic flow or to cross lanes at right angles. Slow ship's speeds and the strong currents found in some places make line following difficult. Satellite navigation errors make close spaced tracks difficult. Large, unmaneuverable ships are sailing through much of the area. The Iran/Oman median line has to be given a wide berth. The main hazards are the almost ubiquitous fish traps. These are wire mesh pots anchored to the sea floor and buoyed at the surface using rope and polystyrene floats. The location of the traps is fairly unpredictable but there are more near the fishing villages. The only areas where they were not observed, to my knowledge, are the traffic separation zones and the strong deep water region north of the Musandam Peninsula. Here there are other hazards to consider. Hence underway work was done during daylight, when there was a choice, and those areas deemed easiest were done first. Running tracks parallel to peak currents, where possible, was found to cause less snagging incidents.]

Sunday 23 March (Day 082)

At 0100, while north of the Musandam Peninsula, the sidescan record deteriorated and when attempting to haul the fish in for inspection the winch tripped. On resuming hauling in, the fish was lost. This happened at the point when its own weight came on the fish while being lifted on board. The survey resumes with the Boomer alone. The replacement Widescan fish is launched in daylight at 0700.

Monday 24 March to Friday 28 March (Day 083-Day 087)

Underway survey in good weather at 4 knots. On the basis of the reconnaissance it is chosen to run the lines at 0.7 nm (1.26km) apart with the nominal sidescan range at 800m. This allows for later filling in to produce a complete coverage in selected places, if it is deemed to be required. Recoveries for potential or real snagging of fish traps happen at 1420/24/4, 1655/27/4, 0825/28/4. On Thursday night sampling is carried out at 1 mile intervals, along a line in the strong current area north of the Peninsula. This is a practice run for the intensive sampling planned for later. The gravity corer is not successful in the coarse bioclastic sediments and the carbonate crusts that are obtained by the Day grab.

Saturday 29 March (Day 088)

The geophysics survey resumes at 0750 and continues until 1745. Proceed to Abu Dhabi for fresh water. (Regulations concerning pollution prevented the ship making water within 20 miles of the coast. Hence a water call was necessary every 10 days or so.)

Sunday 30 March (Day 089)

Sail from Abu Dhabi at 1500 and return to survey area.

Monday 31 March to Friday 4 April (Day 090-Day 094)

Complete most of the geophysical survey, mainly to the east of the Musandam Peninsula, an area within sight of spectacular geological exposures of folded sedimentary rocks. Interruptions to surveying, due to clearance of fish trap mooring lines hooked by the sidescan fish etc. occur at 1415/31/4, 0600/1/5, 0650/1/5, 1205/1/5, 2120/2/5, 2300/2/5, 1630/3/5. The tension on the sidescan fish can be considerable and there is a danger that the mooring lines will part as the fish is hauled on board, causing the fish to smash into the transom. (There would have been many more snagging incidents if the survey lines had not been laid out parallel to the predicted peak current direction.) Survey stops at 1700/4/5 and vessel proceeds to Abu Dhabi for water and personnel change.

Saturday 5 April (Day095)

1000 to 1420 in Main Port, Abu Dhabi. Scientists cannot get permission to leave Port area. Visit by Dr Saif Al-Ghais, Secretary General, Environmental Research and Wildlife Development, UAE, together with Heidi Minshall of the British Embassy, Abu Dhabi. At 1600 a fishing line is discovered lodged in bow thruster. Proceed slowly to Dubai for diver's to clear rope. (We could possibly do this ourselves if there were diving equipment and divers aboard). Mike Somers and John Roberts, working for Geotek, commence assembling SAPPA.

Sunday 6 April (Day 096)

1100-resume course for survey area. Start sediment sampling at 1720. Samples are being taken every 2 miles, along every third geophysical survey line. This is intended to give a fairly evenly distributed sample coverage of the surveyed area on a grid of two miles square. Gravity cores are taken where possible. The strategy is to take a grab sample in the first instance unless neighbouring samples have been fairly muddy, when a core will be taken first.

Monday 7 April to Thursday 10 April (Day 097-Day 100))

Completing most of sampling programme. An attempt is made to sample and survey in the bays east of the Peninsula. Unfortunately the vessel snagged a fishing line in the first bay entered and so the attempt is abandoned with only one sample taken. The Widescan survey is continued from 1900/10/5.

Friday 11 April (Day 101)

Widescan survey stops at 1410. Proceed to Abu Dhabi.

Saturday 12 April (Day 102)

Arrive Abu Dhabi. The weather having deteriorated to a considerable extent it is decided to delay sailing and conduct the first SAPPA test in the harbour. (The waves have clearly disturbed the seafloor sediments and the suspensions of silt/sand have coloured the water a pale turquoise blue.)

Sunday 13 April (Day 103)

0600-ship sails for survey area. 2020/13-2025/14-dredge programme in areas that previously acquired data indicate as having possible cemented carbonates, namely in a deeper channel west of the Peninsula and in an area of possible closely spaced pits to the north of the Peninsula. A dredge was lost at site 153. Most dredge samples have large quantities of muddy sands and have less pieces of crust than expected. It is possible that the dredge is biting into the seafloor, filling and then being towed along without doing any further sampling.

Monday 14 April (Day 104)

2220-SAPPA tests in position east of Peninsula that is safe from shipping, with calm seas, weak currents and daylight. 0300-0830-sediment sampling. 1020-1940-SAPPA measurements. Only shear wave measurements are obtained. Further SAPPA deck tests and calibration is needed. 2130-a camera station, using CTD frame and vertically mounted camera, is aborted due to poor images and danger to the expensive frame when dragged across seabed.

Wednesday 16 April (Day 106)

0020-0630 sampling. 0820-1020 SAPPA measurement after wait for modifications to be completed. 1540-2130 SAPPA sites completed, apart from the southeasternmost. The planned P-wave measurements cannot be made. Widescan deployed from 2230-2248, but recovered and cable reterminated when cable found to have water in it. 2330/16-0100/17 successful camera station in pitted ground, using newly constructed, throwaway camera sledge designed by Chris Hunter, with advice from John Wilson, Steve Whittle and Jeff Jones. Others provide ribald comments prompted by flimsy nature of construction.

Thursday 17 April (Day 107)

0250-1930 sample programme completed west of Peninsula apart from planned sites in the bay Dawhat ash Shisah. 1940-Widescan survey using highest resolution, 325kHz, 100m range each side. 2026-2225 repair to severely damaged Widescan cable, snagged to NW of Peninsula, close to the island Jazirat Umm al Ghanam during final ship's barbecue and PSO's RPC. This repair is carried out rapidly thanks to work by Tim Crocker, Mike Somers and John Roberts. At 0025 survey restarts on first of detailed areas, the "pitted ground", and proceeds to the second area, the "relict features". The survey lines, planned to be 1.5 cables apart, have to be closed up to 1 cable apart when it is found that the sonar range is not as great as expected. This is at or beyond limit of what the ship and navigators are capable of, due to restrictions of the navigation system, shipping and currents. However it is hoped that a useful mosaic can be made from the digital recordings.

Friday 18 April (Day 108)

1350-survey over. 1550-1709 Second successful camera deployment. This one over possible relict bedforms. 1709-start passage to Abu Dhabi.

Saturday 19 April (Day 109)

0900 cruise ends.

5. SCIENTIFIC ACTIVITIES

5.1. Bathymetric survey

(Neil Kenyon)

The precision echo sounder used was the SIMRAD EA500. This provides a coloured print out that should enable data on echo character within the uppermost seafloor sediments to be mapped, but the data has yet to be analysed. The soundings show that the sea floor around the Peninsula falls away very steeply apart from off the western shore. It quickly reaches a remarkably flat plain with depths of 80-100m. Wrapped around the Peninsula there is a linear deep that lies about 2 to 20km from the shore. The deep is usually about 100 to 120m deep except between the tip of the Peninsula and the plateau on which the "Quoins" sit, where it is deeper than 200m. The deep is usually bounded by steep scarps, well seen on the sidescan as well as on the echo sounder profiles.

5.2. Sidescan Sonar Survey

5.2.1. Survey Results

(Neil Kenyon)

The geophysical survey was designed to cover the area in the time available and given the operating restrictions mentioned in the narrative. Following a reconnaissance it was decided that lines with a spacing of 0.7 nm would provide about 50% sidescan sonar coverage with the 100kHz frequency and nominal 800 m range. This would allow the area to be fully covered by running lines between the basic grid. Most of this network of lines was completed by the time that the Boomer team returned home in mid cruise. Filling in was only undertaken for a few lines, mostly in the strong current area, north of Musandam Peninsula. Two detailed sidescan sonar surveys were made in the short time remaining after completion of the basic survey and sampling grids. These used the 325 kHz frequency and a range of 100m each side.

The reconnaissance was also used to decide on the limits of the survey area. This is slightly smaller than proposed in precruise planning as it was found that one of the main mappable features, the current swept sea floor, was neatly encompassed in the smaller area.

Current Swept Seafloor

A large part of the region shows evidence that the seafloor is swept by currents that can move bedload. The largest current swept area is in or around the linear deep. There is a smaller area near the Quoins, islands situated north of the Peninsula. The commonest bedforms are sand ribbons (Kenyon 1970), thin current parallel strips of sand that are being moved across a coarser or otherwise relatively immobile seafloor. They occur in several types-trains of small sand waves, broad sand strips, very thin and very straight strips (resembling harrow marks)-and indicate that the peak near seafloor currents reach 75-150cm/s (Belderson et al 1982). Large sand waves are found to the east of the Peninsula, where they seem to be tied to a headland in the manner found around the British Isles, and also in the deepest area north of the Peninsula. Asymmetrical longitudinal bedforms or obstacle marks, including wreck marks and sand shadows, are also found. Irregular shaped seafloor is usually interpreted as scoured areas. Near the deep there are some remarkable trains of scour holes, a longitudinal bedform that has not been described hitherto, as far as I am aware. The current swept area corresponds approximately to the area where there is least mud and the coarsest shelly sands and gravels.

Together the asymmetrical bedforms provide evidence for a main bedload transport path heading eastwards out of the Gulf. The evidence comes from many examples of asymmetrical sand waves, either as asymmetrical profiles or as barchan shapes in plan view, and of obstacle marks. There are also some apparent obstacle marks in the weaker current zone. These appear in some cases to show evidence of a contrary transport path, into the Gulf.

Weak Current Zone

Beyond the obviously current swept seafloors the main sonar "acoustic facies" is seen as uniform weak backscattering, with or without pockmarks. There are a number of pockmark types, although nearly all have in common a near circular shape and a similar size (about 10m in diameter). Most pockmarks appear to have a higher backscattering rim. Their profile is hard to determine, except on the high resolution records where some of them do appear to have raised rims. Densities vary widely from none to the closely spaced pockmarks of the "pitted ground", where they can be touching. Some are aligned and parallel. The parallel ones are near the current swept zone and may be on low ridges. Some appear to have one part of the strongly backscattering rim missing, resulting in a horshoe shape. The latter may be due to modification by the current. Others appear to have two opposite sides missing and when aligned look like giant animal tracks. These also may be modified by the current. The "pitted ground" is in an area where the Boomer profiles show "acoustic turbidity", indicating that gas is present at or very close to the surface. There are some apparent obstacle marks in the weaker current zone. Dark crusts are found in the dredge samples from the "pitted ground".

No clear evidence for gas in the water column was seen. Most dark features in the water column were fish shoals, as the fishing boats in the vicinity would imply. It is thought probable that evidence for gas bubbles, on the profiles that are presented in Uchupi et al (1996), is spurious.

Possible Relict Features

The linear deep is presumed to have formed at lower sealevel. Its 100m deep edge would have been very close to the shore at the last sea level lowstand, unless the supposed rapid subsidence means that it was above sealevel until more recently. It could have been cut by a river or estuary.

Small dynamic shaped features with a higher level of backscatter are found in both the strong and weak current zones. Most are either transverse or longitudinal with repect to the present transport paths. The supposition is that these are cemented bedforms that indicate a former current regime. Attempts to sample the cemented crusts were partly successful.

The age of these possible bedforms is not known. They could be from a time of lower sealevel and/or they could be from the time of a recent, possibly even a seasonal, change of current regime.

5.2.2. Widescan Equipment
(Angus Best)

The shallow water sidescan equipment used is an Ultra Electronics Model 3050E Widescan with enhancements. It is a lightweight dual frequency (100/325kHz) system capable of operations down to 300m of water. The standard system gives paper images on a 12 inch thermal chart recorder, whereas our system is modified to allow full digital data acquisition. This will enable us to use the 'State-of-the art' processing software (PRISM) developed initially at IOSDL for GLORIA and TOBI deep sea sidescan data.

Operational notes

Winching

The winch was operated using mainly the remote handset. The remote control was useful because it allowed the operator to keep an eye on the sidescan paper record at the same time as paying out or hauling in cable. We found that the cable could be paid out or hauled in at a rate of about 100m per minute which was adequate for most changes in water depth. The latter being sufficiently gradual. Although there was 1000m of cable on the drum, rarely more than 250m was actually used during the survey. This was mainly because the ratio of cable out to towfish depth became unworkable for more than about 250m; that is, letting cable out >250m did not provide a significant increase in towfish depth, probably due to the relative lightness of the towfish. No depressor weight was used, but this is something to be considered for future work, as, especially in water depths >150m, it difficult to fly the towfish sufficiently close to the seabed for optimum results.

Fishing lines were thought to be the cause of the loss of our original Widescan towfish on 23 March 1997. The fish was being winched in, lead by the rope lanyard (the shear pin had failed possibly under the force of a particularly strongly anchored fishing line), when the fishing line apparently sawed through the lanyard with the fish in sight. Consequently, a steel lanyard was added to the spare towfish as a precaution before it was deployed, and this served well. Numerous fishing lines were snagged by the replacement towfish in the following days and part-severed shear pins were replaced on several occasions.

Recording parameters

The Widescan manual recommends that the towfish is flown at an altitude of 10% of the range. This gives the best possible range and swath width with adequate signal level for most seafloors. The mean water depth of about 100m in the survey area meant that we operated the system on maximum range (400m), and flew at an altitude of 40-60m. This was found not to impair the signal strength and it enabled uninterrupted records to be collected for most of the survey area; the action of raising or lowering the towfish results in an unusable section of record.

For the most part the seafloor was slightly undulating and it was possible to set a towfish altitude and maintain it for several hours at a time. In the deepest parts of the survey area, however, where the water depth exceeded 150 m, the seafloor varied more abruptly and hence it was necessary to adjust the cable length more frequently.

The tow speed was 4 knots for the greater part of the survey, when used in conjunction with Bangor's boomer profiler. Otherwise a speed of 5 knots was used. A frequency of 100 kHz with a long pulse length was used for the main survey, which allowed maximum swath width. Smaller, more detailed surveys were conducted using 325 kHz on areas of special interest. Altitude values and 5 minute time lines were recorded automatically on the paper record together with manual annotations (e.g. cable length adjustment; time; date). The digital data were recorded exclusively on DAT drive D:. The tapes were changed regularly so that approximately one day's work was on each tape. This was a precaution in case one tape malfunctioned, or if the logger was powered down accidentally without firstly unloading the DAT tapes (which would result in loss of data).

A separate, stand-alone DAT drive was installed on a shipboard PC via a fast SCSI card connector. This was used to transfer the data to backup tapes via a hard drive and to view occasional data files to ensure that they were in order.

5.3. High-resolution Seismic Sub-bottom Profiler Survey

(Angela Davis and James Bennell)

Single channel high resolution seismic sub-bottom reflection data were acquired within the survey area using a broadband boomer type source as signal generator and a separate towed Design Products hydrophone as receiver. Over a 13 day period, approximately 2000 line km of data were shot, providing a series of sub-bottom seismic reflection time slices of the upper few tens of metres of the sea floor materials.

