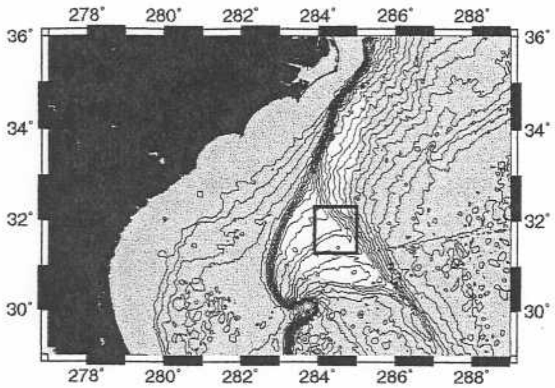
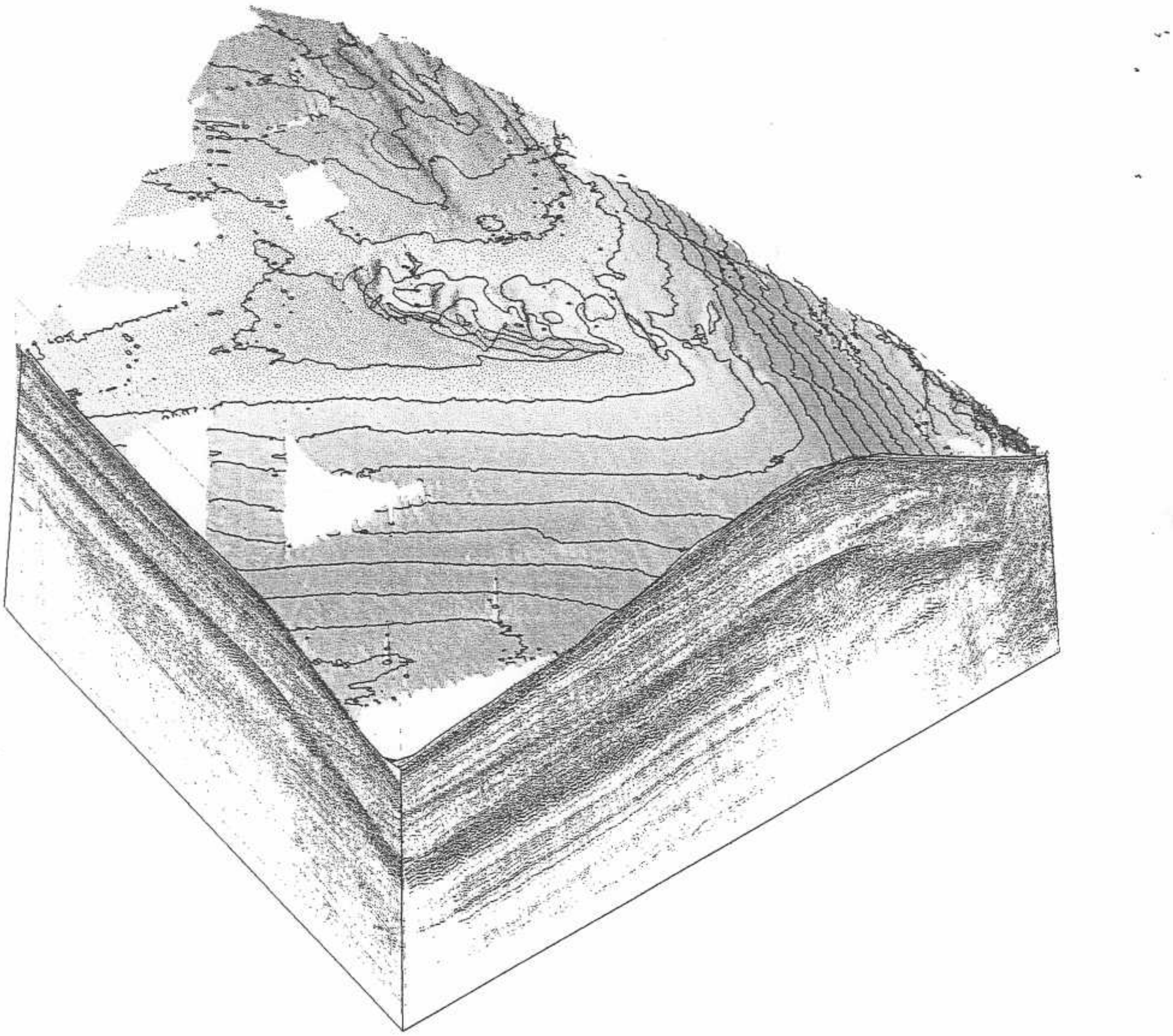


Blake 2000

Cruise Report



R/V Maurice Ewing, Leg 0008
September 2 - October 17, 2000
Newark - Norfolk

BACKGROUND AND SCIENTIFIC OBJECTIVES

Gas hydrate, an ice-like crystalline solid of water and low-molecular-weight gas formed at low temperature and high pressure, appears to be widespread on continental margins and thus constitutes an enormous reservoir of methane in shallow marine sediments. Hydrates and the underlying zone of free gas bubbles are of broad interest for several reasons: they may form a future fossil fuel reserve; they may affect the shear strength, diagenesis, and lithification of marine sediments; and they may play a role in the global carbon cycle and climate change. At present, the lateral variability and dynamics of the methane hydrate/gas system are poorly understood.

The Blake Ridge, offshore South Carolina, constitutes a premier natural laboratory for the study of gas hydrate dynamics, for several reasons. First, the lithological homogeneity of much of the sediment column provides a virtual *tabula rasa* against which deviations in physical properties can be confidently interpreted in terms of hydrate and gas. Second, the lack of tectonic activity removes a major complicating factor that affects many other hydrate locales. Third, a critical mass of previous geological and geophysical data exist, including single-channel seismic data, deep-towed acoustic data, ocean-bottom seismic data, and sampling and downhole logging conducted in three deep (700+ m) holes during Leg 164 of the Ocean Drilling Program. Fourth, circumstantial evidence exists for explusion of massive amounts of methane from the Blake Ridge collapse structure, implying a connection here between the hydrate/gas reservoir and the ocean/atmosphere system. Fourth, previous ocean-bottom seismometer and vertical seismic profile data showed strong ~~P-to-S~~ conversions from the BSR and HSZ, suggesting that a targeted ocean-bottom seismometer (OBS) survey has the potential to determine the effects of hydrate and gas on the shear-wave structure of marine sediments. Finally, strong lateral variations exist in gas distribution, including complex, three-dimensional structures, with several generations of faults, local gassy zones, evidence for recent re-equilibration of a BSR, and a possible incursion of free gas into the hydrate stability zone. These observations point to a highly dynamic, active geological system that offers clear opportunities to test recent ideas regarding the dynamics and mass balance of hydrate/gas systems.

On Leg EW-0008 of the R/V Maurice Ewing we investigated this dynamic hydrate/gas system with three approaches: (1) detailed, three-dimensional multichannel seismic (MCS) data acquired over a 250 km^2 area with a 4-km-long streamer, which will provide basic 3D geometries of stratigraphy, structures, gas accumulations, and gas migration pathways; (2) long-offset (6-km), high-fold (~~480-channel~~) 2D data, which will allow both high-quality images of regional structure and accurate P-velocity determination in the hydrate and free gas zones; and (3) three-component OBS data, which will provide estimates of shear-wave velocities.

The goals of this work are:

- To better understand gas accumulation and migration pathways
- To test the hypothesis that the Blake Ridge collapse structure represents a site of methane escape into the ocean/atmosphere system
- To investigate evidence for free gas in the hydrate stability zone,

$$\text{fold} = \frac{N \Delta x}{2 \Delta s} = 240\left(\frac{12.5}{37.5}\right) = \underline{80}$$

- To assess whether hydrate cements sediments and whether gas-charged sediments represent a zone of weakness.

Ultimately these data will contribute to an improved understanding of the processes that control the mass balance of methane in the hydrate/gas reservoir.

This project is a collaborative effort between the University of Wyoming, the University of Texas Institute for Geophysics, and Georgia Tech, and is jointly supported by the National Science Foundation and the Department of Energy.

OPERATIONAL OBJECTIVES

Our operational plan was to acquire seismic reflection and refraction data across the Blake Ridge, three linked data sets: (1) 3D MCS data in a 6.5 x 39 km area; (2) regional 2D MCS data with the Ewing's 480-channel, 6-km-long streamer; and (3) wide-angle OBS data along the drilling transect on the ridge crest, and, time permitting, on an additional transect to be defined by the new MCS data. Wide-angle data were recorded on 13 ocean-bottom seismometers owned by the U.S. Geological Survey. Shots were fired using three different source configurations: (a) two generator-injector (GI) guns configured at 105/105 cu. in. and towed at 2.5 m depth; (b) the same GI guns but towed at 5 m depth, and (3) a 6-element array of Bolt airguns totalling XXX cubic inches (XXX liter). In addition, time was included in the operational plan to test the various source configurations and for weather contingency. (See Appendix 1 for a cruise timetable.)

All of these operational objectives were met, with the sole exception of the additional OBS survey. We did conduct two OBS deployments (a total of 20 deployments), but sub-par performance of the OBS instrumentation on the first deployment required us to use the second deployment to fill in gaps in the primary transect, rather than acquiring data on a new transect. We decided to deploy one instrument inside the 3D box to record 3D shots.

Primary operational goals for R/V Ewing were to:

- Acquire 3D data with a 4-km streamer and the 2-GI-gun source array.
- Acquire regional 2D data with the 6-km streamer and GI-gun array.
- Acquire OBS data on the drilling transect using both the GI-gun and six-gun arrays.
- Acquire auxiliary geophysical data (gravity, multibeam bathymetry, and 3.5 kHz) along the ship track.
- Produce near-real-time brute stacks of all MCS data.
- Copy all MCS prestack data to DLT tapes for use by participating investigators, and all 2D prestack data to DAT tapes.

~193,256 x .0375

PRELIMINARY CRUISE ASSESSMENT

Cruise EW-0008 was a great success: we completed a full 3D data set; we acquired XXX km of 2D MCS data with the 6-km streamer (more than we originally planned); and we observed clear P-to-S converted waves on a densely spaced OBS data set (200 m instrument spacing). Even at this preliminary stage of processing, the data have provided exciting new insights into the workings of a highly dynamic system, and at least one key paradigm (the origin of the collapse structure) has been overturned. Factors responsible for achieving our goals included: (1) adequate planning and inclusion of sufficient contingency time to cover weather and unforeseen circumstances; (2) generally acceptable (though rarely perfect) weather conditions throughout the cruise; and (3) the excellent Ewing crew and LDEO technical staff, who worked hard to help us achieve our goals and ensure a safe cruise. Of course, no cruise is perfect, and we did encounter several difficulties and problems (listed below), but none of these threatened the success of our venture.

Notable successes included the following:

- A complete 3D MCS data set in a 250 km^2 area, with 99.1% of bins filled at 12.5 x 12.5 m bin spacing (with 25% bin extension) and 99.8% filled at 25 x 25 m bin spacing.

- XXX km of 2D MCS data, covering much of the stable ridge crest and collapse structure. (DETAILS HERE)

- Generally high-quality MCS data. The GI gun array produces a sharp, broadband source signature, and the 480-channel streamer produces closely spaced CMPs and high-fold data, contributing to a high-resolution reflection record.

- Near real-time brute stacks of the MCS data. We stacked the inner part of the streamer (1-4 km, depending on the survey) and copied all prestack data to DLT tapes as data came off the system.

- Clear P-to-S conversions from the hydrate/gas system on the OBS records.

Principal operational difficulties included the following:

- Streamer balance problems.

- Tailbuoy GPS. This continues to be a problem for the Ewing, and one which needs to be addressed. We essentially had no useful tailbuoy GPS during the entire cruise, with the exception of a single, short period.

- OBS instrumentation. The OBS portion of the project can only be considered a qualified success, due to the relatively high rate of instrument losses and failures.

- Weather. We were given a highly sub-optimal weather window in which to work off the southeastern U.S. (peak hurricane season), and the risk of hurricanes was present until the last week or so of the cruise. As it turned out, our luck was good: although Hurricane Florence shut us down for a day and forced us out of our primary work area (thus effectively costing us two days), we managed to skirt (including some near misses) Gordon, Helene, Isaac, Joyce, Keith and Leslie. However, several of these storms, plus other unnamed gales, affected sea state throughout the cruise, making it difficult or impossible to fly the streamer at the desired depth of 2.5 m. As a result, we often had to settle for a 4-5 m towing depth, which strongly affected the resolution of our data. (The difference in bandwidth between data acquired with a 2.5 m vs. a 5 m towing depth is huge; the frequency of the streamer ghost notch moves from 300 Hz to 150 Hz.)

PRELIMINARY SCIENTIFIC RESULTS

Cruise EW-0008 has produced a number of exciting new observations that not only shed new light on the structure and development of the Blake Ridge hydrate province, but that may also elucidate approaches for understanding hydrate dynamics and exploration strategies worldwide. The Blake Ridge as imaged on our new data is seen to be a highly dynamic region in which hydrate and gas distribution is governed by the complex interplay of sedimentation, erosion, methanogenesis, and gas migration. The new results include the following:

- The data show clear cross-stratal reflections within the hydrate stability zone that almost certainly come from layers of highly concentrated hydrate. These reflections occur on the northeast (eroding) flank of the ridge and are likely "paleo-BSRs" left behind when erosional events lowered the BSR, thus freezing free gas into hydrate. This is, to our knowledge, the first clear observation anywhere of a seismic reflection from hydrate alone (with no contribution from free gas).

- Evidence for dynamic gas incursions into the hydrate stability zone (HSZ) comes in the form of vertical chimneys that appear to disrupt strata from beneath and above the BSR. Other possible indicators of gas extrusion into the HSZ, including locally bright reflectors that extend upward from the BSR, exist, but the precise nature of these features will be a target of future analysis.

- There is strong evidence, in the form of laterally varying P-velocities, that gas concentrations outside the Blake Ridge "collapse" structure are much higher than beneath the collapse itself. Analyses on Line R11 show that P-velocity beneath the BSR is anomalously low in a 150-m-thick zone, and remains depressed (relative to velocities inside the collapse) up to 400 m beneath the BSR. If gas concentrations were initially uniform beneath the crest of the ridge, this result lends support to recent suggestions that large quantities of gas may have escaped from the hydrate/gas reservoir into the ocean/atmosphere system.

- However, the new data show clearly that the "collapse" structure is not a structural collapse, but rather a region of rapid Neogene sediment-wave deposition. The strata underlying the BSR are flat and undisrupted, eliminating the possibility of a dramatic "blow-out" and loss of volume beneath the structure, which is the prevailing hypothesis. The bounding structures of the collapse, which have been interpreted on old data as faults, are in fact sequence boundaries between packages of sediment waves. Some minor slumping may occur on these boundaries, but no evidence for large-scale structural disruption exists. This result thus seems to eliminate the proposed mechanism for removing free gas from beneath the "collapse", suggesting that either (1) alternative mechanisms must be sought, or (2) free gas concentrations beneath the collapse were never as high as outside the collapse (i.e., the "missing gas" was never there).

had been

R/V EWING SCIENTIFIC AND TECHNICAL PERSONNEL

W. Steven Holbrook, Chief Scientist
Dept. of Geology and Geophysics
University of Wyoming
P.O. Box 3006
Laramie, WY 82071
Ph: (307) 766-2427
Fax: (307) 766-6679
Email: steveh@uwyo.eduhttp://www.gg.uwyo.edu/faculty/holbrook/

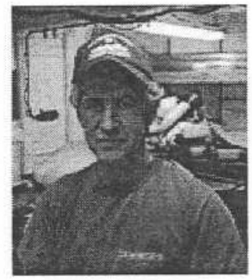
Ingo A. Pecher, Co-Chief Scientist
Institute for Geophysics
University of Texas at Austin
4412 Spicewood Springs, Bldg. 600
Austin, TX 78759-8500
Ph: (512) 232-3203 Fax: (512) 471-8844
Email: ingo@ig.utexas.edu

Dan Lizarralde, Co-Chief Scientist
School of Earth & Atmospheric Sciences
Georgia Institute of Technology
221 Bobby Dodd Way
Atlanta, GA 30332
Ph: (404) 894-3976 Fax: (404) 894-5638
Email: danl@hatteras.eas.gatech.edu

Bob Arko, Systems Manager
Lamont-Doherty Earth Observatory
61 Route 9W
Palisades, NY 10964
Ph: (845) 365-8752 Fax: (845) 365-8719
Email: arko@ldeo.columbia.edu

Andrew Gorman, Shipboard Scientist
Dept. of Geology and Geophysics
University of Wyoming
P.O. Box 3006
Laramie, WY 82071
Ph: (307) 766-3185 Fax: (307) 766-6679
Email: argorman@ UWyo.Edu
http://www.geop.ubc.ca/~gorman/

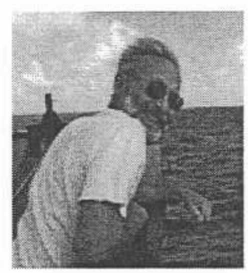
Carlos Gutierrez, Pneumatic Sound Source Officer
Lamont-Doherty Earth Observatory
61 Route 9W
Palisades, NY 10964
Ph: (845) 365-8824 Fax: (845) 359-6817
Email: carlogsu@ldeo.columbia.edu



Kara Hackwith, Watchstander
Graduate Student
Dept. of Geology and Geophysics
University of Wyoming
P.O. Box 3006
Laramie, WY 82071
Ph: (307) 742-5122 (home) Fax: (307) 766-6679
Email: hackwith@uwyo.edu

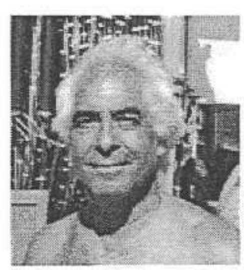
Karl Hagel, Electronics Engineer
Lamont-Doherty Earth Observatory
61 Route 9W
Palisades, NY 10964
Ph: (845) 365-8824 Fax: (845) 359-6817
Email: karlhagel@hotmail.com

Paul Henkart, Shipboard Scientist
Scripps Institution of Oceanography
IGPP
University of California, San Diego
La Jolla, CA 92093-0225
Ph: (858) 534 3487 Fax: (858) 534-5332



Matt Hornbach, Watchstander
Graduate Student
Dept. of Geology and Geophysics
University of Wyoming
P.O. Box 3006
Laramie, WY 82071
Ph: (307) 755-0143 (home) Fax: (307) 766-6679
Email: mhornbac@uwyo.edu
http://w3.uwyo.edu/~mhornbac/web/page1.html

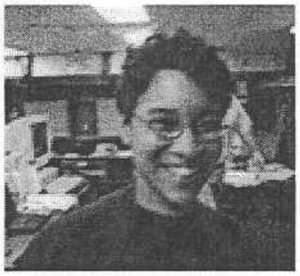
Bob Iuliucci, OBS Technician
Bear Cove Resources, Inc.
RR #1 Brooklyn
Nova Scotia, Canada B0J1H0
Email: bearcove@ns.sympatico.ca



Chris Leidhold, Science Officer
Lamont-Doherty Earth Observatory
61 Route 9W
Palisades, New York 10964
Ph:. (845) 365-8824 Fax: (845) 359-6817
Email: cpl@ldeo.columbia.edu

Ropati Maiwiriwiri, Gunner/Core Bosun
Lamont-Doherty Earth Observatory
61 Route 9W, P.O. Box 1000
Palisades, NY 10964
Ph: (845) 365-8871 Fax: (845) 365-6817
Email: gunner@ldeo.columbia.edu

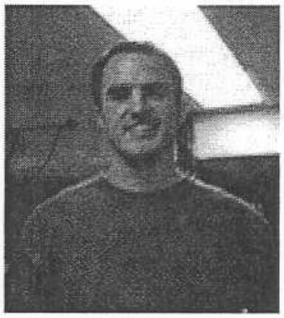
Jill Nimblett, Watchstander
School of Earth & Atmospheric Sciences
Georgia Institute of Technology
221 Bobby Dodd Way
Atlanta, GA 30332
Ph: (404) 894-3607 Fax: (404) 894-5638
Email: jill@hydrate.eas.gatech.edu



Winston Marmion Seiler, Gunner
5 Berachah Avenue
South Nyack, NY 10960
Ph: (845) 358-8791 Fax: (845) 359-6817
Email: winstonseiler@hotmail.com

Donna Shillington, Watchstander
Graduate Student
Dept. of Geology and Geophysics
University of Wyoming
P.O. Box 3006
Laramie, WY 82071
Ph: (307) 766-3363 Fax: (307) 766-6679
Email: djs@uwyo.edu

Mau Thayer, Watchstander
Recent B.S. Graduate
Dept. of Geology and Geophysics
University of Wyoming
P.O. Box 3006
Laramie, WY 82071
Ph: (307) 386-2365 Fax: None
Email: mauritz_thayer@hotmail.com



Harm van Avendonk, Shipboard Scientist
Dept. of Geology and Geophysics
University of Wyoming
P.O. Box 3006
Laramie, WY 82071
Ph: (307) 766-5404 Fax: (307) 766-6679
Email: harm@uwyo.edu

Science Complement

W. Steven Holbrook	Chief Scientist	University of Wyoming
Ingo Pecher	Co-Chief Scientist	University of Texas
Dan Lizarralde	Co-Chief Scientist	Georgia Tech
Harm van Avendonk	Scientist	University of Wyoming
Andrew Gorman	Scientist	University of Wyoming
Paul Henkart	Scientist	Scripps Inst. of Ocean.
Bob Iuliucci	OBS Technician	Bear Cove Resources
Jillian Nimblett	Watchstander	Georgia Tech
Kara Hackwith	Watchstander	University of Wyoming
Donna Shillington	Watchstander	University of Wyoming
Matt Hornbach	Watchstander	University of Wyoming
Mau Thayer	Watchstander	University of Wyoming
Christopher Leidhold	Science Officer	LDEO
Robert Arko	System Manager	LDEO
Karl Hagel	Electronic Technician	LDEO
Carlos Gutierrez	PSSO/Airgun Technician	LDEO
Winston Seiler	Airgun Technician	LDEO
Ropate Maiwiriwiri	Airgun Technician	LDEO

R/V Maurice Ewing Crew

Mark C. Landow	Captain
Earl E. Mayhofer	Chief Mate
David Wolford	2nd Mate
Ralph DiMattia	3rd Mate
Monte M. Arbanas	Boatswain
Henry H. Searls III	A/B
Carl D. Nelson	A/B
James G. Pearson	A/B
Yilmaz Ercan	O/S
Craig R. Kerwick	O/S
Albert D. Karlyn	Chief Engineer
Matthew S. Tucke	First Engineer
Miguel A. Flores	2nd Engineer
Brendan J. Nee	3rd Engineer
Guillermo F. Uribe	Oiler
Leslie G. Strickland	Oiler
Rodolfo A. Florendo	Oiler
Francisco N. Matos	Electrician
John S. Smith	Steward
Ryan E. Dennis	Cook
Luke Moqo	Utility

WATCH SCHEDULE

MAIN LAB

Time (Local)	Scientist	Watchstander
0300 -0900	van Avendonk	Thayer Henkart (0600-0900)
0900 - 1500	Holbrook	Hackwith Iuliucci
1500 - 2100	Pecher	Hornbach Shillington
2100 - 0300	Lizarralde	Nimblett Gorman

GUN WATCH

Time (Local)	Watch
12-16 0800 - 1200 + on call	Gutierrez
1600 - 2400	Maiwiriwiri
0000 -1200	Seiler

BRIDGE

Time (Local)	Watch
12 -4	David Wolford (Second Mate) James Pearson (A/B) Craig Kerwick (O/S)
4 - 8	Earl Mayhofer (First Mate) Hunt Searls (A/B)
8 -12	R.J. DiMattia(Third Mate) Carl Nelson (A/B) "Rusty" John Ercan (O/S)

TIME, DATE, AND LOG KEEPING

All science records and logs kept on Ewing Cruise 00-08 were recorded in GMT (Zulu), which was four hours ahead of local, ship time (Eastern Daylight Time) during the survey. Date annotation was in either Calendar Day or Julian Day. The table below gives calendar days and corresponding Julian days.

CD	JD	CD	JD	CD	JD
02 Sept (Sa)	246	17 Sept (Su)	261	02 Oct.(Mo)	276
03 Sept (Su)	247	18 Sept (Mo)	262	03 Oct.(Tu)	277
04 Sept (Mo)	248	19 Sept (Tu)	263	04 Oct.(We)	278
05 Sept (Tu)	249	20 Sept (We)	264	05 Oct.(Th)	279
06 Sept (We)	250	21 Sept (Th)	265	06 Oct.(Fr)	280
07 Sept (Th)	251	22 Sept. (Fr)	266	07 Oct.(Sa)	281
08 Sept (Fr)	252	23 Sept. (Sa)	267	08 Oct.(Su)	282
09 Sept (Sa)	253	24 Sept. (Su)	268	09 Oct. (Mo)	283
10 Sept (Su)	254	25 Sept. (Mo)	269	10 Oct. (Tu)	284
11 Sept (Mo)	255	26 Sept. (Tu)	270	11 Oct. (We)	285
12 Sept(Tu)	256	27 Sept. (We)	271	12 Oct. (Th)	286
13 Sept (We)	257	28 Sept. (Th)	272	13 Oct. (Fr)	287
14 Sept (Th)	258	29 Sept. (Fr)	273	14 Oct. (Sa)	288
15 Sept (Fr)	259	30 Sept. (Sa)	274	15 Oct. (Su)	289
16 Sept (Sa)	260	01 Oct. (Su)	275	16 Oct. (Mo)	290
				17 Oct. (Tu)	291

Several hard-copy cruise logs were maintained in the Main Lab. A Science Watchstander Log (standard LDEO log sheets) was typically annotated every half hour and at every event with position, course, speed, etc. An R/V Maurice Ewing Seismic Recording Log was maintained once the seismic program commenced. A Scientific Lab Logbook also was maintained, containing detailed notes on all events and observations during the cruise. Copies of all logs are in the possession of the Co-Chief Scientists, and copies will be archived at the University of Wyoming.

RECOMMENDATIONS

Despite the success of EW-0008, no cruise is perfect, and our experience revealed a few areas where improvements in Ewing equipment or procedures could be made. Hopefully the upcoming refit period will provide an opportunity for some of these changes to be made.

1. Several improvements in the computer situation in the main lab are in order:

   - The network should be upgraded to 100 Mbit everywhere in the main lab. Although the network performed better than on EW-0007, it was still not feasible to process seismic data across the network (e.g., either using grampus' CPU and a user's disk, or using a user's CPU and a disk on grampus). This puts a bottleneck on efforts to do serious processing.

   - The Ewing's workstations need to have much larger disks. Several 70 Gb disks (@ only about $1500 each) reserved solely for use of the scientific party would not be too much. Again, this would vastly improve the ability to process seismic data on board.

   - More than one Macintosh (the iMac) should be available to the science party. Many of our tasks, especially in preparing the cruise report, became Mac-limited. (We did bring two Mac Powerbooks along, but we could easily have made good use of 2-3 more shipboard Macs.) It would be nice to have a few more Macs, perhaps replacing the Xterms -- use of Mac-based Xterm software would allow those Macs to function as Xterms as well, thus killing two birds with one stone.

2. Streamer ballasting and stability was a real problem for us -- we spent much more time than we budgeted doing streamer ballasting. Naturally, much of the responsibility for that lies with our planning (since we obviously didn't allot enough time to this task), and poor weather did not help. However, some of these problems might have been alleviated with two changes:

   - Lamont desperately needs to purchase more birds for the streamer. 24 birds are simply not enough to keep a 6 km streamer towing in a stable fashion at shallow depth (2.5-4 m) in anything but the calmest of seas. There should be a bird at every available position on the streamer, plus 4 spare birds. As many of these as possible should be compass birds, to aid in streamer navigation in 3D shooting (especially in view of the difficulties with tailbuoy GPS). Having more birds would make the streamer much more stable, which would reduce the amount of time spent (wasted) doing streamer re-ballasting.

   - Lamont should consider checking PI's cruise plans to verify that ample time has been allowed for streamer ballasting -- especially if PI's intend to use the long streamer for high-resolution work, which requires a shallow towing depth. We allotted 24 hours for this purpose (which would have been ample time if we had

Narrative

NOTE: Unless otherwise indicated, times in this narrative are local time (LT), which is EDT (GMT-4 hrs).

29 Aug – 1 Sept 2000, Tuesday-Friday

The scientific party arrived in various groups throughout the week -- first Ingo Pecher and Bob Iuliucci, who got the USGS OBSs set up on board, then Dan Lizarralde and Jill Nimblett, who got hatteras (SGI workstation) up and running, then Steve Holbrook and Andrew Gorman, who got ballyhoo (HP) up, and finally the rest of the Wyoming crew. Ingo drove to Woods Hole during the week and returned with Hartley Hoskins' hydrophone and winch, which we intend to use as a source monitor. The ship took on fuel late Friday evening.

2 Sept 2000, Saturday

10:15 Pilot aboard and lines away. Our experience with this pilot and the one who brought us into Newark at the end of the last cruise convinces us that the pilots in New York Harbor are the best-dressed anywhere (neckties are de rigeur). We left behind the industrial wasteland of Newark and steamed out into New York Harbor on a hazy day. At 1:20 pm the pilot disembarked and we headed out into the open ocean.

3 Sept 2000, Sunday

We continued south toward Blake Ridge on smooth seas and partly cloudy skies. We finalized deck procedures for deploying and recovering OBSs, as well as handling the source monitor hydrophone. We decided to put the Hoskins winch in the aft starboard corner of the fantail and run the wire through a block mounted on the A-frame gun rail.

By late afternoon we encountered the Gulf Stream, running against us at 4+ knots. We are only making 6.5 knots over the ground. Water temperature 29 C.

4 Sept 2000, Sunday

We continued south toward Blake Ridge on smooth seas and partly cloudy skies. We arrived at our study area around 1400 LT and prepared for OBS launches. We deployed OBS A3 at station 2, then deployed OBS D4 (station 3) while A3 was still descending. We steamed back to station 2 to range across the OBS A3 in a profile parallel to the Leg 164 transect. Results indicated a southwestward (228.2 °) drift of 184 m, i.e., parallel to the Leg 164 transect. We then released OBS D9 (station 4) and steamed back to station 3. Ranging over OBS D4 indicated a drift of 173 m along the Leg 164 transect. Steaming back-and-forth between the instruments did not add much time because of the short transits between positions.

Based on these along-line drifts, we corrected the drop locations for OBSs at stations 5-12 by 179 m to the northeast (48.2°) and released the instruments at about 20-minute intervals. For this operation, the ship was moving with the wind from the north while the bridge counted down the distance until the stern was at the drop location. This operation went very smoothly, and the actual deployment position was usually within a few meters of the intended position.

After deploying OBS D3 (Station 13) at 2310 LT, we ranged over OBSs at stations 5 and 12 perpendicular to the Leg 164 transect. The cross-line drifts were determined to be 0 m at Station 5 and 40 m toward the southeast (138.2°) at Station 12. All in all, we deployed 12 OBSs today; we decided to hold the 13th OBS in reserve to deploy in the 3D box.

5 Sept 2000, Tuesday

We finished pinging around 0200 LT and began deploying the mini-streamer (600 m) at 02:15 LT. The streamer was fully deployed by 03:30 and Carlos and crew began deploying the 6-gun array (total volume 1350 in^3). We began test firing the gun array at 04:40 LT, and at 05:20 we began deploying the source monitor hydrophone from the Hoskins winch; the hydrophone was fully out by 05:45.

During the morning, numerous difficulties with the source monitor hydrophone occurred. After laboring long and hard, Chris and Karl got the hydrophone source monitor working.

At 16:13 LT, we finished Line OBS1 and swapped out the guns, pulling in the 6-gun array and putting out the 2-GI-gun array. After our first detailed looks at the GI gun data today, all we can say is "wow!" As expected, the signal has a much higher resolution (though this may be largely due to the towing depth of 2.5 m, as opposed to the 5 m we towed the 6-gun array at). A pleasant surprise, however, is the comparable depth of penetration -- we are getting clear reflections from > 3 s TWTT, even beneath the gas zone. Contributing factors to this extraordinary data quality are the very calm seas and slow speed (2.5 knots), which are keeping noise levels very low.

6 Sept 2000, Wednesday

Today, despite a glassy sea surface, we're getting a pretty healthy swell from the south. During shooting of the OBS cross-lines the swell is on our quarter, causing us to take some good-sized rolls. During the day we had numerous problems and glitches: the tailbuoy GPS came in and out, and the acquisition system crashed several times. Overall, the acquisition system was unstable during recording of reels 24--~30.

We continued shooting OBS lines today (Lines OBS2-OBS6), with the source monitor hydrophone making multiple trips in and out of the water. We had some difficulties getting the hydrophone to sink deep enough to avoid a receiver ghost.

7 Sept 2000, Thursday

Due to choppy seas, we are having some trouble today keeping the streamer from sinking at the slow target speed (2.5 knots); speeding up helped, but we could not speed up too much without disrupting the desired 20 m shot spacing. A minimum speed to keep the streamer up seems to be about 2.7 knots.

This morning Bob and Ingo are preparing OBS A8 for deployment in the 3D box. We shot Lines OBS7 and OBS8, stopped seismic acquisition at 12:13 LT, and recovered the streamer and tail buoy by 13:00 LT. We spent several hours just shooting to the source monitor hydrophone (this was delayed somewhat by the necessity of replacing the float on a foundering GI gun with a larger float). By late afternoon we were experiencing gale-force winds (>30 kn) as we steamed toward the OBS deployment in the 3D box. We deployed OBS A8 at 17:20, then turned back to the drilling transect to begin recovering the other 12 instruments.

We began recoveries at OBS A2 (station 6), which was on board by 19:43 LT. We adjusted the order of instrument recoveries to account for suspected malfunctioning strobes on instruments at stations 4 and 5. We continued normally with recoveries of OBS D4 (21:52 LT) and A3 (23:56 LT).

8 Sept 2000, Friday

OBSs C3 and D1 (stations 7 and 8) were recovered normally in the wee hours of the morning. OBS B2 (station 9) gave us inconsistent acoustical readings, with numerous random depths reported on ranging, but the lack of a clear indication of release, the instrument did surface at 04:24 LT and was recovered by 04:46. We next released the instrument at station 10 (OBS C4), but were unable to gain any indication that it released, even more than an hour after sending the first release command. We decided to proceed to other instruments and return to station 10 later; OBS D2 was recovered at 07:20 LT, OBS C1 at 08:31, and OBS D3 at 09:50. We tried releasing OBS C4 again at 10:08 LT, but after 30 minutes it was clear that the instrument had not lifted off. We proceeded to OBS D8 (station 5) and recovered it by 11:55 LT; OBS D9 (station 4) was on board at 13:34.

We made a final effort to release OBS C4 during the afternoon, spending another hour pinging and sending release commands, but to no avail. At 14:41 we gave up and steamed toward the beginning of the first MCS line. At 18:00 we deployed the tail buoy and began deploying the streamer.

9 Sept 2000, Saturday

The 6-km streamer was fully deployed by 02:33, at a position 4.5 nm from waypoint 1. We brought the ship up to 4.8 knots. Our intention is to fly the streamer at 2.5 m depth, so as to keep the source and receiver ghosts notches uniform. Unfortunately, this proved to be nearly impossible, as the streamer tended to pop to the surface even from 4 m depth, and we then had tremendous difficulty getting the streamer down off the surface. The aft half of the streamer is clearly too light. At 04:54 we decided that the streamer ballast was untenable, and we began pulling the streamer back in. All birds were back in by 07:26, and we immediately began redeploying and adding lead. This took until 19:11 LT (at this point we had been working on streamer deployment for 25 hours). The guns were deployed by 19:30, and we started Line R0, our first 2D MCS line, at 19:45. We set the streamer depth to 3 m, with the intention of later bringing it up to 2.5 m.

Streamer party.

At 21:00 Carlos pulled in the port side GI gun; there was no display of that gun on the blast phone monitor, and Carlos suspected a bad blast phone. The gun was redeployed at 22:30, but immediately pulled again, as the two guns were firing in opposite sequence. Troubleshooting of this problem continued for several hours.

10 Sept 2000, Sunday

Meanwhile we continued having serious problems keeping the streamer stable -- problems which continued all day (while we shot the long line R1), finally convincing us that we would have to pull in the streamer and reballast it. We tried for several hours to find a stable configuration -- we tried especially to get the forward third of the streamer to fly at ~2.5 m depth, with the aft 2/3 at 7 m. (The rationale behind this idea was to enable selective stacking such that we would get high-resolution data on the front third, but still allow the center and aft parts of the streamer to fly at a more stable depth.) These attempts failed, and at 21:55 we decided to pull in 2/3 of the streamer and reballast, with special attention to putting weight on the center section (birds 16-18). Our plan was to pull in the streamer for 2 hours and re-ballast as far back as we could get in that time.

11 Sept 2000, Monday

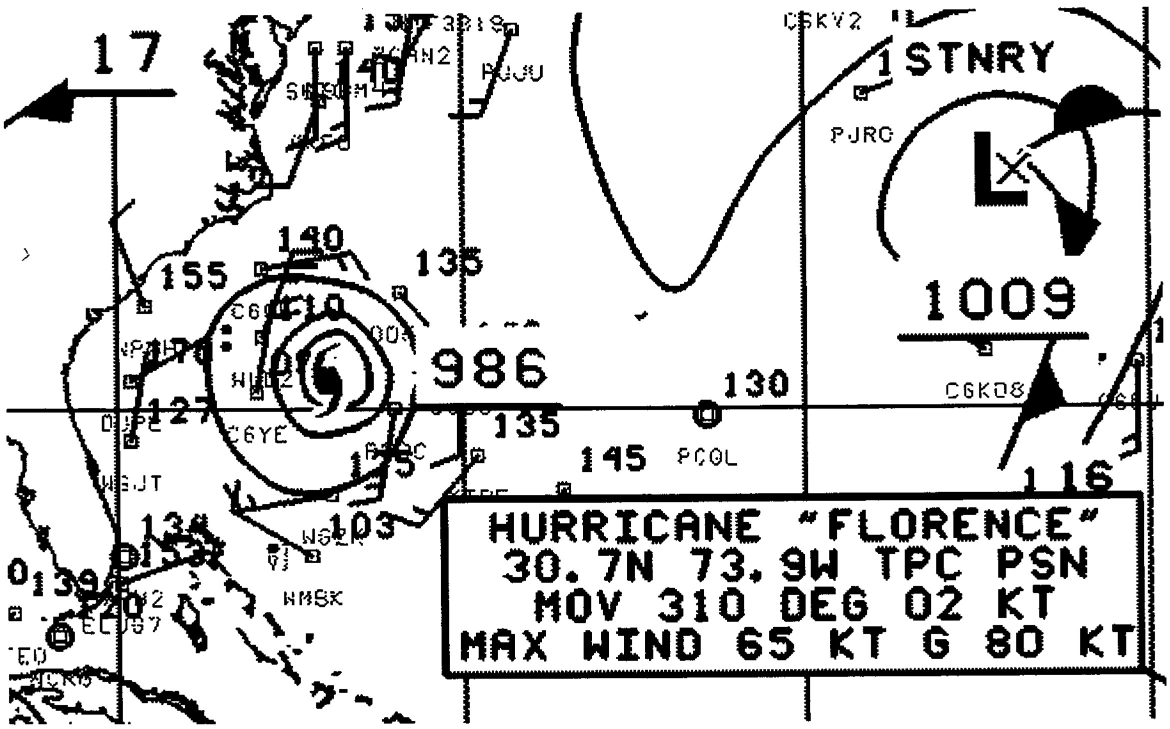
By 00:51 LT we had pulled the streamer in to bird 15. We would have continued to bird 14, but a bad coil on the streamer reel made that ill-advised. Bird 15 was found to have a serious tangle of silver tape wound around it, preventing it from normal operation. Very little lead was present on the near sections. We redeployed the forward half of the streamer and started Line R3 at 06:45 LT. The streamer was stable in the 2-4 m depth range. By later in the morning, however, streamer instabilities started cropping up again, with "waves" of surfaced streamer propagating back through the streamer every 30 minutes or so, creating noisy sections. Many of these problems begin in turns, when we lose control of the streamer. The front tends to be too deep, and the aft part too shallow. A consistent problem seems to be an annoyingly large response time for the birds to react to their depths -- it often takes minutes for a bird to realize that it needs to change its fin angle, by which point it is often too late (the bird having surfaced). (Chris later addressed this problem by changing the "gains" on the birds.) Throughout the day we tried various strategies of flying the streamer, and various depths, but to no avail. Although conditions have been workable, we are probably suffering in part from a noticeable deterioration in sea state -- by 12:37 winds were at 19 knots. We began a strategy of putting the streamer down to 6 m depth in preparation for a turn, but even that usually failed to keep the streamer from surfacing in the turn.

In the mid-afternoon we decided that it was going to be impossible to keep the streamer at a depth similarly shallow to the GI gun towing depth (2.5 m), and that an alternative strategy was needed. Since we couldn't keep the streamer from surfacing at shallow tow depths, we decided to try towing it significantly deeper (16-18 m), in order to move the streamer ghost notch down to 40 Hz, which should be sufficiently different from the source ghost notch (300 Hz) to preserve broadband signal. This would be experimental, and we would have to carefully monitor the source wavelet to ensure that it was not too distorted by such an unusual geometry. At 13:56 LT we set all birds to a target depth of 12 m, planning to bring the streamer gradually down to an 18 m target depth. At 14:01 we began a turn (which was not good timing for this attempt at a new streamer depth), and at 14:03 we set the birds to a 16 m target depth. By 14:11 it was clear that some birds were sinking too readily (several had reached 25 m), so we brought the target depth back up to 12 m. Unfortunately, this did not stop the streamer from sinking further, and by 14:20 some birds were at 35 m depth. Chris and the captain were informed of the situation. By 14:29 birds #13-15 were at 45 m depth, and since this was new territory for most of us, the mood in the lab was tense. The maximum depth attained during this episode was 47.5 m; by 14:47 the situation was under control again, and the streamer began coming up. We cancelled our next turn and asked the bridge to come up to 5.5 knots through the water. By 15:17 the streamer was back to 8-10 m depth, apparently none the worse for wear, and we started a turn. Again, the streamer reached a depth of 47 m at its lowest point in the turn, even though we had started at a much shallower depth than before -- the streamer was simply too heavy to maintain a reasonable towing depth through a turn. This was becoming fairly frustrating. We modified our plan to minimize sharp turns -- i.e., the streamer instability was affecting our ability to shoot a particular desired track plan.

12 Sept 2000, Tuesday

Streamer stability problems continued through the day and became a bit wearing on the watchstanders -- "flying" the streamer became a nearly full-time job. There were brief periods of hope when the streamer appeared to be stable, but this invariably ended in disappointment. The sea state worsened through the day, which didn't help: by mid-afternoon we were getting consistent 6-8' swells, with occasional 12' swells -- probably the effect of Hurricane Florence, which was several hundred miles east of us. We began surfacing the streamer before turns in order to keep it from sinking uncontrollably, which inevitably led to useless patches at the ends and beginnings of lines. We shot Lines R9, R10, and R11 today.

In mid-afternoon the captain reported that Hurricane Florence had changed direction toward the north but was still moving slowly. This course change bought us a little more time; if Florence had continued on her westward course, we would probably have had to pull gear in immediately to run. We agreed on a plan: we would finish the current line (R11) at about midnight and stand ready to pull in the streamer, pending receipt of updated weather info at that time.



13 Sept 2000, Wednesday

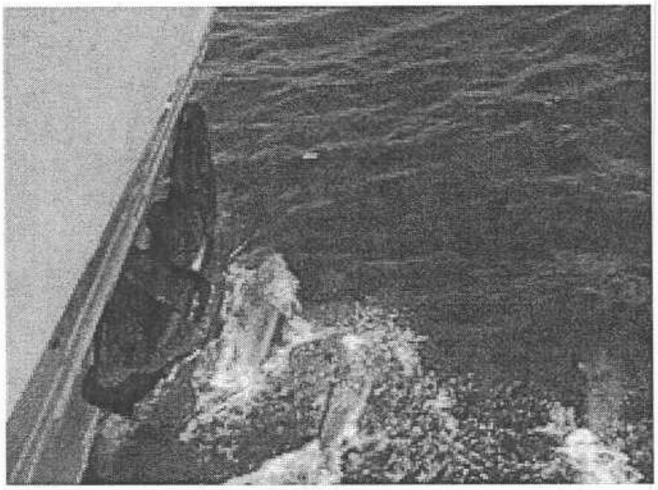
Just after midnight the captain informed us that the latest weather showed Florence heading straight toward us. We decided to pull in the streamer and run west. The streamer was on board at 0430 LT. The tailbuoy appeared to be destroyed, and the GPS unit gone.

We steamed due west as far as 77° 10' W to put some distance between us and the hurricane. At that point, instead of steaming slowly back to the work site, with an uncertain continuing delay, the captain approved an alternative plan: We would head northeast to the Blake Ridge diapir (another site drilled on Leg 164), deploy and ballast a 4-km-long streamer, then shoot across the diapir and down the nose of the ridge toward the 3D box, as Florence allowed. The reason for going with a 4-km streamer was twofold: (1) Our experience so far showed that it would not be possible for a 6-km streamer to tow in a stable fashion at shallow depths, but a 4-km streamer would have significantly greater bird density and thus a good chance of stability; and (2) we did not want to do more than one more deployment of the streamer if possible, so it was not practical to shoot the diapir with a 6 km streamer.

