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07 JUL - 10 AUG 2000

A multidisciplinary study of the environment and ecology of deep-water coral ecosystems and associated seabed facies and features (The Darwin Mounds, Porcupine Bank and Porcupine Seabight)

Principal Scientists

B J Bett[1], D S M Billett[1], D G Masson[2] & P A Tyler[3]

2001

[1]George Deacon Division for Ocean Processes
Southampton Oceanography Centre
University of Southampton
Waterfront Campus
European Way
Southampton
Hants SO14 3ZH
UK

Tel: +44 (0)23 8059 6355
Fax: +44 (0)23 8059 6247
Email: bjb@soc.soton.ac.uk

[2]Challenger Division for Seafloor Processes
[3]School of Ocean and Earth Science

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AUTHOR
BETT, B J, BILLETT, D S M, MASSON, D G, TYLER, P A, et al

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ABSTRACT

RRS *Discovery* Cruise 248 aimed to carry out a multidisciplinary study of the environment and ecology of deep-water coral ecosystems and associated seabed features in the northeast Atlantic. The study was primarily focused on the Darwin Mounds area, northern Rockall Trough (59° 49'N, 07° 22'W), but also examined a number of sites in the Porcupine Seabight area. The cruise was divided into two legs (Govan-Stornoway, 8 Jul-21 Jul 2000; Stornoway-Southampton, 22 Jul-10 Aug 2000). Leg 1 focused on the ecology of the Darwin Mounds area, with seabed photographic surveys (SOC SHRIMP system), coring (Box and Multiple cores) and trawling (Agassiz) forming the main activities. Leg 2 began with detailed geological investigations of the Darwin Mounds area, concentrating on piston coring and sidescan sonar surveys. Leg 2 concluded with combined ecological and geological studies of carbonate mound sites on the Porcupine Bank and in the Porcupine Seabight.

Observations in the Darwin Mounds area confirmed the common occurrence of deep-water corals on these Mounds. The mounds themselves do not appear to be carbonate formations but may be better characterised as sand volcanoes. Numerous xenophyophores were observed in association with the mounds; however, no live specimens were recovered in any of the samples collected. Sidescan sonar images and seabed photography both suggested that the Darwin Mounds area had been subject to considerable commercial trawling with resultant apparent damage to the deep-water coral ecosystems.

The various operations undertaken in the Porcupine Seabight area were also successful in imaging giant carbonate mounds and their associated coral communities with both sidescan sonar and seabed photography, and in recovering biological sample material from these areas. In common with the Darwin Mounds area, the observations made suggested that deep-water fishing impacts on coral ecosystems were also evident in this region.

KEYWORDS
ACES, AGASSIZ TRAWL, ATLNE, BOTTOM PHOTOGRAPHY, BOX CORER, BATHYSNAP, BATHYAL, BATHYSIPHON, BENTHIC COMMUNITIES, CARBONATE MOUNDS, CRUISE 248 2000, CTD OBSERVATIONS, CURRENT METERS, DARWIN MOUNDS, DEEP-WATER CORALS, *DISCOVERY*, DREDGE, ECOMOUND, FISHING EFFECTS, FORAMINIFERA, GRAVITY CORER, IN SITU OPTICAL RECORDER, LOPHELIA, MACROBENTHOS, MEIOBENTHOS, MEGABENTHOS, MUD VOLCANOES, MULTIPLE CORER, MINI PROFILER VEHICLE, NORTHEAST ATLANTIC, ORGANIC CHEMISTRY, PISTON CORER, POCKMARKS, PORCUPINE BANK, PORCUPINE SEABIGHT, ROCKALL TROUGH, SEDIMENTS, SHRIMP, SIDESCAN SONAR, STAND ALONE PUMPING SYSTEM, SYRINGAMMINA, XENOPHYOPHORES

ISSUING ORGANISATION
Southampton Oceanography Centre
Empress Dock
European Way
Southampton SO14 3ZHUK

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Email: nol@soc.soton.ac.uk

CONTENTS PAGE

ITINERARY

Sail Govan	(Leg 1)	0800 BST Saturday 8 July 2000
Arrive Stornoway		0630 UTC Friday 21 July 2000
Sail Stornoway	(Leg 2)	0700 UTC Saturday 22 July 2000
Arrive Southampton		1000 BST Thursday 10 August 2000

SCIENTIFIC PERSONNEL (LEG 1)

TYLER, Paul A. (PS)	School of Ocean and Earth Science (SOC)
BILLETT, David S.M.	George Deacon Division for Ocean Processes (SOC)
BARNES, Nathalie	School of Ocean and Earth Science (SOC)
BOWSER, Sam C.	USA Health Department, New York
DE MESEL, Ilse	University of Gent
DORSCHEL, Boris	University of Bremen
EDGE, David	Ocean Engineering Division (SOC)
EVANS, Jez	Challenger Division for Seafloor Processes (SOC)
GOODAY, Andrew .	George Deacon Division for Ocean Processes (SOC)
JONES, Jeff	Ocean Engineering Division (SOC)
KIRIAKOULAKIS, Kostas	University of Liverpool
KNIGHT, Gareth	Ocean Engineering Division (SOC)
LE GOFF, Marie	School of Ocean and Earth Science (SOC)
McLACHLAN, Robert	Ocean Engineering Division (SOC)
POND, David	George Deacon Division for Ocean Processes (SOC)
ROBERTS, Murray J.	Dunstaffnage Marine Laboratory
ROBERTS, Rhys	Ocean Engineering Division (SOC)
ROGERS, Alex	School of Ocean and Earth Science (SOC)
ROURKE, Elizabeth	Ocean Engineering Division (SOC)
WALLER, Rhian	School of Ocean and Earth Science (SOC)
WYNER, John	Ocean Engineering Division (SOC)

SCIENTIFIC PERSONNEL (LEG 2)

MASSON, Douglas G. (PS)	Challenger Division for Seafloor Processes (SOC)
AXELSSON, Magnus	George Deacon Division for Ocean Processes (SOC)
BILLETT, David S.M.	George Deacon Division for Ocean Processes (SOC)
CHINNERY, Fay	School of Ocean and Earth Science (SOC)
EVANS, Jez	Challenger Division for Seafloor Processes (SOC)
FINLAYSON, Mark	Seatronics Ltd.
JONES, Jeff	Ocean Engineering Division (SOC)
KIRIAKOULAKIS, Kostas	University of Liverpool
KOZACHENKO, Maxim	University College, Cork
McLACHLAN, Robert	Ocean Engineering Division (SOC)
MATTHEW, Duncan	Ocean Engineering Division (SOC)
NETO, Renato	University of Liverpool
ROBERTS, Rhys	Ocean Engineering Division (SOC)
ROURKE, Elizabeth	Ocean Engineering Division (SOC)
WALLER, Rhian	School of Ocean and Earth Science (SOC)
WHEELER, Andy	University College, Cork
WYNER, John	Ocean Engineering Division (SOC)
WYNN, Russell	Challenger Division for Seafloor Processes (SOC)

SHIP'S PERSONNEL

CHAMBERLAIN, Roger J.	Master
SARGEANT, Peter	Chief Officer
COPE, Andrew	2nd Officer
VRETTOS, Christos	3rd Officer
JETHWA, Jet	Chief Engineer
McDONALD, Bernie	2nd Engineer
HEALY, Anthony	3rd Engineer
HARNETT, John	3rd Engineer
MacASKILL, Norman	Electrical/Technical Officer
TREVASKIS, Michael	Chief Petty Officer (Deck) - Bosun
THOMSON, Iain N.M.	Petty Officer (Deck) - Bosun's Mate
ALLISON, Philip	Rating SG1A
COOK, Stuart	Rating SG1A
MOORE, Michael S.	Rating SG1A
DICKINSON, Robert	Rating SG1A (1st leg)
HEBSON, Harry	Rating SG1A (2nd leg)
JOHNSON, Robert	Rating SG1A
HAUGHTON, John	Senior Catering Manager
LYNCH, Peter A.	Chef
KENNEDY, Thomas	Steward
ORSBORN, Jeff	Steward
SEARLE, P.G.	Motor Man
MacKENZIE, Iain	Mess Steward 1A

INTRODUCTION

The Darwin Mound field, located at about 1000 m water depth in the northeast Rockall Trough, was discovered during the Atlantic Margin Environmental Survey, 1998[1] - a major survey funded by a consortium of oil companies and led by SOC. The numerous mounds (100+) in the field are generally 100 m across and about 5m high. The mounds appear to be unique in possessing 'tails' - apparently downstream features that, while seen on sidescan sonar, have no obvious physical expression at the seafloor. Both the mounds and their tails are characterised by particularly interesting faunas: the mounds by the deep-water coral *Lophelia pertusa*, the tails by dense populations of the giant protozoan (xenophyophore) *Syringammina fragilissima*. In addition to the Darwin Mound field, the area has a number of other potentially related seafloor features. There is a second mound field, where the mounds lack tails, and there is a large area of pockmarked seabed. It is possible that the formation of mounds and pockmarks may be related to fluid escapes from the seabed.

Subsequent to these discoveries, a successful application to the Natural Environment Research Council was made to conduct a detailed study of the Darwin Mounds area[2]. This research aimed to assess several questions:

- What is the overall distribution of mounds and pockmarks in this region, and does it relate to any common underlying structure or process?
- What are the structures of the different mound types and pockmarks present in the region, could all or some have a common origin?
- Do the distributions of biological communities reflect the structures of the different mound types and pockmarks, and do these distributions reveal anything about the processes that may be associated with these structures?
- Are the mounds and / or pockmarks active; active or not, by what means do they influence the local environment?
- What are the biological characteristics of the dominant organisms associated with mounds and pockmarks (e.g. corals and xenophyophores), and what do they reveal about the structures and any associated processes of these seabed features?

These general objectives are closely tied to those of two European Union funded programmes, ACES and ECOMOUND, that have also provided financial support for RRS *Discovery* cruise 248. In addition to the Darwin Mounds area, these programmes are addressing deep-water coral ecosystems and carbonate mounds in other locations. Consequently, this cruise will also study the environment and ecology of deep-water coral ecosystems at locations in the Porcupine Seabight area.

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[1] AFEN, 2000. Environmental Surveys of the Seafloor of the UK Atlantic Margin, Atlantic Frontier Environmental Network [CD-ROM, 53 pp., 45 figs, 11 tabs]. Available from Geotek Limited, Daventry, Northants NN11 5EA, UK.

[2] Bett, B.J., Pond, D., Masson, D.G. & Rogers, A.'*The Darwin Mounds*': An interdisciplinary study of a carbonate mound field, and other related seafloor features, in the Northern Rockall Trough. SOC-NERC Shiptime Proposal.

NARRATIVE

Wednesday 5 July

The first members of the scientific party arrived at the ship in the early morning. Scientific gear was moved to appropriate laboratories and secured in place. The delivery of the Seatronics sidescan sonar winch system was late and did not arrive until the afternoon, delaying the mobilisation of the system. However, during the day the rest of the system was gradually connected to the ship's facilities. It was apparent that there was a problem with the aft crane and that this might delay the departure of the vessel.

Thursday 6 July

The rest of the scientific party arrived during the day, unpacked and organised the laboratory spaces. In the early morning it became apparent that the problems with the aft crane were serious. The bearing in the wire spooling mechanism had collapsed and the crane could not be used. The crane had to be dismantled and the bearing was taken away for refurbishment. The mobilisation of the Seatronics system took rather longer than expected and a test of the system, including the Ultra-Short Baseline System (USBL), in the dock (2000 to 2130 BST) was unsuccessful. This was due to a number of factors including a software problem, the shallowness of the dock, the ship's hull blocking the USBL communication from the mid-ships gantry to the aft gantry, and the lowering of the sonar system into the filthy black mud at the bottom of the dock. A severe wash-down of the fish was required to get rid of the stench of hydrogen sulphide.

Friday July

Mobilisation of the scientific equipment continued. The Seatronics system was tested again at 1200 and after some tweaking of the software worked well. The crane was re-assembled during the afternoon and load-tested in the early evening. Sailing of the vessel was set for 0800 the following day.

Saturday 8 July

The ship sailed at 0800 as planned. A meeting was held at 1400 to discuss the scientific work programme for the cruise, followed by another meeting to discuss in how to deal with the box core and multicore samples. A muster for emergency and boat stations was held at 1615. The sea was slightly choppy with the wind from the north. Clocks were set back one hour to UTC at midnight.

Sunday 9 July

Good progress was made to the study site during the morning. At 1420Z the ship hove to, to move equipment on deck and to launch the 3.5 kHz fish.

The ship arrived at the first station to the south of the Darwin Mounds area at 1924Z. The 10 kHz hull transducer proved to be rather noisy and did not give clear information on the sounding, so the 10 kHz fish was deployed in addition to the 3.5 kHz fish at 1924Z. The first SHRIMP (Seabed High Resolution Imaging Platform) (St. 138121#1) was deployed at 1957Z in an area of pockmark features on the seabed. Problems were encountered at first when all the systems were switched on close to the seabed. Over the course of the first hour

the problem, relating to the still camera and its power supply, was identified. The camera was switched off and the deployment was continued. Owing to a lack of memory space on the computer the system crashed several times during the deployment. On recovery one of the video recorders was found not to have worked. The other video provided good images of the seafloor, but no obvious pockmark features were noted.

Monday 10 July

Following the retrieval of the first SHRIMP the ship headed for a group of carbonate mounds in the northeast of the study area. Two echosounding lines were run between 0522 to 0916Z to identify the positions of the carbonate mounds. These mounds would be sampled later in the cruise.

The ship then headed for a Bathysnap mooring that had been laid in August 1999 (RRS *Charles Darwin* cruise 119). Attempts to switch the Bathysnap release on started at 1034Z. Bathysnap failed to respond to interrogation and the attempt at recovery was abandoned at 1124Z for the present.

The ship then made for the main study area a few miles to the east of the Bathysnap position. The releases for each of three current meter moorings were tested individually (1224 to 1545Z). In addition, two releases for the SAMS *IS*OR mooring (*In Situ* Optical Recorder) and the SOC Bathysnap were tested on the CTD frame. A successful CTD profile of the water column structure was obtained (St. 13813#1, 1629 to 1740Z).

It was planned to position all 5 moorings (3 near-bed current meters, *IS*OR and Bathysnap) on, and close to, two closely spaced mounds on the edge of the western Darwin mound field. To set the mooring results in context, SHRIMP was guided over the mounds to characterise the seabed and fauna in the area (St 13814#1). Following an initial echosounding survey (1753 to 2113Z), to position the mounds accurately, SHRIMP was deployed at 2153Z, drifting southwest over the mounds and then manoeuvering the ship against the prevailing wind in a north-easterly direction. A good video and a set of still photographs were obtained.

Tuesday 11 July

The ship headed south to the pockmark area at 0115Z arriving at 0330Z. SHRIMP was deployed at 0334Z and obtained a good 3-hour video run across the seabed. During the haul the echosounding record showed evidence of a small depression in the seabed. Similar features were noted just as the video ran out of time. This position was noted for a future SHRIMP deployment.

Heading north again, the wire was changed to the coring warp. The aim of the next few hours was to sample the fauna of the Darwin Mounds and their associated tail-like features (as seen in 30 kHz sidescan sonar records), in particular coral communities (mounds) and xenophyophores ("tails"). Three box cores were taken in the first instance (13816#1-3, 1025 to 1528Z). Two good cores were obtained (#1 and #3) and sieved through 1mm, 500 and 250μm mesh for macrofauna. The surfaces of the cores were covered in many small ophiuroids. Sadly, there were no xenophyophores. A multicore was taken at the same locality (St. 13816#4, 1605Z) and was moderately successful, producing 5 short sandy cores. The cores were quite fluid and were removed with great care from the coring head. One core contained half of a dead xenophyophore.

The ship then moved to deploy two moorings. The first, the *In Situ* Optical Recorder (*ISOR*) (a joint venture between the Scottish Association for Marine Science (SAMS) and the University of Stirling) was deployed at 1819Z (St. 13817#1). The weight was deployed first and the mooring was lowered on the coring warp until it was almost in contact with the seabed. It was then released (1935Z) so that there was minimum disturbance to the instrument when it landed on the seabed. The optical package (transmissometer, nephelometer and fluorometer) was placed some 1m above the seabed. A similar method was used to place a near-bed current meter (St. 13817#2) at 2140Z.

An echosounding run was then started at 2243Z to characterise a set of mounds for more coring activity.

Wednesday 12 July

Several mounds were spotted during the echosounding exercise when survey lines 50m apart were achieved. However, the most impressive mounds were seen during the turns between the survey lines in an area lying outside the chosen mounds. It was decided that these would make a more suitable target.

The first box core (13818#1; 0132 to 0300Z) was mostly washed out but had a small amount of sand and a small xenophyophore (dead, as it turned out). Two subsequent deployments of the box corer (Sts. 13818#2 and 3; 0320 to 0545Z) were unsuccessful, although dead coral fragments were found in the last core. The ship then returned to the wide "tail" feature identified in the original sampling area for a multicorer deployment (St. 13819#1; 0614 to 0716Z). This was successful taking 11 out of 12 short cores, although one was so short that it dribbled out of the core tube on deck.

A second attempt was then made at raising the Bathysnap mooring, which was unsuccessful (0740 to 0830Z).

A near-bed current meter mooring was then deployed (St. 13820#1) on the "tail" of a mound on which the Bathysnap mooring was to be laid. The site was close to where the *IS*OR had been deployed. The mooring was deployed at 0953Z and was released within a metre of the seabed for a soft landing at 1017Z. The second current meter mooring was then deployed, but there was a problem with communicating with the release, so the deployment was aborted (1300Z).

More coring was then undertaken (1322 to 1747Z) for the elusive xenophyophores and corals on the "off-site mounds" that had been charted during the echosounding run (see above). One good box core was obtained and was sieved (no coral or xenophyophores) (St. 13821#2). The previous sample (St. 13821#1) had been part washed out and was saved as a qualitative sample only. It contained sediment with streaks of tar. A multicorer deployment was made at the same site (St. 13821#3) taking 11 good cores.

The final two moorings were then laid, starting with a near-bed current meter (St. 13822#1) in an area some 200m south of the "tail" current meter mooring and off the "tail" feature. The deployment was started at 1900Z and the current meter was released close to the seabed at 2003Z. During this deployment the Bathysnap mooring was prepared. The system was deployed (St. 13822#2) without incident between 2106Z and 2113Z and reached the seabed at 2138Z. The camera interval had been set at 18 minutes (80 frames per day) and was placed in the centre of a mound.

An attempt was made to collect coral on a mound using the box core at 2234Z, but was unsuccessful (St. 13823#1). A small washed out sample of sediment was obtained.

Thursday 13 July

Another attempt to core the mound and its coral communities (St. 13823#2; 0010 to 0127Z) met with a similar fate to the previous box core. It became apparent that for both these box cores the box was not sitting properly on the spade and that one side of the box was bowed. The box was removed and a bit of persuasion was used to get it back into shape. A third box core deployment was made on a mound (13823#3; 0200Z to 0326Z). It retrieved a certain amount of sediment, but again the box had not sealed properly. However, the sample did contain two (dead) xenophyophores.

Two multicore samples were then taken on the mound (0356 to 0705Z). The first (13823#4) retrieved 8 out of twelve cores, the second (13823#5) 10/12 cores.

The Agassiz Trawl was then prepared and shot at 0924Z (13823#6). With a minor course adjustment to give the moorings a wide sweep, the haul progressed almost directly west through the study area. The net was on the bottom from 1115Z until 1328Z. There was a sharp increase in tension towards the end of the trawl and the weak link parted. Despite this, a reasonable catch was obtained of fish, echinothuriid sea urchins (*Calveriosoma hystrix* and *Sperosoma grimaldii*), seastars, gastropods, hermit crabs (*Parapagurus pilosimanus*) and their commensal zoanthids (*Epizoanthus paguriphilus*) and fragments of the corals *Lophelia pertusa* and *Madrepora oculata*.

Following the trawl the CTD was cast to the bottom and back (St. 13823#13; 1524 to 1638Z). ***Through error, this station was not allocated a station number at the time. It was given a number subsequently and as a result is out of sequence***. Two sets of 3 water bottles were fired at 5 and 150 m above bottom (mab). However, in each case, only one water bottle closed.

The wire was changed to the conducting cable between 1640 and 1920Z, and a meeting was held of the scientific personnel to discuss the results of the first few days. A SHRIMP deployment was then made to characterise a group of mounds and "tails" in the centre of the western Darwin Mounds (St. 13823#7). SHRIMP was deployed at 1923Z and produced a good series of videos and photographs of xenophyophores and some coral associated with the mounds.

Friday 14 July

Following the retrieval of the SHRIMP at 0039Z two deployments of the Stand Alone Pumps (SAPS) were made at 0231Z (St. 13823#8) and 0442Z (St. 13823#9). On the first deployment two SAPS were suspended on the wire at about 3 and 4 m above bottom (mab) in a "tail" region down-current of some mounds. Both worked well and water was filtered over a 2-hour period in each case. The second deployment placed the two pumps some 150m above the seabed in the same area. This was somewhat of a trial as it was not clear how long the batteries in the SAPS would last without being recharged. In the event one lasted only a very short time and the other for about a third of the required period. As a result only small volumes of water were filtered.

Two further deployments of SHRIMP were made. The first deployment at 1126Z (St. 13823#10) lasted only 47 minutes on the seabed because the colour video camera had malfunctioned. SHRIMP was recovered at 1318Z and suffered a severe knock against the ship's side. While the problem with the colour camera was solved relatively easily it took some time to re-seat all the electronic boards dislodged when the SHRIMP impacted with the ship. The second deployment started at 1542Z (St. 13823#11). Images from both SHRIMP

runs were obtained of the down-current "tail-like" seabed features associated with the mounds imaged at St. 13823#7.

With the SAPS batteries now fully charged, the two pumps were deployed at 2057Z (St. 13823#12), one on the wire about 5m above the seabed and the other at 150 mab. The deployment occurred directly over a mound and was successful.

Saturday 15 July

SHRIMP was deployed again at 0112Z (St. 13824#1) to image the seafloor around another set of mounds. These mounds had been visited first in May/June 1998 (RRS *Charles Darwin* cruise 112) when the Darwin Mounds were first discovered. Excellent video images of coral were obtained, but unfortunately the still camera failed to work. Several shots were taken in midwater to create a break with the series of photographs taken during the previous SHRIMP run, but when the camera was switched on to image the seabed it malfunctioned. When the camera was opened up at the end of the run it was found that the film had fallen off the take-up spool.

Another SAPS deployment was made at 0650Z (St 13825#1) at a non-tail/mound location slightly to the east of the area sampled by previous SAPS. Two good samples at c. 5 and 150 mab were obtained. The wire was then changed to the coring warp.

Five box core samples (Sts. 13926#1-5) were then taken (1151 to 1930Z) to sample xenophyophores in the tail features (the SHRIMP images and previous experience had indicated that this was a preferred habitat for xenophyophores). While 3 of the cores took good sediment samples (#2,3,4), no xenophyophores were found. A new position was then tried (Sts. 13827#1 and 2), but again although good cores were obtained, no xenophyophores were encountered (1952 to 2325Z).

Sunday 16 July

To give the box coring team a bit of a breather another SAPS deployment was made between 0011 and 0342Z (St. 13828#1) over a mound. Again the SAPS were placed at about 5 and 150 mab and water was filtered for a 2-hour period.

Four box core deployments were then made on a mound (Sts. 13829#1-4) for coral (0418 to 0955Z). None were successful despite excellent coring weather. Some sub-surface coral debris was finally collected in a multicore (St. 13830#1; 1025 – 1150Z). A French fishing vessel had been seen trawling in the area close to where the moorings had been laid at the start of the cruise. Contact had been made with the vessel and the trawler had been warned of the possible danger to their, and our, equipment. On the way to the start of the deployment of the Agassiz Trawl it was decided to pass the moorings and make sure they were all in place (1200 to 1600Z). All 5 moorings were still in position.

The Agassiz trawl (St. 13831#1; 1640 – 2240Z) was an exceptionally good one. It collected several large fragments of live coral, *Lophelia pertusa* and *Madrepora oculata*, which were kept live in aquaria for observation and experimentation. The trawl also contained numerous sea urchins (*Calveriosoma hystrix*, *Sperosoma grimaldii*, *Phormosoma placenta* and *Cidaris cidaris*) as well as a variety of anemones and other fauna. Samples were preserved for molecular genetics, organic chemistry and reproductive biology.

A multicorer deployment was then made on a "tail" region (St 13832#1; 2338Z).

Monday 17 July

With the multicorer safely inboard at 0100Z with an almost complete set of cores, the ship then remained at the same position for another SAPS (St 13832#2; 0145-0515Z). Once more the SAPS were set at 5 and 150 mab. There then followed two multicorers back-to-back to sample an area of seabed that was neither on a mound nor within a tail feature (Sts. 13833#1,2; 0552 to 0837Z). The first deployment had only a few short cores of fluid sand, but the second deployment was more successful.

Another series of box core samples were then taken for the elusive xenophyophores (Sts. 13834#1-4; 0854-1435Z). One core had an abundance of the foraminiferan *Bathysiphon*, but otherwise the cores were unsuccessful for their prime purpose.

The ship then steamed to the pockmark area to the south and made two further multicorer deployments (Sts 13835#1-2; 1715-1943Z). The samples were taken as close as possible to features seen on the 10 kHz echosounder and which were believed to be responsible for the pockmark features seen on the sidescan records. The two corers within 100m of each other delivered two quite different samples, one muddy and the other a sandy silt. The wire was then changed and a SHRIMP deployment was started at 2132Z to image the area in detail (St. 13835#3).

Tuesday 18 July

SHRIMP criss-crossed the pockmark area several times making an extensive video run lasting 3 hours, and ending at 0150Z. The still camera failed to work. On recovery the camera was found to have flooded because the 'O' ring seal had been pinched.

The ship then steamed to a location of some other seabed features that had been identified during the 1998 sidescan sonar survey of the area. The features were referred to previously as "tail-less mounds", but it soon became apparent that they were patches of hard ground and not mounds. Towards the end of the SHRIMP run (St. 13836#1) patches of coarse, gravelly sediment were seen. Efforts were made to download some of these images directly onto the computer, which sadly did not work. In addition, it was found that the video had malfunctioned so there was no permanent record of the seabed in this area.

Once SHRIMP was inboard at 0743Z, a short echosounder survey was conducted to pinpoint the positions of the "moundless mounds" more accurately. This was achieved by 0946Z and the ship then steamed for the Ymir Ridge to the west to use SHRIMP within a deep channel to the west of the ridge. The channel was thought to be one possible route for the introduction of cold Arctic water into the Rockall Trough region.

The ship arrived on site at 1436Z and commenced an echosounding run to locate precise co-ordinates of the floor of the channel. Once this had been accomplished SHRIMP was deployed at 1724Z (St. 13837#1) reaching the seabed at 1810Z. An easterly course was set along the axis of the channel. While the seabed was interesting after one hour it was decided to proceed in a northerly direction up the steep side to the channel (1917Z). Difficulties occurred in maintaining a good angle on the electrical cable and controlling the ship's movements. It was obvious from the video, analysed later, that there was a strong current running down the channel and this kept dragging the cable under the ship. The SHRIMP deployment was terminated at 2010Z. However, just as SHRIMP was hauled in, it transmitted a picture of some very colourful soft coral. After a considerable tussle with the elements to get the ship in a good position relative to 1) the target, 2) the wind and 3) the deep-water current, SHRIMP was lowered back to image the seabed. An excellent video

sequence was obtained of a rich sponge and soft coral community. SHRIMP was finally recovered at 2345Z.

Wednesday 19 July

Once SHRIMP was inboard and tied down the ship returned to the Darwin Mound area, proceeding to the eastern mound field, arriving for another SHRIMP deployment at 0540Z (St. 13838#1). Good video images were obtained of the seabed, but very little of interest was seen apart from many dead coral fragments. The seabed appeared to have been impacted, presumably by the trawler fleet seen in the area. The wire was then changed for the final time to the coring warp once SHRIMP was inboard at 0946Z.

An Agassiz trawl was then deployed at 1119Z (St. 13838#2) to see whether any live coral could be collected from the eastern mound area. The trawl was recovered at 1621Z. It was torn end to end. A small amount of dead coral was attached to the net as well as zoanthids and brachiopods. The latter were sampled for molecular genetics research.

The ship then returned to the western Darwin Mounds for a multicore deployment (St. 13839#1; 1734Z) followed by a series of box corers to sample xenophyophores. The first core (St 13840#1) was successful and had a good sample, although only half a xenophyophore (presumed dead). There were a number of ophiuroids on the surface of the core. The core was dissected carefully for numerous *Bathysiphon* foraminiferans. The next two cores (St. 13840#2,3) were less successful, but both contained xenophyophores.

Thursday 20 July

Once the final box core was inboard at 0012Z the ship adjusted position slightly for a SAPS deployment (St 13841#1; 0044Z to 0420Z), a repeat of a previous deployment at a location not associated with a mound or its “tail” feature.

Four further box core deployments were made for xenophyophores. The first two (Sts. 13842#1,2) obtained small washed out sandy samples with no xenophyophores. The ship’s position was changed slightly and while two good cores were obtained subsequently (Sts. 13842#3,4), no xenophyophores were found. However, these two cores were used to sample for other fauna including the foraminiferan *Bathysiphon*.

With the final box core inboard at 1004Z the ship then returned to the eastern Darwin Mounds for another trawl (St. 13843#1; 1129 to 1631Z). This trawl was also torn badly and only a small catch of juvenile *Synaphobranchus* eels and amphipods was obtained. The trawl also contained an excellent specimen of *Madrepora oculata*. The 3.5 kHz and 10 kHz fish were brought inboard at 1656Z and the ship steamed for Stornoway at 1700Z for a boat transfer of personnel the following morning.

Friday 21 July

The ship’s scientific personnel and one rating transferred to shore between 0630 and 0830Z. The day was spent placing piston coring gear in position. The ship steamed for Darwin Mounds at 2000H. There was a glorious sunset.

Saturday 22 July

The ship arrived on station at 0700Z. The weather was excellent; with almost zero wind and a calm sea (and sunny!!). A first piston core site (St 13844#1) was chosen in the

area of the low backscatter “black hole” facies identified on the TOBI sidescan sonar data collected in 1998. “Black hole” is the background seabed signature in the “tailed mound” area. A 9 m piston core rig was deployed at 0926Z. The corer reached the seabed at 1002Z. A weak pull out load of 2.0 t was observed suggesting either very soft sediment or limited penetration of the corer. On recovery the corer was found to contain approximately 6 m of sandy mud.

A second piston coring site (St 13845#1) was chosen in the centre of one of the larger mound “tails”. A 9 m coring rig was deployed at 1352Z. The corer reached the seabed at 1422Z and a 3.2 t pull out was observed at 1424Z. An 8.12 m core was recovered at 1512Z.

The aim at the next coring site (St 13846#1) was to obtain a core from one of the western Darwin mounds. In anticipation of a harder seabed, the coring rig was shortened to 6 m to reduce the likelihood of bending the core barrel. The corer was deployed at 1830Z and reached the seabed at 1930Z. A weak pull out of 2.1 t was observed. On recovery the core was found to contain 1.3 m of coarse sand with some coral fragments, suggesting that the target mound had been hit. A second attempt at the same site (St 13846#2) was begun at 2042Z. At 2243Z a weak pull out of 2.1 t was again observed. A 2.6 m core of coarse sandy material, very similar to that obtained during the previous coring attempt, was recovered. The lower core barrel was slightly bent during this station and was replaced.

Sunday 23 July

The next coring site (St 13847#1) was selected on another of the western Darwin mounds. A 6 m coring rig was used. The corer was deployed at 0228Z and reached the seabed at 0307Z. A 2.7 t pull out was observed. On recovery the core was found to contain 4.8 m of muddy sediment, perhaps suggesting that the core had failed to hit the mound. A second coring attempt (St 13847#2) was therefore made on the same site. The 6 m coring rig was deployed at 0521Z and reached the seabed at 0600Z. A 2.7 t pull out was again observed and a 5.3 m core of muddy sediment recovered when the corer reached the surface.

A coring site (St 13848#1) was next selected on a large high backscatter target seen on TOBI images just to the west of the Darwin Mounds. Because the nature of the sediments in this area was not known, a 6 m corer was rigged as a precaution. The corer was deployed at 0843Z and reached the seabed at 0917Z. A 2.8 t pull out was observed. A 5 m core of muddy sediment was recovered to the surface. A second attempt at a nearby site (St 13849#1) on the same high backscatter target was then made using a 9 m coring rig. The corer was deployed at 1142Z and reached the seabed at 1212Z. A 3.0 t pull out was observed and an 8.4 m core recovered to the surface. The top part of the core (sections 1 and 2) was jammed in the core barrel and may have been disturbed by the heavy handling required to free it.

The “tail” of the mound sampled at station 13847#1 was then selected as the site of the next coring attempt (St 13850#1), again using the 9 m coring rig. The corer was deployed at 1645Z and reached the seabed at 1728Z. A 2.8 t pull out was observed and an 8.8 m core recovered to the surface.

The aim at the next coring site (St 13851#1) was to collect a reference sample from the “background” low to moderate backscatter area which surrounds the Darwin mound field. A 9 m corer was deployed at 2035Z and reached the seabed at 2115Z. A 3.0 t pull out was observed and a 6.5 m core recovered to the surface.

Monday 24 July

We then steamed some 20 miles to the south of the Darwin Mounds, to the area where abundant pockmarks can be seen on the TOBI images. Two cores were collected at one site (St 13852) in the pockmark field, using a 9 m coring rig. The corer was first deployed at 0226Z (St 13852#1) and reached the seabed at 0330Z. A pull out of 2.9 t was observed and a 6.25 m core was recovered. The second deployment (St 13852#1) began at 0546Z and the corer reached the seabed at 0631Z. Again a 2.9 t pull out was observed. An 8.2 m core was recovered.

The next target selected for coring was an area of sediment waves imaged by TOBI to the southwest of the Darwin Mounds. A short echosounder and 3.5 kHz survey of the wave field was carried out between 0902Z and 1011Z to confirm the position of one particularly large sediment wave. Coring sites were then selected on the up-current and down-current wave faces. The first site (St 13853#), on the down-current (lee) face was occupied using a 9 m coring rig. The deployment began at 1123Z and the corer reached the seabed at 1201Z. A 3.3 t pull out was observed and an 8.36 m core recovered to the surface.

The second sediment wave core site (St 13854#1) was positioned on the up-current (stoss) face of the selected sediment wave. A 12 m corer was rigged, after considerable difficulties in finding a combination of core barrels, barrel joiners and a core cutter, which would fit together. Some previously unused barrels were found to be slightly too small in diameter, such that neither the core liner nor the core cutter could not be inserted into them. Other barrels had attachment holes drilled slightly out of line, such that they could not be matched with the barrel joiners. Eventually, one core cutter had to be machined down to allow it to fit into the bottom barrel. The corer was deployed at 1610Z and reached the seabed at 1646Z. A 3.4 t pull out was observed. On recovery to the surface, it was clear that the top three barrels were full of sediment. However, the core liner was completely jammed in the middle barrel and only the top and bottom sections of the core could be recovered. The middle liner was only removed from the liner by considerable hammering, when the cause of the problem was found to be an imploded core liner. All of the sediment in the middle core barrel was lost during its extraction from the barrel. A second attempt (St 13854#2) was then made to core this site, again using a 12 m coring rig. The free fall of the corer was increased by 1 m to try to prevent a repeat of the liner implosion. The corer was deployed at 2155Z and reached the bottom at 2239Z. A pull out of 3.4 t was observed. A 7.2 m core was recovered to the surface despite minor implosion damage to the top core liner.

At this stage bad weather and rough seas terminated the piston coring programme. While waiting for the weather to improve, it was decided to return to the north and undertake an echosounder and 3.5 kHz survey of an area of mound-like features to the south of the western Darwin Mounds. Preliminary work in this area had shown that these “mounds” had no positive topographic relief, but were flat or even negative topographic features.

Tuesday 25 July

The echosounder and 3.5 kHz survey was commenced in the area of “moundless mounds” at 0524Z. Several of these features showed apparent sub-bottom reflectors on the 10 kHz echosounder profiles, suggesting that they were negative relief features largely obscured by side-echoes. This type of structure on the profiles results from trying to image a small negative feature with an instrument that has a seafloor “footprint” considerably larger than the size of the seafloor feature. The survey was completed at 0801Z, at which point it was determined that it was still too rough for coring to re-commence. A further echosounder

and 3.5 kHz survey was therefore undertaken in an area of pockmarks to the southwest of the Darwin Mounds. A few weak apparent sub-bottom reflectors were seen on the 10 kHz data, again suggesting that the pockmarks have negative relief. This survey was terminated at 1200Z, when it was determined that the weather had moderated sufficiently to allow coring to begin again.

A core site was selected in the area of pockmarks that had just been surveyed. A 12 m coring rig was deployed at 1225Z and reached the seabed at 1300Z. A 3.6 t pull out was observed and a 6.75 m core was recovered. A bad smell and a tendency for the core to extrude itself from the core liner suggested that the core might have some gas content.

The vessel then returned to the area of the "moundless mounds", where a site (St 13856#1) was selected over one of the areas showing apparent sub-bottom reflectors on the 10 kHz data. Since a sandy or hard seabed was predicted on the basis of the high sidescan sonar backscatter associated with these features, the length of the coring rig was shortened to 6 m. The corer was deployed at 1750Z and reached the seabed at 1837Z. A pull out of 2.8 t was observed and a 3.65 m core was recovered. A second deployment on an adjacent similar feature began at 2050Z, again using a 6 m coring rig. Some difficulty was encountered in trying to position the corer above the intended target and the corer was not placed in the seabed until 2202Z. A 2.6 t pull out was observed and a core of 4.36 m length was recovered. However, when drifting off station while the core was being recovered to the surface the profiler data indicated that we had missed the target "moundless mound". It was then decided to make a second attempt on this site (St 13857#2).

Wednesday 26 July

The weather was now excellent, with little wind and calm seas. A second attempt was made to piston core on a "moundless mound" (St 13857#2). A 6 m coring rig was deployed at 0041Z and reached the bottom at 0134Z. A pull out of 2.9 t was observed and a 5.15 m core was recovered at 0222Z.

At this point it was decided to finish the coring programme by attempting to recover several cores from mounds within the western Darwin Mounds field. A 6 m piston coring rig was used at the three sites initially selected. The corer was deployed at the first of these (St 13858#1) at 0451Z and reached the seabed at 0524Z. A pull out of 3.7 t was observed and a 3.4 m core of sandy sediment was recovered. The second site (St 13859#1) was begun at 0728Z and the corer reached the seabed at 0806Z. A weak 2.0 t pull out was observed. On recovery, it was found that the bottom barrel of the corer was severely bent. A small sample of sand was recovered from the core catcher. The final mound piston core site (St 13860#1) was begun at 1036Z. The corer reached the seabed at 1110Z, but did not appear to trigger and gave only a weak pull out of 2.0 t. Despite this, on recovery the core was found to contain 1.03 m of sand.

A final coring experiment, using a heavy gravity corer to try to recover a longer sediment sample from a mound, was then carried out. The gravity corer was built using the 1 t piston coring head, a 6 m cut down giant piston coring barrel and a giant piston core cutter. The coring pennant was connected directly to the piston core head, but the piston corer trigger was set up to allow the corer to free fall for the final 5 m through the water column, in order to give the corer maximum impact on the seabed. The corer was deployed at 1425Z and reached the seabed at 1509Z. A pull out of 3.0 t was observed. On recovery, traces of sediment on the outside of the barrel showed that the corer had penetrated at least 1 m into the seabed. However, the loose sandy sediment had largely washed out of the core during recovery, leaving only a residue of coarse coral fragments.

At this point the piston coring programme was completed and we moved to the start of the deep towed sidescan sonar survey. The ultra-short baseline (USBL) navigation system was made ready for use by mounting the sensor head on a heavy steel tube that was bolted onto the piston core head and deployed using the coring bucket. Initial tests were carried out, with the vessel stationary, by lowering transponders from various points around the ship. These showed that the sensor head was working and aligned properly. Tests at 1 and 2 Kt showed that system noise levels due to ship motion and vibration were acceptable. However, it was clear that the piston core bucket and deployment system were not strong enough to withstand the lateral load imposed by the drag of the steel tube in the water, even at these slow speeds. Despite attempts to brace the system using wire strops and welded steel reinforcement, it was reluctantly agreed that steaming at the anticipated survey speeds of 3 to 4 Kt was completely out of the question. It was therefore decided to proceed with the sidescan survey without the USBL system.

The sidescan sonar fish was deployed at 2300Z. However, initial problems with the tow winch, eventually traced to a problem with the ship's wiring, delayed the start of the survey.

Thursday 27 July

The weather continued to be excellent, with little wind and calm seas. Line 1 of the sidescan sonar survey (St 13862#1) was commenced at 0159Z, using the 100 kHz frequency option giving a swath width of approximately 500 m and flying the sonar fish about 25 m above the seabed. The system proved to be remarkably responsive to winch movement and, aided by the perfect sea conditions, was relatively easy to maintain at a constant height. The 100 kHz survey was laid out as a series of parallel lines trending approximately 080°, extending across both the western and eastern Darwin Mounds. Good images of mounds, sand waves and trawl marks were obtained. The end of line 1 was reached at 0700Z. Line 2 was run between 0840Z and 1446Z, line 3 between 1620Z and 2115Z. Line 4 was started at 2303Z.

Friday 28 July

The weather continued to be excellent, with little wind and calm seas. Line 4 of 100 kHz sidescan survey ended at 0345Z. Line 5 was run between 0607Z and 1102Z, line 6 between 1330Z and 1736Z. At this point it was decided to complete the first phase of the sidescan survey by running a high resolution 410 kHz line through the western Darwin Mound field. Line 7 was run between 2001Z and 2130Z. Superb images of mounds and sand waves were obtained. The survey was terminated at 2130Z and the fish recovered on deck by 2330Z.