This source receiver configuration was adopted after an initial trial with a fixed catamaran-mounted combined source-receiver system - the IKB Seistec - had shown that a line-in-cone receiver (the type incorporated into the Seistec) had a directivity pattern that was incompatible with the prevailing sea state and water depth i.e. calm conditions and 80-200m depths.

Throughout the survey the catamaran-mounted boomer was towed slightly astern of the vessel on the port side, with the hydrophone astern the starboard side of the ship on the opposite side of the wake. This towing arrangement has the effect of optimising signal-to-noise, with the wake acting to alternate the direct wave (and sea surface multiples) whilst not interfering with bottom and sub-bottom returns. The boomer was powered by a GeoAcoustics Power Supply Unit operating at 175 joules. The source was fired 3 times a second.

Data were recorded in both analogue and digital format, the analogue records printed onto a Dowty Waverley Thermal Linescan Recorder (model 3700) and a Dowty Wideline Recorder (model no. 195/135). The Wideline was used to record the raw unprocessed signal (200ms. record) while the Waverley generally recorded a filtered and variably amplified signal. A TSS (model 305) swell filter was used to smooth out the effects of sea surface motion and a time varying gain was applied using an IKB Dual Slope Processor (model SPA1-F). Wherever appropriate, i.e. outside areas of severe topographical change, the Waverley recorder was set to display a 100ms record to enhance vertical resolution. For both recorders the delay time facility was used to optimise display of the subsurface structure.

Digital data were recorded onto DAT tape using a Sony Digital Audio Tape Recorder (model TCD-D7). The ingoing signal was continuously monitored using a Nicolet oscilloscope. Each tape recorded between 2.5 and 3 hours worth of seismic data.

At the start of the survey all recorders were synchronised to record time in GMT, thus allowing navigation data to be incorporated at the processing/interpretation stage. These times were checked and amended if necessary on a daily basis.

During the survey a preliminary interpretation of seabed surface and near surface features/acoustic character was attempted using the analogue data (see annotated track plot accompanying this report). The boomer data were also used to make recommendations on sampling sites for control information. Xeroxed annotated copies of relevant boomer records for the proposed site also accompany this report.

Diary for Seismic Acquisition

29.3.97 Setting up equipment prior to sailing.

21.3.97 Continue assembling equipment. Initial test deployment of Seismic Catamaran enroute to survey area (15:00 local time).
Operational problems identified with relation to use of the GeoAcoustic Power Supply Unit. Apparent incompatibility between the PSU and the ship's electrical supply causing some concern to the ship's engineers. Haul in Catamaran and discuss problems with engineers.
Redeploy at 17:00 local time to test operation off different circuits (ship's mains circuit and scientific supply circuit - both 220 volt supplies). Earthing problems persist. Shut down and haul in equipment.
Discuss options:

1. operate off separate 3KVA generator (not available onboard)
2. operate through 3KVA isolation transformer (not available onboard)
3. test after rewiring PSU to 110 volts.

Decision to explore option 2 through agents. Option 3 scheduled for following day.

22.3.97 06:30 GMT Redeploy boomer for test on 110 volt scientific supply.
Operation passed OK by ship's engineers. Start recording through Seismic receiver.

09:16 GMT Transfer to recording through separate towed hydrophone to reduce noise and improve data quality.

Continuous recording until 04:23 GMT on 28.3.97.

28.3.97 04:23 GMT Shut down equipment, haul in Seistec and check over whilst sidescan survey continues over an area previously covered by the sub-bottom profiler.

11:55 GMT Redeploy and recommence recording on a new line.

15:04 GMT Complete lines and haul in gear ready to commence coring and grab sampling.

29.3.97 03:51 GMT Redeploy boomer to commence surveying new line.

14:40 GMT End of line. Shut down and bring in gear ready to steam to port for water call.

31.3.97 02:47 GMT Boomer redeployed in heavy seas. Variable to slight sea state becoming calm.

4.4.97 13:00 GMT End of boomer survey.

5.4. Sampling and Underwater Video Recording

(John Wilson)

Sediment and benthic faunal sampling was undertaken using the Day grab, the rock dredge, the gravity corer, the Kastenlot corer and the box corer. The Day grab was operated midships using the hydrographic wire on the starboard davit. The Day grab takes a sample with a surface aea of 0.1 square metre. The gravity corer, Kastenlot corer and box corer were operated from the starboard davit using the main warp. Dredging was undertaken from the stern A-frame using the main warp. For the dredging operations a 100m sacrificial pennant was attached to the main warp to ensure that the main warp itself did not make contact with the sea-floor. A 5 ton weak link was then mounted between the pennant and a length of studded cable. A 3 ton weak link was placed between the end of the studded cable and the rock dredge itself. The pipe dredge was attached to the end of the dredge grommet bag by means of two short chains. The pipe dredge provided additional weight at the end of the dredge to control its movement over the sea floor.

A total of 206 stations were occupied and appropriate sampling gear was deployed. At some stations where the Day grab sample indicated a soft silty mud or muddy sand bottom, a gravity core was also taken. Where it was thought that the sediment would be suitable, only a gravity core was taken. The Kastenlot corer was used 3 times where the thicker silty mud from the "Iranian mud blanket" was considered to be suitable for shipboard geotechnical measurements to be made at intervals down the core. The box corer was similarly used with geotechnical measurements being made in successive layers within the sediment and two sub cores being taken from the undisturbed box cores for further analysis. The remaining sediment from each layer from the box cores was sieved and the biogenic carbonate was retained.

At each Day grab station any noteworthy surface features were recorded, the shear strength of the sediment was measured if possible, the volume of the sediment was noted, a "whole" sediment sample taken and the remaining sediment was sieved through an appropriate sieve (usually >1500 microns) to retain the coarser material which was mostly biogenic carbonate. Any live invertebrates were collected separately and preserved in methanol.

12 rock dredge tows were undertaken where the side-scan sonar records and the information gleaned from Day grab samples suggested additional useful data would be obtained. The dredge was towed for 10 - 25 minutes as appropriate. A sediment sample along the tow was collected by the pipe dredge towed immediately behind the rock dredge. A sediment sample from the pipe dredge was taken and the remainder sieved through an appropriate mesh sieve to retain the biogenic carbonate and carbonate crust fragments. One dredge was unfortunately lost when the 5 ton weak link unexpectedly failed when the dredge was thought to have encountered an area of cemented carbonate crust. The 3 ton weak link should have parted, in which case the safety strop would have throttled the bag and enabled the dredge to be recovered. The 3 ton weak link did fail on the last dredge haul (station 162) but the dredge and sample were successfully recovered.

Preliminary examination of the faunas was undertaken during the sieving process. Over much of the area the sediments are fine to medium sands with a proportion of mud present. These sediments support a characteristic invertebrate fauna consisting predominantly of polychaetes and corals. Some of the polychaetes lived in tubes which protruded above the surface of the sediment. Some tubes were parchment-like, others were reinforced either by sand grains or as in the case of the larger diameter tubes, by shell fragments Other polychaetes live within the top 2 to 3 cm of the sediment. Small crustacea are also present on the sediment surface and in shallow burrows. Three species of non-zooxanthellate solitary Caryophyllid corals were recorded. These are very distinctive and when live are a vivid orange colour. The largest one was present in densities up to 20 per square metre in some areas. The smallest coral was much more common and widely distributed. It was recorded at a few stations with densities as high as 250 to 300 per square metre. The free living serpulid polychaete *Ditrupa* sp was collected from a few stations.

Portions of the cemented carbonate crust were collected from parts of the area. These tended to have an epifauna of serpulid polychaetes on the underside of the crust. On the upper surface, distinctive, bright red attached foraminifera are common along with hydroids and gorgonids. These attached foraminifera-*Homotrema* sp., are also found on gastropod shells, portions of serpulid tube and bivalve fragments in a few of the samples.

Although the sediment is predominantly a silty sand or a medium to coarse grained sand with or without some admixture of mud, in most samples there was a greater or lesser amount of biogenic carbonate present in the coarser fraction. This material greater than 1.5mm was retained for detailed bulk faunal analysis. In some samples there was a relatively high proportion of black stained shell debris. This was distinctively different from the rest of the biogenic carbonate and suggests that mixing of shelly material of different ages is common in some parts of the area.

The dredge samples were mostly muddy sand with a varying proportion of biogenic carbonate. Gastropod shells belonging to the genera *Murex*, *Conus*, *Xenophora* and *Cypraea* were not uncommon in these samples. Somewhat surprisingly no live gastropods were obtained. Many of the dead shells, especially *Conus* retained their colour suggesting that they are not particularly old (although some shells do retain their colour for thousands of years). Radiocarbon dating of some of these shells will help to resolve this. One dredge haul (Station 160) contained portions of carbonate crust and numerous oyster valves. Some of these were stained black. The presence of these oysters suggests an extensive region of crust which perhaps had some topographic height above the surrounding sea-floor, thus providing a suitable habitat for the oysters. No live oysters were obtained.

One box core station was occupied close inshore on the west coast, 1km off Ash Sha'm. This yielded an interesting and different fauna including several species of infaunal bivalves, polychaetes, crustaceans and irregular echinoids.

The underwater television camera was used three times. The first deployment was not particularly successful although images of the sea-floor were obtained. A purpose built frame was then constructed from materials that were available on the ship and the camera was deployed from the hydrographic wire midships on the starboard side. When on the bottom the frame was allowed to drift over the sea-floor as the ship moved in response to surface currents and wind. Excellent video sequences were obtained. The first of these (deployment 2) was in the region of the "pitted ground", where the sediment is muddy, and revealed a heavily bioturbated sea-floor with numerous enteropneust burrows very reminiscent of parts of the deep ocean floor. At intervals there were small isolated areas where gorgonids and other attached epifauna were present indicating the presence of a hard substrate, presumably an area of cemented carbonate crust. The second tow (deployment 3) was in an area of presumed relict bedforms, where carbonate crust was thought to be present. The images confirmed this by showing areas with an epifauna of gorgonids and hydroids. There was evidence to suggest that much of the crust was covered by a thin veneer of sediment. The areas of crust alternated with areas of sediment which supported a fauna typical of that obtained in Day grab samples and included the smaller of the ahermatypic corals. The TV images indicated just how common this coral is in the region.

5.5. Geotechnical Measurements

5.5.1. SAPPA

(Mike Somers and John Roberts)

Concept

Sediment Acoustic and Physical Properties Apparatus (SAPPA) is an instrument designed to measure the in situ properties of seabed sediments that are important to acoustic characterisation and geotechnical investigations. It is designed to be a flexible vehicle that can carry a variety of instrumentation. In the prototype version used on this cruise (CD104/2) it was fitted with source and receiver for p-wave velocity and attenuation and shear wave generators to measure the components of shear wave velocity and wave mode conversion. For p-waves there are two probes which are designed to be driven into the sediment to a depth of one metre. The probe tips contain respectively a p-wave source and a hydrophone. For s-waves there are two generators, one primarily for Sv waves (the vertically polarised component) and the other primarily for Sh waves (the horizontally polarised component).

On cruise CD104/2 SAPPA was in a prototype form with experimental probe systems and one purpose of the cruise was to test the concept of the instrument and the operation of various components. In addition nine out of ten sites chosen for deployment were occupied.

In its later development the SAPPA will have at least three probes so that profiles of both velocity and attenuation of p-waves can be measured absolutely. For the prototype on this cruise the system had only two probes placed a known distance (approx. 1m) apart. There were similar restrictions on the s-wave generators. Again in its fully developed form SAPPA will have built in processing power to conduct remote experiments under loose control of a limited bandwidth acoustic link. Before this final stage the plan is to deploy a system with a conducting cable which will allow closer control of the onboard processing power. For cruise CD104/2 a primitive system was provided with a hardwire link to the surface for all onboard instruments. In the shallow water experiments of this cruise this arrangement allowed a maximum of flexibility and control while the basic instrument components were tested.

Description of Instrument

SAPPA consists of a heavy steel framework, circular in shape, 2.5m in diameter and with an all up weight of 1.5t. It is deployed on a strain bearing cable so as to sit firmly on the seafloor while the experimental programme is carried out, a process occupying no more than 5-10 minutes. During this time the ship has to keep station on the wire so as not to topple the frame. Once on the seabed the system is commanded to make a series of measurements; the probes are driven into the seabed and the measurements can be repeated at a series of probe depths. At the end of the measurement sequence the instrument is lifted from the seabed and it is possible to move the ship and replace the instrument on the seabed for a subsequent series. SAPPA is fitted with a mechanism for extracting the probes from the seabed before the entire weight of the frame is lifted subject to wide limits on the wire angle.

In the prototype SAPPA the Sv waves are generated as a by-product of the insertion method for one of the probes. The Sh waves have a special bi-directional hammer and anvil mechanism which is spring loaded onto the sediment interface. S-waves are detected by means of an orthogonal triad of geophones.

The probes consist of 38mm OD steel tubes, with 25mm ID, built up of threaded sections terminating in a 90° probe tip. The probes are 1.3m total length, of which 1m is available to penetrate the seabed (and on this cruise both were observed to penetrate a considerable distance - 95cm in one case). Following beach experiments the probe insertion mechanism was designed to have a spring mounted pre-load of 25kg and a motor operated spring return hammer mechanism to "pile drive" the probe into a sandy seabed. In soft sediment the pre-load was expected to provide sufficient insertion force, for at least the first 50cm. The beach experiments had indicated that approximately 100 blows of 2.5 J stored energy would drive the probe into a coarse sand (with no mud or clay) to a depth of 30 - 40cm.

The probe hammers are driven by motor gearheads coupled to a starwheel arrangement, in which a shuttle is lifted against a spring. On the top of the stroke the shuttle falls off the starwheel fingers and delivers a blow. Because of the weight of the pressure tube and sealing systems for the motor the coupling consisted of a long flexible shaft (1.5m) with the motor mounted on the main framework.

The Sh waves were generated by a pair of pivoted hammer arms driven by a cam so that impulses were delivered to the anvil from left and right alternately. These impulses were coupled to the seabed by an anvil bolted to a sole plate. The motion was at right angles to the direction of the geophone array. The Sh mechanism was spring loaded via a set of high compliance shock mounts to minimise the unsprung weight and to cut down the precursor pulse. The design was developed from a series of experiments carried out by GEOTEK at SOC on an artificial sandy seabed. The geophone array was mounted on a sole plate and spring loaded to the seabed with coupling by four spikes screwed through the sole plate in to the geophone housing. The geophone platform was also decoupled by four high compliance shock mounts. For CD 104/2 the telemetry system had not been implemented so instead a multi core cable connection to the surface allowed the operation of the system to be closely monitored and controlled. The price paid for this was that the connections to the surface would not allow the entire suite of instruments to operate simultaneously. Instead, alternate connections would be made so as to carry out either p-wave or s-wave measurements. To change mode from p to s-waves or back required the platform to be recovered and two plugs to be exchanged.

For this cruise where the seabed substrate was expected to be coarse carbonate sand, the p-wave generator had to operate in the low kHz region because of the high attenuation in the substrate. The only practical way of achieving this is by an impulsive source and within the available probe diameter the options are severely limited. The solution developed by GEOTEK and verified in a set of measurements from an early prototype at SOC was to apply an impulse to a mechanical transformer which converted the axial momentum of the generator into radial motion of the probe walls. This generated a source level of 166 dB in the frequency band of 1-5 kHz.

Narrative

The equipment was air freighted to the ship in March, just prior to the cruise, in knock down form. The first week of the cruise was spent assembling the system from its parts and testing all subsystems. During this process several modifications proved to be necessary because many parts had not been integrated before shipping from the UK. Also the details of the method of handling onboard and over the side had to be worked out with the ship.

The platform was deployed from the starboard A-frame through the gate in the ship's gunwhale. With the weight, size and apparent vulnerability of many of the fittings it was necessary to go through a series of phases of discussion with the crew of CD and the RVS technicians.