On deployment at 2100 LT, the tail buoy was listing heavily to one side, so we recovered it. Chris and Karl discovered and repaired a hole, and they strapped additional flotation to the buoy as well, which fixed the problem.

14 Sept 2000, Thursday

The streamer was fully deployed at 0356 LT, and we began shooting Line R14 with the streamer stable at 5 m. The weather was calm, with minimal swells, though 20 knot winds were kicking up some light chop. Just after 1100 LT, the bridge alerted us to a pod of about 8 dolphins playing in the bow wave, and several of us went up to the forepeak for a wonderful show. The dolphins played for at least 20 minutes (a good photo op), then suddenly departed off to port, as if bored with us.



We finished up the diapir lines and, thanks to a favorable northward turn by Hurricane Florence, headed down the ridge crest toward the 3D area. We finished Line R18 at 23:33 LT and began the 3D shoot with Line 3D-47. During the 3D shoot we will tow the streamer at 4 m and the 2 GI guns at 2.5 m; although this is not an ideal configuration, we have verified that the source wavelet is acceptable (no "Fedora hat" artifacts). We do not believe it would be wise to attempt to tow the streamer at 2.5 m: even though we can achieve that towing depth with the 4 km streamer in calm weather, we cannot count on maintaining that depth throughout a 3-week period, and consistency of the source wavelet will be important for imaging in the 3D volume.

15 Sept 2000, Friday

We are settling into the routine of shooting the 3D data, which should occupy us for the next three weeks. The streamer navigation program is working well, except for the tailbuoy GPS, which is not functioning. We are able to monitor streamer feathering (which is vitally important for our plan to fill the 3D box at 75 m) and will be able to get updated bin maps as we proceed through the box. The streamer is behaving well; the higher bird density of the 4 km streamer really helps. We shot lines 3D-47, 3D-05, 3D-51, and 3D-09.

16 Sept 2000, Saturday

More 3D shooting: Lines 3D-55, -13, -59, and -17. During the day we realized that even though we only deployed 4 km of streamer, the data is coming through the additional 2 km on the reel, which apparently requires that those channels on the reel are recorded. We are thus wasting 3490E tapes. On the turn from 3D-59 to -17 Chris disconnected the 2 km on the reel from the rest of the streamer, and from that point forward we were only recording the 324 channels of interest. Sea state good; streamer stable.

17 Sept 2000, Sunday

3D continues: Lines 3D-63, -21, -67, -25, and -71. The sea state is worsening a bit, causing the front of the streamer to pop up during turns. Not a big deal yet.

18 Sept 2000, Monday

3D redux: Lines 3D-29, -75, -33, and -79. Sea state has worsened throughout the day. The data quality is good when the streamer is at 4 m, but we are having some difficulty getting the streamer down after it surfaces in a turn. We suffered a hydrosweep failure at 2200 LT, which lasted about 30 minutes.

19 Sept 2000, Tuesday

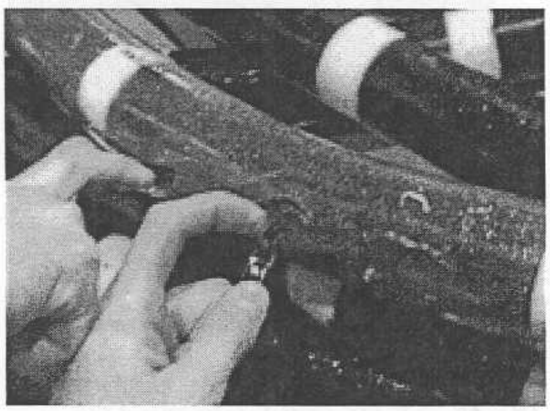
3D galore: Lines 3D-37, -83, -41, -87, and -45. The sea state remains about the same as yesterday: workable but a little rough.

20 Sept 2000, Wednesday

3D rules: Lines 3D-88, -03, -49, -07, and -53. There is some confusion as to the name of Line 3D-88: the waypoints are 89A and 89B, but the labels say -88, and the line is called 3D-88 in the ts files.

21 Sept 2000, Thursday

3D sharkbite: After we completed Line 3D-11 and started -57, acquisition errors began occurring around 1100 LT -- file numbers were not updating properly on the acquisition monitor screen, and the LABEL program froze. Chris restarted the acquisition program at 1129 LT, but the streamer failed to initialize (Chris' reaction: "That's not good.") It looks like there is a bad can around bird #4 -- pretty far aft. Chris was able to rebuild the streamer with only 23 cans (as opposed to our earlier 27), giving us 276 channels out of our original 324. The maximum offset is now 3335 m, instead of 4000 m. This presented us with a decision to make: we could probably go on fine with this shortened streamer, or we could pull it in and repair it, which would cost time. We decided that the combined considerations of maximum offset plus filling cross-line bins required us to pull in the streamer and fix it. This would have the added benefit of allowing Chris and Karl to attempt to fix the tailbuoy GPS. Upon recovering the streamer, we discovered the cause of the streamer failure: shark bites (see photo below). During the evening Chris and Karl worked on the tailbuoy GPS, and at 2118 LT we began redeploying the 4 km streamer, which we finished at 0055 LT (Friday).



Shark-bit.

22 Sept 2000, Friday

3D returns: Lines 3D-15x, -61, -19, and -65. The streamer has been riding very stably at 4 m since the redeployment.

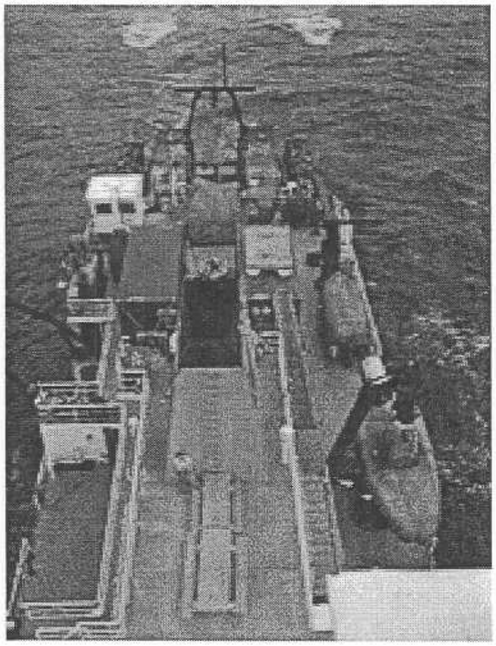
23 Sept 2000, Saturday

3D slop chest: Lines 3D-23, -69, -27, -73, and -31.

The tail buoy GPS has been working since our redeployment of the streamer, but only intermittently. This turns out to be worse than not having the tail buoy at all, since occassional loss of tail buoy fixes causes the realtime streamer navigation program to crash. We have therefore decided not to use the tail buoy GPS fixes in our streamer navigation. This decision is bolstered by Harm's investigation of the mismatch between tail buoy position as predicted by the compass birds (our standard method so far) and as measured by the tail buoy GPS: somewhat surprisingly, the mismatch is only 6-12 m (remember, for a 4-km streamer) while steaming on line. This is well within our tolerance for binning at 12.5 CMP spacing, especially since the CMP's will only be mislocated by half of the 6-12

m. The compass/GPS mismatch is greater during turns (>50 m), but that is less critical to our dataset.

Today Chris and Karl climbed up into the crow's nest to place the tail buoy modem antenna in a higher profile position, in the hope that that would alleviate the GPS communication problem. (Steve got a chance to climb into the crow's nest as well, thus fulfilling a lifelong -- well, cruise-long -- ambition.) The antenna repositioning seemed to work -- although fixes were not coming in every second, they were coming in at least every 10 seconds, which would have been adequate for our shooting rate. Unfortunately, though, during the night the tail buoy lost power, so all was for naught. Chris suspects the power converter, which was cobbled together after we lost the first tail buoy, since there was no spare. We do not expect to have tail buoy GPS for the remainder of the cruise.



The view from the crow's nest.

<u>24 Sept 2000, Sunday</u>

3D barbecue: Lines 3D-77, -35, -81, and -39.

Seas overnight were a little higher than in the past two days, but the swell is still only about 2 m, and data quality remains high. We will have to keep a close eye on Hurricane Isaac, though -- this storm sounds nasty (sustained winds already at 110 kn), and although it is still 2000 miles away from us (at 15.1°N, 35.7°W), it is moving WNW, in our direction.

<u>25 Sept 2000, Monday</u>

3D Monday: Lines 3D-85, -43, -86, -40, and -82.

<u>26 Sept 2000, Tuesday</u>

3D forever: Lines 3D-36, -78, -32, -74, and -28. We had an acquisition system failure on Line 3D-78 that resulted in an 8-minute gap in recording (sounds Watergate-ish). Chris restarted the acquisition and also set the birds to be a bit more responsive -- they had been having some trouble keeping the streamer level.

<u>27 Sept 2000, Wednesday</u>

3D jeebees: Lines 3D-70, -24, -66, -20, and -62.

We decided to change the acquisition to record only 9 s of data, rather than 10 s, to save tape.

Isaac is now 1600 miles away from us and still moving in our direction. At 12 knots, that's about 5 days away. It has weakened a bit (winds at 90 kn) but still packs a sufficient punch to be worrisome.

28 Sept 2000, Thursday

3D shall set you free: Lines 3D-16, -58, -12, and -56.

29 Sept 2000, Friday

3D fire and boat drill: Lines 3D-10, -52, and -04. During Line 3D-04 the streamer's front end became somewhat erratic in its depth-keeping abilities, surfacing often. We decided to pull in the front of the streamer and investigate (one of the guns came aboard with some fishing gear tangled in it, and it is possible that the forward birds are similarly hampered). This only took two hours, and by 1134 LT we were ready to shoot again, picking up with Line 3D-42x, -04B, and -50. The streamer continues to be a bit "lumpy." We discovered at 21:58 that one can (12 channels) was not recording, and examination of the logs showed that this has been happening since BOL 3D-50. Chris rebuilt the streamer successfully at 2230 LT, and we started Line 3D-02.

30 Sept 2000, Saturday

3D weather: Worsening conditions (winds 34 knot, max gust 32 knots, agitated sea state with occasional breaking waves and some streaming foam) are causing gun problems (towing lines and bundles). After Line 3D-44 we break off at 1122 LT to deal with the problems. Streamer tension fine. We wait for an improvement in conditions.

1 Oct 2000, Sunday

3D encore: At 0133 LT we redploy the guns, as the ride has become quite reasonable, especially with a following sea, and the seas appear to be laying down somewhat. Lines 3D-88, -48, -80, and -42. Gun problems continue (due to rough seas), keeping Carlos, Ropate, and Winston busy with repairs. By late in the day it is raining hard and the wind has picked back up. The streamer depth is a little wobbly. At 2000 LT we decided to stop shooting again and wait out the weather.

2 Oct 2000, Monday

3D blues: We try again at 0900, starting Line 3D-42X, and continuing with -42Y and -76. Conditions not perfect, but we are getting useful data.

3 Oct 2000, Tuesday

3D on my mind: Lines 3D-38, -72, -34, -68, and -30.

4 Oct 2000, Wednesday

Variations on a theme in 3D: At this point we have abandoned approximately 10 of the intended lines whose CMPS were covered by feathering on adjacent lines. Instead, we are planning new traverses through the 3D box, with waypoints hand-chosen so as to fill in the worst of the remaining gaps. Most of these lines zig-zag through the box in a non-obvious way. Waypoints can only be selected two or three lines in advance, since we need to calculate continual updates to the CMP bin map in order to select an optimum gap-filling path. We shoot Lines 3D-64, -26, -60, -22, and -65X.

We are aiming to end the 3D shooting by Saturday at noon. If we don't encounter any more weather delays, this should allow 2.5 days of OBS work and about 5 days of regional 2D lines with the 6-km streamer.

5 Oct 2000, Thursday

3D anxiety: We are concerned about Tropical Storm Leslie, which is currently east of Florida and forecast to move straight over our position. Nevertheless, we forge ahead with Lines 3D-14, -50X, -28X, and -87X. None of the lines are straight anymore; they are all targeting specific gaps, so there are several waypoints and turns along each line. Harm the Navigator is keeping us well up to date with bin maps.

6 Oct 2000, Friday

3D escape: Tropical Storm Leslie stayed south of us and skirted east without appreciably affecting the winds or seas. Having dodged another bullet, we continue shooting the remaining gap-filling lines in the 3D box: 3D-39X, -11X, -29X, -58X, and -13X.

7 Oct 2000, Saturday

3D Photo Finish: Lines 3D-21X and 82X. Seas continued to be calm until the end of the 3D shoot. At about 1000 LT we stopped shooting, having continued Line 82X 9 miles west of the box. Bin maps showed that there is one remaining 70 m gap adjacent to the east end of Line 20; unusually, the streamer was feathering north during the attempt to fill that gap, so we missed the gap. We may shoot one of the last 2D lines with the 6-km streamer over that gap if time allows at the end of the cruise.

Recovery of the 4 km streamer went normally; Chris double-checked the bird, can, and section positions against his list during recovery, so that we would be absolutely certain as to the streamer geometry for final geometry processing of the 3D data (there was some uncertainty after the last redeploy as to the exact bird positions). The tail buoy came aboard shortly after 1300 LT, and we got underway for the 8-mile steam to OBS C4, the instrument that failed to release from its anchor during the OBS recovery operation several weeks ago.

Our plan regarding the OBS operation is as follows: We will first see if OBS C4 communicates to our deck unit. If so, that would indicate that the instrument is not flooded and therefore probably has sufficient positive buoyancy to return to the surface, so we will attempt to drag for it, after first recovering OBS A8 from the 3D box, so as to give Chris and Karl time to prepare the core winch for dragging operations. If OBS C4 does not communicate, that indicates it is either flooded, gone, or otherwise inoperable, and we will give up on it, recover OBS A8, and then begin with the final deployment of 7 OBS's on the drilling transect.

OBS C4 did in fact communicate with us at 1415 LT with a slant range of 2794 m, but it would not release (no great surprise). We informed Chris that there would be a dragging operation later in the day.

We successfully and uneventfully recovered OBS A8 at 1640 LT.

Dragging operations began at 1751 LT and continued until 2144 LT, requiring almost exactly the four hours that Chris had estimated. We had no luck in budging OBS C4 from its position on the seafloor. With some sadness, we decided to abandon OBS C4 to its watery grave.

We began OBS deployments with C3 at 2221 LT.

8 Oct 2000, Sunday

OBS deployments went quickly and efficiently, with all seven instruments deployed by 0301 LT. We then deployed the mini-streamer and 6-gun array and started Line OBS9 at 0544 LT. We finished OBS9 at 1349 LT, deployed the 2 GI guns (twice, as a miscommunication caused them to deploy them first with a 5 m towing depth, when we wanted 2.5 m) and we shot Line OBS10, finishing around midnight.

9 Oct 2000, Monday

We shot line OBS11 by 0715 LT and recovered the guns and streamer, ready for OBS recoveries.

Overnight the seas picked up considerably and unexpectedly -- there were no major low pressure systems on the map, only a relatively benign-looking cold front that must have generated a gale while crossing the Gulf Stream. We are seeing 12-15' seas on the morning that we are to begin OBS recoveries. The ride is stable enough while pointed into the seas, but the concern is that we would have to manuever into the trough while approaching an OBS on the surface, which could get a little too exciting on the waistdeck. In consultation with the captain, we decided to release one OBS and see how the recovery operation goes, then decide whether to proceed with the rest of the recoveries.

We recovered OBS D9 at 1333 LT without incident; the recovery went smoothly and safely. It is challenging to hook the instrument as it bobs up and down with the seas, but the bridge crew did a fabulous job of keeping the OBS right under our position so that we could have multiple stabs at it. (Later, 2nd mate Dave Wolford, who watched a recovery from B deck, remarked that if he hadn't already known what we were doing, he would have concluded that the operation simply entailed several grown men beating an orange sphere with long sticks.) After that recovery, we concluded that it was safe to proceed with recoveries through the day.

One casualty of the heavy seas was our plan to shoot (separately) to two OBSs while they rose through the water column. This would have been a good way to measure both the source wavelet and source directivity, and the relative ease of deploying and recovering the GI guns would have made this practical on recovery of an OBS. However, the plan would have entailed us ending up a mile or more away from the surface position of the OBS, which we deemed too risky (even in daylight) in such a high sea state. We will have to leave that idea for another cruise.

We continued with recoveries throughout the day. Unfortunately, we had one more recalcitrant instrument: OBS A3, which we were not able to recover. Numerous release commands were sent, and we could not confirm release. Acoustics were inconsistent, though the most consistent slant ranges were around 2800 m, suggesting that the OBS never lifted off the seafloor. All in all, we spent about six hours trying to recover OBS A3, including steaming several hours downwind and listening for a radio signal, on the off chance that the OBS had surfaced surreptitiously. All to no avail, and we had to face the fact of a second lost OBS.

<u>10 Oct 2000, Tuesday</u>

Streamer deployment began around 0230 LT and continued until around 1000 LT. We began deploying the two GI guns at 1030 LT, but due to a miscommunication (stemming from cancelling the plan to shoot to rising OBSs), Carlos still had the 5 m towing depth cables on, so we had to ask him to put the 2.5 m towing cables on. He swapped the guns one at a time, and they were both back on line at 2.5 m depth by 1200 LT (1600 Z), and we began shooting Line R13 (later renamed to Line R19 due to an error in naming convention).

The weather improved nicely through the day, and by afternoon seas were calm, and we were able to tow the streamer at 4 m depth consistently.

During the afternoon we began experiencing acquisition system problems (the system would freeze up totally and require rebooting). Eventually Chris and Bob A. tracked this down to a bad VME board in the Syntrak, and the system behaved stably from that point forward.

<u>11 Oct 2000, Wednesday</u>

In the early morning hours, the sea state had calmed sufficiently that we were emboldened to bring the streamer up to an even shallower towing depth -- at 0326 Z we set them to 3.5 m, and at 0650 Z we set them to 3.0 m, where they towed well. (The ideal towing depth would be 2.5 m, which is the gun depth, but we are hesitant to push our luck. Lines R20, R21, R22, R23 and R24.

At 1920 LT we were treated to a unique and beautiful sight: the launch of space shuttle Discovery. Several of us assembled up on the steel beach just after sunset, knowing that the launch was scheduled (thanks largely to ringleader Andrew Gorman). Not only could we see it from our distance of about 400 miles from Cape Canaveral, but it was an absolutely spectacular sight. It started as a bright line on the western horizon, emerging from some low-lying clouds into a clear, cloudless night sky. As it arced upward past Venus, the vapor trail behind it swelled into a pillar of red, lit by the sun that had set 20 minutes earlier. After the booster rockets tumbled away, the exhaust from the main engine billowed out into a streaked, silvery trail that looked like a huge (and very fast-moving) comet. All of this was mirrored in the ocean, which was calm. Our vantage point in the ocean afforded us an unusual view: instead of moving away from us after launch, the shuttle passed directly over us (at one point it was visible passing through the rails of the mast overhead). We were able to follow the shuttle, visible as a bright, fast-moving star, almost to the opposite horizon, when it suddenly winked out (which must have been the main engine cutting out). Looking back to the western horizon, the red column of exhaust was still visible (this now eight minutes after the launch), along with a huge, moonlit, platinum cloud high in the sky, which must have been where the shuttle pierced the atmosphere.

All in all, a most amazing experience.

12 Oct 2000, Thursday

The streamer has been riding so well that at 1450 LT we brought it up to 2.5 m towing depth, where it towed stably. This should give us the optimal bandwidth in our data. .) We recorded some spectacular data -- the best of the cruise -- on Lines R27 and R28, across the collapse structure.

13 Oct 2000, Friday

Overnight the sea state has picked up a bit -- we are getting 15 knot winds, even though barometric pressure is still up at 1023 mb, and skies are clear. We must be in a gradient zone between the high pressure system over the eastern U.S. and the front that's parked a few hundred miles east of us. We were forced to bring the streamer down to 3-3.5 m towing depth at 0930 LT. Lines R29, R30, R31.

14 Oct 2000, Saturday

We continued with the final 2D survey, shooting Lines R32-R37. The sea state continues to be sloppy, despite the high pressure -- swells of 6-8 feet brought out the streamer's tendency to pop to the surface, forcing us to tow it at 4.5 m. This will result in lower-resolution images for these lines.

15 Oct 2000, Sunday

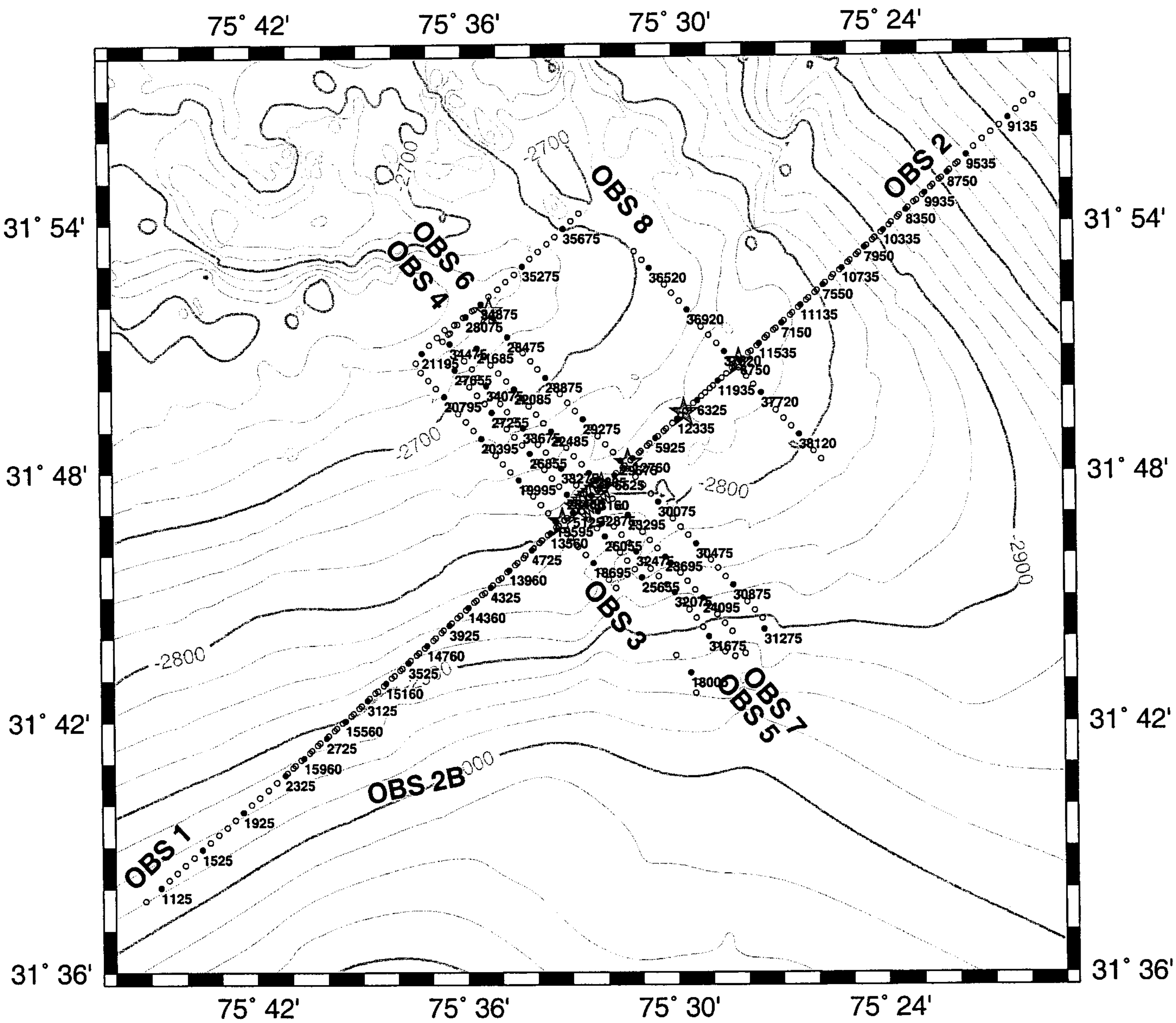
On our last day of shooting, we acquired Lines R38-R39. We ended all shooting at 1400 LT (as per the captain's orders) and began recovering the gear. The tailbuoy came aboard at 2030 LT -- impressively imploded, probably during the recovery operation, when a puzzlingly slow speed over the ground brought the streamer down to a new record depth (in our experience) of >100 m (!!). At 2045 LT we turned toward Norfolk. We requested a slight westward detour during the beginning of this transit so that we could fill in an important gap in our Hydrosweep coverage on the ridge crest; the captain readily agreed. We're making 9.7 knots during the early part of the transit, and it's a pretty rough ride.

16 Oct 2000, Monday

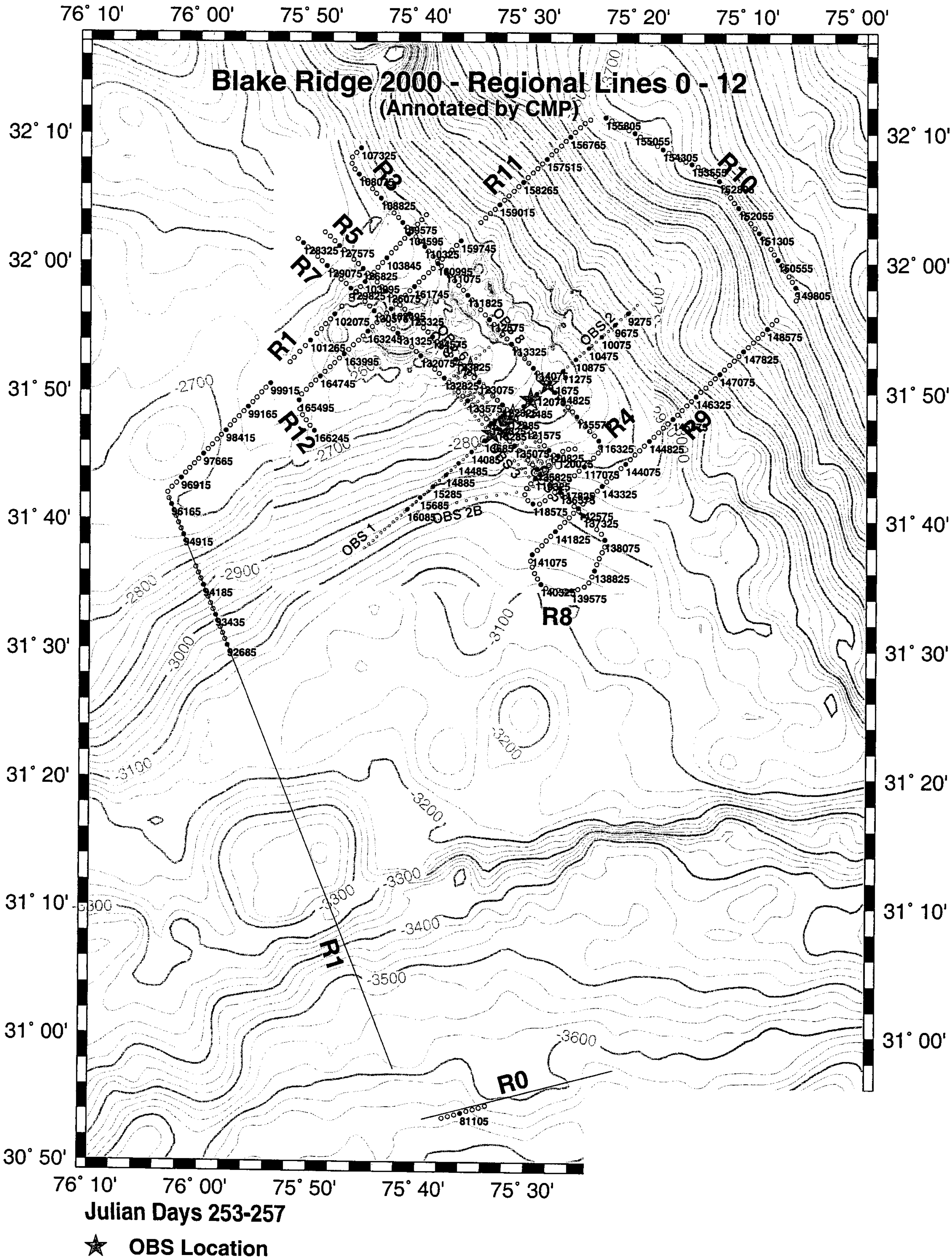
Transiting and cobbling away furiously on the cruise report. Sea state improving throughout the day.

17 Oct 2000, Tuesday

Blake Ridge 2000
First OBS Deployment - OBS Lines 1 - 8
(Annotated by CMP)

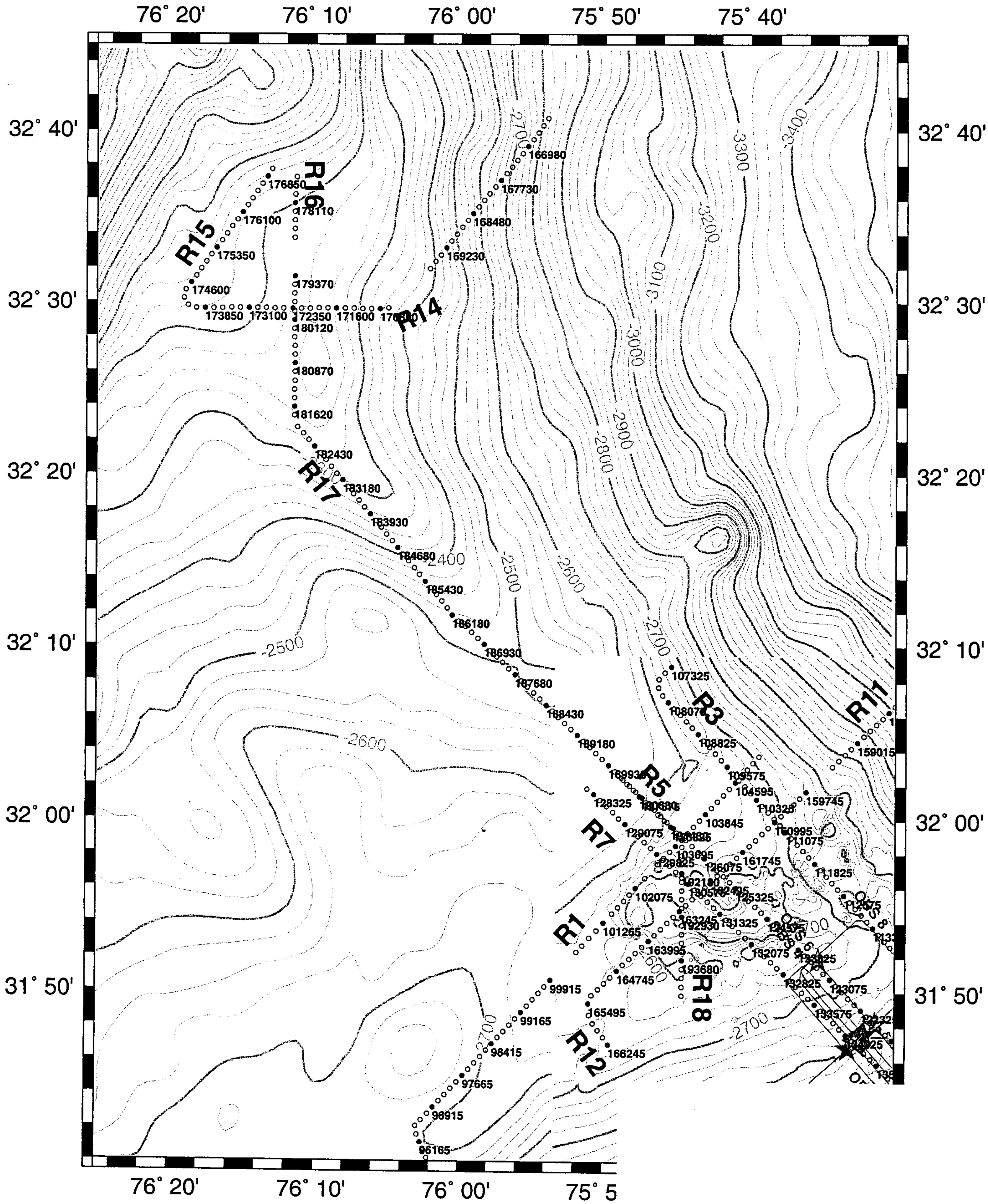


Julian Days 249-251 ★ **OBS Location**


Blake Ridge 2000 - Regional Lines 0 - 12
(Annotated by CMP)
76° 10'
76° 00'
75° 50'
75° 40'
75° 30'
75° 20'
75° 10'
75° 00'
32° 10'
32° 00'
31° 50'
31° 40'
31° 30'
31° 20'
31° 10'
31° 00'
30° 50'
R0
R1
R2
R4
R5
R7
R8
R9
R10
R11
R12
OBS 1
OBS 2
OBS 2B
OBS 8
-2700
-2800
-2900
-3000
-3100
-3200
-3300
-3400
-3500
-3600
Julian Days 253-257
OBS Location

Blake Ridge 2000 - Hurricane Florence Diversion

(Regional Lines 14-18 - Annoted by CMP)

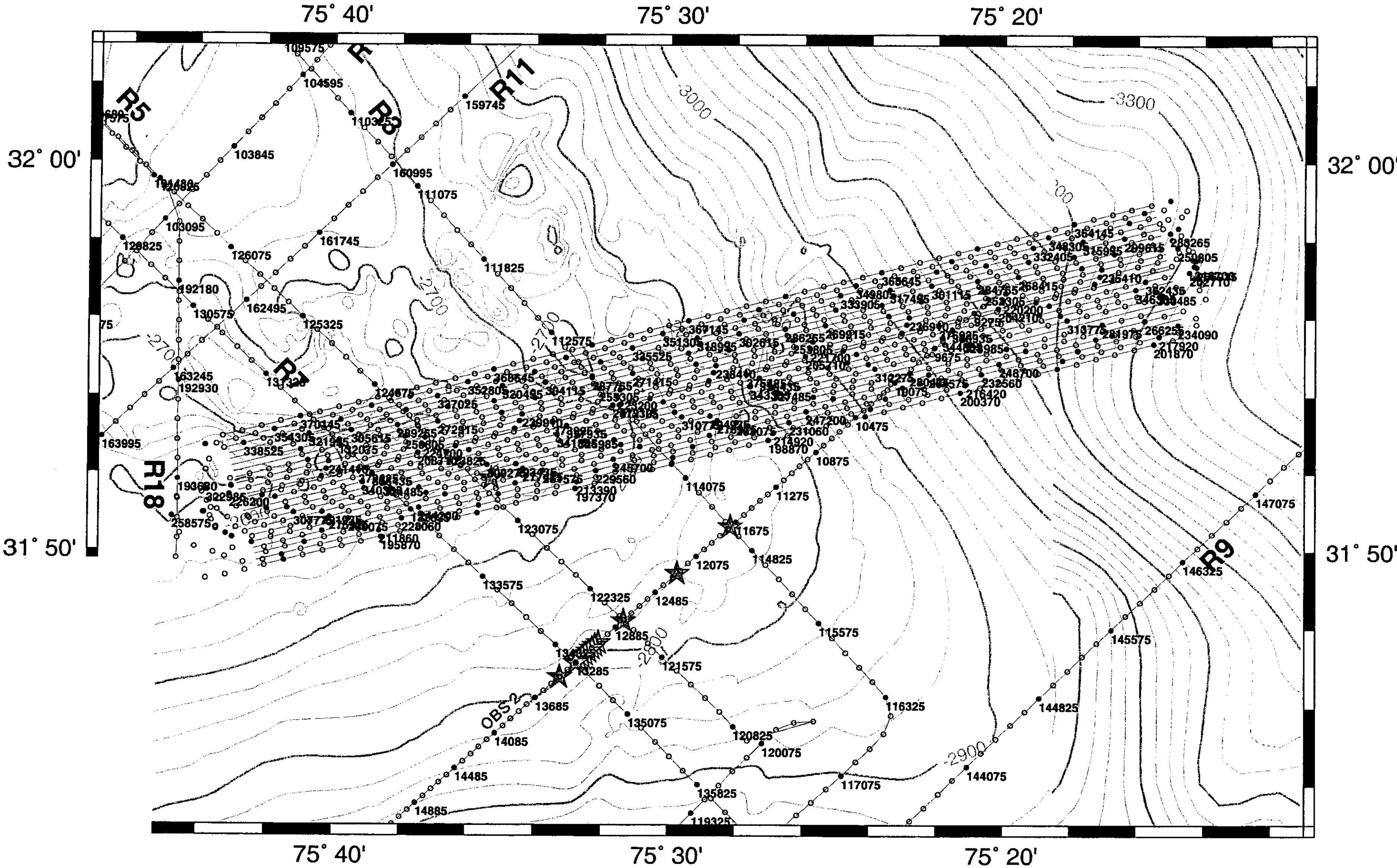


Julian Days 258-259

★ **OBS Location**

Blake Ridge 2000 - 3D Box - First Zamboni

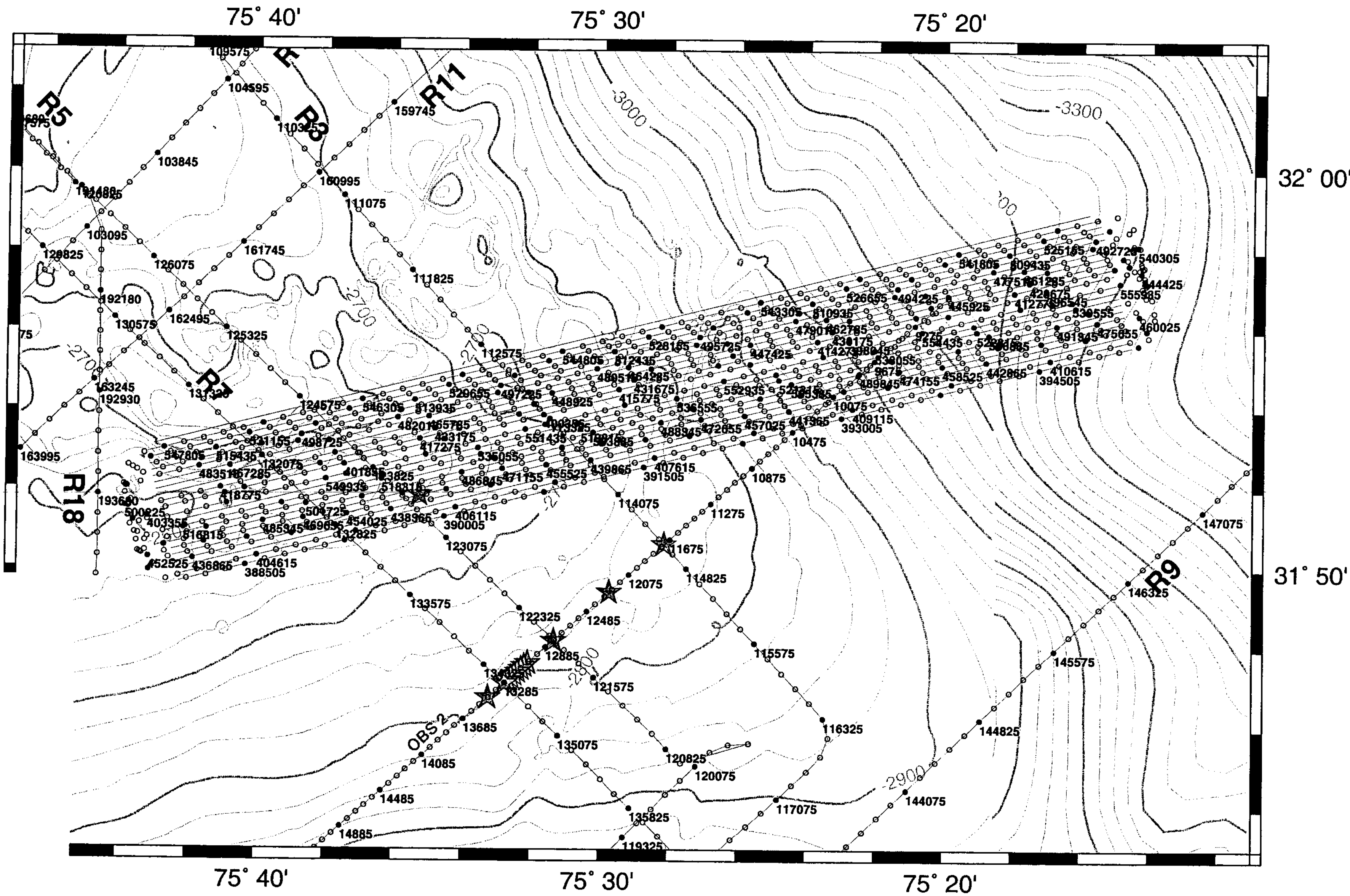
(Annotated by CMP)



Line numbers in 3-D Box increase from south to north:
1, 5, 9, 13, 17, 21, 25, 29, 33, 37, 41, 45 and
47, 51, 55, 59, 63, 67, 71, 75, 79, 83, 87
Julian Days 259-264

Blake Ridge 2000 - 3D Box - Second Zamboni

(Annotated by CMP)

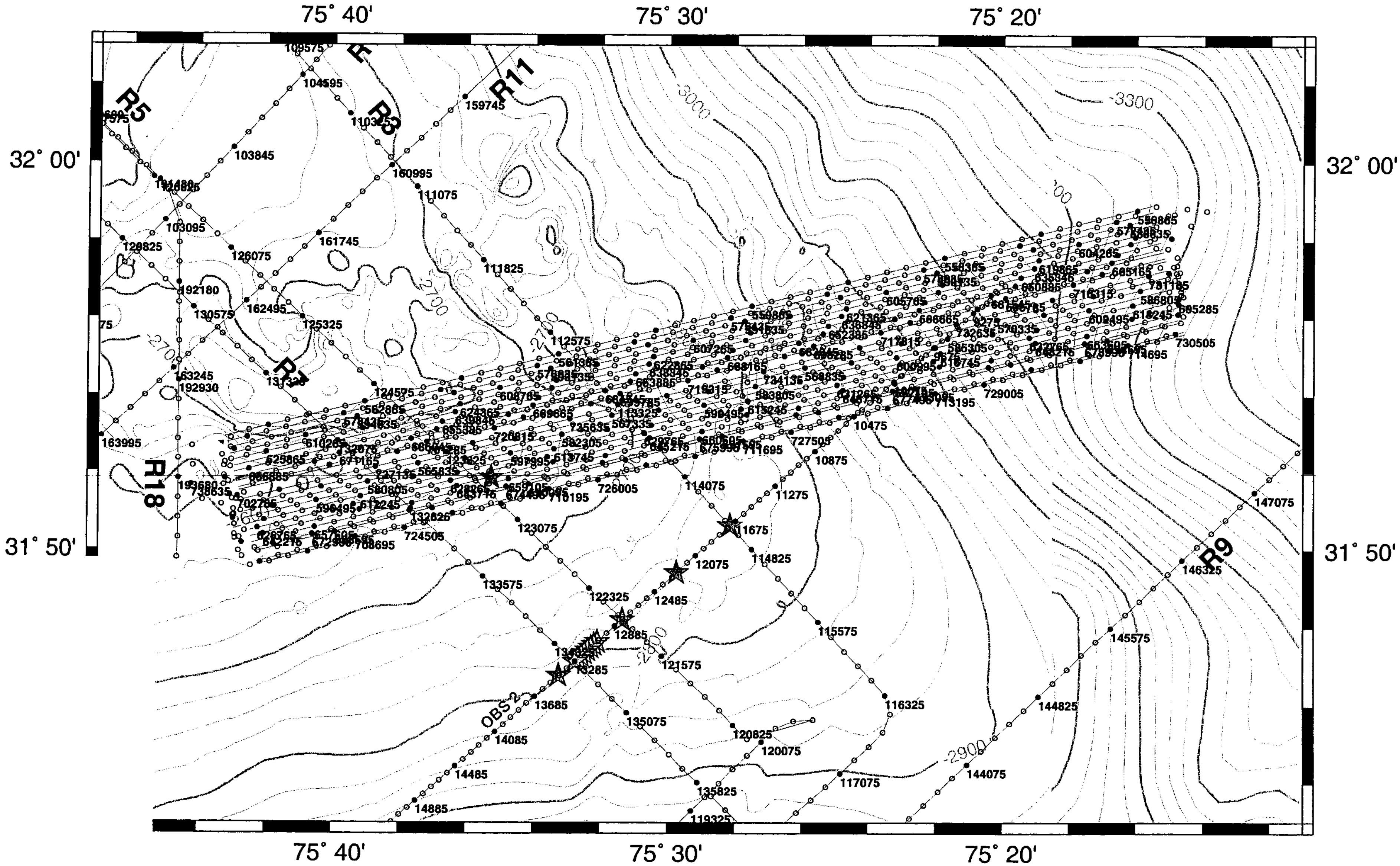


Line numbers in 3-D Box increase from south to north:
3, 7, 11, 15, 19, 23, 27, 31, 35, 39, 43 and
49, 53, 57, 61, 65, 69, 73, 77, 81, 85, 88
Julian Days 264-269

★ **OBS Location**

Blake Ridge 2000 - 3D Box - Third Zamboni

(Annotated by CMP)