Saturday 29 July

The weather was now exceptionally good, with little wind and completely calm seas. In view of this, we decided that it would be possible to deploy SHRIMP over the stern A-frame (deployment from the mid-ships A-frame was not possible because of the position of the coring bucket and launch winch). The next part of the programme consisted of two SHRIMP runs over mound types referred to a “tailess” and “moundless” mounds. The former are positive relief features several tens of metres in diameter and up to 5 m high. On 30 kHz sidescan sonar data they are similar in appearance to the western Darwin mounds, except that mound “tails” are absent. “Moundless” mounds are similar in appearance to

"tailess" mounds on sidescan data, but have no relief or may even have negative relief when observed on profiles. The first SHRIMP deployment (St 13863#1), over a "tailess" mound, began at 0133Z, and the vehicle reached the seabed at 0211Z, when the video was switched on. Coral patches, similar to those observed on mounds with "tails" were seen. The run ended at 0520Z, when the video was switched off.

The second SHRIMP deployment (St 13864#1), over a "moundless" mound began at 0744Z, and the video was switched on at 0845Z, when the vehicle reached the seafloor. The seabed was largely featureless and none of the coarse gravely bottom was seen, as previously encountered in this area. The run ended at 1212Z, when the video was switched off.

A second sidescan run (St 13865#1) was then programmed, to give 100 kHz coverage of part of the pockmark field and a variety of "tailess" and "moundless" mounds, and a further line at 500 kHz across the western Darwin Mounds. The sidescan fish was deployed at 1441Z and the first 100 kHz line, line 8, was run between 1525Z and 1954Z. The sidescan frequency was then changed to 410 kHz and line 9, across the western Darwin mounds, was run between 2000Z and 2210Z. The fish was then recovered on board at 2341Z.

Sunday 30 July

With the exceptionally good weather continuing, a further SHRIMP run (St 13866#1) in the western Darwin Mounds was then programmed. SHRIMP was launched at 0125Z and the video was switched on at 0159Z, when the vehicle reached the seafloor. Many coral patches were seen on two different mounds. The video was switched off and the run ended at 0502Z.

An area of speckled texture on the 100 kHz records, observed adjacent to the eastern Darwin Mounds, was selected as the next SHRIMP target (St 13867#1). SHRIMP was launched at 0657Z and the run began at 0738Z, when the video was switched on. In this area there were many broken fragments of dead coral strewn across the seabed. The area had the appearance of being severely impacted, probably from deep-sea demersal trawling. The video was switched off and the run ended at 1108Z.

The Miniprofiler Vehicle (MPV) was then prepared for deployment (St 13868#1). The MPV was launched at 1450Z, but it immediately became apparent that the trigger signal, generated in the vehicle, was not being received on board. The run was therefore aborted and the vehicle brought back on board at 1555Z.

While repairs to the MPV were attempted, a further sidescan sonar survey was programmed. The sidescan fish was launched at 1620Z. This failed immediately because of a flooded electronics tube. However, not before the fish had been "flown" into the seabed because the operator had not noticed the lack of a transmitted signal and a resulting bottom return. The sidescan fish was immediately recovered on board, where it was determined, fortunately, that the only damage was the original electronics failure. A large sample of gravelly mud, recovered from the fish, was collected and sieved as a biological sample (St 13869#1). The spare fish was launched again at 1900Z (St 13869#2). Line 10, extending southeast from the southern flank of the Wyville Thomson Ridge across the eastern Darwin Mounds, was started at 1935Z. The first part of the line was run at 100 kHz, but a change was made to 410 kHz for the crossing of the mounds and the area of "speckled" texture observed on previous 100 kHz runs immediately to the south of the mounds. Line 10 was completed at 2235Z. Line 11, crossing the eastern part of the eastern Darwin mounds, was started at 2344Z, using the 410 kHz option.

Monday 31 July

Line 11 of the sidescan sonar survey, was completed at 0230Z. Several mounds were imaged at 410 kHz on this line, but most had a subdued backscatter character, compared to the western mounds, on the sidescan images. Trawl marks were also observed over almost all the area. The final line, line 12, was run using the 100 kHz option. The aim was to image a small patch of mounds previously observed on 30 kHz data to the north of the main eastern mounds field. The line was completed between 0352Z and 0532Z. The sidescan fish was then recovered on board.

The aim of the final SHRIMP deployment in the Darwin Mounds area (St 13870#1) was to obtain video coverage of one of the western mounds imaged at 410 kHz and then to continue the transect across an area of ~10 m wavelength sediment bedforms seen on the sidescan data. SHRIMP was deployed at 0742Z and the run began when the video was switched on at 0818Z. Coral patches were observed on the mound and giant protozoans (xenophyophores) in both the "tail" area down-stream of the mound and in the area of the sand waves. In the latter the xenophyophores occurred in groups, but it was not possible to ascertain whether these groups occurred consistently within the troughs or on the peaks of the sand waves. The video was switched off and the run ended at 1123Z.

A second trial of the Miniprofiler vehicle (MPV) was then attempted. The vehicle was launched at 2000Z and appeared initially to be working. The depressor was launched at 2025Z and an attempt to collect data began. However, it soon became clear that there were severe problems with the quality of the data being received, and after some further trials the run was again aborted. The system was onboard at 2230Z.

With the weather deteriorating, it was decided at this point to terminate work in the Darwin Mounds area and head south to the northern Porcupine Bank area. The transit was planned to include a detour to a sheltered area west of the Outer Hebrides where the piston core equipment could be moved off the starboard deck to make way for SHRIMP and the box core, which we would require to deploy from the midships gantry during the work in the Porcupine area.

Tuesday 1 August

Arrived west of the island of Harris at 1058Z. The coring weight was removed from its deployment "bucket" to allow the hydraulics to be disconnected from the coring system. It was decided to proceed south, to a point west of the island of Benbecula, while the disconnection work was carried out. However, in the next two hours the wind swung rapidly to a southerly direction, such that no shelter was then available. With no possibility of moving the heavy equipment around the deck whilst in the Hebrides region, it was reluctantly agreed to make passage across the Minches to the Sound of Mull, where shelter was guaranteed, whatever the wind direction.

Wednesday 2 August

Arrived in the Sound of Mull at 0500Z. During the next two hours, all piston coring equipment was moved to the storage container and the box corer and SHRIMP were moved from the aft deck to the starboard midships deck. Discovery began the passage to the northern Porcupine Bank working area at 0700Z.

Thursday 3 August

There was a moderate wind and sea from the northwest. The ship arrived at a position of 54° N, 13° W, on the northern edge of Porcupine Bank at 0700Z, when the echosounder and 3.5 kHz fish were deployed. An echosounder and 3.5 kHz traverse towards the WSW along the 700 m contour, towards a known site of carbonate mounds 14° W, was then undertaken, to attempt to discover whether this mound field extended further to the east. However, no evidence of any mound-like structures was seen until we approached 14° W. At 1430Z, the sidescan fish was deployed (St 13871#1), and we began a survey of the large mounds in the vicinity of around 53° 45' N, 14° W. Line 14, using the 100 kHz option, began at 1445Z. Several large (up to 100 m high) mounds were imaged, although the images were a little disappointing, in that few structures that might be identified as coral colonies, similar to those seen on the Darwin Mounds, were seen. Line 14 was completed at 1947Z. It was then decided that we would attempt a survey line through the large mounds using the 410 kHz sidescan option.

At this point an e-mail message alerted us to the possible presence of a group of moorings that had been laid by the Dutch vessel '*Pelagia*' in the area we were surveying. Contact with the *Pelagia* was established by radio, and the location of two moorings, one within 500 m of out initial survey line, was confirmed. Our planned high resolution 410 kHz survey (line 15) was therefore re-positioned to ensure we kept well away from the mooring sites. Line 15 was begun at 2059Z. Some difficulty was experienced in flying the fish over the severe topography. Even at the higher resolution provided by the 410 kHz, the mounds appeared to have little structure.

Friday 4 August

There was a gentle wind and sea from the northwest. Line 15 was terminated prematurely at 0120Z after the sidescan fish collided with the seafloor. Although the sidescan was still working, on recovery at 0228Z the fish was found to have experienced considerable damage. The bottom casing had been completely lost, the upper casing was bent, and the cable termination had been damaged by a large quantity of fishing net, in which the fish was still entangled. A piece of live coral, recovered from among the debris caught on the sidescan fish, was preserved for genetic studies. Sidescan operations at this site were then abandoned.

SHRIMP was now made ready and deployed at 0420Z with the objective of examining several large mounds that had been observed during the sidescan sonar surveys. The SHRIMP run (St 13872#1) began at 0452Z, when the video was switched on. To our surprise, rather than finding coral mounds similar to those observed in the eastern Porcupine Seabight (Belgica Mounds), the Porcupine Bank mounds were found to be rocky outcrops although patches of coral did occur in the area. The SHRIMP station was completed at 1029Z.

Some debate then ensued regarding the sampling requirements at this site. The scattered coral colonies and the frequently rocky substrate observed on the SHRIMP video ruled out the possibility of box coring. It was therefore decided to dredge one of the mounds, with the twin objectives of recovering both more coral and some of the rocky material. The dredge (St 13872#2) was deployed at 1235Z and was on the seabed between 1354Z and 1426Z. Several 'bites', up to 1.8 t compared to a background of about 0.8 t, were observed on the wire load monitor. On recovery, however, the dredge bag was found to be completely empty, although the pipe dredge towed behind the main dredge was almost full of small rocks

and broken coral fragments. Most of the rocks appeared to be ice-rafted debris. However, several specimens of red sandstone may represent in situ material. Some small fragments of fragile but indurated carbonate sediments were also obtained. Biological specimens, including some holothurians attached to some of the rocks, were preserved for further study.

At this point, the programme on the north Porcupine Bank was completed, and at 1518Z the ship set off towards the 'Belgica Mounds' in the eastern Porcupine Seabight.

Saturday 5 August

Arrived on site in the Porcupine Seabight at 0536Z. The weather was now excellent, with little wind and calm seas. The sidescan sonar was deployed at 0550Z (St 13873#1). The survey of the Belgica mounds, using the 100 kHz option, was begun at 0603Z. Line 16, run towards the NW/SE, was completed between 0603Z and 0750Z. Seven parallel NNE/SSW lines, each between 10 and 12 km in length, were then run over the main area of the Belgica Mounds. Line 17 was completed between 0926Z and 1218Z, line 18 between 1338Z and 1537Z, line 19 between 1957Z and 2202Z. Line 20 was begun at 2308Z.

Sunday 6 August

The excellent weather continued. Line 20 (100 kHz sidescan survey of the Belgica mounds) was completed at 0123Z. Line 21 was completed between 0223Z and 0421Z, line 22 between 0458Z and 0628Z, and line 23 between 0715Z and 0926Z. This survey showed that mounds were rather smooth and featureless on the sidescan images, although the seafloor between the mounds was covered with sediment bedforms (sand waves, barchan dunes) overlying a coarse gravel substrate. The 'flying' of the sidescan fish was also difficult in the severe topography of the mounds, which are up to 150 m high, but the lines were completed without incident. The sidescan was recovered on board at 1020Z.

A box core station (St 13874#1) was then occupied on the 'Theresa' Mound, with the aim of collecting live specimens of coral and the associated fauna. The corer was deployed at 1150Z and reached the seafloor at 1232Z. A small sample of soft corals was recovered. The box corer was redeployed at the same site (St 13874#2) at 1330Z, and reached the seafloor at 1414Z. On this occasion a spectacular sample of the stony corals *Lophelia pertusa* and *Madrepora oculata* was recovered, together with a large number of associated fauna. In view of this success, a final deployment was undertaken at the same site (St 13874#3). The corer was deployed at 1520Z and reached the seafloor at 1556Z. However, the corer did not close and no sample was recovered.

Following the success of the box coring, it was decided to complete the final three NNE/SSW lines of the 100 kHz survey of the Belgica Mounds area. The sidescan fish was deployed at 1704Z (St 13875#1). Line 24 was completed between 1717Z and 1917Z and line 25 between 2016Z and 2210Z. Line 26 was begun at 2318Z.

Monday 7 August

The excellent weather continued. Line 26 (100 kHz sidescan survey of the Belgica Mounds) was completed at 0200Z and the sidescan fish was recovered at 0255Z. SHRIMP was then deployed for a study of the 'Theresa' mound (St 13876#1). The vehicle was launched at 0357Z and the run began at 0426Z. 5 separate passes were made in a star-shaped pattern over the mound. The mound was covered in a rich coral community, as encountered in previous years (e.g. RRS *Challenger* cruise 142). Of note, however, was the presence of a different stranded fishing net on the mound on each run. In some cases spider crabs were

observed feeding on animals caught within the mesh of the net. The run was completed at 0731Z, when the video was switched off.

A second SHRIMP station (St 13877#1) was then occupied with the intention of examining two additional large mounds just to the north of 'Therese'. The vehicle was deployed and video recording began at 0928Z. Again a rich coral community was observed on the mounds with coral patches and coral rubble occurring between the mounds. The run was completed at 1232Z, when the video was switched off, and SHRIMP was recovered on deck at 1305Z.

Following the success of the 100 kHz sidescan sonar survey of the Belgica Mounds, it was decided that we should complete the sidescan programme by attempting to obtain some coverage using the 410 kHz option. The sidescan sonar fish was launched at 1419Z (St 13878#1). Line 27 was run between 1423Z and 1736Z. The line was run in a downslope direction (west and then northwest) to help the operator 'fly' at 10 m above the seafloor while maximising the opportunity of lifting the sidescan fish off the seafloor should rough topography be encountered. No problems were encountered in completing this line, which produced good images of sediment bedforms and some small mounds. A second line, 28, was then attempted towards the south. This was completed between 1856Z and 2117Z, despite a minor collision with the seafloor at 2051Z. The sidescan fish was recovered on deck at 2220Z.

SHRIMP was then deployed to 'groundtruth' an area of sediment waves and small mounds observed on the 100 kHz sidescan images (St 13879#1). The vehicle was launched at 2333Z.

Tuesday 8 August

The ship continued to experience excellent weather. The SHRIMP run began at 0012Z when the video was switched on. The seabed showed areas of sandy rippled seabed with areas of coarse gravel and patches of coral. At 0139Z, the software that controls the SHRIMP operation crashed, and despite considerable effort, it could not be persuaded to restart. The run was aborted at 0320Z and SHRIMP was recovered on board at 0350Z.

A Bathysnap system was now prepared for deployment (St 13880#1) in an area of patchy coral cover between the mounds imaged by SHRIMP at St 13877#1. The deployment began at 0741Z. The mooring was released from the ship at 0746Z, and it reached the bottom at 0809Z.

The final part of the programme was dedicated to the collection of further biological samples from the Therese Mound, using the box corer. The corer was deployed at 0900Z (St 13881#1) and reached the seabed at 0933Z. A pull out of 1.4 t was observed and a moderate haul of live coral and associated fauna was recovered. A second attempt at the same site (St 13881#2) began at 1025Z, with the corer reaching the seabed at 1101Z. A pull out of 1.44 t was observed, but the content of the corer was disappointing, consisting mainly of dead coral. A final attempt at the same site (St 13881#3) was begun at 1151Z. The corer reached the seabed at 1225Z and a pull out of 1.34 t was observed. This core contained a large haul of live coral and associated fauna, an excellent finale to a highly successful scientific programme.

The 10 kHz and 3.5 kHz fish were then recovered and *Discovery* began the passage back to Southampton at 1324Z.

Wednesday 9 August

On passage to Southampton. The day was spent packing up, writing cruise reports and, for one, at least, recovering from the celebrations of a highly successful cruise.

Thursday 10 August

Arrived Southampton Oceanography Centre at 1000 BST in excellent weather and pleased to see all our family and friends once more. A track chart for the cruise is given in Figure 1.

ACKNOWLEDGEMENTS

We would like to thank all those aboard *Discovery* for a very successful and pleasant cruise. This cruise was funded through the SOC-NERC shiptime programme and received additional support from the EU ACES (EVK3-CT-1999-00008) and ECOMOUND (EVK3-CT-1999-00013) projects.

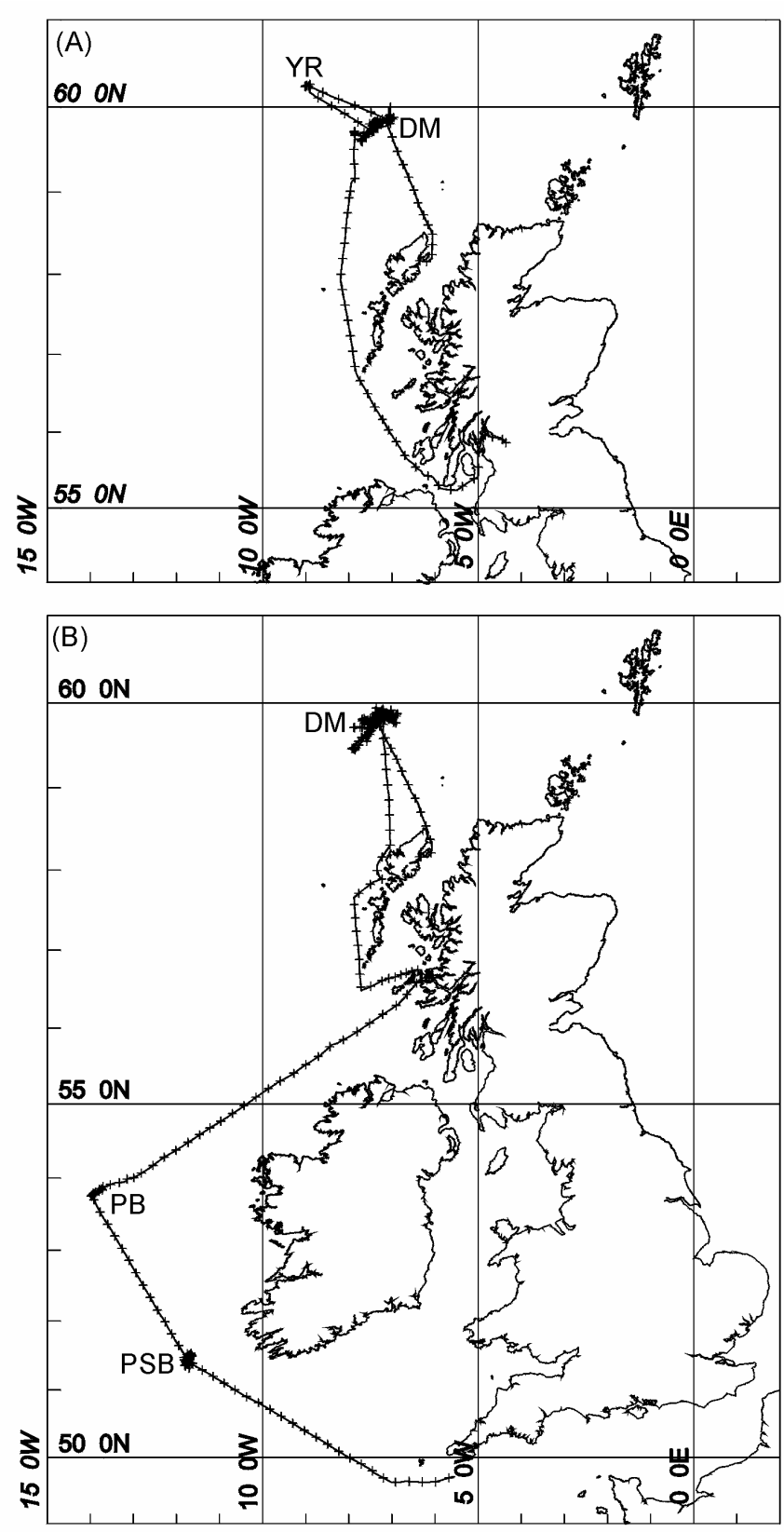

Figure 1. Cruise track RRS *Discovery* Cruise 248. (A) Leg 1; (B) Leg 2. YR – Ymir Ridge, DM – Darwin Mounds, PB – Porcupine Bank, PSB – Porcupine Seabight.

SCIENCE REPORTS

Very high frequency (100 kHz) and ultra high frequency (410 kHz) sidescan sonar surveys

Equipment

100kHz and 410kHz side-scan sonar imagery was obtained using a dual frequency GeoAcoustics side-scan sonar system depth rated to 2000m. Swath width was 600m at 100kHz and 200m at 410kHz. The side-scan sonar fish was deployed from the aft deck using 4000m of armoured cable with an electro-hydraulic winch remotely operated from the main lab. A Hytech cable counter was used to calculate layback. The signal to the towfish was supply by a GeoAcoustics transceiver (SS941) that was externally triggered from a CODA DA100 sonar processing system, which supplied a real-time image recorded to DAT tapes. A navigation string supplied by NaviPac survey software running on a PC, that also provided a helmsman's display for the operators, fixed the acquired side-scan data. NaviPac took its navigation string from a Sonardyne USBL system that was linked to the ship's GPS, gyro and a TSS 330 series motion sensor installed in the centre of the vessel (stable lab). A hardcopy output of the side-scan record was also obtained directly from the GeoAcoustics transceiver using an Ultra Electronics Wideline 200 series 12-inch thermographic recorder with manual fixes. Cable layback was also manually recorded every 5 minutes.

The system performed successfully, although initial attempts to supply underwater USBL navigation failed due to a strumming problem associated with a side-mounted rig holding the transceiver head. Scrolling problems were also found with the winch that required operator monitoring. To obtain optimum results the side-scan sonar towfish was flown at 25m off the seabed at 100kHz and 10m off the seabed at 410kHz at 3.5 knots. This operation required between 2000 and 3700m of cable layout in 1000m of water. This was practical in the Darwin Mounds area were seabed topography was minimal. In the SE Rockall Trough margin and Belgica Mound area in the eastern Porcupine Seabight margin, control of the towfish was more problematic due to more extreme topographic relief. Collision of the towfish with a hard seafloor in the SE Rockall Trough margin caused irreparable damage to a towfish housing and the survey was completed using a second towfish. In the Darwin Mounds area, the electronic bottle on the towfish leaked seawater and subsequently short-circuited. A spare electronics bottle was used as a replacement. All survey objectives were obtained as well as additional information.

Preliminary results

Side-scan sonographs acquired during this survey provided insights into biological and geological processes affecting mound growth as expressed through surface morphology. The spatial resolution provided by this new dataset, bridges the gap between interpretations based on video imagery and lower frequency side-scan sonar mapping (e.g. 30kHz TOBI in AFEN, 2000).

100kHz and 410kHz sidescan of the Darwin Mounds area

Existing side-scan sonar coverage from the Darwin Mounds area implies that mound morphology is strongly dictated by prevailing basal current activity with mounds often located at the interface between water masses (Wheeler *et al.*, 1998; Huvenne *et al*., 1999; AFEN, 2000). Current regime, physiochemical and sedimentological water properties were

also found to be important environmental agents for *Lophelia* corals at other locations along the continental margins (Frederiksen *et al.*, 1992; Freiwald *et al.*, 1997).

Mounds measure approximately 70m in diameter and 5m in height. All deep-water coral mounds (with or without tails) possessed discrete boundaries with a rubbly surface texture. The rubbly texture probably reflects small accumulations of coral, coral debris and other organisms with positive relief acting as nuclei for further growth. Live coral is represented by spots of very high backscatter and tends to be slightly more dominant at the edges of the mound. Internal structuring of the mound surface is irregular with a slight concentric arrangement of coral colonies. Distinctions can be made between undisturbed mounds (with well developed coral patches) and other mounds that have become covered by sand with no obvious coral stands. These may have been impacted by deep-water trawling activities.

Tails to mounds were visible as higher backscatter suggesting a change in sediment composition or surface roughness that may be caused by a number of processes. Some of the tails also have a positive relief and always occurred in the lee of the mound. When this was the case, the mounds were often scoured on the opposing side of the mound. Background sediment around the mounds was usually featureless (SHRIMP video data suggested the presence of small ripples) although some mounds occurred in or at the edge of sediment wave fields.

There was abundant evidence of benthic trawling over mounds and in the intervening seabed. Some areas were 100% trawled.

Areas of "speckly" backscatter on the TOBI imagery in the east of the area were probably the result of a combination of geological and biological processes. The high backscatter patches may represent coral and/or patches of more reflective seabed (e.g. gravel). In some areas, 50% of the seafloor was covered with these high backscatter patches. Inter-patch arrangement is random although in some places there was a tendency towards a current-parallel fabric. Trawling in this area could also be intense.

In the south of the area, pockmarks were imaged. These appeared as shallow depressions that sometimes had smaller, positive conical features (? sand volcanoes) at their centre and/or rim.

Linear sediment waves were also imaged mainly in the north of the area of varying wavelengths and crest heights.

100kHz sidescan of the SE Rockall Trough margin

Side-scan sonar images were acquired in an area where existing 6.5kHz GLORIA side-scan (McGrane *et al*., 1997) and 30kHz side-scan imagery had been obtained (Limonov *et al*., 1998). The strong slope currents on the Porcupine Bank cause seabed scour and erosion resulting in a very coarse surface lag (including boulders) that offers a suitable substrate for coral colonisation. The surface morphology of the seabed around, and on, these structures shows that they are often covered with boulders and coarse debris with occasional linear rock outcrops. The newly acquired data suggests that the "carbonate mounds" previously identified by Limonov *et al*. (1998) in this area may possibly be colonised rock outcrops as some of the mounds show apparent bedding planes. This is at possible odds with existing seismic interpretations and a definitive answer cannot be given from the data available at present.

100kHz and 410kHz sidescan of the Belgica Mound area in the eastern Porcupine Seabight margin

The newly acquired side-scan imagery provides detail to existing multibeam echosounder (recently acquired by Alfred Wegner Institute, Bremerhaven), 6.5kHz GLORIA side-scan data (McGrane *et al*., 1997), 9.5 kHz OKEAN side-scan data (Kenyon & Akhmetzhanov, 1997) and 30kHz OREtech side-scan data (Wheeler *et al.*, 1997). In the Belgica mound area, giant carbonate mounds have been identified that form slope-parallel ridges aligned to strong currents. It is thought that these ridges form from the coalescing of mounds that form either in the lee or in front of existing mounds.

Side-scan imagery of mounds reveals that they are largely covered in sediment waves. The topography of the mounds (often up to 100m high) provides an obstacle to basal currents causing acceleration in current speed and facilitating sediment transport in the form of migratory waves. A grading of the sediment wave styles exists in relation to mound proximity and position up the flank of the mounds. At 410kHz frequency, the side-scan was able to identify mounds with coral accumulations. These appear as several metre-size accumulations of high backscatter. SHRIMP video clarified these as coral and not boulders. Accumulations occur on all parts of the sediment wave although a tendency for preferential growth on crests and upper flanks is possible. Further away from the foot of the mound, coral accumulation density decreases and they occur on the wave crests and upper flanks and not in the troughs.

Other mounds in the Belgica Mound area showed no evidence of coral accumulations and may therefore be relic mounds or possess limited coral activity and are becoming buried by the sediment waves. On the flanks of the easternmost ridges, current velocities were sufficient to produce barchan dunes forms feeding off the preceding dune tails. These were often associated with inferred gravel sediment waves.

Inter-ridge areas are characterised by a homogenous seafloor with isolated sediment wave fields. Some of these sediment wave fields infrequently contain “Darwin Mound”-size coral mounds on their peripheries. A 410kHz side-scan line confirmed this interpretation.

Trawl marks were also common in this area.

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ANDY WHEELER, MAXIM KOZACHENKO

Seabed High Resolution IMaging Platform (SHRIMP)

SHRIMP completed a total of 11 missions on the first leg, 2 of which were aborted due to technical problems. Nine further deployments were made on the second leg of the cruise. All, but the last worked well. During the last deployment the SHRIMP system crashed and it was not possible to revive it.

SHRIMP's payload included a 1500-frame photographic camera and 1200J flash, CCD colour and SIT monochrome video cameras, HID 400W Daylight and Thallium Iodide Video lights, 200m altimeter and 2 Hi 8 video recorders.

Deployments were made from amidships on the Rochester deep tow electrical cable. Compressed JPEG frame-grabbed images were transmitted to the deck control computer via the 9600 Baud modem with a quality factor of 20 and x 2 sub-sampling. These settings proved optimum for the situation with scientists able to identify >10cm features. Image updates were transmitted at irregular intervals ranging from 10 to 60 seconds. Software improvements in both the sub-sea and deck-unit computers would provide a more regular update interval.

The HID (High Intensity Discharge) AC-driven 400W lamps, used for the first time on this cruise provided excellent target illumination. For the majority of operations the combination of the colour CCD video camera and the broad-spectrum daylight lamp were used. Good colour images were obtained from altitudes up to 3m above the seafloor.

After the second deployment a problem with one of the sub-sea video-recorders occurred. As there was no spare recorder on board subsequent operations were restricted to a maximum of 3 hours video recording.

On Run 5 the operation was aborted when the CCD video camera failed to supply images. On recovery the vehicle struck the ship's side with some hefty blows. This dislodged

some of the computer boards from their back plane and took some time to mend. The camera fault was traced to a loose connector.

Run 8 proved disastrous when the photographic camera flooded and the inhibit switch on the videotape had been activated. As a result no video record was made. On inspection of the photographic camera it was found that the end-cap 'O' seal had been damaged when the camera had been inserted into the pressure housing.

In preparation for the cruise, SHRIMP underwent a major electronic / connector rebuild to improve reliability and power supply noise suppression, which had affected the video quality. This modification proved successful, but it was found that the photographic camera and flash combination required further electrical isolation. An attempt was made to reduce the power supply effects by powering it from its own battery pack, but isolation was incomplete because an RS232 connection had to be used to provide a data link between the vehicle computer and camera.

Although not required for this cruise the SIT camera was operated to identify whether the HID lights provided suitable illumination. It was found at close range (<5m) a centre image 'hotspot' appeared. This dissipated at higher altitudes, but a vignetting effect appeared, possibly because of the sensitivity of the cathode plate. On return to the laboratory confirmation will be sought from the manufacturer that the camera is working correctly and to try to achieve an improvement.

During the cruise some work was carried out to improve the shipborne display software so that data logging system and the graphical data displays were improved. During one deployment an attempt was made to use this software, but there was a "re-fresh timing" problem possibly resulting from the Windows 98 operating system.

In conclusion, the SHRIMP operations during the cruise performed well and provided scientists with many hours of quality seabed video footage. The 'real-time' image transmission proved an essential facility for wide area searches enabling scientist to respond immediately by modifying the search pattern. Although SHRIMP is now equipped with fibre optic capability this electrical transmission of images will serve as a very suitable backup in the event of possible fibre damage. Software modifications alone will improve transmitted image refresh rates and it was recognized that the enhancement of the sensor suite to include a compass and CTD would be beneficial for data analysis.

DAVID EDGE, DUNCAN MATTHEW

Piston corer operations

Some 4 days were dedicated to piston coring in the area of the Darwin mounds during the second leg of the cruise. The main aims of the coring were:

1. to sample the material making up the mounds
2. to characterise any variation, in the sub-surface sediments, between the mounds, mound 'tails', areas where pockmarks occur, and areas of background sedimentation
3. to test the sedimentary record of any bottom current variation that might be preserved in the sediment wave field to the south of the Darwin mounds

A standard 7.5 cm diameter piston corer comprising a 1 t head and a barrel length of 6, 9, or 12 m was used throughout, except at the final site where an experimental gravity corer was tested. The piston corer was triggered by a small pilot corer. This allowed 3 m of

free fall for the 6 or 9 m corer and 4 m of free fall for the 12 m corer. The gravity corer used the piston core head and a single 6 m length of 11 cm diameter giant piston corer pipe, but without the piston. A free fall of 5 m was generated using the piston corer trigger arm with the wire attached directly to the corer head.

The piston coring operation was highly successful, with 21 cores recovered from 22 attempts. Two of the recovered cores suffered some damage due to implosion of the core liner; in one of these the middle 3 m section of the core could not be removed from the barrel and was completely lost. The single failed coring attempt resulted from a failure of the corer to penetrate a hard (probably sandy) seafloor. The core barrel was bent during this operation. The single gravity core attempt produced only a few handfuls of coral fragments. Although it was clear from sediment traces on the outside of the barrel that the corer had penetrated at least 1 m into the seabed, the absence of a piston had allowed the sandy core to be washed out of the corer during recovery, with the core catcher able only to retain the coarser coral fragments.

All the cores were split on board and a preliminary core description was produced for each section. The major initial results can be summarised as follows:

1) Four of the six cores collected from the tops of the mounds consist of structureless, medium-grained sand with some foraminiferans and bioclastic fragments, and contain some layers rich in coral fragments up to 5 cm long. The sand consists almost entirely of terrigenous material (quartz and rock fragments), suggesting that it is derived by some winnowing process from the underlying glacial sediments. With the exception of the coarse coral fragments, carbonate material was notably absent. Muddy ‘background’ sediments dominated the two cores taken at Station 13847, and it is presumed that we failed to hit the target mound at this site.

2) Two cores collected from the high backscatter mound tails, and two cores collected from an extensive high backscatter area (possibly an amalgamated mound tail), were surprisingly similar to those collected from areas of ‘background facies’, with a thin (5-15 cm) Holocene sand overlying a thick sequence of structureless, dark brownish-grey mud.

3) Three cores recovered from an area of 'mounds-like' sidescan sonar targets that have little or no relief on profiles also contain a thin (5-40 cm) Holocene sand overlying structureless muds.

4) A core taken from the moderate backscatter ‘background facies’ contains 20 cm of structureless, medium-grained, Holocene sand overlying an interesting 8cm thick ‘hard ground’ horizon. This horizon consists of a reddish-brown, partially cemented, muddy sand containing abundant dropstones and bioclastic fragments. It is underlain by a thick sequence of dark brownish-grey, structureless muds, presumed to have been deposited during the last glacial. The mud is bioturbated in places, with rare sand-filled burrows and dropstones. It contains locally very abundant dark flecks, occasionally forming concentric rings, which may represent decaying iron oxides, pyrite or carbonaceous material. This dark material is probably the origin of the strongly sulphurous smell that occurred when the core was split.

5) Three cores recovered from an area of pockmarks contain a thin (<10 cm) bioturbated mud/sand, with large sandy burrows and rare coral fragments, overlying structureless dark muds.

6) Three cores obtained from a field of bottom current sediment waves contain a thin (5-25 cm) muddy sand overlying a sequence of locally bioturbated, dark brownish-grey muds.

DOUG MASSON, RUSSELL WYNN, JEZ EVANS

Multicorer operations

The multiple corer was deployed 12 times and recovered between 5 and 12 cores (Table 1). In most cases the cores were short (9-14cm), but those recovered from two deployments (13821#3 and 13835#2) were substantially longer (25-28cm). In the area of the Darwin Mounds, the cores consisted of about 10cm of sand overlying sticky mud. Different kinds of sediment were encountered in the pockmark area. At Station 13835#1 the cores were short and consisted of sandy silt. The long cores obtained at Station 13835#1 were composed of dark grey mud that became progressively stickier with depth into the sediment.

Table 1. Multiple corer deployments and fate of samples

Station/ series	Location	Usable cores	Length cm	Meio-fauna	Foram-inifera	Micro-biology	Geo-chemistry	Stable isotopes	Other
13816#4	Tail	5	12-14	1	1	1	1	0	1
13819#1	Tail	5	10-14.5	1	1	1	1	1	0
13821#3	Edge of mound	11	25-27	2	3	1	3	1	
13823#4	Mound	5	11-14	1	1	1	2	0	0
13823#5	Mound	9	12-14	2	1	1	2	1	2
13830#1	Mound	5	10-12	1	1		2	1	0
13832#1	Tail	11	27-29	1	6	1	2	1	0
13833#1	Back-ground	3	12-14	1	1	0	0	1	0
13833#2	Back-ground	9	13-14.5	1	5	0	2	1	0
13835#1	Pock-mark	6	9-12	1	0	1	3	1	0
13835#2	Pock-mark	12	25-28	1	1	1	3	1	5
13839#1	Back-ground	7	10-14.5	1	0	1	2	1	2

The cores were used for meiofaunal, foraminiferal, microbiological, geochemical (lipids, pigments) and stable isotopes analyses (Table 1). The muddy cores obtained at Station 13835#1 yielded a large number of agglutinated foraminifera (mainly *Astrorhiza arenaria*). These will be used for molecular (DNA) analysis. Further details are given in individual reports.

ANDY GOODAY, ILSE DE MESEL, BORIS DORSCHEL, KOSTAS KIRIAKOULAKIS

Box corer operations

The box corer was deployed 33 times in the Darwin Mounds area and returned a good core on 15 occasions. Another 8 deployments yielded core remnants that were usable for some purposes. All of the cores consisted of sandy sediments about 10cm thick, overlying sticky mud. The surfaces were rippled.

The box corer had only limited success in collecting corals and xenophyophores, one of the main purposes of the coring programme. Pieces of dead coral were obtained on several occasions in washed-out cores, but never in intact cores. A total of 6 xenophyophores (all dead) was recovered, but only two of these occurred in undisturbed samples. Therefore the

cores were used in whole or subsampled for a variety of other purposes, including sedimentology, meiofaunal foraminiferal and isotope studies, selected megafauna (mainly ophiuroids) and macrofauna. Further details are given in individual reports.

Table 2. Box core samples

Station	Location	Comments	Use
13816#1	Tail	Good core; 10cm rippled sand overlying sticky mud	1) Subcore for sedimentology 2) Subcore for stable isotopes 3) *Bathysiphon, Rhabdammina* removed; into glutaraldehyde, cell tracker, liquid N_2 4) Top 10cm sieved for macrofauna
13816#2	Tail	No sample	
13816#3	Tail	Good core; 10cm rippled sand overlying sticky mud	1) 2 syringe subcores for sediment impregnation 2) *Bathysiphon, Rhabdammina* removed; into glutaraldehyde, cell tracker, liquid N_2 3) Top 10cm sieved for macrofauna
13818#1	Tail	Core washed out; 1 dead xeno	Xeno fixed in formalin, ethanol, liquid N_2; used for: 1) study of decomposed stercomata 2) lipids
13818#2	Tail	No sample	
13818#3	Tail	No sample	
13821#1	Mound	Partly washed out	Remnants sieved; contained tar fragments
13821#2	Mound	Good core	1) Subcore for isotopes 2) Top 10cm sieved for macrofauna
13823#1	Mound	No sample	
13823#2	Mound	No sample	
13823#3	Mound	Washed out; 2 dead xenos on spade	Xeno fragments preserved in glutaraldehyde, ethanol, formalin
13826#1	Tail	No sample; a few stones	
13826#2	Tail	Good core	1) Dead xeno for granulometry 2) Syringe subcores taken beneath and away from xenophyophore 3) *Bathysiphon, Astrorhiza* glutaraldehyde, cell tracker 4) Top 10cm sieved for macrofauna
13826#3	Tail	Good core	Top 10cm sieved for macrofauna
13826#4	Tail	Good core	1) 3 syringe subcores for meiofauna 2) Forams into glutaraldehyde 3) Top 10cm sieved for macrofauna
13826#5	Tail	Remnants of core	1) Echinoid removed 2) Bathysiphon, Rhabdammina into glutaraldehyde,
13827#1	Tail	Good core	1) 3 syringe subcores for meiofauna 2) Subcore for sedimentology 3) *Bathysiphon* in formalin 4) Remainder of core discarded
13827#2	Tail	Good core	1) *Bathysiphon* removed 2) Remainder discarded
13829#1	Tail	Remnants of core with sponges, echinoid, dead coral	Sieved
13829#2	Tail	Washed out	
13829#3	Tail	Washed out	

13829#4	Tail	Washed out	
13834#1	Tail	Remnants with coral fragments and ophiuroids *Ophiocanthus abyssicola, Ophiactis abyssicola*	Remnants sieved
13834#2	Tail	Good core	1) *Bathysiphon* carefully documented, photographed, fixed in formalin 2) Remainder discarded
13834#3	Tail	Washed out	
13834#4	Tail	Washed out	
13840#1	Tail	Good core	1) Dead xeno for inhabitant study 2) Syringe subcores under and away from xenophyophore 3) Core dissected for *Bathysiphon*
13840#2	Tail	Washed out; remnants contained coral and xenophyophore	1) Remnants sieved 2) Dead xenophyophore used for lipids and associates
13840#3	Tail	Washed out' remnants contained fragmented xenophyophore	Dead xenophyophore used for lipids and associates
13842#1	Tail	Washed out; small amount of sediment	
13842#2	Tail	Washed out; small amount of sediment	
13842#3	Tail	Good core	1) Surface foraminiferans removed 2) Dissected for *Bathysiphon*
13842#4	Tail	Good core	1) Surface foraminiferans removed 2) Dissected for *Bathysiphon*

ANDY GOODAY

Large agglutinated rhizopods

A number of large agglutinated rhizopods were targeted for studies of molecular genetics, cell ultrastructure, test granulometry and fatty acid biomarkers. In addition, sediment samples were taken from box cores and multicores for DNA extraction and subsequent PCR-based probing to characterize the molecular diversity of foraminifera.

1) *Syringammina fragilissima* (xenophyophore)

Seven specimens were obtained from six box cores (13818#1, 13823#3, 13826#2, 13840#1, 13840#2 13840#3) and one multicore (13816#4). Examination under the binocular microscope indicated that they were all dead. All specimens, or parts of them, were fixed in formalin in order to characterise diagenetic changes and meiofauna and macrofauna associated with the complex test structure. Fragments from three specimens were subject to solvent extraction in order to characterise fatty acids. Other determinations include SEM of the agglutinated wall and TEM of the organic tube system (to determine whether its ultrastructure is comparable to the organic linings of foraminifera), STEM and X-ray microanalysis of stercomata and barite and granulometry of test vs. sediment (to determine whether foraminiferal tests are a preferred building material.