In the event, the s-waves systems gave very little trouble but the p-wave measurements presented several problems. The main problem concerned a feedback loop from a minor leak to seawater in the hydrophone common lines which caused instability in the p-wave amplifiers. This problem was compounded and partially concealed by current spikes in one of the timing circuits. The separation and remedy for these problems occupied several days. Unfortunately the detection and remedy involved disassembly of the p-wave probe at least twice and on the second reassembly a leak occurred, thus it proved impossible in the final analysis to obtain p-wave data.

The s-wave system behaved as it should except for an uncertainty in the timing of the impulse. This arose from the unknown delay between the reed switch operated sync pulse and the actual moment of impact. This unknown was removed from the Sh system by means of an inertial switch developed and constructed on board by T. Crocker of Scimar Engineering Ltd. It was thus possible to get accurate pulse timing online for the Sh waves. The Sv wave data on the other hand could not be corrected online (because there was only one inertia switch. However, a post deployment calibration was carried out on deck with the additional control that the geophones were remounted to be in close proximity (<3 cm) with the probe tip. Also post deployment, the geophones were mounted on the Sh generator sole plate to give direct indication of the wavelet take off.

During the second week of the cruise 9 designated stations were occupied. This process was complicated by the fact that they were set in the main traffic lanes of the Strait of Hormuz. Thus the ship's crew had to exercise great caution in developing the deployment sequence. For example, it was not considered safe for a day or two to deploy out of daylight hours. With the need to wait for a sufficient gap in the traffic this imposed appreciable delays on the operations in the early days. It is a tribute to the officers and crew that these problems were very quickly overcome.

Not surprisingly the system sustained a certain amount of damage and on the third to last station the lifting mechanism on one of the probes (the p-wave source) jammed during extraction and pulled the probe free of its housing, in the process damaging the motor drive coupling and the probe head. For this reason no further attempt could be made to aquire p-wave data.

Unfortunately the final station had to be aborted because of a failure of the Sh trigger - believed to be a failure of the jury-rigged inertia switch.

Results, Conclusions and Lessons for the Future

SAPPAs contribution to the scientific objectives was to occupy nine out of ten of the designated SAPPA sites and to produce Sh wave results from them all and Sv results from five sites. Several lessons have been learnt but the essential concept has shown itself to be sound.

When the problems with the p-wave system are overcome (as we believe they were until the final leakage) SAPPA will provide valuable in situ acoustic and geotechnical data.

It has been possible from the experience to draw many conclusions for simplification and improvement. In particular the framework was deliberately over designed to ensure that the base was stable on the seabed. Operational experience indicates that a smaller frame would provide adequate stability while making the handling and operation very considerably easier. There are, in addition, many points relating to construction and operation which have been noted and which will make future deployments more productive.

It should be emphasised that this initial deployment was carried out with no telemetry system and so required a multi core connection to the surface which had to be provided by taping a separate umbilical to the coring warp on deployment and removing it on recovery. This umbilical was a vulnerable component and we believe a main link in the feedback path of the p-wave amplifier instability. The next deployment will use telemetry via conducting cable allowing the system to be completely free of the ship's earth. Meanwhile the telemetry will allow good control of the operation of the probe.

5.5.2. Geotechnical Measurements on Samples
(Angus Best)

Day Grab samples

Shear strength values were measured on each sample while still in the grab using a Pilcon shear vane tester. The 300mm vane was found to be suitable for the sediments tested, giving readings in the range 0 - 30kPa. The above device is primarily designed for cohesive sediment testing, and therefore, the readings may not be indicative of true shear strength. Also, the Day grab samples were only c. 15cm deep (maximum) and it was not always possible to insert the vane sufficiently into the sediment for valid measurements. It is also debatable as to how undisturbed the sediment was in the Day grab. Despite the shortcomings, the readings did give some indication of the relative shear strength of the samples from site to site.

Kasten cores

Kasten cores were collected from sites CD104/61, CD104/65 & CD104/68; 156cm, 189cm & 157cm long , respectively. They comprised grey-green clay with occasional silty layers and a strong odour of "rotten eggs".

Vane shear strength readings were taken with the Pilcon tester (300mm vane) at 10cm intervals from the top of each core. The vane was inserted about 10cm deep, perpendicular to the core, at each measurement point, thus sampling the strength of the central part of the core (which should be relatively undisturbed).

Sub-samples were taken also at 10cm intervals, but offset by 5cm from the shear vane measurements. Plastic syringes were used as mini piston corers to extract the surface c. 5cm of sediment before extruding the samples into individual plastic sample pots of diameter 27mm, length 42mm. A freshly washed syringe was used for each sample to avoid any contamination. Each sample pot was completely filled before being sealed with an air-tight lid. These sub-samples will be used to determine porosity, water content, bulk density and mineral grain density by wet-dry weighing. Granulometry will also be carried out.

An attempt was made to measure shear wave velocity on the cores using bender transducers, but this proved unsuccessful. The bender elements are very sensitive to electrical pickup. The noise level on board from the ship's generators, etc., meant that the received signals were unstable with a poor signal to noise ratio; no useful data could be collected.

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7. APPENDICES

7.1. Diary of Events-RRS Charles Darwin Cruise 104C, Leg 2

(Richard Bourne)

Friday 21st.March.'97.

1140 - Pilot Boards.

1200 - Vessel Clear of Berth.

1212 - Pilot Disembarks.

1300 - Full Away, Abu Dhabi Light Float Brg: 318 T at 4.5 miles.

1512 - Lat: 24 56.5 N. Long: 54 24.0 E. Widescan Fish Deployed for Test Purposes.

1547 - Lat: 24 57.4 N. Long: 54 22.9 E. Boomer Sledge Deployed for Test Purposes.

1653 - Lat: 24 59 6 N. Long: 54 20.6 E. Equipment Recovered; Resume Passage.

1719 - Lat: 25 01.6 N. Long: 54 23.0 E. Boomer Deployed.

1752 - Lat: 25 02.4 N. Long: 54 21.9 E. Boomer Recovered.

2246 - Lat: 25 37.0 N. Long: 55 06.0 E. Widescan Sonar Fish Deployed.

2255 - 3.5 kHz. Fish Deployed.

Saturday 22nd March.'97.

1029 - Lat: 26 14.8 N. Long: 55 56.6 E. Boomer Deployed.

1100 - 1142 - 3.5 Khz Fish Recovered for Repair.

Noon Position: Lat: 26 18.4 N. Long: 56 01.5 E.

Vessel Undertaking Widescan and Boomer Survey at 4 knots, off Musandam Peninsular, Oman.

Sunday 23rd. March.'97.

0123 - Lat: 26 23.6 N. Long: 56 17.5 E. Reduced Speed to 2 knots to Recover Sidescan.

0127 - Lat: 26 23.3 N. Long: 56 17.2 E. Widescan Fish Lost on reaching surface.

0708 - Lat: 26 05.8 N. Long: 55 58.0 E. Replacement Widescan Fish Deployed.

Noon Position: Lat: 26 20.1 N. Long: 56 12.0 E.

Vessel Undertaking Widescan and Boomer Survey at 4 knots, off Musandam Peninsular. Oman.

Monday 24th. March '97.

Noon Position: Lat: 26 18.6 N. Long: 56 05.7 E.

Vessel Undertaking Widescan and Boomer Survey at 4 knots, off Musandam Peninsular, Oman.

1419 - 1424 - Lat: 26 09.5 N. Long: 55 57.5 E. Widescan Fish Recovered for Inspection.

1648 - Lat: 26 12.4 N. Long: 56 00.0 E. 3.5 kHz. Fish Recovered.

Tuesday 25th. March '97.

Noon Position: Lat: 26 30.3 N. Long: 56 15.2 E.

Vessel Undertaking Widescan and Boomer Survey at 4 knots, off Musandam Peninsular, Oman.

Wednesday 26th. March '97.

Noon Position: Lat: 26 33.0 N. Long: 56 19.4 E.

Vessel Undertaking Widescan and Boomer Survey at 4 knots, off Musandam Peninsular, Oman.

Thursday 27th. March '97.

Noon Position: Lat: 26 37.0 N. Long: 56 27.6 E.

Vessel Undertaking Widescan and Boomer Survey at 4 knots, off Musandam Peninsular, Oman.

1655 - Lat: 26 24.0 N. Long: 56 04.0 E. Sidescan Fish Recovered.

1732 - Lat: 26 24.4 N. Long: 56 04.6 E. Sidescan Fish Redeployed, Resumed Survey.

Friday 28th. March '97.

0825 - Lat: 26 04.5 N. Long: 55 58.0 E. Widescan Fish Recovered.

0832 - Lat: 26 04.2 N. Long: 55 58.1 E. Boomer Recovered.

0844 - Lat: 26 04.1 N. Long: 55 58.3 E. Widescan Fish Redeployed.

0853 - Lat: 26 04.6 N. Long: 55 58.6 E. Resumed Survey at 5 knots.

0930 - Lat: 26 07.0 N. Long: 56 00.9 E. Reduced Speed to Deploy 3.5 Khz. Fish.

Noon Position: Lat: 26 17.1 N. Long: 56 10.3 E.

Vessel Undertaking Widescan Survey at 5 knots, off Musandam Peninsular, Oman.

1554 - Lat: 26 24.8 N. Long: 56 26.8 E. Boomer Deployed; Survey Speed 4 knots.

1902 - Lat: 26 25.9 N. Long: 56 42.0 E. Complete Survey Line.

Friday 28th. March '97. Continued:

1910 - Lat: 26 25.9 N. Long: 56 41.9 E. Sidescan Fish Recovered.

1915 - Lat: 26 25.7 N. Long: 56 42.0 E. Boomer Recovered.

1923 - Lat: 26 25.6 N. Long: 56 42.0 E. 3.5 Khz. Fish Recovered.

2018 - Lat: 26 27.0 N. Long: 56 35.8 E. Commenced a Line of Sediment Sampling Stations; On a Line 264 True, at 1 mile intervals, through the Inshore Traffic Lane, off the Musandam Peninsular.

Saturday 29th. March '97.

0708 - Lat: 26 25.1 N. Long: 56 16.0 E. Completed Sediment Sampling. 15 Stations occupied; Gravity Corer used initially, without success, then the Day-Grab utilised to aquire sediment samples.

0744 - Lat: 26 23.6 N. Long: 56 19.0 E. Boomer Deployed.

0748 - Lat: 26 23.6 N. Long: 56 19.0 E. Widescan Fish Deployed. Increase to 4 knots.

Noon Position: Lat: 26 11.6 N. Long: 56 05.9 E.

1415 - Lat: 26 02.3 N. Long: 55 57.3 E. Vessel Questioned by UAR Coast Guard Patrol Boat 665, off Mina Saqr. Assisted in explanation by Supply Boat Inchcape 6.

1742 - Lat: 26 05.1 N. Long: 55 59.1 E. Complete Survey Line.

1745 - Lat: 26 05.2 N. Long: 55 59.1 E. Widescan Fish Recovered.

1750 - Lat: 26 05.2 N. Long: 55 59.0 E. Boomer Recovered.

1754 - All Secure; Set Course for Abu Dhabi, for Water Call.

Sunday 30th. March '97.

0700 - SBE, EOP; Abu Dhabi Fairway Buoy Abeam.

0819 - Pilot Embarked.

0840 - Vessel Secured Port Side To, No.19 Berth, Main Port, Abu Dhabi.

1030 - Commenced Taking Fresh Water.

1330 - Completed Taking Fresh Water.

1509 - Vessel Clear of Berth.

1600 - Full Away on Passage.

Monday 31st. March '97.

0636 - Lat: 26 27.3 N. Long: 56 17.0 E. Boomer Deployed.

0646 - Lat: 26 27.7 N. Long: 56 17.3 E. Widescan Fish Deployed; Resumed Survey.

Noon Position: Lat: 26 27.4 N. Long: 56 30.3 E.

1413 - Lat: 26 28.0 N. Long: 56 21.1 E. Widescan Fish Recovered; major Course alteration.

1438 - Lat: 26 27.8 N. Long: 56 20.8 E. Widescan Fish Redeployed.

Tuesday 1st. April '97.

0556 - Lat: 26 15.7 N. Long: 56 40.9 E. Widescan Fish Inboard/Outboard to clear Fishing Line.

0650 - Lat: 26 12.1 N. Long: 56 42.3 E. Widescan Fish Inboard/Outboard to clear Fishing Line.

Noon Position: Lat: 26 26.5 N. Long: 50 40.5 E.

1205 - Lat: 26 26.8 N. Long: 56 40.4 E. Widescan Fish Recovered to clear Fishing Line.

1300 - Lat: 26 26.3 N. Long: 56 38.4 E. Widescan Fish Redeployed.

Wednesday 2nd. April '97.

Noon Position: Lat: 26 10.7 N. Long: 56 42.9 E.

Vessel Undertaking Widescan and Boomer Survey at 4 knots, off Musandam Peninsular, Oman.

2118 - Lat: 26 11.3 N. Long: 56 39.2 E. Widescan Fish Recovered to clear Fishing Line.

2136 - Lat: 26 11.3 N. Long: 56 38.4 E. Widescan Fish Redeployed.

2258 - 2309 - Reduced to 2 knots, to clear Fishing Line from Widescan Fish.

Thursday 3rd. April '97.

Noon Position: Lat: 26 13.6 N. Long: 56 31.5 E.

Vessel Undertaking Widescan and Boomer Survey at 4 knots, off Musandam Peninsular, Oman.

1628 - Lat: 26 10.6 N. Long: 56 31.4 E. Reduced speed to Recover Widescan Fish to exibit to local fishing craft, to reassure them that vessel was not engaged in fishing.

Friday 4th. April '97.

Widescan and Boomer Survey at 4 knots through Westbound Traffic Lane in Strait of Hormuz.

Noon Position: Lat: 26 24.6 N. Long: 56 02.8 E.

1705 - Lat: 26 10.3 N. Long: 55 47.3 E. Widescan Fish Recovered.

1708 - Lat: 26 10.2 N. Long: 55 47.3 E. Boomer Recovered; Commenced Passage to Abu Dhabi.

Saturday 5th. April '97.

0706 - End of Passage; Vessel abeam of Abu Dhabi Fairway Buoy.

0830 - 0910 - Vessel Awaiting Berth Clearance off Bouy Z15.

0912 - Pilot Embarked.

1006 - First Line Ashore.

1010 - Vessel Securely Moored, Port Side Alongside, No.19 Berth, Main Port, Abu Dhabi. Personnel Transfer, Taking Fresh Water and Emptying Garbage Skip.

1418 - SBE, Singling up lines.

1421 - Vessel Clear of Berth.

1500 - Full Away, at Buoy Z10.

1600 - Engineroom Reported a rattling noise, beneath the hull, in vicinity of the workshop.

1656 - Vessel stopped, in calm sea; RIB Launched. Fishing Line discovered leading down to Bow Thrust. Secured to Messenger.

1737 - Inchcape Shipping, Abu Dhabi, contacted and rendezvous with Diving Team requested for the following morning at Dubai anchorage.

1744 - Mr C.M.G.Adams, RVS Operations Manager contacted, and informed of vessel's situation.

1748 - R.I.B. Recovered; Commenced Slow Speed Steam towards Dubai Anchorage.

Sunday 6th. April '97.

0648 - SBE, End of Passage; Dubai SW Breakwater Brg: 142 True at 2.7 miles.

0708 - Let go Starboard Anchor.

0726 - Vessel brought up to 3 shackles of cable; 2 miles NW of Dubai Breakwater.

0840 - UMC International, Diving Support Boat, Interseas 5, Alongside.

0855 - 1000 - Divers in Water, clearing fishing line from Bow Thrust Impeller and insp. hull.

1030 - Diving Boat Departs.

1042 - SBE; Commenced Weighing Anchor.

1058 - Anchor Aweigh.

1112 - Full Away; Resumed Passage towards Scientific Research area, in Strait of Hormuz.
Loss of Scientific Time, 12 hours.