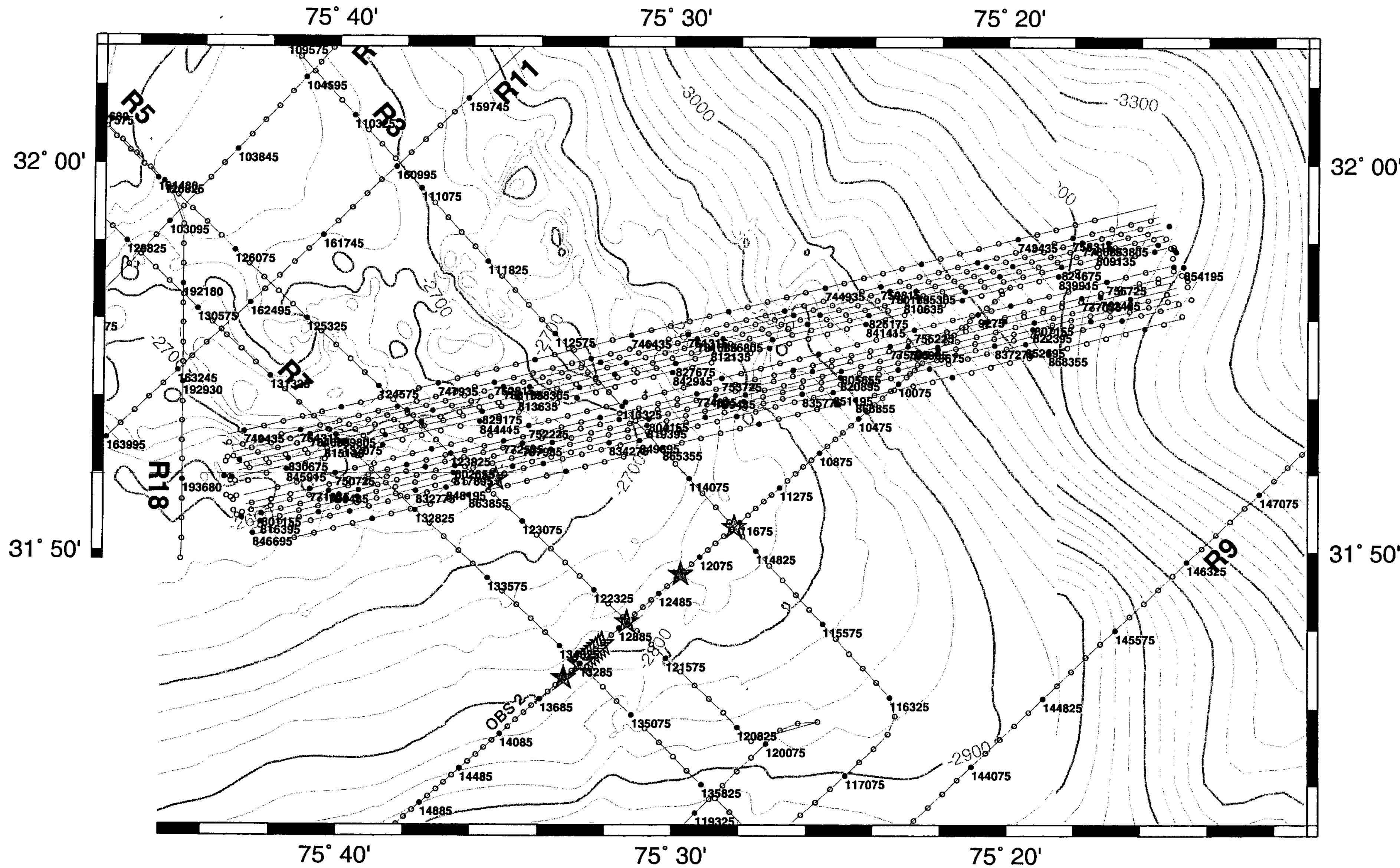


Line numbers in 3-D Box increase from south to north:
2, 4, 10, 12, 16, 20, 24, 28, 32, 36, 40, 44,
and 50, 52, 56, 58, 62, 66, 70, 74, 78, 82, 86
Julian Days 269-274

★ **OBS Location**

Blake Ridge 2000 - 3D Box - Fourth Zamboni

(Annotated by CMP)

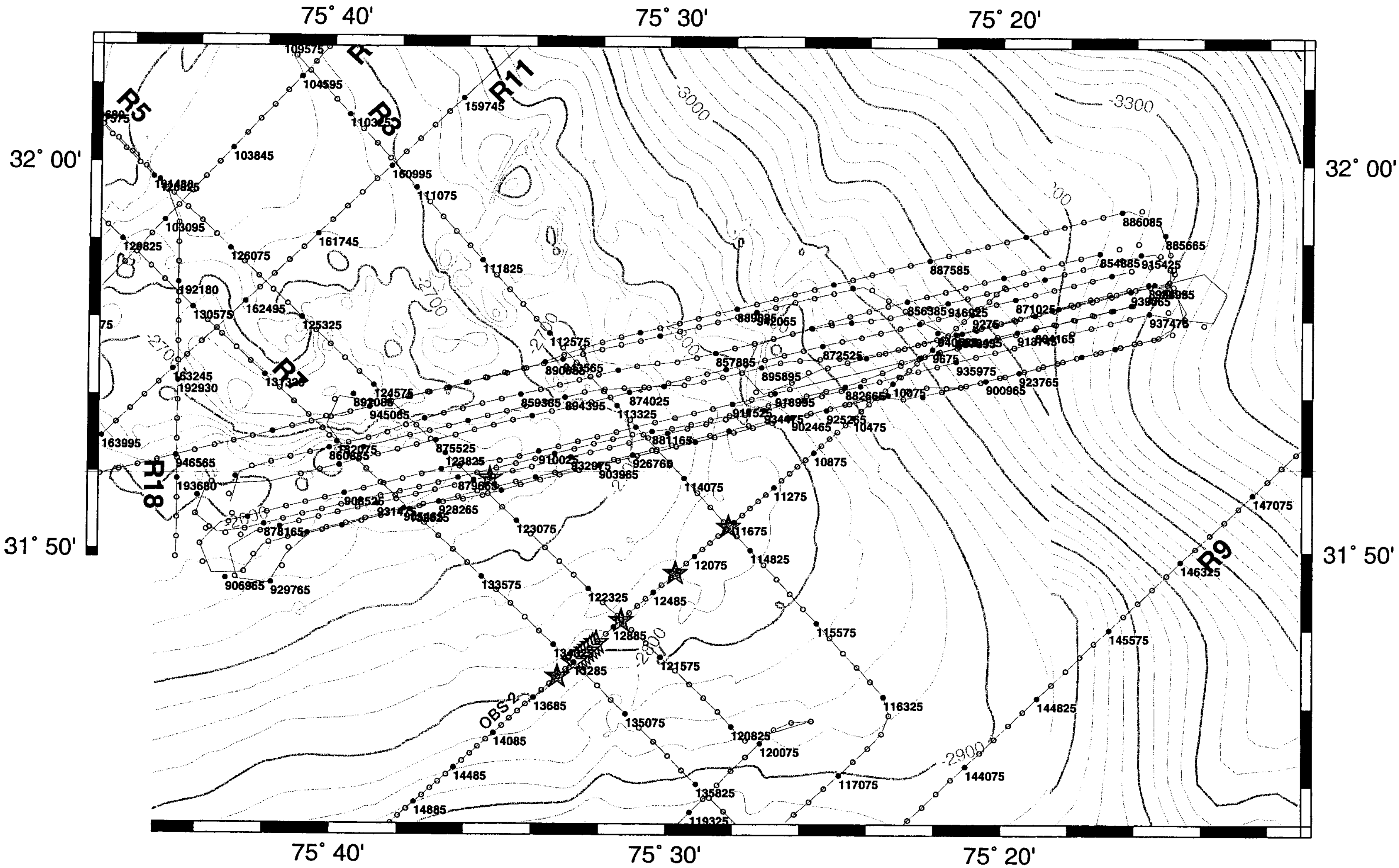


Line numbers in 3-D Box increase from south to north:
14, 22, 26, 30, 34, 38, 42, 48,
and 60, 64, 68, 72, 76, 80, 88X
Julian Days 274-279

★ **OBS Location**

Blake Ridge 2000 - 3D Box - Make-up Lines

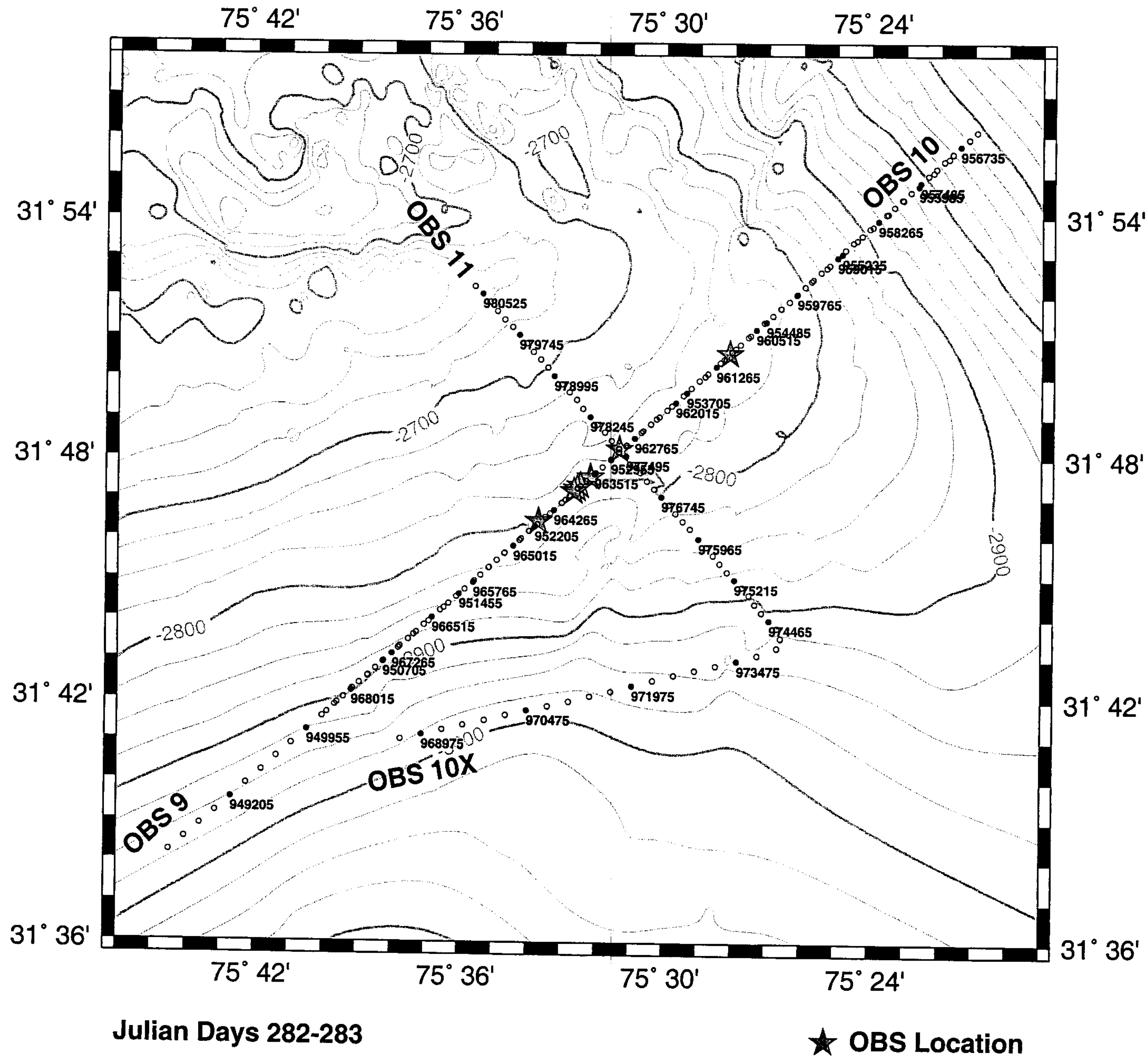
(Annotated by CMP)

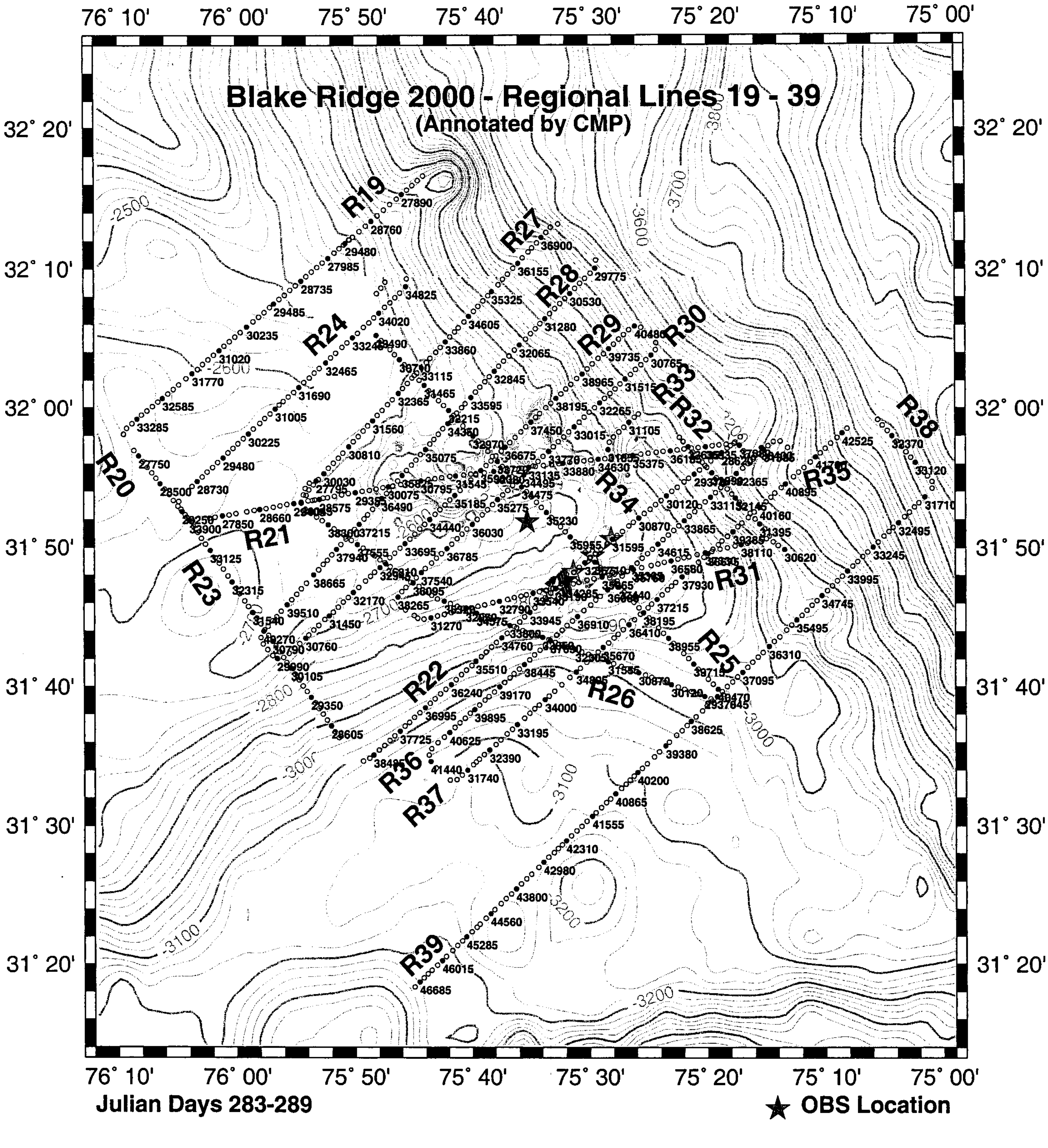


Line numbers in 3-D Box increase from south to north:
11X, 13X, 21X, 28X, 29X, 38X, 39X,
and 50X, 58X, 65X, 82X, 82Y, 87X
Julian Days 279-281

★ **OBS Location**

Blake Ridge 2000
Second OBS Deployment - OBS Lines 9 - 11
(Annotated by CMP)




Blake Ridge 2000 - Regional Lines 19 - 39
(Annotated by CMP)
76° 10'
76° 00'
75° 50'
75° 40'
75° 30'
75° 20'
75° 10'
75° 00'
32° 20'
32° 10'
32° 00'
31° 50'
31° 40'
31° 30'
31° 20'
R19
R20
R21
R22
R23
R24
R25
R26
R27
R28
R29
R30
R31
R32
R33
R34
R35
R36
R37
R38
R39
Julian Days 283-289
OBS Location

MCS and Shooting Operations

Acquisition Parameters.

We used the Syntron streamer in several different configurations during the cruise. For the regional 2D lines we used 6000 m (480-channels) of the streamer; during the 3D shooting and the Blake Ridge diapir lines, we used 4000 m (324 channels); during the OBS shooting we used 600 m (36 channels). Group spacing was 12.5 m for all configurations, yielding a CMP spacing of 6.25 m.

We recorded at a sample rate of 0.002 s, with record lengths varying from 9-10 s.

Shooting was done on distance, with principal shot intervals of 37.5 m during 2D and 3D MCS shooting and 20 m when shooting to the OBS's.

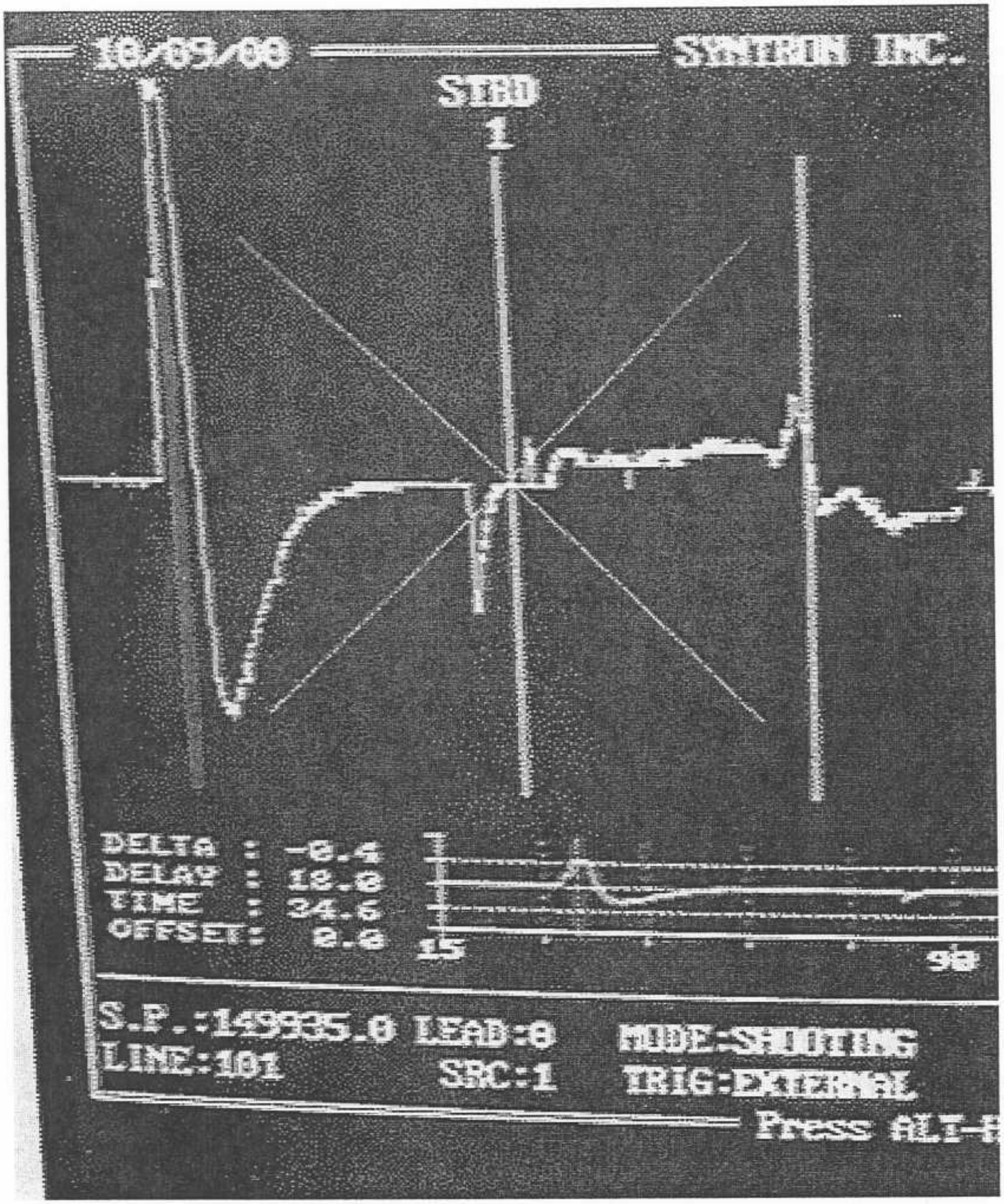
Shooting on distance served two goals: (1) It effectively randomized shot times, to prevent coherent previous shot noise, and (2) it simplified assignment of geometry in MCS processing.

Acquisition System

The Syntrak 480 acquisition system generally performed well, with the exception of system freezes during the final 2D shoot, which Chris traced to a bad VME board and repaired.

Airgun Array

We used two different source configurations: (1) a 6-gun, 8540 cu. in. (22 liter) airgun array throughout the cruise, with gun sizes ranging from 80 to 500 cu. in., and (2) a two-element GI (generator-injector) gun array, with GI guns configured at 105/105 cu.in. Guns were floated from Norwegian floats, with a nominal depth of 5 m for the 6-gun array, and either 2.5 m or 5 m (OBS only) for the GI guns. The airguns performed well throughout the cruise, with little maintenance needed, apart from occasional line tangles due to heavy seas. When functioning normall, the GI gun source is remarkably sharp and stable, with practically no bubble pulse (see Source Monitor Hydrophone section). However, through much of the cruise, a negative spike appeared on the blast phone monitor, which we believe produces a clear bubble pulse in the data (see figure below). The problem always occurred on the starboard gun. Chris thought that the spike might be due to electrical noise somewhere between the blast phone and the monitor (i.e., that it didn't actually indicate a gun misfire), but the presence of a bubble in much of our data contradicts that theory. In future cruises using the GI guns, an effort should be made to get to the bottom of this problem should it surface again.



Smaller

Streamer Configuration

The full Syntron streamer consisted of 480 channels, 6000 m total of active sections, 40 active cans, and groups spaced at 12.5 m intervals. The offset of the near trace (channel #480) from the center of the gun array is 181.65 m (see setback diagram), and the offset of the far trace (channel #1) is 6169 m. Other configurations used fewere channels. Twenty-four birds (12 with compasses) were attached to the streamer. Towing depth varied from 2.5 m (when possible) to as deep as 7 m in heavy seas (4 m was the target depth during the 3D shoot).

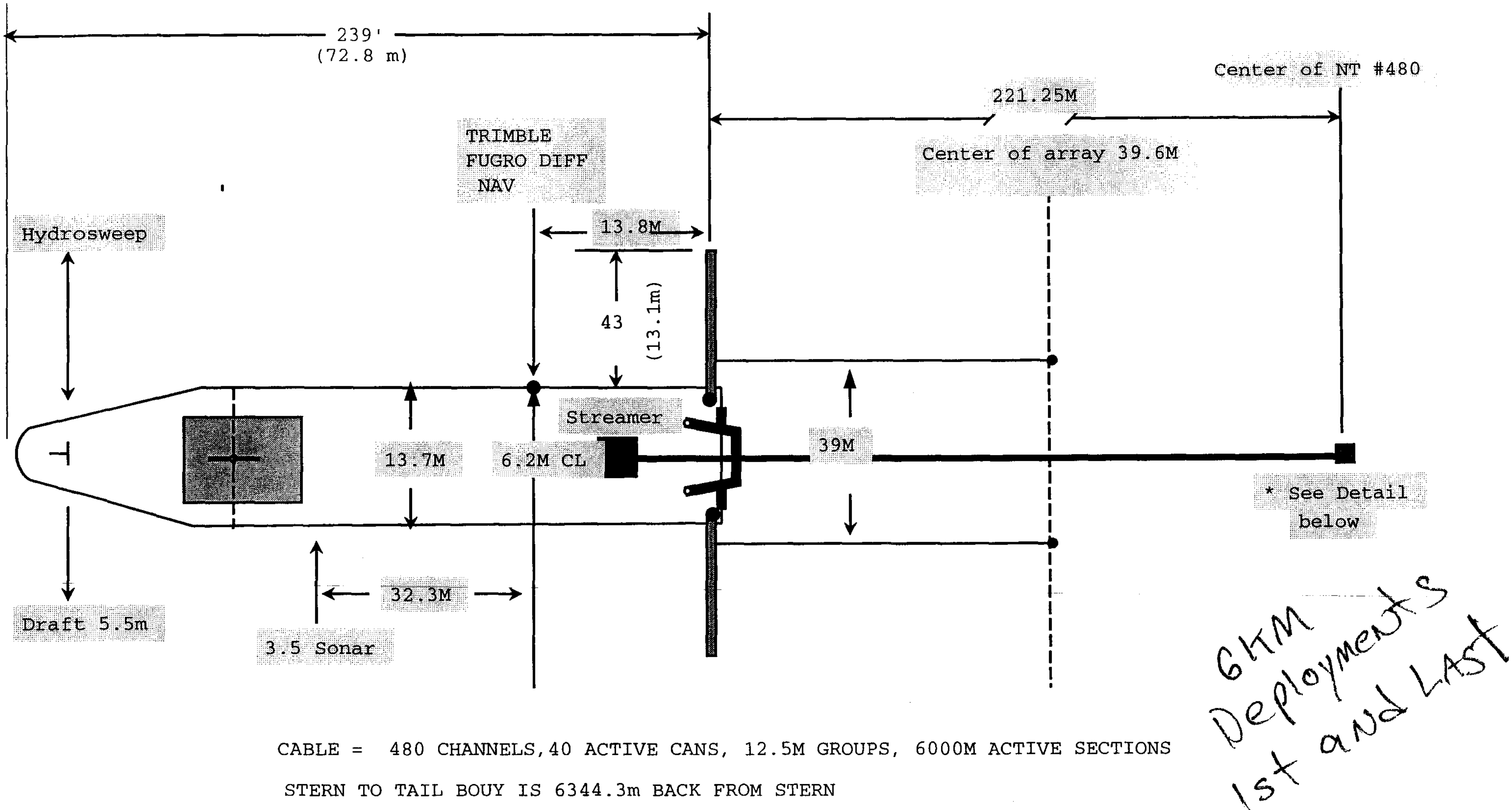
We had many problems with streamer balance, as detailed in the recommendations section.

3D Survey Design

The design of a 3D survey is a difficult procedure in which many competing factors -- including geological targets, survey size, line spacing, temporal and spatial resolution, and survey time -- need to be balanced. We decided on the following parameters (all of which, in hindsight, have held up as sound decisions):

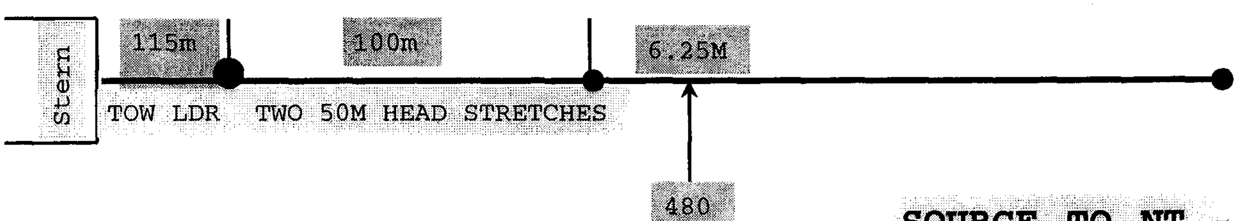
- The 3D box was approximately 6.5 km by 39 km in size (250 km^2) and was shot (as planned) in 22 days. The location was selected to cover a combination of stable ridge crest, collapse structure, and eroding ridge flank, and to encompass several high-priority proposed drill sites. It would not have been possible to achieve all of those objectives if the box had been located over the existing Leg 164 drill sites, so we instead acquired high-quality 2D tie lines between each of the drill sites and the 3D box.
- The box was rotated from its original NE-SW orientation into a more E-W orientation, due to our observation of currents during the 2D shooting. The predominant current direction was NE-SW, which would have given us very little streamer feathering in the planned box, thus preventing us from filling cross-line bins.
- Line spacing was 75 m. This decision was based on our observation of streamer feathering during the 2D shooting, which gave us reasonable (and ultimately justified) confidence that we could fill in 12.5 m bins between the shot lines.
- 4 m streamer towing depth. A 2.5 m depth would have been preferable (to keep the source and streamer ghosts consistent), but we knew we couldn't count on the 3 weeks of solidly good weather ~~we would have needed~~ to keep the streamer at such a shallow depth. The 4 m depth turned out to be a good compromise between resolution, source character, and streamer stability ~~and was a good decision.~~
- We used a 4-km streamer rather than the full 6-km streamer. This was a calculated risk -- although we would have preferred the full streamer (both for filling additional bins and for providing longer offsets), we were not confident that we would be able to keep the 6-km streamer stable at 4 m depth, given the greater spacing between birds. As it turned out, the 4-km streamer was just sufficient to fill in our bins at 75 m line spacing, and we were, by and large, able to tow it well at 4 m depth.

MAURICE EWING MCS SETBACK AND OFFSET DIAGRAM



CABLE = 480 CHANNELS,40 ACTIVE CANS, 12.5M GROUPS, 6000M ACTIVE SECTIONS

STERN TO TAIL BOUY IS 6344.3m BACK FROM STERN

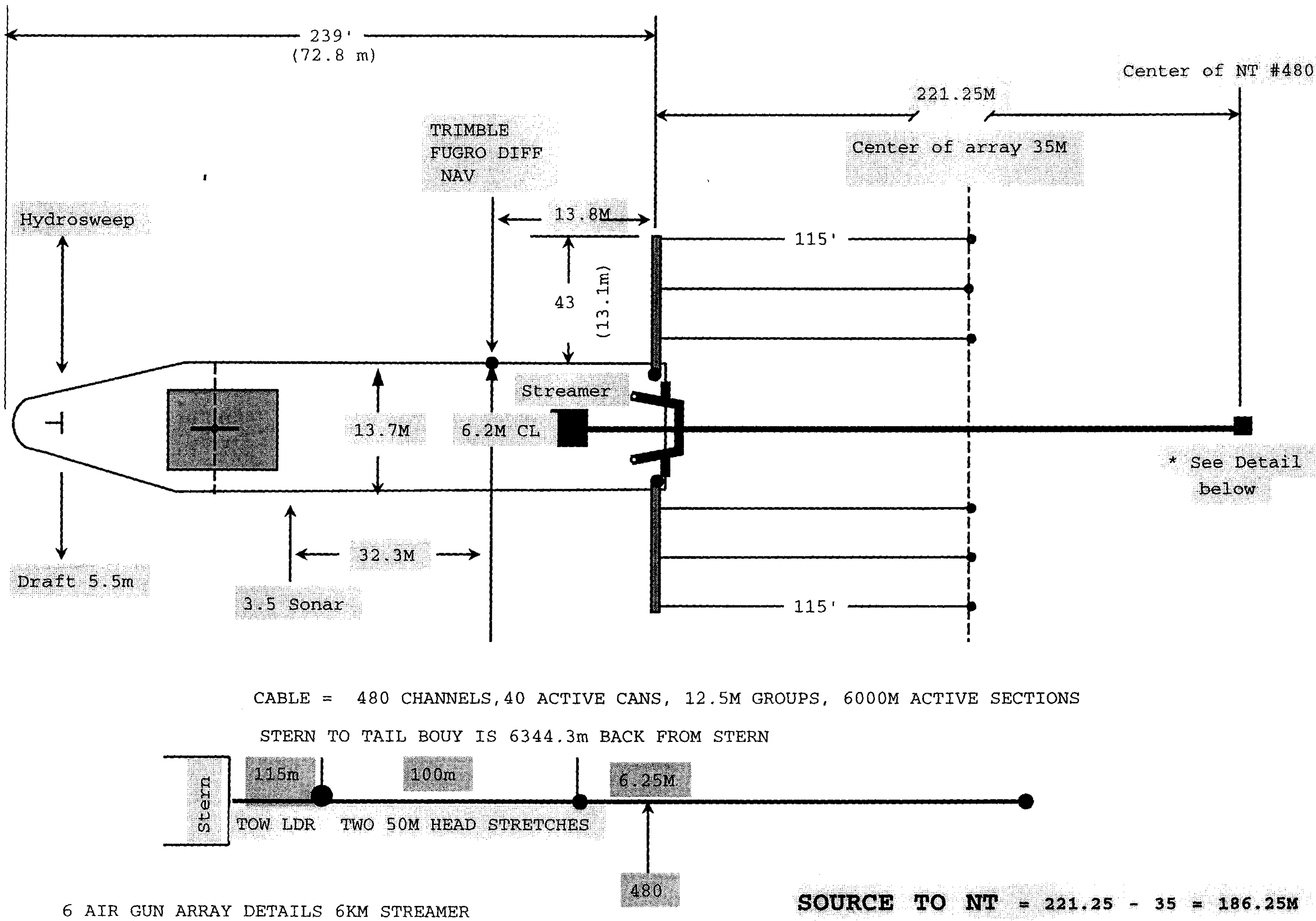


SOURCE TO NT = 221.25 - 39.6 = 181.65M

2 GI GUN ARRAY DETAILS 6KM STREAMER

OCT 16, 2000 CPL **CLIENT: HOLBROOK** **AREA: BLAKE RIDGE** **Cruise: EW-2008**

MAURICE EWING MCS SETBACK AND OFFSET DIAGRAM



OCT 16, 2000 CPL **CLIENT: HOLBROOK** **AREA: BLAKE RIDGE** **Cruise: EW-2008**

1st. 6KM Deployment

STREAMER CONFIGURATION

MOD	SERIAL #	CAN#	SHIP OFFSET	CHANNELS	BIRD	COMMENTS
TB			6344.3M			TAIL BUOY AT 6345M
STIC	CABLE 25.3M		6319M TO 6344M			
1		2151				POWER MODULE 12151
HS	30120-HS	50M	6269M TO 6319M			
TS	0697-30284TS	50M	6219M TO 6269M			
AT	0498-30024	4M	6215M TO 6219M			
	?????	RED	6140M TO 6215M	1 TO 6	1C	BIRD AT 6209M
2		3538				30291 shark bite
	0298-31388	ORNG	6065M TO 6140M	7 TO 12		
	0298-31407	RED	5990M TO 6065M	13 TO 18		
3		2734			2	Bird at 5996M & SRD1
	0198-31319	ORNG	5915M TO 5990M	19 TO 24		
	0198-31333	RED	5840M TO 5915M	25 TO 30		
4		2731			3C	BIRD AT 5846M
	0298-31385	ORNG	5765M TO 5840M	31 TO 36		
	0298-31399	RED	5690M TO 5765M	37 TO 42		
5		3165			4	BIRD AT 5696M
	0298 31416	ORNG	5615M TO 5690M	43 TO 48		
	0298 31361	RED	5540M TO 5615M	49 TO 54		
6		3607				
	0298-31402	ORNG	5465M TO 5540M	55 TO 60		
	0298-31337	RED	5390M TO 5465M	61 TO 66		
7		3189			5C	BIRD at 5396M
	0298-31382	ORNG	5315M TO 5390M	67 TO 72		
	0298-31390	RED	5240M TO 5315M	73 TO 78		
8		3606				
	0298-31346	ORNG	5165M TO 5240M	79 TO 84		
	0298-31381	RED	5090M TO 5165M	85 TO 90		
9		3107			6	Bird at 5096M
	0298-31391	ORNG	5015M TO 5090M	91 TO 96		
	0298-31336	RED	4940M TO 5015M	97 TO 102		
10		3395				
	0298-31384	ORNG	4865M TO 4940M	103 TO 108		
	0198-31341	RED	4790M TO 4865M	109 TO 114		
11		3599			7C	Bird at 4796 SRD2
	0198-31398	ORNG	4715M TO 4790M	115 TO 120		
	0298-31387	RED	4640M TO 4715M	121 TO 126		
2		3597				
	0298-31378	ORNG	4565M TO 4640M	127 TO 132		
	0298-31369	RED	4490M TO 4565M	133 TO 138		
3		3604			8	Bird at 4496M
	0298-31396	ORNG	4415M TO 4490M	139 TO 144		
	0198-31335	RED	4340M TO 4415M	145 TO 150		
		2965				
	0198-31362	ORNG	4265M TO 4340M	151 TO 156		
	0298-31373	RED	4190M TO 4265M	157 TO 162		
		2714			9C	BIRD at 4196M
	0198-31334	ORNG	4115M TO 4190M	163 TO 168		

STREAMER CONFIGURATION

MOD	SERIAL #	CAN#	SHIP OFFSET	CHANNELS	BIRD	COMMENTS
	0298-31405	RED	4040M TO 4115M	169 TO 174		
16		2757				
	0198-31348	ORNG	3965M TO 4040M	175 TO 180		
	0397-31119	RED	3890M TO 3965M	181 TO 186		
17		3031			10	Bird at 3896M
	0198-31318	ORNG	3815M TO 3890M	187 TO 192		
	0198-31343	RED	3740M TO 3815M	193 TO 198		
18		3602				
	1296-30312	ORNG	3665M TO 3740M	199 TO 204		
	0996-30302	RED	3590M TO 3665M	205 TO 210		
19		2940			11C	BIRD at 3596M
	30804	ORNG	3515M TO 3590M	211 TO 216		
	0996-30327	RED	3440M TO 3515M	217 TO 222		
20		2935				
	0197-31058	ORNG	3365M TO 3440M	223 TO 228		
	0298-31389	RED	3290M TO 3365M	229 TO 234		
21		3185			12	Bird at 3296. SRD3
	31329	ORNG	3215M TO 3290M	235 TO 240		
	0996-30279	RED	3140M TO 3215M	241 TO 246		
22		2563				
	0297-31082	ORNG	3065M TO 3140M	247 TO 252		
	????	RED	2990M TO 3065M	253 TO 258		30330 leaky section
23		2507			13C	BIRD at 2996M
	31350	ORNG	2915M TO 2990M	259 TO 264		
	31363	RED	2840M TO 2915M	265 TO 270		
24		2567				
	0996-30300	ORNG	2765M TO 2840M	271 TO 276		
	0696-31347	RED	2690M TO 2765M	277 TO 282		
25		2717			14	Bird at 2696M
	????	ORNG	2615M TO 2690M	283 TO 288		31351 leaky section
	31383	RED	2540M TO 2615M	289 TO 294		
26		2523				
	0996-30304	ORNG	2465M TO 2540M	295 TO 300		
	0996-30283	RED	2390M TO 2465M	301 TO 306		
27		3163			15C	Bird at 2396, SRD4
	298 31372	ORNG	2315M TO 2390M	307 TO 312		
	0996-30301	RED	2240M TO 2315M	313 TO 318		
'8		2511				
	1096-30332	ORNG	2165M TO 2240M	319 TO 324		
	????	RED	2090M TO 2165M	325 TO 330		
9		2570			16	Bird at 2096M
	0597-31248	ORNG	2015M TO 2090M	331 TO 336		
	0597-31269	RED	1940M TO 2015M	337 TO 342		
)		3172				
	0597-31268	ORNG	1865M TO 1940M	343 TO 348		
	0996-30281	RED	1790M TO 1865M	349 TO 354		
		2505			17C	BIRD at 1796M
	696 10406	ORNG	1715M TO 1790M	355 TO 360		

STREAMER CONFIGURATION

MOD	SERIAL #	CAN#	SHIP OFFSET	CHANNELS	BIRD	COMMENTS
	0996-30303	RED	1640M TO 1715M	361 TO 366		
32		2554				
	1096-30346	ORNG	1565M TO 1640M	367 TO 372		
	30313	RED	1490M TO 1565M	373 TO 378		
33		3182			18	Bird at 1496M
	0696-10388	ORNG	1415M TO 1490M	379 TO 384		
	0697-31277	RED	1340M TO 1415M	385 TO 390		
34		2506				
	0696-31280	ORNG	1265M TO 1340M	391 TO 396		
	SS1-0696-10057	RED	1190M TO 1265M	397 TO 402		
35		2462			19C	Bird at 1196. SRD5
	1096-30320	ORNG	1115M TO 1190M	403 TO 408		
	0996-31349	RED	1040M TO 1115M	409 TO 414		
36		2747				
	0697-31282	ORNG	965M TO 1040M	415 TO 420		
	????	RED	890M TO 965M	421 TO 426		1096-30337 leaky bad
37		3192			20	Bird at 896M
	SS1-0696-0140	ORNG	815M TO 890M	427 TO 432		
	31400	RED	740M TO 815M	433 TO 438		
38		3543			21C	BIRD AT 746M
	0298-31410	ORNG	665M TO 740M	439 TO 444		
	0298-31365	RED	590M TO 665M	445 TO 450		
39		2728			22	Bird at 596M
	31346	ORNG	515M TO 590M	451 TO 456		
	0298-31377	RED	440M TO 515M	457 TO 462		
40		2485			23C	BIRD AT 446M
	?????	ORNG	365M TO 440M	463 TO 468		31321 leaky section
	???	RED	290M TO 365M	469 TO 474		
41		2970			24	BIRD AT 296M
	0298-31360	ORNG	215M TO 290M	475 TO 480		
	30128HS		165M TO 215M	STRETCH		
42		10284				PASSIVE CAN
	30134HS		115M TO 165M	STRETCH		
DR	0498-30025		STERN TO 115M	LEADER		FIBER OPTIC

Last Deployment

CRUISE EW-0008 — 6KM — 10/15/00

LAST DEPLOYMENT — CONFIG

MOD	SERIAL #	CAN#	SHIP OFFSET	CHANNELS	BIRD	COMMENTS
TB			6344.3M			TAIL BUOY AT 6345M
STIC	CABLE 25.3M		6319M TO 6344M			
1		2151				POWER MODULE 12151
HS	30120-HS	50M	6269M TO 6319M			
TS	0697-30284TS	50M	6219M TO 6269M			
AT	0498-30024	4M	6215M TO 6219M			
	31374	RED	6140M TO 6215M	1 TO 6		
2		3538			1C	BIRD AT 6146M
	0298-31388	ORNG	6065M TO 6140M	7 TO 12		
	0298-31407	RED	5990M TO 6065M	13 TO 18		
3		2734			2	Bird at 5996M & SRD1
	0198-31319	ORNG	5915M TO 5990M	19 TO 24		
	0198-31333	RED	5840M TO 5915M	25 TO 30		
4		2731				
	0298-31385	ORNG	5765M TO 5840M	31 TO 36		
	0298-31399	RED	5690M TO 5765M	37 TO 42		
5		2754			3C	BIRD AT 5696M
	31408	ORNG	5615M TO 5690M	43 TO 48		
	0298 31361	RED	5540M TO 5615M	49 TO 54		
6		3607			4	BIRD AT 5546M
	0298-31402	ORNG	5465M TO 5540M	55 TO 60		
	0298-31337	RED	5390M TO 5465M	61 TO 66		
7		3189				
	0298-31382	ORNG	5315M TO 5390M	67 TO 72		
	0298-31390	RED	5240M TO 5315M	73 TO 78		
		3606			5C	BIRD AT 5246M
	0298-31346	ORNG	5165M TO 5240M	79 TO 84		
	0298-31381	RED	5090M TO 5165M	85 TO 90		
9		3107			6	Bird at 5096M
	0298-31391	ORNG	5015M TO 5090M	91 TO 96		
	0298-31336	RED	4940M TO 5015M	97 TO 102		
10		3395				
	0298-31384	ORNG	4865M TO 4940M	103 TO 108		
	0198-31341	RED	4790M TO 4865M	109 TO 114		
1		3599			7C	Bird at 4796 SRD2
	0198-31398	ORNG	4715M TO 4790M	115 TO 120		
	0298-31387	RED	4640M TO 4715M	121 TO 126		
2		3597				
	0298-31378	ORNG	4565M TO 4640M	127 TO 132		
	0298-31369	RED	4490M TO 4565M	133 TO 138		
		3604			8	Bird at 4496M
	0298-31396	ORNG	4415M TO 4490M	139 TO 144		
	0198-31335	RED	4340M TO 4415M	145 TO 150		
		2965				
	0198-31362	ORNG	4265M TO 4340M	151 TO 156		
	0298-31373	RED	4190M TO 4265M	157 TO 162		
		2714			9C	BIRD at 4196M
	0198-31334	ORNG	4115M TO 4190M	163 TO 168		