2) *Astrorhiza arenaria* (foraminifera)

Specimens from box cores 13826#2 and 13842#4 were fixed in glutaraldehyde for SEM/TEM analysis of test wall and cytoplasm (the latter for use in 'food item analysis' to help determine diet). Live specimens incubated in CellTracker Orange (molecular probes) for further development of fluorescence-based live/dead assays for foraminifera. Other

specimens were snap-frozen in liquid nitrogen for rDNA phylogenetic analysis and placed in solvent for lipid analysis.

3) *Bathysiphon capillare* (foraminifera)

Specimens from box core deployments 13816#1, 13816#3, 13826#2, 13826#5, 13827#2, 13834#2 were fixed in (a) formaldehyde for rose Bengal staining (live/dead assay) and (b) glutaraldehyde for SEM/TEM analysis of test wall and cytoplasm (the latter for use in 'food item analysis' to help determine diet). Live specimens were incubated in CellTracker Orange (molecular probes) for further development of fluorescence-based live/dead assays for foraminifera. Other specimens were snap-frozen in liquid nitrogen for rDNA phylogenetic analysis.

A special study was made of the abundance and distribution within the sediment of *Bathysiphon capillare*, a long slender tubular species, which reaches a length of up to 10cm. Box cores 13834#2, 13840#1, 13842#3, 13840#4 were carefully dissected and the positions and lengths of all individuals of *Bathysiphon capillare* were documented before the specimens were removed. All but a few specimens were infaunal, occurring in the upper layer of brownish sandy sediment at depths between 1cm and 4cm below the sediment surface. Most were orientated horizontally but a number were observed to curve downwards into the sediment at one end.

SAM BOWSER, DAVID POND, ANDY GOODAY

Meiofauna analysis

The aim of this cruise was to sample meiofauna associated with different habitats, i.e. corals, sponges, different types of sediment, water above sediment. The associated meiofauna will be analysed and compared. Samples were taken with the multicorer, the box corer and the trawl (Table 3).

From each drop of the multicorer one core was sectioned. The water above the sediment (2 - 3 cm) was removed and formalin was added. The upper 5 cm of the sediment was sectioned every cm, while the next 5 cm (5-10cm depth) were taken as a whole. Formalin was added to the samples.

Table 3. Box core meiofauna samples for the University of Ghent.

Station number + location	
13821 # 2 (mound)	subcore sediment
13826 # 3 (tail)	4 subcores from sediment (under Xeno, 5.5cm, 10cm, 30cm away from Xeno)
13826 # 4 (tail)	filtration upper water (38µm), 3 subcores from sediment
13826 # 5 (tail)	filtration upper water (38µm), 3 subcores from sediment
13827 # 1 (between tails)	filtration upper water (38µm), 3 subcores from sediment
13827 # 2 (between tails)	3 subcores from sediment
13829 # 1 (mound)	fragments of coral (187g), Sea-urchin
13840 # 1 (tail)	4 subcores from sediment (under Xeno, 5.5cm, 11cm, 25cm away from Xeno)
13840 # 2 (tail)	fragments of coral (17), sediment

Sponges and fragments of living corals were taken from the trawl at station 13831 # 1.

ILSE DE MESEL

Organic geochemistry

Multicorer and box corer sampling

Sediment was collected from 11 multiple corer deployments (2-4 cores per deployment; see Table 4). One core from each multicorer deployment was sectioned as follows: 0-5 mm, 5-10 mm, 10-15 mm, 15-20 mm, 20-30 mm, 30-40 mm, 40-50 mm, 50-60 mm, 60-80 mm, 80-100 mm. The sediment samples were stored in solvent rinsed, foil wrapped petri dishes. These samples will be used for sedimentary lipid analyses (hydrocarbons, sterols, fatty acids, long chain alkenones etc.) and whenever possible pigment analyses (chlorophyll and its degradation products, carotenoids etc.). The rest of the cores were frozen immediately (-70° see Table 4) within the core tubes for a few days. Whole frozen core samples were then extruded from the core tubes and wrapped in solvent-rinsed foil paper and kept in the -70° freezer for the rest of the cruise (including Leg 2). Some of the frozen cores will be used for microbiology (see Table 4) by the University of Galway (John Patching) and the rest will be back up cores for geochemical analyses (used perhaps for pigment analyses). The cores were taken from three different locations, namely from a mound (3 deployments), its tail (3 deployments) and from an area away from the mounds which serves as a control site (2 deployments) for comparative analyses (see Table 4). Cores from a pockmark area (2 deployments) were also taken.

One subcore from an undisturbed box core was also taken for geochemical analyses (see Table 4). This core was frozen and extruded as described above.

Table 4. Multicorer (MC) and box corer (BC) sampling for Liverpool University.

Date	Position		Station	Location	Micro-biology	Geo-chemistry	Gear
11/07	59°48.85	07°22.68	13816#4	Tail	1	1	MC
12/07	59°48.79	07°22.60	13819#1	Tail	1	1	MC
12/07	59°48.76	07°22.67	13821#2	Mound	0	1	BC
12/07	59°48.75	07°22.66	13821#3	Edge of mound	1	3	MC
13/07	59°48.89	07°22.51	13823#4	Mound	1	1	MC
13/07	59°48.89	07°22.54	13823#5	Mound	1	2	MC
16/07	59°48.89	07°22.52	13830#1	Mound	0	2	MC
17/07	59°48.84	07°22.72	13832#1	Tail	1	2	MC
17/07	59°48.86	07°22.05	13833#2	Control	0	2	MC
17/07	59°36.11	07°41.87	13835#1	Pockmark	1	3	MC
17/07	59°36	07°41	13835#2	Pockmark	1	3	MC
19/07	59°48.85	07°22.10	13839#4	Control	1	2	MC
Total number of cores used for geochemistry							23
Total number of cores used for microbiology							9

CTD and water bottle rosette sampling

10 L of seawater from 10 metres above bottom (mab) and 10 L from 150 mab were taken from one CTD (13/07, 13823#13). This sample came from the same mound site as some of the multicorer samples. The water samples were filtered using a large volume

filtration apparatus and pre-ashed (450°C; 4 h) filters (142 mm diameter; GF/F). The filters were frozen at –70°C and kept there for the rest of the cruise. The particulate material collected on the ashed filters will be used for lipid and pigment analyses in a similar fashion described for the sediment samples.

Stand Alone Pump System (SAPS) sampling

Particulate material in the water column was also sampled from the mound sampled by multicorer, from the "tail" region adjacent to the mound, and a control area, using two Stand Alone Pumping Systems (SAPS). These pumps have the capacity to filter large volumes of seawater in a short amount of time (see Table 5). SAPS are ideal for collecting particulate material from various depths during the length of one cruise. In this case the pumping time was two hours. The particulate material was collected on pre-ashed (450°C; 4 h) filters (293 mm diameter; GF/F) and will be used for lipid and pigment analyses in a similar fashion described for the sediment samples.

Table 5. Stand Alone Pump System (SAPS) sampling details.

Date	Position Start		Station	Location	Depth deployed	Volume (litres) pumped in 2 hours
14/07	59°48.83	07°22.76	13823#8	Tail	10mab	1005
14/07	59°48.83	07°22.76	13823#8	Tail	10mab	913
14/07	59°48.84	07°22.79	13823#9	Tail	150mab	313.4
14/07	59°48.84	07°22.79	13823#9	Tail	150mab	34.6
14/07	59°48.86	07°22.45	13823#12	Mound	10mab	904.2
14/07	59°48.86	07°22.45	13823#12	Mound	150mab	1187.8
15/07	59°48.75	07°22.13	13825#1	Control	10mab	1154.4
15/07	59°48.75	07°22.13	13825#1	Control	150mab	1290.5
16/07	59°48.90	07°22.55	13828#1	Mound	10mab	1160.1
16/07	59°48.90	07°22.55	13828#1	Mound	150mab	514.6
17/07	59°48.86	07°22.66	13832#2	Tail	10mab	1082.9
17/07	59°48.86	07°22.66	13832#2	Tail	150mab	1330.6
19/07	59°48.80	07°22.10	13841#1	Control	10man	1135.5
19/07	59°48.80	07°22.10	13841#1	Control	150man	1344.5

Trawls

A few animal species were taken from two trawls for lipid and pigment analyses. The animals were kept frozen at –70°C for the rest of the cruise.

Samples taken from 1st trawl (13823#6):

- 3 large sea urchins
- 3 small sea urchins
- 1 tissue from a leg of an octopus
- 1 tissue from *Coryphaenoides rupestris* (large specimen)
- 1 whole (small) fish - *Coryphaenoides rupestris*
- 1 brachiopod (*Terebratulina retusa*?)

- 1 whole fish (chimaerid)
- 1 spider crab
- 3 hermit crabs

Coral samples taken from the 2nd trawl (13831#1):

Lophelia samples:

- 1 fragment, 4.5 cm, 3 polyps.
- 1 fragment, 2.7cm 2 polyps.
- 1 fragment, 7.5cm 3 alive polyps (orange) and 3 dead ones (white)
- 1 fragment, 5.5cm 6 polyps
- 1 fragment, 3.5cm 2 polyps
- 1 fragment, 5.5cm 2 alive polyps and 4 dead polyps
- 1 fragment, 3cm 3 polyps
- 1 fragment, 3cm 1 large polyp
- 1 fragment 4cm 4 polyps

Madrepora samples

- 1 fragment, 9.5cm, 31 polyps
- 1 fragment, 4cm, 10 or 12 polyps
- 1 fragment, 3 cm, 10 polyps
- 1 fragment, 2 cm 4 polyps
- 1 fragment, 8.5cm, lots of dead polyps
- 1 fragment 2.2 cm lots of dead polyps

Piston corer

Small sections of piston cores were taken, cupped and frozen (-70°C) for hydrocarbon analyses (see Table 6).

Table 6. Piston core (PC) sampling for Liverpool University.

Date	Station	Location	Core depth (m)	Purpose	Gear
23/08/00	13847#1	Mound	4.69-4.84	Hydrocarbon chemistry	PC
23/08/00	13847#2	Mound	5.20-5.35	Hydrocarbon chemistry	PC
23/08/00	13848#1	Tail	4.87-5.02	Hydrocarbon chemistry	PC
23/08/00	13849#1	Large tail	8.25-8.40	Hydrocarbon chemistry	PC
24/08/00	13852#1	Pockmark	6.09-6.24	Hydrocarbon chemistry	PC
24/08/00	13854#2	Sed. wave	7.08-7.23	Hydrocarbon chemistry	PC
25/08/00	13855#1	Pockmark	6.50-6.75	Hydrocarbon chemistry	PC

Box core samples

Certain pieces of hard and soft corals were taken for biochemical analyses from three box core deployments at the Belgica Mounds (Porcupine Seabight). In particular:

- 2 soft coral fragments (13874#1)
- 1 piece of bryozoan (13874#2)
- 1 piece of orange soft coral (13874#2)
- 1 *Lophelia* coral fragment with 20 polyps (13874#2)
- 1 *Madrepora* coral fragment with several polyps (13874#2)
- 1 *Lophelia* coral fragment with 17 polyps (13881#3)
- 1 orange soft coral fragment (13881#3)

KOSTAS KIRIAKOULAKIS, RENATO NETO

Macrofaunal sample collection from box cores

One of the objectives of the box core sampling was to examine the macrofaunal and epifaunal communities in relation to the presence of cold-water corals (live colonies or dead fragments). The strategy adopted was to core on the mounds and on the "tail" regions associated with the mounds. This project is a component of Workpackage 3 of the Atlantic Coral Ecosystem Study (ACES).

Table 7. Summary of stations sieved for macrofauna and the number of containers prepared

Station	Location	Containers (250 µm)	Containers (500 µm)	Containers (1000 µm)	Comments
13816 #1	Tail	5	1	1	see box core report
13816 #3	Tail	7	1	1	see box core report
13818 #3	Tail	4	1	1	partially washed out, dead coral fragments
13821 #1	Mound	0	2	0	partially washed out (renumbered from 13820 #1)
13821 #2	Mound	3	1	1	see box core report (renumbered from 13820 #2)
13826 #2	Tail	2	1	0	see box core report
13826 #3	Tail	2	2	0	see box core report
13829 #1	Tail	1	1	3	Dead coral fragments in partially washed out core
13840 #2	? Tail	3	2	0 (+1 of coral fragments)	Dead coral fragments in partially washed out core (freshly broken coral)

The three box cores to recover dead coral fragments were partially washed out but were sieved since these were the only samples that will allow any comparison of the fauna between areas with and without coral fragments.

J MURRAY ROBERTS

Natural isotope studies

Nine sediment/water samples from the multicorer and 3 sub-samples from box cores were taken for isotopic analyses. The whole cores were sliced in 1 cm intervals. They ranged in depth between 10 and 30cm. Down to 10cm the samples were stained with Rose Bengal. Parts of the samples will be sieved in the size fractions 63-125 µm and >125 µm in the laboratory. From the coarse fraction, carbonate tests of benthic foraminifera will be selected. The tests without organic matter will be analysed for a stratigraphic interpretation and for correlation between cores.

Tests containing organic matter will be sampled and measured separately to see if the isochronic data show differences in the isotopic signal. The idea is that changes in these data may reflect local differences (e.g. seepage or food supply) in the sediment. For this reason samples were taken from 1) mounds, 2) "tail" regions of the mounds, 3) pockmark areas and 4) from an area without significant seabed structures (background conditions). Water samples taken from the multicorer were poisoned with 3 drops of mercury dichloride to prevent alteration. Isotopic data from the water samples will later be compared with the foraminifera data to see if there is a correlation between the carbonate and the overlaying water. Depending on the data, further analyses, such as grain size measurements, will be carried out.

BORIS DORSCHEL

Agassiz Trawl samples

Cnidarians from the Agassiz Trawl over the Darwin Mounds (13831#1) were removed from the trawl into cold water and transferred to a cold-water aquarium in the dark. Excellent specimens of *Lophelia pertusa*, the anemone cf. *Actinauge* and the solitary coral *Desmophyllum* were collected. An unidentified deep purple anemone and a small, unidentified zoanthid were also collected in this trawl. A variety of the material was fixed in 5% seawater formalin the following day to ensure good preservation for oocyte and fecundity analysis. The live material was maintained until later in the cruise. The live material was observed periodically for spawning or the expulsion of embryos. As the reproductive periodicity of these species is unknown we were unsure whether spawning would occur. None was observed. A second zoanthid, *Epizoanthus paguriphilus*, was obtained from Agassiz Trawl 13826#3 and maintained in the aquarium until preserved. Additional zoanthid material was obtained from the dead coral rubble in the Agassiz Trawl (13838#2). In the last Agassiz Trawl (13843#1) an excellent specimen of *Madrepora* was taken and used for molecular and reproductive studies.

Other material of interest included the seastars *Zoroaster fulgens* and ?*Psilaster andromeda* that were frozen at –70°C for population analysis. Specimens of *Echinus* ?*acutus* were preserved in 95% ethanol for analysis as part of study of the distribution and speciation in the genus *Echinus*.

PAUL TYLER, RHIAN WALLER

Molecular biology

Understanding the spatial genetic structure of *Lophelia pertusa* is an important component of the EU project Atlantic Coral Ecosystem Study (ACES). Migration rates between coral areas will have a major influence on recruitment to reefs and may determine recovery rates at some sites after anthropogenic impacts. Genetic variation is also the most basic element of biological diversity. Therefore, the determination of the localities that harbour the greatest genetic diversity for *Lophelia* is an important aspect of this work. Samples were taken during the cruise from a variety of locations to investigate the spatial genetic structure of *Lophelia pertusa.* Other species that are common on the continental slope and which may provide additional background data on the spatial genetic structure of benthic invertebrates were also collected.

In order to investigate the population structure of different deep-sea organisms, tissue samples were taken and preserved in ethanol. After DNA extraction, molecular markers can be developed to assess the genetic variability of these populations. The genetic study of the

deep-sea corals recovered in the Darwin Mounds involved the collection of polyps from each coral fragment from the colonial species *Lophelia pertusa* and *Madrepora oculata*, and tentacles from the solitary coral *Desmophyllum dianthus*. The polychaete *Eunice norvegica* and the brachiopod *Terebratulina retusa* (?) were also sampled because they are associated with *Lophelia pertusa*.

Table 8. Summary of samples taken for molecular biology from box core and trawl samples.

Station	Gear	Species	Number of samples
13816#1	Box core	***Ophiocten gracilis***	60
		Echinus	1
13816#3	Box core	***Ophiocten gracilis***	40
13821#2	Box core	***Ophiocten gracilis***	60
13823#6	Agassiz trawl	*Coryphaenoides rupestris*	22
		Octopus	1
		Synaphabranchus kaupi	1
		Chimaera monstrosa	5
		Lepidion eques	3
		Lophelia pertusa	2
		Madrepora oculata	6
		Terebratulina retusa?	7
		Pagurus	18
13826#2	Box core	***Ophiocten gracilis***	20
		Anemone	1
		Thyone	1
13826#3	Box core	***Ophiocten gracilis***	7
		Starfish	1
13826#4	Box core	Holothurian	1
		Ophiocten gracilis	40
13827#1	Box core	*Ophiocten gracilis*	40
		Terebratulina retusa?	2
13827#2	Box core	***Ophiocten gracilis***	40
13829#1	Box core	*Terebratulina retusa*?	19
		Ophiocten gracilis	11
		Anemone	1
13831#1	Agassiz trawl	*Eunice norvegica*	7
		Lophelia pertusa	54
		Madrepora oculata	19
		Terebratulina retusa?	7
		Coryphaenoides rupestris	12
		Lepidion eques	4
		Chimaera monstrosa	1
		Synaphabranchus kaupi	5
		Nezumia aequalis	1
		Echinus acutus	3
		Desmophyllum dianthus	2
13834#2	Box core	***Ophiocten gracilis***	60
13838#2	Agassiz trawl	Zoanthids	63
		Terebratulina retusa?	16
		Lophelia?	1
13840#1	Box core	*Ophiocten gracilis*	60
		Cerianthid larva	1
13840#3	Box core	*Spatangus*?	2
13842#3	Box core	*Ophiocten gracilis*	60
		Irregular sea urchin	1
13842#4	Box core	*Ophiocten gracilis*	60
		Ophiuroid	1

Reproductive studies on corals

Samples of corals, primarily of the genera *Lophelia*, *Madrepora* and *Desmophyllum*, were obtained from the Darwin Mounds (Rockall Trough), Porcupine Bank and the Porcupine Seabight. The Darwin Mounds samples were collected with an Agassiz Trawl. Fortuitously, the ultra high frequency sidescan sonar run on the Porcupine Bank yielded a small *Lophelia* colony when the sidescan sonar fish impacted the seabed, while rather more conventionally collected coral was taken in five box cores on the Theresa Mound in the Porcupine Seabight. All the fauna associated with the stony corals were also collected, including *Eunice* polychaetes, gorgonians, actiniarians and zooanthids. The samples were preserved in formalin (later transferred to 80% Industrial Methylated Spirits) or frozen at -70^0C.

All cnidarian samples will be used to assess their reproductive strategies, including seasonality, using material from previous and future cruises to this area. The frozen material will be used for molecular work.

Six small live pieces of *Lophelia* from the Porcupine Seabight were kept alive in aquaria within the fridge and transferred to aquaria within SOC. It is hoped that this material will be induced to spawn so as to gain a better grasp of the reproductive biology. With further live material it is also hoped to study interactions with associated fauna.

RHIAN WALLER, PAUL TYLER

Current meter moorings

Deployment of moorings

Four separate Aanderaa current meters (type: RCM 8) were moored close to the seafloor. Three current meters were placed within a few hundreds of metres of each other around a mound, one current meter on a mound, one in the "tail" region immediately "downstream" of the mound and one to the side of the mound. The fourth current meter was deployed in conjunction with the SAMS ISOR instrumented mooring on a mound (see separate report).

The current metres were placed as close as possible to the seafloor (Figure 2). To facilitate this, the acoustic release was clamped above the current meter on a long stainless steel bar with the RCM fitted to gimbals below it. An acoustic release was used to fire sacrificial pyrotechnic material attached to a release clamp at the end of the bar. There were two such pyros fitted to each clamp, and each was connected to separate channels on the acoustic release, thus giving a measure of redundancy. The concrete block anchor weight was shackled into the release clamp. To further reduce the height of the speed rotor of the RCM from the seafloor, the RCM was fitted upside down in the gimbals. The mooring was fitted with a marker buoy, a light and a flag, and with three 17-inch glass spheres for buoyancy.

The mooring could not be deployed conventionally by allowing it to free-fall through to the seafloor because of the rigid attachment of the release to the anchor weight. Instead the current meter was lowered by winch and then released within a few metres of the seabed using a second acoustic release (Oceano RT661). Once it was clear that the rig was safely deployed, the acoustic release signal was switched off.

This deployment procedure was used for all the current meter moorings including the SAMS mooring. The first rig to be deployed was the SAMS mooring including an RCM 8.

It was on the bottom and released at 1935H on 11 July 2000 at 59° 49.86 N, 07° 20.34 W, in a water depth of 958m. The second mooring was released and on the bottom at 2140H at 59° 49.77 N, 07° 20.03 W, in a water depth of 960m. The third current meter began was released at 1017H (12 July) at 59° 49.59 N, 07° 20.54 W, in a water depth of 958m. The final deployment was aborted initially owing to a failure in the telemetry to the acoustic release. The release was replaced with one of a similar design and was on the bottom at 2004H at 59° 49.40 N, 07° 20.68 W, in a water depth of 966m. Telemetry was again difficult, but was re-established using a dunking transducer instead of the ship's hull transducer.

Recovery of moorings

The moorings were recovered on the afternoon of the 31 July with favourable weather conditions, but with the wind increasing to Force 3-4 and the swell deepening.

The first mooring to be approached was the SAMS rig. The acoustic release was interrogated using a TT301 Oceano deck unit and a dunking transducer lowered over the ship's side. This approach was chosen rather than the vessels hull transducer because of the problems encountered during deployment (see above). Consistent ranges were received and a good diagnostic value was obtained confirming the rig's position on the sea floor at 958m depth. The acoustic release was then commanded to fire both channels, one at a time to ensure successful release and to prevent a "live" pyro being brought on board. Release was confirmed at 13.04H and measurements indicated an ascent rate of 88m/min. The marker buoy was on the surface at 13.16H. The rig streamed out well on the surface, making a good target for grappling. The stray line was grappled and shortly after the buoyancy and instruments were safely and efficiently hoisted on deck. The RCM8 (S/N: 11571) was later found to have logged data over the deployment period. Attempts to download data from the ISOR instrument, however, failed. The owners of the instrument were contacted for instructions.

Following the same procedure as outlined above, the second mooring was released at 13.57H and observed on the surface at 14.12H. Grappling was made difficult because the buoyancy had become entangled during the ascent, forcing the crew to haul the marker buoy manually on deck before recovering the remainder of the mooring. The problem was caused by the "monkey's fist" wrapping around the buoyancy and marker buoy. The next mooring was commanded to release at 15.09H and was on the surface at 15.21H. It was brought on deck shortly after. The final rig was released at 16.07H and spotted on the surface at 16.23H. However, on the ascent the marker buoy had again become entangled with the buoyancy package. The result was that the marker buoy was snagged below the three glass spheres and the pole holding the flashing light and flag had broken. These were both lost to the deep as the rig was hauled aboard.

All the current meters recorded data for the entire deployment period. The data were downloaded the day after the recovery of the moorings. The RCM 8's were all instrumented with temperature, compass and speed sensors.

JOHN WYNAR

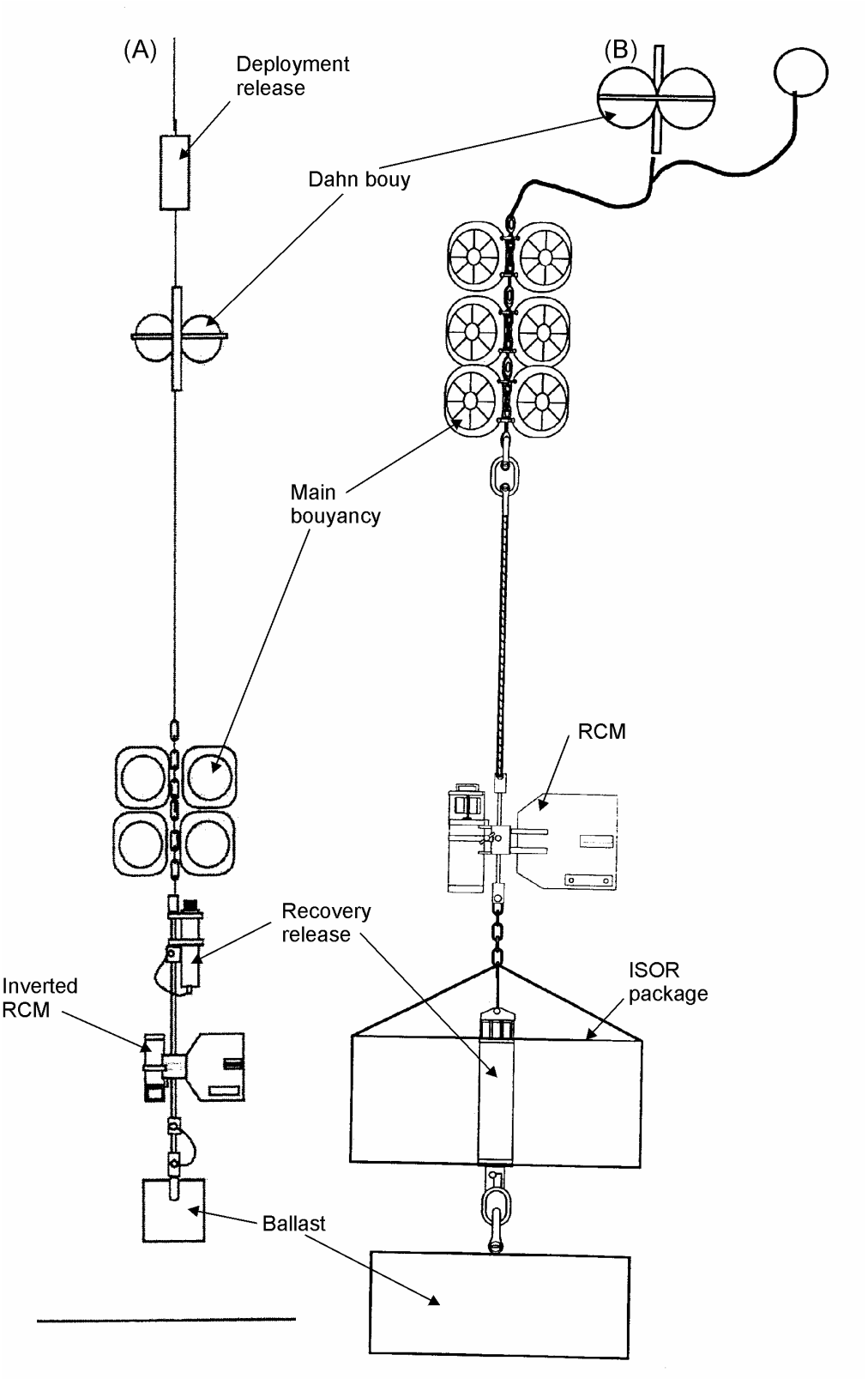

Figure 2. Recording current meter (RCM) moorings employed during RRS *Discovery* Cruise 248. (A) Inverted near-bottom RCM rig; (B) combined near-bottom RCM and ISOR rig.

In Situ Optical Recorder (ISOR)

The *in situ* optical recorder (ISOR) mooring was designed by the Scottish Association for Marine Science and University of Strathclyde to record the near bed particle field. It consisted of two pressure housings, one containing batteries and the second the instrument and data-logging computer. During the deployment (Station 13817 #1) the ISOR was programmed to measure light transmission, forward and backward light scatter and fluorescence every fifteen minutes. The mooring design positioned the ISOR 1 m from the seabed and a recording current meter 2 m from the bed (Figure 2). This project is a component of Workpackage 3 of the EU project Atlantic Coral Ecosystem Study (ACES). Details of how the mooring was deployed, and its subsequent recovery, are given in the section above.

J MURRAY ROBERTS

CTD and Water Bottle Rosette Sampler

There were only two CTD casts made during the cruise. Both casts were carried out on the first leg. A Neil Brown MkIIIc CTD and a G.O. 1016 rosette were used together with a transmissometer, fluorometer, light scatter sensor and pinger. Twelve Niskin 10-litre water bottles were used on the second cast to obtain near-bottom water for the organic geochemistry samples.

The first deployment was made on the 10 July. In part, this deployment was carried out as a test for two acoustic releases, which were tied to the frame. The CTD was in the water at 16.30H at 59° 50.27 N, 07° 23.20 W with a water depth of 915m. In the calm seas we experienced during the cast, the only factor which limited how close the CTD could be lowered to the seafloor, was how well the pinger trace could discriminated on the waterfall display (no altimeter was fitted to the CTD array). The closest approach was 9m off the bottom at 17.00H. The releases were tested at 50m above the seabed. The CTD was back on deck at 17.44H. No water samples were taken on this cast.

The second cast was on the 13 July at 59° 48.77 N, 07° 22.29 W in 956m of water. The CTD was deployed at 15.25H and reached 11m off the bottom at 16.03H. Three water bottles were triggered at this depth and another three at 795m. However, on recovery it was found that only bottles 3 and 4 had closed properly, probably because the lanyards had been positioned incorrectly. This fault was rectified, but as there were no further casts made during the cruise there was no opportunity to test the system again.

JOHN WYNAR

Mini Profiler Vehicle (MPV)

Overview

The vehicle is fitted with the standard SOC Towed Ocean Bottom Instrumentation (TOBI) profiler transducer array, but uses chirp profiler technology for its operation. This operates with a 6-10 kHz swept frequency of 26 ms duration. A transmission rate of one 'ping' ever 4 seconds was used.

The vehicle had reconfigured buoyancy for better trim, based on previous trials cruise experience. Deployment was with the standard two-body tow configuration of vehicle,

neutrally buoyant umbilical and depressor weight, using the ship's coaxial deep-tow cable. The vehicle makes use of the coaxial cable for power, command and data transfers.

Top end (laboratory) data de-multiplexing was by in-house 'deck unit' and logging was to be conducted using a modified TOBI logging/profiler display package, written in-house. The TOBI profiler display system was also employed in order to give flying data, using the first bottom return, for the winch drivers.

The chirp profiler system had been previously field-tested (2 trials cruises CD123 - 1999, D240 - 2000) with resultant excellent data. Subsequent development included the integration of a modem operating at up-to 9600 baud and an FSI-CTD unit.

Deployment

Two deployments were conducted during the second leg of the cruise.

The first deployment was made on 30/07/2000 (59 54.60 N, 07 14.36 W). The vehicle was lowered into the water with the depressor-weight/swivel connected up ready to deploy. The vehicle trim looked very good in the water. The water depth was circa. 900m. The vehicle was powered up and communication was successfully achieved between the vehicle's computer and the deck unit's computer. Communications and logging of CTD data, with date and time stamp, from the FSI unit was successfully achieved. However, although a profiler transmit signal could be detected, indicating the sonar was operational, no 4-second trigger pulse was evident. The vehicle was recovered for investigation.

Bench testing of the communications/power pod was instigated. The 4-second trigger was detectable, on test equipment, at the vehicle end, but not in the top-end deck unit. A thorough investigation was carried out, but no 4-second pulse appeared to be regenerated at the top-end decoding board. A stopgap implementation was instigated to provide a 4-second trigger which had a delay before the transmit pulse. This was to be processed out later.

A second deployment was made at 14:50 hours, 30/07/2000 (59 54.60 N, 07 14.36 W). The launch went smoothly and the vehicle trim, again, looked very good in the water. The water depth was 913 m. The vehicle was tested in the water and the trigger and transmitting pulses were evident. The depressor-weight was then deployed and the vehicle taken down to a depth of 150 m. This depth was held to allow further checks on the vehicle's status. Communication between processors, vehicle and top-end, was established and the CTD data could be accessed and logged with a synchronised time stamp, to the vehicle's hard disc.

However, the output from the chirp profiler was not encouraging. The received signal looked noisy, on investigation with an oscilloscope, and there was no real evidence of any correlated signals. From past experience the sea bottom should easily be detected in this range of water depths. The monitor display of the profiler was highly noisy, particularly when the modem was active. Turning off the modem, only possible at the top-end, greatly reduced the noise. There was still significantly greater noise, than on previously non-modem trials, evident on the output display. This is thought to be from the vehicle's modem in cyclic listening mode.

It was decided that an investigation time greater than what was available on the cruise schedule was required. It was decided therefore to stand down the use of the MPV for the rest of the cruise. Further investigation and development will be conducted in the laboratory back at base.

DUNCAN R. MATTHEW

Bathysnap

The Bathysnap time-lapse camera system was deployed twice during the cruise. It was intended to recover a second Bathysnap system that had been placed on the seabed in 1999 (Station 55001#1), but no contact could be made with the module. Sidescan sonar records made during the cruise showed that commercial demersal trawls had trawled the area in recent months. It is likely that commercial trawling destroyed the Bathysnap system. As a result a second long-term deployment of Bathysnap in this area was abandoned.

A short-term (3 weeks) deployment of Bathysnap was made however, nominally on the summit of one of the Darwin Mounds. This deployment was successful, although it turned out to be a rather unexciting sequence of photographs on a sandy area. The interval between frames was set at 18 minutes (80 frames per day). The camera was activated at 1954Z 12 July 2000 before deployment began at 2106Z. Bathysnap landed on the seabed at 2138Z. It was released from the seabed at 1704Z on 31 July 2000.

Bathysnap was deployed for a second time in the vicinity of the Belgica Mounds in the Porcupine Seabight towards the end of the second leg of the cruise. The area chosen was close to an area that had been imaged by SHRIMP (St. 13877#1). The area was relatively flat in between two large coral mounds, but in an area where large patches of low-standing coral had been seen. The frame interval was set at 36 minutes (40 photographs per day). The camera was activated at 0658Z 8 August 2000. The first flash was noted at 0734Z before deployment began at 0741Z. The camera system reached the seabed at 0809Z.

DAVID BILLETT

Computing

Data Logged

Data was logged using the ISG ABC System. The Level A system collects data from individual pieces of scientific equipment. The Level B collects each of the Level A SMP messages and writes them to a disk, monitoring the frequency of the messages and warns the operator when messages fail to appear. The Level C system takes these messages and parses them into data streams.

The following list shows the data collected on D248

Chernikeeff Log	LOG CHF	MkII Level A
Ships Gyro	GYRONMEA	MkII Level A
Trimble GPS	GPS-4000	MkII Level A
Ashtec ADU	GPS_ASH	MkII Level A
Ashtec Glonass GPS	GPS_GLOS	MkII Level A
Echo-Sounder	EA500DI	MkII Level A
Surface Logger	SURFMET	SIG PC
CLAM System	WINCH	SEG PC
CTD MkIIIc	CTD-12C	MkII Level A

Problems encountered during the cruise

Level A

GPS_GLOS: On the second leg of the cruise the GPS_GLOS was not recording data properly. The reason was because of the extra precision caused by the differential input signal. The Level A chips will need to be replaced.

GPS ASH: Throughout the cruise, the GPS ASH was not recording reliable data.

GYRO NMEA: Duplicate times and missing times, were causing problems throughout the cruise.

Level B

There was a master clock jump during the second leg of the cruise. All Level A's were reset and no more problems occurred.

Level C

No problems noted.