1720 - Lat: 25 12.1 N. Long: 55 53.4 E. Station 16; Commenced Sediment Sampling,
every 2 miles, in approaches to Eastbound Traffic Lane in Strait of Hormuz.

1720 - 2351 - St'ns 16 to 26; Day-Grab at 16,17,18,19,20,21,22,23,24,25, & 26.+ Gravity at 24.

Monday 7th. April '97.

0017 - Lat: 26 26.1 N. Long: 56 12.0 E. Station 27.

0017 - 1200 - Stations 27 to 43; Day-Grab at 27,28,29,30,31,32,33,34,35,36,40,41,42. and 43.
Gravity-Corer at 31,35,36,37,38,39,40, and 41.

Noon Position: Lat: 26 24.8 N. Long: 56 39.4 E. Sediment Sampling.

1257 - 2345 - Stations 44 to 58; Day-Grab at 44,45,46,47,48,49,50,51,52,55,56,57, and 58.
Gravity-Corer at 47,51,52,54, and 55.
Box-Corer at 53.

Vessel approaching West-Bound Traffic Lane in Strait of Hormuz.

Tuesday 8th. April '97.

0015 - Lat: 26 26.8 N. Long: 56 42.0 E. Station 59.

0015 - 1153 - Stations 59 to 72; Day-Grab at 59.
Gravity-Corer at 59,60,62,63,64,66,67,69,70,71, and 72.
Box-Corer at 72.
Kasten-Corer at 61,65, and 68.

Noon Position: Lat: 26 35.5 N. Long: 56 20.7 E. Vessel in West-Bound Traffic Lane.

Tuesday 8th. April '97. Continued:

1203 - 2354 - Stations 72 to 90; Day-Grab at 86,87,88,89, and 90.
Gravity-Corer at 73 to 86 inclusive, 14 Stations.
Box-Corer at 72.

2354 - Lat: 26 12.0 N. Long: 55 57.0 E. Vessel on NE'ly Station Line towards Hormuz Str.

Wednesday 9th. April '97.

0035 - 1159 - Stations 91 to 110; Day-Grab at 91 to 108 inclusive, 18 Stations, plus 110.

Gravity-Corer at 109, and 110.

Box-Corer at 109.

Noon Position: Lat: 26 31.0 N. Long: 56 33.0 E.

1208 - 2359 - Stations 110 to 127; Day-Grab at 110,111, and 113 to 127 inclusive.

Gravity-Corer at 111, and 112.

Box-Corer at 112.

2359 - Lat: 26 22.0 N. Long: 56 35.5 E. Vessel off Eastern Coast of Musandam Peninsular.

Thursday 10th. April '97.

0001 - 1154 - Stations 127 to 144; Day-Grab at 127 to 144 inclusive, 18 Stations.

Gravity-Corer at 129 and 141.

Noon Position: Lat: 26 10.5 N. Long: 56 29.8 E.

1218 - 1554 - Stations 145 to 150; Day-Grab at 145,146,147,148, and 149.

Gravity-Corer at 150.

1554 - Fishing Float Line Snagged Aft; Vessel Manoeuvring with BowProp.

1635 - 1752 - RIB Launched in Calm Sea and Line Cleared from Propeller Blade.

1905 - Lat: 26 21.2 N. Long: 56 33.6 E. Widescan Fish Deployed.

1957 - Lat: 26 25.3 N. Long: 56 32.1 E. Widescan Fish Recovered.

2001 - 3.5 Khz.Fish Deployed; Vessel Proceeding through Strait of Hormuz Inshore Traffic Zone.

2128 - Lat: 26 24.1 N. Long: 56 20.4 E. Widescan Fish Deployed.

Friday 11th. April '97.

0000 - Lat: 26 14.7 N. Long: 56 10.0 E. Widescan Survey off Western Coast of UAE and Oman.

Noon Position: Lat: 26 08.9 N. Long: 56 05.6 E.

1412 - Lat: 26 17.0 N. Long: 56 13.0 E. Widescan/3.5 Khz. Fish Recovered; Set Co.for A.Dhabi.

Saturday 12th. April '97.

0000 - Lat: 25 22.8 N. Long: 54 54.4 E.

0712 - SBE/EOP; Off Abu Dhabi Fairway Buoy.

0835 - Pilot Embarked.

0850 - Vessel Secured Port Side To, No.19 Berth, Mina Zayed, Main Port, Abu Dhabi.

1300 - Vessel Completed Taking Fresh Water and Changing Personnel.

Due to Adverse Weather Conditions in the Arabian Gulf; Unsuitable for SAPPA Trials, Vessel Remained Alongside Deploying SAPPA in Harbour Bottom for Test Purposes.

Sunday 13th. April '97.

0540 - SBE; Singled up For'd and Aft.

0542 - Vessel Clear of Berth and Proceeding Outwards.

0654 - Full Away, off Abu Dhabi Lightfloat.

Noon Position: Lat: 25 22.8 N. Long: 54 54.3 E.

2024 - Lat: 26 17.0 N. Long: 56 04.4 E. Commenced Series of Dredge Stations in Western Approaches to Strait of Hormuz.

2024 - 2400 - Dredge Stations 151, 152 and 153.(Complete Dredge Assembly Lost at St'n.153).

Monday 14th. April '97.

0150 - 1214 - Dredge Stations 154, 155, 156, 157, and 158.

Noon Position: Lat: 26 33.1 N. Long: 56 23.5 E.

1247 - 2025 - Dredge Stations 159, 160, 161, and 162.

2221 - Lat: 26 10.8 N. Long: 56 31.0 E. SAPPA Deployed for Testing Purposes.

Tuesday 15th. April '97.

0021 - Lat: 26 10.8 N. Long: 56 31.0 E. SAPPA Recovered; Two Test Deployments Completed.

0256 - 0833 - Stations 163 to 172; 10 Day-Grab Stations.

1019 - 1100 - Lat: 26 31.4 N. Long: 56 22.7 E. SAPPA Deployment, Station #07.

Noon Position: Lat: 26 34.4 N. Long: 56 28.6 E. Awaiting Traffic Clearance, Eastbound Lane.

1254 - 1342 - Lat: 26 33.4 N. Long: 56 28.9 E. SAPPA Deployment, Station #08.

1432 - 1514 - Lat: 26 37.4 N. Long: 56 28.1 E. SAPPA Deployment, Station #04.

1637 - 1729 - Lat: 26 35.5 N. Long: 56 20.7 E. SAPPA Deployment, Station #05.

1901 - 1940 - Lat: 26 33.0 N. Long: 56 32.7 E. SAPPA Deployment, Station #09.

2130 - 2208 - Lat: 26 35.2 N. Long: 56 22.7 E. Camera Deployed to Sea Floor.

Wednesday 16th. April '97.

0020 - 0630 - Stations 173 to 182; 10 Day-Grab Stations.

0818 - Lat: 26 18.1 N. Long: 56 01.9 E. Vessel Hove To; Awaiting SAPPA Readiness.

0838 - 0845 - Lat: 26 18.1 N. Long: 56 01.9 E. Gravity-Corer Deployed at Station 183.

0946 - 1018 - Lat: 26 18.1 N. Long: 56 01.9 E. SAPPA Deployment, Station #06.

Noon Position: Lat: 26 28.3 N. Long: 56 19.7 E.

1428 - Vessel Awaiting Traffic Clearance in Hormuz Traffic Lane; To Deploy SAPPA.

1539 - 1557 - Lat: 26 30.2 N. Long: 56 40.3 E. SAPPA Deployment, Station #02.

1721 - 1754 - Lat: 26 28.2 N. Long: 56 36.4 E. SAPPA Deployment, Station #10.

1849 - 1925 - Lat: 26 30.2 N. Long: 56 40.3 E. SAPPA Deployment, Station #02.

2026 - 2130 - Lat: 26 37.6 N. Long: 56 35.5 E. SAPPA Deployment, Station #03. Malfunction.

2234 - Lat: 26 36.6 N. Long: 56 26.6 E. Widescan Deployed.

2248 - Widescan Recovered, Malfunction; Reterminating Cable.

2335 - Lat: 26 35.4 N. Long: 56 23.8 E. Camera #02 Deployed.

Thursday 17th. April '97.

0057 - Camera Recovered.

0249 - 1200 - Stations 184 to 198; Day-Grab at Stations 184 to 194.
Gravity-Corer at Stations 195, 196, and 197.
Box-Corer at Station 198.

1042 - 1058 - Vessel interrogated by UAE Coastguard, off Mina Saqr.

Noon Position: Lat: 26 02.0 N. Long: 56 04.0 E.

1304 - 1443 - Stations 199 to 201; Day-Grab at 199, 200, and 201.
Gravity-Corer at 199, and 200.

1454 - 1507 - Widescan Fish Deployed on Test.

1527 - 1532 - Station 202; Day-Grab Deployed.

1540 - 1600 - Vessel interrogated by Omani Police Launch, Haras 7.

1618 - 1927 - Stations 203 to 206; Day-Grab Deployments.

1941 - Lat: 26 20.1 N. Long: 56 18.0 E. Widescan Fish Deployed.

2026 - Lat: 26 23.6 N. Long: 56 18.5 E. Widescan Fish Recovered; Damaged Cable.

2225 - Lat: 26 36.7 N. Long: 56 26.5 E. Widescan Fish Deployed for High Resolution Survey.

Friday 18th. April '97.

0000 - Lat: 26 36.0 N. Long: 56 26.0 E.
Vessel Engaged in High Resolution Widescan Survey.

Noon Position: 26 16.5 N. Long: 56 01.3 E.

1354 - Lat: 26 16.7 N. Long: 56 01.8 E. Complete Survey; Widescan Fish Recovered.

1400 - 1442 - Vessel at Full Speed for Engine Room Purposes; Peak Pressure Measurments.

1552 - 1709 - Lat: 26 16.2 N. Long: 56 01.5 E. Camera Deployed to Sea-Bed.

1709 - Complete Science; Commenced Passage towards Abu Dhabi.

Saturday 19th. April '97.

- SBE, EOP, Fairway Buoy Brg:

7.2. Specification of Widescan System

(Angus Best)

Principal components:

1. Towfish
2. Signal processing unit (SPU)
3. Thermal chart recorder
4. Winch
5. Cable
6. Digital data logging system

1. Towfish

Dimensions: length 1.61m; diameter 0.11m;

Weight 23kg;

Body material: aluminium;

Transducers: solid encapsulated, flush mounted, depression angle 20∞; down-looking altimeter;

Fin span: horizontal 0.61m; vertical 0.61m;

Tail fins: knock-free in event of snagging;

Depth range: 0 - 300m (operational); 1000m (survival);

Operating frequencies: 100kHz (low frequency, LF) or 325kHz (high frequency, HF);

Source level: 210dB re 1mP @ 1m, nominal at HF;

Beam pattern: horizontal LF 1.9∞, HF 0.6∞; vertical LF 32∞, HF 32∞;

Pulse length: long LF 330ms, HF 102ms; short LF 90ms, HF 28ms;

Pulse interval: range 37.5/50m, 85ms; range 75/100m, 155ms; range 150/200 m, 295 ms; range 300/400, 575 ms;

Maximum towing speed: 12 knots;

Recommended max. Operational speed: 6 knots;

Recommended towing altitude: 10% of range.

2. Signal processing unit (SPU)

Dimensions: 0.66 x 0.25 x 0.57m;

Weight: 21kg;

Power supply: 2 to 30 V DC (nominal 24 V DC) at 15 Amps or 240/115 V AC.

Gain control: time variable gain (pre-set); range adaptive gain; automatic gain control;

Range options: 37.5, 50, 75, 100, 150, 200, 300, 400m;

3. Thermal chart recorder

Model: 3700;

Dimensions: 0.43 x 0.18 x 0.44m;

Weight: 22kg;

Power supply: 115/230 V AC (± 10%) 50/60 Hz; 320 Watts maximum;

Paper: Black image thermal facsimile paper, Group 3;

Paper size: 100m x 315mm rolls;

Scan width: 305mm;

Dynamic range: 16 shades of grey, from white to solid black;

Resolution: 9 pixels/mm2 ; 144 dots/mm2; 896 pixels/line; 3584 pixels/line; image edge definition 1/12 mm;

Synchronisation: external trigger from SPU;

Print head: fixed thermal print head mounted on a finned heat sink with forced ventilation by brushless DC fan;

Dot format: line array of 3584 dots on 1/12mm pitch;

Temperature control: print density compensated for ambient temperature variations.

4. Winch

Dimensions:

Weight:

Power supply: 3-phase, 240 V AC, 50 Hz

Slip rings: 8-way

Control: remote handset or directly from winch;

On hire from Seatronics Ltd., Aberdeen, U.K.

5. Cable

Main cable: Rochester 301301, coaxial conducting, armoured;

Length: 1000m;

Deck cable: lightweight Kevlar tow cable;

Length: 100m.

6. Digital data logging system

Dimensions: 0.19 x 0.52 x 0.60m (main box) plus PC monitor;

Weight: 20kg

Processor & motherboard: Intel Zappa Pentium 75 MHz

RAM: 16 Mb

Hard disk: 1.2 Gb (drive c:);

DAT drives: 2 x Conner 4326 (drives d: and e:);

Power supply: 250 W minimum;

Video card: Diamond Stealth 64 DRAM

Interfaces: Adaptec AHA1542 Fast SCSI-2 card; Keithley Metrabyte PDMA-16 digital I/O card;

Operating system: MSDOS V6.2

Software: "SCAN" specially written for SOC Widescan System; Tapedisk V6.5.2.

File format: MSDOS binary files;

File size: 50 Mb;

Recorded parameters: time; sidescan port & starboard channels; towfish altitude; frequency; pulse length; range;

7.3 Station List

Station	Water depth (m)	Time on bottom	Latitude	Longitude	Sampler
CD104/1/1	95.0	1623/087/97	26.450333	56.596333	Gravity Core
CD104/1/2	95.0	1639/087/97	26.450500	56.596000	Gravity Core
CD104/1/3	95.0	1617/087/97	26.450167	56.596167	Day Grab
CD104/2/1	93.0	1734/087/97	26.448167	56.579167	Day Grab
CD104/2/2	93.0	1744/087/97	26.447333	56.578667	Day Grab
CD104/3/1	96.0	1812/087/97	26.447000	56.559833	Day Grab
CD104/3/2	96.0	1824/087/97	26.447000	56.559833	Day Grab
CD104/4/1	139.0	1853/087/97	26.445000	56.542000	Day Grab
CD104/4/2	139.0	1907/087/97	26.443833	56.541333	Day Grab
CD104/5/1	187.0	1937/087/97	26.442667	56.522833	Day Grab
CD104/5/2	187.0	1957/087/97	26.443167	56.522833	Day Grab
CD104/6/1	143.0	2027/087/97	26.445000	56.501667	Day Grab
CD104/6/2	143.0	2042/087/97	26.448333	56.496667	Day Grab
CD104/7/1	140.0	2136/087/97	26.441667	56.481667	Day Grab
CD104/7/2	140.0	2149/087/97	26.443333	56.476667	Day Grab
CD104/8/1	131.0	2224/087/97	26.436667	56.463333	Day Grab
CD104/8/2	131.0	2235/087/97	26.938333	56.460000	Day Grab
CD104/9	120.0	2306/087/97	26.433333	56.450000	Day Grab
CD104/10/1	124.0	2335/087/97	26.433333	56.430000	Day Grab
CD104/11/1	140.0	0013/088/97	26.431167	56.408333	Day Grab
CD104/11/2	140.0	0022/088/97	26.430000	56.409500	Day Grab
CD104/12/1	116.0	0100/088/97	26.429000	56.372500	Day Grab
CD104/12/1	116.0	0109/088/97	26.428667	56.372833	Day Grab
CD104/13/1	110.0	0149/088/97	26.425667	56.337333	Day Grab
CD104/13/2	110.0	0157/088/97	26.426333	56.338333	Day Grab
CD104/14	107.0	0232/088/97	26.417167	56.299833	Day Grab
CD104/15	99.5	0304/088/97	26.418000	56.267333	Day Grab
CD104/16	84.5	1324/096/97	26.201500	55.889500	Day Grab
CD104/17	100.0	1354/096/97	26.221333	55.916333	Day Grab
CD104/18/1	104.0	1430/096/97	26.244167	55.948167	Day Grab
CD104/18/2	104.0	1428/096/97	26.244500	55.948500	Day Grab
CD104/19	97.0	1511/096/97	26.265500	55.974000	Day Grab
CD104/20	78.5	1543/096/97	26.287030	56.004040	Day Grab
CD104/21	81.0	1621/096/97	26.308667	56.031833	Day Grab
CD104/22	85.5	1658/096/97	26.329833	56.058667	Day Grab