CRUISE EW-0008 **6KM** **10/15/00**

LAST DEPLOYMENT **CONFIG**

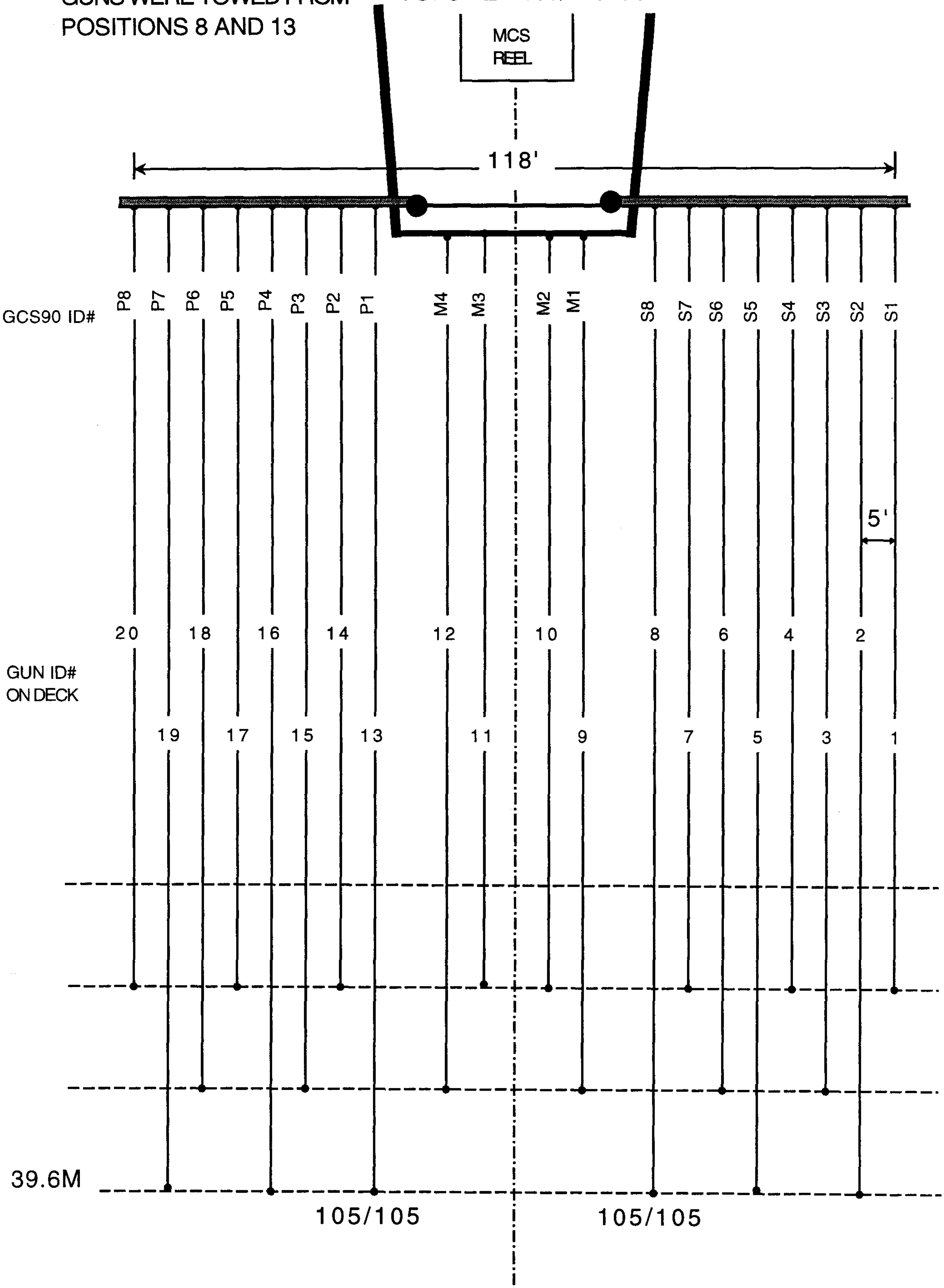
MOD	SERIAL #	CAN#	SHIP OFFSET	CHANNELS	BIRD	COMMENTS
	0298-31405	RED	4040M TO 4115M	169 TO 174		
16		2757				
	0198-31348	ORNG	3965M TO 4040M	175 TO 180		
	0397-31119	RED	3890M TO 3965M	181 TO 186		
17		3031			10	Bird at 3896M
	0198-31318	ORNG	3815M TO 3890M	187 TO 192		
	0198-31343	RED	3740M TO 3815M	193 TO 198		
18		3602				
	1296-30312	ORNG	3665M TO 3740M	199 TO 204		
	0996-30302	RED	3590M TO 3665M	205 TO 210		
19		2940			11C	BIRD at 3596M
	30804	ORNG	3515M TO 3590M	211 TO 216		
	0996-30327	RED	3440M TO 3515M	217 TO 222		
20		2935				
	0197-31058	ORNG	3365M TO 3440M	223 TO 228		
	0298-31389	RED	3290M TO 3365M	229 TO 234		
21		3184			12	Bird at 3296. SRD3
	31329	ORNG	3215M TO 3290M	235 TO 240		
	0996-30279	RED	3140M TO 3215M	241 TO 246		
22		2563			13C	BIRD AT 3146M
	0297-31082	ORNG	3065M TO 3140M	247 TO 252		
	31371	RED	2990M TO 3065M	253 TO 258		
23		2507			14	BIRD at 2996M
	31350	ORNG	2915M TO 2990M	259 TO 264		
	31363	RED	2840M TO 2915M	265 TO 270		
24		2567				
	0996-30300	ORNG	2765M TO 2840M	271 TO 276		
	0696-31347	RED	2690M TO 2765M	277 TO 282		
25		2717			15C	Bird at 2696M
	31327	ORNG	2615M TO 2690M	283 TO 288		
	31383	RED	2540M TO 2615M	289 TO 294		
26		2523				
	0996-30304	ORNG	2465M TO 2540M	295 TO 300		
	0996-30283	RED	2390M TO 2465M	301 TO 306		
27		3163			16	Bird at 2396, SRD4
	298 31372	ORNG	2315M TO 2390M	307 TO 312		
	0996-30301	RED	2240M TO 2315M	313 TO 318		
28		2511				
	31326	ORNG	2165M TO 2240M	319 TO 324		
	????	RED	2090M TO 2165M	325 TO 330		
29		2570			17C	Bird at 2096M
	0597-31248	ORNG	2015M TO 2090M	331 TO 336		
	0597-31269	RED	1940M TO 2015M	337 TO 342		
30		3172				
	0597-31268	ORNG	1865M TO 1940M	343 TO 348		
	0996-30281	RED	1790M TO 1865M	349 TO 354		
31		2505			18	BIRD at 1796M
	696 10406	ORNG	1715M TO 1790M	355 TO 360		

MOD	SERIAL #	CAN#	SHIP OFFSET	CHANNELS	BIRD	COMMENTS
	0996-30303	RED	1640M TO 1715M	361 TO 366		
32		2554				
	1096-30346	ORNG	1565M TO 1640M	367 TO 372		
	30313	RED	1490M TO 1565M	373 TO 378		
33		3182			19C	Bird at 1496M
	0696-10388	ORNG	1415M TO 1490M	379 TO 384		
	0697-31277	RED	1340M TO 1415M	385 TO 390		
34		2506				
	0696-31280	ORNG	1265M TO 1340M	391 TO 396		
	SS1-0696-10057	RED	1190M TO 1265M	397 TO 402		
35		2462			20	Bird at 1196. SRD5
	1096-30320	ORNG	1115M TO 1190M	403 TO 408		
	0996-31349	RED	1040M TO 1115M	409 TO 414		
36		2747				
	0697-31282	ORNG	965M TO 1040M	415 TO 420		
	????	RED	890M TO 965M	421 TO 426		
37		3192			21C	Bird at 896M
	SS1-0696-0140	ORNG	815M TO 890M	427 TO 432		
	31400	RED	740M TO 815M	433 TO 438		
38		3543				
	0298-31410	ORNG	665M TO 740M	439 TO 444		
	0298-31365	RED	590M TO 665M	445 TO 450		
39		2728			22	Bird at 596M
	31346	ORNG	515M TO 590M	451 TO 456		
	0298-31377	RED	440M TO 515M	457 TO 462		
40		2485			23C	BIRD AT 446M
	?????	ORNG	365M TO 440M	463 TO 468		
	???	RED	290M TO 365M	469 TO 474		
41		2970			24	BIRD AT 296M
	0298-31360	ORNG	215M TO 290M	475 TO 480		
	30128HS		165M TO 215M	STRETCH		
42		10284				PASSIVE CAN
	30134HS		115M TO 165M	STRETCH		
LDR	0498-30025		STERN TO 115M	LEADER		FIBER OPTIC

EWING GI AIRGUN ARRAY- 2GI GUN ARRAY FOR EW008

VOLUME= 105/105 CU IN

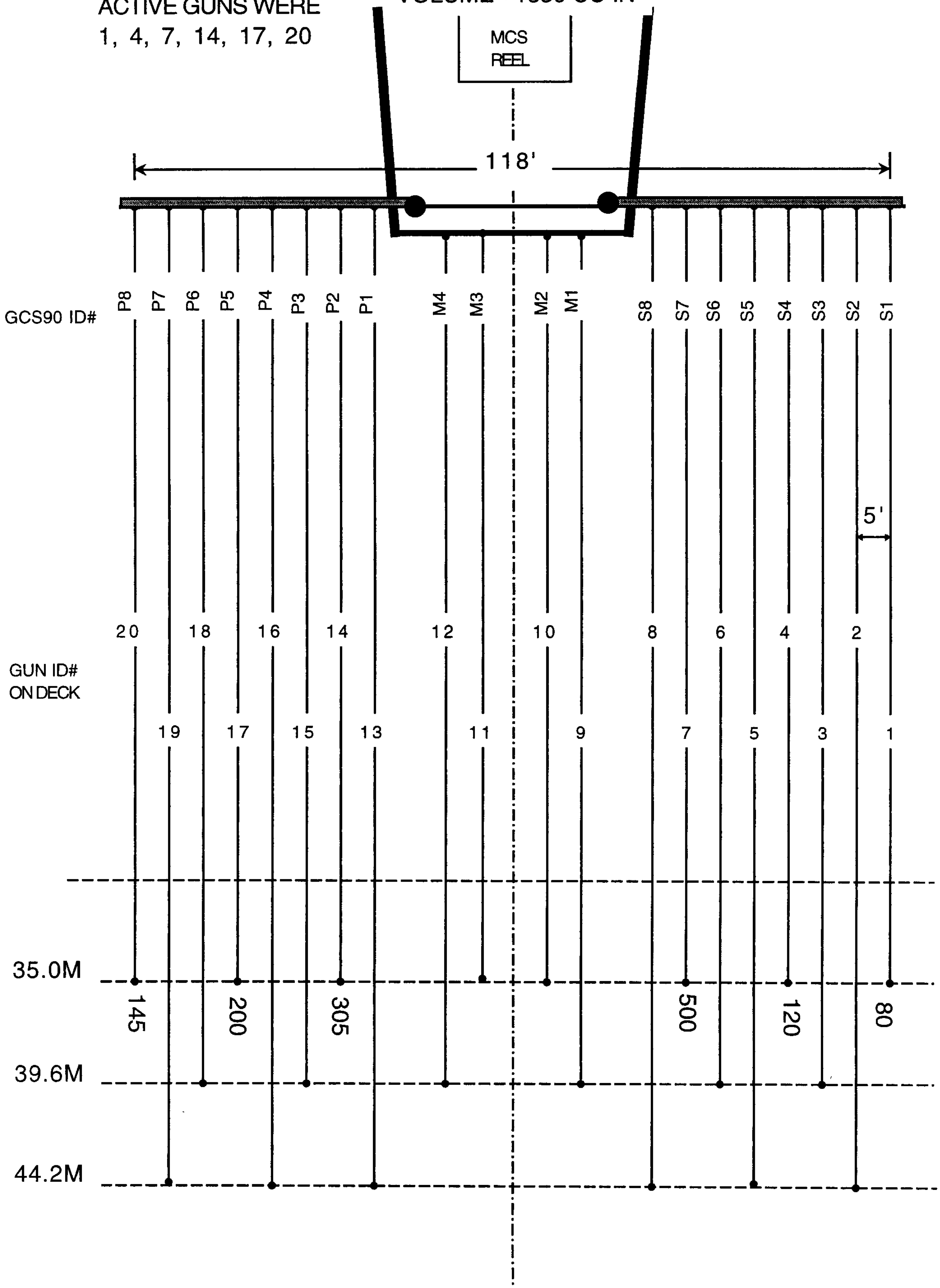
GUNS WERE TOWED FROM POSITIONS 8 AND 13



EWING MCS AIRGUN ARRAY- 6 GUN ARRAY FOR EW008

VOLUME= 1350 CU IN

ACTIVE GUNS WERE
1, 4, 7, 14, 17, 20

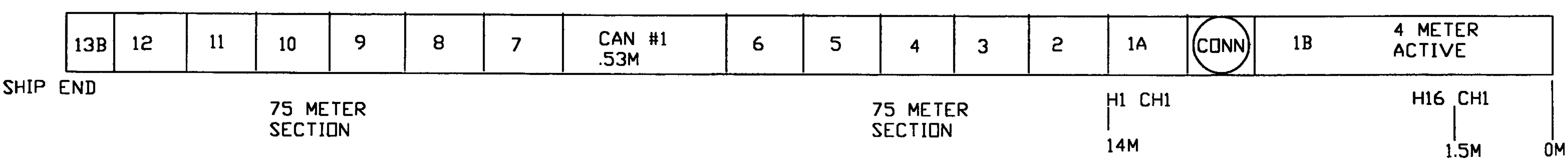


12.5 METER GROUPS

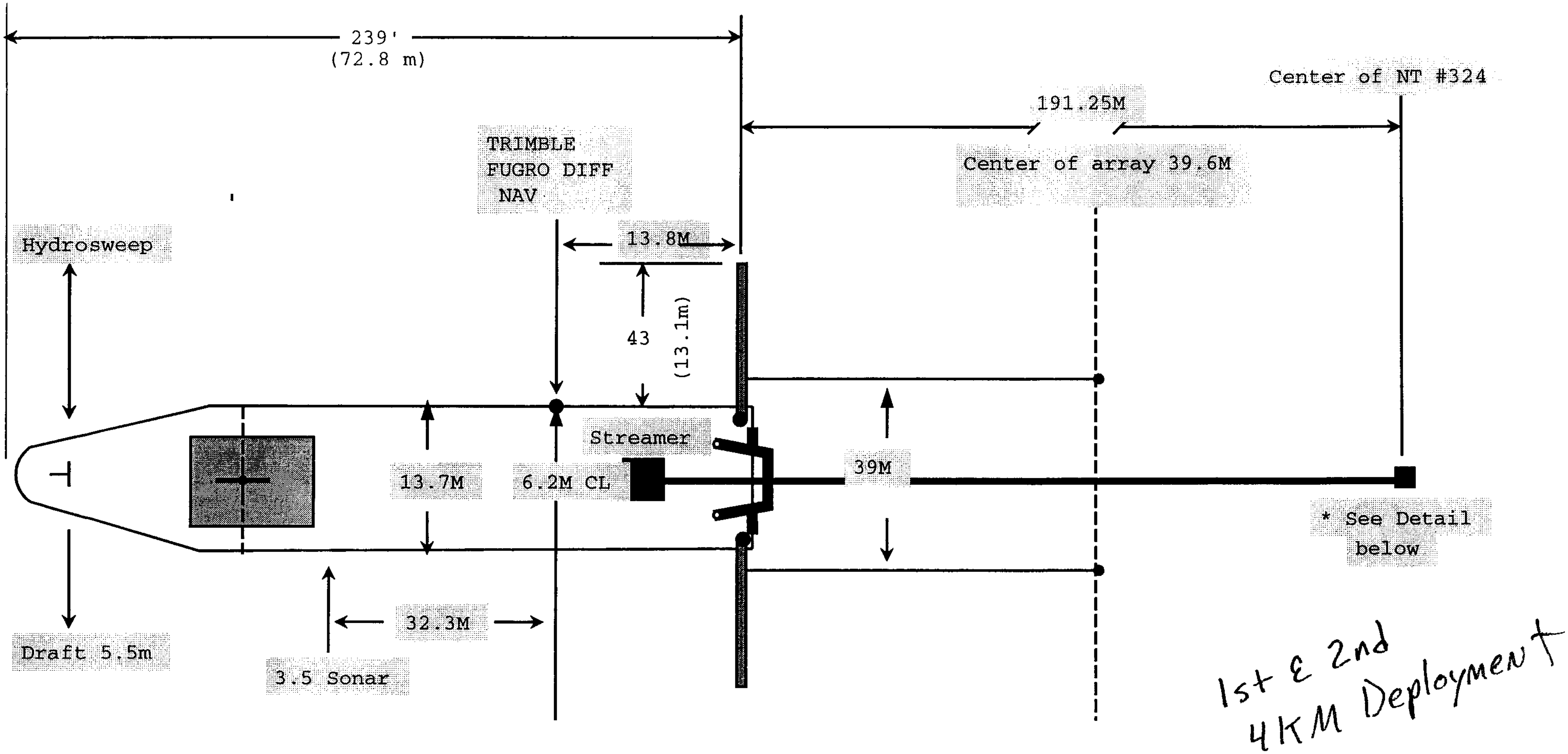
IN ONE 150 METER SECTION THERE ARE 12 CHANNELS

THERE ARE 16 HYDROPHONES PER CHANNEL

THE HYDROPHONES ARE SPACED 2.25 FEET (.694M) FROM EACH OTHER

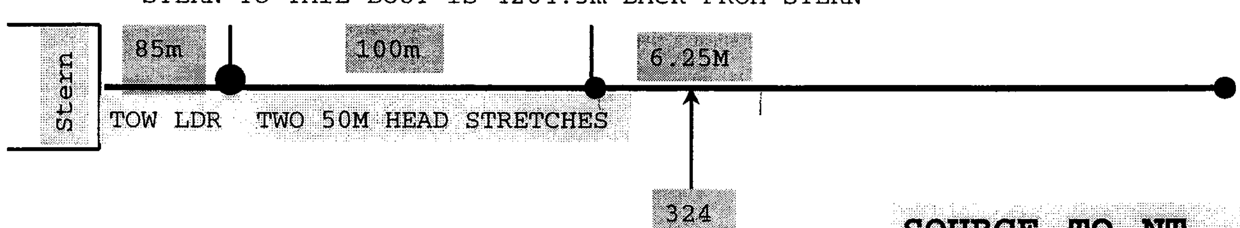


MAURICE EWING MCS SET[illegible] CK AND OFFSET DIAGRAM



CABLE = 324 CHANNELS,27 ACTIVE CANS, 12.5M GROUPS, 4050M ACTIVE SECTIONS

STERN TO TAIL BOUY IS 4264.3m BACK FROM STERN

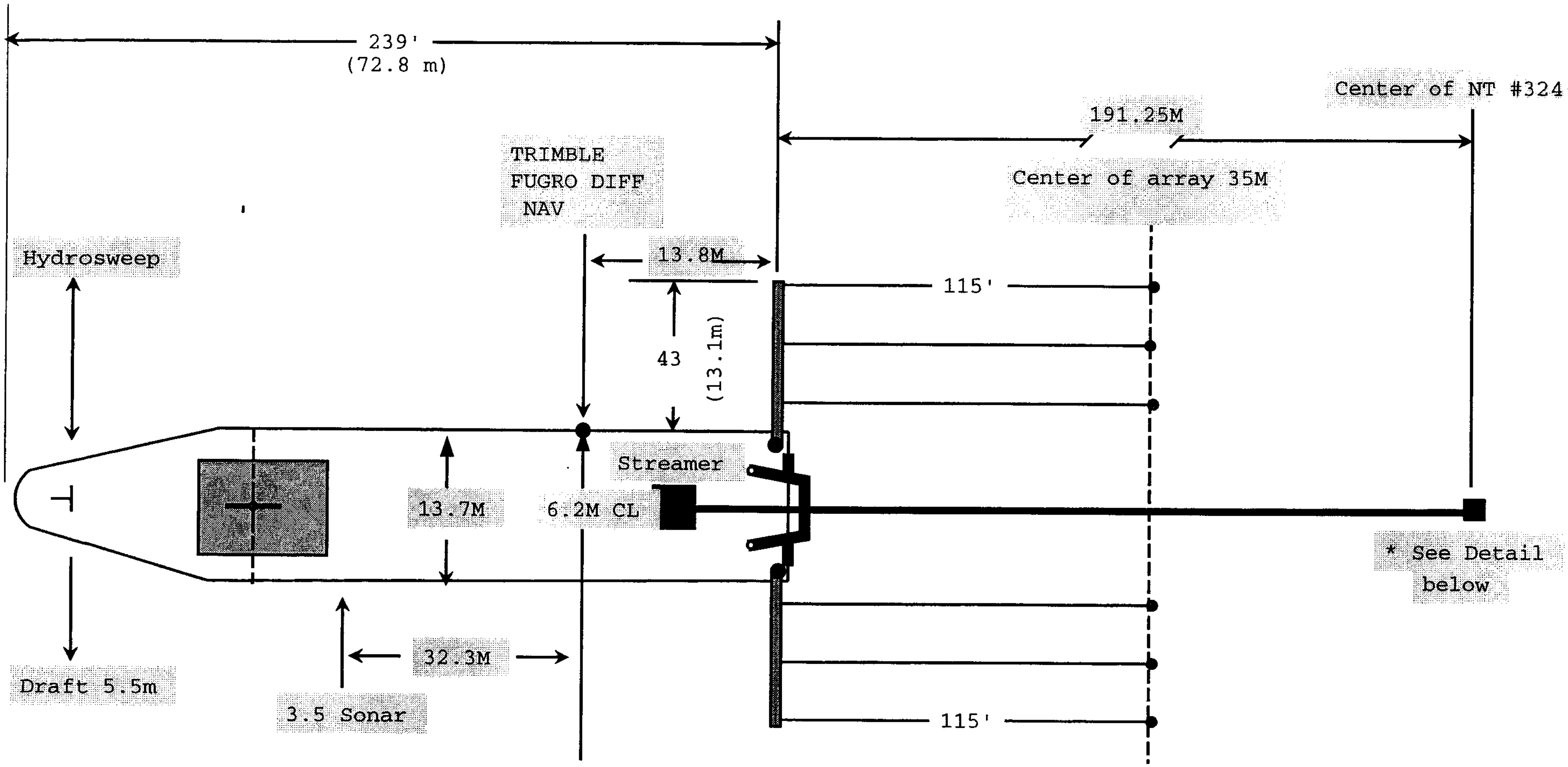


2 GI GUN ARRAY DETAILS 4KM STREAMER

SOURCE TO NT = 191.25 - 39.6 = 151.65M

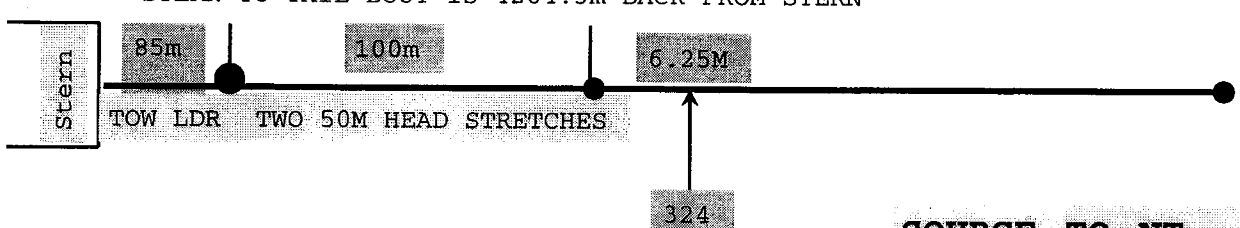
OCT 16, 2000 CPL **CLIENT: HOLBROOK** **AREA: BLAKE RIDGE** **Cruise: EW-2008**

MAURICE EWING MCS SET CK AND OFFSET DIAGRAM



CABLE = 324 CHANNELS,27 ACTIVE CANS, 12.5M GROUPS, 4050M ACTIVE SECTIONS

STERN TO TAIL BOUY IS 4264.3m BACK FROM STERN



6 AIR GUN ARRAY DETAILS 4KM STREAMER

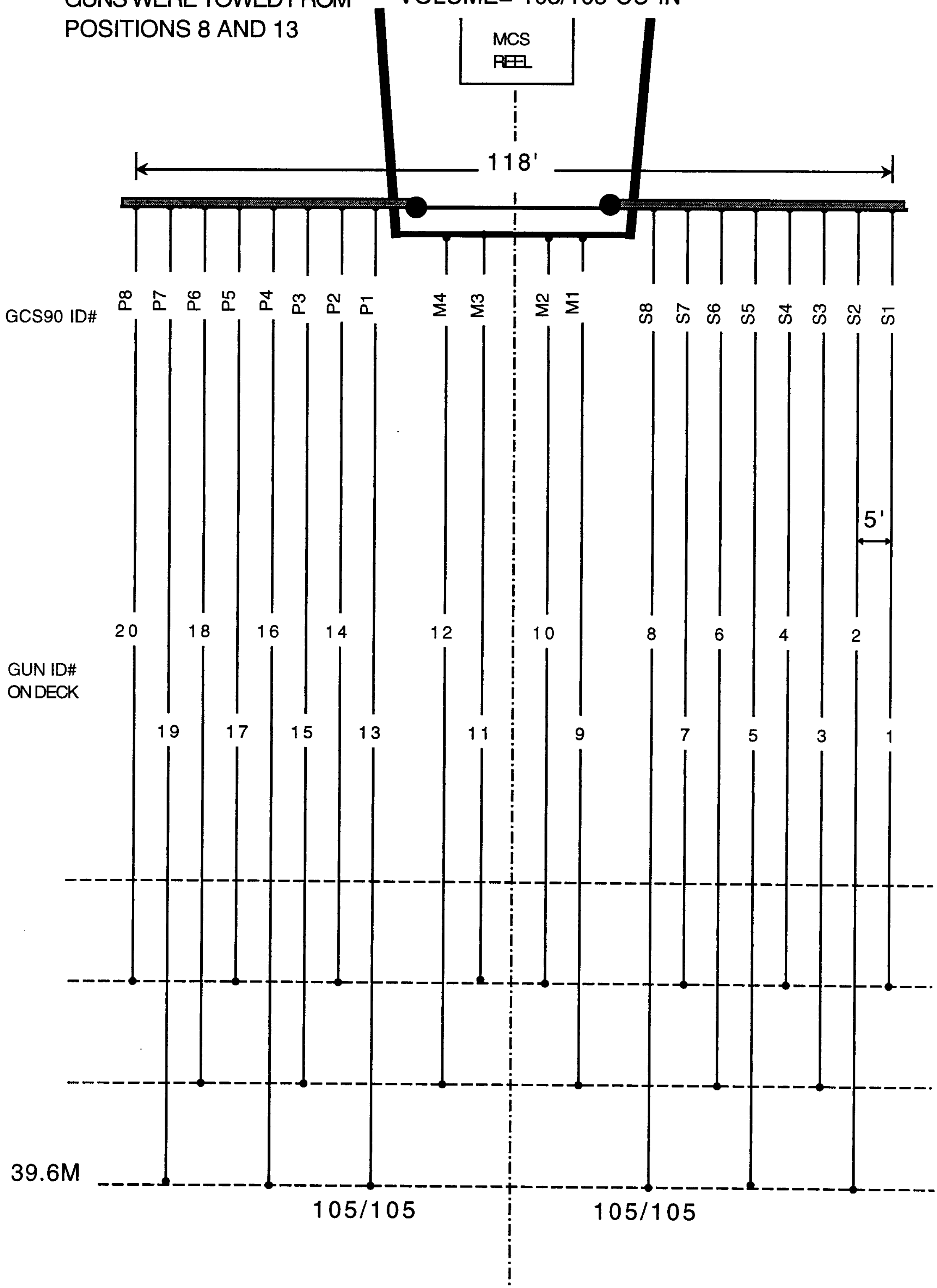
SOURCE TO NT = 191.25 - 35 = 156.25M

OCT 16, 2000 CPL **CLIENT: HOLBROOK** **AREA: BLAKE RIDGE** **Cruise: EW-2008**

EWING GI AIRGUN ARRAY- 2GI GUN ARRAY FOR EW008

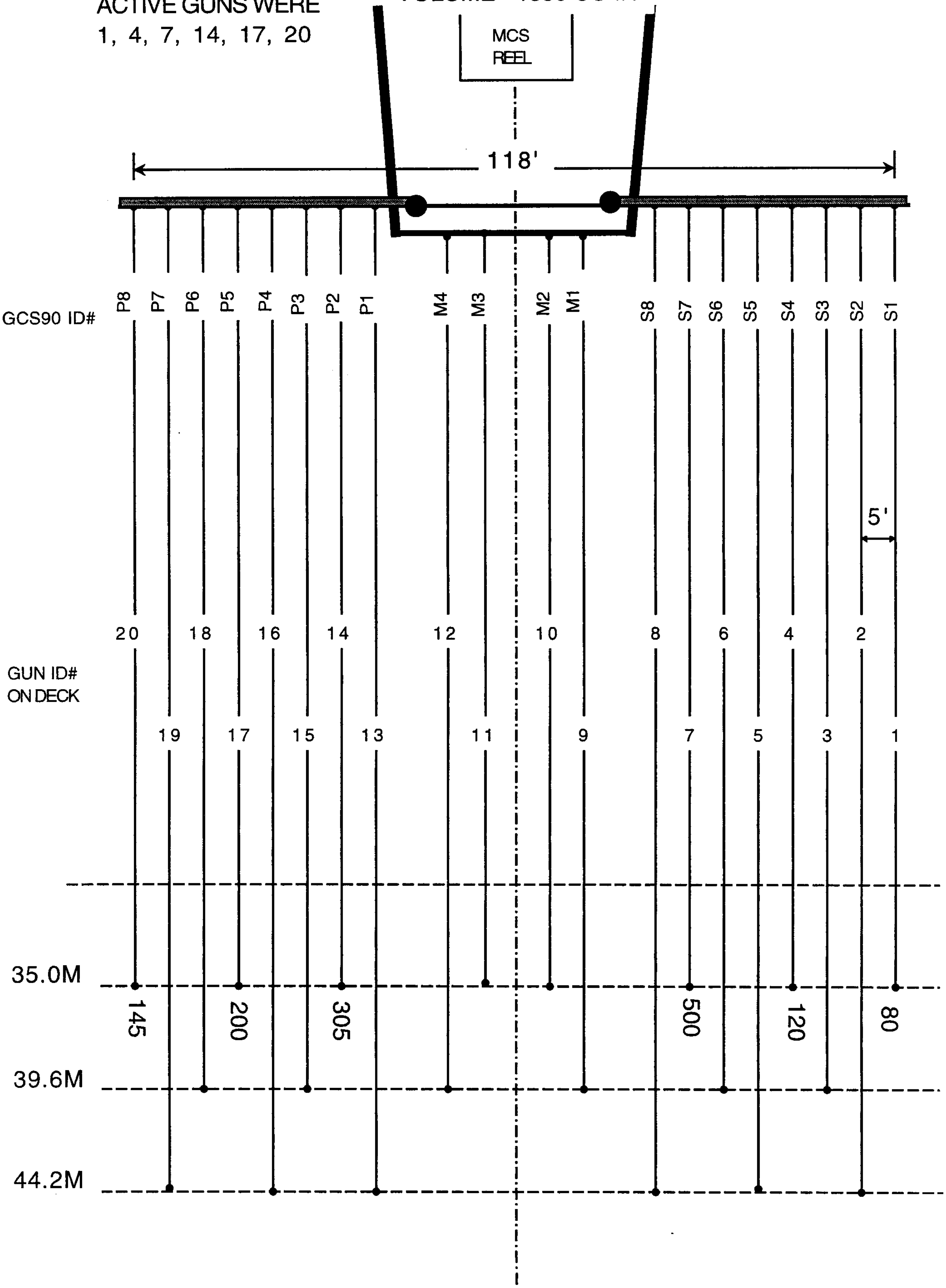
VOLUME= 105/105 CU IN

GUNS WERE TOWED FROM POSITIONS 8 AND 13



# EWING MCS AIRGUN ARRAY- 6 GUN ARRAY FOR EW008
VOLUME= 1350 CU IN

ACTIVE GUNS WERE
1, 4, 7, 14, 17, 20



2nd. 4KM Deployment

CRUISE EW-0008
2ND. DEPLOYMENT

4KM STRMR CONF.

10/15/00

MOD	SERIAL #	CAN#	SHIP OFFSET	CHANNELS	BIRD	COMMENTS
TB						TAIL BUOY AT 4264.3M
STIC	CABLE 25.3M		4239M TO 4264.3M			
1		2151				POWER MODULE 12151
HS	30120-HS	50M	4189M TO 4239M			
TS	0697-30284TS	50M	4139M TO 4189M			
AT	0498-30024	4M	4135M TO 4139M			30291 shark bite
	31374	RED	4060M TO 4135M	1 TO 6	1C	BIRD AT 4129M
2		3538			2	BIRD AT 4054M
	0298-31388	ORNG	3985M TO 4060M	7 TO 12		
	0298-31407	RED	3910M TO 3985M	13 TO 18		
3		2734			3C	BIRD AT 3904M
	0198-31319	ORNG	3835M TO 3910M	19 TO 24		
	0198-31333	RED	3760M TO 3835M	25 TO 30		
4		2731			4	BIRD AT 3754M
	0298-31385	ORNG	3685M TO 3760M	31 TO 36		
	0298-31399	RED	3610M TO 3685M	37 TO 42		
5		2754			5C	BIRD AT 3604M
	31408	ORNG	3535M TO 3610M	43 TO 48		*bad can3165*
	0298 31361	RED	3460M TO 3535	49 TO 54		
6		3607				
	0298-31402	ORNG	3385M TO 3460M	55 TO 60		
	0298-31337	RED	3310M TO 3385M	61 TO 66	6	BIRD AT 3379M
7		3189				
	0298-31382	ORNG	3235M TO 3310M	67 TO 72		
	0298-31390	RED	3160M TO 3235M	73 TO 78		
8		3606			7C	BIRD AT 3154M
	0298-31346	ORNG	3085M TO 3160M	79 TO 84		
	0298-31381	RED	3010M TO 3085M	85 TO 90		
9		3107			8	BIRD AT 3004M
	0298-31391	ORNG	2935M TO 3010M	91 TO 96		
	0298-31336	RED	2860M TO 2935M	97 TO 102		
10		3395				
	0298-31384	ORNG	2785M TO 2860M	103 TO 108		
	0198-31341	RED	2710M TO 2785M	109 TO 114		
11		3599			9C	BIRD AT 2704
	0198-31398	ORNG	2635M TO 2710M	115 TO 120		
	0298-31387	RED	2560M TO 2635M	121 TO 126		
12		3597				
	0298-31378	ORNG	2485M TO 2560M	127 TO 132		
	0298-31369	RED	2410M TO 2485M	133 TO 138		
13		3604			10	BIRD AT 2404M
	0298-31396	ORNG	2335M TO 2410M	139 TO 144		
	0198-31335	RED	2260M TO 2335M	145 TO 150		
14		2965				
	0198-31362	ORNG	2185M TO 2260M	151 TO 156		
	0298-31373	RED	2110M TO 2185M	157 TO 162		
15		2714			11C	BIRD AT 2104M
	0198-31334	ORNG	2035M TO 2110M	163 TO 168		

MOD	SERIAL #	CAN#	SHIP OFFSET	CHANNELS	BIRD	COMMENTS
	0298-31405	RED	1960M TO 2035M	169 TO 174		
16		2757			12	BIRD AT 1954M
	0198-31348	ORNG	1885M TO 1960M	175 TO 180		
	0397-31119	RED	1810M TO 1885M	181 TO 186		
17		3031			13C	BIRD AT 1804M
	0198-31318	ORNG	1735M TO 1810M	187 TO 192		
	0198-31343	RED	1660M TO 1735M	193 TO 198		
18		3602			14	BIRD AT 1654M
	1296-30312	ORNG	1585M TO 1660M	199 TO 204		
	0996-30302	RED	1510M TO 1585M	205 TO 210		
19		2940			15C	BIRD AT 1504M
	30804	ORNG	1435M TO 1510M	211 TO 216		
	0996-30327	RED	1360M TO 1435M	217 TO 222		
20		2935			16	BIRD AT 1354M
	0197-31058	ORNG	1285M TO 1360M	223 TO 228		
	0298-31389	RED	1210M TO 1285M	229 TO 234		
21		3185			17C	BIRD AT 1204M
	31329	ORNG	1135M TO 1210M	235 TO 240		-
	0996-30279	RED	1060M TO 1135M	241 TO 246		
22		2563			18	BIRD AT 1054M
	0297-31082	ORNG	985M TO 1060M	247 TO 252		
	1096-30330	RED	910M TO 985M	253 TO 258		
23		2507			19C	BIRD AT 904M
	31350	ORNG	835M TO 910M	259 TO 264		
	31363	RED	760M TO 835M	265 TO 270		
24		2567			20	BIRD AT 754M
	0996-30300	ORNG	685M TO 760M	271 TO 276		
	0696-31347	RED	610M TO 685M	277 TO 282		
25		2717			21C	BIRD AT 604M
	0697-31351	ORNG	535M TO 610M	283 TO 288		
	31383	RED	460M TO 535M	289 TO 294		
26		2523			22	BIRD AT 454M
	0996-30304	ORNG	385M TO 460M	295 TO 300		
	0996-30283	RED	310M TO 385M	301 TO 306		
27		3163			23C	BIRD AT 304M
	298 31372	ORNG	235M TO 310M	307 TO 312		
	0996-30301	RED	160M TO 235M	313 TO 318		
28		2511			24	BIRD AT 154M
	1096-30332	ORNG	85M TO 160M	319 TO 324		
LDR			0 TO 85M	LEADER		FIBER OPTIC

1st. 4KM Deployment

CRUISE EW-0008
1ST. DEPLOYMENT

4KM STRMR CONF

10/15/00

MOD	SERIAL #	CAN#	SHIP OFFSET	CHANNELS	BIRD	COMMENTS
'B						TAIL BUOY AT 4264.3M
ᴗTIC	CABLE 25.3M		4239M TO 4264.3M			
1		2151				POWER MODULE 12151
HS	30120-HS	50M	4189M TO 4239M			
TS	0697-30284TS	50M	4139M TO 4189M			
AT	0498-30024	4M	4135M TO 4139M			
	0398-30291	RED	4060M TO 4135M	1 TO 6	1C	BIRD AT 4129M
2		3538			2	BIRD AT 4054M
	0298-31388	ORNG	3985M TO 4060M	7 TO 12		
	0298-31407	RED	3910M TO 3985M	13 TO 18		
3		2734			3C	BIRD AT 3904M
	0198-31319	ORNG	3835M TO 3910M	19 TO 24		
	0198-31333	RED	3760M TO 3835M	25 TO 30		
4		2731			4	BIRD AT 3754M
	0298-31385	ORNG	3685M TO 3760M	31 TO 36		
	0298-31399	RED	3610M TO 3685M	37 TO 42		
5		3165			5C	BIRD AT 3604M
	0298 31416	ORNG	3535M TO 3610M	43 TO 48		
	0298 31361	RED	3460M TO 3535M	49 TO 54		
6		3607				
	0298-31402	ORNG	3385M TO 3460M	55 TO 60		
	0298-31337	RED	3310M TO 3385M	61 TO 66		
7		3189			6	BIRD AT 3304M
	0298-31382	ORNG	3235M TO 3310M	67 TO 72		
	0298-31390	RED	3160M TO 3235M	73 TO 78		
8		3606				
	0298-31346	ORNG	3085M TO 3160M	79 TO 84		
	0298-31381	RED	3010M TO 3085M	85 TO 90		
9		3107			7C	BIRD AT 3004M
	0298-31391	ORNG	2935M TO 3010M	91 TO 96		
	0298-31336	RED	2860M TO 2935M	97 TO 102		
10		3395			8	BIRD AT 2854M
	0298-31384	ORNG	2785M TO 2860M	103 TO 108		
	0198-31341	RED	2710M TO 2785M	109 TO 114		
11		3599				
	0198-31398	ORNG	2635M TO 2710M	115 TO 120		
	0298-31387	RED	2560M TO 2635M	121 TO 126		
12		3597			9C	BIRD AT 2554M
	0298-31378	ORNG	2485M TO 2560M	127 TO 132		
	0298-31369	RED	2410M TO 2485M	133 TO 138		
13		3604			10	BIRD AT 2404M
	0298-31396	ORNG	2335M TO 2410M	139 TO 144		
	0198-31335	RED	2260M TO 2335M	145 TO 150		
14		2965				
	0198-31362	ORNG	2185M TO 2260M	151 TO 156		
	0298-31373	RED	2110M TO 2185M	157 TO 162		
15		2714			11C	BIRD AT 2104M
	0198-31334	ORNG	2035M TO 2110M	163 TO 168		

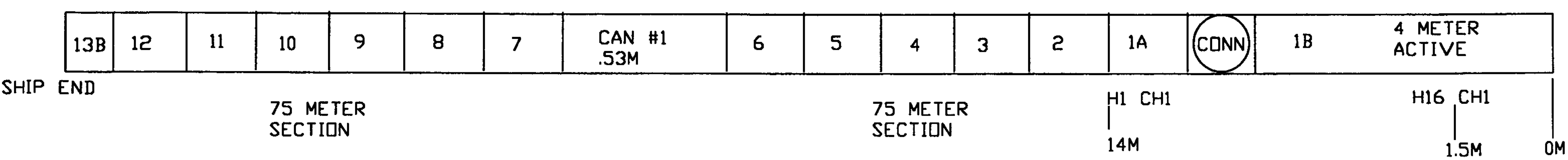
MOD	SERIAL #	CAN#	SHIP OFFSET	CHANNELS	BIRD	COMMENTS
	0298-31405	RED	1960M TO 2035M	169 TO 174		
16		2757			12	BIRD AT 1954M
	0198-31348	ORNG	1885M TO 1960M	175 TO 180		
	0397-31119	RED	1810M TO 1885M	181 TO 186		
17		3031			13C	BIRD AT 1804M
	0198-31318	ORNG	1735M TO 1810M	187 TO 192		
	0198-31343	RED	1660M TO 1735M	193 TO 198		
18		3602			14	BIRD AT 1654M
	1296-30312	ORNG	1585M TO 1660M	199 TO 204		
	0996-30302	RED	1510M TO 1585M	205 TO 210		
19		2940			15C	BIRD AT 1504M
	30804	ORNG	1435M TO 1510M	211 TO 216		
	0996-30327	RED	1360M TO 1435M	217 TO 222		
20		2935			16	BIRD AT 1354M
	0197-31058	ORNG	1285M TO 1360M	223 TO 228		
	0298-31389	RED	1210M TO 1285M	229 TO 234		
21		3184			17C	BIRD AT 1204M
	31329	ORNG	1135M TO 1210M	235 TO 240		
	0996-30279	RED	1060M TO 1135M	241 TO 246		
22		2563			18	BIRD AT 1054M
	0297-31082	ORNG	985M TO 1060M	247 TO 252		
	31371	RED	910M TO 985M	253 TO 258		30330 leaky section
23		2507			19C	BIRD AT 904M
	31350	ORNG	835M TO 910M	259 TO 264		
	31363	RED	760M TO 835M	265 TO 270		
24		2567			20	BIRD AT 754M
	0996-30300	ORNG	685M TO 760M	271 TO 276		
	0696-31347	RED	610M TO 685M	277 TO 282		
25		2717			21C	BIRD AT 604M
	31327	ORNG	535M TO 610M	283 TO 288		31351 leaqky section
	31383	RED	460M TO 535M	289 TO 294		
26		2523			22	BIRD AT 454M
	0996-30304	ORNG	385M TO 460M	295 TO 300		
	0996-30283	RED	310M TO 385M	301 TO 306		
27		3163			23C	BIRD AT 304M
	298 31372	ORNG	235M TO 310M	307 TO 312		
	0996-30301	RED	160M TO 235M	313 TO 318		
28		2511			24	BIRD AT 154M
	1096-30332	ORNG	85M TO 160M	319 TO 324		
LDR	30251		0 TO 85M	LEADER		FIBER OPTIC

12.5 METER GROUPS

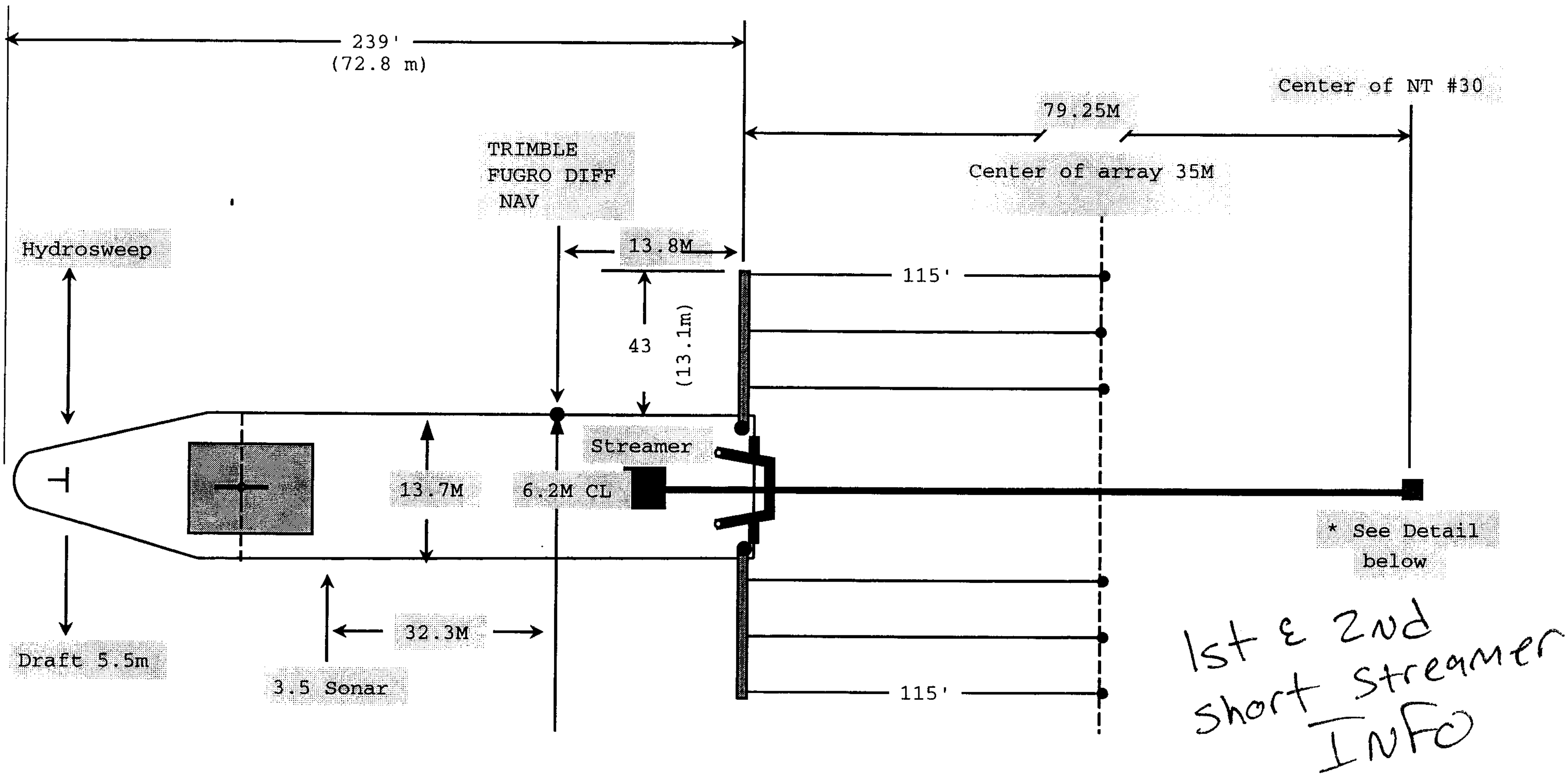
IN ONE 150 METER SECTION THERE ARE 12 CHANNELS