ELIZABETH ROURKE

GEAR CODES USED IN STATION LIST

AT	Agassiz Trawl
BC	USNEL Mk-2-type Box Corer
BSNAP	SOC “Bathysnap”
CM	Current Meter
CTD	Conductivity-Temperature-Depth probe
DREDGE	Rock Dredge
GA 100/410	GeoAcoustics 100 and 410 kHz sidescan sonar system
GGC	‘Giant’ Gravity Corer (6 m barrel)
ISOR	SAMS *In Situ* Optical Recorder
MC	SMBA pattern Multiple Corer
MPV	SOC Mini Profiler Vehicle
PC6, 9, 12	Piston Corer 6, 9 or 12 m barrel
SAPS	Stand Alone Pumping System
SHRIMP	SOC Seabed High Resolution Imaging Platform

RRS Discovery Cruise 248 Station List

Station	Date 2000	Start Position °N	°W	End Position °N	°W	Gear	Depth Start (m)	Depth End (m)	Time Start	Time End	Comments	Sounding (m)
13812#1	09-Jul	59 43.12	07 52.19	59 40.65	07 51.15	SHRIMP	740	796	20:30	1:30	One good video Still photographs	768
13813#1	10-Jul	59 50.26	07 23.21	59 50.03	07 22.37	CTD	0	915	16:29	17:40	Total water column cast No water bottles	920
13814#1	10-Jul	59 49.88	07 20.34	59 50.24	07 20.23	SHRIMP	955	968	22:25	0:32	Image mounds for moorings 2 good videos	962
13815#1	11-Jul	59 37.78	07 43.55	59 36.61	07 42.33	SHRIMP	866	890	4:02	7:26	Image pockmark field 2 good videos	878
13816#1	11-Jul	59 48.83	07 22.73			BC	946		11:11		Good core	946
13816#2	11-Jul	59 48.86	07 22.72			BC	945		13:20		No sample	945
13816#3	11-Jul	59 48.85	07 22.71			BC	946		14:55		Good core	946
13816#4	11-Jul	59 48.85	07 22.68			MC	947		16:48		5/12 cores Good cores	947
13817#1	11-Jul 31-Jul	59 49.87	07 20.34			ISOR	956		19:35	13:04	On carbonate mound	956
13817#2	11-Jul 31-Jul	59 49.77	07 20.03			CM	964		21:40	13:57	North of mounds	964
13818#1	12-Jul	59 48.74	07 21.88			BC	958		2:14		Part washed out sample Xeno and some sand	958
13818#2	12-Jul	59 48.76	07 21.79			BC	958		3:52		Washed out core No sample	958
13818#3	12-Jul	59 48.73	07 21.72			BC	958		5:13		Part washed out sample Sediment+ coral fragments	958
13819#1	12-Jul	59 48.79	07 22.60			MC	949		6:45		5/12 cores	949
13820#1	12-Jul 31-Jul	59 49.59	07 20.54			CM	961		10:17	15:09	On "tail"	961
13821#1	12-Jul	59 48.75	07 21.67			BC	959		14:08		Part washed out sample Sediment with tar	959
13821#2	12-Jul	59 48.76	07 21.67			BC	960		15:39		Good core	960
13821#3	12-Jul	59 48.75	07 21.66			MC	960		17:17		11/12 good cores	960
13822#1	12-Jul 31-Jul	59 49.42	07 20.66			CM	962		20:03	16:07	South of mounds and "tail"	962
13822#2	12-Jul 31-Jul	59 49.71	07 20.38			BSNAP	957		21:38	17:04	On carbonate mound	957
13823#1	12-Jul	59 48.99	07 22.46			BC	944		23:17		Part washed out sample	944
13823#2	13-Jul	59 48.91	07 22.47			BC	948		0:47		Part washed out sample	948
13823#3	13-Jul	59 48.81	07 22.50			BC	947		2:49		Part washed out sample 2 xenophyophores	947
13823#4	13-Jul	59 48.89	07 22.51			MC	946		4:39		8/12 cores On mound	946
13823#5	13-Jul	59 48.89	07 22.54			MC	945		6:35		10/12 cores On mound	945
13823#6	13-Jul	59 48.38	07 21.88	59 48.39	07 29.25	AT	904	993	11:15	13:28	Weak link parted Reasonable catch	948
13823#7	13-Jul	59 48.84	07 22.39	59 49.01	07 22.46	SHRIMP	941	954	20:00	0:10	Good video and photos Patchy coral	948
13823#8	14-Jul	59 48.83	07 22.76	59 48.83	07 22.74	SAPS	942		3:15	5:15	"Tail" area SAPS at c. 3 and 4 mab	947
13823#9	14-Jul	59 48.84	07 22.79	59 48.83	07 22.69	SAPS	796		7:30	9:30	34 L and 300 L filtered SAPS at c. 150 mab	946
13823#10	14-Jul	59 48.80	07 22.63	59 48.83	07 22.57	SHRIMP	946	949	12:00	12:47	No colour video Run terminated early	947
13823#11	14-Jul	59 48.70	07 22.58	59 48.88	07 22.34	SHRIMP	946	956	16:08	19:54	Good video and photos "Tail" region	951
13823#12	14-Jul	59 48.86	07 22.45	59 48.89	07 22.45	SAPS	798	943	21:44	23:44	SAPS at c. 5 and 150 mab Over mound	948
13823#13	13-Jul	59 48.75	07 22.28	59 48.78	07 22.39	CTD	0	950	15:24	16:37	Two WB only (5 and 150 mab) St. no. out of sequence	950
13824#1	15-Jul	59 49.08	07 21.41	59 49.12	07 21.05	SHRIMP	955	965	1:53	5:16	No still photography	960
13825#1	15-Jul	59 48.75	07 22.13	59 48.78	07 22.18	SAPS	803	948	7:45	9:45	Off tail/mound areas SAPS at c. 5 and 150 mab	953
13826#1	15-Jul	59 48.81	07 22.54			BC	946		12:42		Core part washed out Discarded	946
13826#2	15-Jul	59 48.82	07 22.60			BC	948		14:18		Good core Retained and sieved	948
13826#3	15-Jul	59 48.82	07 22.57			BC	946		15:53		Good core Retained and sieved	946
13826#4	15-Jul	59 48.81	07 22.58			BC	948		17:22		Good core No xenos - discarded	948
13826#5	15-Jul	59 48.81	07 22.59			BC	949		18:58		Core part washed out Irregular echinoid retained	949

13827#1	15-Jul	59 48.95	07 22.52			BC	948		20:22		Good core	948
13827#2	15-Jul	59 48.95	07 22.53			BC	946		22:44		No xenos - discarded Good core	946
13828#1	16-Jul	59 48.90	07 22.55	59 48.90	07 22.54	SAPS	793	938	1:00	3:00	No xenos - discarded On mound	943
13829#1	16-Jul	59 49.05	07 21.22			BC	958		4:48		SAPS at c. 5 and 150 mab Small amount of sediment	958
13829#2	16-Jul	59 49.07	07 21.35			BC	958		6:33		sponges, echinoid, dead coral Mostly washed out core	958
13829#3	16-Jul	59 49.08	07 21.24			BC	959		7:55		Mostly washed out core	959
13829#4	16-Jul	59 49.09	07 21.26			BC	959		9:16		Mostly washed out core	959
13830#1	16-Jul	59 48.89	07 22.52			MC	945		11:10		5/12 cores	945
13831#1	16-Jul	59 48.88	07 17.99	59 46.32	07 22.90	AT	989	1011	18:33	21:25	On mound area, coral Good trawl	1000
13832#1	17-Jul	59 48.84	07 22.72			MC	946		0:22		Some live coral fragments "Tail" area	946
13832#2	17-Jul	59 48.86	07 22.66	59 48.89	07 22.74	SAPS	793	938	2:38	4:38	11/12 cores "Tail" area	943
13833#1	17-Jul	59 48.83	07 22.14			MC	954		6:26		SAPS at c. 5 and 150 mab Off mound/tail area	954
13833#2	17-Jul	59 48.85	07.22.07			MC	955		7:55		4/12 cores Off mound/tail area	955
13834#1	17-Jul	59 49.09	07 21.42			BC	956		9:29		On mound, no xenos	956
13834#2	17-Jul	59 49.09	07 21.49			BC	958		10:51		On mound, no xenos	958
13834#3	17-Jul	59 49.10	07 21.44			BC	956		12:25		On mound, no xenos	956
13834#4	17-Jul	59 49.09	07 21.46			BC	956		13:57		On mound, no xenos	956
13835#1	17-Jul	59 36.01	07 41.86			MC	904		17:48		Pockmark area	904
13835#2	17-Jul	59 36.00	07 41.86			MC	905		19:12		Pockmark area	905
13835#3	17-Jul	59 36.00	07 41.86	59 36.01	07 41.70	SHRIMP	900	906	22:07	1:21	12/12 cores Pockmark area	903
13836#1	18-Jul	59 43.03	07 25.86	59 43.13	07 25.85	SHRIMP	934	952	3:54	7:10	Still camera flooded "Tail-less" mound	943
13837#1	18-Jul	60 14.61	09 00.44	60 15.24	08 58.30	SHRIMP	1205	1312	18:09	23:02	Video recorder did not work Ymir Channel	1257
13838#1	19-Jul	59 51.08	07 04.24	59 50.97	07 03.96	SHRIMP	1043	1050	6:14	9:16	Video only Eastern Darwin mounds	1046
13838#2	19-Jul	59 51.54	07 01.29	59 50.81	07 05.30	AT	1017		12:35	14:40	Video only Eastern Darwin mounds	1017
13839#1	19-Jul	59 48.84	07 22.16			MC	954		18:30		Net torn. No catch Off tail/mound area	954
13840#1	19-Jul	59 49.09	07 21.51			BC	958		20:15		Good core	958
13840#2	19-Jul	59 49.08	07 21.43			BC	958		21:49		Part washed out core	958
13840#3	19-Jul	59 49.08	07 21.44			BC	958		23:32		Coral and xenophyophore Part washed out core	958
13841#1	20-Jul	59 48.81	07 22.10	59 48.80	07 22.23	SAPS	948	803	1:39	3:39	Xenophyophore Off tail/mound area	953
13842#1	20-Jul	59 49.08	07 21.45			BC	958		5:27		SAPS at c. 5 and 150 mab Part washed out core	958
13842#2	20-Jul	59 49.07	07 21.44			BC	959		6:51		Part washed out core	959
13842#3	20-Jul	59 49.08	07 21.51			BC	958		8:00		Good core	958
13842#4	20-Jul	59 49.08	07 21.50			BC	959		9:25		Good core	959
13843#1	20-Jul	59 50.86	07 04.61	59 50.24	07 05.87	AT	1052	1068	14:10	15:15	Net torn	1060
13844#1	22-Jul	59 49.21	07 21.57			PC9	955		10:02		Small sample -eastern mounds Non-tail/mound area	955
13845#1	22-Jul	59 49.37	07 21.29			PC9	955		14:22		c. 600 cm Tail area	955
13846#1	22-Jul	59 49.47	07 21.18			PC6	952		19:30		812 cm Mound area	952
13846#2	22-Jul	59 49.48	07 21.16			PC6	954		22:43		131 cm Mound area	954
13847#1	23-Jul	59 49.61	07 23.90			PC6	914		3:07		266 cm Mound area	914
13847#2	23-Jul	59 49.61	07 23.89			PC6	914		6:00		484 cm Mound area	914
13848#1	23-Jul	59 48.80	07 26.00			PC6	904		9:17		535 cm Large tail area	904
13849#1	23-Jul	59 48.89	07 25.66			PC9	906		12:12		502 cm Large tail area	906
13850#1	23-Jul	59 49.50	07 23.90			PC9	918		17:28		840 cm Mound tail	918
											881 cm	

13851#1	23-Jul	59 47.01	07 24.88			PC9	941		21:15		Medium backscatter area 628 cm	941
13852#1	24-Jul	59 35.97	07 41.84			PC9	904		3:30		Pockmark area 624 cm	904
13852#2	24-Jul	59 36.01	07 41.86			PC9	902		6:31		Pockmark area 824 cm	902
13853#1	24-Jul	59 28.42	07 53.11			PC9	1120		12:01		Sediment wave 836 cm + 88 cm trigger core	1120
13854#1	24-Jul	59 28.50	07 52.39			PC12	1115		16:46		Sediment wave 488 cm + centre part imploded	1115
13854#2	24-Jul	59 28.51	07 52.40			PC12	1116		22:39		Sediment wave 723 cm	1116
13855#1	25-Jul	59 42.66	07 52.75			PC12	749		13:00		Pockmarks 681 cm	749
13856#1	25-Jul	59 43.21	07 25.72			PC6	948		18:37		"Moundless mound" 362 cm	948
13857#1	25-Jul	59 43.10	07 25.76			PC6	950		22:02		"Moundless mound" 436 cm	950
13857#2	26-Jul	59 43.01	07 25.95			PC6	948		1:34		Tail-less mound 515 cm	948
13858#1	26-Jul	59 47.17	07 22.26			PC6	969		5:24		Mound 340 cm	969
13859#1	26-Jul	59 48.91	07 22.58			PC6	944		8:06		Mound Core bent - no sample	944
13860#1	26-Jul	59 48.64	07 21.80			PC6	958		11:10		Mound 103 cm	958
13861#1	26-Jul	59 48.90	07 22.56			GGC	945		15:09		Mound Washed dead coral sample only	945
13862#1	27-Jul 28-Jul	59 48.55	07 27.99	59 51.98	07 21.27	GA100/410	761	1102	1:59	21:30		932
13863#1	29-Jul	59 47.13	07 22.27	59 47.18	07 22.33	SHRIMP	969	977	2:11	5:20	Tail-less mound	973
13864#1	29-Jul	59 43.09	07 25.82	59 43.13	07 25.78	SHRIMP	945	949	8:45	12:12	"Moundless" mound	947
13865#1	29-Jul	59 34.62	07 34.76	59 49.11	07 31.63	GA100/410	838	1034	15:25	22:10		936
13866#1	30-Jul	59 48.60	07 21.79	59 48.77	07 21.71	SHRIMP	955	964	1:59	5:02	Mounds	960
13867#1	30-Jul	59 48.99	07 00.04	59 48.97	07 02.26	SHRIMP	1070	1086	7:38	11:08	Speckled backscatter area	1078
13868#1	30-Jul	59 54.60	07 14.36	59 53.89	07 15.30	MPV	0	150	14:50	15:55	System failed - no data	913
13869#1	30-Jul	59 53.39	07 15.34	59 52.61	07 11.57	GA100/410	938	991	16:15	17:00	Impacted seabed Good benthic sample	965
13869#2	30-Jul 31-Jul	59 54.19	07 12.63	59 53.42	07 12.04	GA100/410	864	1070	19:15	5:32	Eastern mounds	967
13870#1	31-Jul	59 49.49	07 21.61	59 50.38	07 20.18	SHRIMP	947	950	8:18	11:23	Mound and sand wave area	948
13871#1	03-Aug 04-Aug	53 41.14	14 07.12	53 43.49	14 01.79	GA 100/410	667	916	14:45	1:20	Porcupine Bank	792
13872#1	04-Aug	53 46.90	13.54.63	53 45.09	13 58.62	SHRIMP	684	775	4:52	10:29	Mounds Porcupine Bank	730
13872#2	04-Aug	53 45.11	13 58.51	53 44.96	13 58.64	DREDGE	701	722	13:54	14:26	Porcupine Bank	712
13873#1	05-Aug 06-Aug	51 23.71	11 42.34	51 30.19	11 41.18	GA 100/410	544	1174	6:03	9:20	Porcupine Seabight mounds	859
13874#1	06-Aug	51 25.68	11 46.40			BC	862		12:32		Small amount of coral	862
13874#2	06-Aug	51 25.67	11 46.41			BC	865		14:14		Excellent core Large coral community	865
13874#3	06-Aug	51 25.66	11 46.39			BC	862		15:56		Core did not close No sample	862
13875#1	06-Aug 07-Aug	51 23.90	11 44.59	51 30.74	11 40.92	GA 100/410	598	1178	17:31	2:00	Porcupine Seabight mounds	888
13876#1	07-Aug	51 25.62	11 46.24	51 25.63	11 46.42	SHRIMP	856	905	4:31	7:31	"Theresa" mound	881
13877#1	07-Aug	51 27.38	11 45.00	51 26.06	11 45.84	SHRIMP	784	952	9:28	12:31	"Belgica" mounds	868
13878#1	07-Aug	51 23.41	11 37.29	51 21.37	11 43.16	GA 100/410	540	968	14:23	21:17	Porcupine Seabight mounds	754
13879#1	08-Aug	51 26.06	11 44.69	51 26.77	11 44.69	SHRIMP	897	938	0:17	1:39	Sidescan validation	918
13880#1	08-Aug	51 26.77	11 45.22			BSNAP	884		8:09		36 minute photo interval	884
13881#1	08-Aug	51 25.66	11 46.31			BC	863		9:33		Good Lophelia core	863
13881#2	08-Aug	51 25.66	11 46.33			BC	863		11:01		Good Madrepora core	863
13881#2	08-Aug	51 25.66	11 46.32			BC	859		12:25		Excellent coral core	859

APPENDICES I- VII

I.. Track plots for Seabed High Resolution Imaging Platform (SHRIMP) - figures 3-22.

II. Track plots for very high frequency (100kHz) and ultra high frequency (410kHz) sidescan sonar surveys - figures 23-30.