CD104/23	86.0	1736/096/97	26.349833	56.086167	Day Grab
CD104/24/1	89.0	1814/096/97	26.371833	56.115000	Day Grab
CD104/24/2	105.0	1836/096/97	26.372667	56.114833	Gravity Core
CD104/25	88.0	1913/096/97	26.392000	56.142167	Day Grab
CD104/26	94.0	1947/096/97	26.414000	56.172000	Day Grab
CD104/27	92.0	2021/096/97	26.435717	56.199833	Day Grab
CD104/28	93.0	2056/096/97	26.456148	56.228965	Day Grab
CD104/29	92.5	2126/096/97	26.478833	56.257833	Day Grab
CD104/30	90.0	2218/096/97	26.501713	56.292958	Day Grab
CD104/31/1	89.5	2247/096/97	26.514667	56.323000	Day Grab
CD104/31/2	89.5	2312/096/97	26.516000	56.323833	Gravity Core
CD104/32	90.0	2355/096/97	26.528258	56.357991	Day Grab
CD104/33	88.0	0027/097/97	26.540667	56.394500	Day Grab
CD104/34	80.5	0101/097/97	26.557167	56.428833	Day Grab
CD104/35/1	80.5	0134/097/97	26.567500	56.462167	Day Grab
CD104/35/2	80.5	0200/097/97	26.568167	56.462667	Gravity Core
CD104/36/1	83.0	0236/097/97	26.574667	56.500000	Day Grab
CD104/36/2	83.0	0257/097/97	26.574333	56.501167	Gravity Core
CD104/37	88.0	0330/097/97	26.573667	56.541667	Gravity Core
CD104/38	90.0	0413/097/97	26.559700	56.569833	Gravity Core
CD104/39	95.0	0451/097/97	26.531167	56.589667	Gravity Core
CD104/40/1	94.0	0528/097/97	26.499890	56.609662	Gravity Core
CD104/40/2	94.0	0546/097/97	26.500500	56.609667	Day Grab
CD104/41/1	91.0	0619/097/97	26.472167	56.629667	Day Grab
CD104/41/2	91.0	0630/097/97	26.473000	56.628833	Day Grab
CD104/41/3	91.0	0649/097/97	26.472000	56.630167	Gravity Core
CD104/42	92.0	0723/097/97	26.445000	56.645833	Day Grab
CD104/43	99.5	0758/097/97	26.413167	56.656500	Day Grab
CD104/44	102.0	0911/097/97	26.380592	56.667319	Day Grab
CD104/45	99.0	0954/097/97	26.340508	56.681678	Day Grab
CD104/46	95.0	1024/097/97	26.307792	56.691478	Day Grab
CD104/47/1	88.5	1057/097/97	26.276558	56.703276	Day Grab
CD104/47/2	88.5	1112/097/97	26.274667	56.704500	Gravity Core
CD104/48	87.5	1140/097/97	26.244643	56.712478	Day Grab
CD104/49	86.5	1215/097/97	26.210500	56.726500	Day Grab
CD104/50	87.0	1237/097/97	26.186667	56.734000	Day Grab
CD104/51/1	95.0	1312/097/97	26.188167	56.783167	Day Grab
CD104/51/2	95.0	1331/097/97	26.185500	56.782333	Gravity Core
CD104/52/1	98.0	1414/097/97	26.219500	56.772800	Day Grab
CD104/52/2	98.0	1431/097/97	26.217833	56.771333	Gravity Core
CD104/53	97.0	1535/097/97	26.269508	56.760640	Box Core
CD104/54	95.5	1631/097/97	26.288167	56.751400	Gravity Core
CD104/55/1	89.5	1711/097/97	26.313000	56.743000	Gravity Core
CD104/55/2	89.5	1727/097/97	26.314000	56.742667	Day Grab
CD104/56	95.0	1813/097/97	26.344667	56.735167	Day Grab
CD104/57/1	93.0	1856/097/97	26.376453	56.724088	Day Grab
CD104/57/2	93.0	1905/097/97	26.377333	56.723667	Day Grab
CD104/58	95.0	1940/097/97	26.411667	56.710833	Day Grab
CD104/59/1	95.0	2018/097/97	26.447000	56.699667	Day Grab
CD104/59	95.0	2035/097/97	26.446877	56.699520	Gravity Core
CD104/60	88.5	2141/097/97	26.479833	56.690073	Gravity Core
CD104/61	84.0	2313/097/97	26.507487	56.670208	Kastenlot Core
CD104/62	77.0	0009/098/97	26.539162	56.650085	Gravity Core
CD104/63	73.5	0113/098/97	26.564333	56.634167	Gravity Core
CD104/64	68.0	0155/098/97	26.596000	56.613833	Gravity Core
CD104/65	65.0	0242/098/97	26.625333	56.592500	Kastenlot Core

CD104/66	68.0	0322/098/97	26.621000	56.558167	Gravity Core
CD104/67	72.0	0410/098/97	26.623167	56.519000	Gravity Core
CD104/68	77.0	0504/098/97	26.624667	56.466500	Kastenlot Core
CD104/69	79.0	0534/098/97	26.614833	56.442600	Gravity Core
CD104/70	79.0	0607/098/97	26.604667	56.407167	Gravity Core
CD104/71	79.0	0647/098/97	26.596500	56.369667	Gravity Core
CD104/72/1	79.5	0716/098/97	26.591167	56.345333	Gravity Core
CD104/72/2	79.5	0806/098/97	26.591167	56.348333	Box Core
CD104/73	83.0	0853/098/97	26.572667	56.296000	Gravity Core
CD104/74	84.0	0937/098/97	26.563000	56.262833	Gravity Core
CD104/75	84.0	1023/098/97	26.547667	56.229667	Gravity Core
CD104/76	83.5	1103/098/97	26.529257	56.201395	Gravity Core
CD104/77	84.0	1137/098/97	26.508500	56.175330	Gravity Core
CD104/78	83.0	1215/098/97	26.483500	56.144667	Gravity Core
CD104/79	84.5	1246/098/97	26.463667	56.115833	Gravity Core
CD104/80	84.0	1323/098/97	26.441667	56.054667	Gravity Core
CD104/81	86.0	1405/098/97	26.423667	56.062500	Gravity Core
CD104/82	89.0	1436/098/97	26.399167	56.033667	Gravity Core
CD104/83	84.0	1515/098/97	26.378000	56.004667	Gravity Core
CD104/84	84.0	1552/098/97	26.355833	55.977667	Gravity Core
CD104/85	79.0	1620/098/97	26.333043	55.945698	Gravity Core
CD104/86	75.0	1701/098/97	26.312500	55.917500	Day Grab
CD104/86/2	75.0	1718/098/97	26.312833	55.919000	Day Grab
CD104/87	76.0	1750/098/97	26.289833	55.888000	Day Grab
CD104/88(2)	79.0	1832/098/97	26.256667	55.845000	Day Grab
CD104/89	92.0	1923/098/97	26.179500	55.920500	Day Grab
CD104/90	90.0	1954/098/97	26.200667	55.949187	Day Grab
CD104/91	96.0	2038/098/97	26.225854	55.577539	Day Grab
CD104/92	99.5	2120/098/97	26.243833	56.004333	Day Grab
CD104/92/2	99.5	2130/098/97	26.242167	56.004167	Day Grab
CD104/93	105.0	2208/098/97	26.265667	56.033667	Day Grab
CD104/93/2	105.0	2218/098/97	26.264167	56.032833	Day Grab
CD104/94	106.0	2301/098/97	26.297368	56.069532	Day Grab
CD104/95	96.0	2339/098/97	26.312667	56.096500	Day Grab
CD104/95/2	96.0	2346/098/97	26.312833	56.098167	Day Grab
CD104/96	87.0	0020/099/97	26.337333	56.126833	Day Grab
CD104/96/2	87.0	0031/099/97	26.338000	56.130167	Day Grab
CD104/97	84.0	0059/099/97	26.364000	56.157167	Day Grab
CD104/98	82.0	0127/099/97	26.388833	56.186333	Day Grab
CD104/99	86.0	0154/099/97	26.418667	56.212500	Day Grab
CD104/100	91.0	0217/099/97	26.439000	56.236500	Day Grab
CD104/101	89.0	0239/099/97	26.454500	56.260667	Day Grab
CD104/101/2	89.0	0247/099/97	26.456167	56.265000	Day Grab
CD104/102	91.0	0308/099/97	26.466500	56.296500	Day Grab
CD104/103	93.0	0329/099/97	26.479667	56.326667	Day Grab
CD104/104	100.0	0354/099/97	26.492333	56.366000	Day Grab
CD104/105	95.0	0423/099/97	26.504280	56.396918	Day Grab
CD104/106	89.0	0449/099/97	26.518930	56.430958	Day Grab
CD104/107	89.0	0514/099/97	26.530667	56.469533	Day Grab
CD104/108	83.0	0543/099/97	26.537477	56.502690	Day Grab
CD104/109	89.0	0616/099/97	26.550397	56.545825	Box Core
CD104/109/2	89.0	0654/099/97	26.549667	56.545167	Box Core
CD104/109/3	89.0	0707/099/97	26.550333	56.545500	Box Core
CD104/110	93.0	0743/099/97	26.518667	56.548667	Gravity Core
CD104/110/2	93.0	0759/099/97	26.516667	56.549667	Gravity Core
CD104/110/3	93.0	0812/099/97	26.519667	56.547000	Day Grab

CD104/111		92.0	0903/099/97	26.482833	56.575333	Gravity Core
CD104/111/2		92.0	0922/099/97	26.486000	56.575167	Day Grab
CD104/112		93.0	1005/099/97	26.469500	56.611167	Gravity Core
CD104/112/2		93.0	1052/099/97	26.470667	56.610667	Box Core
CD104/113		96.0	1132/099/97	26.445333	56.599890	Day Grab
CD104/114		104.0	1205/099/97	26.414500	56.612500	Day Grab
CD104/114/2		104.0	1218/099/97	26.414167	56.614167	Day Grab
CD104/115		114.0	1250/099/97	26.381500	56.628833	Day Grab
CD104/116		101.0	1319/099/97	26.349000	56.637667	Day Grab
CD104/117		105.0	1347/099/97	26.319500	56.649833	Day Grab
CD104/118		103.0	1414/099/97	26.285167	56.660667	Day Grab
CD104/119		97.0	1442/099/97	26.254833	56.670333	Day Grab
CD104/120		89.0	1510/099/97	26.221333	56.679833	Day Grab
CD104/121		92.0	1541/099/97	26.190333	56.691333	Day Grab
CD104/122		115.0	1613/099/97	26.192073	56.651225	Day Grab
CD104/123		112.0	1642/099/97	26.225732	56.647585	Day Grab
CD104/124		120.0	1715/099/97	26.258333	56.641167	Day Grab
CD104/124/2		120.0	1726/099/97	26.259167	56.639333	Day Grab
CD104/125		127.0	1817/099/97	26.291500	56.618857	Day Grab
CD104/126		129.0	1846/099/97	26.324667	56.608667	Day Grab
CD104/127		130.0	1920/099/97	26.363853	56.593355	Day Grab
CD104/127/2		130.0	1954/099/97	26.365167	56.593000	Day Grab
CD104/127/3		115.5	2006/099/97	26.369500	56.591333	Day Grab
CD104/127/4		111.5	2035/099/97	26.365500	56.593333	Day Grab
CD104/128		128.0	2125/099/97	26.361833	56.556560	Day Grab
CD104/129		112.0	2215/099/97	26.341330	56.554655	Day Grab
CD104/130		120.5	2308/099/97	26.329672	56.564527	Day Grab
CD104/131		116.0	2344/099/97	26.296667	56.575833	Day Grab
CD104/131/2		116.0	2353/099/97	26.295505	56.575500	Day Grab
CD104/132		120.0	0042/100/97	26.262500	56.585333	Day Grab
CD104/133		121.0	0120/100/97	26.226500	56.597333	Day Grab
CD104/134		119.0	0153/100/97	26.188500	56.609000	Day Grab
CD104/135		108.0	0226/100/97	26.188667	56.569000	Day Grab
CD104/136		114.0	0300/100/97	26.218667	56.576167	Day Grab
CD104/137		113.0	0333/100/97	26.248000	56.570200	Day Grab
CD104/138		112.0	0402/100/97	26.271253	56.565917	Day Grab
CD104/139		117.0	0431/100/97	26.299667	56.556833	Day Grab
CD104/140		115.0	0509/100/97	26.266667	56.548833	Day Grab
CD104/141		113.0	0542/100/97	26.233333	56.539000	Gravity Core
CD104/141/2		113.0	0551/100/97	26.234167	56.538833	Gravity Core
CD104/141/3		100.0	0606/100/97	26.236000	56.538500	Day Grab
CD104/142		98.0	0638/100/97	26.199833	56.530167	Day Grab
CD104/143		95.0	0707/100/97	26.167333	56.520667	Day Grab
CD104/144		80.0	0735/100/97	26.167500	56.493333	Day Grab
CD104/144/2		80.0	0750/100/97	26.167833	56.493180	Day Grab
CD104/145		87.0	0821/100/97	26.201772	56.503293	Day Grab
CD104/146		106.5	0853/100/97	26.230667	56.512500	Day Grab
CD104/147		97.0	0926/100/97	26.262902	56.520700	Day Grab
CD104/148		129.0	1001/100/97	26.963990	56.530419	Day Grab
CD104/148/2		129.0	1010/100/97	26.298167	56.530419	Day Grab
CD104/149		139.0	1041/100/97	26.325000	56.538667	Day Grab
CD104/149/2		139.0	1049/100/97	26.325500	56.539833	Day Grab
CD104/150		80.0	1149/100/97	26.278822	56.498275	Gravity Core
CD104/151	start	101.0	1637/103/97	26.282667	56.065500	Rock Dredge
	end			26.276833	56.065500	
CD104/152	start	105.0	1810/103/97	26.274667	56.042167	Rock Dredge