THERE ARE 16 HYDROPHONES PER CHANNEL

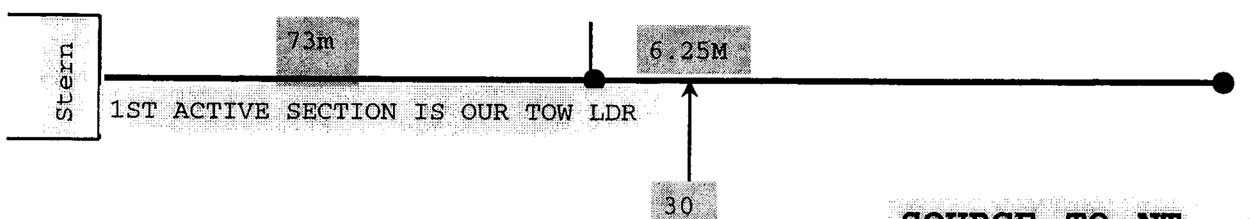
THE HYDROPHONES ARE SPACED 2.25 FEET (.694M) FROM EACH OTHER



MAURICE EWING MCS SETBACK AND OFFSET DIAGRAM



CABLE = 42 ACTIVE CHANNELS,3 ACTIVE CANS, DISREGUARD CHANNELS 31-42,31-36 ARE THE LEADER AND 37-42 ARE ON DECK, 12.5M GROUPS, 450M ACTIVE SECTIONS

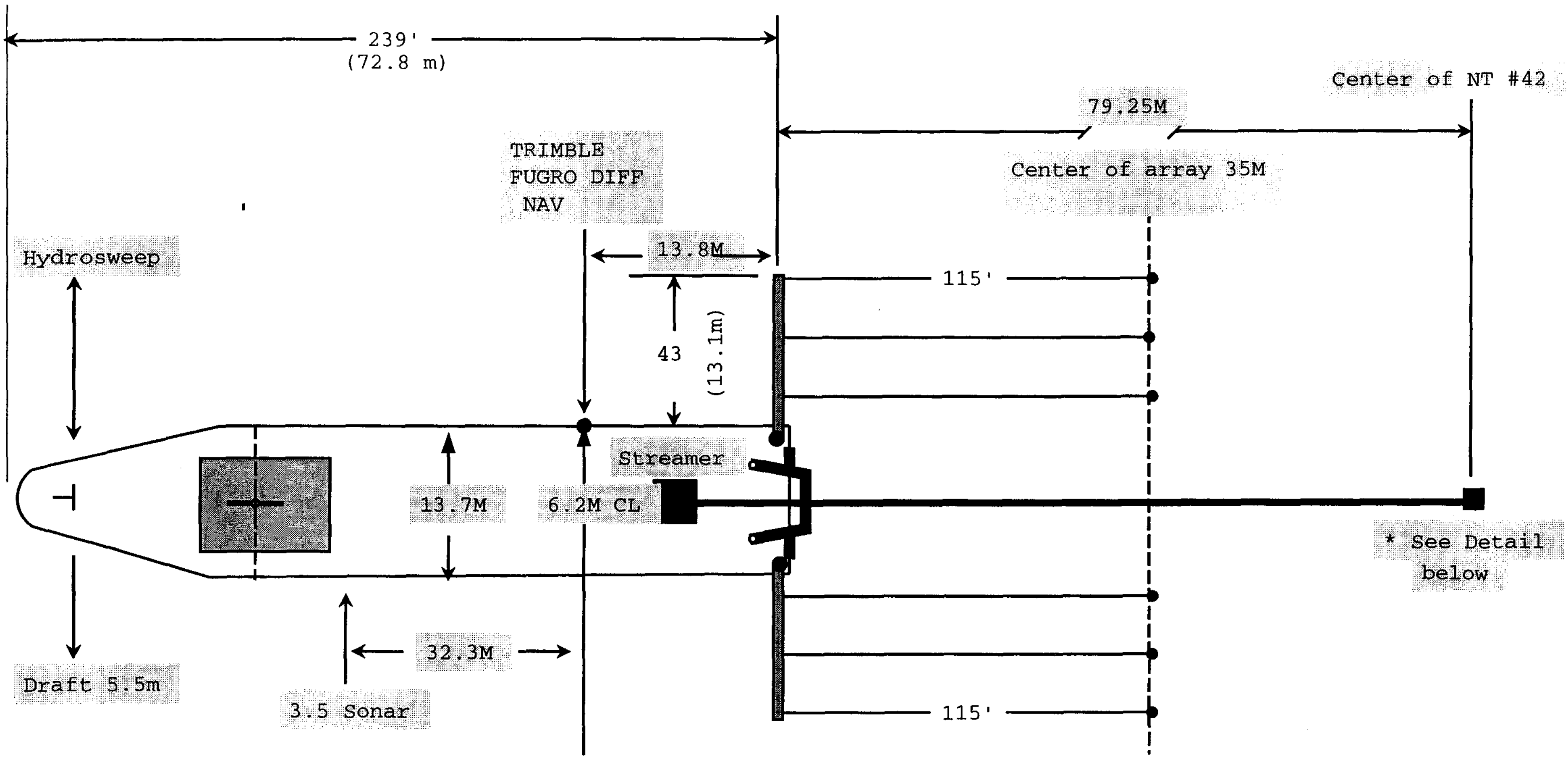


6 AIR GUN ARRAY DETAILS 1ST SHORT STREAMER

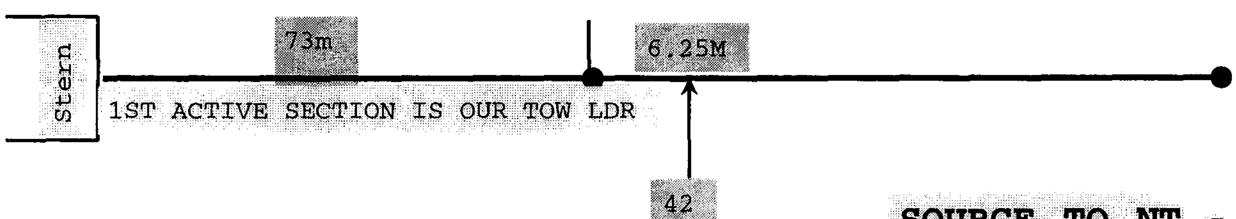
SOURCE TO NT = 79.25 - 35 = 44.25M

OCT 16, 2000 CPL **CLIENT: HOLBROOK** **AREA: BLAKE RIDGE** **Cruise: EW-2008**

MAURICE EWING MCS SETBACK AND OFFSET DIAGRAM



CABLE = 54 ACTIVE CHANNELS,4 ACTIVE CANS, DISREGUARD CHANNELS 43-54,49-54 ARE THE LEADER AND 43-48 ARE ON DECK, 12.5M GROUPS, 600M ACTIVE SECTIONS

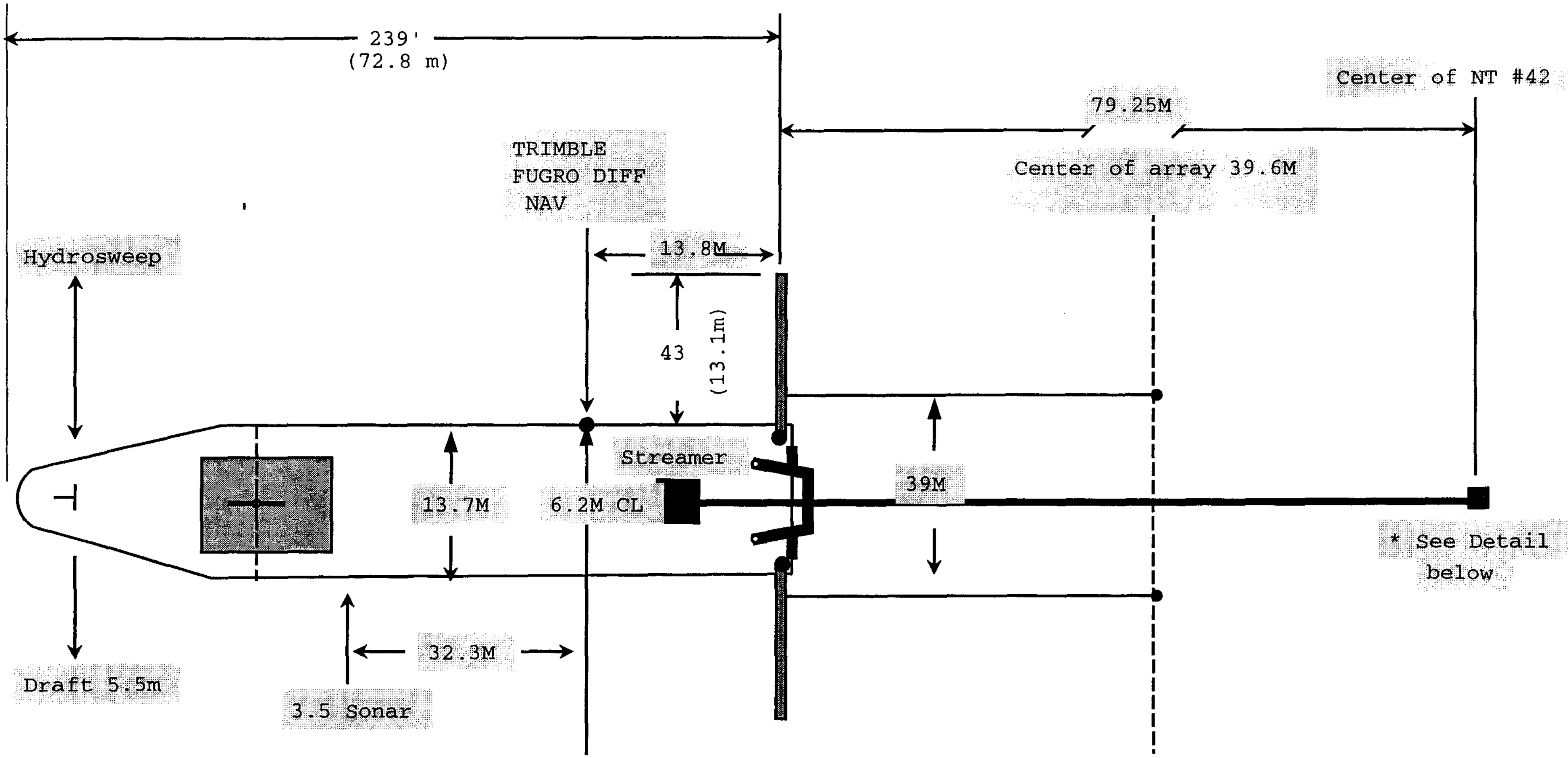


SOURCE TO NT = 79.25 - 35 = 44.25M

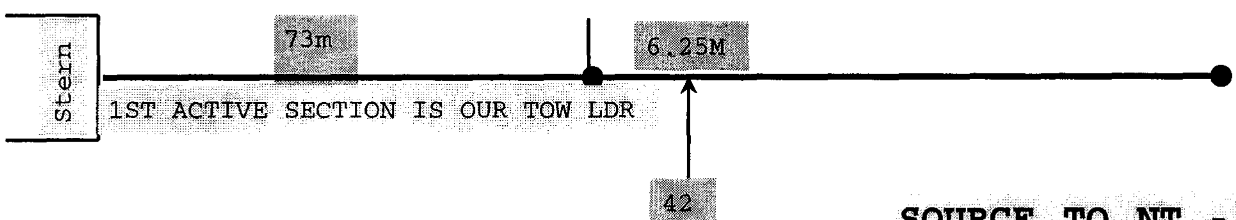
6 AIR GUN ARRAY DETAILS 2ND SHORT STREAMER

OCT 16, 2000 CPL **CLIENT: HOLBROOK** **AREA: BLAKE RIDGE** **Cruise: EW-2008**

MAURICE EWING MCS SETBACK AND OFFSET DIAGRAM



CABLE = 54 ACTIVE CHANNELS,4 ACTIVE CANS, DISREGUARD CHANNELS 43-54,49-54 ARE THE LEADER AND 43-48 ARE ON DECK, 12.5M GROUPS, 600M ACTIVE SECTIONS

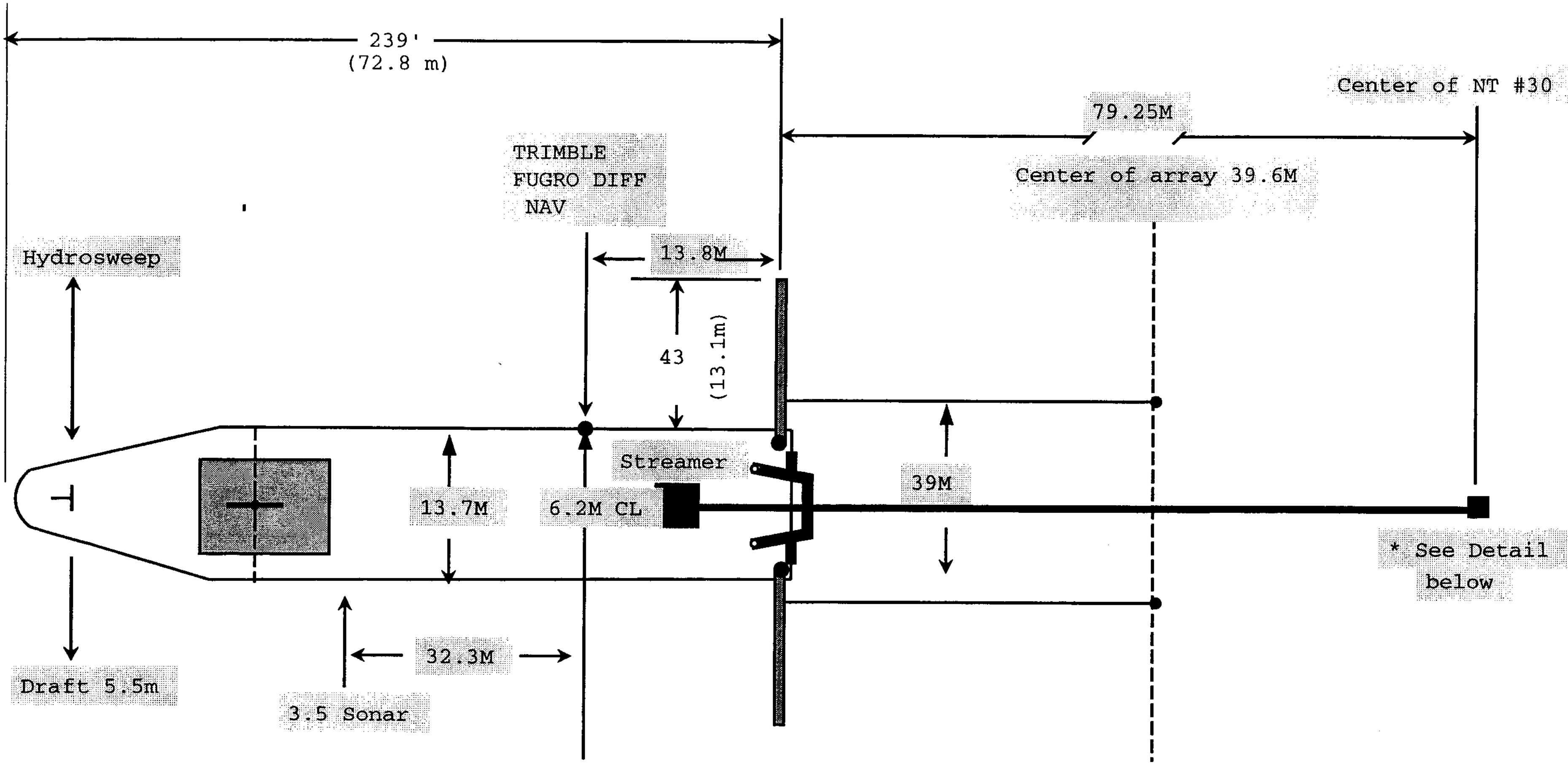


GI GUN ARRAY DETAILS 2ND SHORT STREAMER

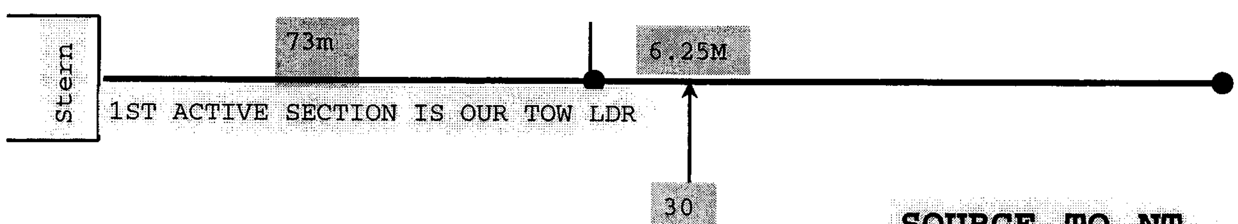
SOURCE TO NT = 79.25 - 39.6 = 39.65M

OCT 16, 2000 CPL **CLIENT: HOLBROOK** **AREA: BLAKE RIDGE** **Cruise: EW-2008**

MAURICE EWING MCS SETBACK AND OFFSET DIAGRAM



CABLE = 42 ACTIVE CHANNELS,3 ACTIVE CANS, DISREGUARD CHANNELS 31-42,31-36 ARE THE LEADER AND 37-42 ARE ON DECK, 12.5M GROUPS, 450M ACTIVE SECTIONS



GI GUN ARRAY DETAILS 1ST SHORT STREAMER

SOURCE TO NT = 79.25 - 39.6 = 39.65M

OCT 16, 2000 CPL **CLIENT: HOLBROOK** **AREA: BLAKE RIDGE** **Cruise: EW-2008**

1st short Streamer Config

CRUISE EW-0008 — **SHORT** — **10/16/00**

1ST SHORT CONFIG — **STREAMER CONFIGURATION**

MOD	SERIAL #	CAN#	SHIP OFFSET	CHANNELS	BIRD	COMMENTS
B						
TIC	CABLE 25.3M		552M TO 577.5M			
1		**2151**				**POWER MODULE 12151**
HS	30120-HS	50M	502M TO 552M			
TS	0697-30284TS	50M	452M TO 502M			
					1C	**BIRD AT 456.7 METERS**
AT	0498-30024	4M	448M TO 452M			
	0398-30291	**RED**	373M TO 448M	**1 TO 6**	**2**	**BIRD AT 442.2 METERS**
2		**3538**			**3C**	**BIRD AT 367.2 METERS**
	0298-31388	**ORNG**	298M TO 373M	**7 to 12**		
	0298-31407	**RED**	223M TO 298M	**13 to 18**	**4**	**BIRD AT 292.2 METERS**
3		**2734**			**5C**	**BIRD AT 217.2 METERS**
	0198-31319	**ORNG**	148M TO 223M	**19 to 24**		
	0198-31333	**RED**	73M TO 148M	**25 to 30**	**6**	**BIRD AT 142.2 METERS**
4		**2731**			**7C**	**BIRD AT 67.2 METERS**
	0298-31385	**ORNG**	0-73M	**31 to 36**		**USED AS LEADER**
	0298-31399	**RED**	ON DECK	**37 to 42**		**ON DECK**

2nd Short Config

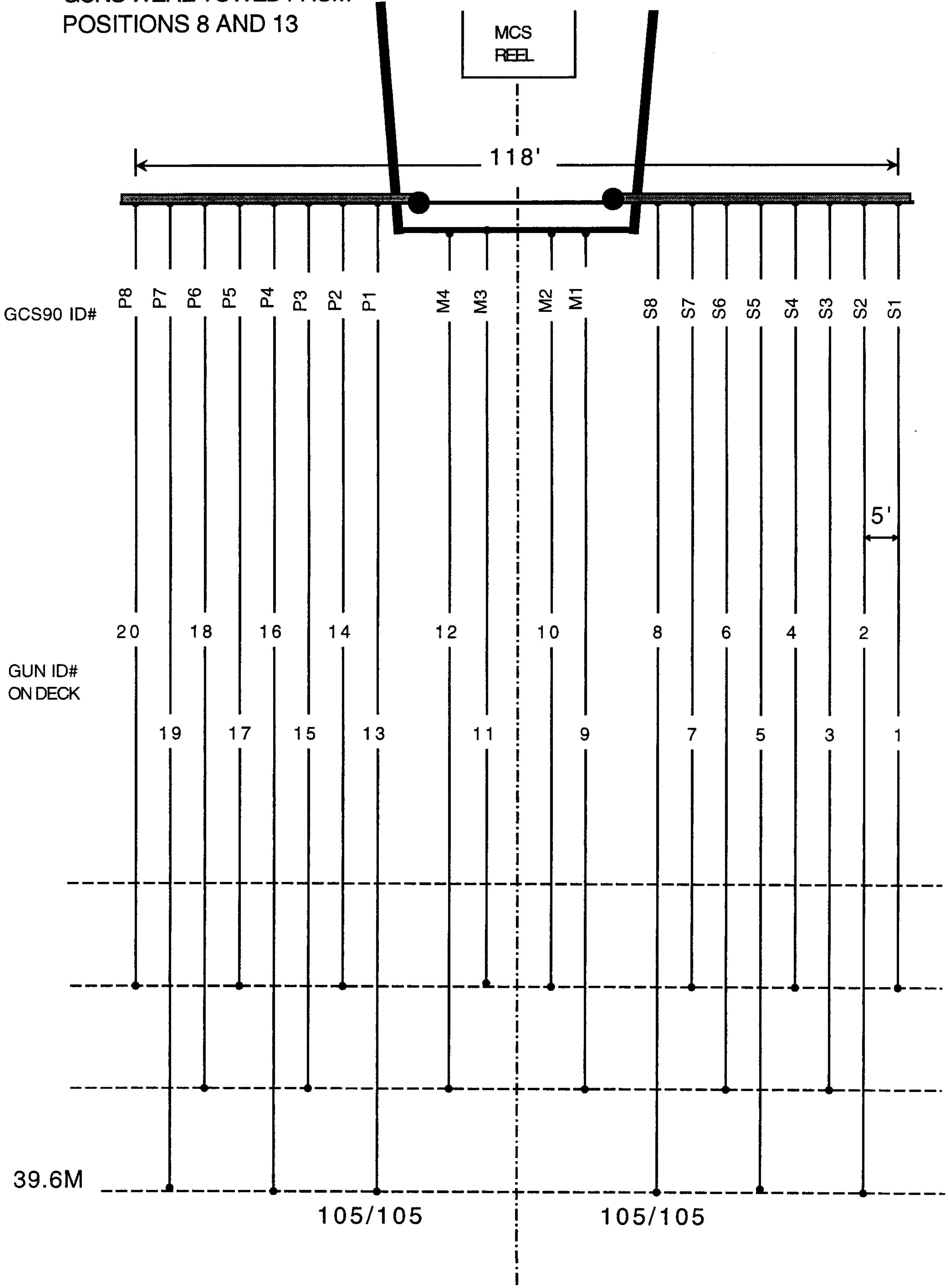
CRUISE EW-0008 — **SHORT STREAMER CONFIGURATION** — **10/16/00**

MOD	SERIAL #	CAN#	SHIP OFFSET	CHANNELS	BIRD	COMMENTS
B						
TIC	CABLE 25.3M		702M TO 727.3M			
1		**2151**				**POWER MODULE 12151**
HS	30120-HS	50M	652M TO 702M			
TS	0697-30284TS	50M	602M TO 652M			
					1C	**BIRD AT 608 METERS**
AT	0498-30024	**4M**	598M TO 602M			
	0398-30291	**RED**	523M TO 598M	**1 TO 6**		
2		**3538**			**2**	**BIRD AT 517 METERS**
	0298-31388	**ORNG**	448M TO 523M	**7 to 12**		
	0298-31407	**RED**	373M TO 448M	**13 to 18**	**3C**	**BIRD AT 442 METERS**
3		**2734**			**4**	**BIRD AT 367 METERS**
	0198-31319	**ORNG**	298M TO 373M	**19 to 24**		
	0198-31333	**RED**	223M TO 298M	**25 to 30**	**5C**	**BIRD AT 292 METERS**
4		**2731**			**6**	**BIRD AT 217 METERS**
	0298-31385	**ORNG**	148M TO 223M	**31 to 36**		
	0298-31399	**RED**	73M TO 148M	**37 to 42**	**7C**	**BIRD AT 142 METERS**
5		**3165**			**8**	**BIRD AT 67 METERS**
	0298 31416	**ORNG**	0-73M	**43 to 48**		
	0298 31361	**RED**	ON DECK	**49 to 54**		**THIS SECTION IS ON DECK**

EWING GI AIRGUN ARRAY- 2GI GUN ARRAY FOR EW008

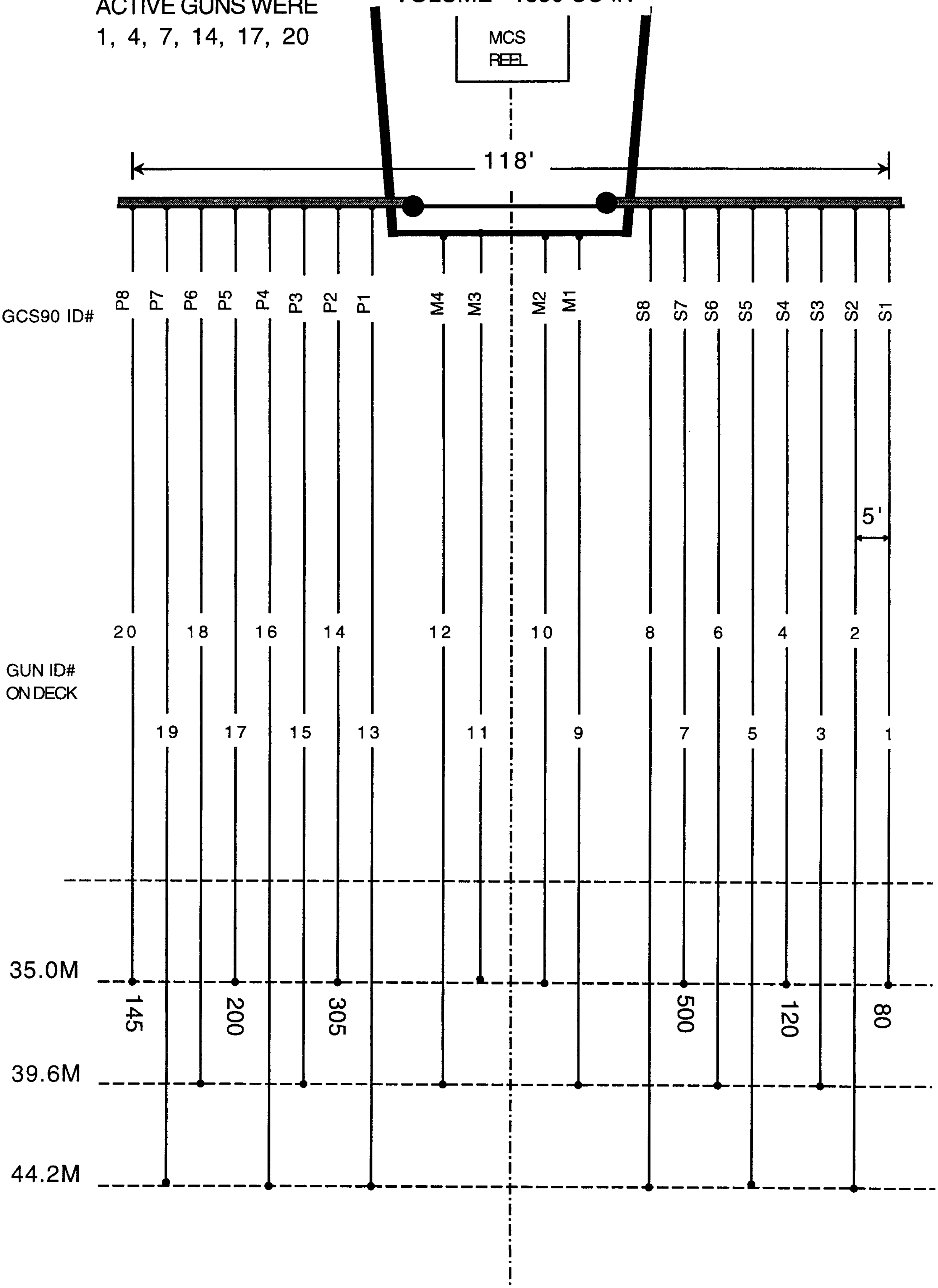
VOLUME= 105/105 CU IN

GUNS WERE TOWED FROM POSITIONS 8 AND 13



# EWING MCS AIRGUN ARRAY- 6 GUN ARRAY FOR EW008
VOLUME= 1350 CU IN

ACTIVE GUNS WERE
1, 4, 7, 14, 17, 20

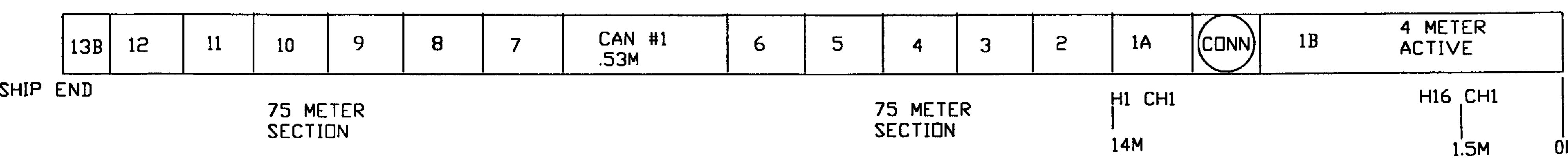


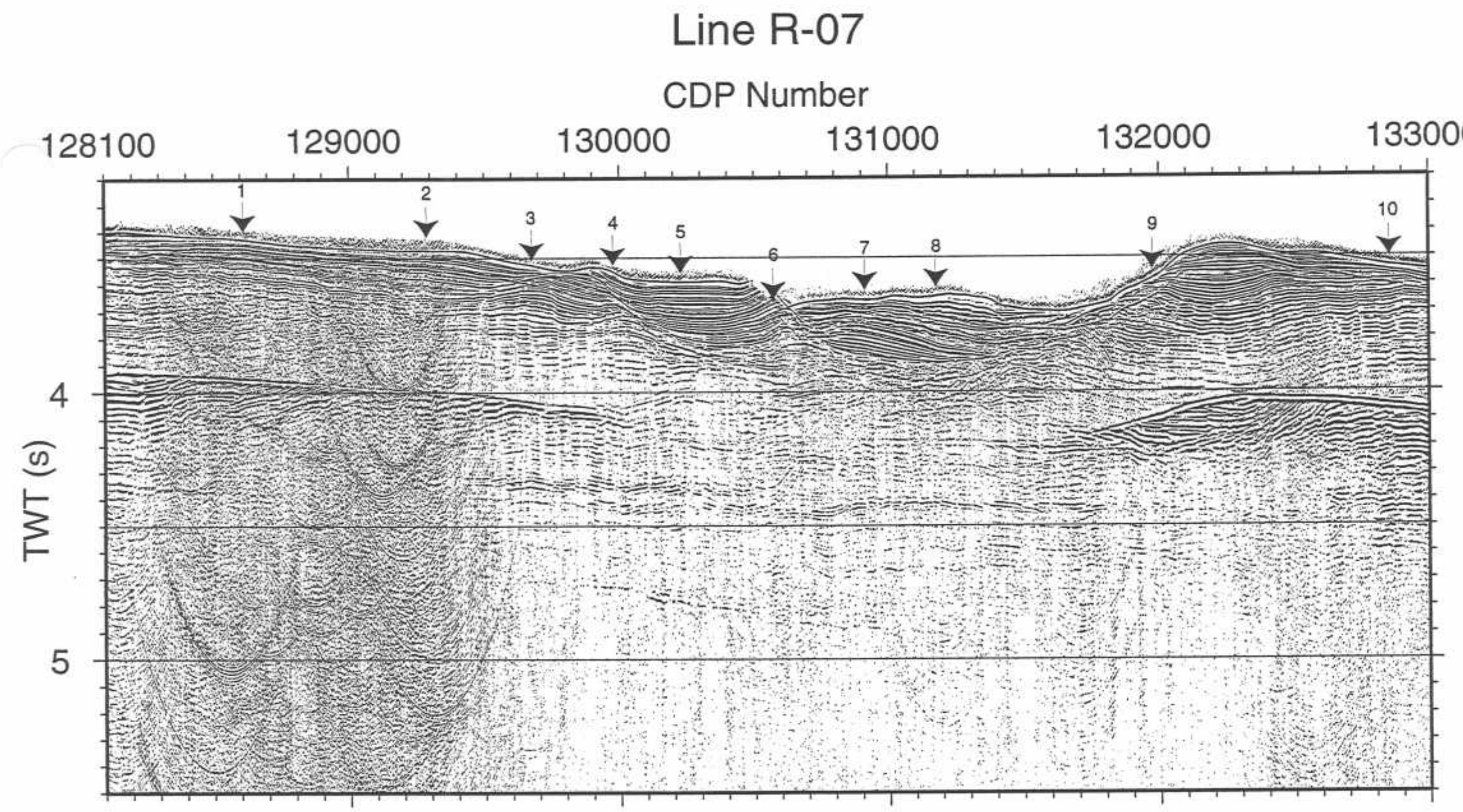
12.5 METER GROUPS

IN ONE 150 METER SECTION THERE ARE 12 CHANNELS

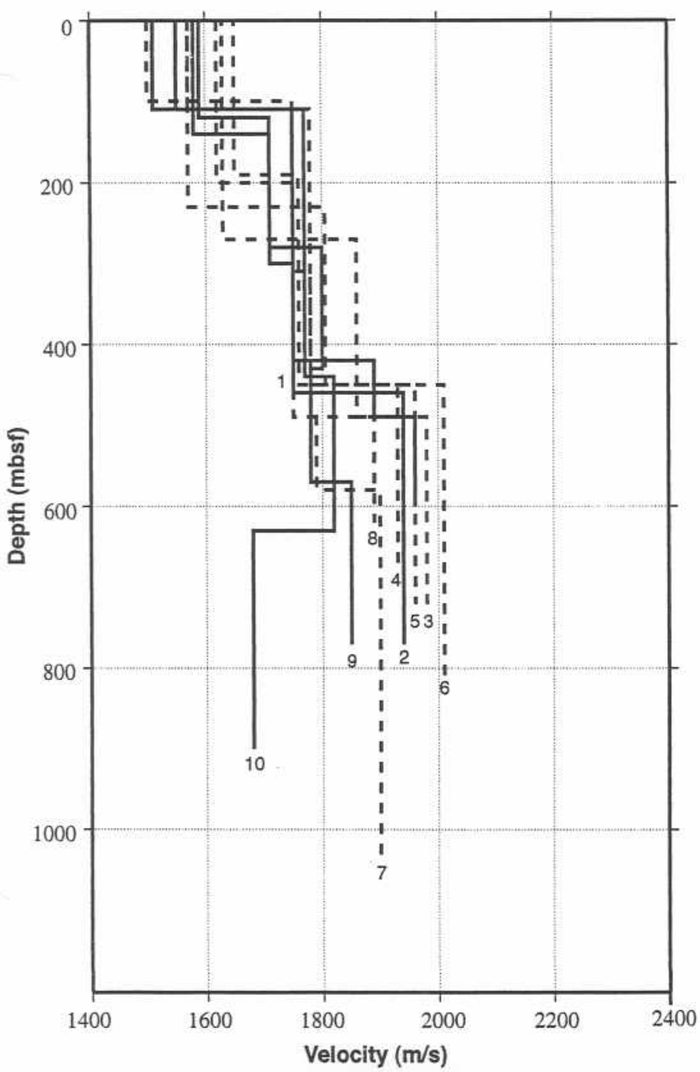
THERE ARE 16 HYDROPHONES PER CHANNEL

THE HYDROPHONES ARE SPACED 2.25 FEET (.694M) FROM EACH OTHER



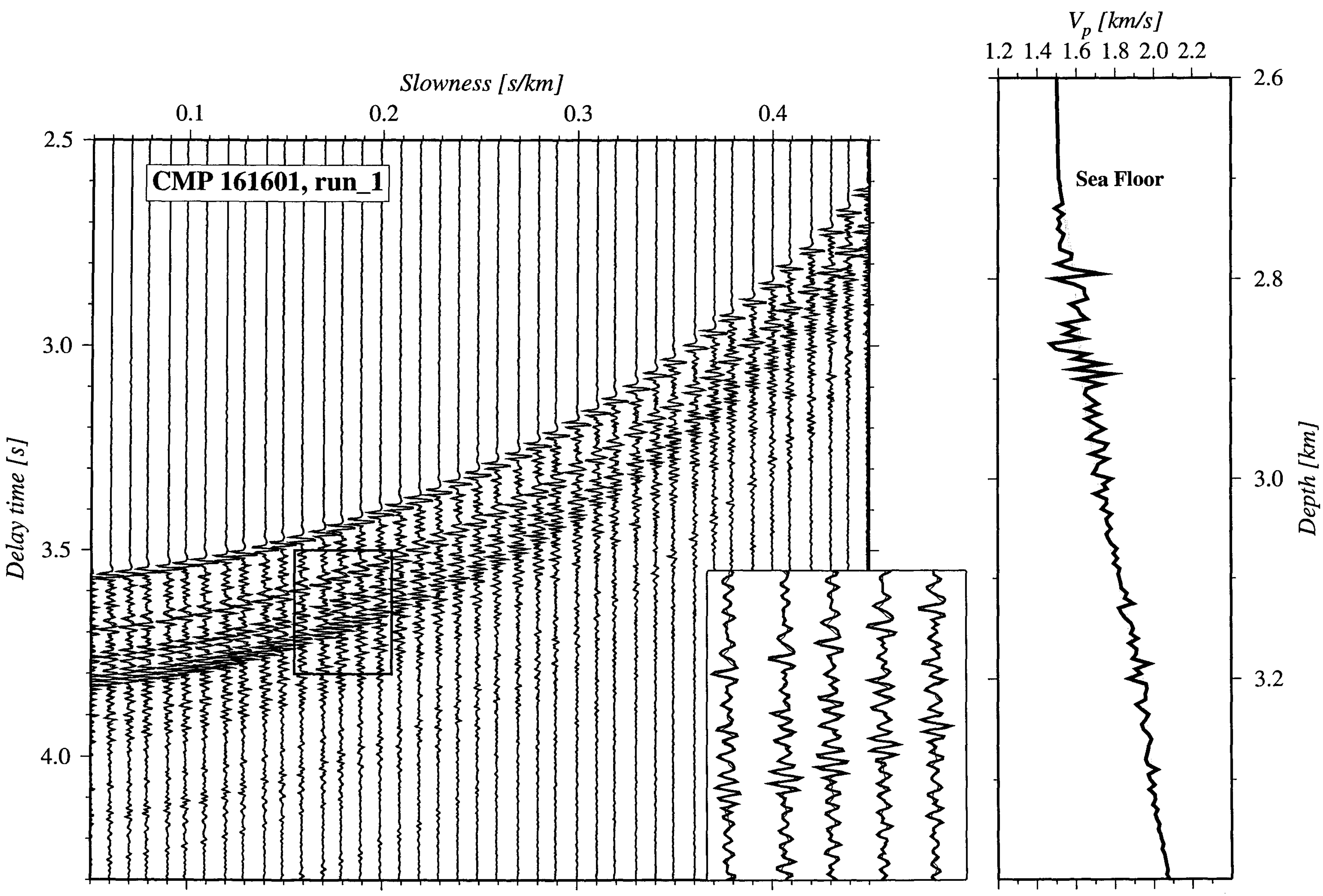


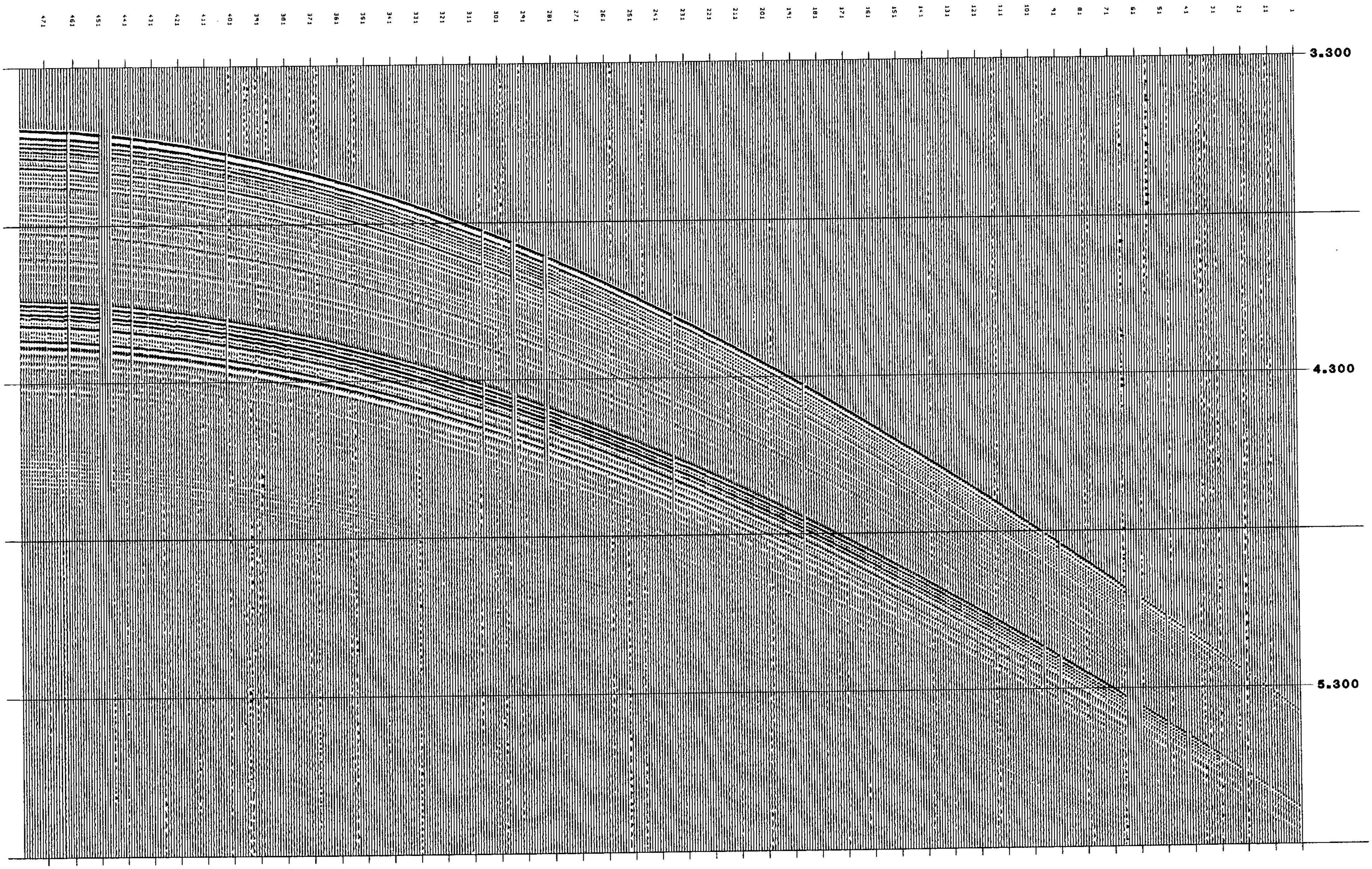
Line R-07: 1D Velocity Profile



Dashed lines represent velocity profiles of CMPs within the collapse structure. Solid lines represent velocity profiles of CMPs outside the collapse structure. The numbers on the figure correcpond to the following CMPs:

Number	CMP
1	128568
2	129283
3	129689
4	129973
5	130239
6	130555
7	130902
8	131187
9	131960
10	132853


Slowness [s/km]
0.1
0.2
0.3
0.4
2.5
3.0
3.5
4.0
Delay time [s]
CMP 161601, run_1
Vp [km/s]
1.2 1.4 1.6 1.8 2.0 2.2
2.6
2.8
3.0
3.2
Depth [km]
Sea Floor


3.300
4.300
5.300

Newfoundland Basin (EW0007) Tape Inventory

Box #	Tape Numbers	Comments
1	1-18; 846-851	
2	20-49	
3	50-79	
4	80-111	missing 98, 99
5	112-142	missing 129
6	143-173	missing 157
7	174-204	missing 188
8	205-235	missing 215
9	236-266	missing 255
10	267-299	missing 278, 289, 290
11	300-329	
12	330-359	
13	360-389	
14	390-419	
15	420-449	
16	450-479	
17	480-509	
18	510-539	
19	540-569	
20	570-604	missing 577, 578, 583, 588, 593
21	605-635	missing 606
22	636-665	
23	666-695	
24	696-725	
25	726-755	
26	756-785	
27	786-815	
28	816-845	

Blake Ridge (EW0008) Tape Inventory

Box #	Tape Numbers	Comments
1	10-38	
2	39-68	
3	69-98	
4	99-128	
5	129-158	
6	159-188	
7	189-218	
8	219-248	
9	249-278	
10	279-308	
11	309-338	
12	339-368	
13	369-398	
14	399-428	
15	429-458	
16	459-488	
17	489-518	
18	519-548	
19	549-578	
20	579-608	
21	609-638	
22	639-668	
23	669-699	missing 672
24	700-729	
25	730-759	
26	760-790	missing 762
27	791-820	
28	821-850	
29	851-880	
30	881-910	
31	911-940	
32	941-970	
33	971-1000	
34	1001-1030	
35	1031-1060	
36	1061-1090	
37	1091-1120	
38	1121-1150	
39	1151-1180	
40	1181-1210	
41	1211-1240	
42	1241-1270	
43	1271-1300	
44	1301-1330	
45	1331-1360	

46	1361-1390	
47	1391-1420	
48	1421-1450	
49	1451-1480	
50	1481-1510	
51	1511-1540	
52	1541-1570	
53	1571-1600	
54	1601-1630	
55	1631-1660	
56	1661-1690	
57	1691-1720	
58	1721-1750	
59	1751-1780	
60	1781-1811	missing 1800
61	1812-1841	
62	1841-1871	
63	1872-1901	

EW0008 GPS Setup

John E. Chance and Associates (Fugro) installed dual SpotBeam differential GPS systems which provided RTCM (differential) corrections to their Trimble 4000DS GPS receiver and several Ewing GPS receivers. The Trimble 4000 NMEA output was used as the primary navigation system (GP01) for the Ewing steering and navigation. The only failure of this system occurred on day 259 (in the 3-D shoot) and was rectified by switching from the AM-SAT satellite to the AMSC-E satellite (AM-SAT was set for Port Newark and AMSC-E was set for the work area). The switch was reset to AM-SAT on day 276.