III. Track plots for trawl and dredge operations - figures 31-35.

IV. Position charts for piston corer sites - figures 36-39.

V. Position charts for box and multiple coring sites - figures 40-45.

VI. Position charts for CTD, SAPS, Mooring operations - figures 46-48.

VII. Track plots for echo sounding surveys carried out during the cruise - figures 49-55.

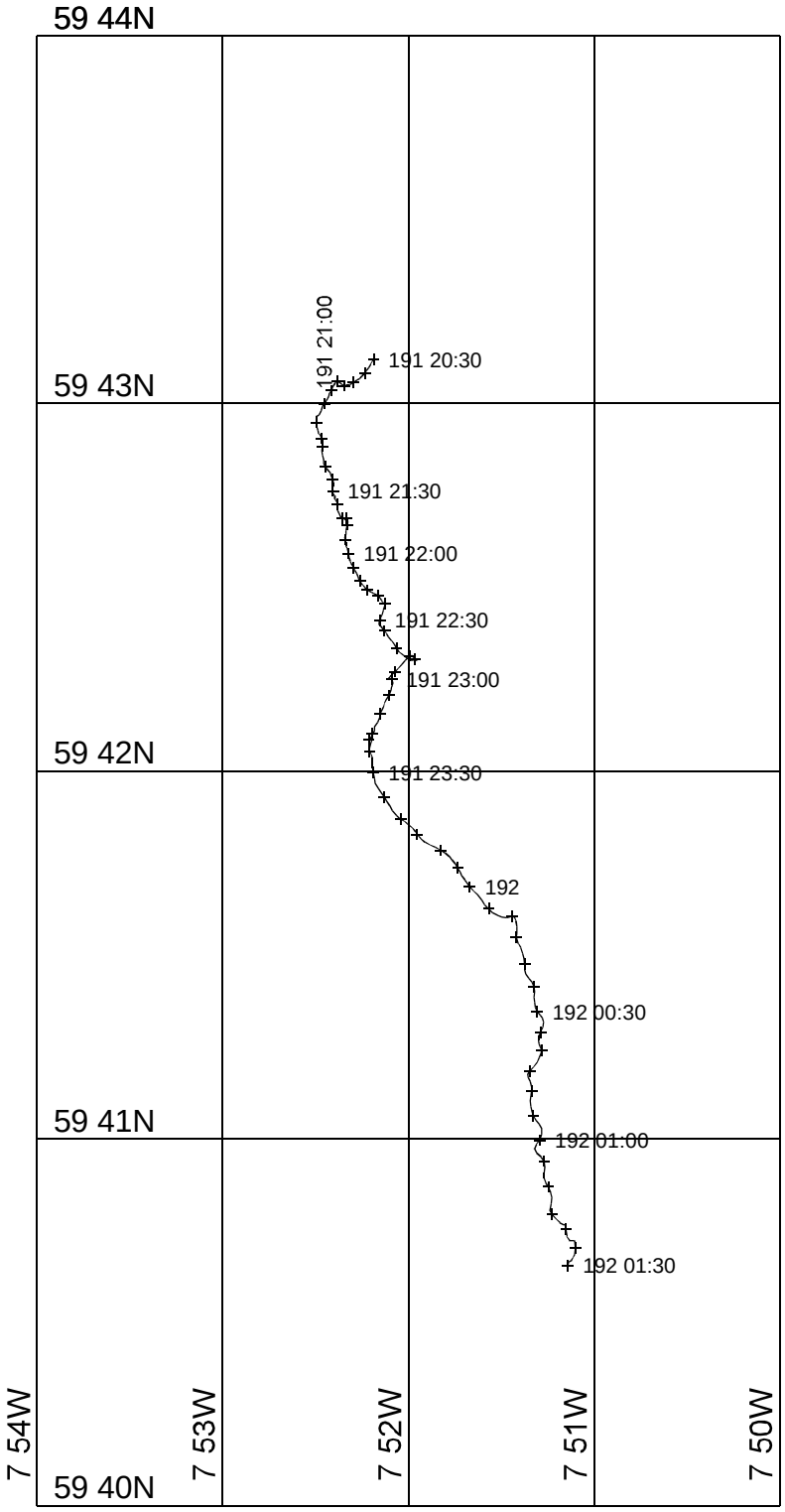

Figure 3. 13812#1 SHRIMP 00 191 20:30:00 - 00 192 01:30:00

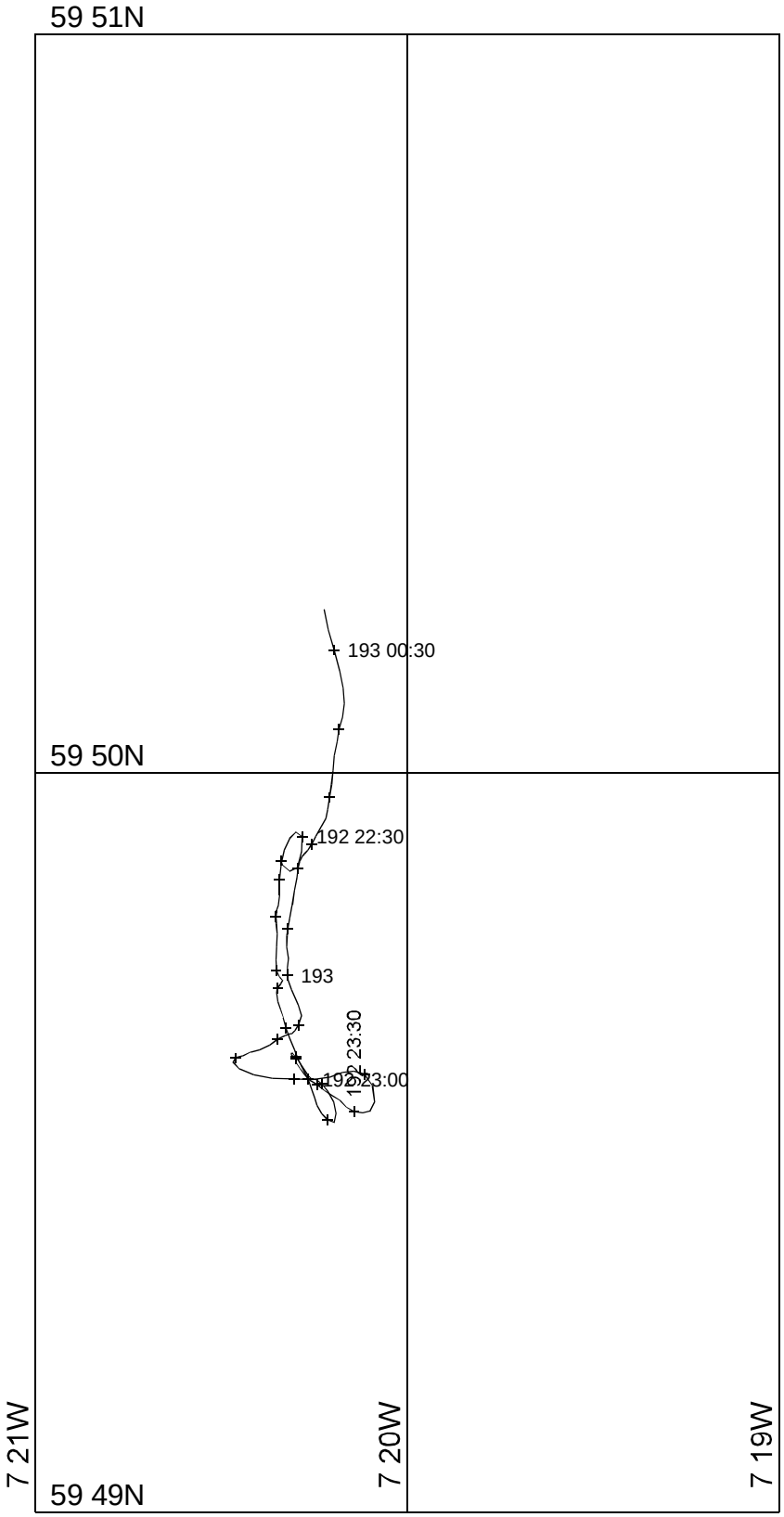

Figure 4. 13814#1 SHRIMP 00 192 22:25:00 - 00 193 00:32:00

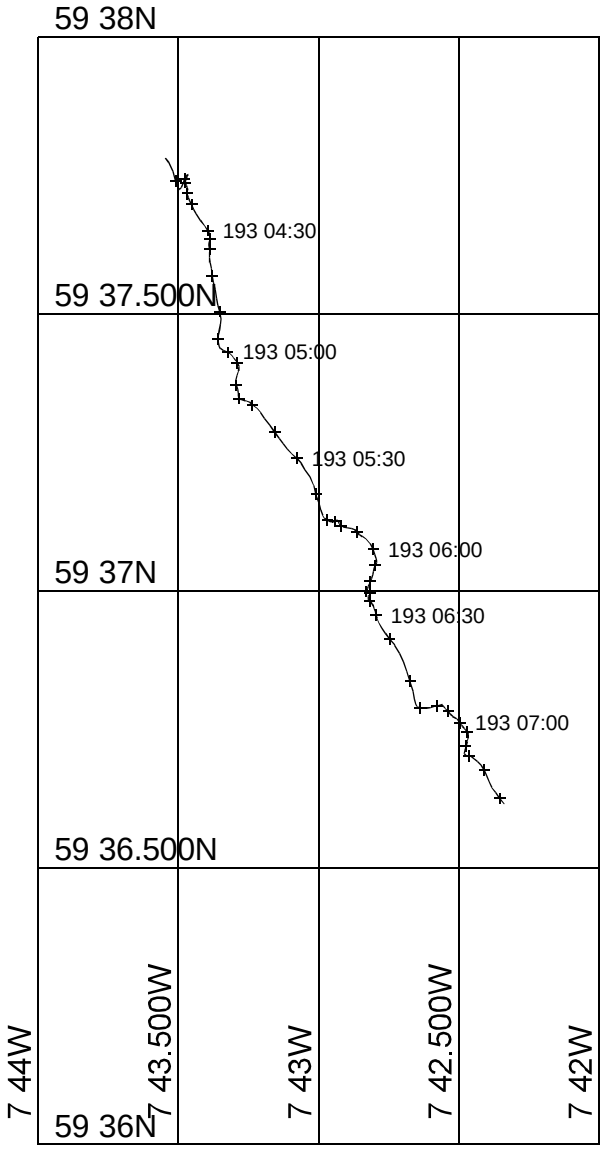

Figure 5. 13815#1 SHRIMP 00 193 04:02:00 - 00 193 07:26:00

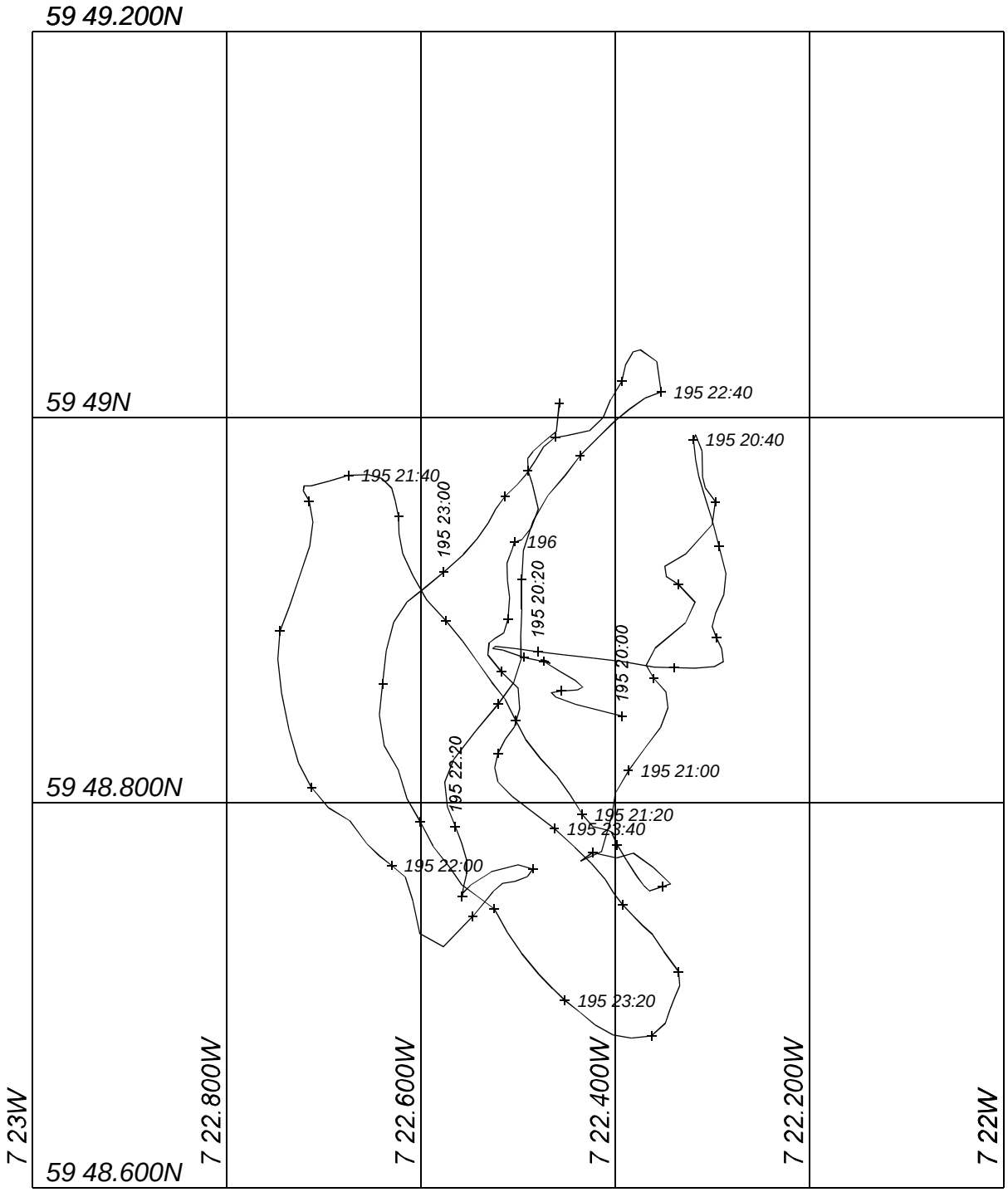

Figure 6. 13823#7 SHRIMP 00 195:20:00:00 - 00 196 00:10:00

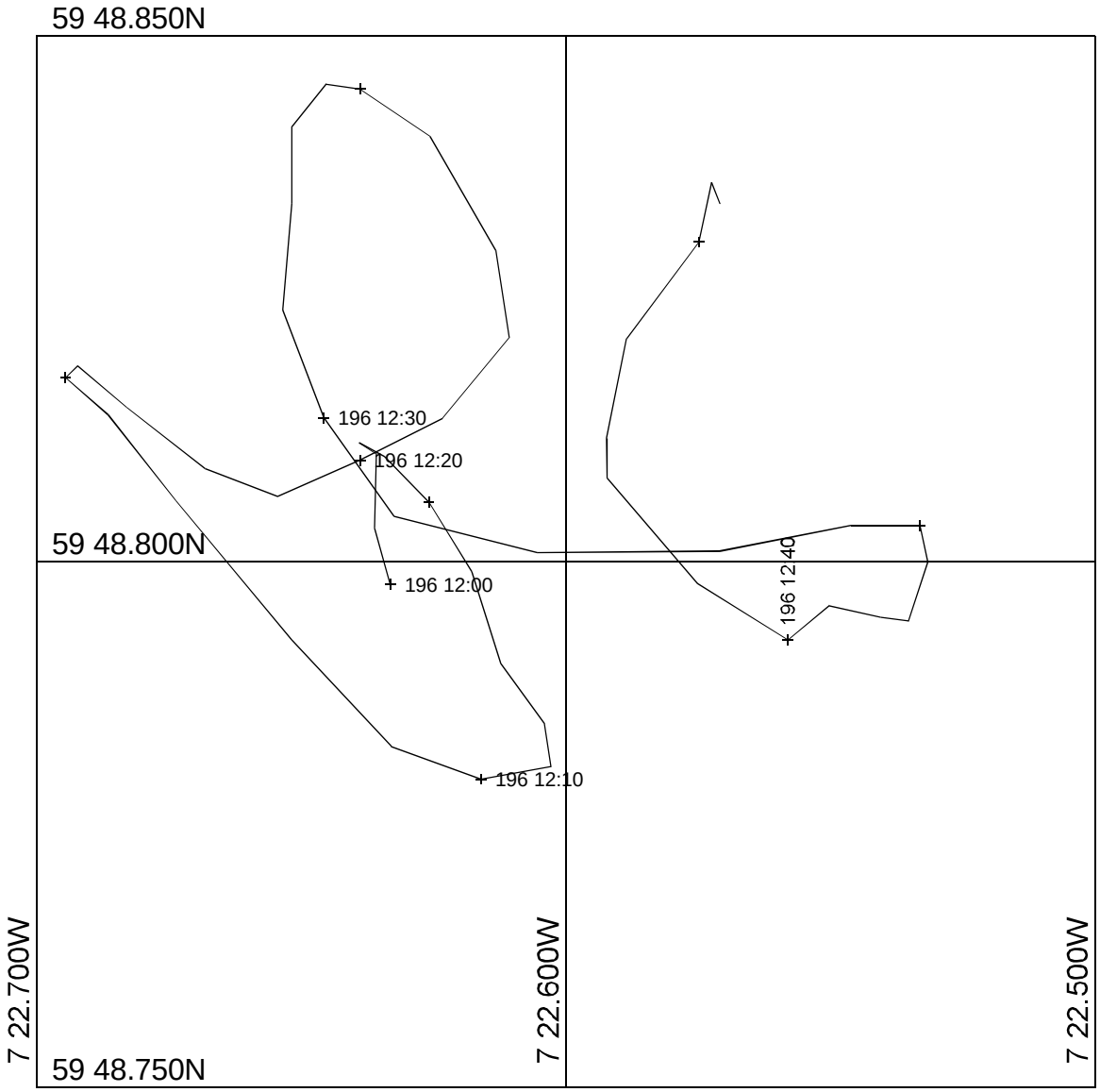

Figure 7. 13823#10 SHRIMP 00 196 12:00:00 - 00 196 12:47:00

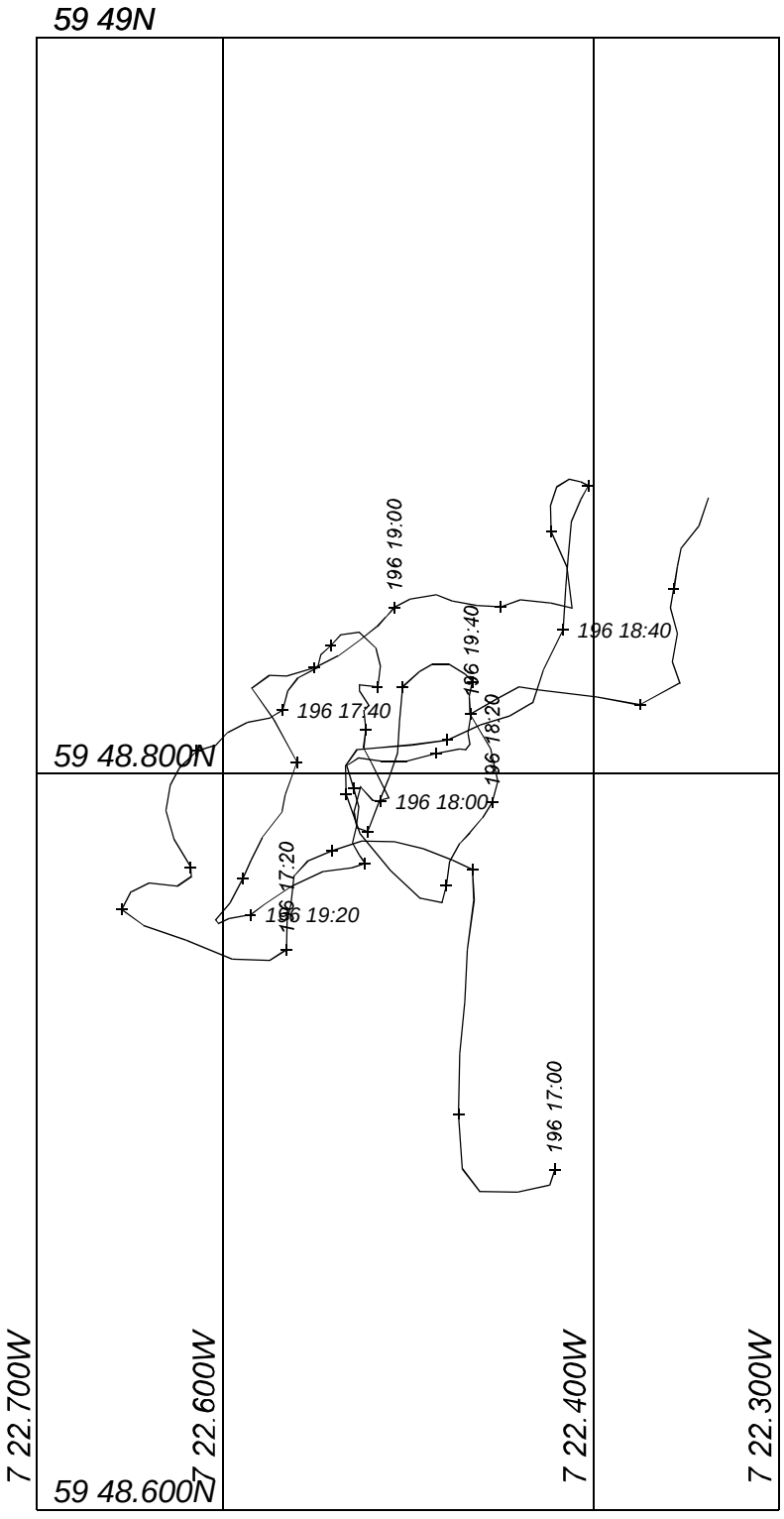

Figure 8. 13823#11 SHRIMP 00 196 17:00:00 - 00 196 19:54:00

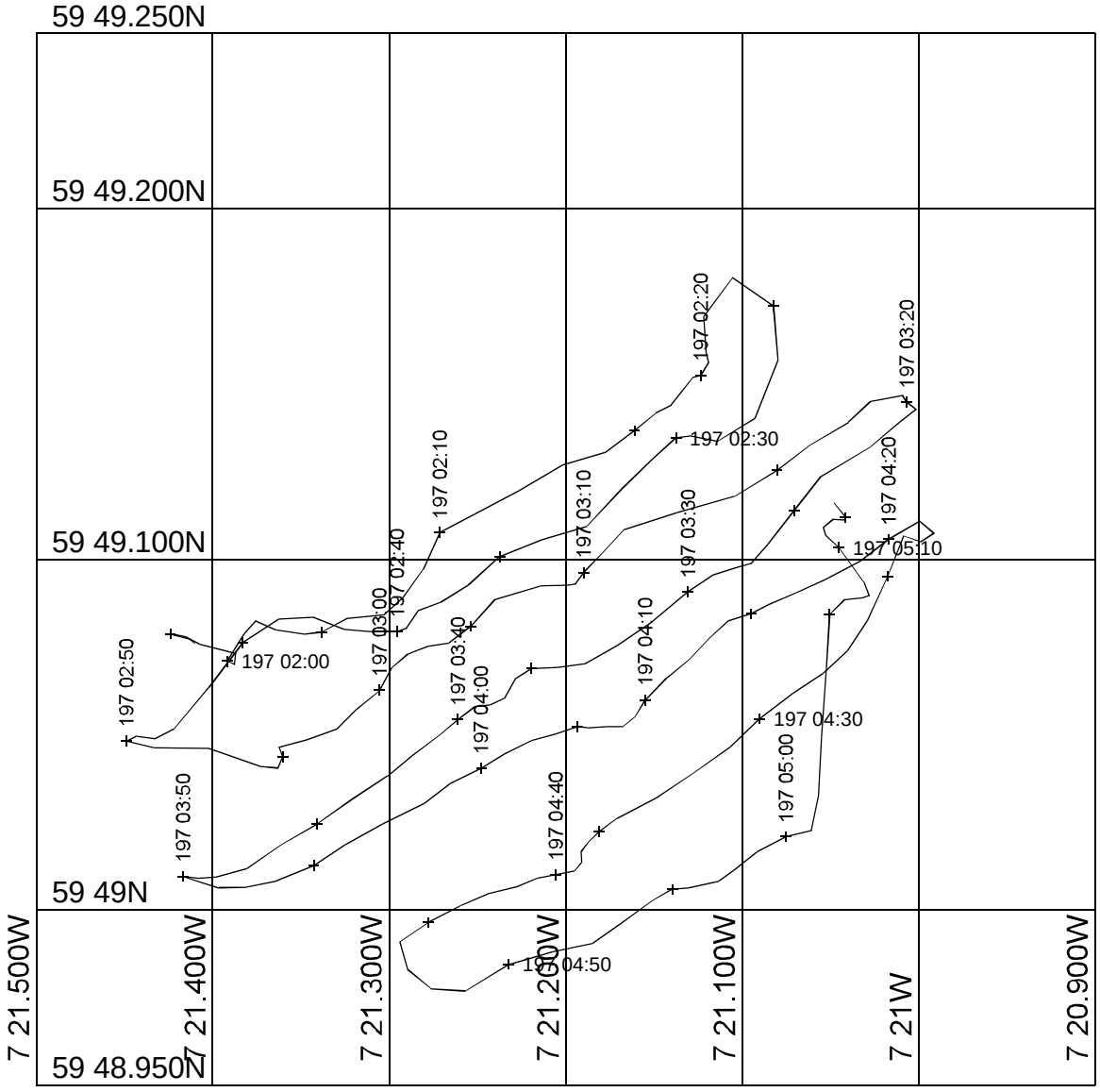

Figure 9. 13824#1 SHRIMP 00 197 01:53:00 - 00 197 05:16:00

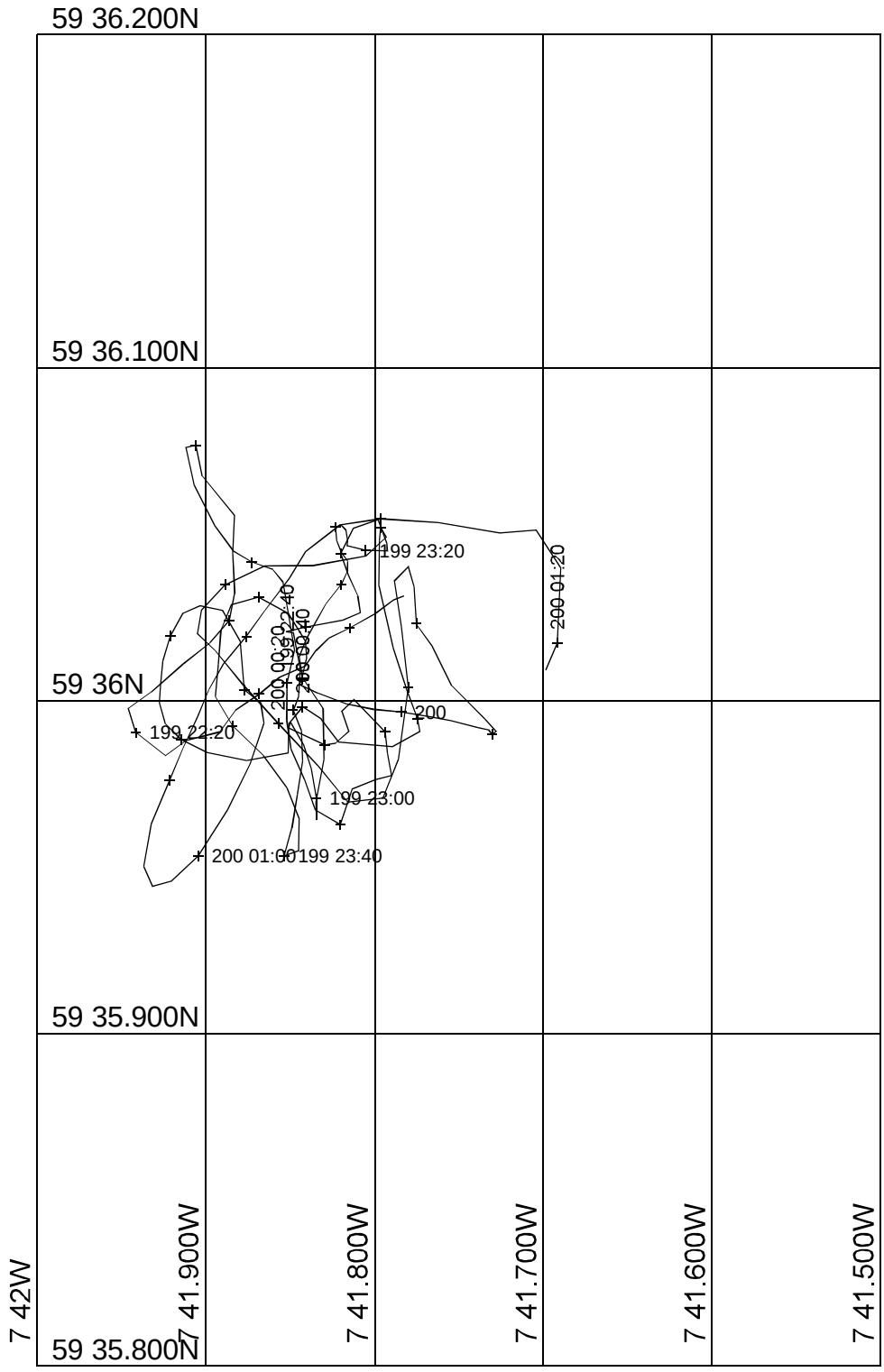

Figure 10. 13835#3 SHRIMP 00 199 22:07:00 - 00 200 01:21:00

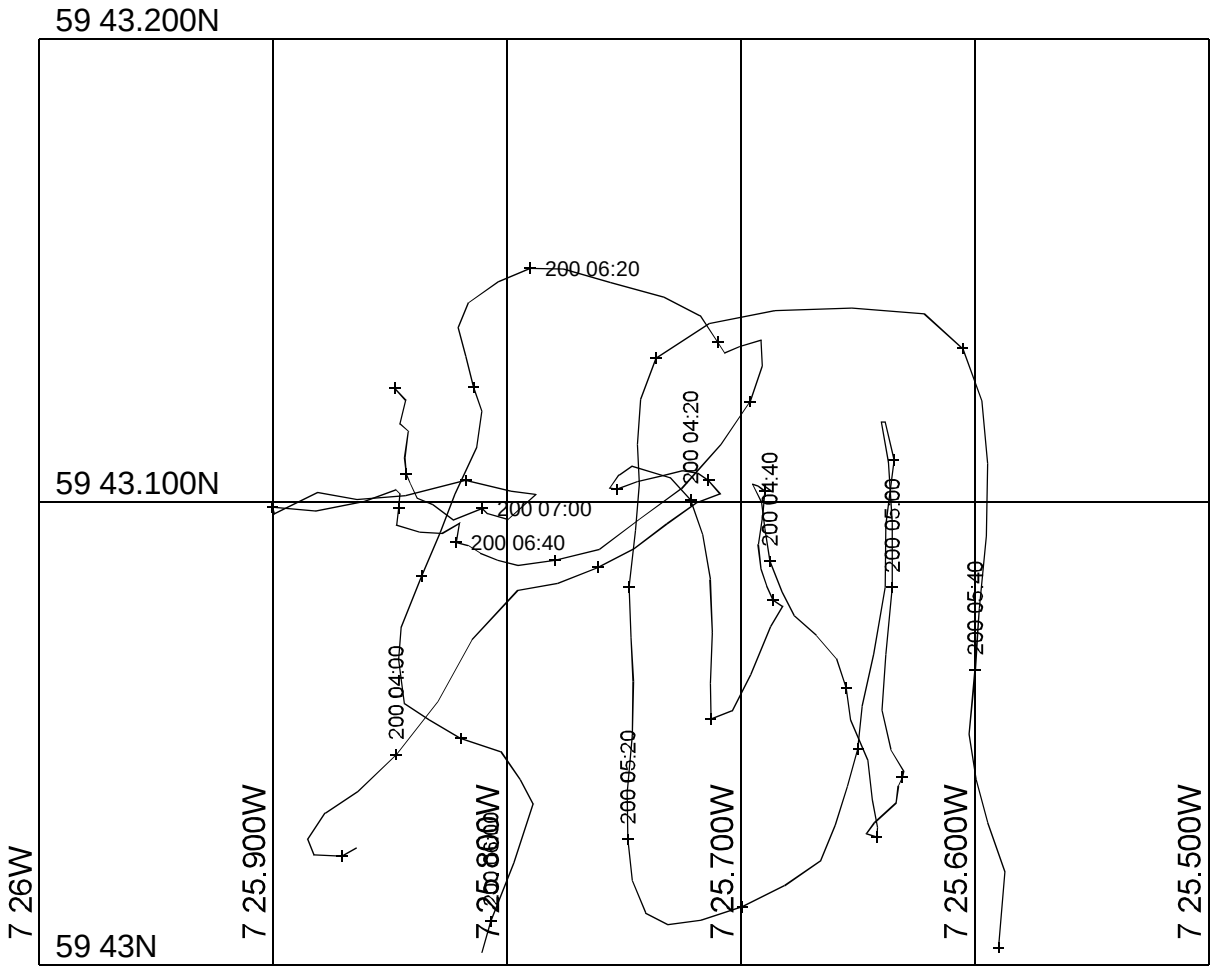

Figure 11. 13836#1 SHRIMP 00 200 03:54:00 - 00 200 07:10:00

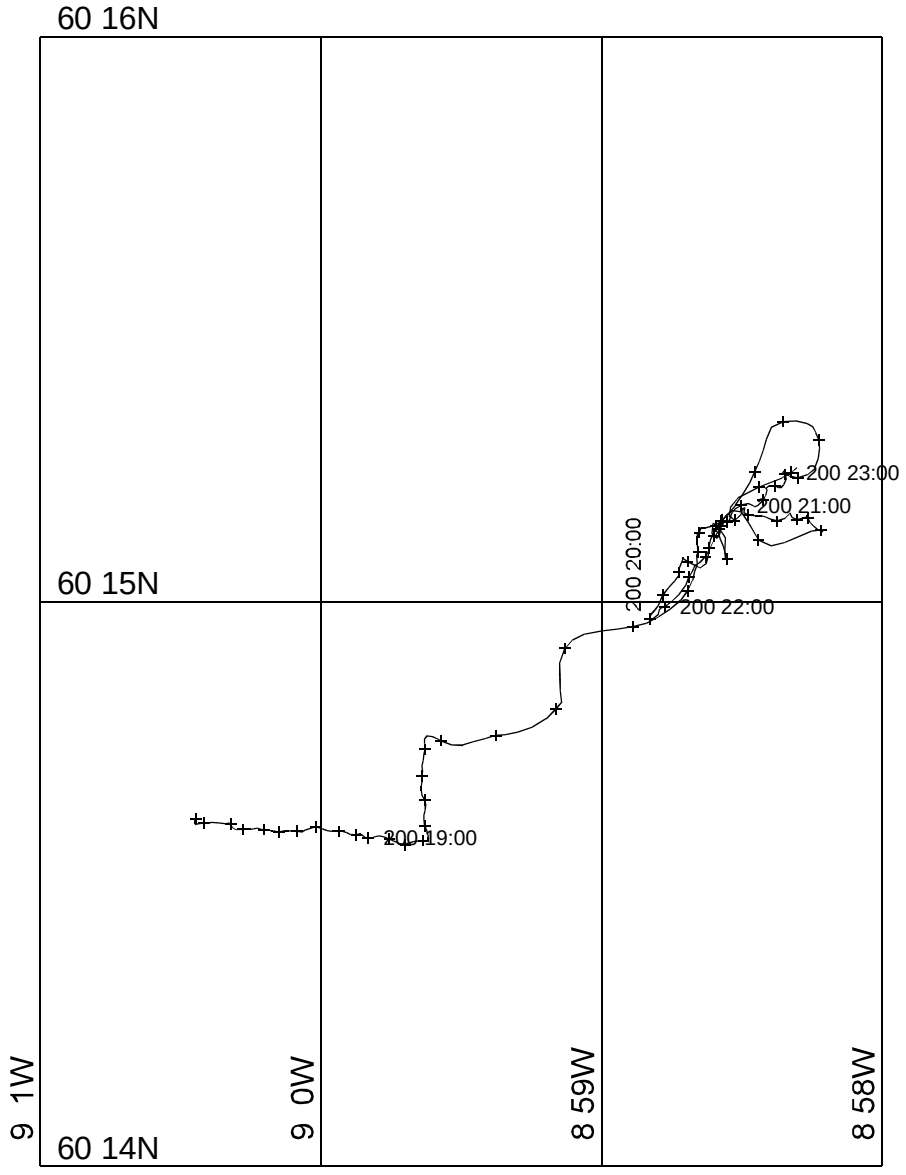

Figure 12. 13837#1 SHRIMP 00 200 18:09:00 - 00 200 23:02:00

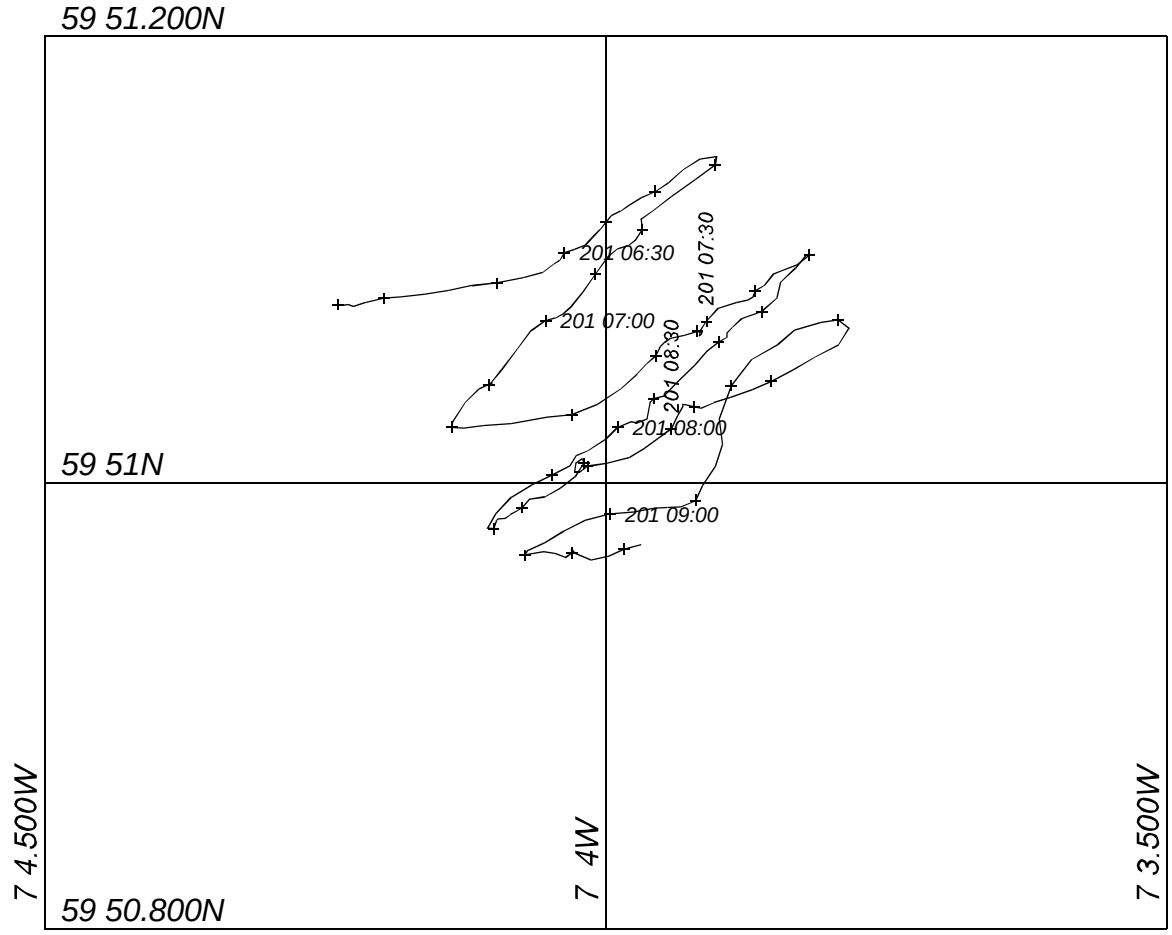