	end			26.271166	56.040166	
CD104/153*	start	100.0	2009/103/97	26.259167	56.001667	Rock Dredge
	end			26.253166	55.998166	
CD104/154	start	108.0	2201/103/97	26.264833	55.971833	Rock Dredge
	end			26.252000	55.968333	
CD104/155	start	98.0	0024/104/97	26.251944	55.923095	Rock Dredge
	end			26.243700	55.921200	
CD104/156	start	89.0	0352/104/97	26.428667	56.175167	Rock Dredge
	end			26.423600	56.174900	
CD104/157	start	84.0	0606/104/97	26.552647	56.365450	Rock Dredge
	end			26.546921	56.364432	
CD104/158	start	84.0	0755/104/97	26.562777	56.392857	Rock Dredge
	end			26.551333	56.391833	
CD104/159	start	78.0	0859/104/97	26.537333	56.398667	Rock Dredge
	end			26.583333	56.385000	
CD104/160	start	78.0	1034/104/97	26.603167	56.415250	Rock Dredge
	end			26.604000	56.402000	
CD104/161	start	95.0	1334/104/97	26.512167	56.616667	Rock Dredge
	end			26.506300	56.603000	
CD104/162	start	102.0	1530/104/97	26.417833	56.606500	Rock Dredge
	end			26.419700	56.604500	
CD104/163		96.5	2301/104/97	26.472605	56.497167	Day Grab
CD104/164		115.5	2332/104/97	26.471685	56.459415	Day Grab
CD104/165		120.0	0010/105/97	26.467600	56.423167	Day Grab
CD104/166		130.5	0041/105/97	26.459667	56.385833	Day Grab
CD104/167		95.0	0114/105/97	26.458833	56.341667	Day Grab
CD104/167/2		95.0	0132/105/97	26.457500	56.342333	Day Grab
CD104/168		107.0	0202/105/97	26.435100	56.316167	Day Grab
CD104/169		103.0	0234/105/97	26.410167	56.288000	Day Grab
CD104/170		102.0	0307/105/97	26.388167	56.262167	Day Grab
CD104/171		105.0	0343/105/97	26.366833	56.231833	Day Grab
CD104/171/2		105.0	0352/105/97	26.366667	56.232667	Day Grab
CD104/172		109.0	0428/105/97	26.342675	56.206625	Day Grab
CD104/173		114.0	2025/105/97	26.319953	56.177483	Day Grab
CD104/174		110.0	2101/105/97	26.297055	56.153608	Day Grab
CD104/174/2		110.0	2110/105/97	26.298167	56.154000	Day Grab
CD104/175		93.0	2145/105/97	26.269384	56.130953	Day Grab
CD104/175/2		92.5	2152/105/97	26.269333	56.130000	Day Grab
CD104/176		94.5	2224/105/97	26.243397	56.107322	Day Grab
CD104/177		89.5	2313/105/97	26.217333	56.083833	Day Grab
CD104/178		82.5	2340/105/97	26.202667	56.066833	Day Grab
CD104/179		73.5	0016/106/97	26.165667	56.035333	Day Grab
CD104/179/2		73.5	0025/106/97	26.166333	56.035333	Day Grab
CD104/180		65.0	0103/106/97	26.141000	56.012333	Gravity Core
CD104/181		47.0	0138/106/97	26.114833	55.988167	Day Grab
CD104/181/2		46.5	0153/106/97	26.115833	55.988833	Gravity Core
CD104/182		51.0	0227/106/97	26.083167	55.956667	Day Grab
CD104/183		75.0	0441/106/97	26.301449	56.031963	Gravity Core
CD104/184		111.0	2253/106/97	26.376418	56.310448	Day Grab
CD104/185		103.0	2332/106/97	26.356265	56.287973	Day Grab
CD104/185/2		103.0	2341/106/97	26.355833	56.288000	Day Grab
CD104/186		103.0	0016/107/97	26.333667	56.260500	Day Grab
CD104/187		101.5	0049/107/97	26.309667	56.235167	Day Grab
CD104/188		101.0	0121/107/97	26.286333	56.209500	Day Grab
CD104/189		83.0	0152/107/97	26.264800	56.186167	Day Grab
CD104/189/2		83.0	0200/107/97	26.266000	56.187500	Day Grab

CD104/190	79.0	0232/107/97	26.238167	56.159167	Day Grab
CD104/191	60.0	0302/107/97	26.212700	56.137300	Day Grab
CD104/192	63.5	0335/107/97	26.187800	56.112500	Day Grab
CD104/192/2	62.5	0342/107/97	26.187167	56.111500	Day Grab
CD104/193	51.0	0414/107/97	26.162265	56.088518	Day Grab
CD104/194	53.0	0440/107/97	26.136293	56.064513	Day Grab
CD104/195	49.0	0510/107/97	26.111167	56.041167	Gravity Core
CD104/196	48.0	0543/107/97	26.085667	56.017167	Gravity Core
CD104/197	43.0	0619/107/97	26.059965	55.992427	Gravity Core
CD104/198	22.0	0757/107/97	26.032833	56.066000	Box Core
CD104/198/2	22.0	0805/107/97	26.032667	56.065667	Box Core
CD104/199	40.0	0907/107/97	26.072333	56.067167	Day Grab
CD104/199/2	40.0	0919/107/97	26.075167	56.070500	Day Grab
CD104/200	44.0	0947/107/97	26.095500	56.080100	Gravity Core
CD104/200/2	44.0	1001/107/97	26.095500	56.082000	Gravity Core
CD104/201	44.0	1041/107/97	26.123833	56.102667	Day Grab
CD104/202	48.0	1129/107/97	26.149333	56.119500	Day Grab
CD104/203	43.0	1222/107/97	26.176667	56.141333	Day Grab
CD104/203/2	43.0	1228/107/97	26.177667	56.141667	Day Grab
CD104/204	47.0	1402/107/97	26.267300	56.240667	Day Grab
CD104/204/2	47.0	1409/107/97	26.266833	56.239500	Day Grab
CD104/205	53.0	1443/107/97	26.307167	56.275333	Day Grab
CD104/205/2	53.0	1449/107/97	26.306500	56.276167	Day Grab
CD104/206	76.5	1523/107/97	26.333667	56.298500	Day Grab

* Lost dredge

7.4. Data Files

7.4.1 Sidescan data files.

Tape name	Filename	File size (Mb)	Start time	End time
BACKUP#2	fri21.001	50	1848/080/97	1944/080/97
	fri21.002	50		2141/080/97
	fri21.003	50		2338/080/97
	fri21.004	50		0135/081/97
	fri21.005	50		0332/081/97
	fri21.006	50		0529/081/97
	fri21.007	50		0726/081/97
	fri21.007	50		0922/081/97
	fri21.008	50		1119/081/97
	fri21.009	50		1316/081/97
	fri21.010	50		1513/081/97
BACKUP#1	fri21.012	10		1538/081/97
	scheh001.000	50	1538/081/97	1754/081/97
	scheh001.001	50		1951/081/97
	scheh001.002	50		0425/082/97
	scheh001.003	50		0622/08297
	scheh001.004	50		0819/082/97
	scheh001.005	50		1015/082/97
	scheh001.006	50		1212/082/97
	scheh001.007	50		1409/082/97
	scheh001.008	50		1606/082/97
	scheh001.009	50		1803/082/97
	sceh001.010	42.5		1944/082/97

	scheh002.000	7.5	1947/082/97	2004/082/97
	scheh002.001	50		2201/082/97
	scheh002.002	50		2358/082/97
	scheh002.003	50		0155/083/97
	scheh002.004	50		0352/083/97
	scheh002.005	4		0401/083/97
	scheh003.006	46	0407/083/97	0553/083/97
	scheh003.007	50		0750/083/97
	scheh003.008	50		0947/083/97
	scheh003.009	50		1110/083/97
	scheh003.010	50		1210/083/97
	scheh003.011	50		1249/083/97
	scheh003.012	50		1321/083/97
	scheh003.013	50		1415/083/97
	scheh003.014	50		1530/083/97
	scheh003.015	50		1727/083/97
	scheh003.016	50		1924/083/97
	scheh003.017	50		2120/083/97
	scheh003.018	50		2317/083/97
	scheh003.019	50		0114/084/97
	scheh003.020	50		0311/084/97
	scheh003.021	50		0508/084/97
	scheh003.022	50		0705/084/97
	scheh003.023	50		0902/084/97
	scheh003.024	50		1059/084/97
	scheh003.025	50		1255/084/97
	scheh003.026	50		1452/084/97
	scheh003.027	50		1649/084/97
	scheh003.028	50		1846/084/97
	scheh003.029	50		2043/084/97
	scheh003.030	50		2240/084/97
	scheh003.031	50		0037/085/97
	scheh003.032	50		0233/085/97
	scheh003.033	36.5		0401/085/97
BACKUP#2	scheh004.033	13.5	0401/085/97	0433/085/97
	scheh004.034	50		0630/085/97
	scheh004.035	50		0827/085/97
	scheh004.036	50		1024/085/97
	scheh004.037	50		1220/085/97
	scheh004.038	50		1417/085/97
	scheh004.039	50		1627/085/97
	scheh004.040	50		1823/085/97
	scheh004.041	50		2020/085/97
	scheh004.042	50		2217/085/97
	scheh004.043	50		0014/086/97
	scheh004.044	50		0211/086/97
	scheh004.045	50		0408/086/97
	scheh004.046	50		0605/086/97
	scheh004.047	50		0801/086/97
	scheh004.048	50		0958/086/97
	scheh004.049	50		1155/086/97
	scheh004.050	23		1338/086/97
	scheh005.051	50	1338/086/97	1537/086/97
	scheh005.052	50		1733/086/97
	scheh005.053	50		1930/086/97
	scheh005.054	50		2127/086/97

	scheh005.055	50		2324/086/97
	scheh005.056	50		0121/087/97
	scheh005.057	50		0318/087/97
	scheh005.058	50		0539/087/97
	scheh005.059	50		0736/087/97
	scheh005.060	50		0933/087/97
	scheh005.061	50		1129/087/97
	scheh005.062	50		1326/087/97
	scheh005.063	50		1509/087/97
BACKUP#3	scheh006.063	6.2	0311/088/97	0403/088/97
	scheh006.064	50		0600/088/97
	scheh006.065	50		0757/088/97
	scheh006.066	50		0954/088/97
	scheh006.067	50		1135/088/97
	scheh006.068	50		1332/088/97
	scheh006.069	5.2		1351/088/97
	scheh007.069	45	0248/090/97	0434/090/97
	scheh007.070	50		0630/090/97
	scheh007.071	50		0827/090/97
	scheh007.072	50		1024/090/97
	scheh007.073	50		1228/090/97
	scheh007.074	50		1425/090/97
	scheh007.075	50		1622/090/97
	scheh007.076	50		1819/090/97
	scheh007.077	50		2015/090/97
	scheh007.078	50		2212/090/97
	scheh007.079	50		0009/091/97
	scheh007.080	50		0206/091/97
	scheh007.081	50		0403/091/97
	scheh007.082	50		0600/091/97
	scheh007.083	50		0757/091/97
	scheh007.084	50		1053/091/97
	scheh007.085	50		1250/091/97
	scheh007.086	50		1447/091/97
	scheh007.087	50		1644/091/97
	scheh007.088	50		1841/091/97
	scheh007.089	50		2038/091/97
	scheh007.090	50		2235/091/97
	scheh007.091	50		0032/092/97
	scheh007.092	50		0228/092/97
	scheh007.093	50		0425/092/97
	scheh007.094	50		0622/092/97
	scheh007.095	39		07052/092/97
BACKUP#4	scheh008.096	50	0755/092/97	0952/092/97
	scheh008.097	50		1149/092/97
	scheh008.098	50		1351/092/97
	scheh008.099	50		1548/092/97
	scheh008.100	50		1758/092/97
	scheh008.101	50		2005/092/97
	scheh008.102	50		2205/092/97
	scheh008.103	50		2359/092/97
	scheh008.104	50		0156/093/97
	scheh008.105	50		0353/093/97
	scheh008.106	50		0550/093/97
	scheh008.107	50		0746/093/97
	scheh008.108	50		0943/093/97

	scheh008.109	50		1140/093/97
	scheh008.110	50		1343/093/97
	scheh008.111	50		1540/093/97
	scheh008.112	50		1737/093/97
	scheh008.113	50		1934/093/97
	scheh008.114	50		2131/093/97
	scheh008.115	50		2328/093/97
	scheh008.116	50		0124/094/97
	scheh008.117	50		0321/094/97
	scheh008.118	50		0518/094/97
	scheh008.119	50		0715/094/97
	scheh008.120	50		0912/094/97
	scheh008.121	50		1109/094/97
	scheh008.122	49		1317/094/97
	scheh009.123	50	1131/100/97	1833/100/97
	scheh009.124	50		2032/100/97
	scheh009.125	50		2229/100/97
	scheh009.126	50		0025/101/97
	scheh009.127	50		0222/101/97
	scheh009.128	50		0419/101/97
	scheh009.129	50		0629/101/97
	scheh009.130	50		0826/101/97
	scheh009.131	40		1109/101/97
BACKUP#5	scheh010.133	50	1755/106/97	1837/106/97
	scheh010.134	50		1909/106/97
	scheh010.135	50		2027/106/97
	scheh010.136	50		2212/106/97
	scheh010.137	50		2243/106/97
	scheh010.138	50		2315/106/97
	scheh010.139	50		2346/106/97
	scheh010.140	50		0018/107/97
	scheh010.141	50		0049/107/97
	scheh010.142	50		0121/107/97
	scheh010.143	50		0152/107/97
	scheh010.144	50		0224/107/97
	scheh010.145	50		0255/107/97
	scheh010.146	50		0327/107/97
	scheh010.147	50		0358/107/97
	scheh010.148	50		0430/107/97
	scheh010.149	50		0501/107/97
	scheh010.150	50		0555/107/97
	scheh010.151	50		0641/107/97
	scheh010.152	50		0712/107/97
	scheh010.153	50		0759/107/97
	scheh010.154	50		0830/107/97
	scheh010.155	50		0917/107/97
	scheh010.156	50		0949/107/97
	scheh010.157	4		1013/107/97

7.4.2. SAPPA data file list

Site	Time on bottom (GMT)	Water depth (m)	Latitude	Longitude	Directory c:/cd104/...	Files	Description
Test site	1817/104/97	15	26.181293	56.517233	cd104p	scx.001 - scx.004	P-wave water column shots
	1945/104/97	86.5	26.180175	56.515907	cd104s	scx.000 - scx.001	SV-waves
						scx.002 - scx.004	SH-waves
S07a	0624/105/97	88.5	26.523667	56.378333	sappa07	scx.000 - scx.010	Station A, SV-waves
						scx.011 - scx.021	Station A, SH-waves
S07b	0652/105/97	88.5	26.52206	56.378708		scx.022 - scx.032	Station B, SH-waves
						scx.033 - scx.043	Station B, SV-waves
S08a	0854/105/97	82	26.55624	56.482772	s08bsh1	scx.000 - scx.004	Station A, SV-waves
					s08bsh2	scx.005 - scx.009	Station A, SH-waves
S08b	0920/105/97	82	26.556083	56.481357	s08bsh1	scx.000 - scx.004	Station A, SV-waves
						scx.005 - scx.009	Station B, SH-waves
S04a	1033/105/97	79	26.624347	56.467632	s09asv1	scx.000 - scx.004	Station A, SV-waves
					s09asv2		
					s09ash1		Station A, SH-waves
					s09ash2		
S04b	1057/105/97				s09bsh1		Station B, SH-waves
					s09bsh2		
					s09bsv1		Station B, SV-waves
					s09bsv2		
S05a	1231/105/97	79	26.592022	56.347108	s05asv1	scx.000 - scx.004	Station A, SV-waves
					s05asv2		
					s05ash1		Station A, SH-waves
					s05ash2		
S05b	1310/105/97				s05bsv1		Station B, SV-waves
					s05bsv2		
					s05bsh1		Station B, SH-waves
					s05bsh2		
S09a	1457/105/97	89	26.550542	56.54525	x09asv1	scx.000 - scx.004	Station A, SV-waves
					x09asv2		
					x09ash1		Station A, SH-waves
					x09ash2		
S09b	1525/105/97				x09bsv1		Station B, SV-waves
					x09bsv2		
					x09bsh1		Station B, SH-waves
					x09bsh2		
S06a	0605/106/97	75	26.3016104	56.031925	s06ash1	scx.000 - scx.004	Station A, SH-waves
					s06ash2		
S06b					s06bsh1		Station B, SH-waves
					s06bsh2		
s10a	1323/106/97	93	26.469167	56.607	s02ash1	scx.000 - scx.004	Station A, SH-waves, new trigger
					s02ash2		

s10b					s02bsh1		Station B, SH-waves, new trigger
					s02bsh2		
s02a	1447/106/97	86	26.504168	56.672722	z02ash1	scx.000 - scx.004	Station A, SH-waves, new trigger
					z02ash2		
s02b					z02bsh1		Station B, SH-waves, new trigger
					z02bsh2		
On deck					temp	scx.000 - scx.004	Trigger test for SV-waves
					temp2	scx.000 - scx.009	Test for old SH-waves trigger

8. FIGURES

Figure1. CD 104 Leg 2. Track chart for whole cruise.