The SpotBeam was selected over the past Inmarsat setup because of the well known problem of the Ewing mast blocking the Ewing Inmarsat dome. The two SpotBeam antennae and the Trimble 4000 antenna were installed on the roof of the A-booth (winch booth on the A-deck), well away from the Ewing's mast. The antenna was 6.2 meters starboard of the ship's centerline and 14 meters forward of the transom (the aft most part of the stern).

The RTCM differential corrections were supposed to be sent to the tailbuoy, so that the tailbuoy's Ashtech G-8 GPS receiver would send back corrected positions (NMEA strings). This objective was NEVER successful. When the ship could receive tailbuoy positions, the receiver did not send back differential NMEA strings.

Figure gp01.ps is a scatter plot of twelve hours of the Fugro system. While no formal statistics were done on the data, they clearly show a diurnal (tidal) pattern and are probably within the one meter RMS desired.

Streamer navigation.

The real-time navigation of the streamer cable, using GPS measurements and the magnetic bearings provided by the compass streamer birds, was an essential tool for the 3D survey. It allowed us to monitor with sufficient accuracy which areas of our study area had been covered by common mid-points (CMP) at any time. The effectiveness of our shooting geometry for the purpose of this 3D survey depended highly on the amount of streamer feathering, i.e., the deviation between the streamer position and the ship track. Feathering is caused by the ship's turning or by ocean currents (see figure Nav-1), and it creates a swath of CMP points half as wide as the amount of feathering, rather than a set of truly two-dimensional paths. The target of the 3D survey, the so-called CMP box, was a 39000 by 6525 m rectangle rotated 76° clockwise from the north, spanned by the coordinates (75° 40.236 W, 31° 49.520 W) to the south, (75° 41.400 W, 31° 53.400 W) to the west, (75° 17.409 W, 31° 58.600 W) to the north, and (75° 16.260 W, 31° 54.716 W) to the east. For the 3-D survey we originally planned 89 shot lines parallel to the long side of the box, spaced 75 m apart. The target resolution across the shot lines was 12.5 m. Therefore, many bins were outside the ship's track A 75 m wide swath can be filled by a single pass of the streamer if the streamer feathers at least 150 m. In this simple calculation it is assumed that the seismic traces of source-receiver pairs with short and long offsets have sufficiently similar character. Indeed, separate stacks of long and short offsets have few differences (see figure XXX). The histogram of figure Nav-2 shows that streamer feathering was often more than sufficient. The real-time streamer navigation proved its value towards the end of the 3D survey, when the ship had to be maneuvered to fill specific gaps of less than 50 m width in the data coverage. The various shot lines of the 3D survey, as well as some regional lines through the CMP box, are shown in figures Nav-3.1 to Nav-3.25. Additional processing of the raw navigation data will be necessary to obtain the final source-receiver geometry of this 3D data set. However, this improved analysis will not be very different from the procedures described in this section.

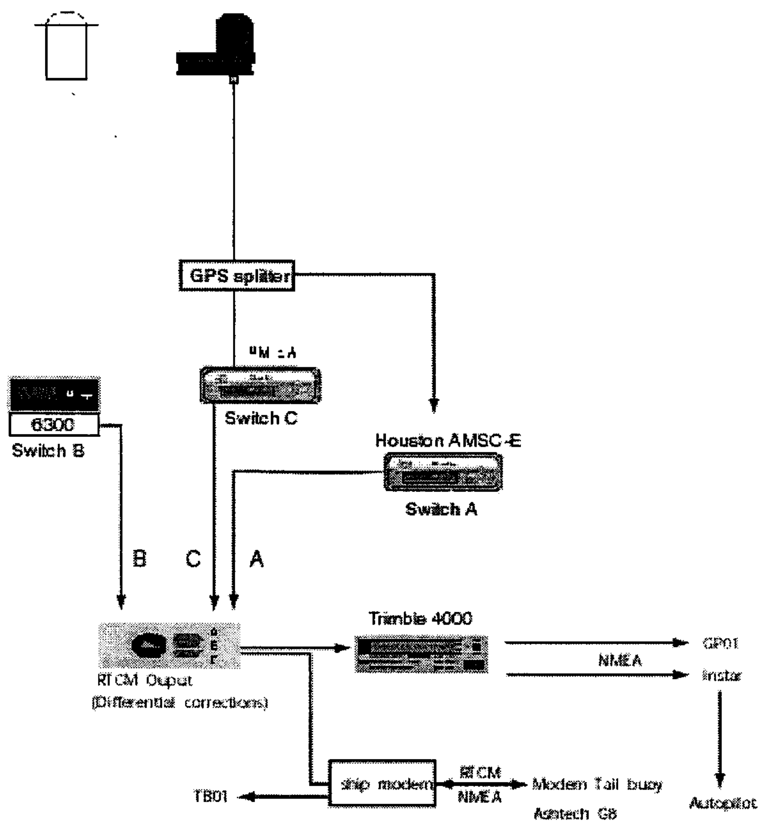
During the seismic survey, the compass navigation block is sent from shipboard computer "grampus" after every shot. The navigation data are also stored in the cb01 files in the raw data directory on grampus. The ascii string looks as follows:

```
2000+264:00:00:09.755 3D-45 062175 N 31 53.4303 W 075 32.9608 N 31
53.4416 W 075 32.9440 N 50 10.4577 W 054 28.7714  69.2 C01 77.2 C03
77.4 C05 78.1 C07 78.3 C09 76.0 C11 77.2 C13 76.8 C15 77.3 C17 78.3 C19
78.0 C23 78.8
```

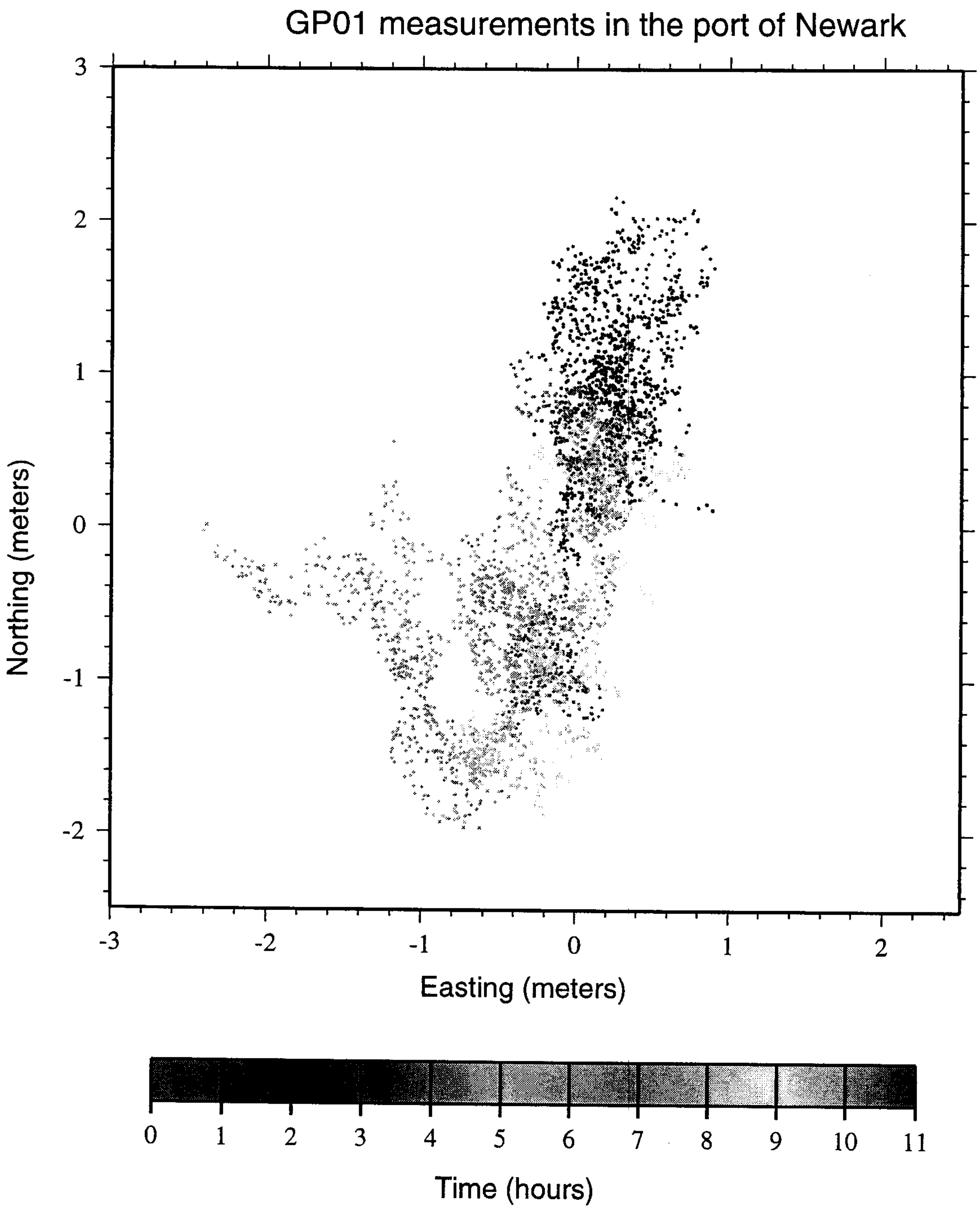
The different words in this data block are clarified below:

2000+264:00:00:09.755	Time
3D-45	Line name
062175	Shot number
N 31 53.4303 W 075 32.9608	Coordinates of Fugro GPS (GP01)
N 31 53.4416 W 075 32.9440	Coordinates of ship's trimble GPS
N 50 10.4577 W 054 28.7714	Coordinates of tailbuoy GPS
69.2	Ship's heading
C01 77.2	Magnetic bearing of bird C01
C03 77.4	Magnetic bearing of bird C03
… etcetera.	

GPS layout for EW0008



6300A and 3000 for AM-Sat as well as all antennas are located in A-Booth
3000 for AMSC, Trimble 4000, and ABC switch are located in Lab.
Baud rates are 4800, N,8,1



GP01 measurements in the port of Newark
Northing (meters)
Easting (meters)
3
2
1
0
-1
-2
-3
-2
-1
0
1
2
0
1
2
3
4
5
6
7
8
9
10
11
Time (hours)

For the streamer reconstruction we used the matlab script "realtime_nav" of Alistair Harding. The matlab routine reads the `cb01` data block, and it fits a piecewise polynomial curve to the compass headings. Beside the streamer layout, a precise measure of the relative position of the Fugro GPS (GP01) and the air guns is required. The GP01 antenna was positioned 5.85 m starboard off the center line of the ship, and 13.84 m from the aft. The gun booms are 2.00 m from the aft, and the distance between the guns and GP01 was 34.70 for the 6-gun array and 39.30 for the GI guns. A strong feature of Harding's program is the very convenient display of the streamer, which allowed us to check the amount and direction of streamer feathering during the survey. The matlab script was modified to ouput a file with the ship and streamer position for every shot in the following format:

`3D-50    119039`	Shot line name and shot number
`2000 273 21 30    43.693000`	Year, day, and time
`-75   14.526423   31   56.229348`	Coordinates of GP01
`-75   14.527717   31   56.214524`	Coordinates of the ship's guns.
`-37   -76`	Position of the hydrophone channels
`-43   -88`	relative to GP01 in meters easting
`-48   -99`	and northing.
`-54   -110`	
`-59   -121`	
`-65   -132`	
… etcetera.	

This output file is already very similar to the UKOOA format, which is standard for 3D seismic surveys. The UKOOA format writes a header for the survey (lines starting with an H), a header for each shot (starts with an S), and it requires that the channel positions are written out in three columns, starting with the channel nearest to the ship (lines starting with R). A sample is shown here:

```
H0100AREA NAME ...............: BLAKE RIDGE, US ATLANTIC MARGIN
H0101JOB DESCRIPTION .........: SINGLE VESSEL, ONE STREAMER, ONE SOURCE
H0102VESSEL DETAILS ..........: R/V MAURICE EWING
H0200DATE OF SURVEY ..........: SEPTEMBER-OCTOBER 2000
H0700       TRINAV DGPS STARFIX
S      R27      176637                  40446.3  7695.6             24791618
R   1  40594.1    7561.2 7.5   2  40597.1   7549.2 7.5   3  40601.1   7537.2 7.5
R   4  40605.1    7525.2 7.5   5  40608.1   7513.2 7.5   6  40612.1   7501.2 7.5
R   7  40616.1    7489.2 7.5   8  40619.1   7477.2 7.5   9  40623.1   7465.2 7.5
R  10  40627.1    7453.2 7.5  11  40631.1   7441.2 7.5  12  40634.1   7429.2 7.5
R  13  40638.1    7417.2 7.5  14  40642.1   7405.2 7.5  15  40645.1   7393.2 7.5
R  16  40649.1    7382.2 7.5  17  40653.1   7370.2 7.5  18  40656.1   7358.2 7.5
R  19  40660.1    7346.2 7.5  20  40664.1   7334.2 7.5  21  40667.1   7322.2 7.5
R  22  40671.1    7310.2 7.5  23  40674.1   7298.2 7.5 ,
```

etcetera.

The shot header reads as follows:

R27	line name
176637	shot number
40446.3	easting (m) of gun position
7695.6	northing (m) of gun position
24791618	time (s).

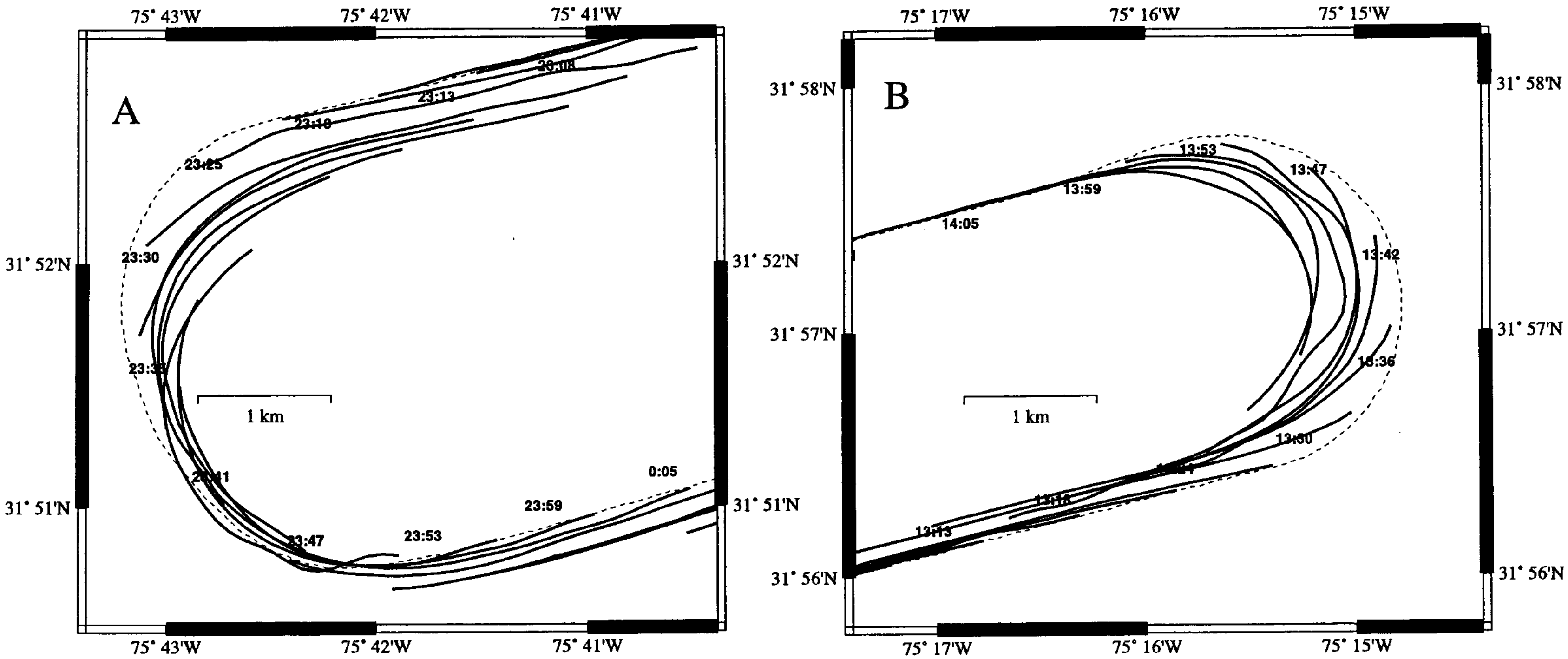
The receiver records list channel number, easting, northing, and depth of the hydrophone groups. For the UKOOA files created on board we chose all coordinates of both sources and receivers relative to the western corner of the CMP box (75° 41.400 W, 31° 53.400 W). UKOOA files were written after each shot line was finished.

Beside writing a UKOOA file, we used the output from the matlab script to bin the reflection points in various bin maps. Figure Nav-4 shows the fold of all the seismic data on a 12.5 m grid over the CMP box. The coverage, using the full streamer, is generally good at this scale, but very narrow gaps remain, in particular in the eastern portion of the box. The gaps are somewhat reduced by applying 25% bin extension, which means that neighboring bins overlap, and some reflection points are binned twice in adjacent tiles. The remaining gaps are better visible in a map where the distances across the shot lines are exaggerated, such as in figure Nav-3. In figure Nav-5 the fold is displayed in the CMP box and surrounding area, along with the ship tracks from the survey. Most of the shot lines parallel the length of the box. These lines were shot with the 4 km streamer, using 324 channels. Towards the end of the 3D survey smaller adjustments were made to fill in gaps. These lines often have a few small jogs. The straight shot lines crossing the upright direction at a high angle are the regional lines that were shot with a 6 km streamer, and 480 channels.

The goodness of the data coverage is shown in more detail in figures Nav-6. The largest gaps in the eastern portion of the model occupy almost the full width of 75 m between two shot lines (see figure Nav-6a). Nevertheless, these gaps in the 12.5 m bin map still comprise less than 1% of the surface area of the CMP box, and figure Nav-6b is more representative of the data density. The streaking of the fold in the 12.5 m bin map is due to the fact that the shot spacing is 37.5 m, three times larger than the bin spacing.

The data coverage of the CMP box is nearly complete if the entire streamer is used (see figure Nav-7a and Nav-7b), but the coverage for less than the full streamer remains patchy, even if the bin size is increased to 25 m. In figures Nav-7c to Nav-7h we mapped the coverage for the first, middle and last third of the streamer, on both 12.5 and 25 m grids. It should be noted again, however, that preliminary stacks indicate that the near and far-offset source-receiver pairs contribute fairly equally to the stacked image, and the gaps in figures Nav-7c to Nav-7h do not imply holes in the 3-D coverage.

As a last interesting display, we summed the fold of the 12.5 and 25 m bins in histograms, which shows that in fact few bins have a truly low fold. The few gaps in the data will require some special attention to avoid smearing of seismic structure, but these gaps are few and far in between. It may even be considered to decrease the bin size to 6.25 m in some portions of the model, in order to enhance the resolution of the image.



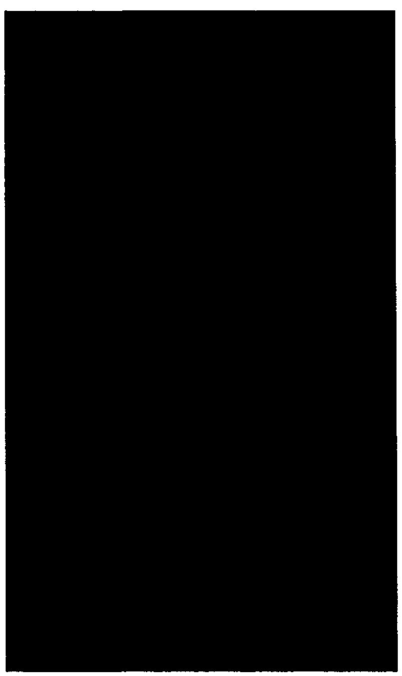


Figure Nav-1. During the 3-D survey, the streamer was reconstructed for everry shot. The solid lines in a) and b) are streamer reconstructions during a turn. The dashed line is the ship track. Note that the streamer is feathering to the south in a), which was the predominant direction, but in b) the streamer is feathering to the north.

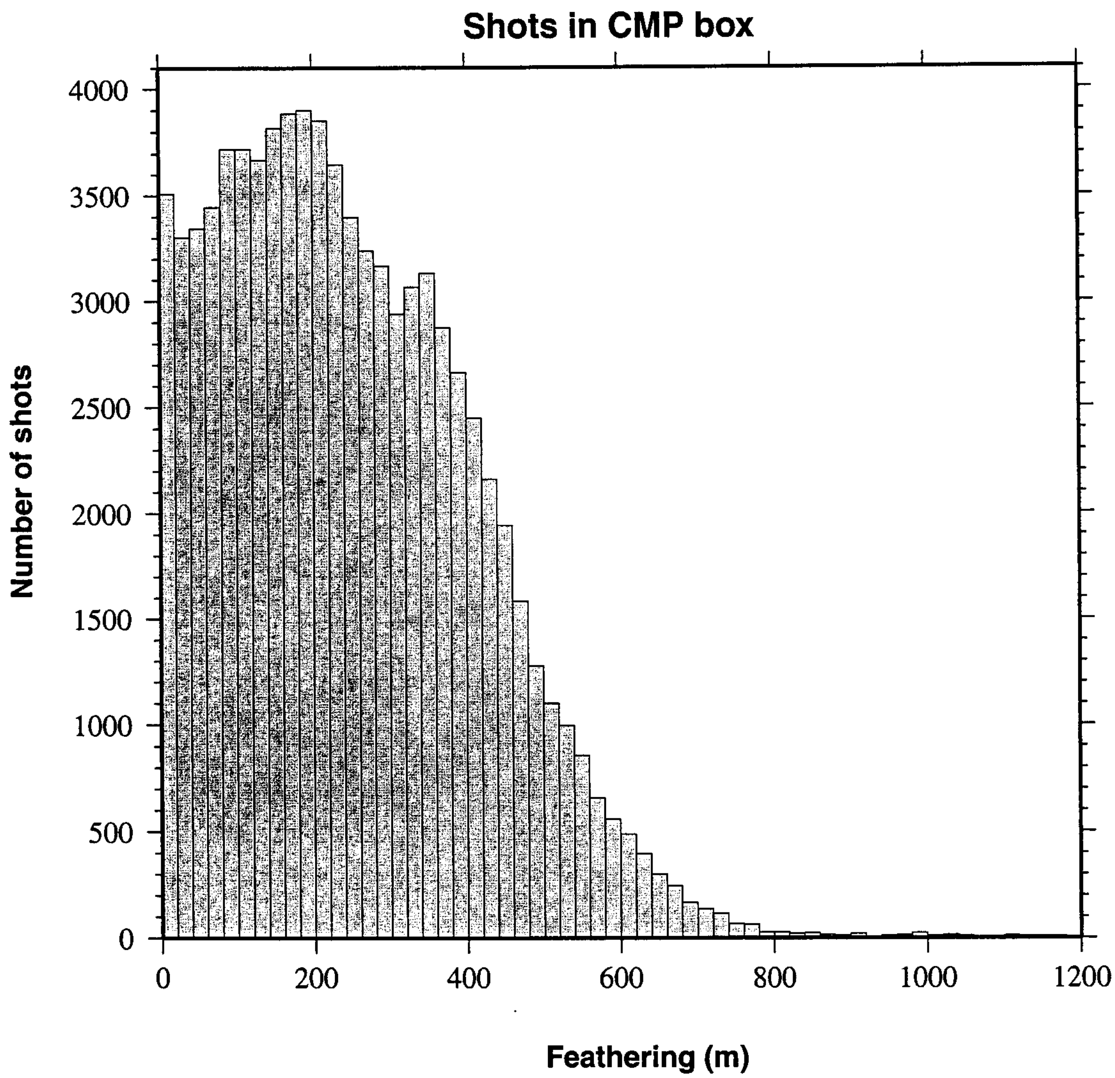


Figure Nav-2. The amount of streamer feathering during the 3-D survey was usually very substantial. The data for the histogram shown are taken from all shots in the CMP box sufficiently far from the ship turns.

Ship tracks and shot numbers 3-D survey

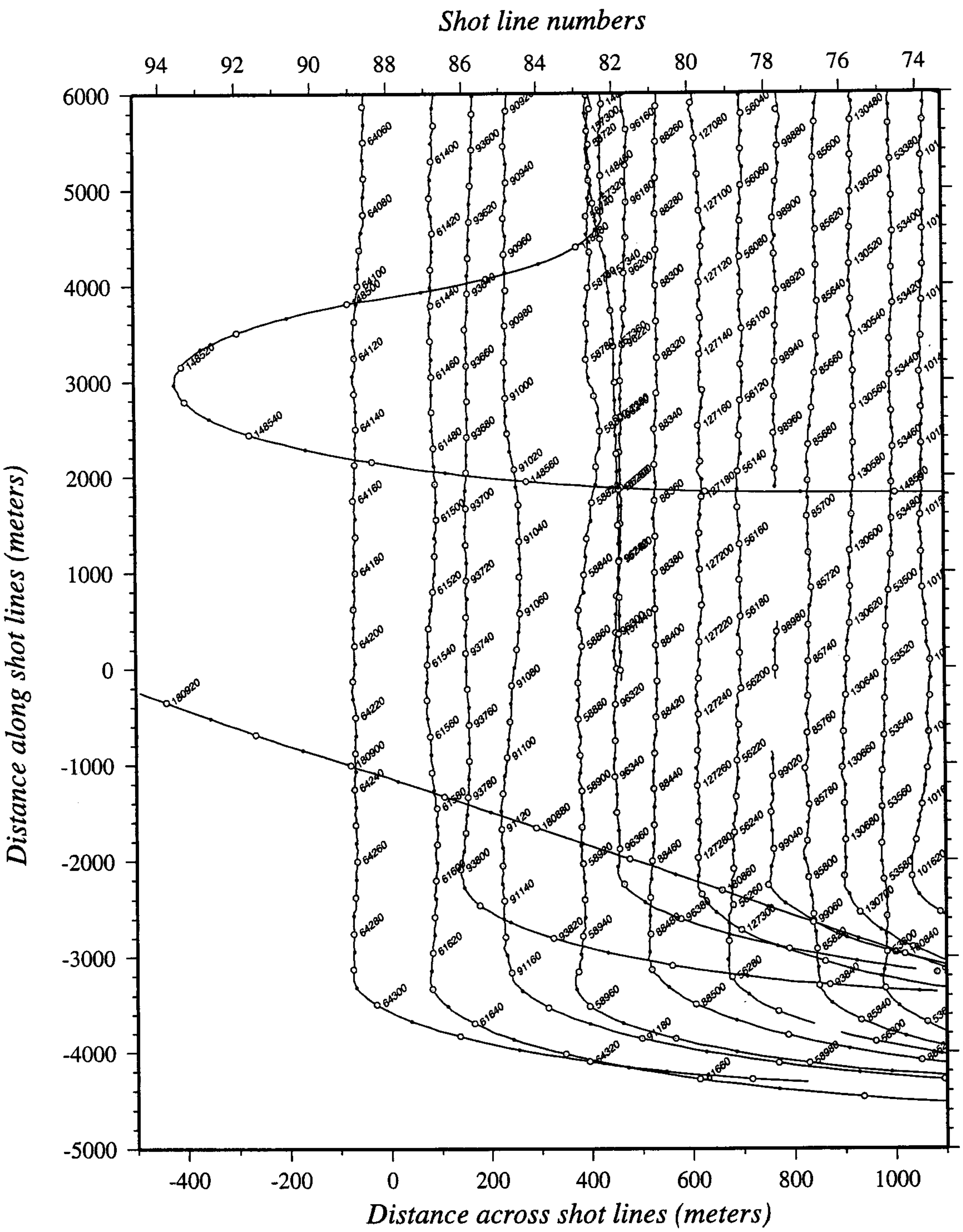
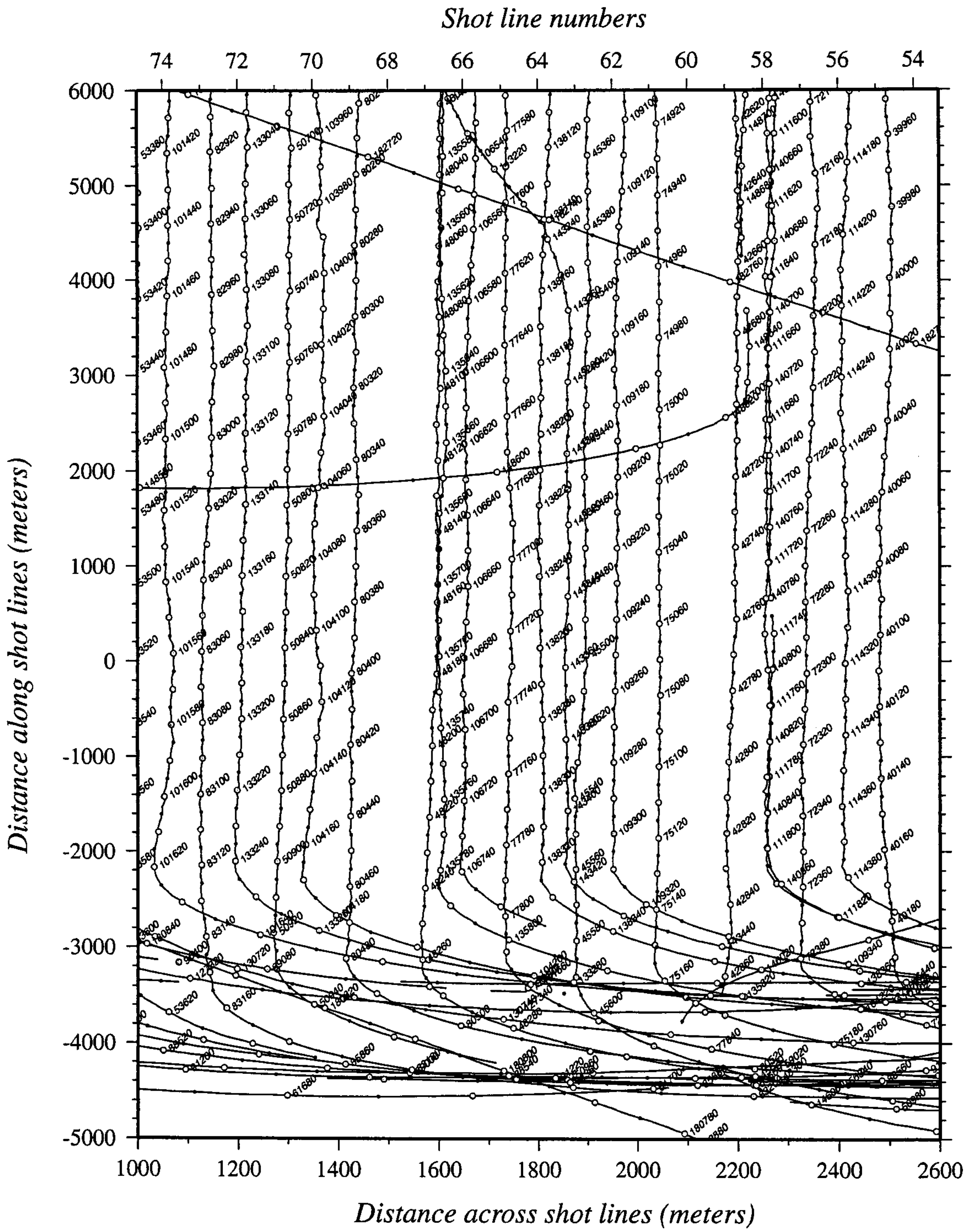
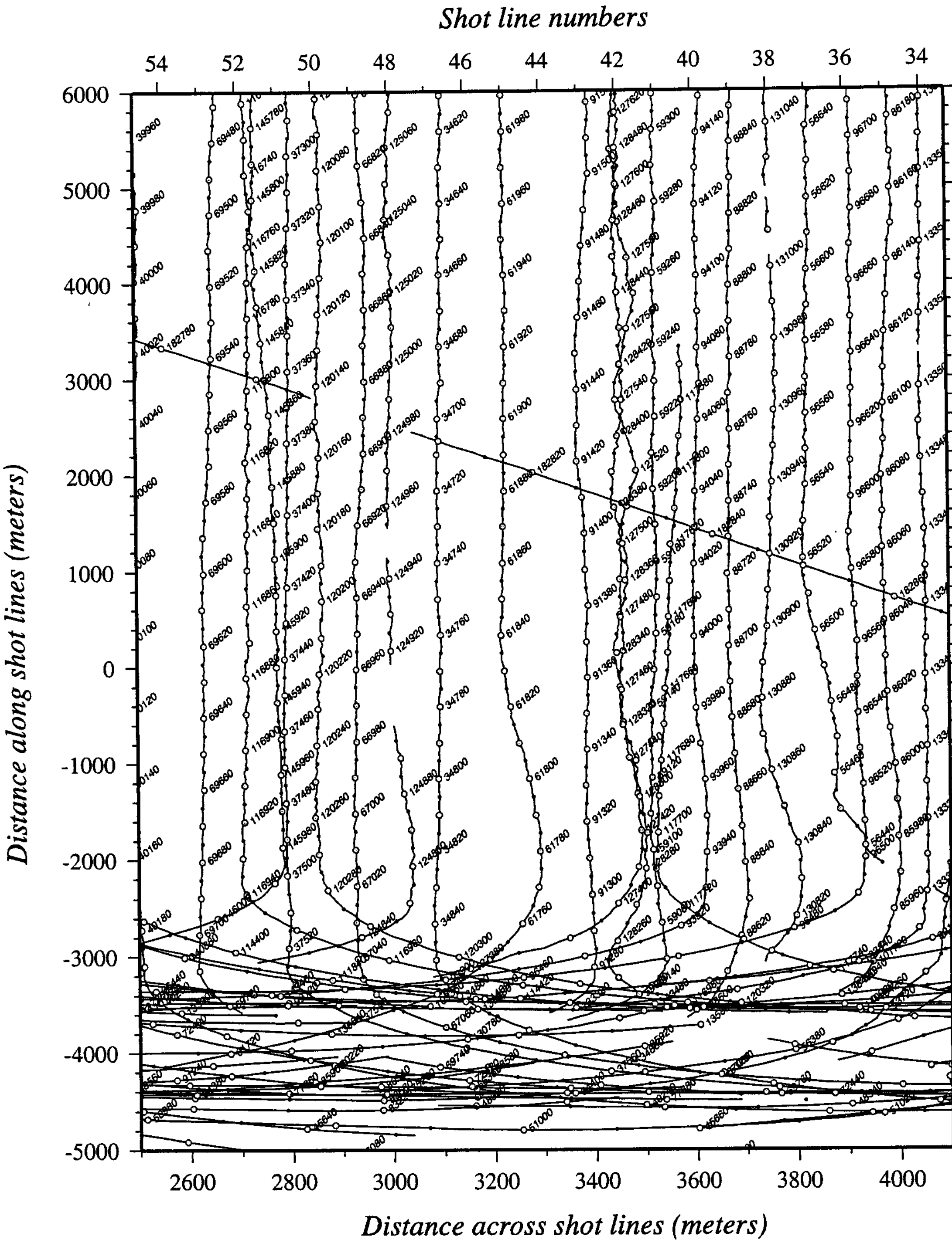


Figure Nav-3.1 to 3.25. The ship track and shot numbers of the shot lines of the 3-D survey and some regional lines are displayed in 25 maps that cover the CMP box and surrounding area. The horizontal scale, extending across the shot lines, is exaggerated in order to create space for the shot number labels. The shot line numbers are labeled on the scale at the top of the figure.