Figure 13. 13838#1 SHRIMP 00 201 06:14:00 - 00 201 09:16:00

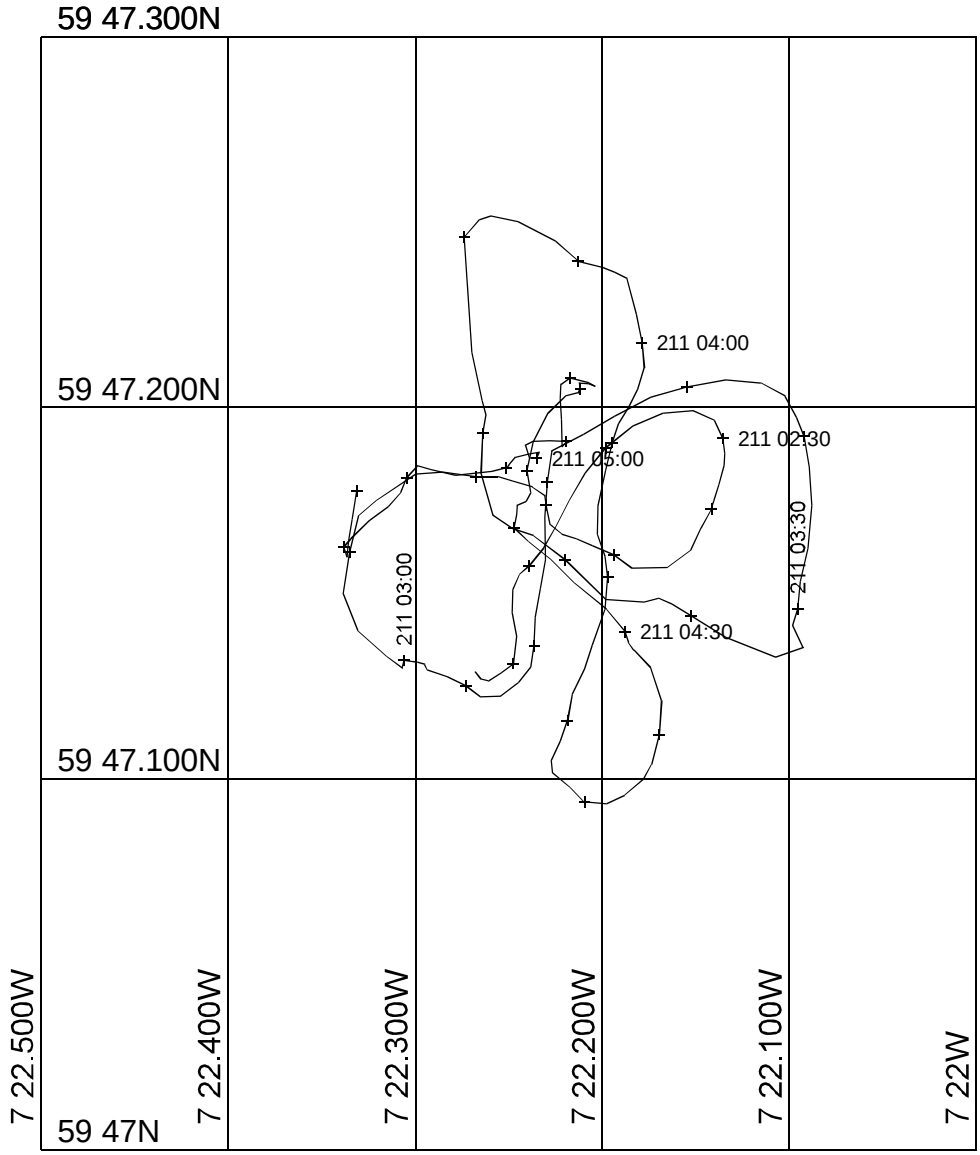

Figure 14. 13863#1 SHRIMP 00 211 02:11:00 - 00 211 05:20:00

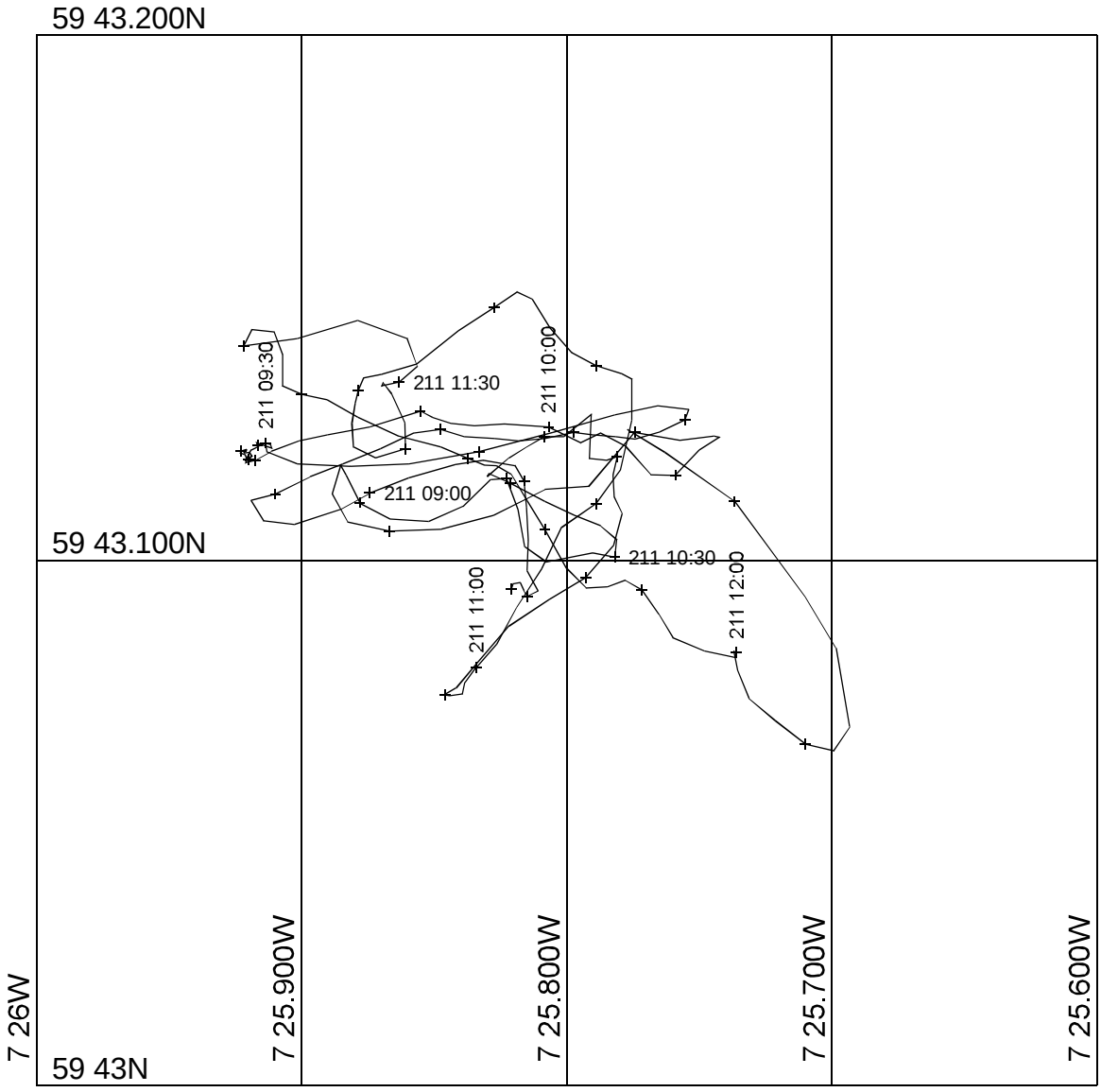

Figure 15. 13864#1 SHRIMP 00 211 08:45:00 - 00 211 12:12:00

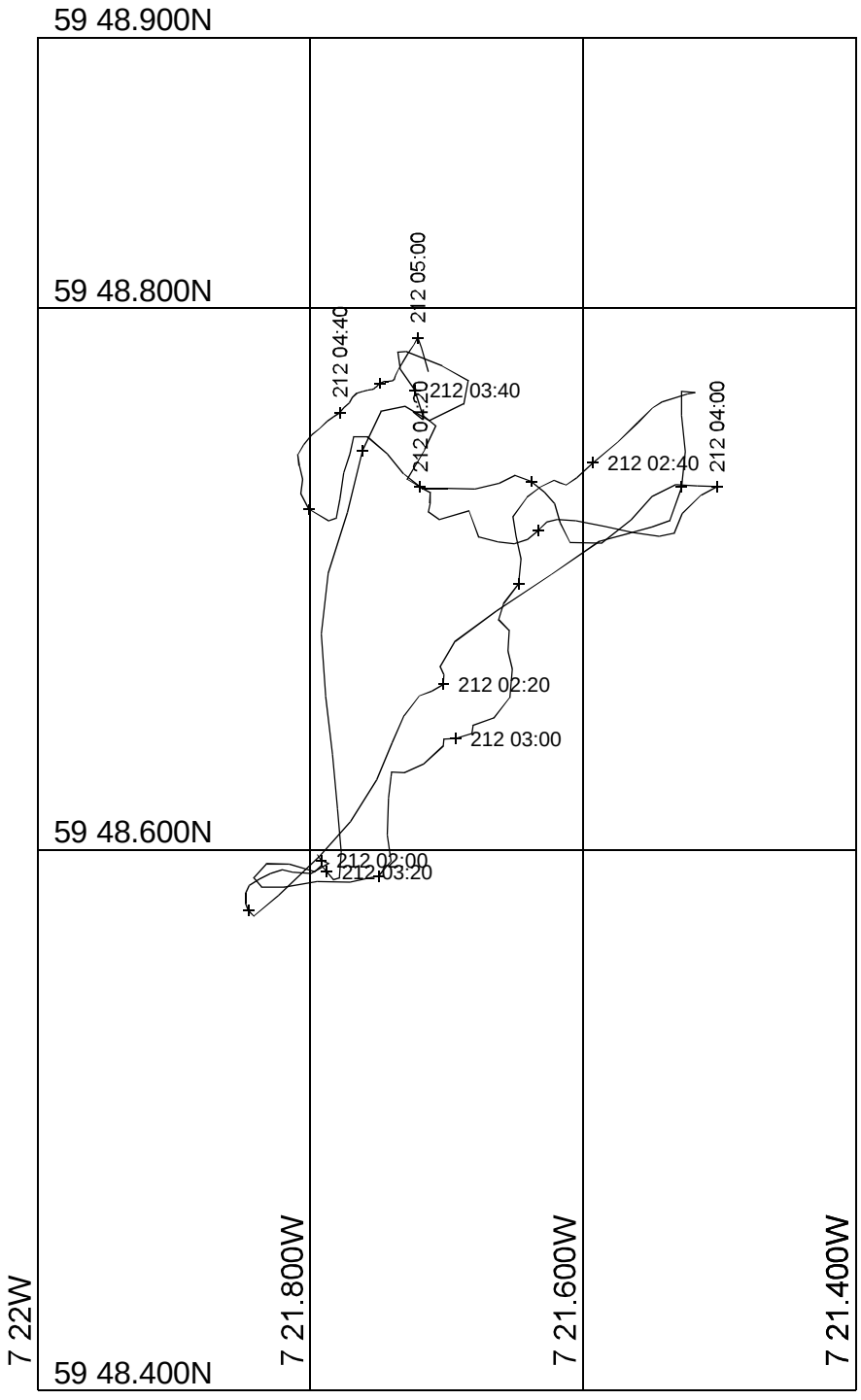

Figure 16. 13866#1 SHRIMP 00 212 01:59:00 - 00 212 05:02:00

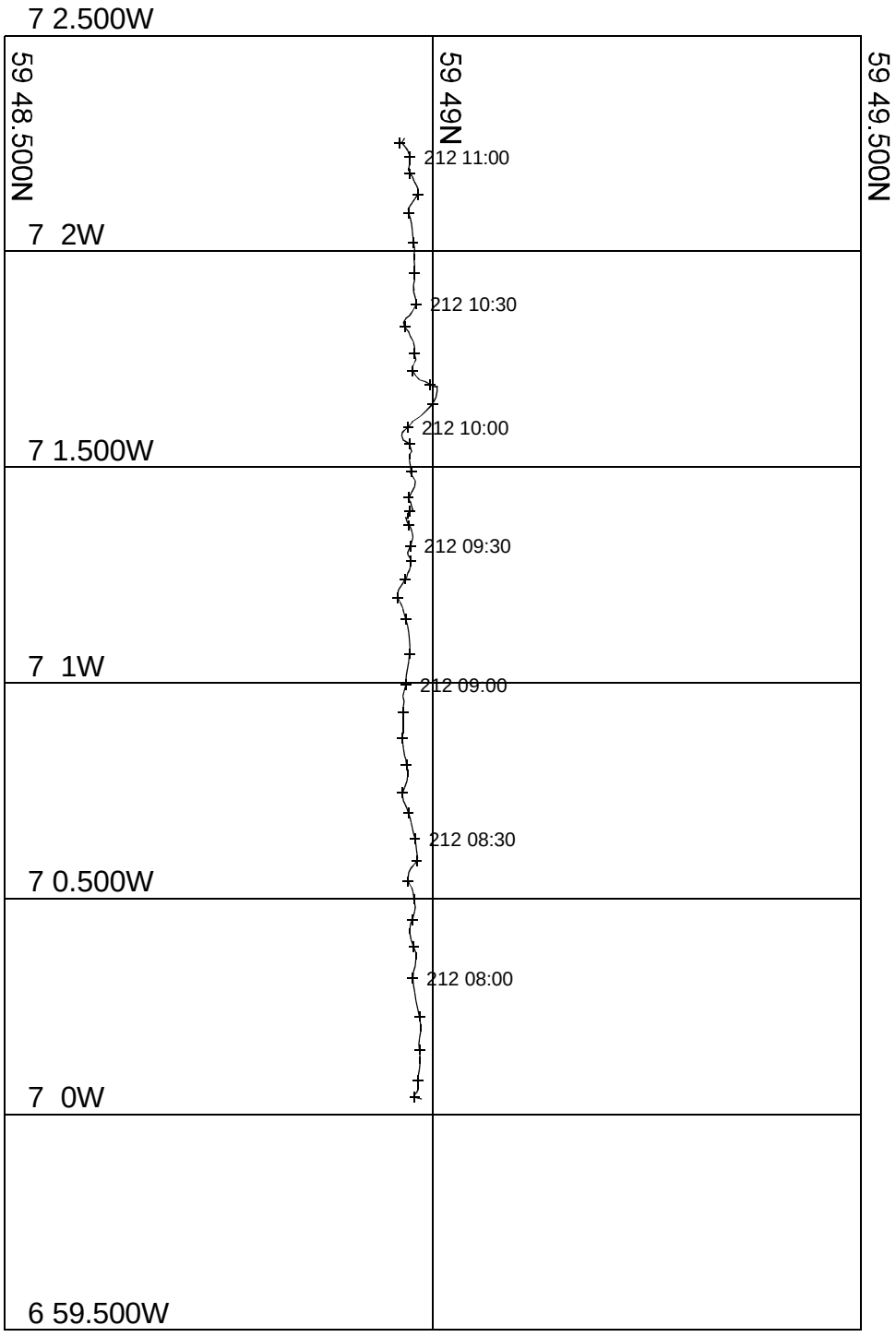

Figure 17. 13867#1 SHRIMP 00 212 07:38:00 - 00 212 11:08:00

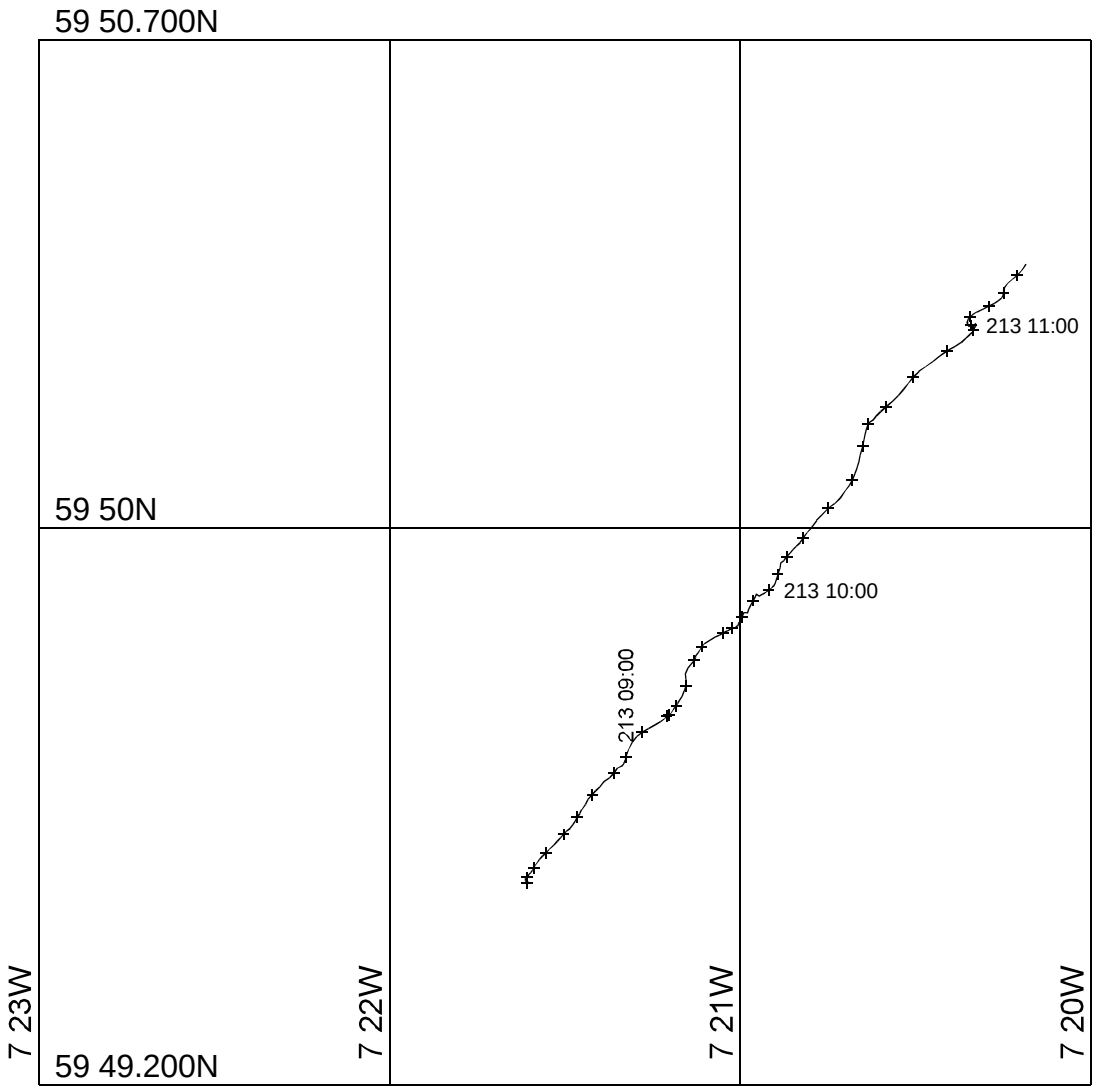

Figure 18. 13870#1 SHRIMP 00 213 08:18:00 - 00 213 11:23:00

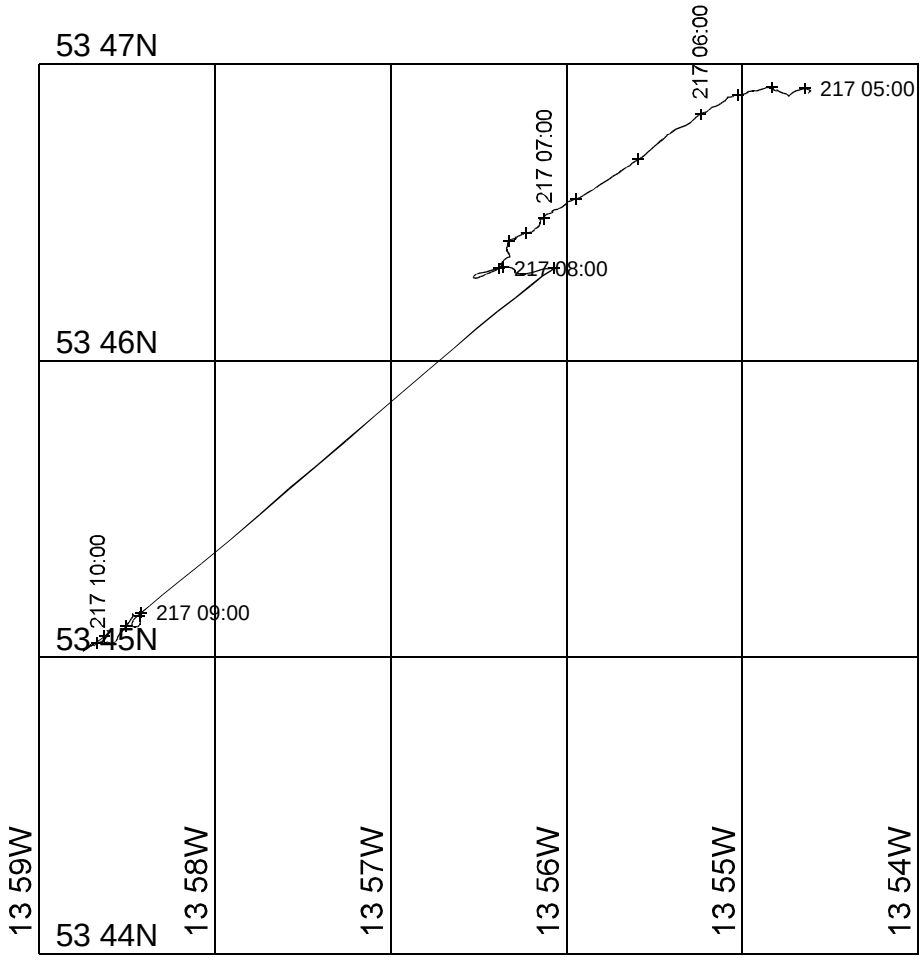

Figure 19. 13872#1 SHRIMP 00 217 04:42:00 - 00 217 10:29:00

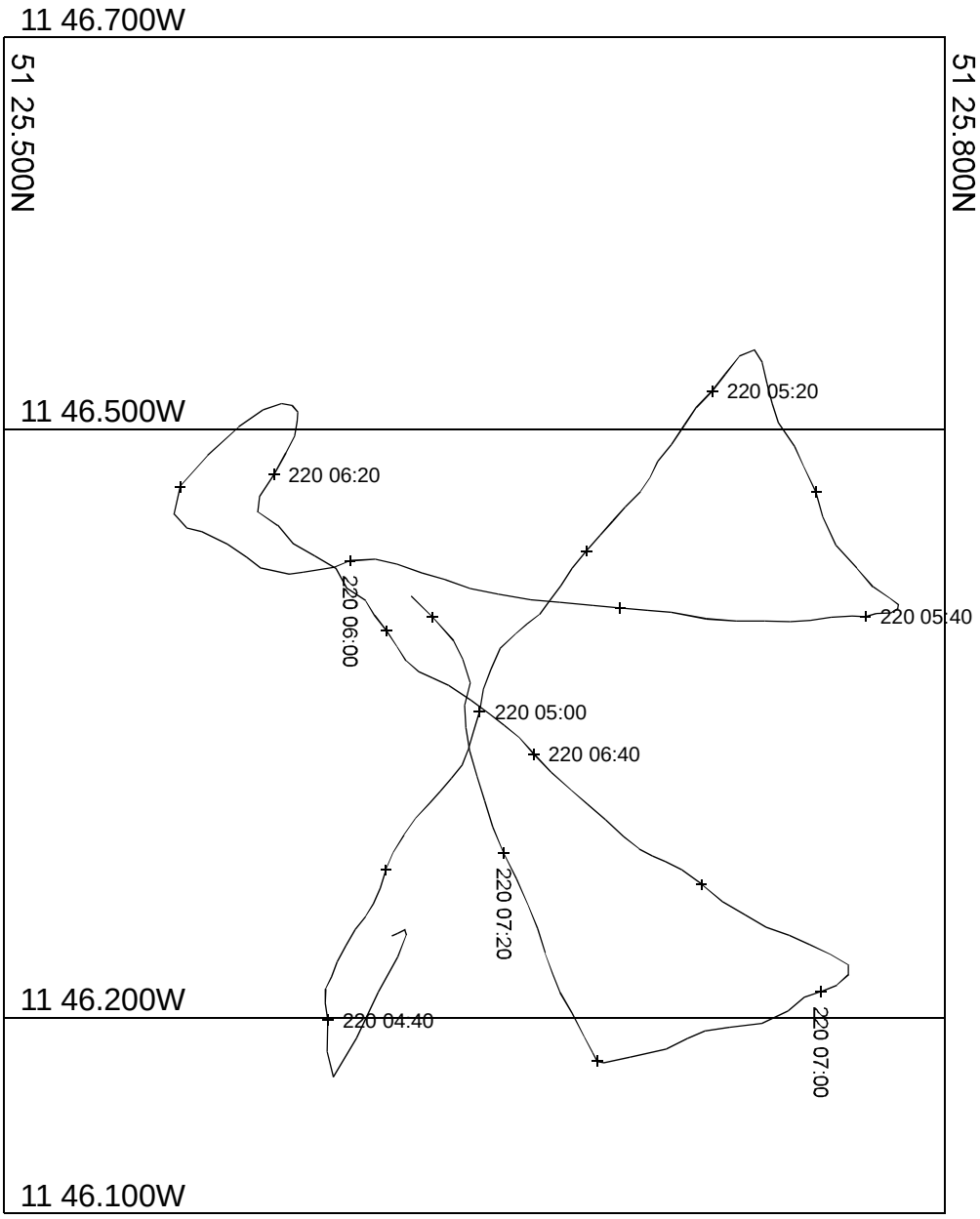

Figure 20. 13876#1 SHRIMP 00 220 04:31:00 - 00 220 07:31:00

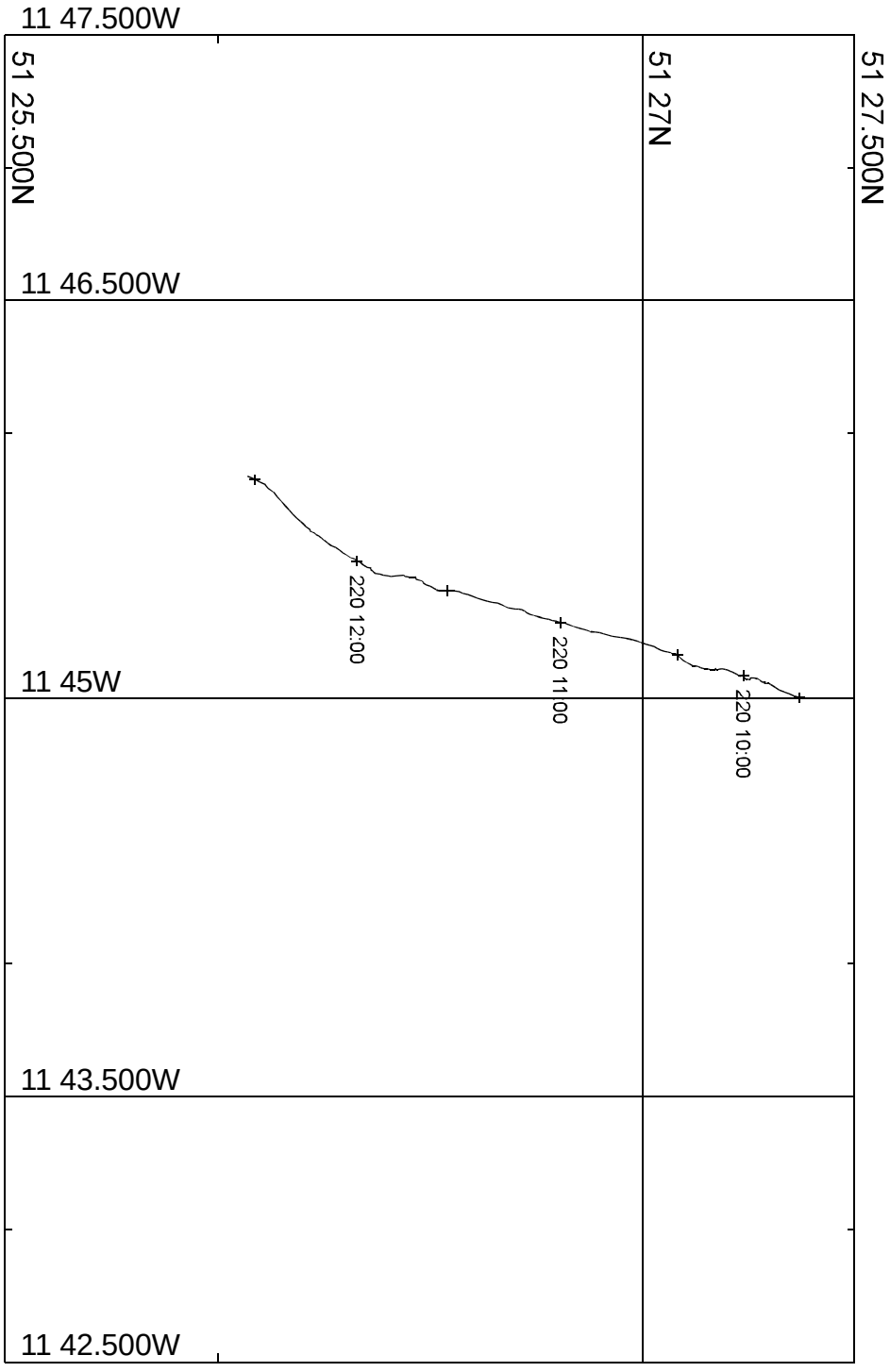

Figure 21. 13877#1 SHRIMP 00 220 09:28:00 - 00 220 12:31:00

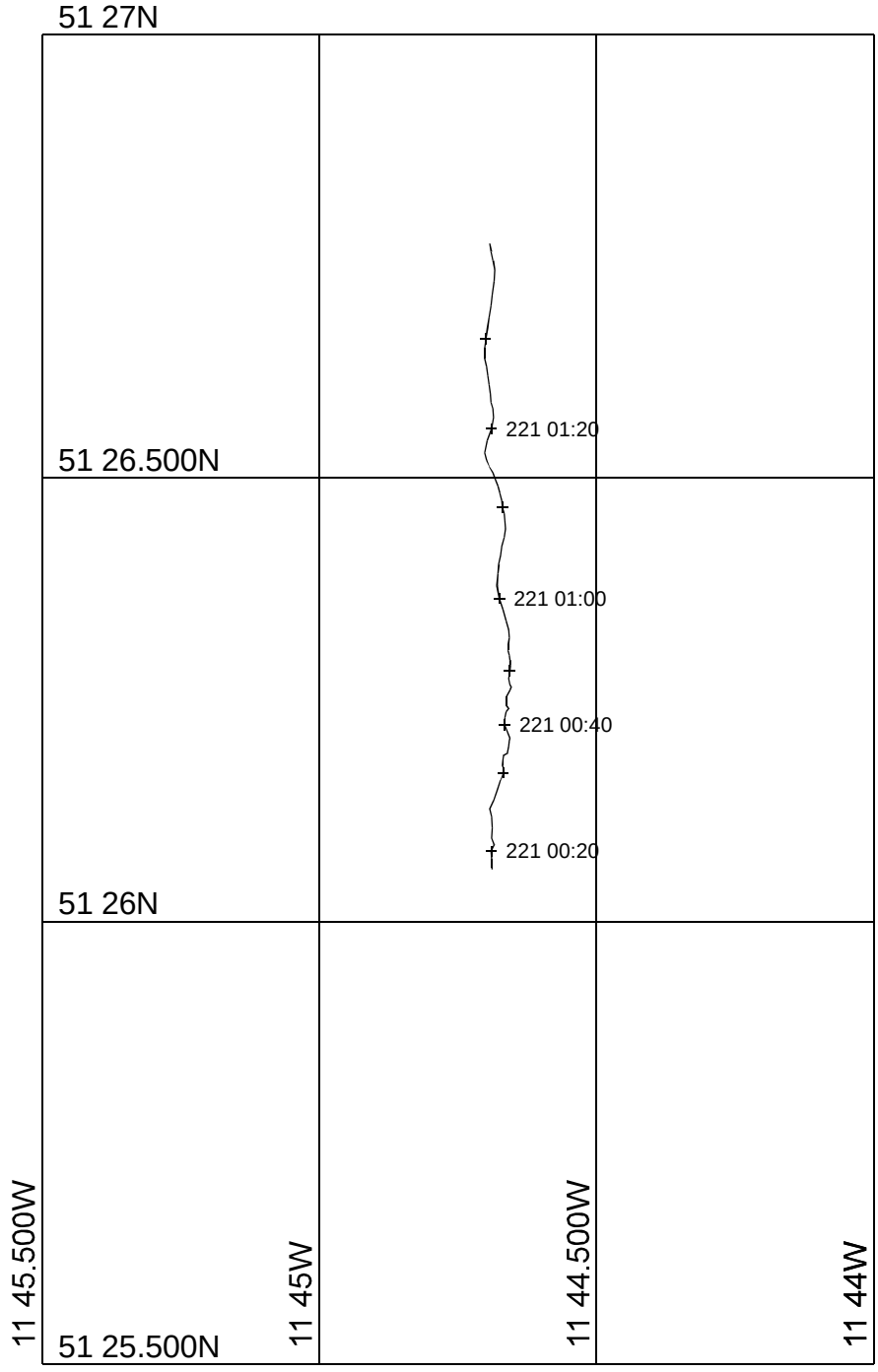

Figure 22. 13879#1 SHRIMP 00 221 00:17:00 - 00 221 01:39:00

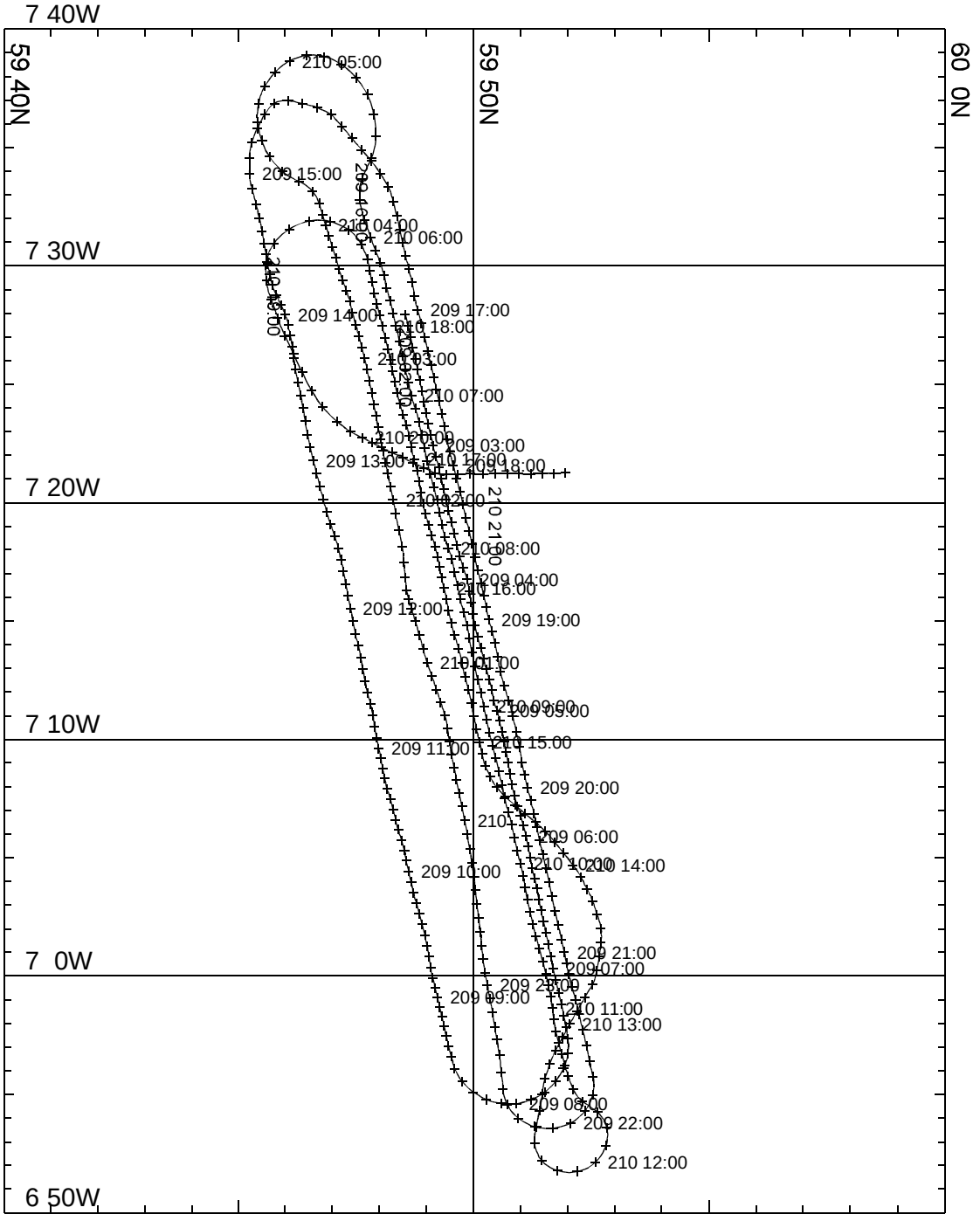

Figure 23. 13862#1 GA100/410 00 209 01:59:00 - 00 210 21:30:00

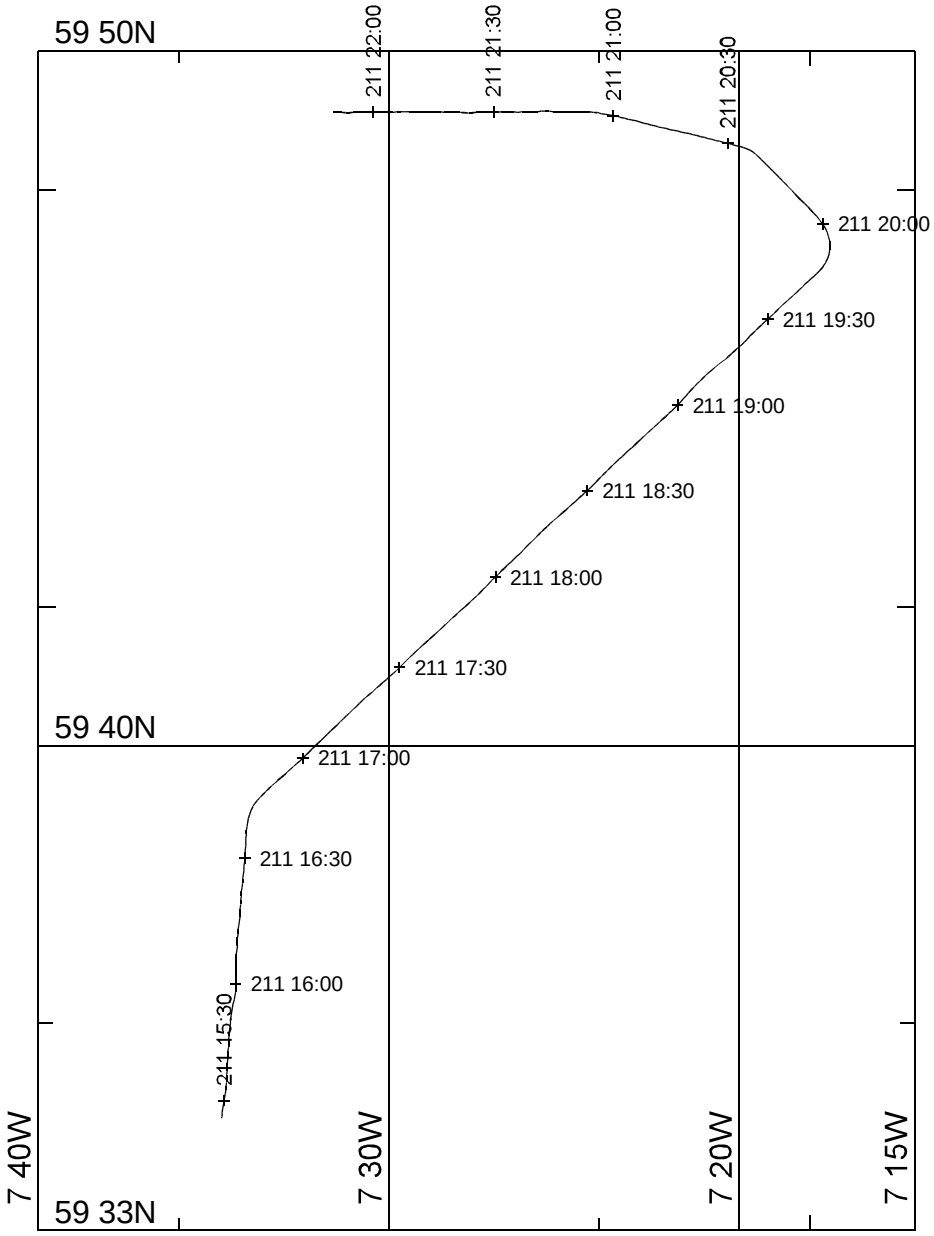

Figure 24. 13865#1 GA100/410 00 211 15:25:00 - 00 211 22:10:00

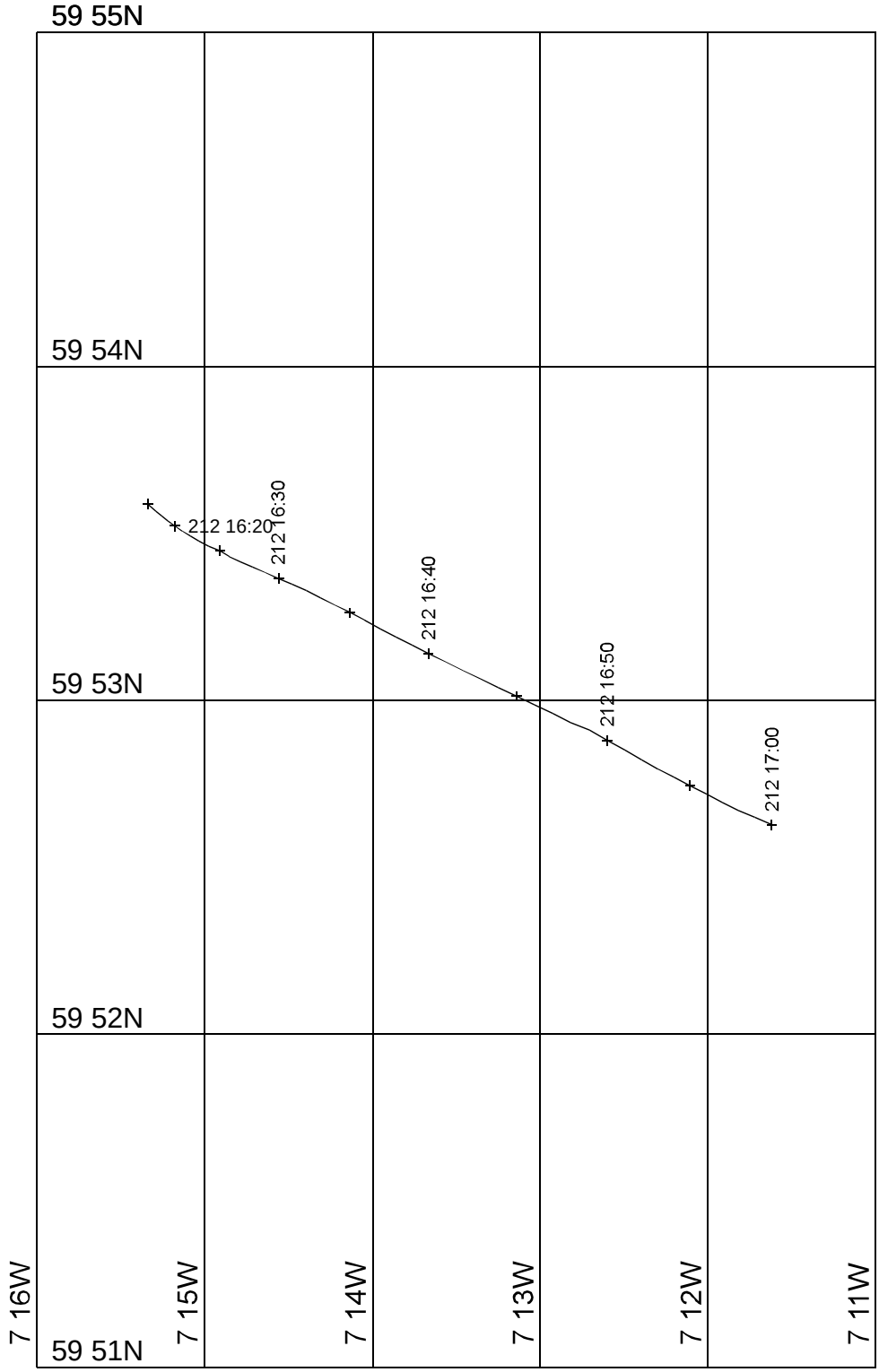

Figure 25. 13869#1 GA100/410 00 212 16:15:00 - 00 212 17:00:00

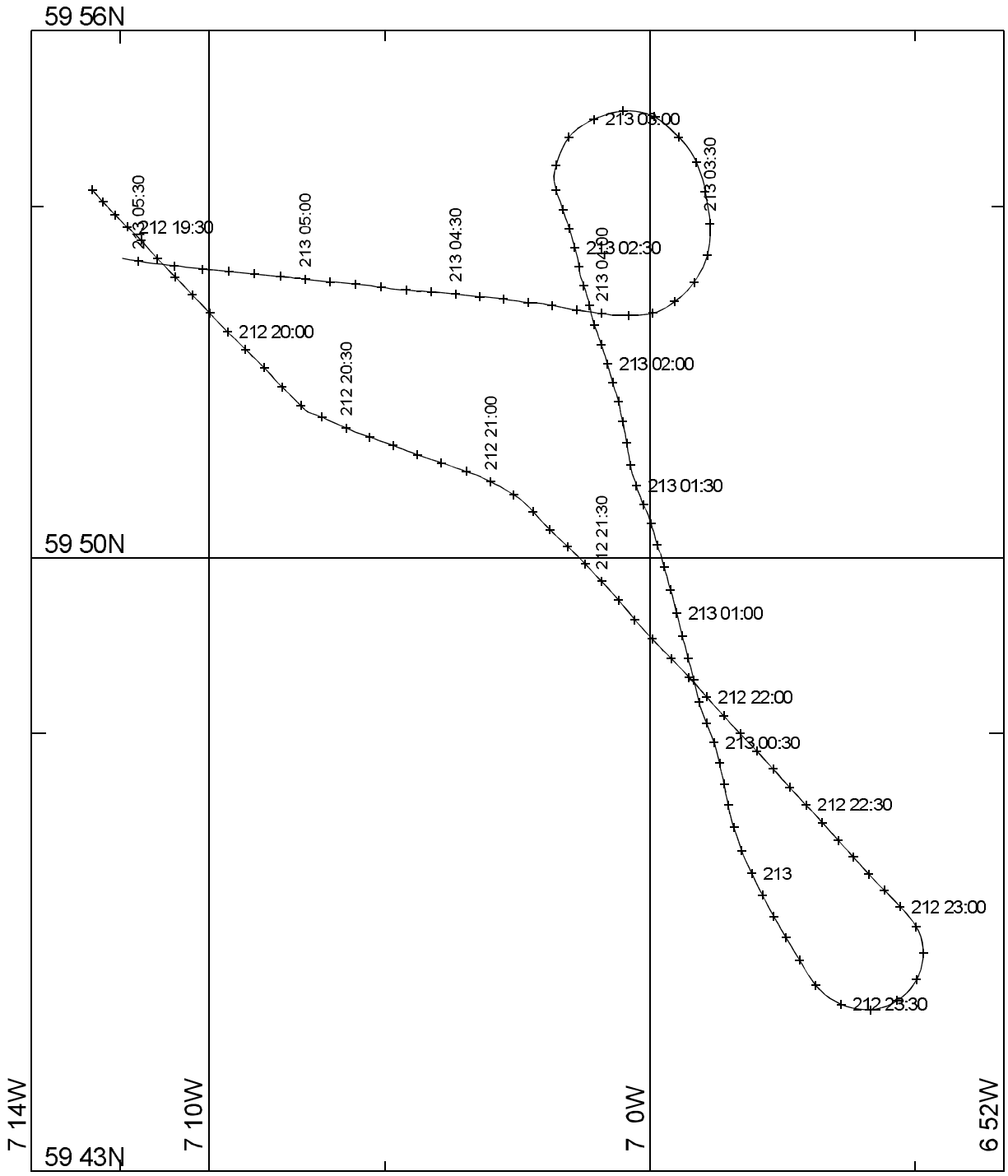

Figure 26. 13869#2 GA100/410 00 212 19:15:00 - 00 213 05:32:00