Figure 2. Digitally recorded sidescan sonar coverage around the Musandam Peninsula. Some of the data from the east side of the Penisular exists as hard copy only, due to corruption of the data tapes.

Figure 3. Grab sample stations (dots), gravity core stations (stars), box core stations (B) and Kasten core stations (K).

Figure 4. SAPPA sites.

Figure 5. Dredge sites (dots) and camera stations (c).

Figure 6. Example of Boomer seismic profile showing buried mounds or ridges.

Figure 7. Example of high resolution sidescan sonar record showing the pitted ground.

Figure 8. Example of SAPPA Sh wave measurement.

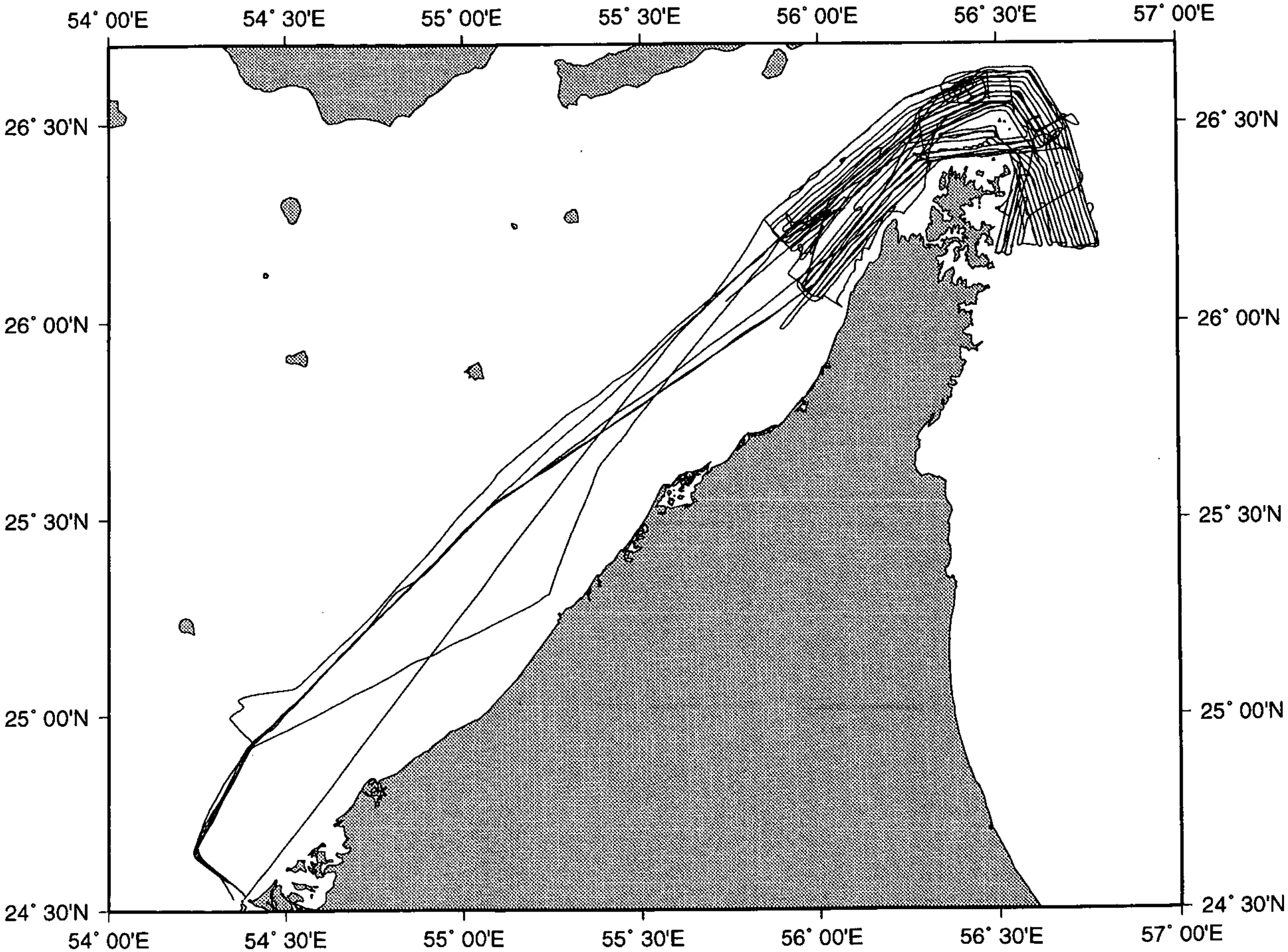

Figure1. CD 104 Leg 2. Track chart for whole cruise.

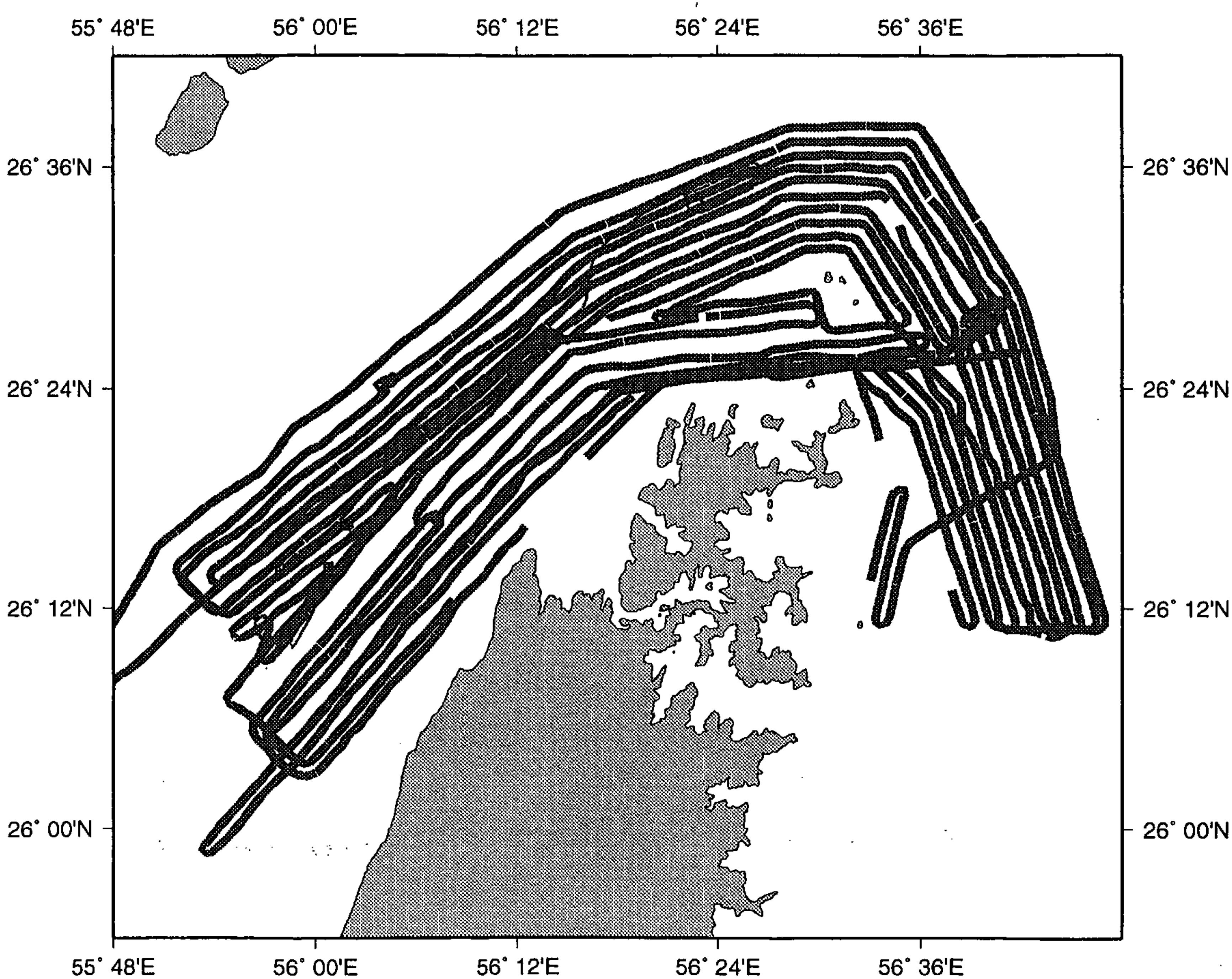

Figure 2. Digitally recorded sidescan sonar coverage around the Musandam Peninsula. Some of the data from the east side of thre Peninsula exists as hard copy only, due to corruption of the data tapes.

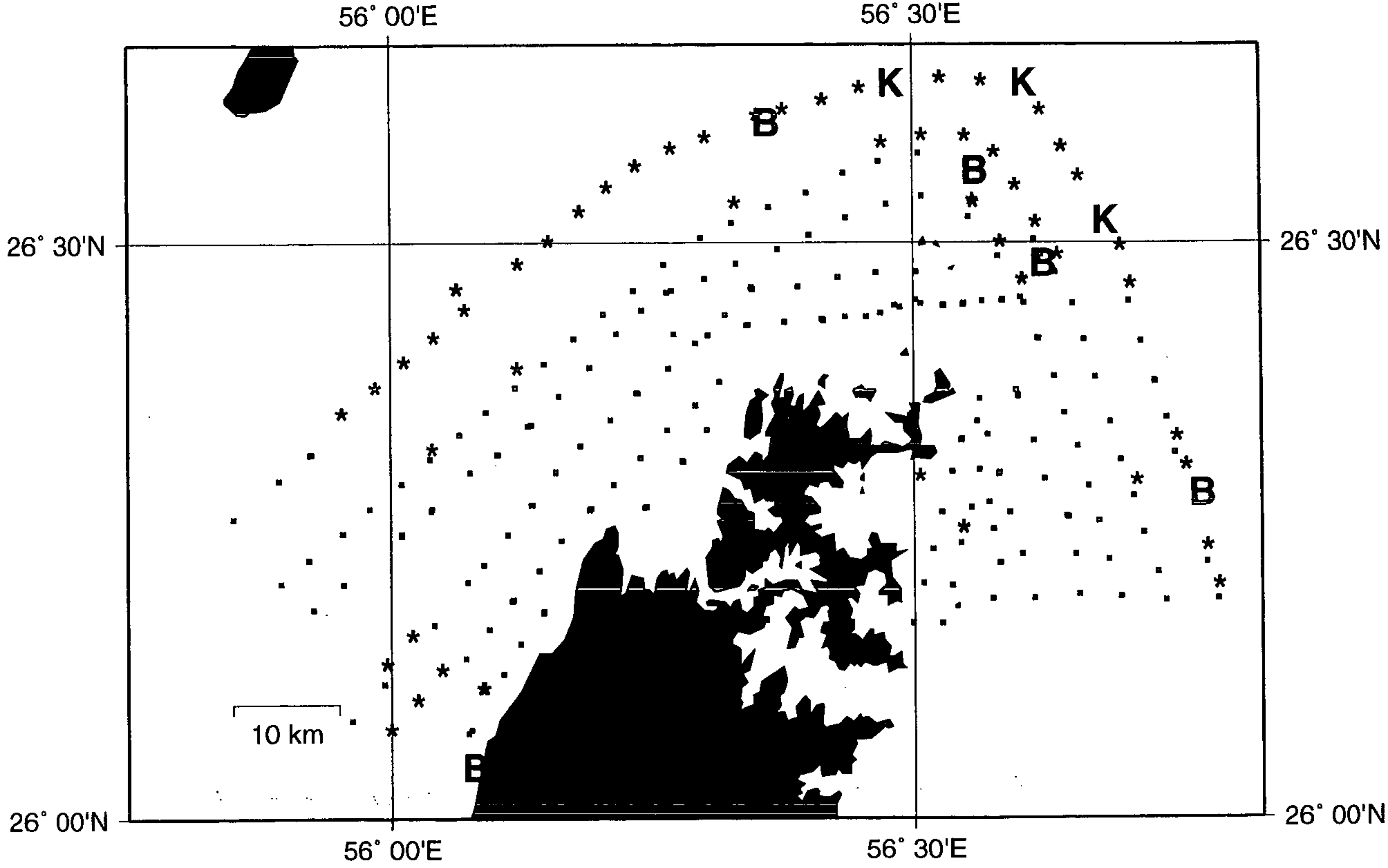

Figure 3. Grab sample stations (dots), gravity core stations (stars), box core stations (B) and Kasten core stations (K).

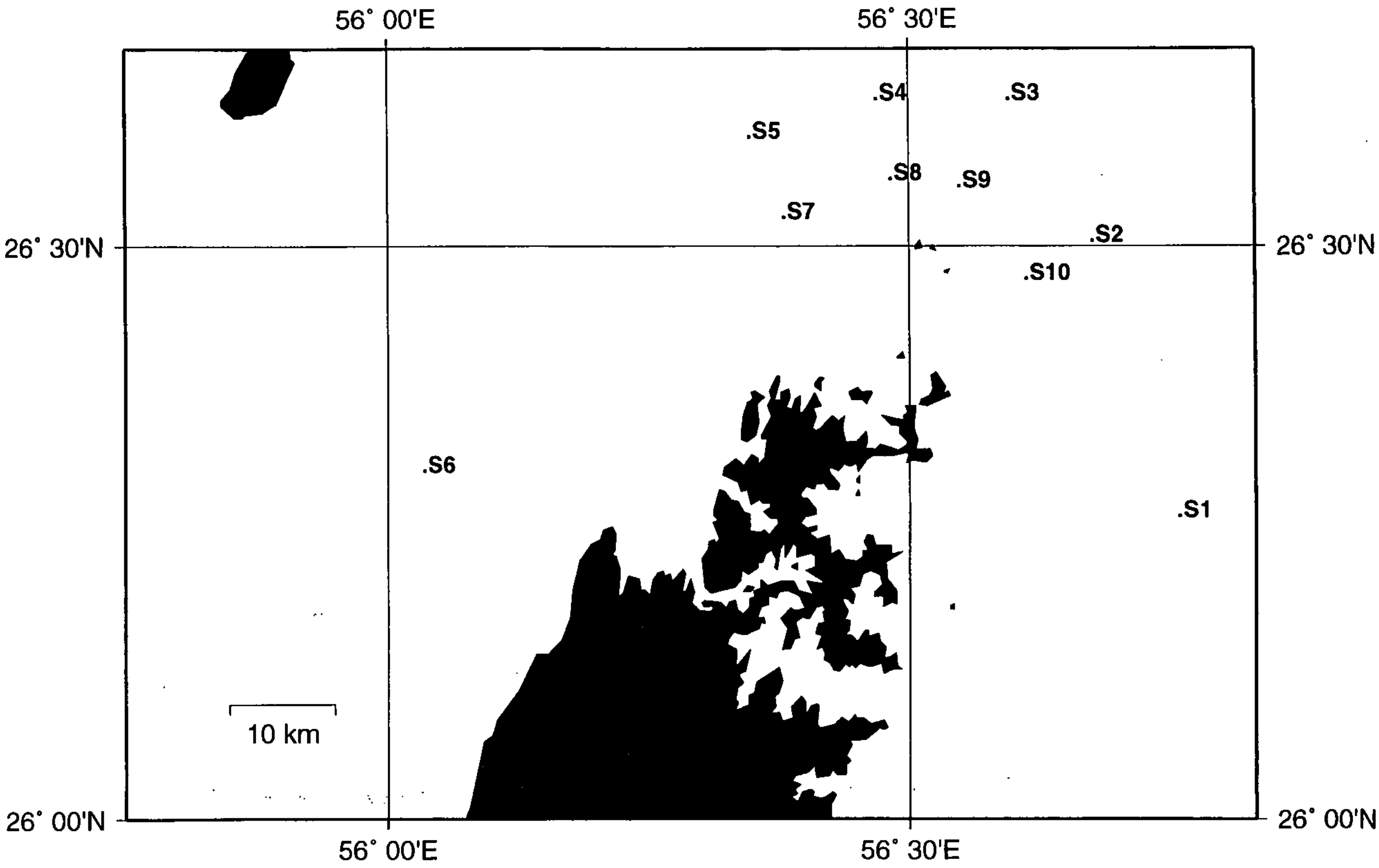

Figure 4. SAPPA sites.