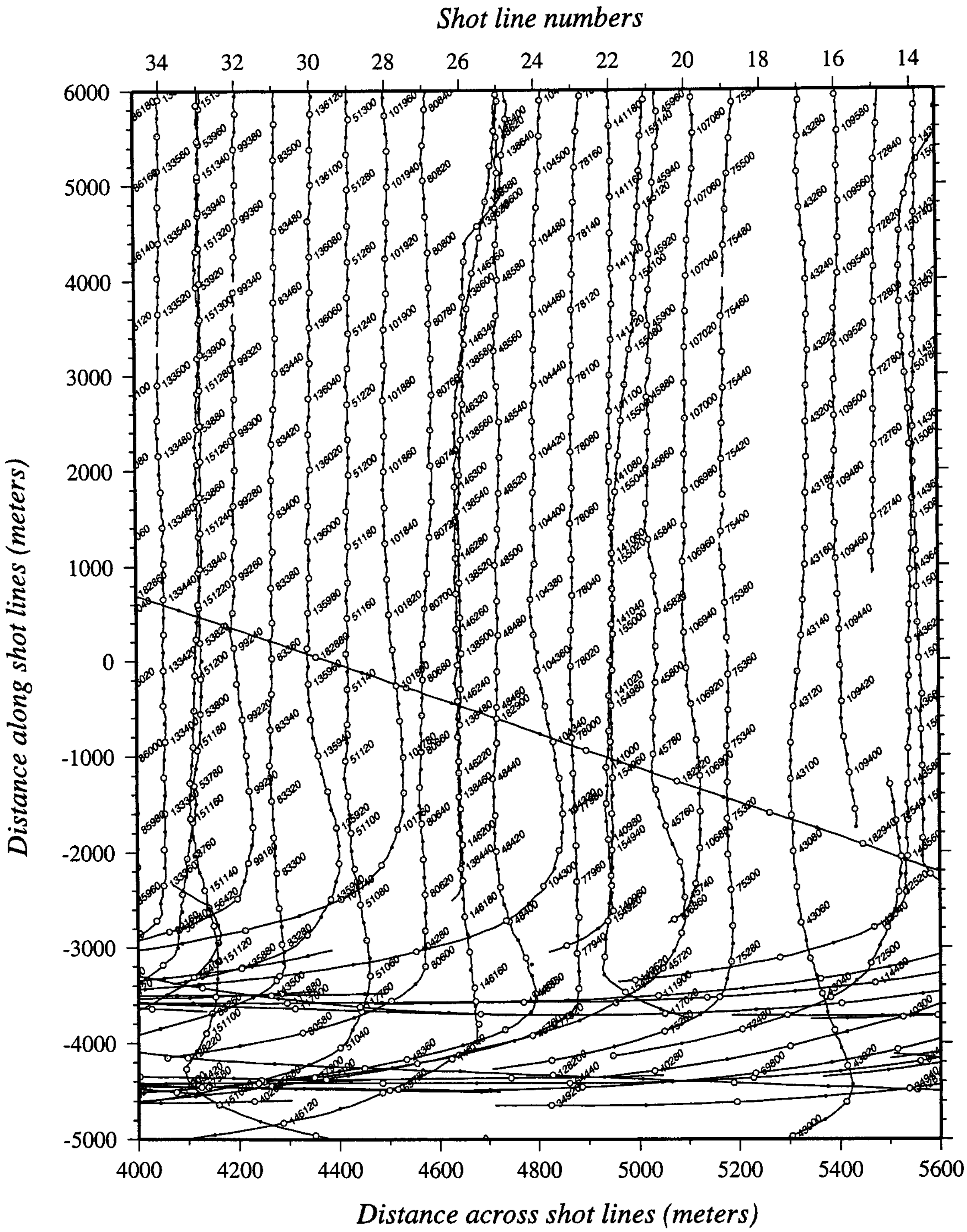
Ship tracks and shot numbers 3-D survey



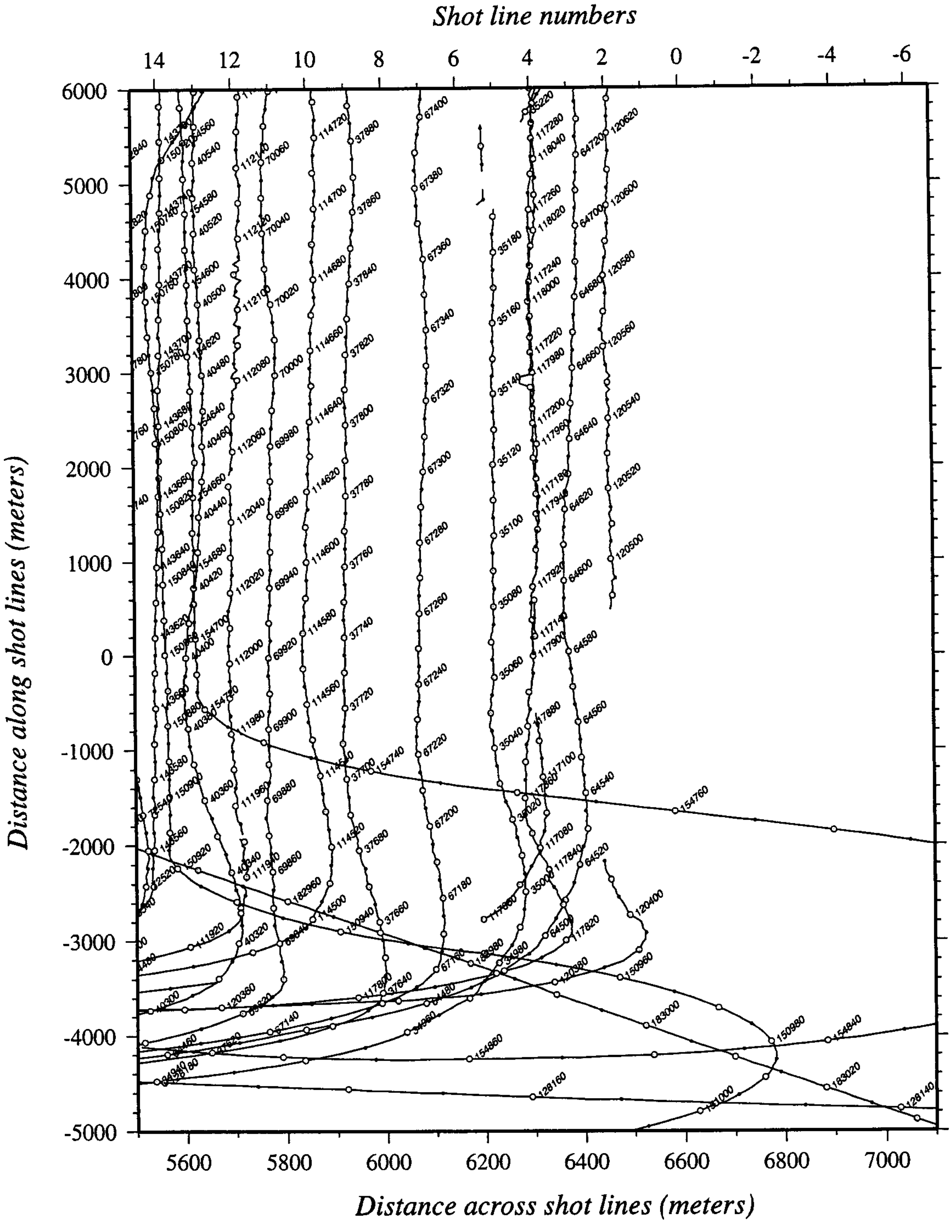
Ship tracks and shot numbers 3-D survey



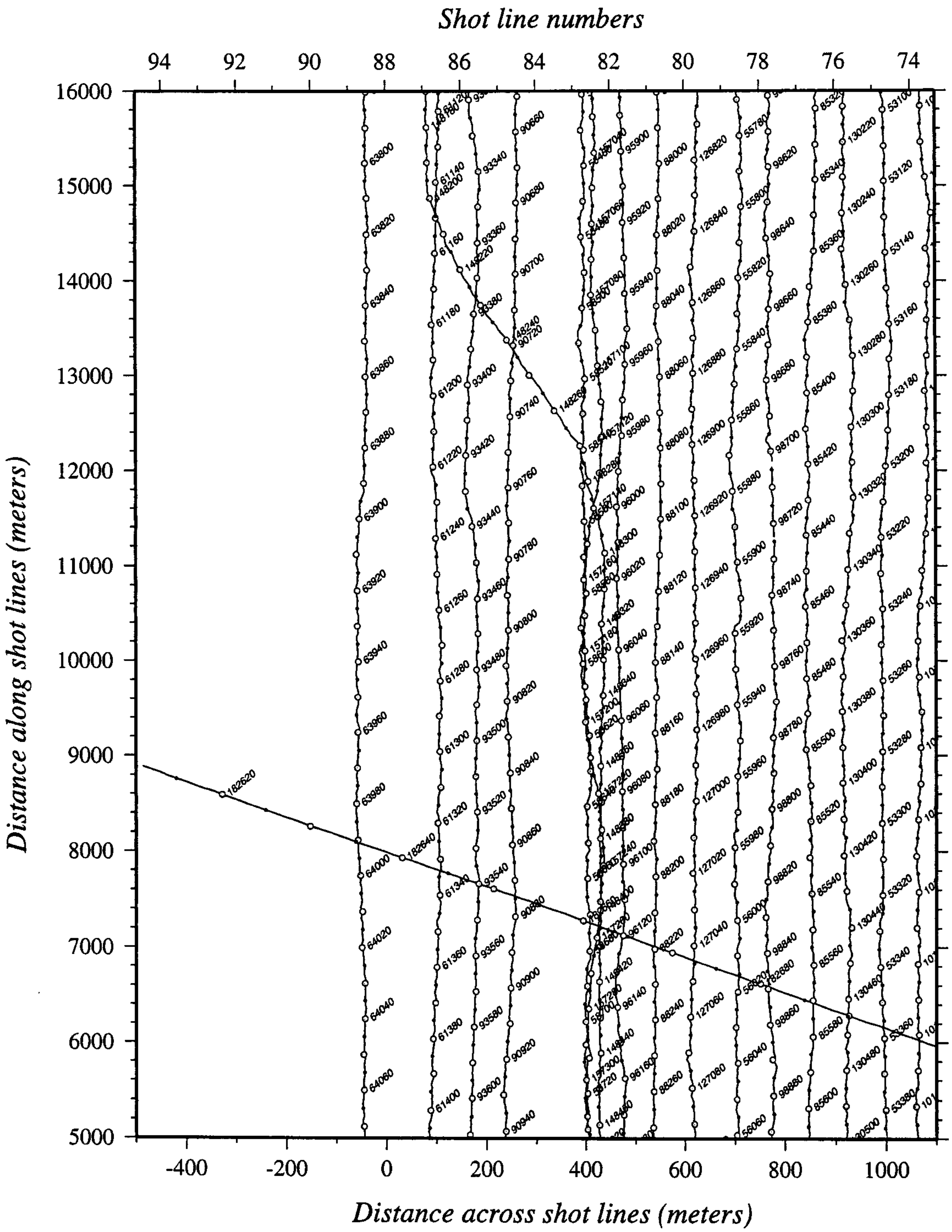
Ship tracks and shot numbers 3-D survey



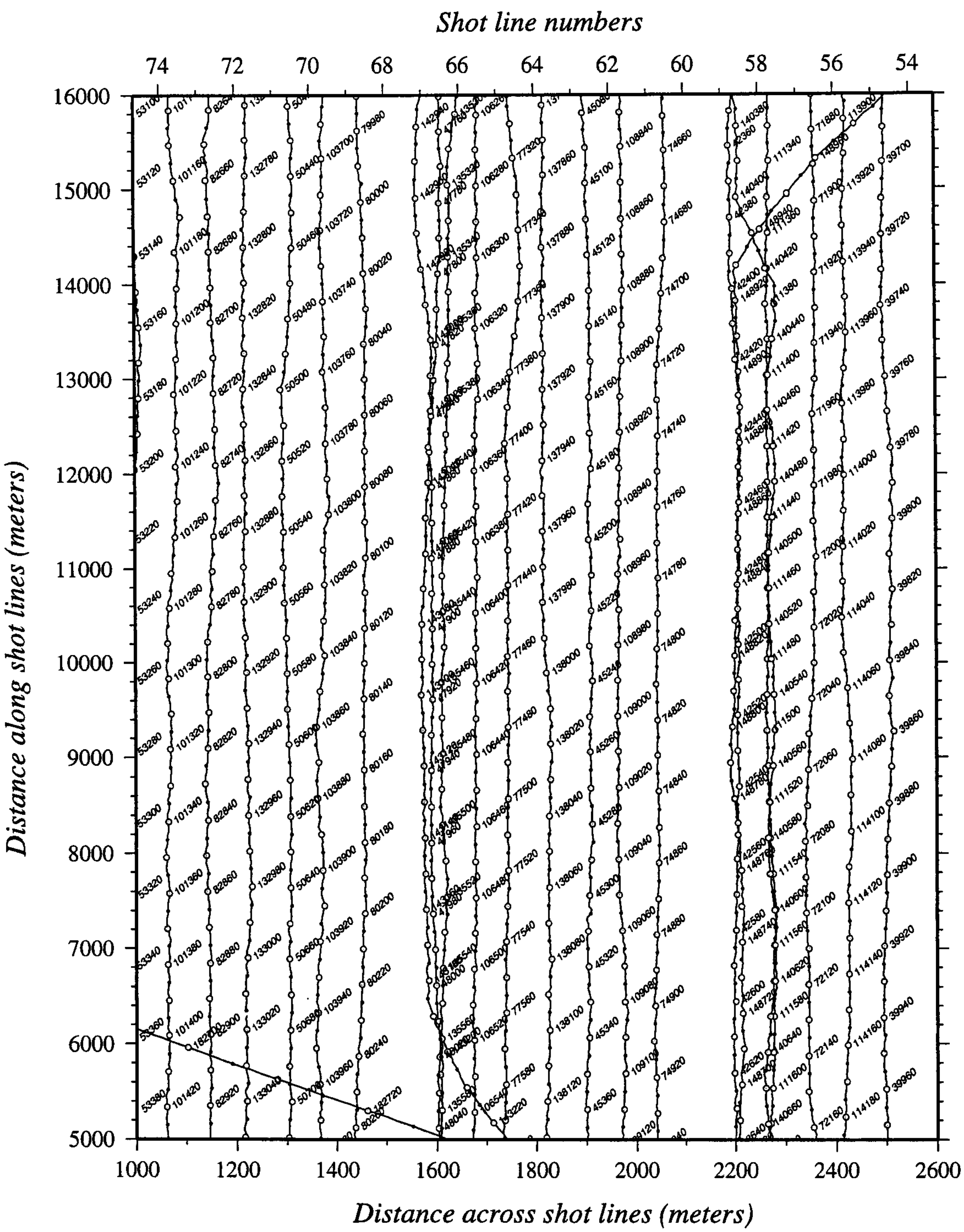
Ship tracks and shot numbers 3-D survey



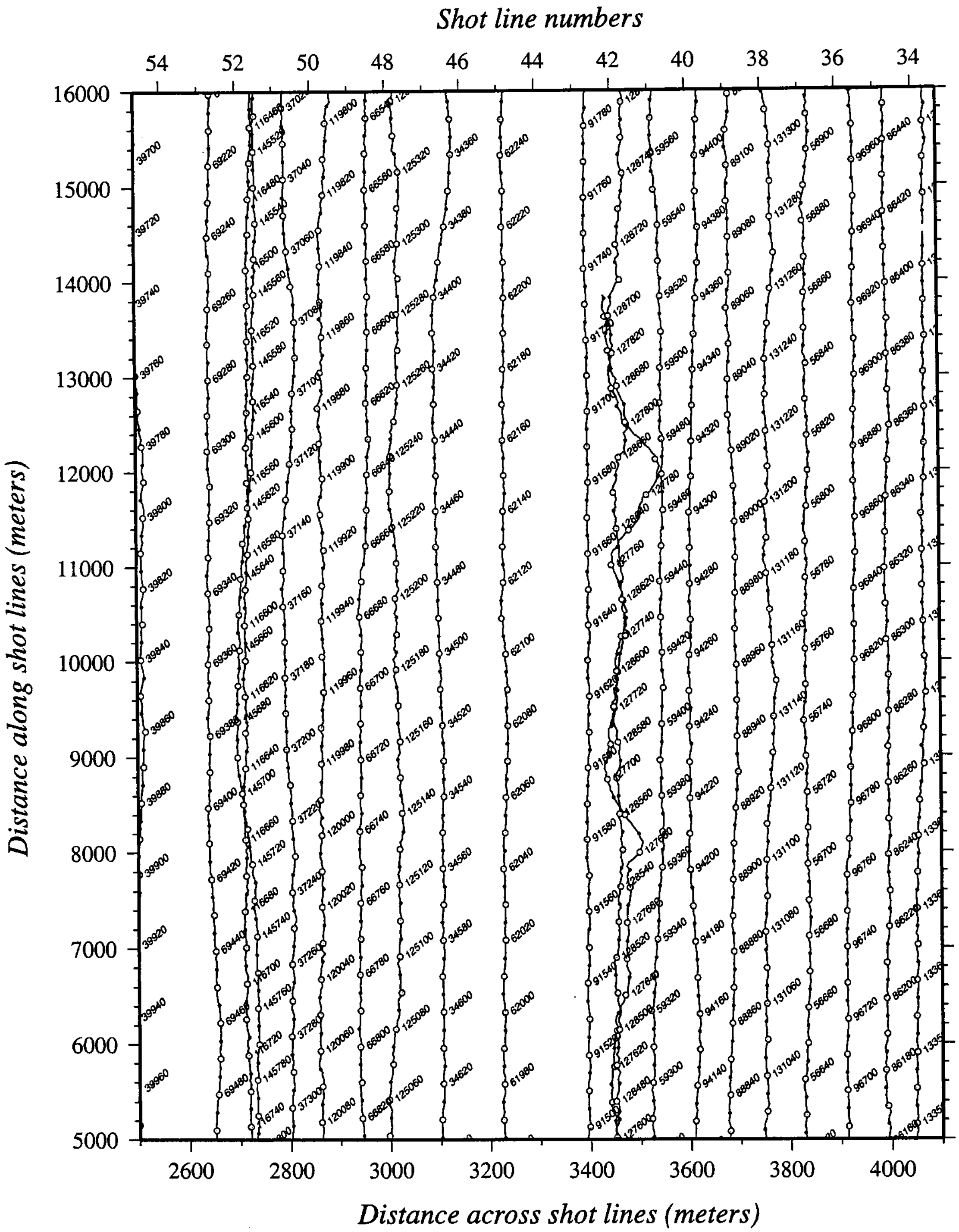
Ship tracks and shot numbers 3-D survey



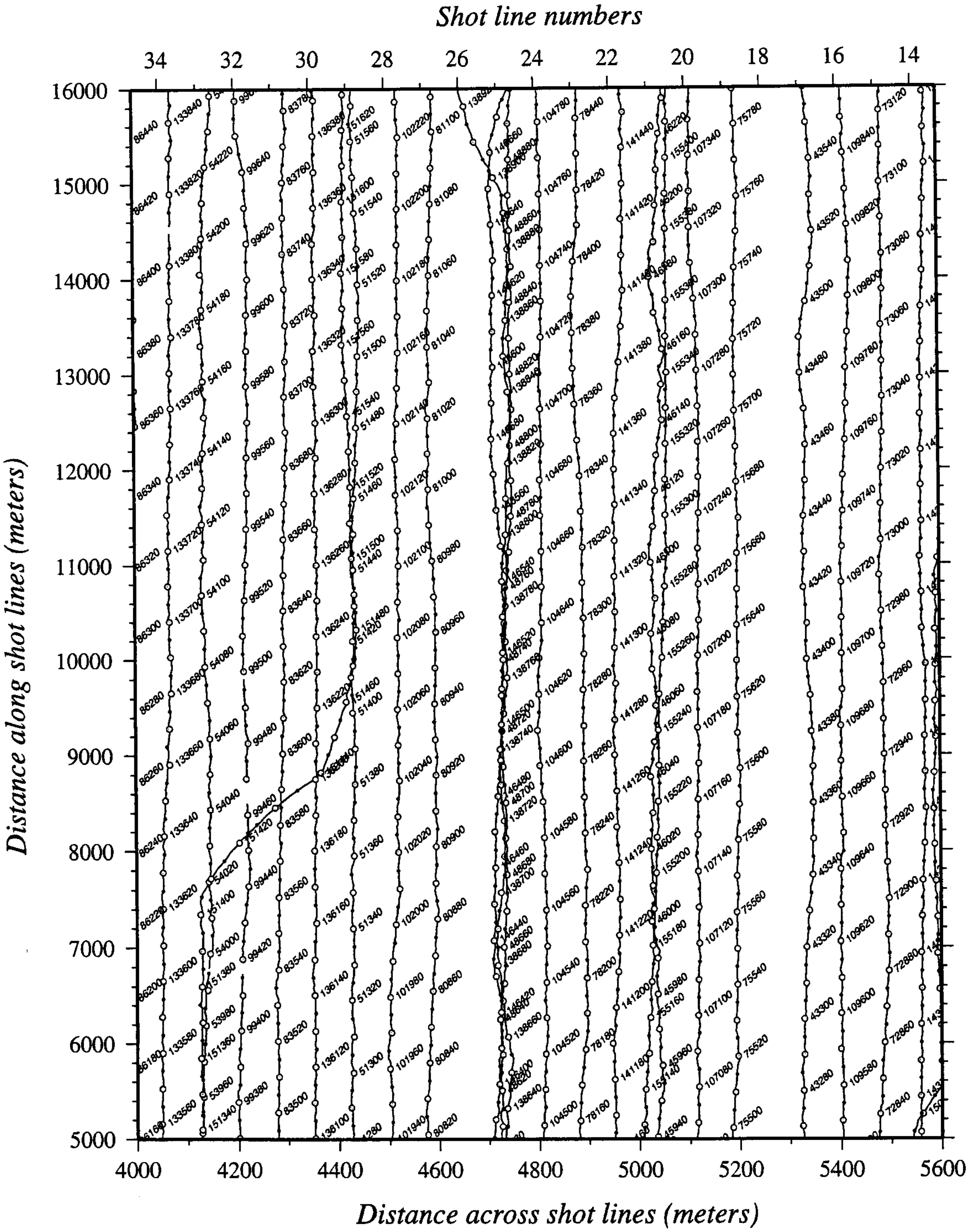
Ship tracks and shot numbers 3-D survey



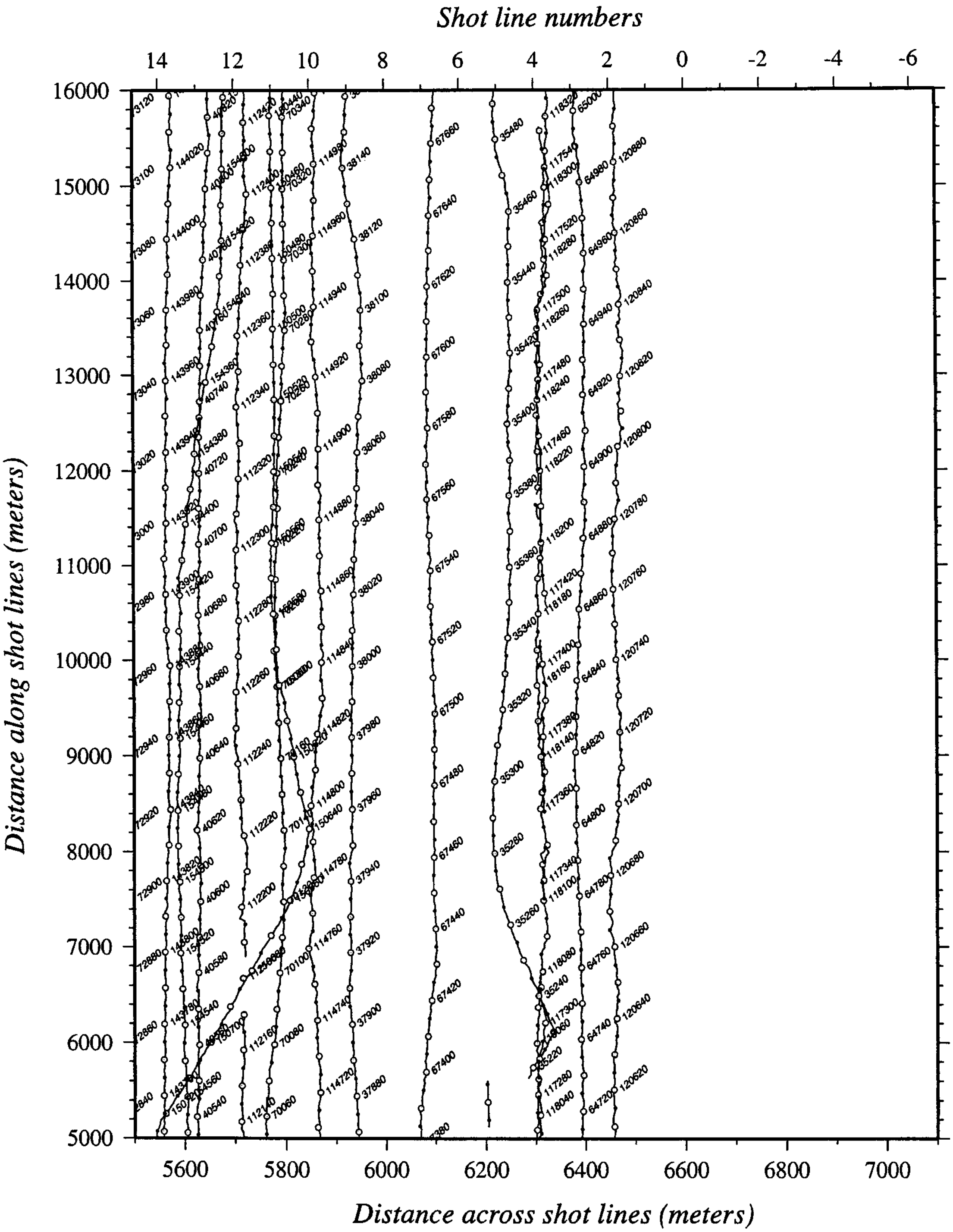
Ship tracks and shot numbers 3-D survey



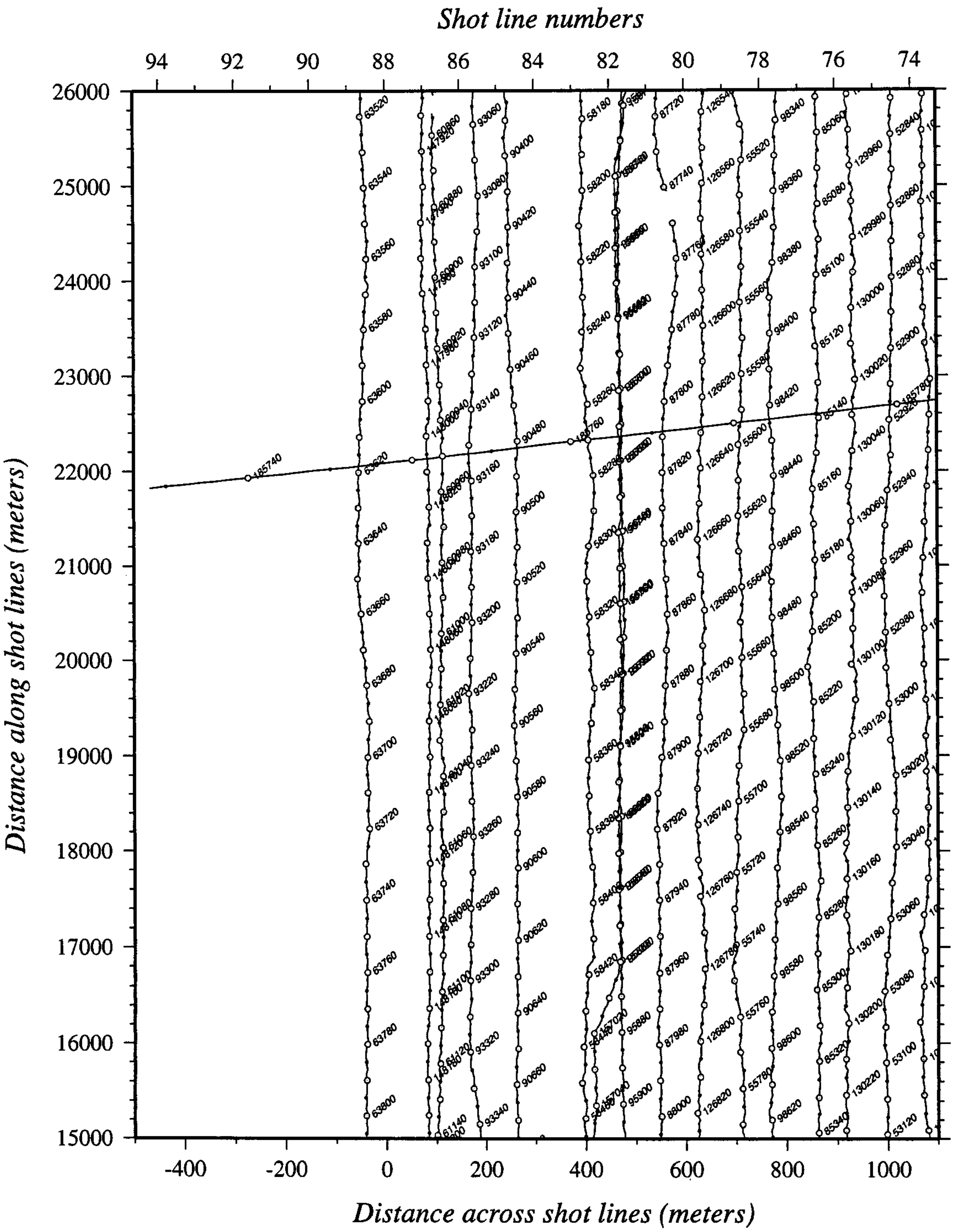
Ship tracks and shot numbers 3-D survey



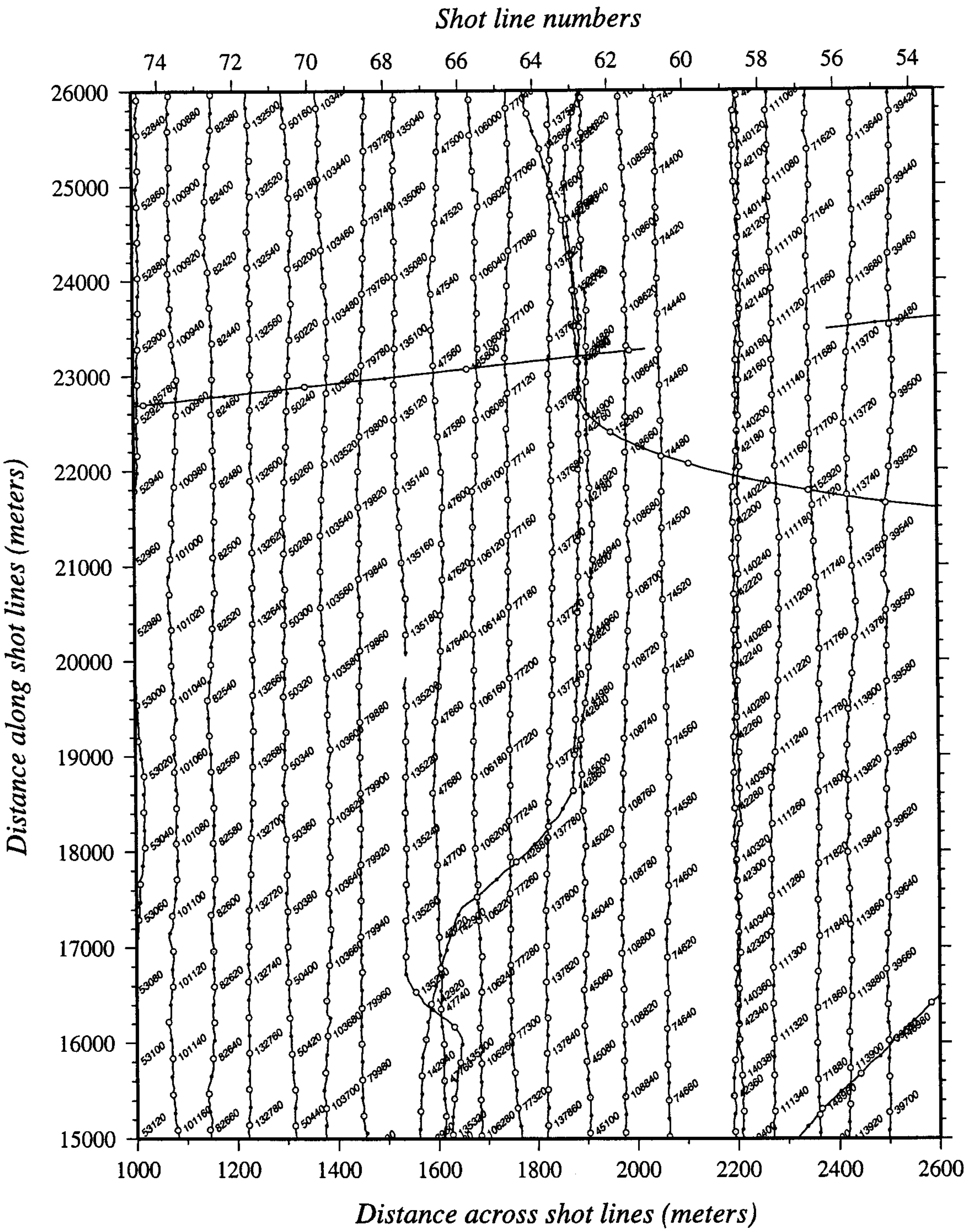
Ship tracks and shot numbers 3-D survey



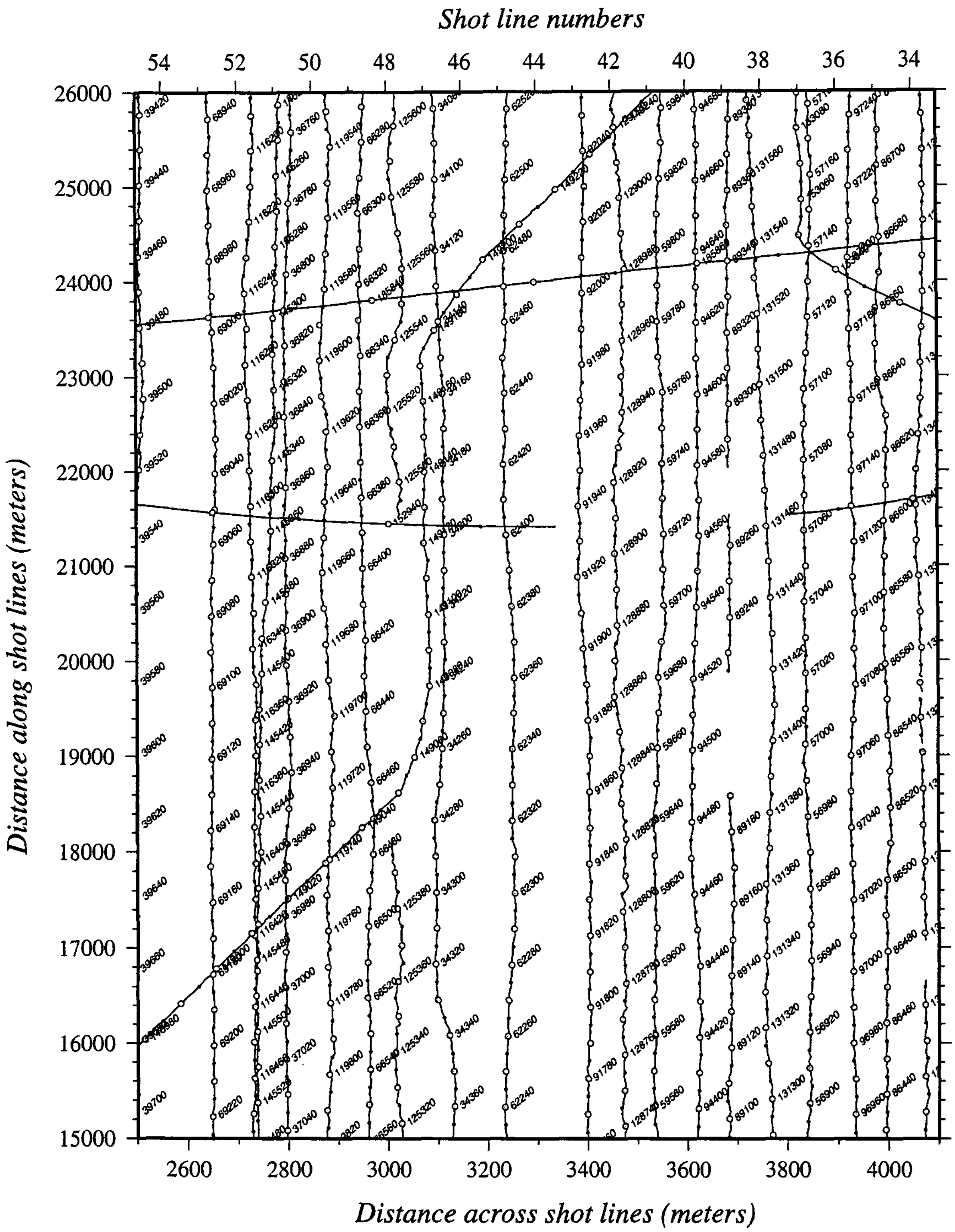
Ship tracks and shot numbers 3-D survey



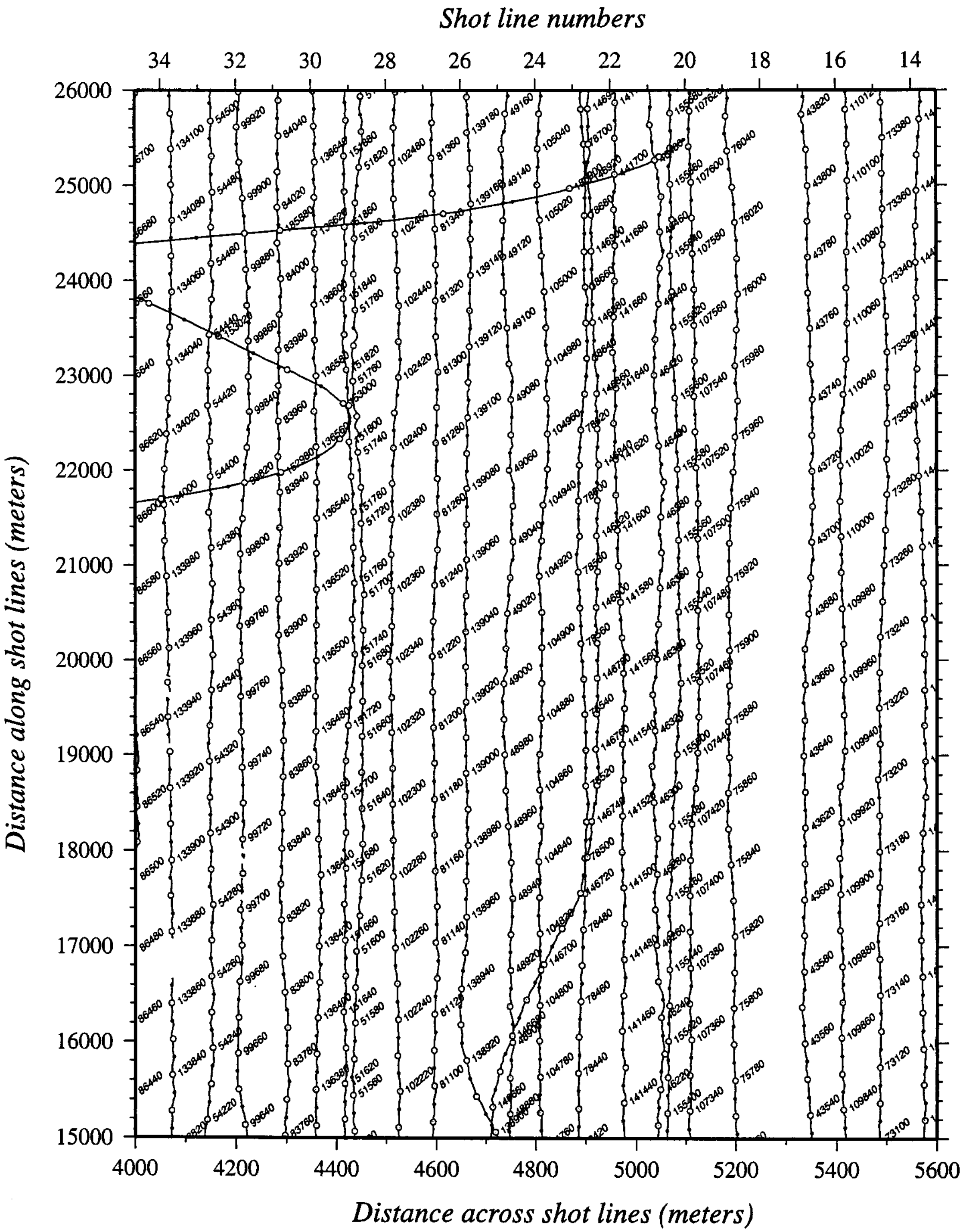
Ship tracks and shot numbers 3-D survey



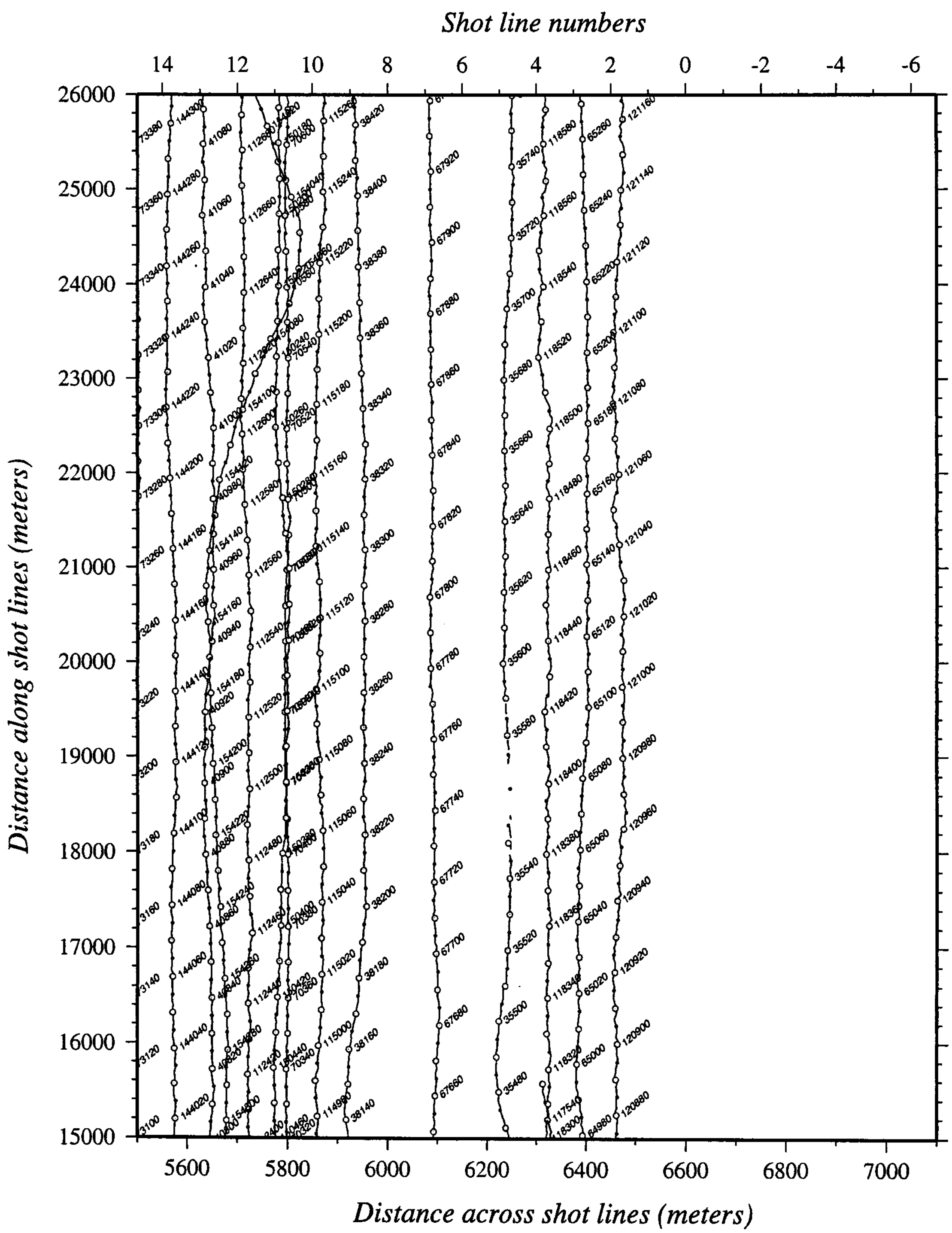
Ship tracks and shot numbers 3-D survey



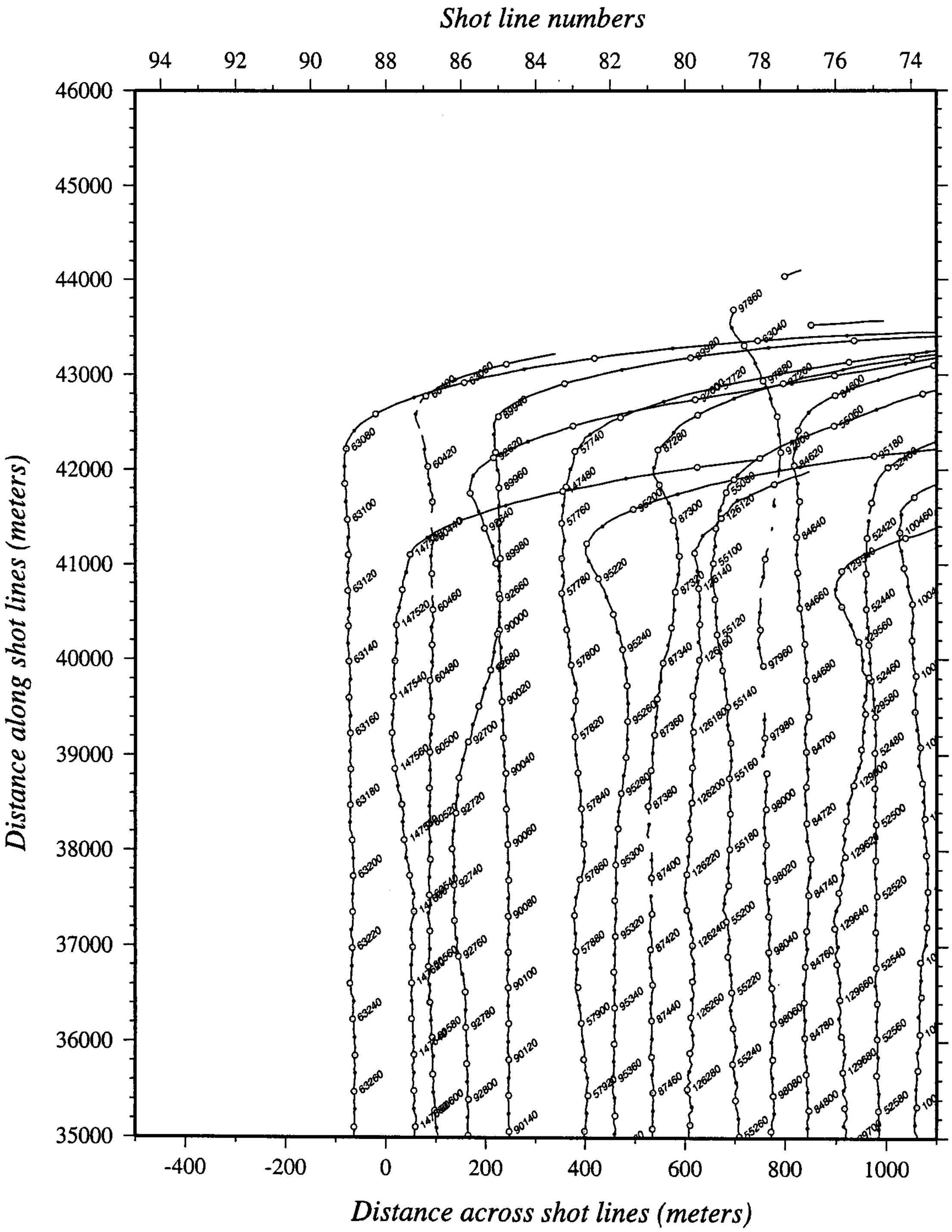
Ship tracks and shot numbers 3-D survey



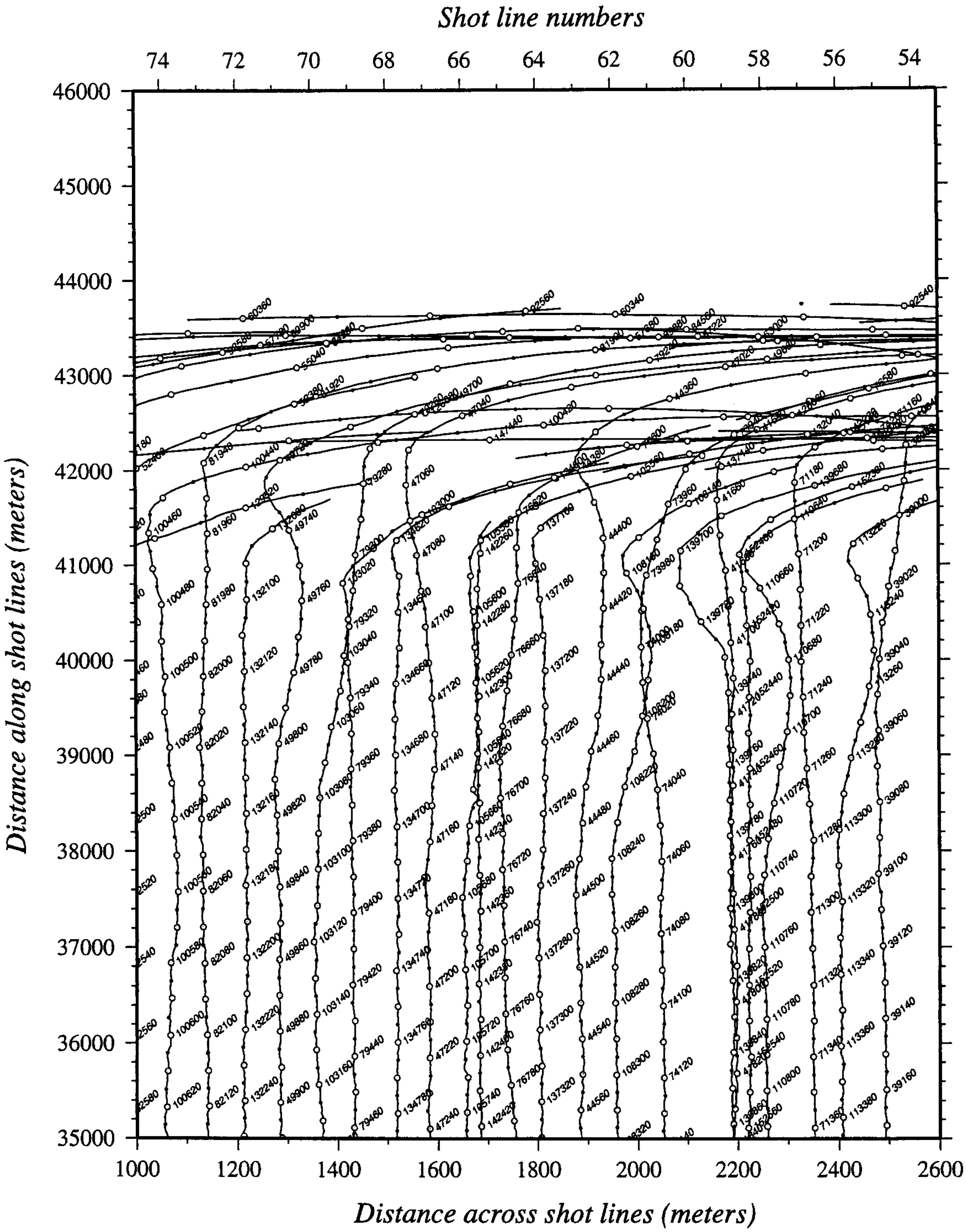
Ship tracks and shot numbers 3-D survey



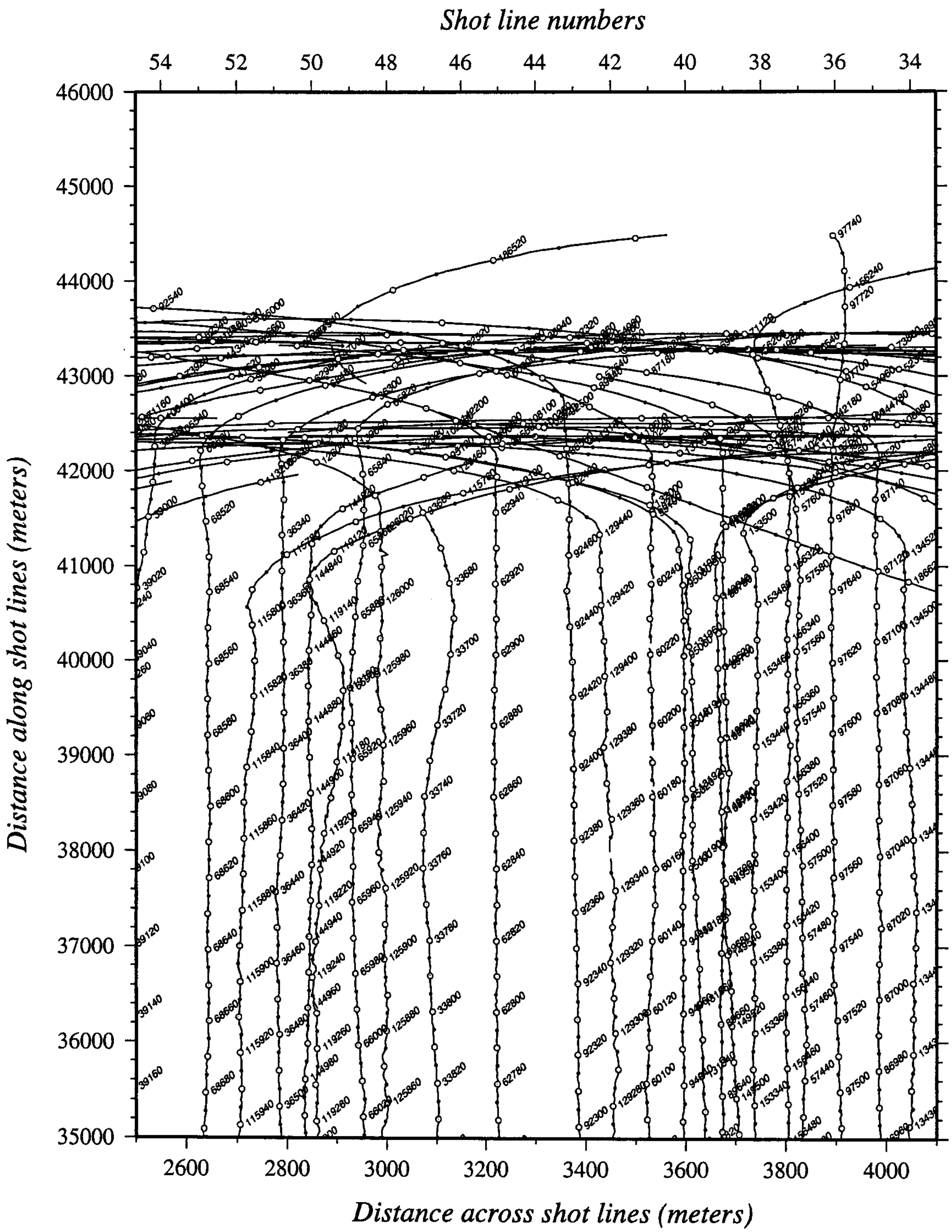
Ship tracks and shot numbers 3-D survey