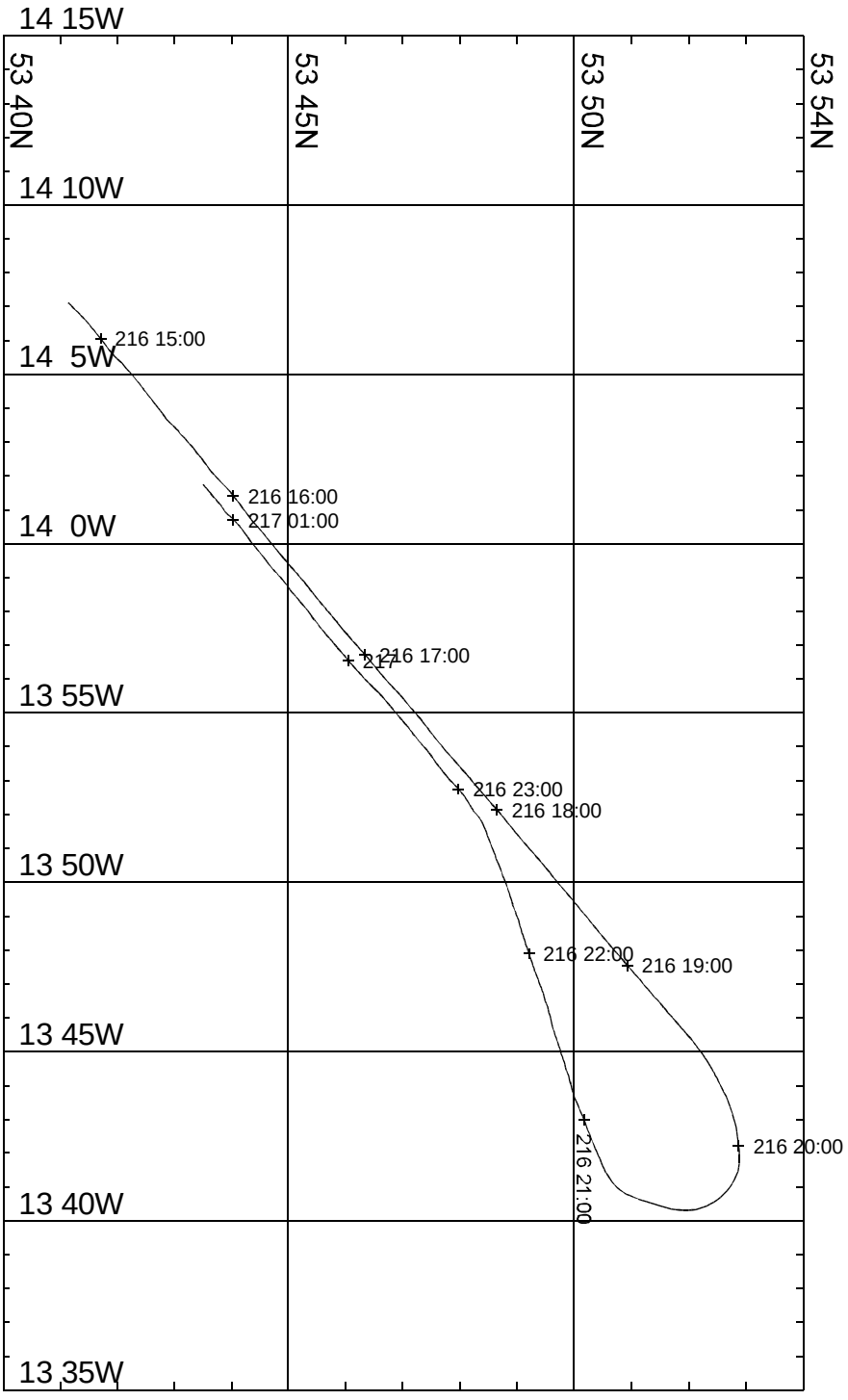

Figure 27. 13871#1 GA100/410 00 216 14:45:00 - 00 217 01:20:00

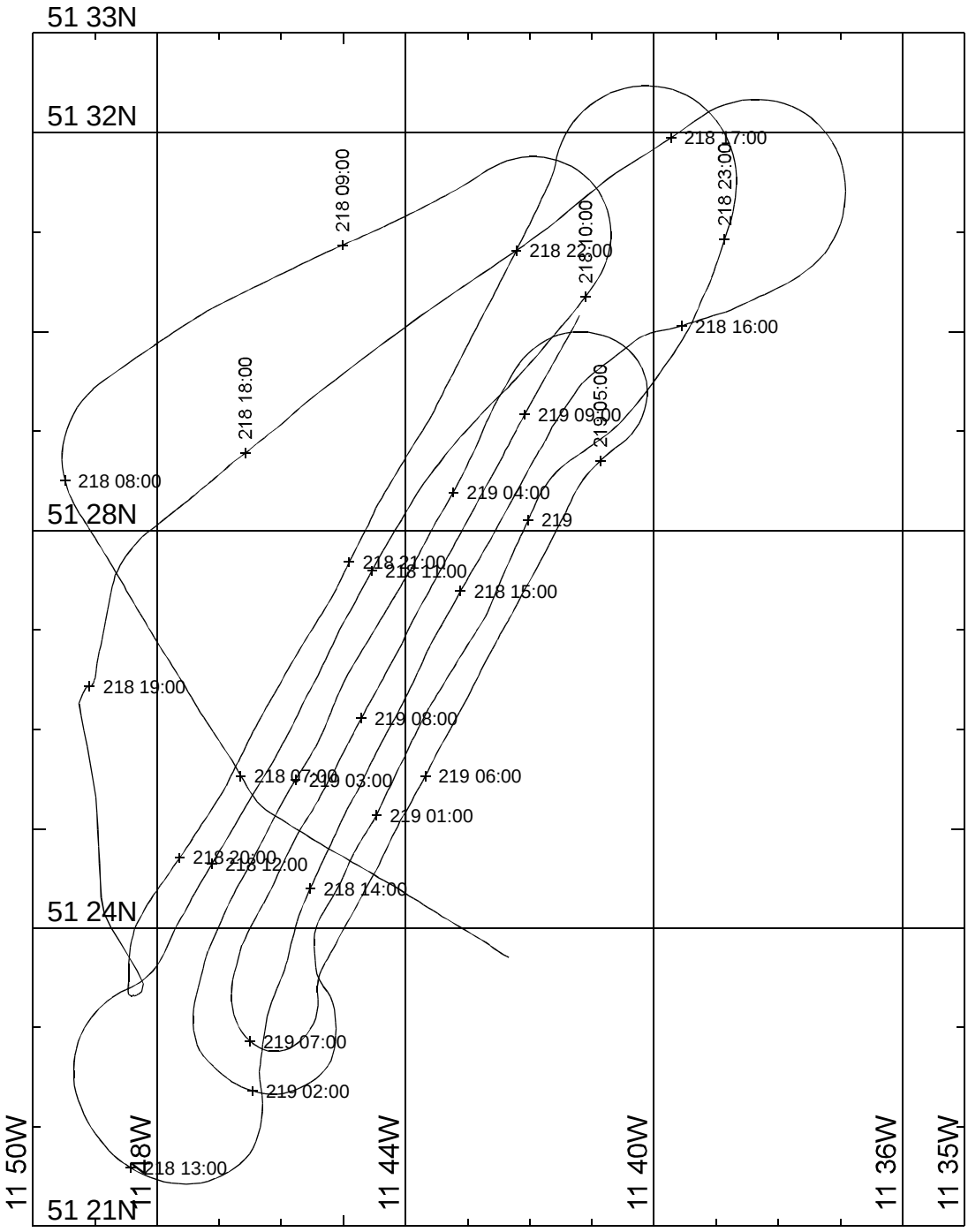

Figure 28. 13873#1 GA100/410 00 218 06:03:00 - 00 219 09:20:00

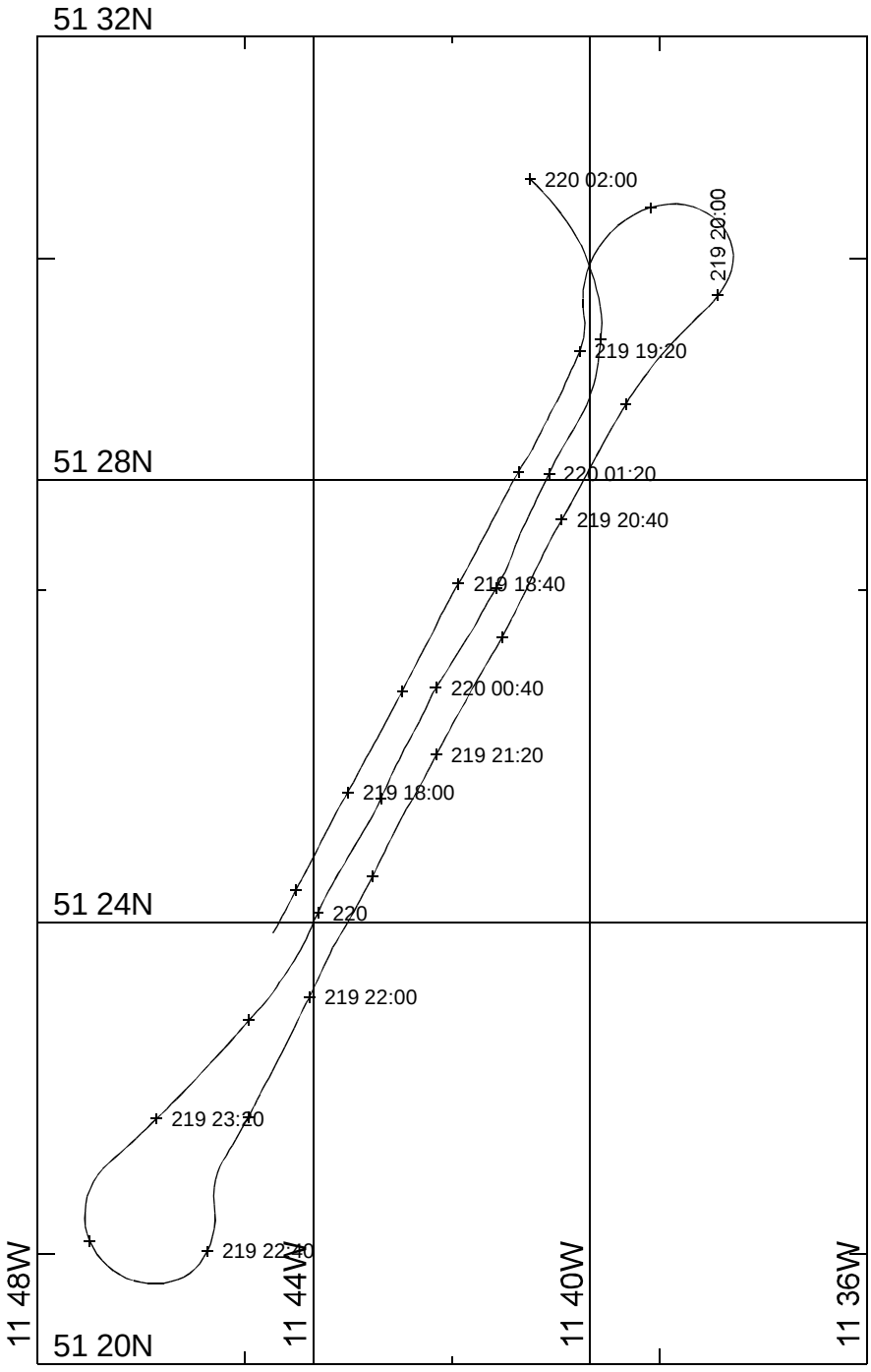

Figure 29. 13875#1 GA100/410 00 219 17:31:00 - 00 220 02:00:00

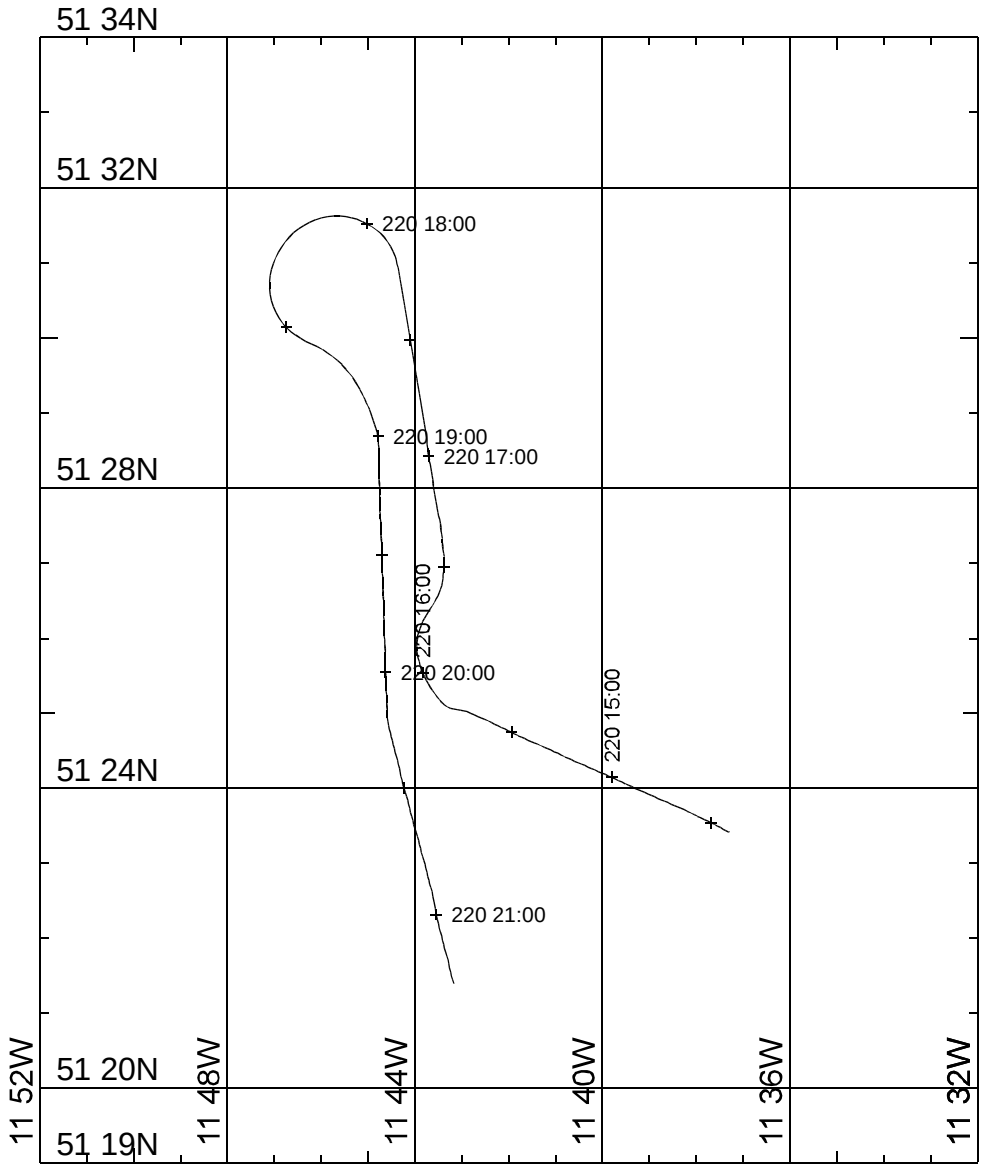

Figure 30. 13878#1 GA100/410 00 220 14:23:00 - 00 220 21:17:00

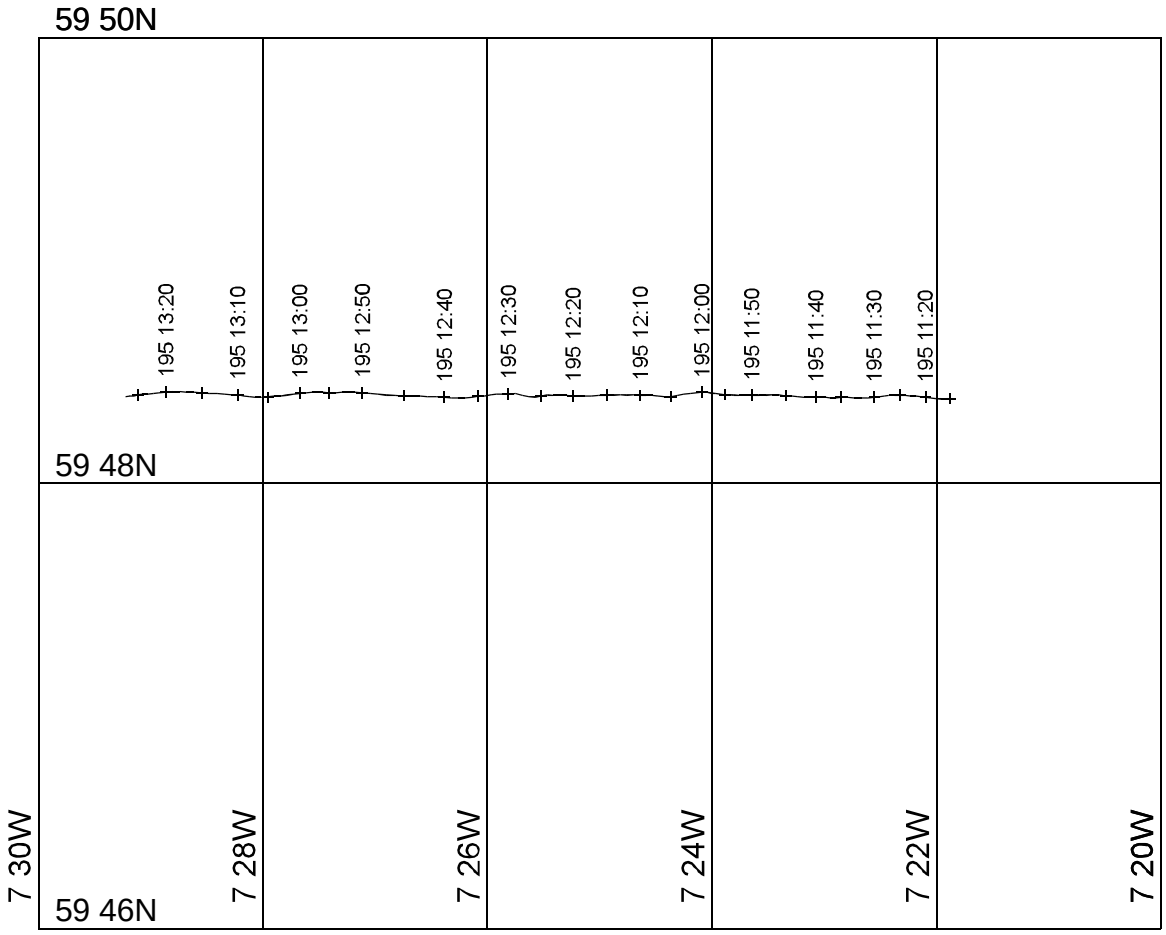

Figure 31. 13823#6 AGASSIZ 00 195 11:15:00 - 00 195 13:28:00

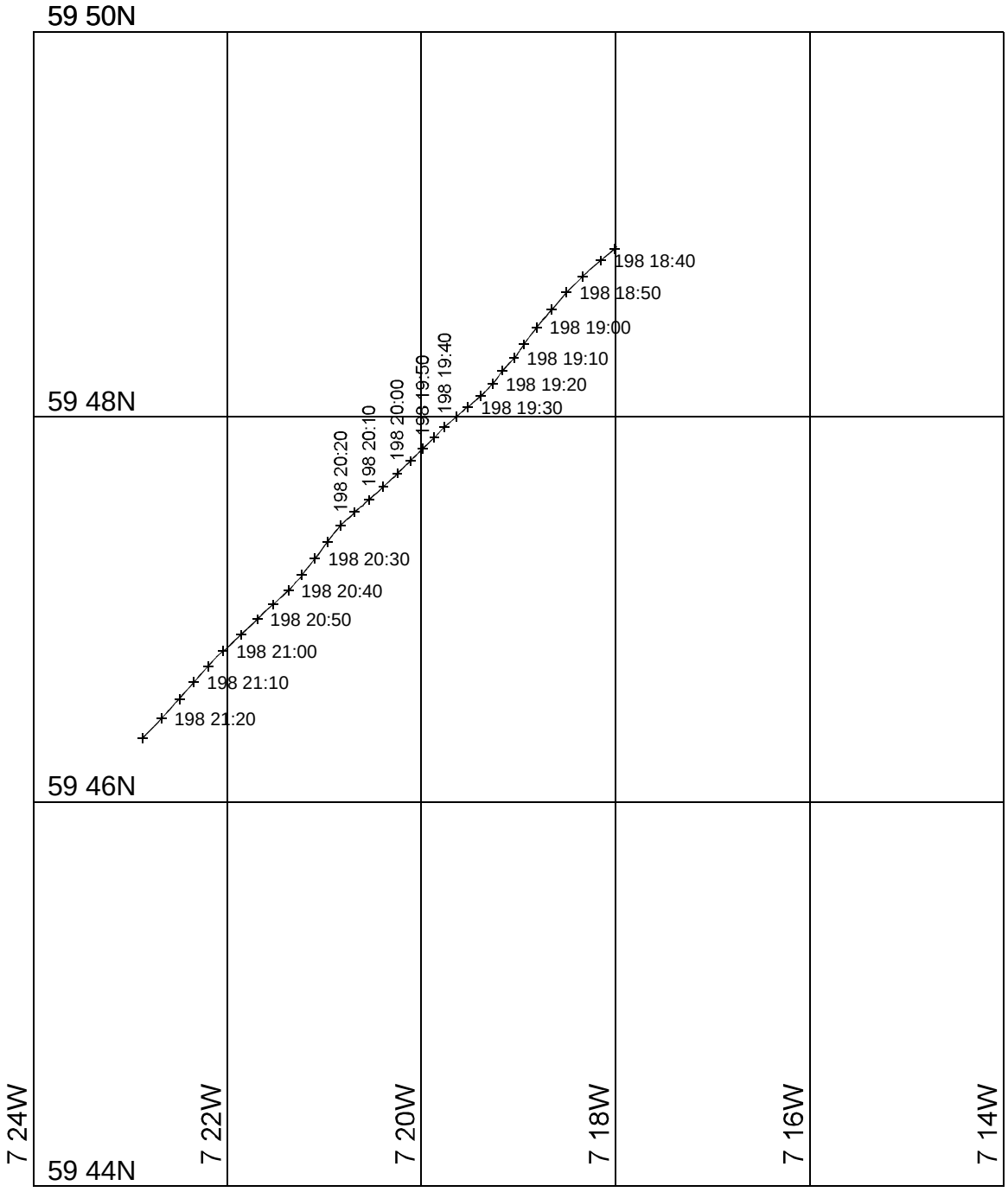

Figure 32. 13831#1 AGASSIZ 00 198 18:33:00 - 00 198 21:25:00

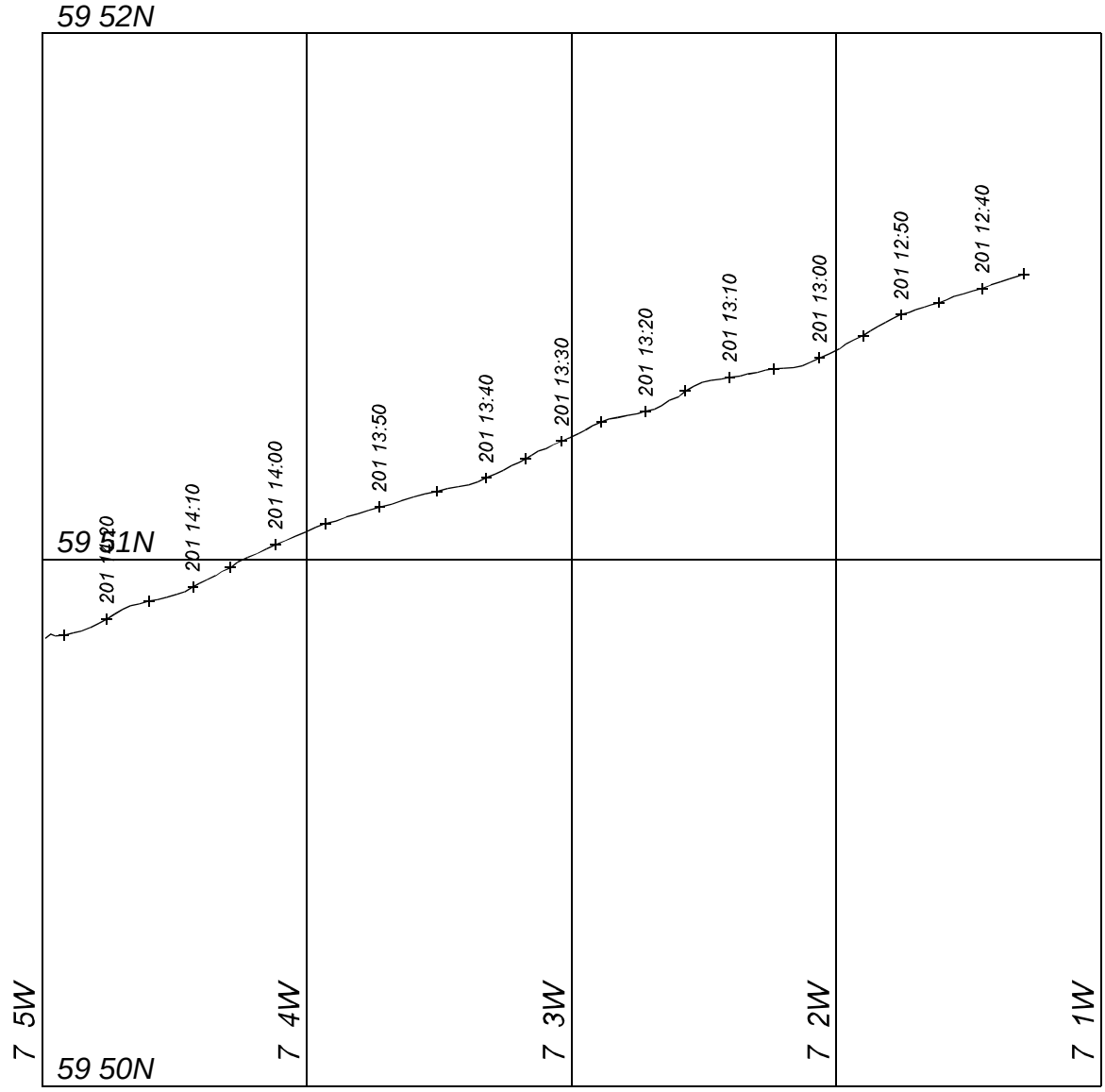

Figure 33. 13838#2 AGASSIZ 00 201 12:35:00 - 00 201 14:40:00

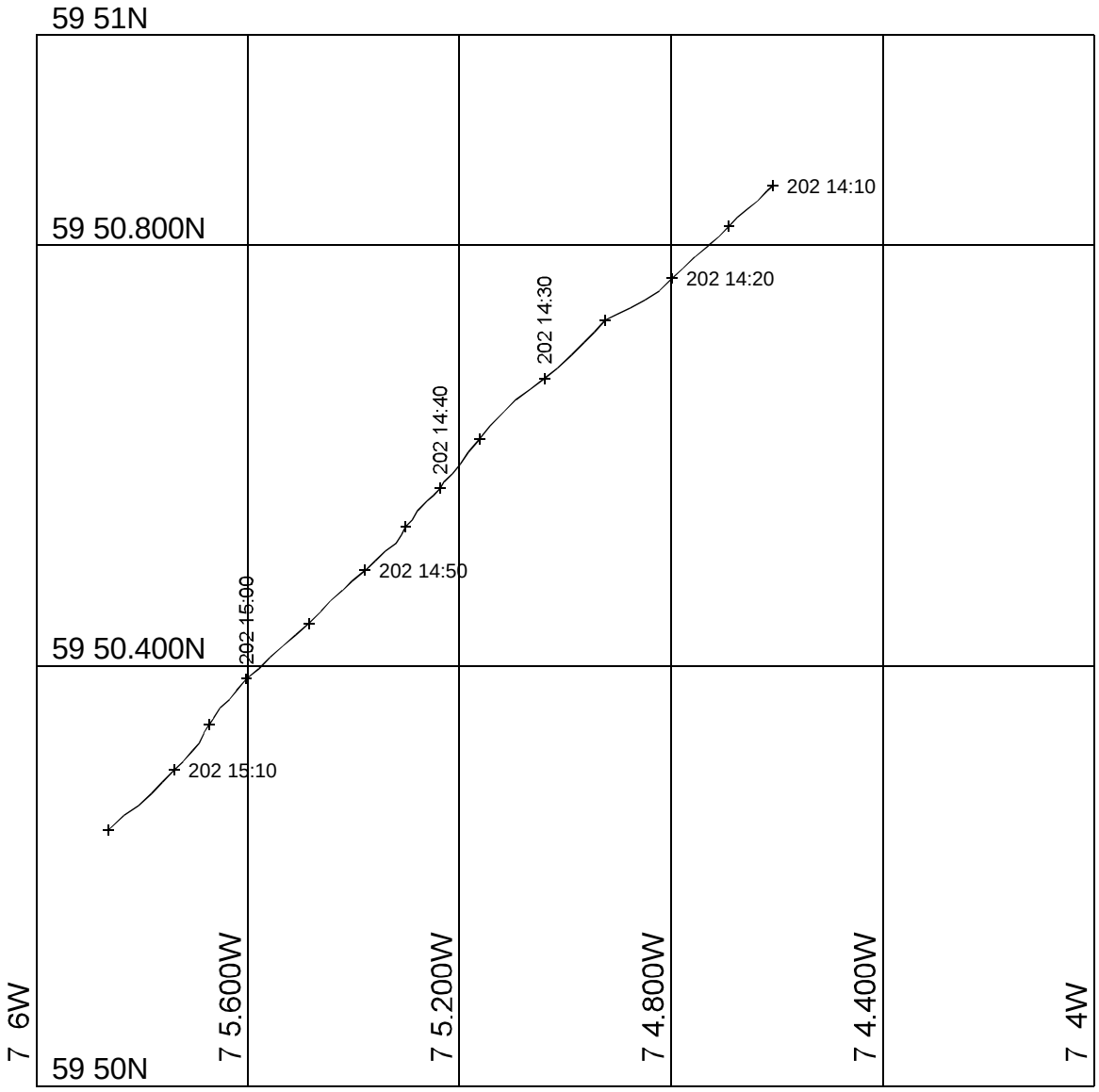

Figure 34. 13843#1 AGASSIZ 00 202 14:10:00 - 00 202 15:15:00

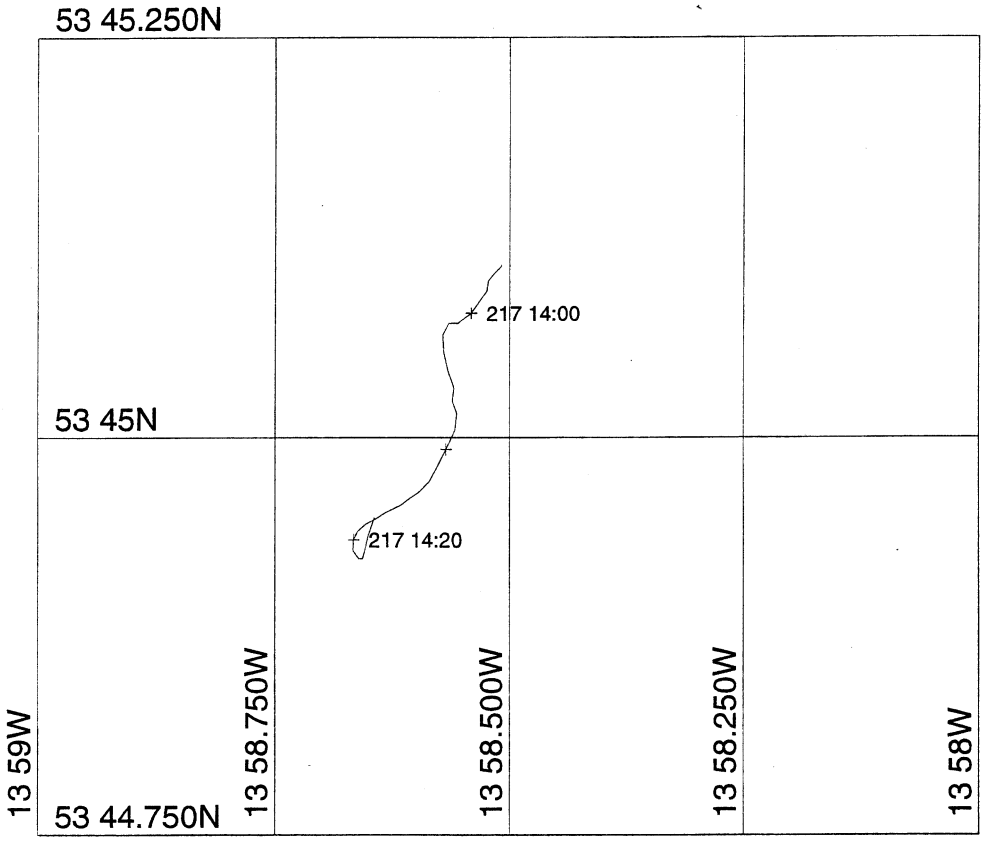

Figure 35. 13872#2 DREDGE 00 217 13:54:00 - 00 217 14:26:00

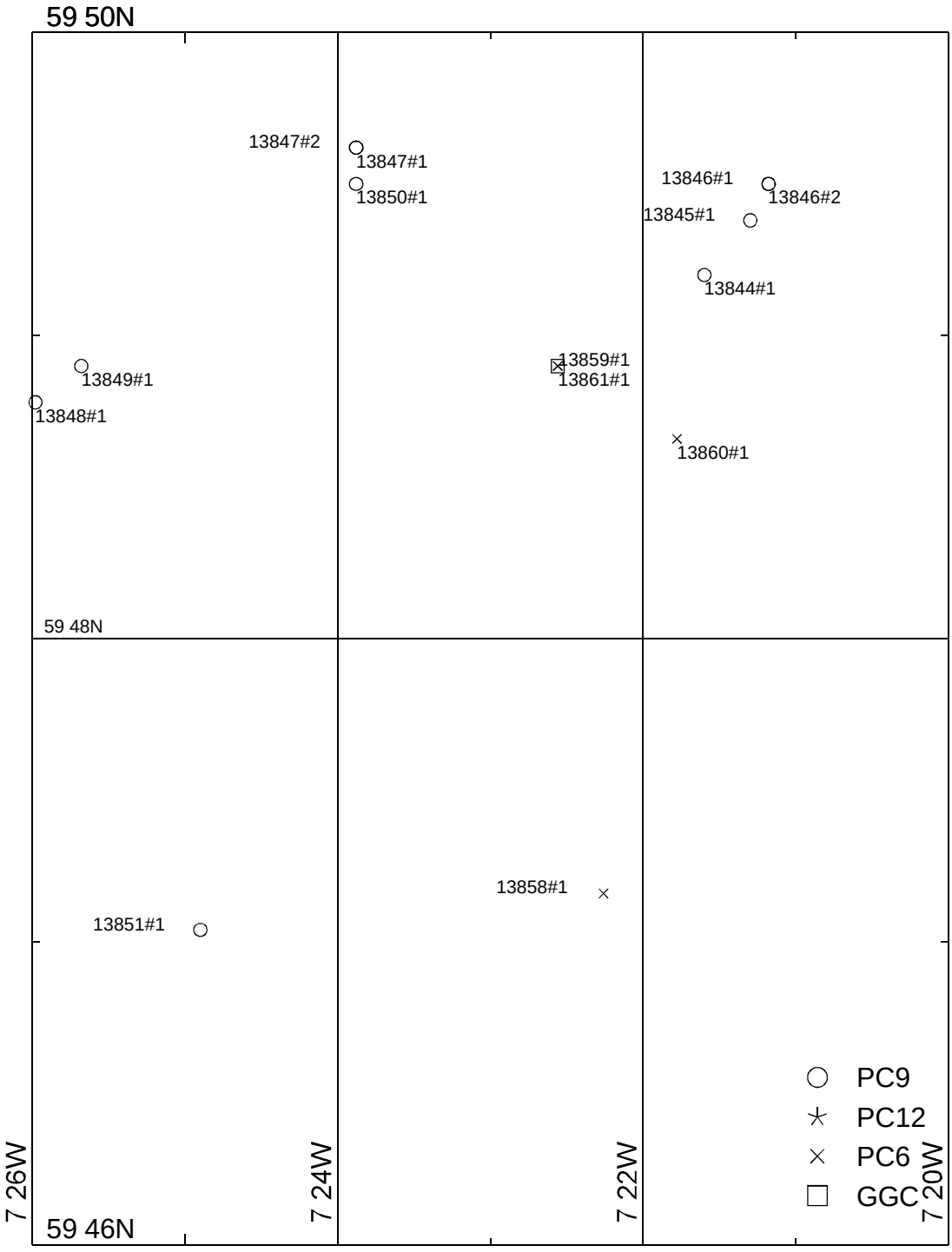

Figure 36. D248 PISTON CORES WORK AREA A

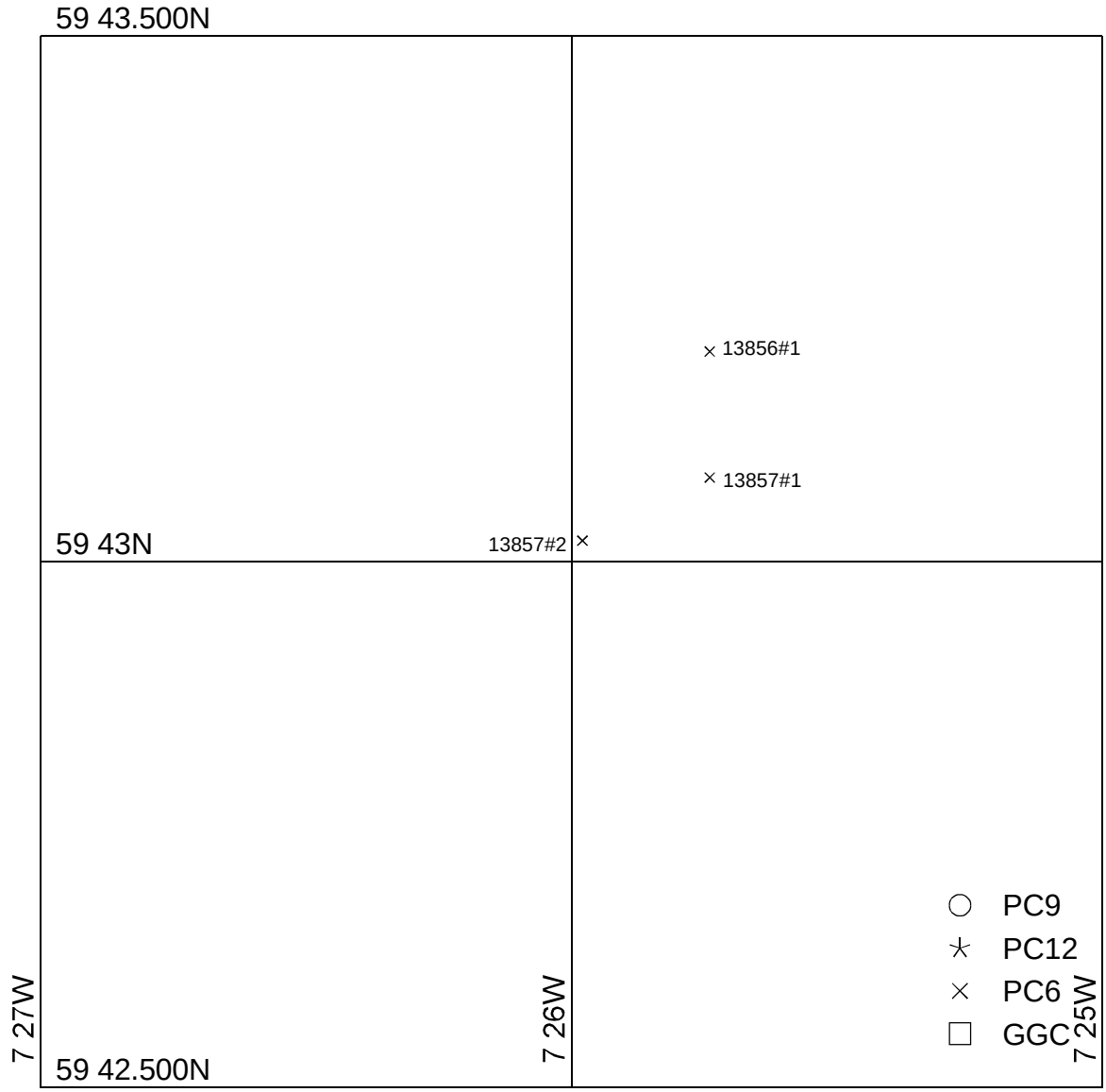

Figure 37. D248 PISTON CORES WORK AREA B

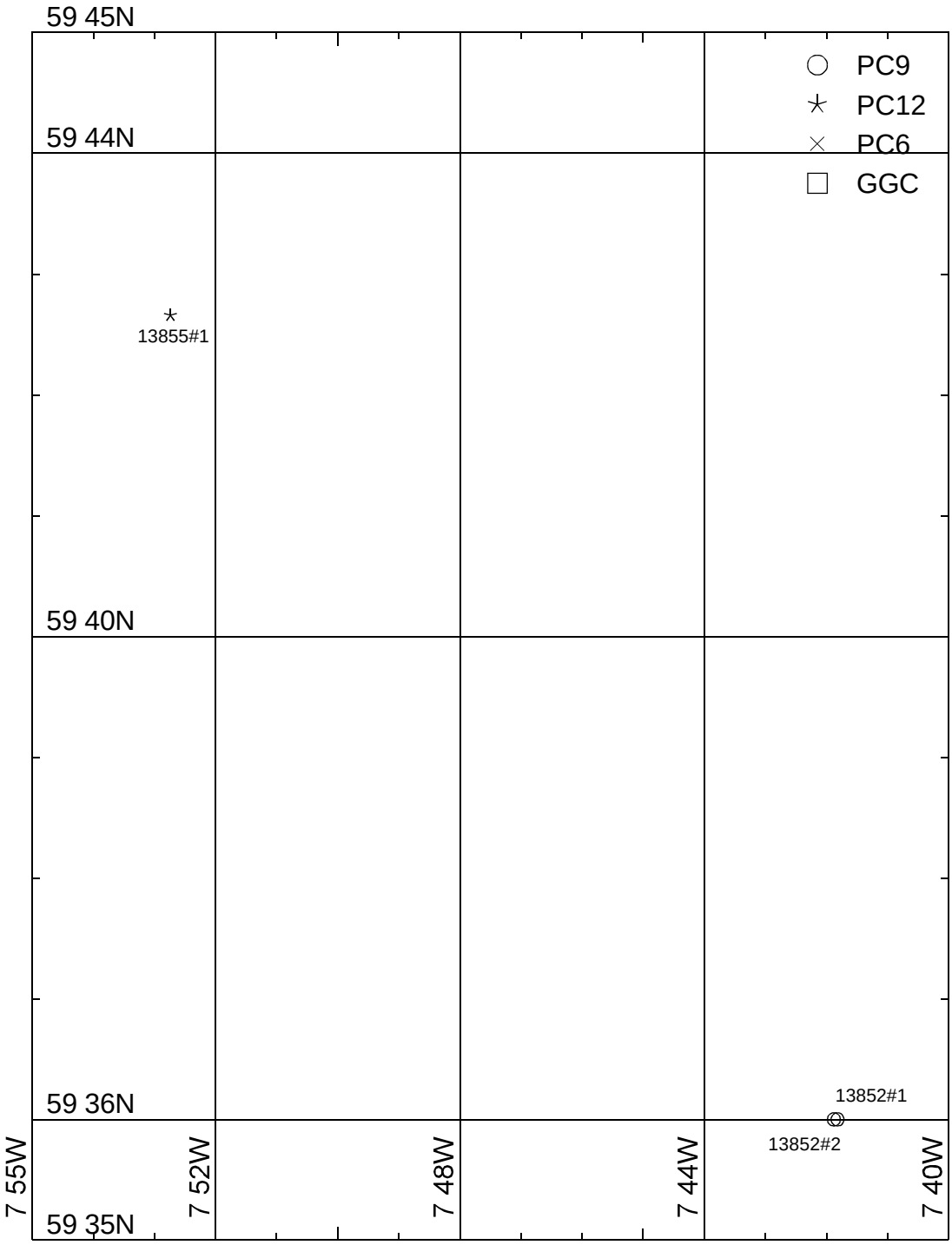

Figure 38. D248 PISTON CORES WORK AREA C

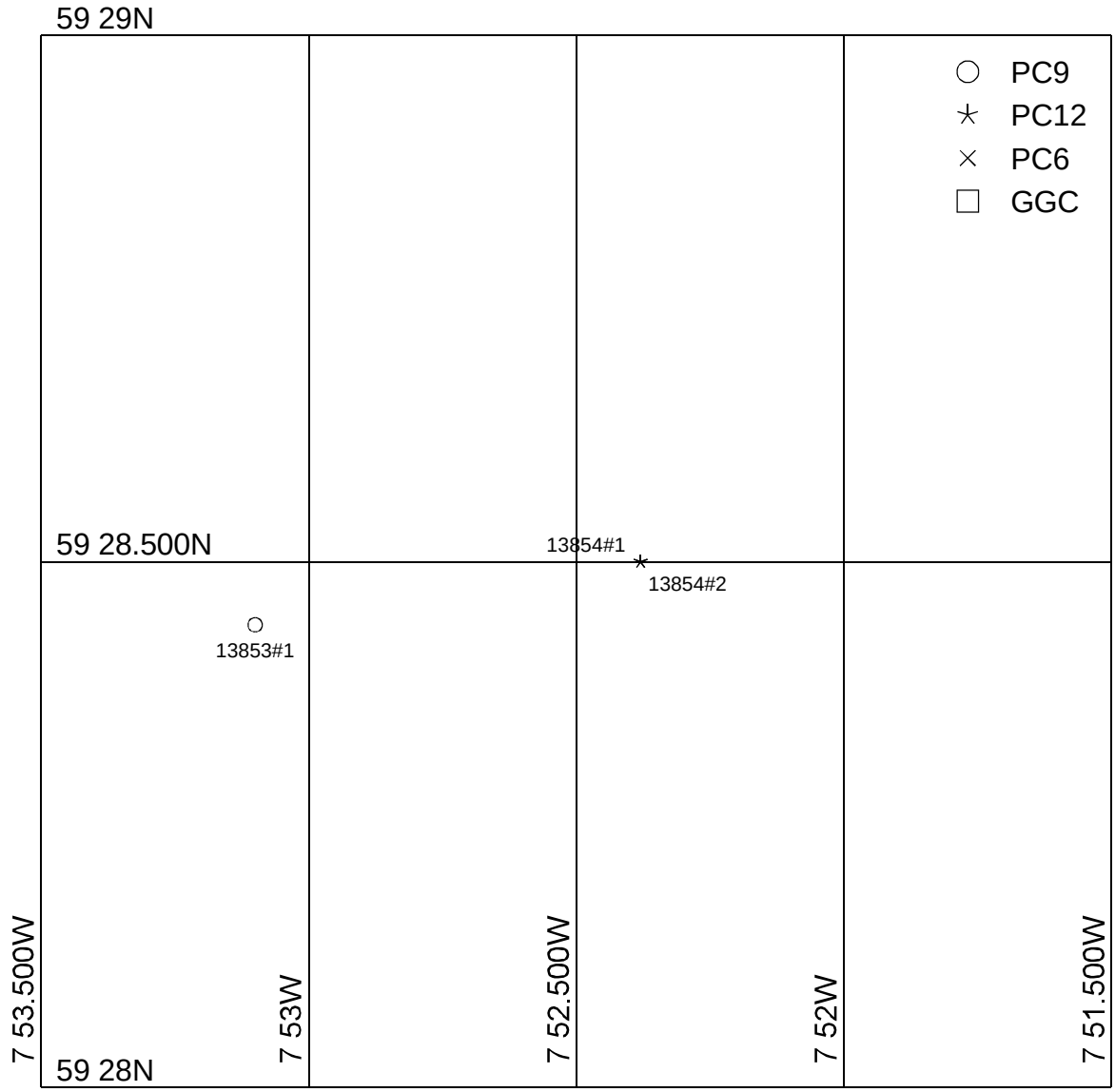

Figure 39. D248 PISTON CORES WORK AREA D

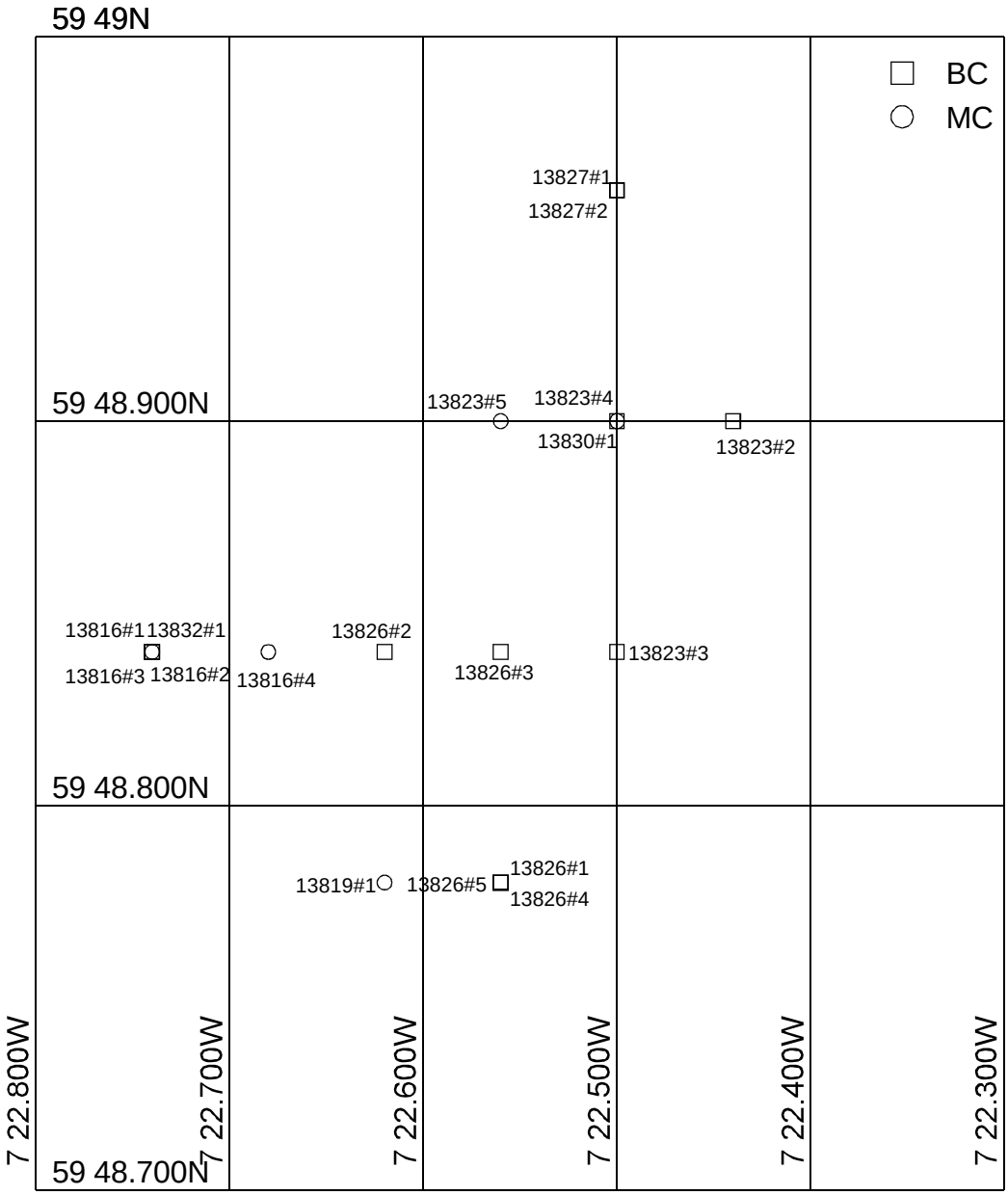

Figure 40. D248 BOX AND MULTI CORE: AREA A

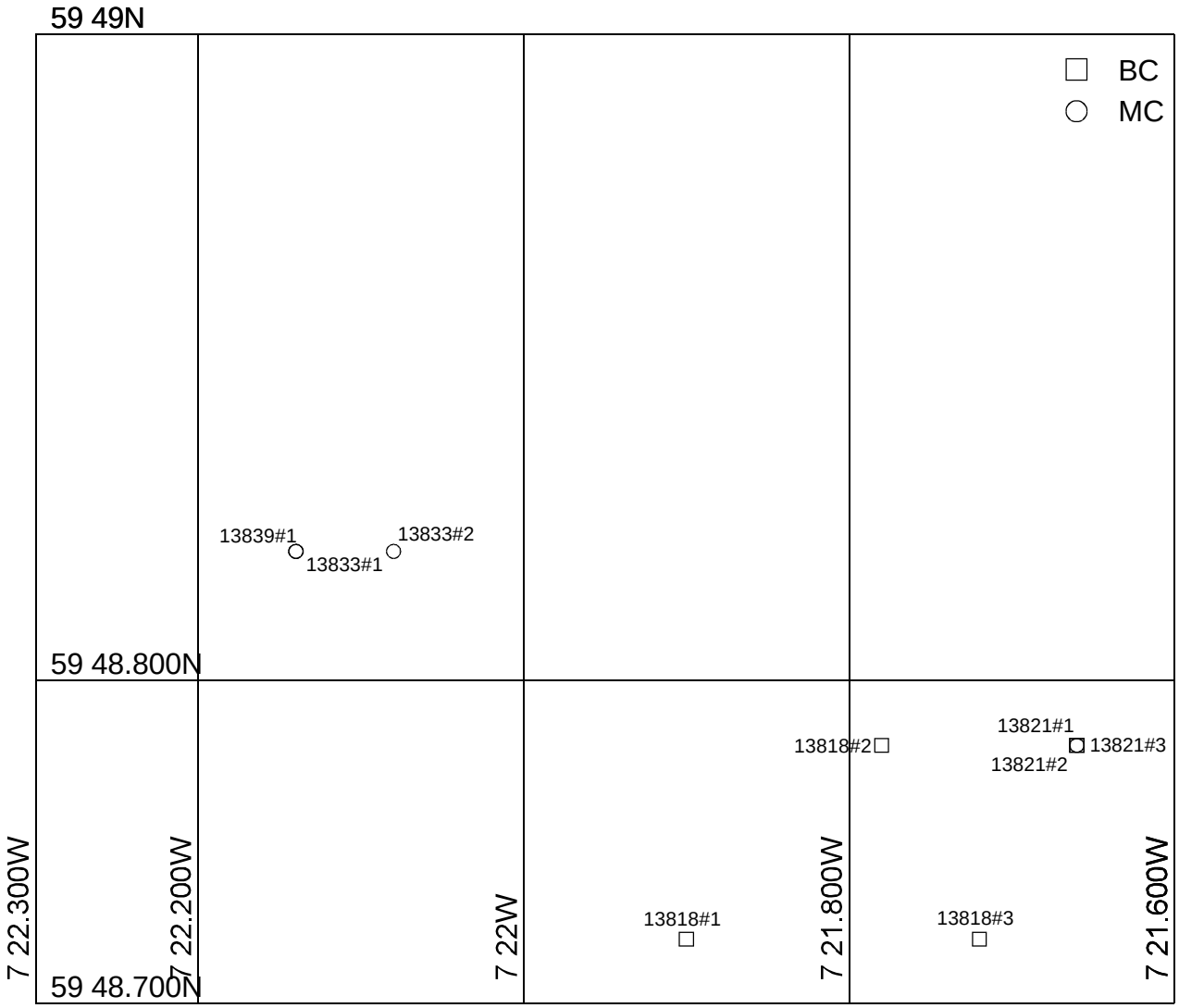