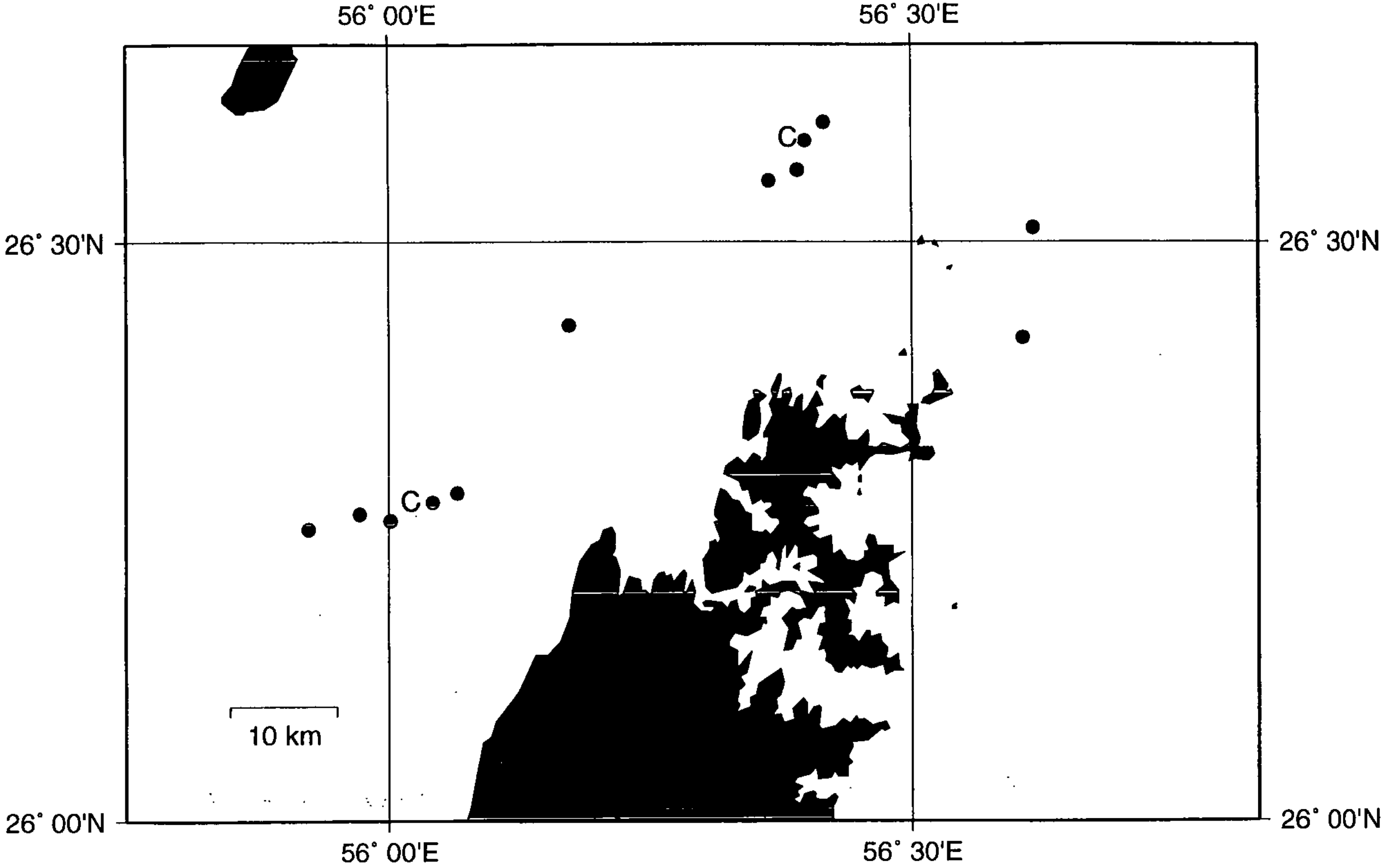

Figure 5. Dredge sites (dots) and camera stations (C).

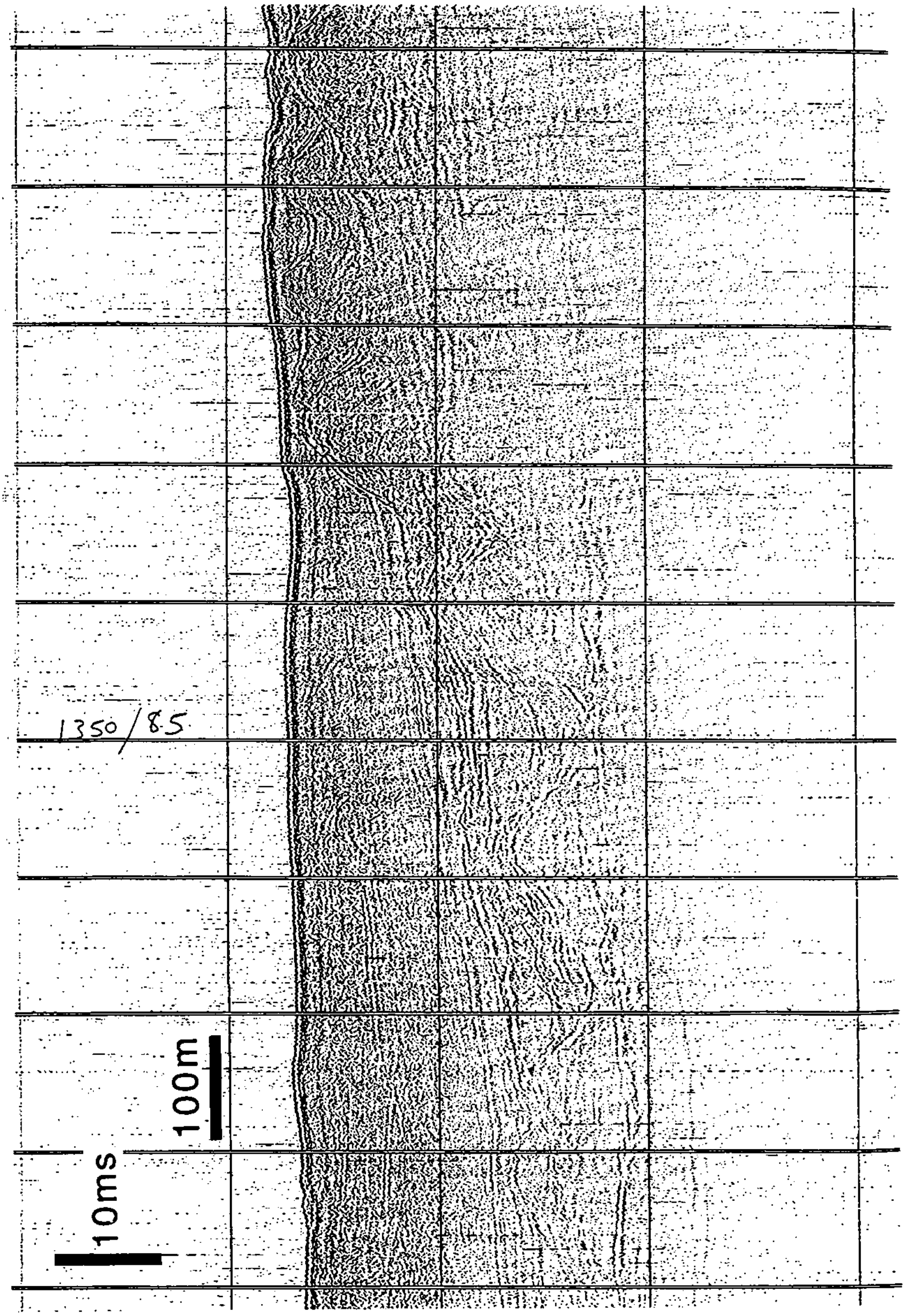

Figure 6. Example of Boomer seismic profile showing buried mounds or ridges.

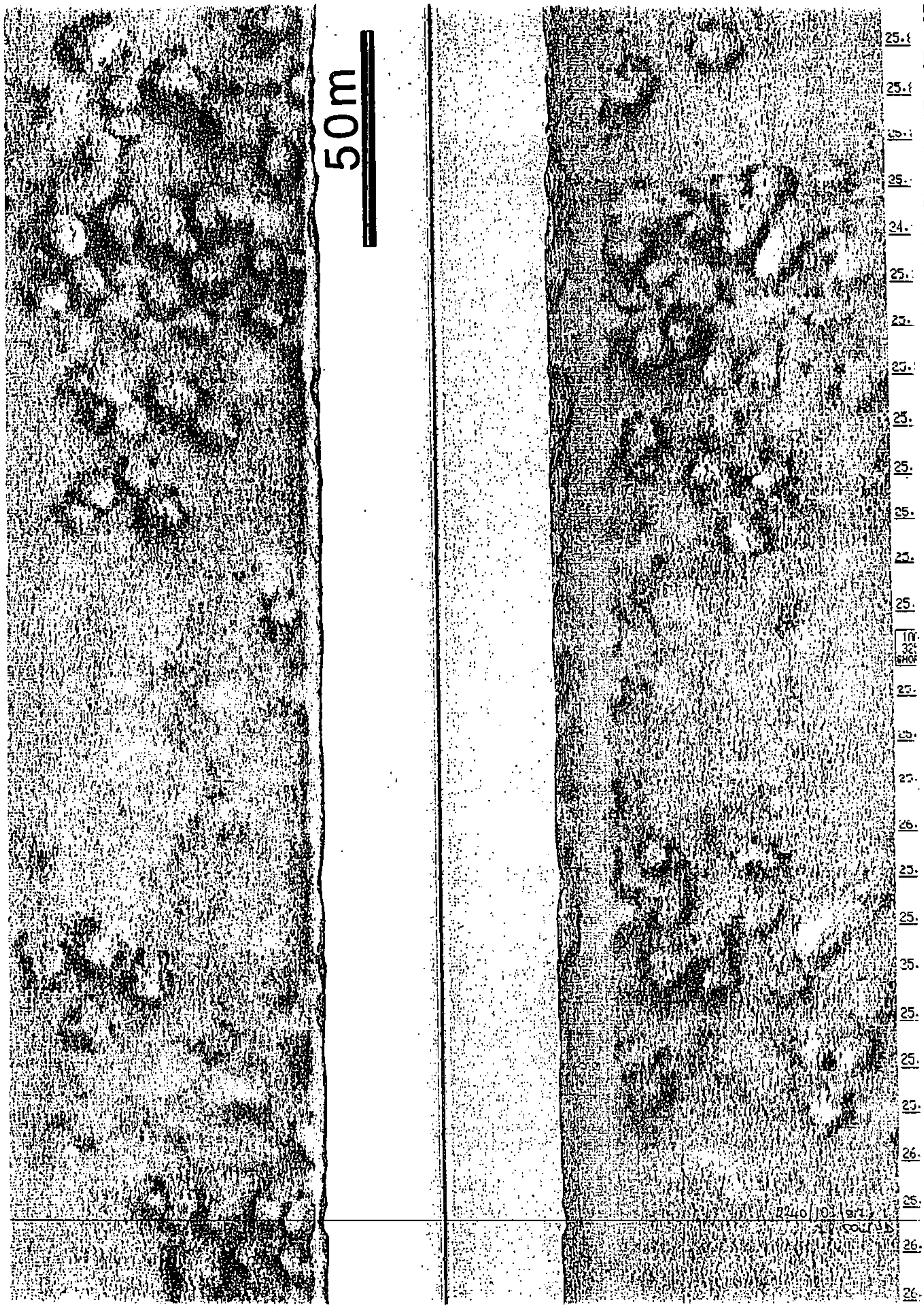

Figure 7. Example of high resolution sidescan sonar record showing the pitted ground.

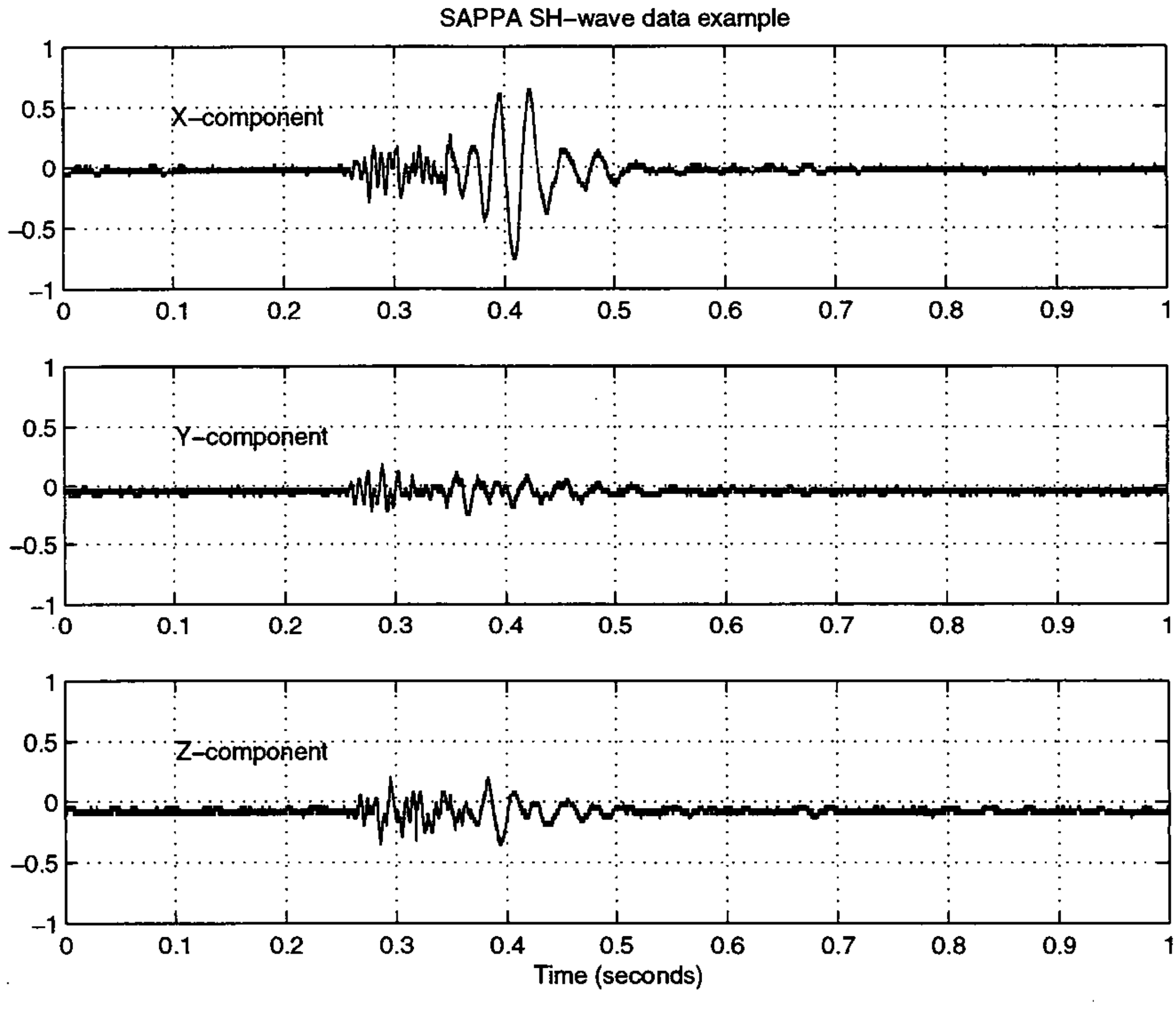

Figure 8. Example of SAPPA SH wave measurement.