Figure 41. D248 BOX AND MULTI CORE: AREA B

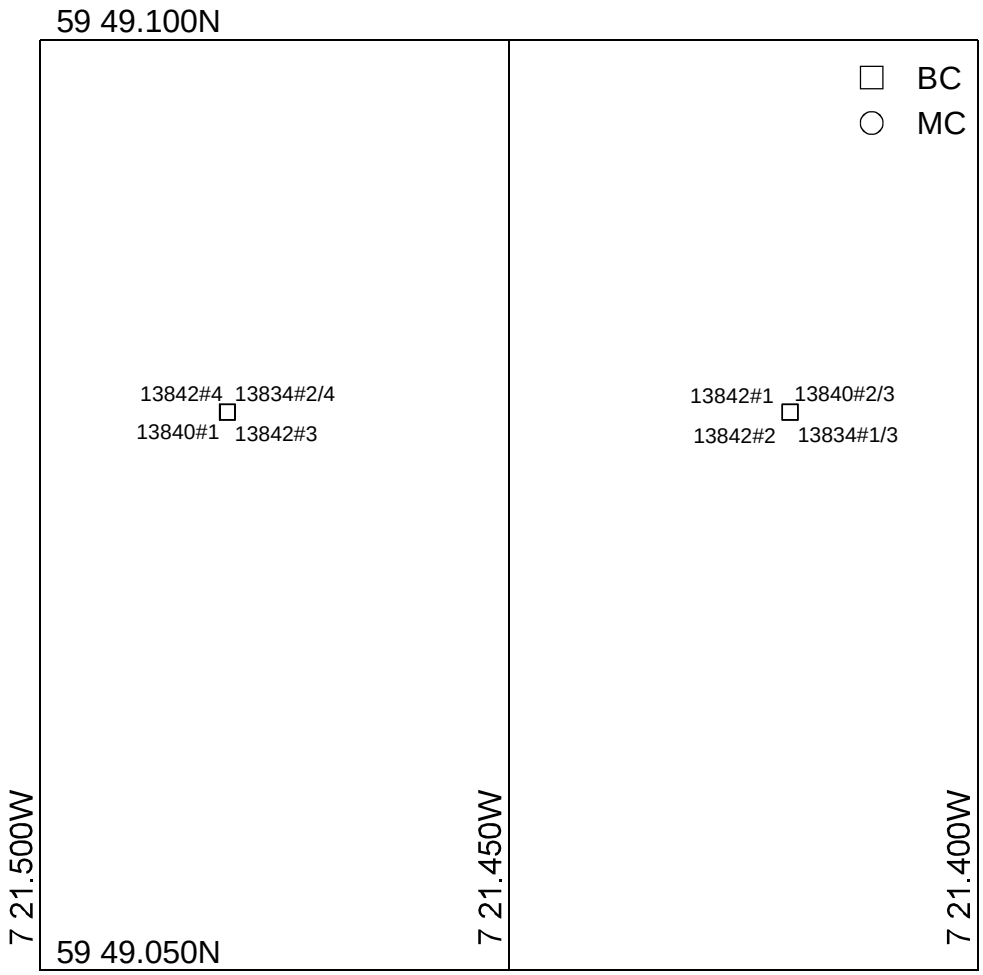

Figure 42. D248 BOX AND MULTI CORE: AREA C

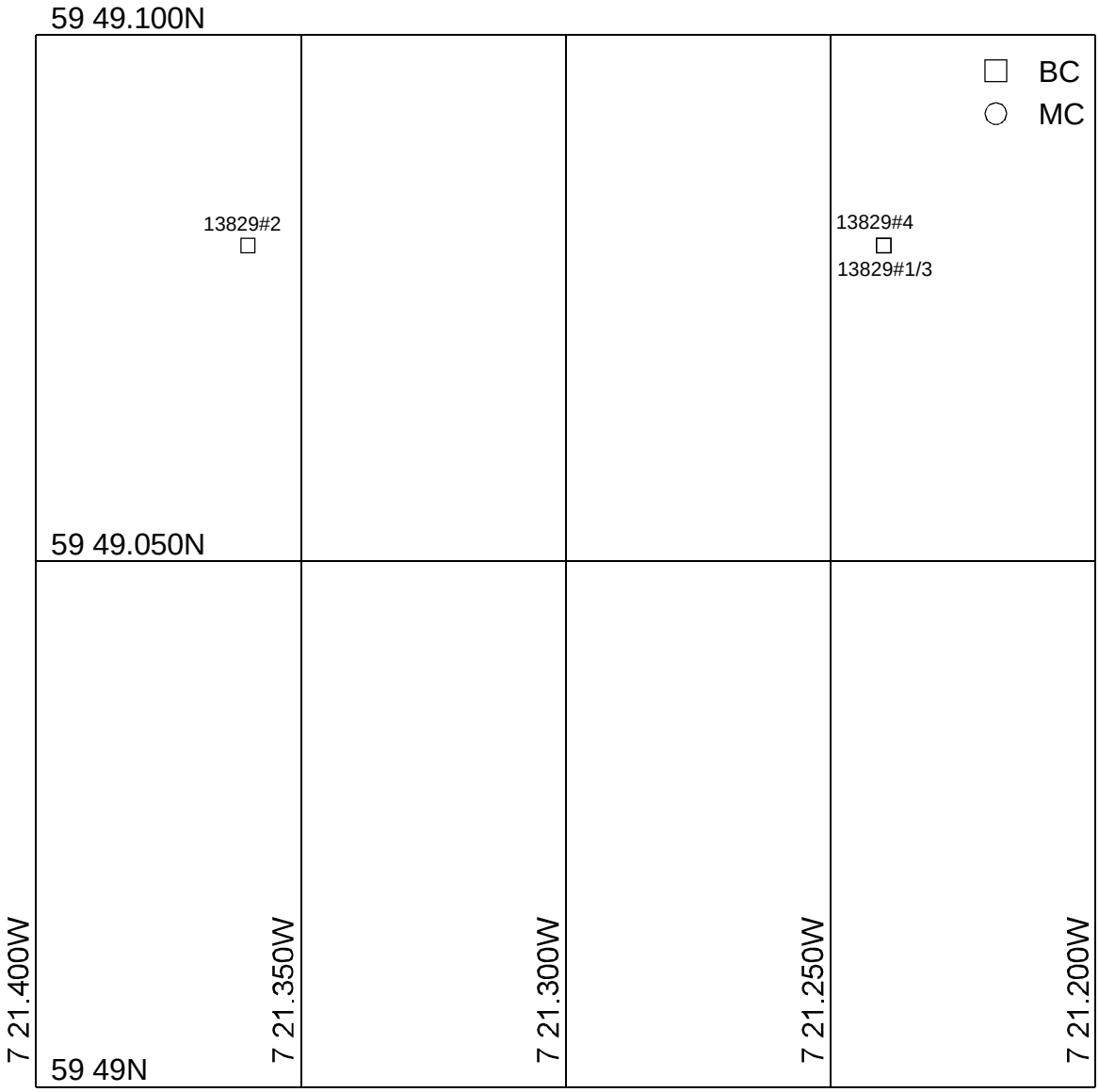

Figure 43. D248 BOX AND MULTI CORE: AREA D

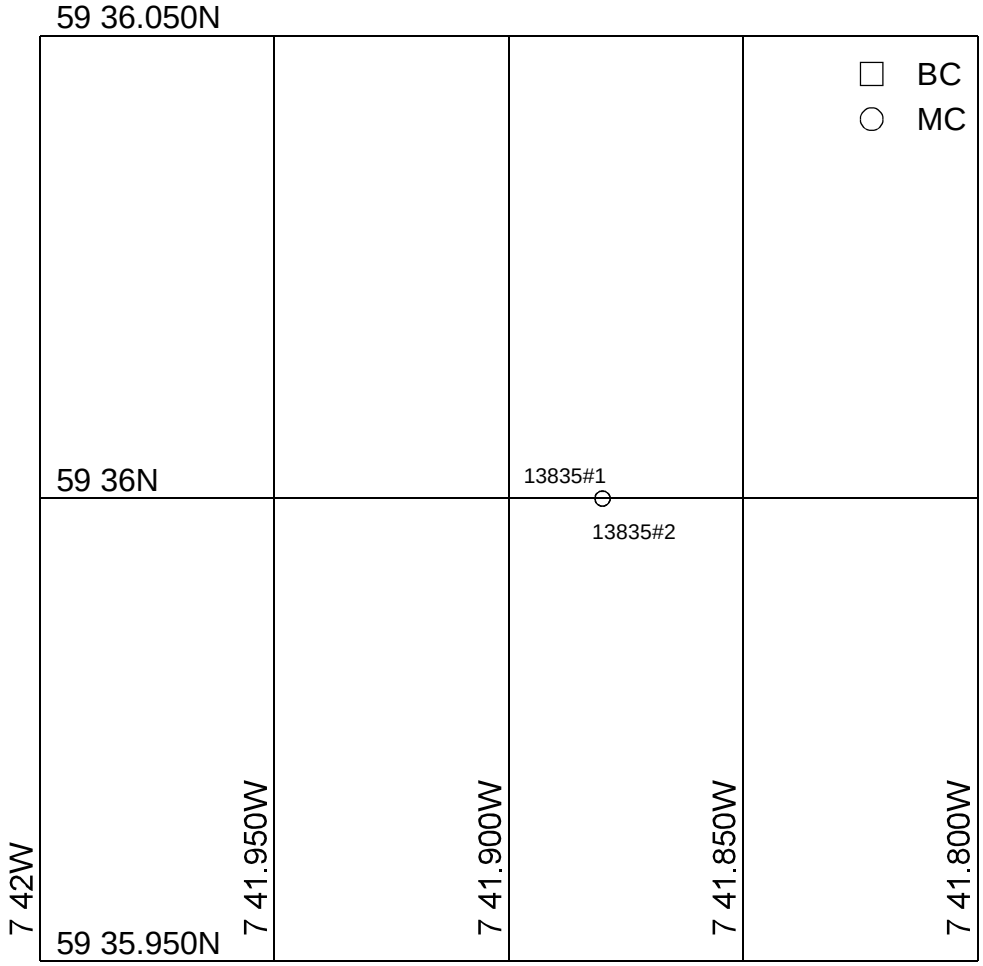

Figure 44. D248 BOX AND MULTI CORE: AREA E

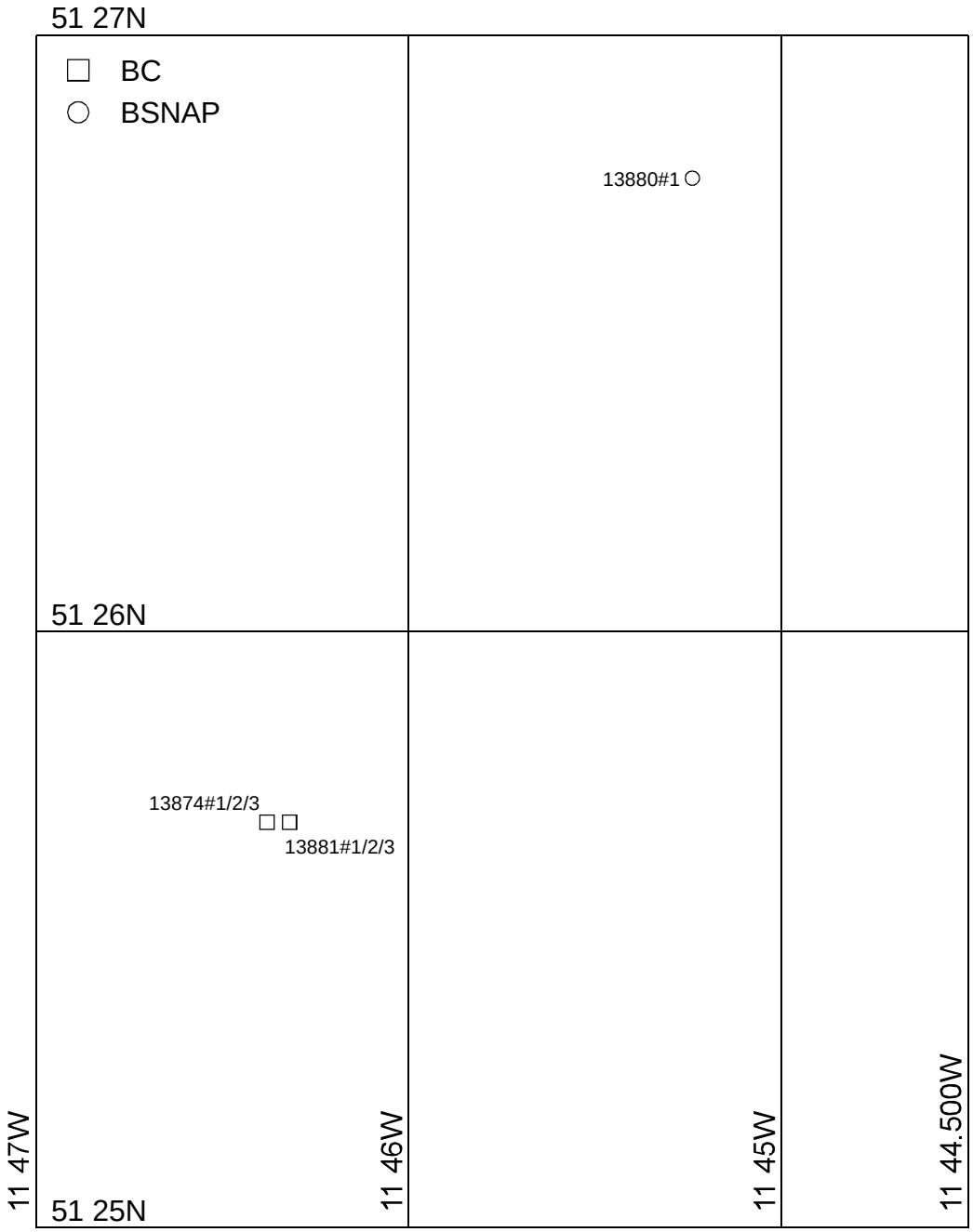

Figure 45. D248 SITES OF BOX CORES IN THE PORCUPINE SEABIGHT

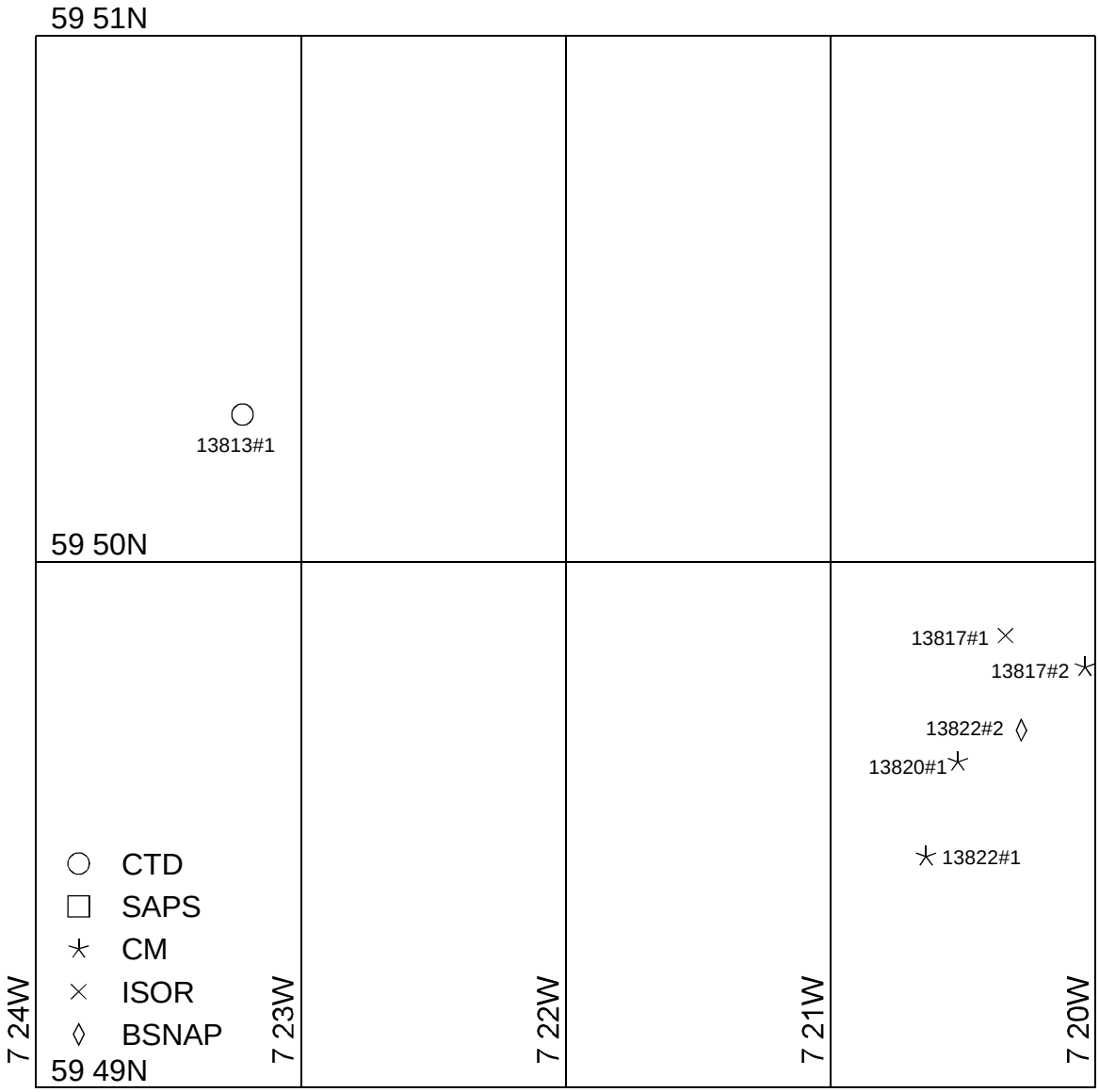

Figure 46. D248 POSITIONS OF CTD, SAPS, ISOR, CM BSNAP: AREA A

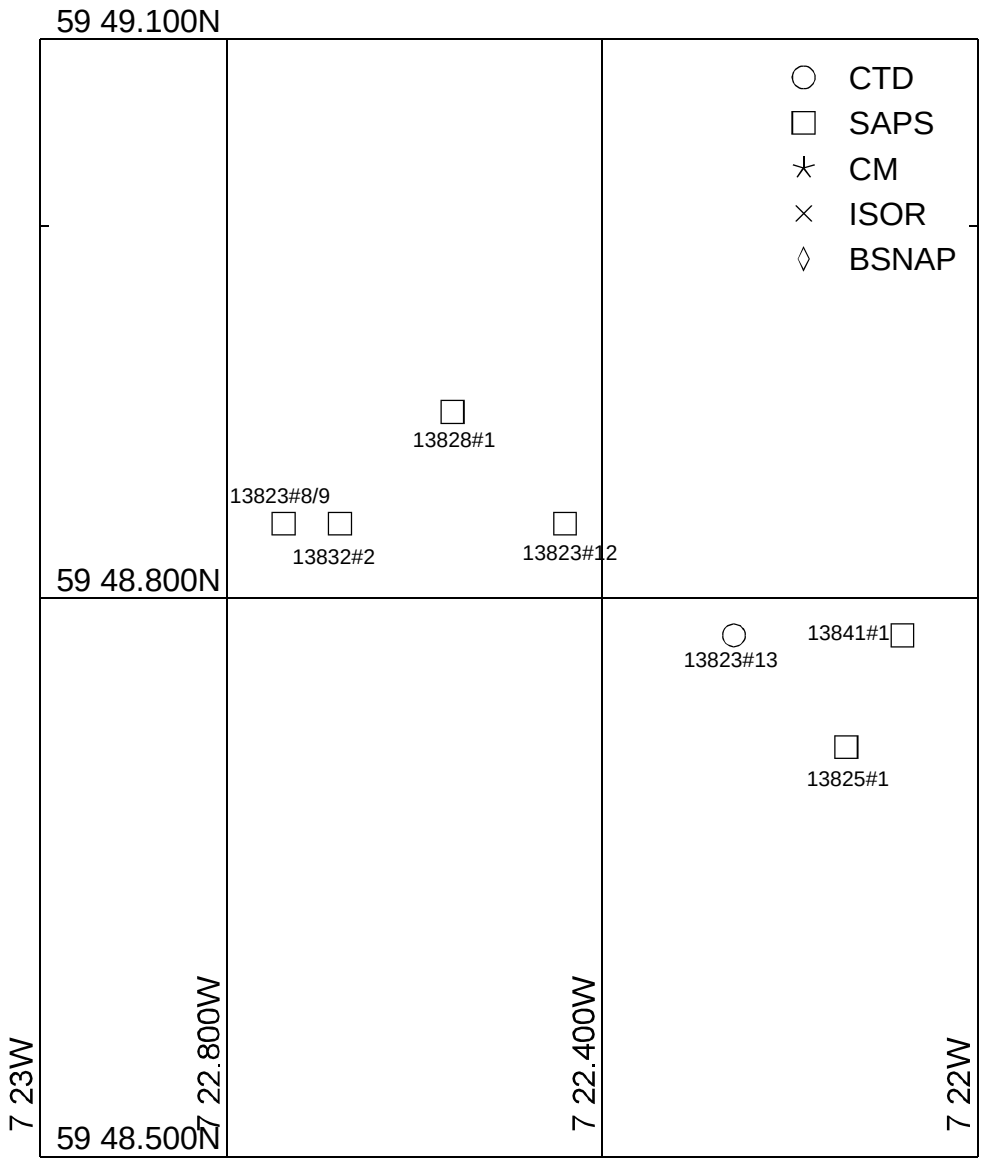

Figure 47. D248 POSITIONS OF CTD, SAPS, ISOR, CM BSNAP: AREA B

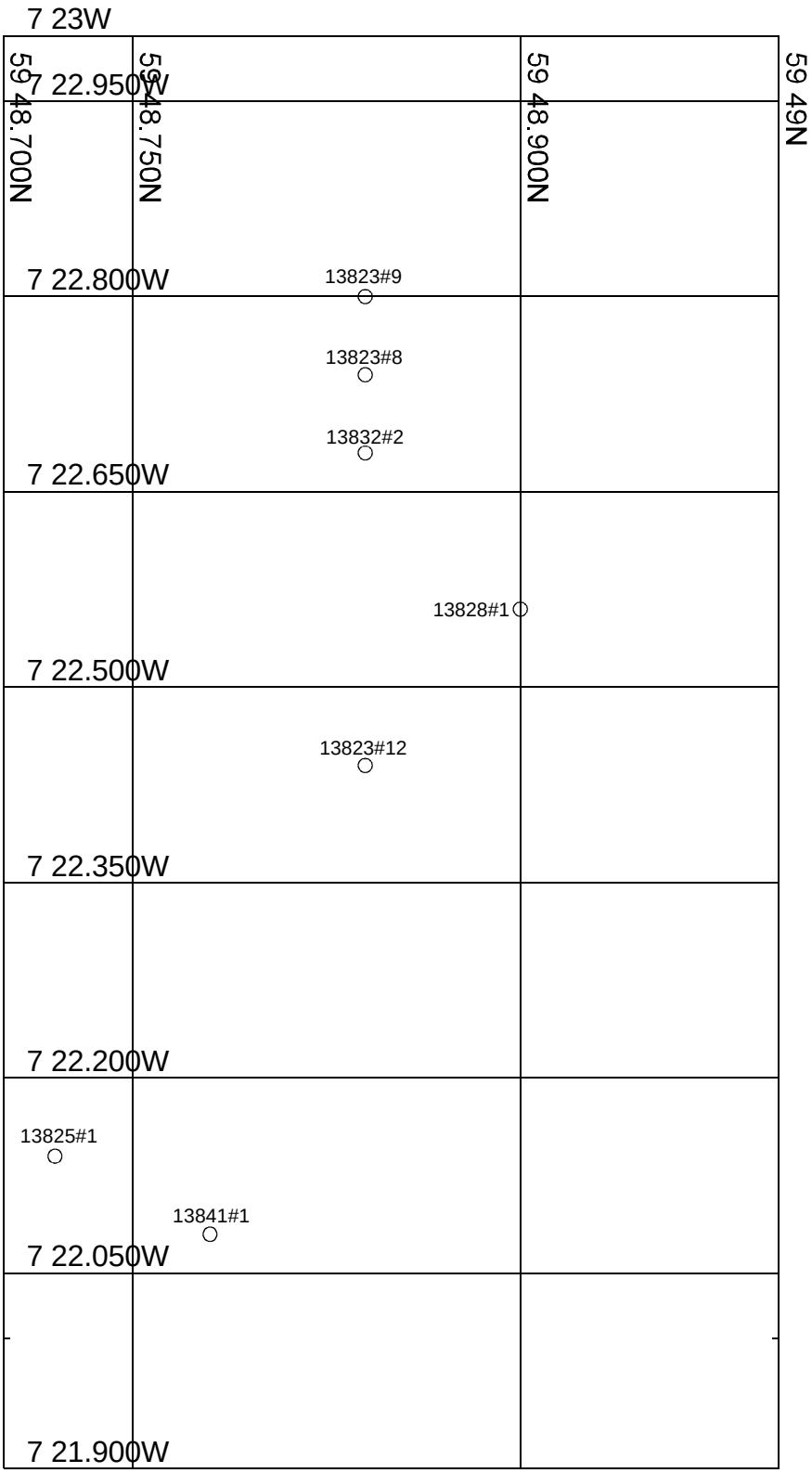

Figure 48. D248 START TIME SAPS POSITIONS

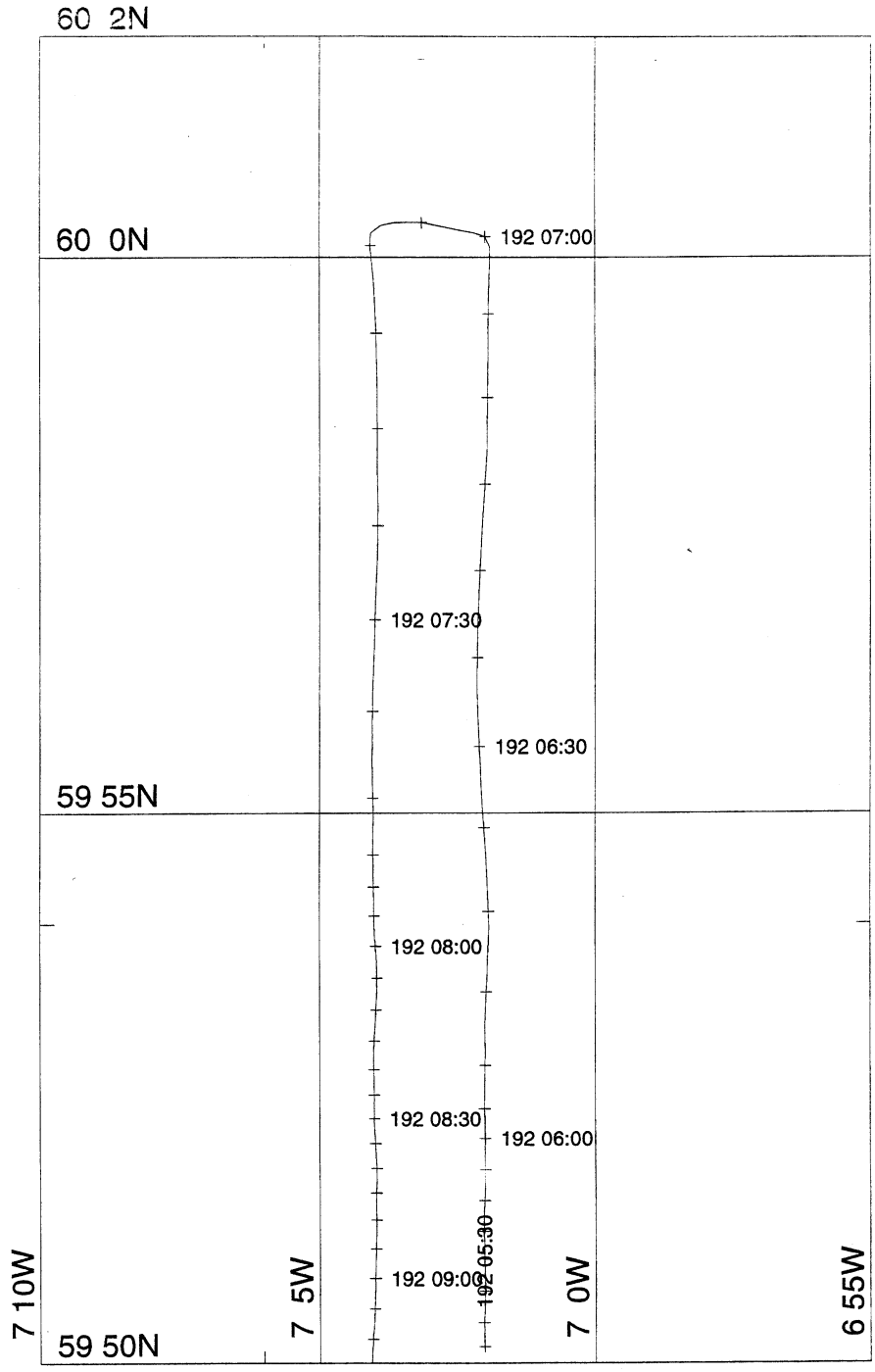

Figure 49. Echo sound track 00 192 05:25:00 to 00 192 09:14:00

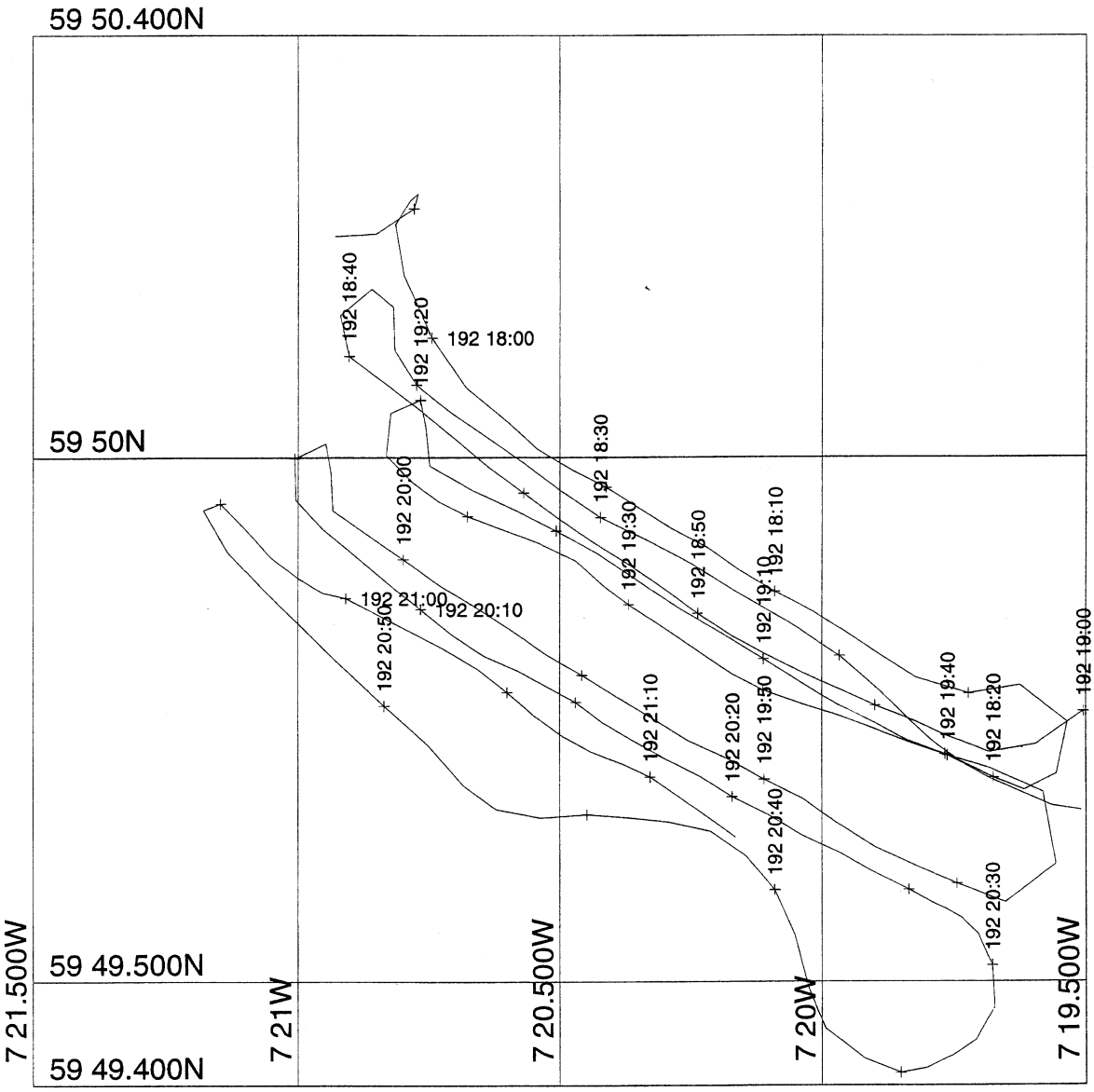

Figure 50. Echo sound track 00 192 17:53:00 to 00 192 21:13:00

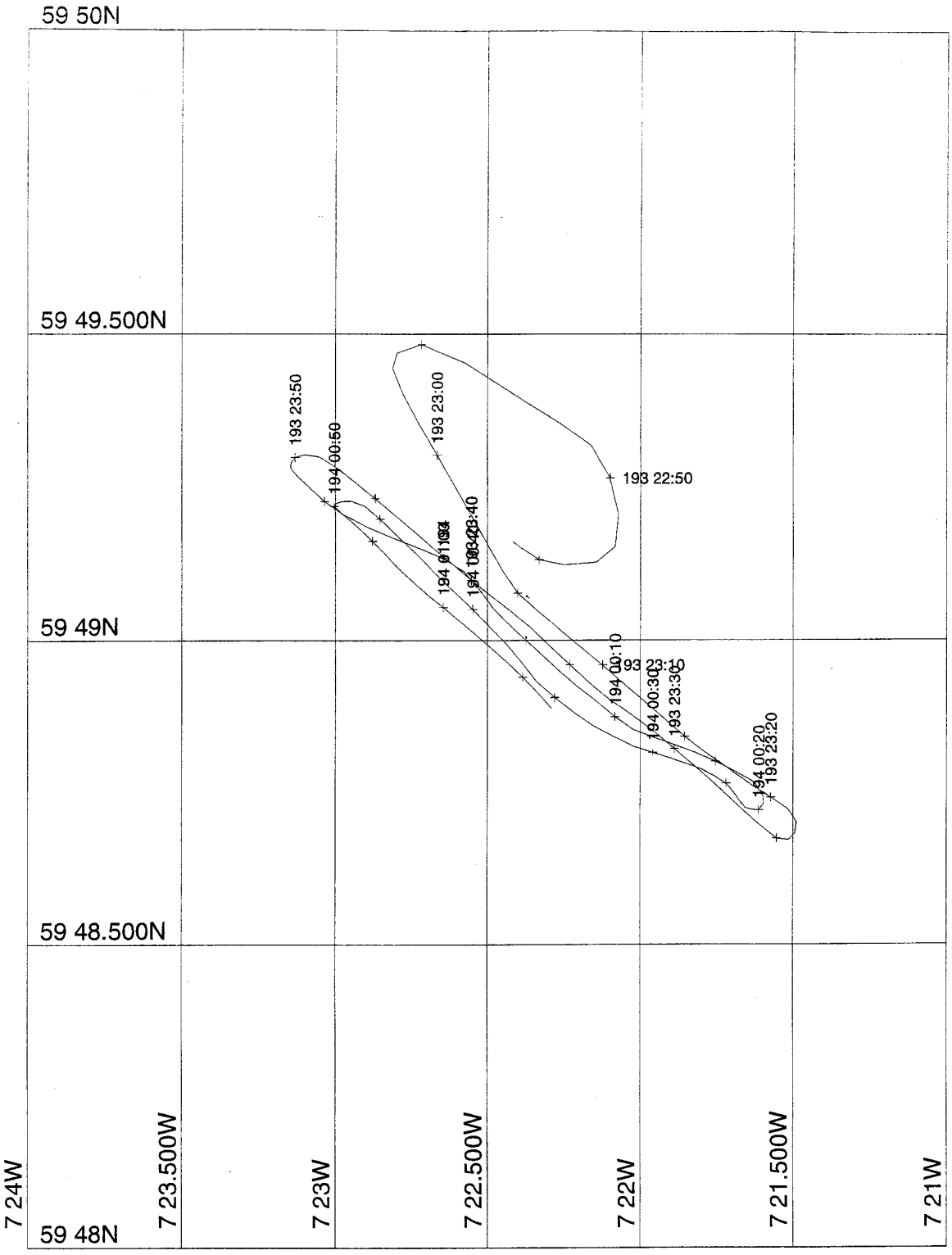

Figure 51. Echo sound track 00 193 22:43:00 to 00 194 01:07:00

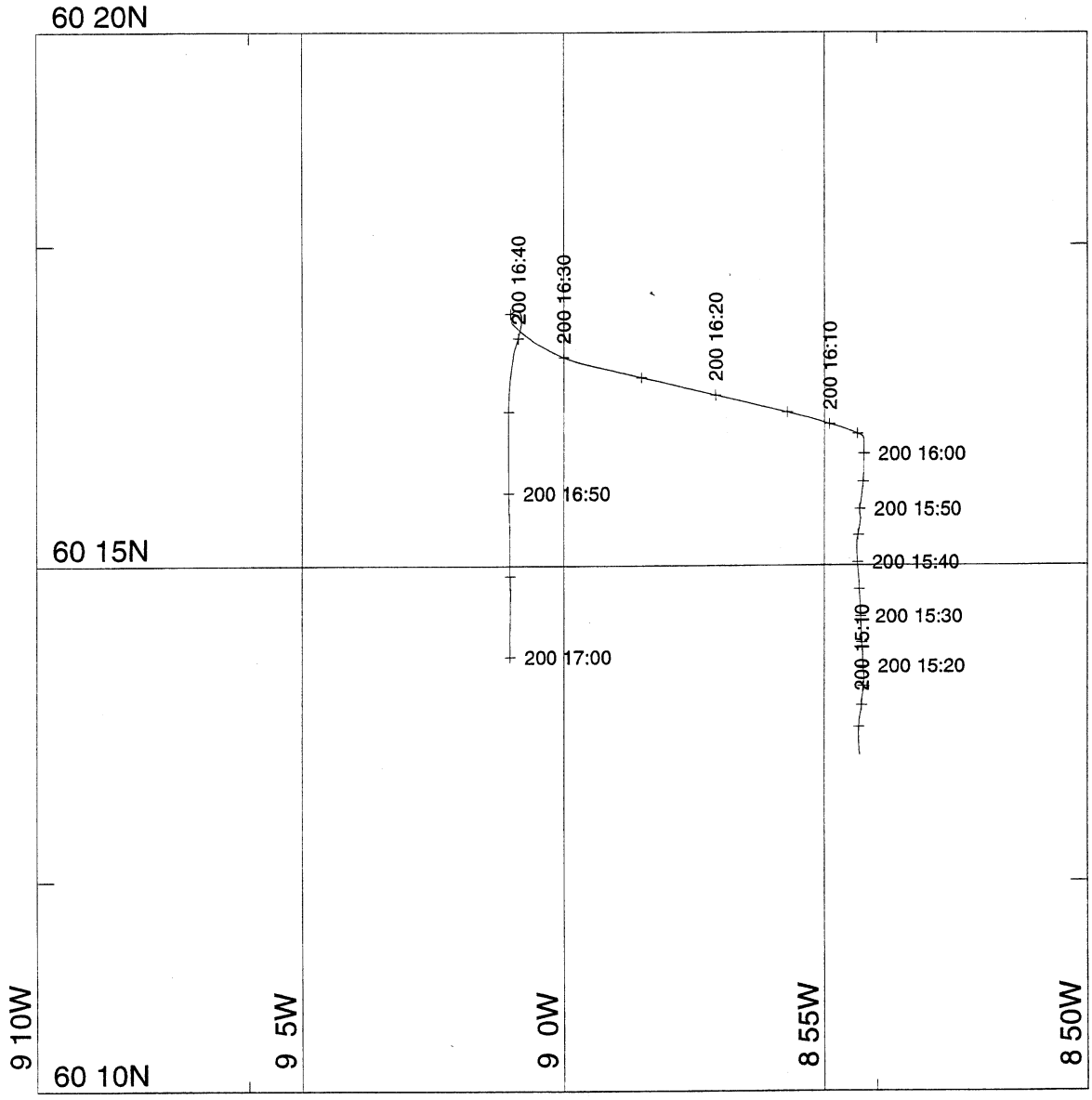

Figure 52. Echo sound track 00 200 15:01:00 to 00 200 17:00:00

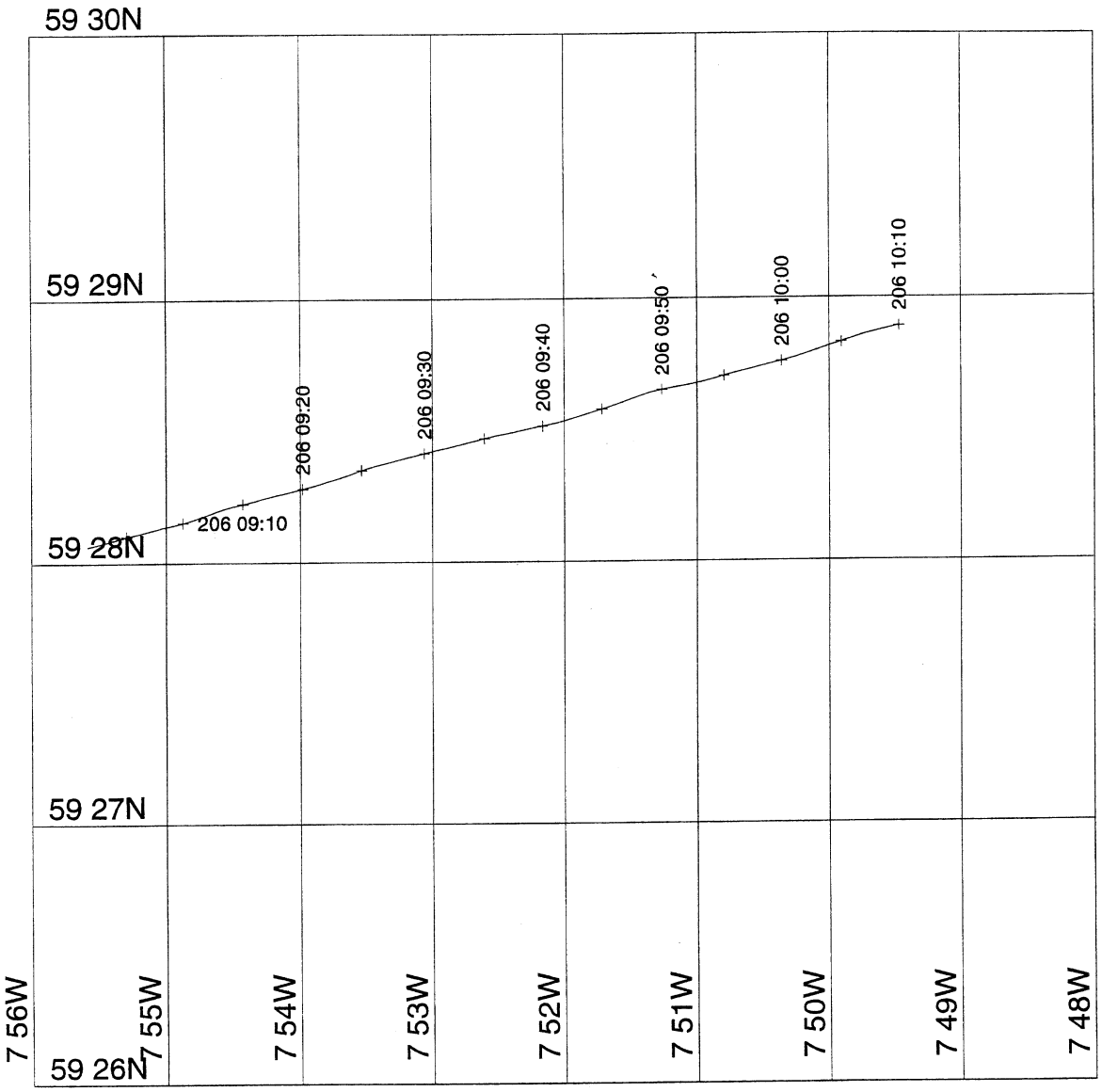

Figure 53. Echo sound track 00 206 09:02:00 to 00 206 10:10:00

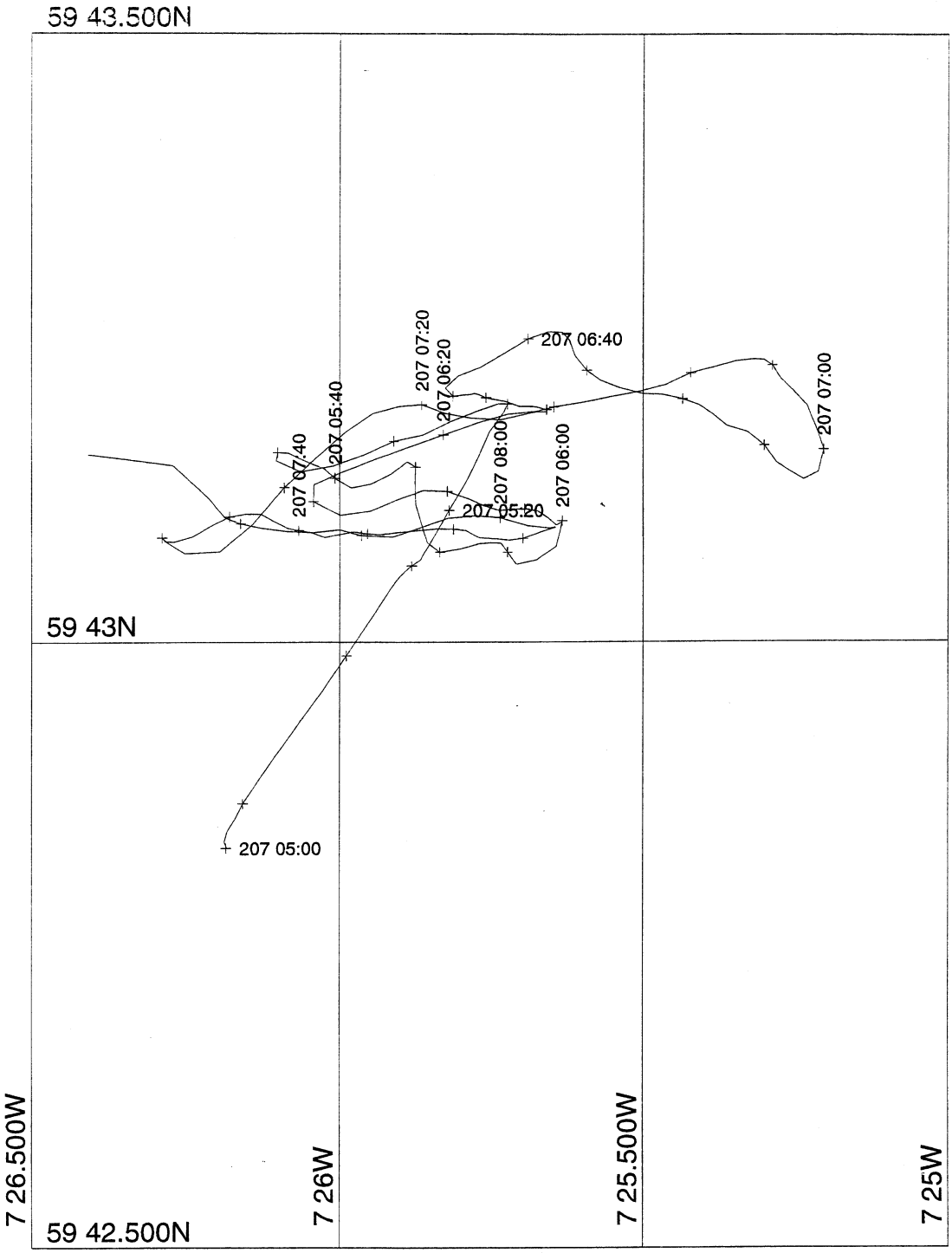

Figure 54. Echo sound track 00 207 05:00:00 to 00 207 08:30:00

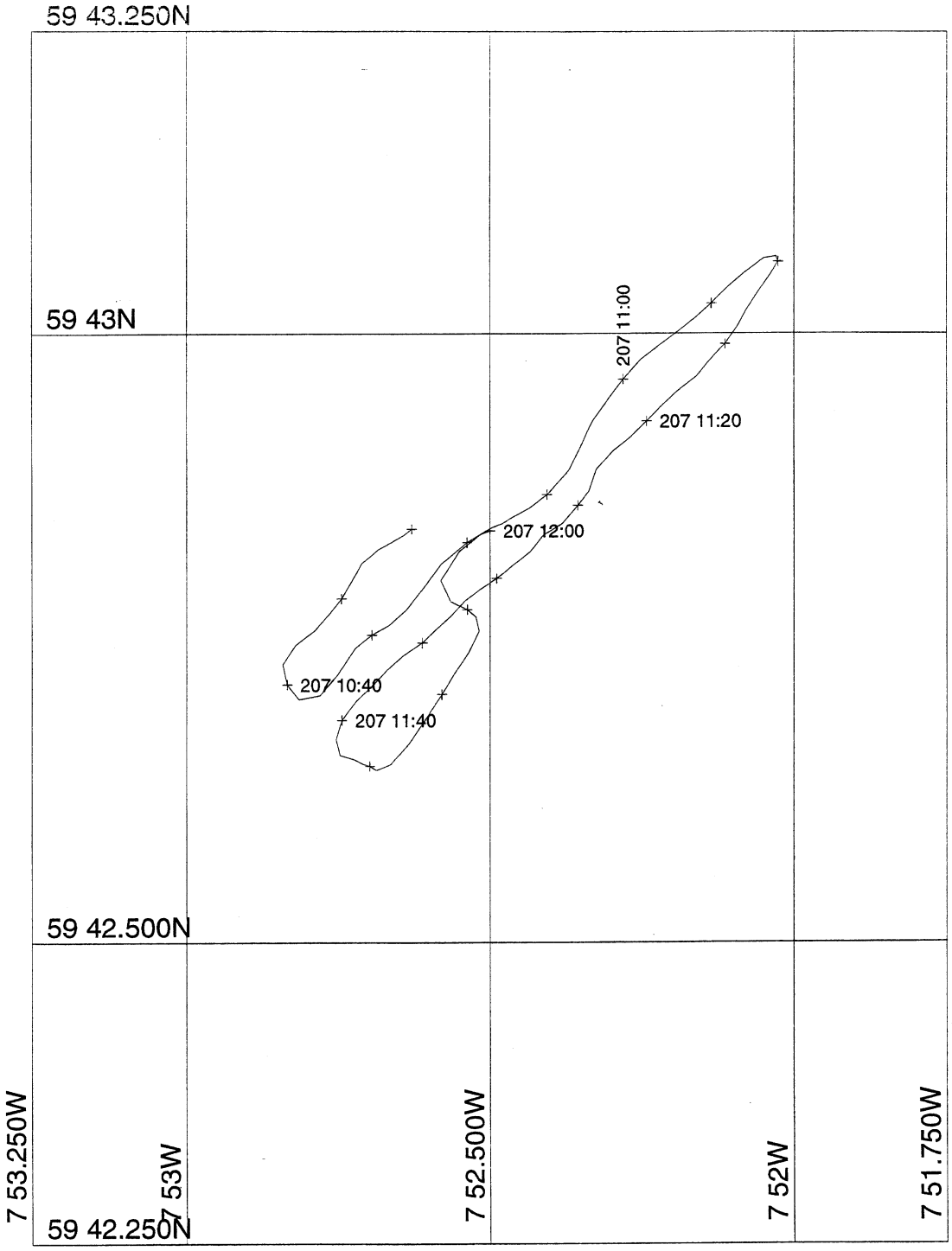

Figure 55. Echo sound track 00 207 10:30:00 to 00 207 12:00:00