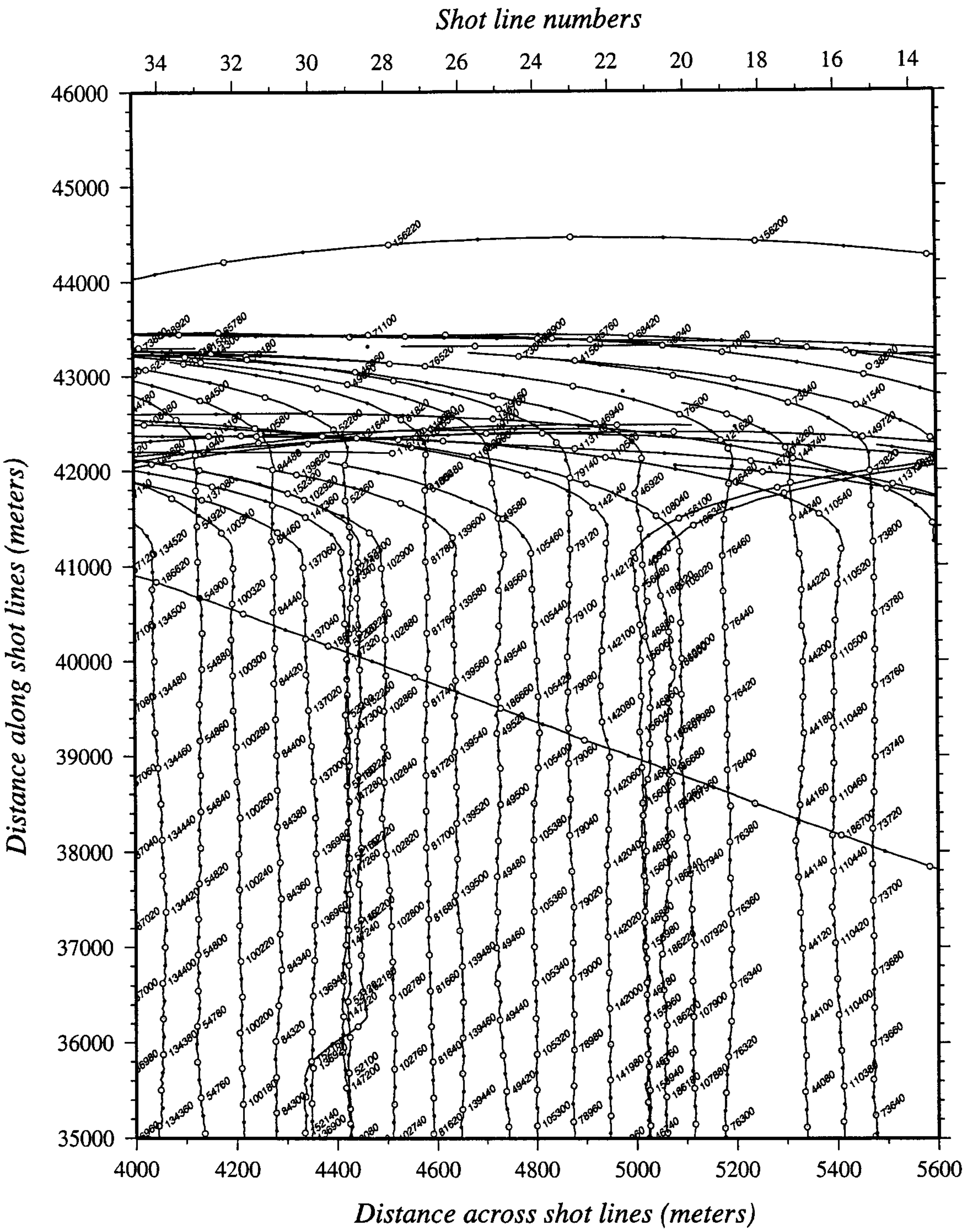
Ship tracks and shot numbers 3-D survey



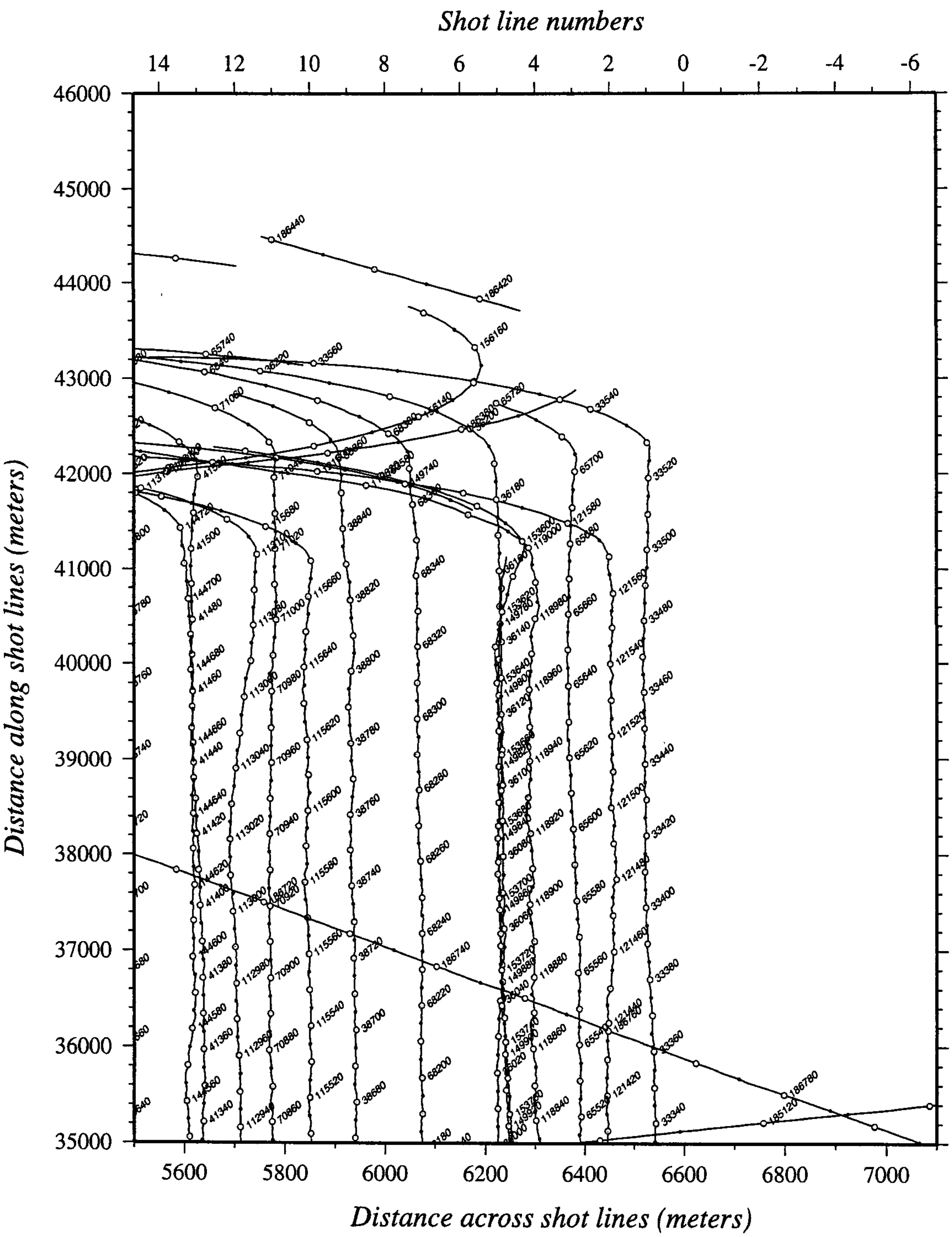
Ship tracks and shot numbers 3-D survey



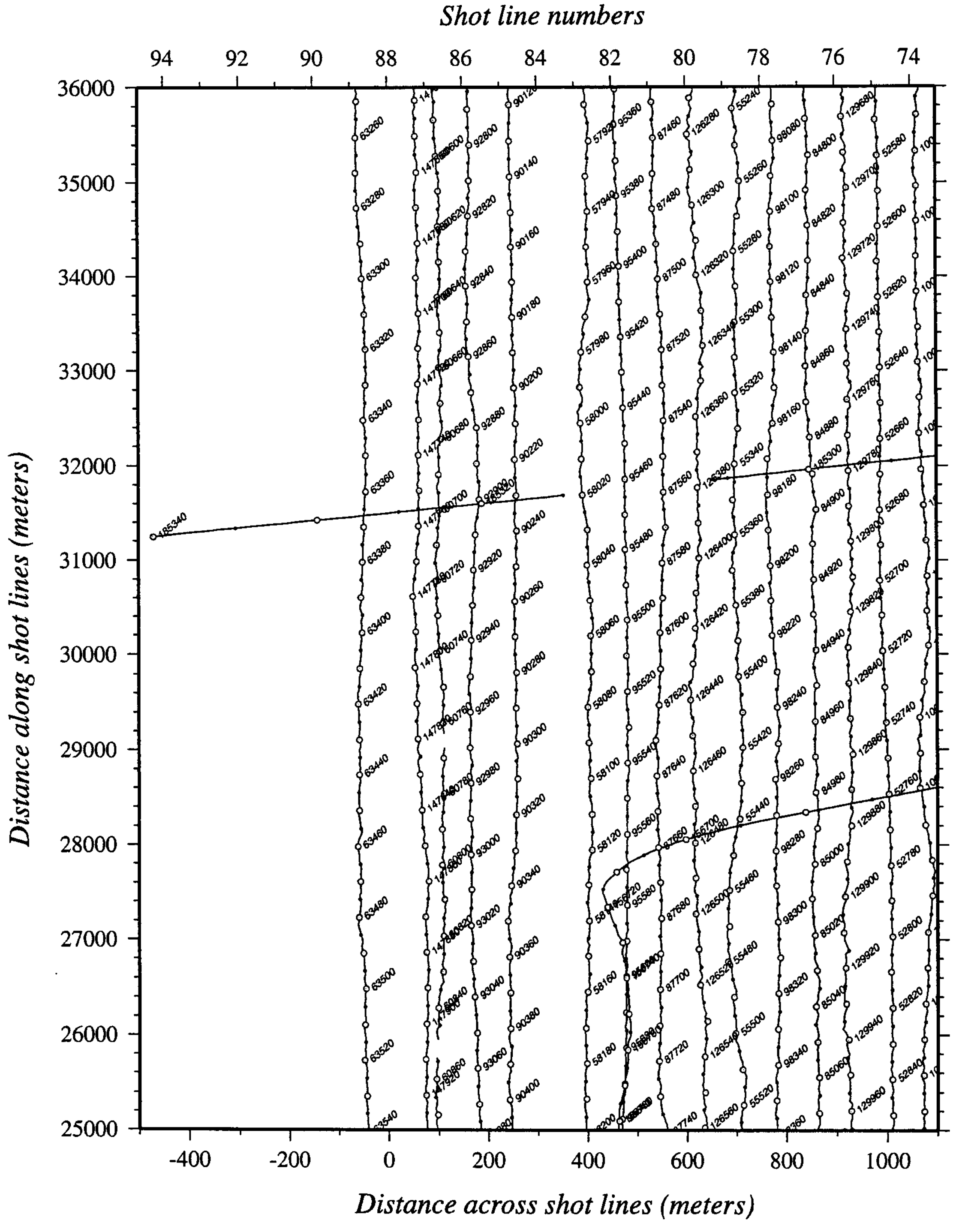
Ship tracks and shot numbers 3-D survey



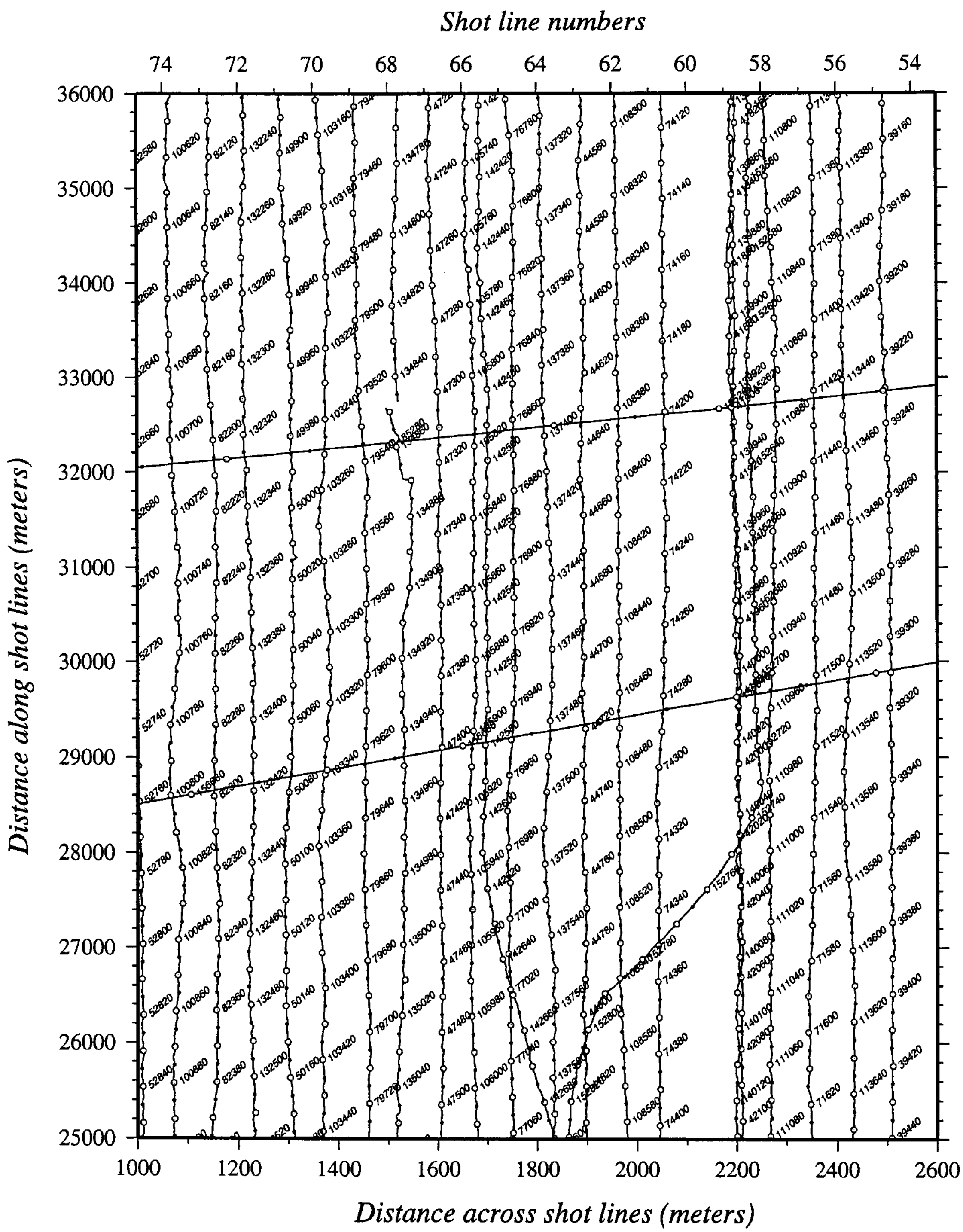
Ship tracks and shot numbers 3-D survey



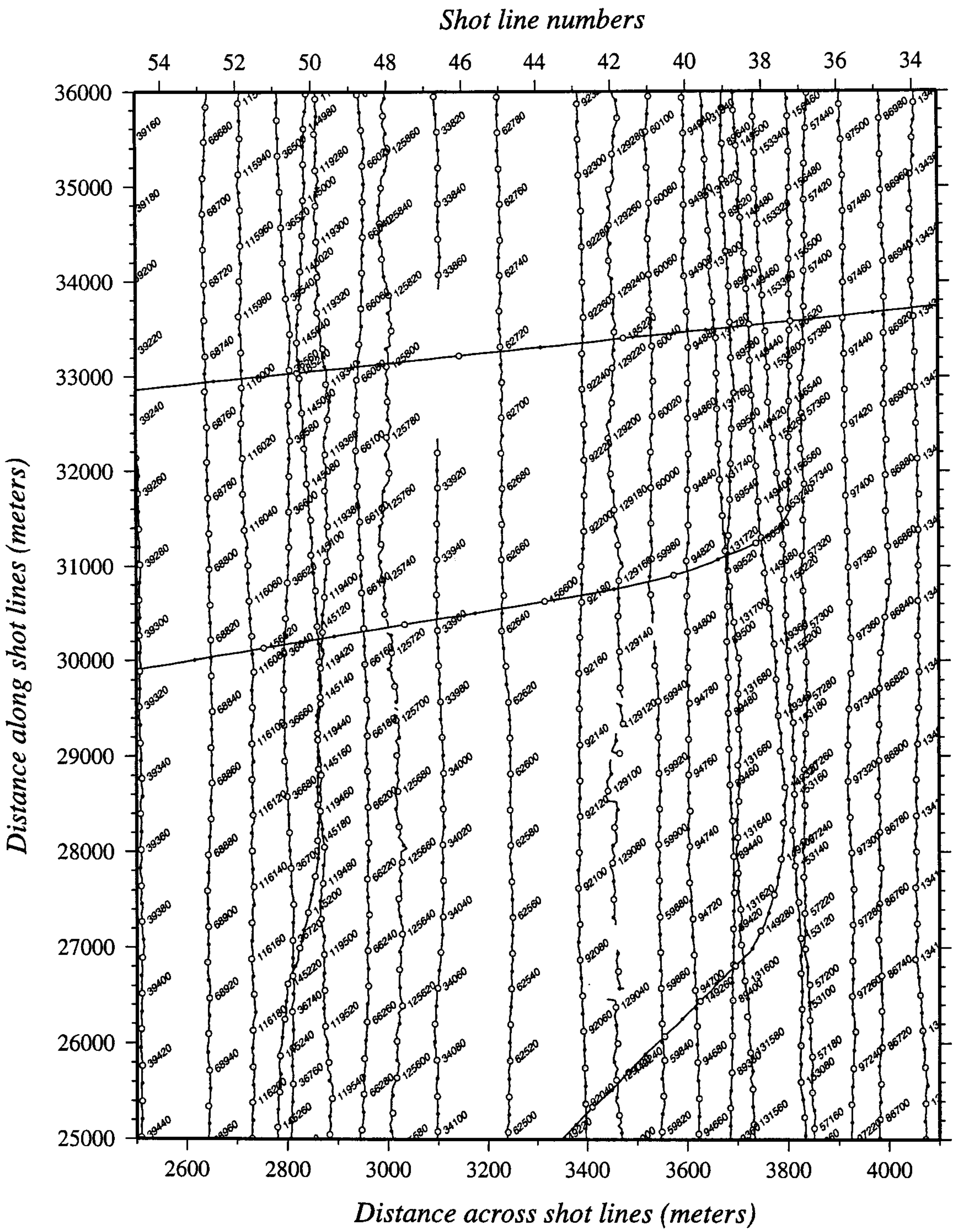
Ship tracks and shot numbers 3-D survey



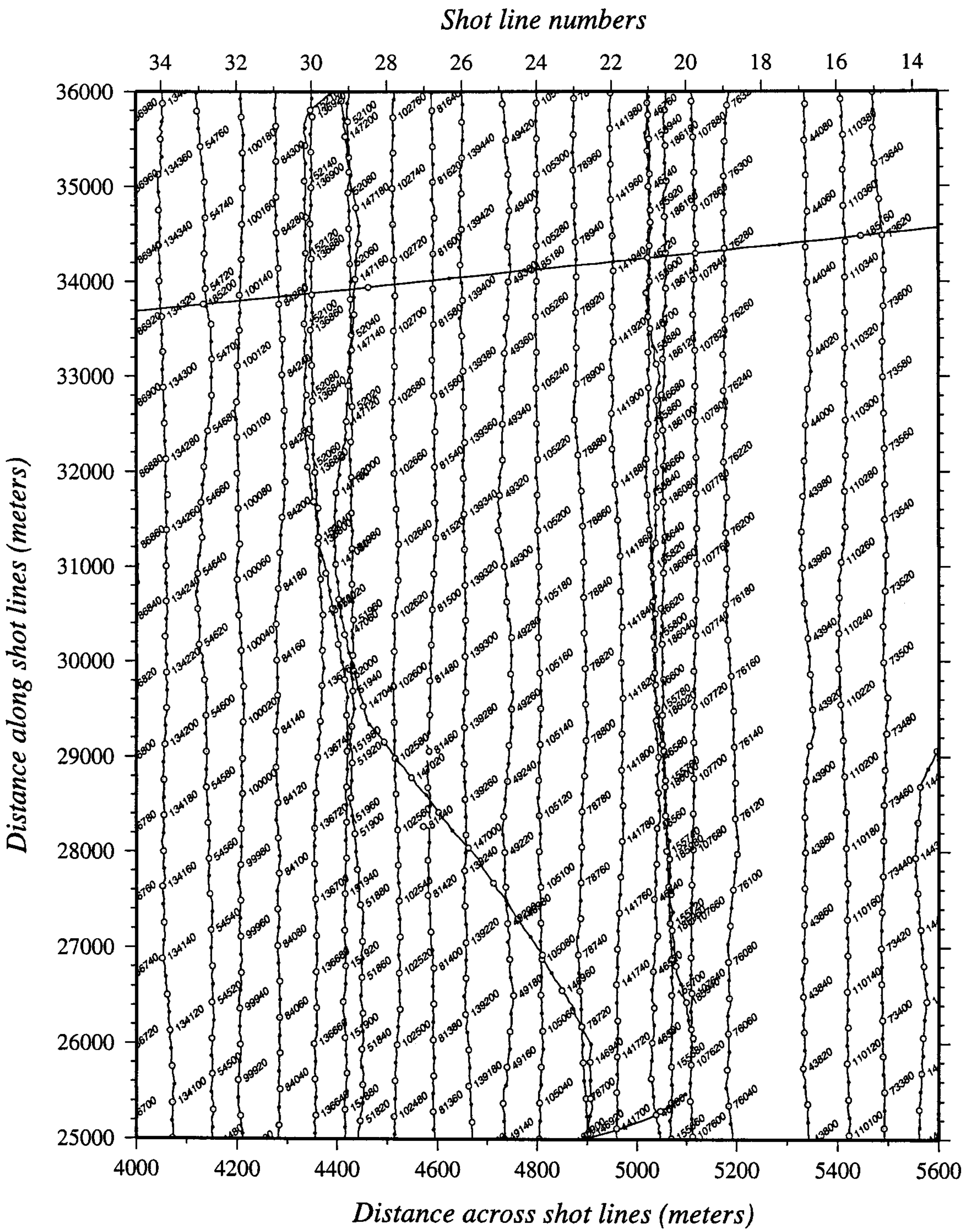
Ship tracks and shot numbers 3-D survey



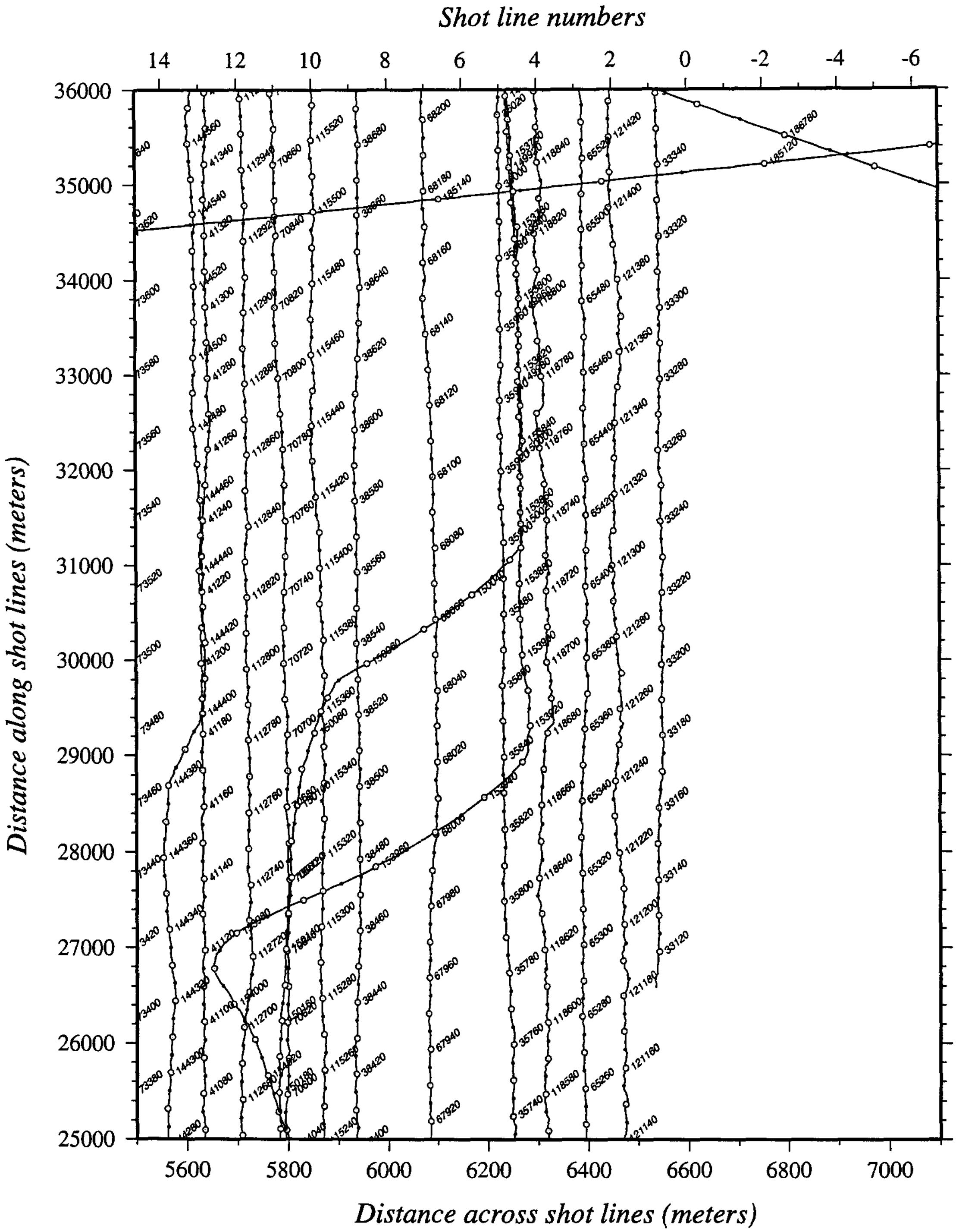
Ship tracks and shot numbers 3-D survey

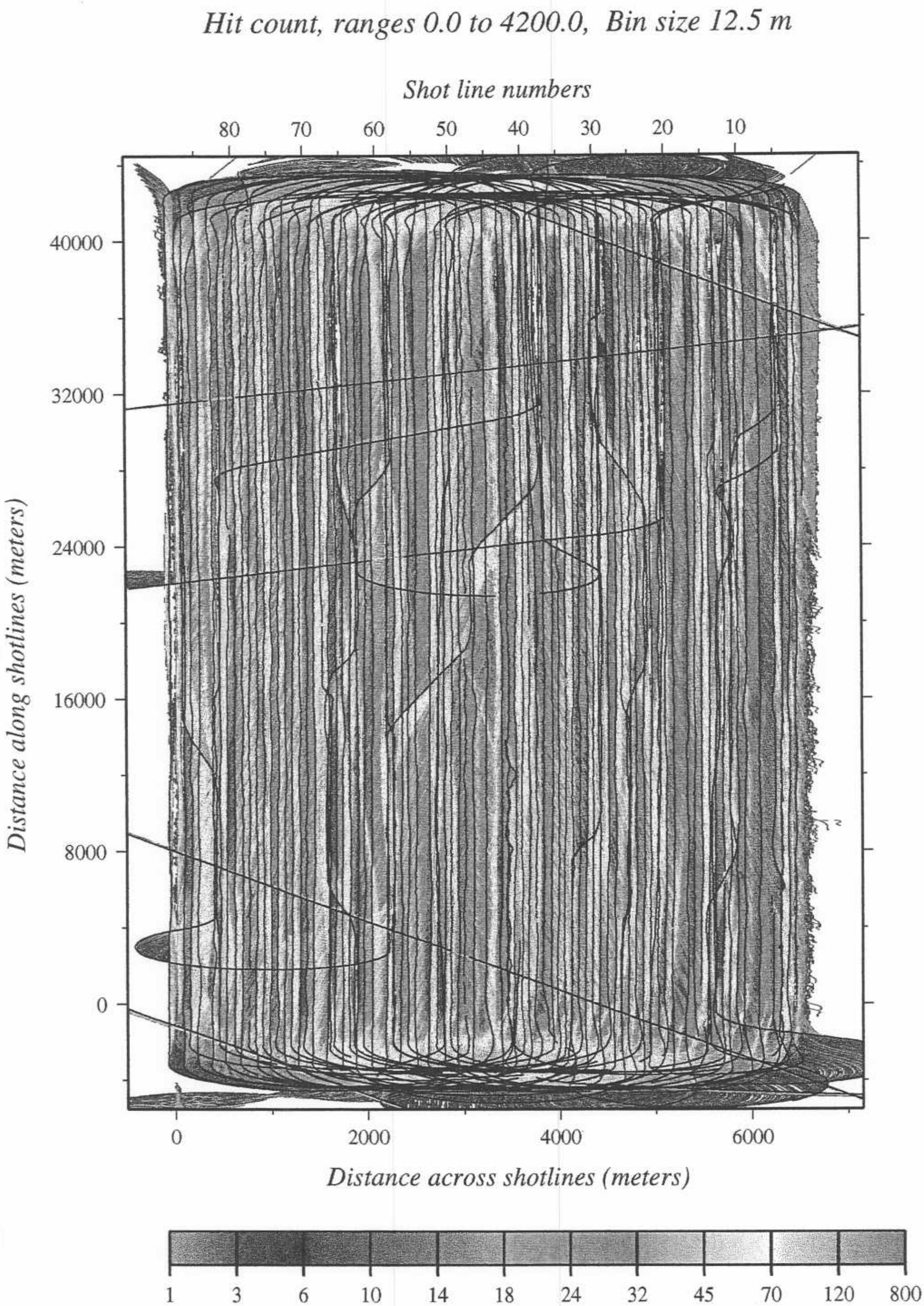


Ship tracks and shot numbers 3-D survey



Ship tracks and shot numbers 3-D survey





Hit count, ranges 0.0 to 4200.0, Bin size 12.5 m
Shot line numbers
80
70
60
50
40
30
20
10
40000
32000
24000
16000
8000
0
Distance along shotlines (meters)
0
2000
4000
6000
Distance across shotlines (meters)
1
3
6
10
14
18
24
32
45
70
120
800

Figure 5

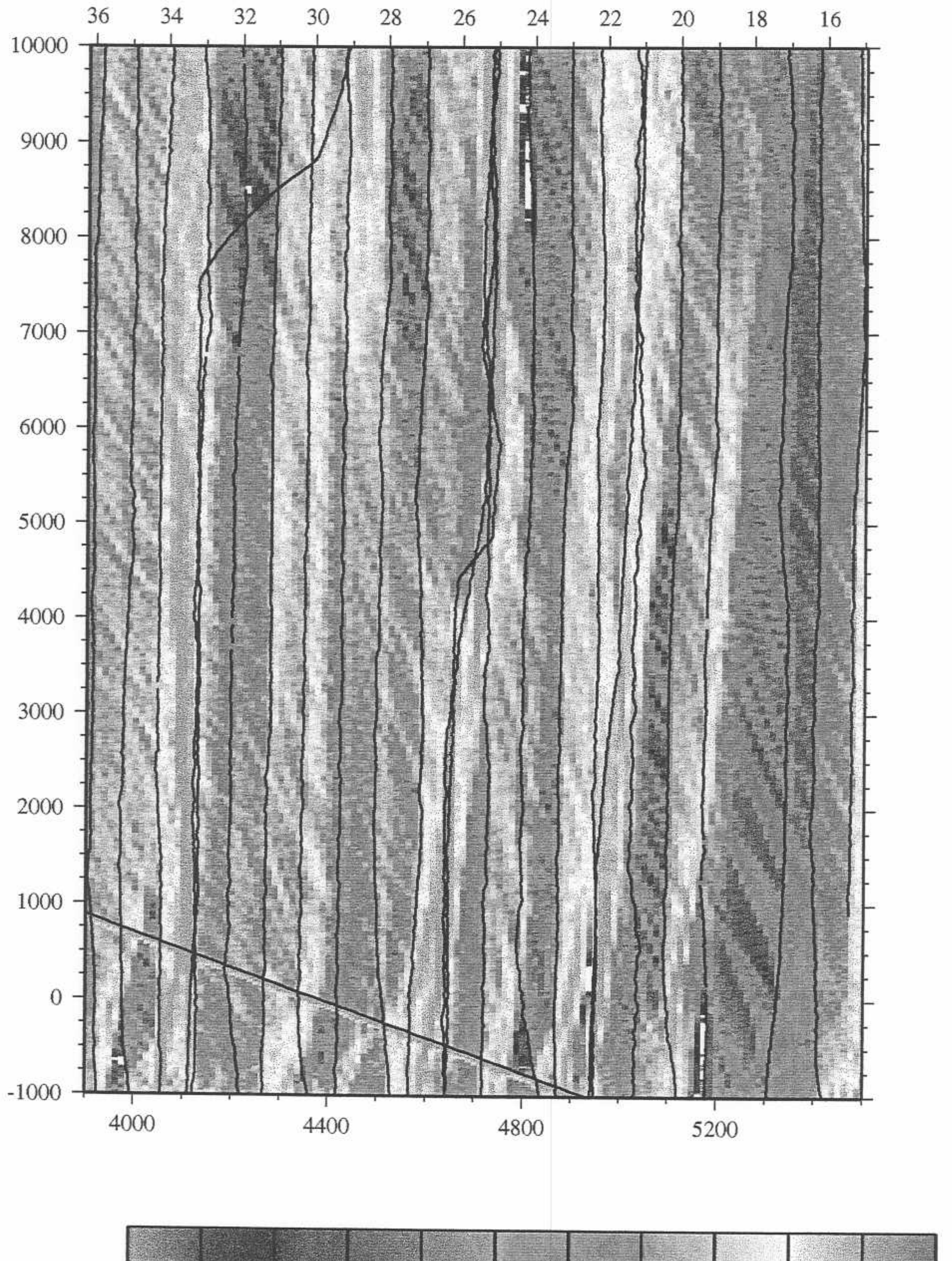
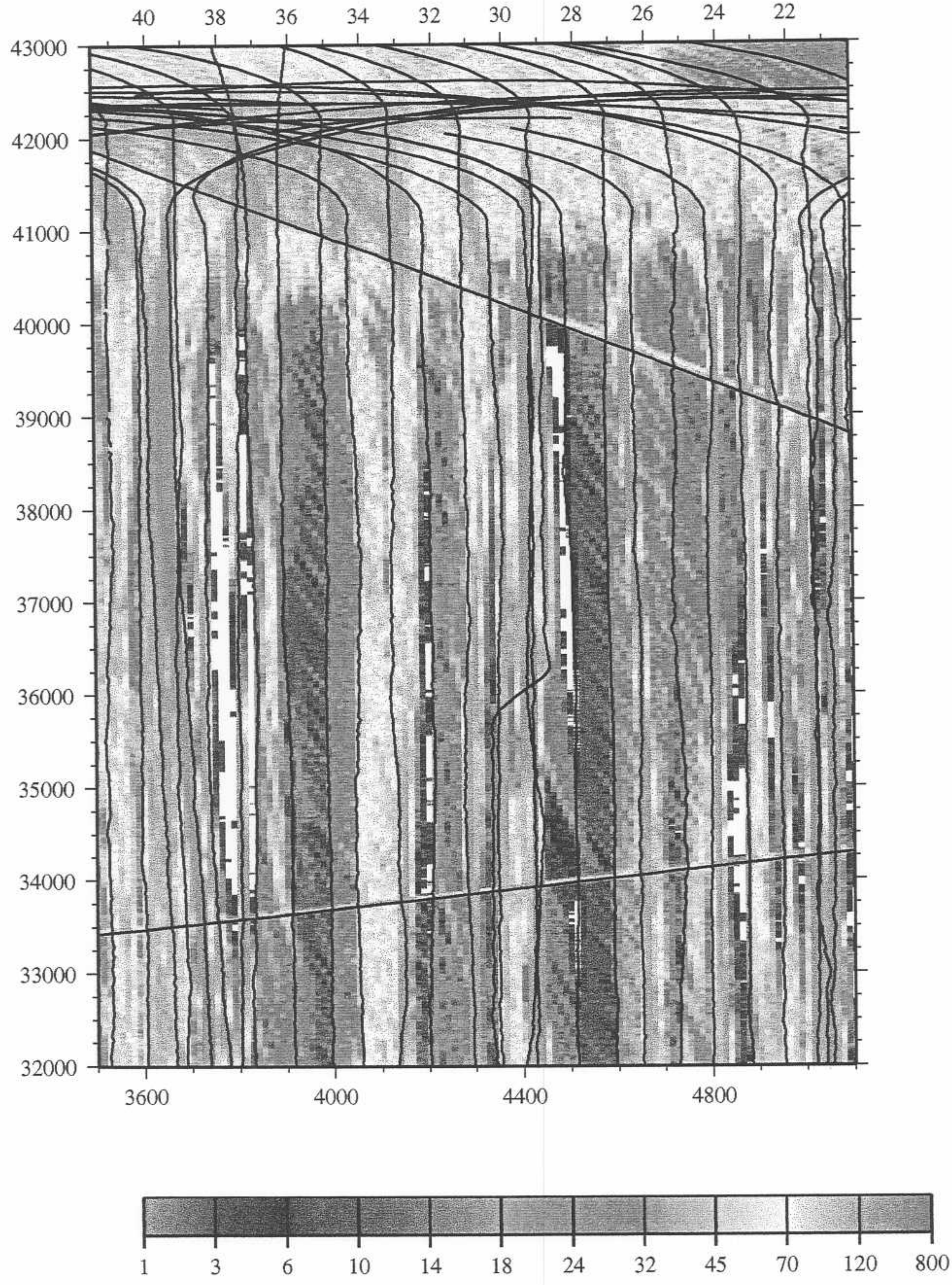
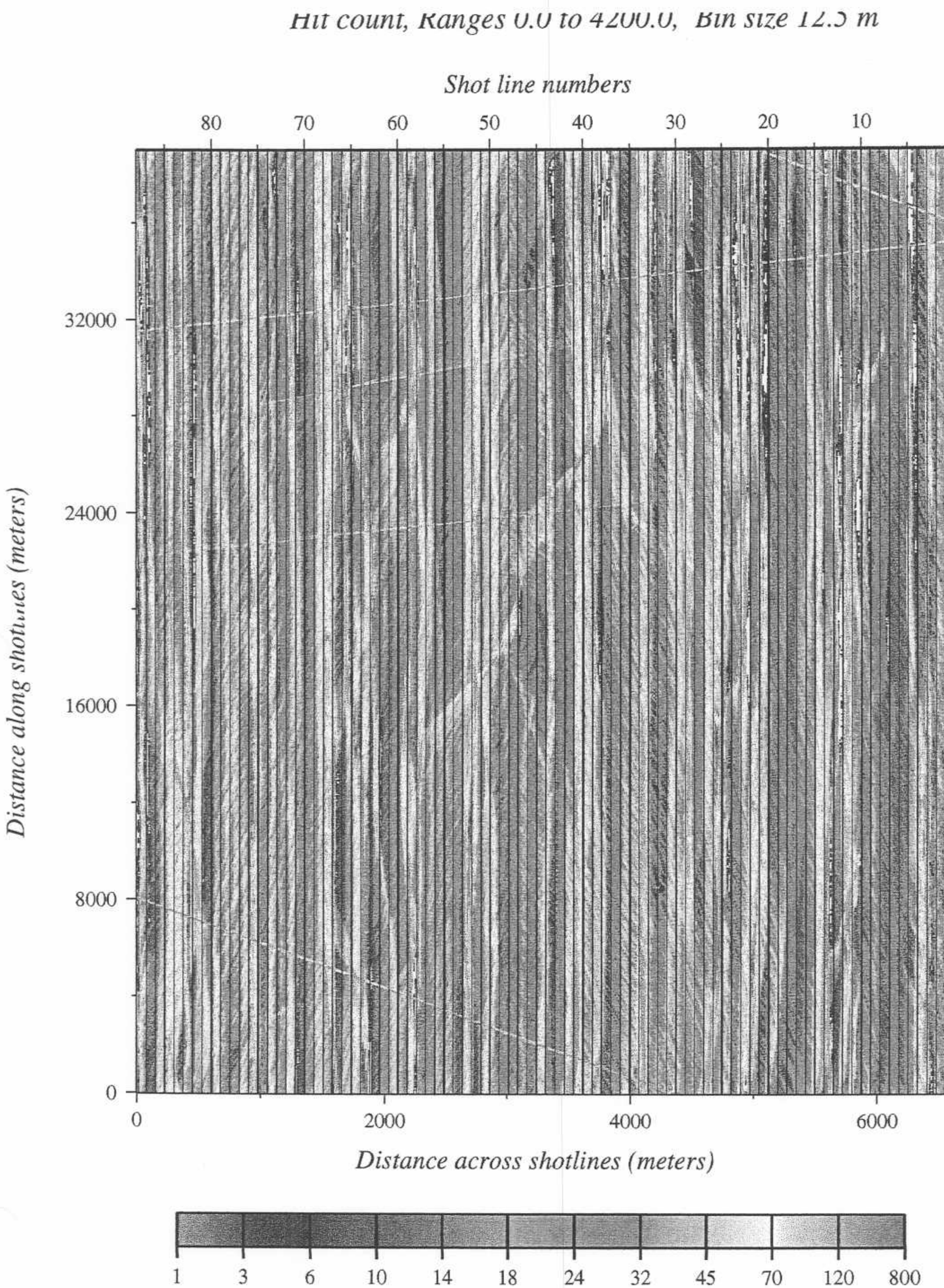

36
34
32
30
28
26
24
22
20
18
16
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
4000
4400
4800
5200
1
3
6
10
14
18
24
32
45
70
120
800

Figure 6b



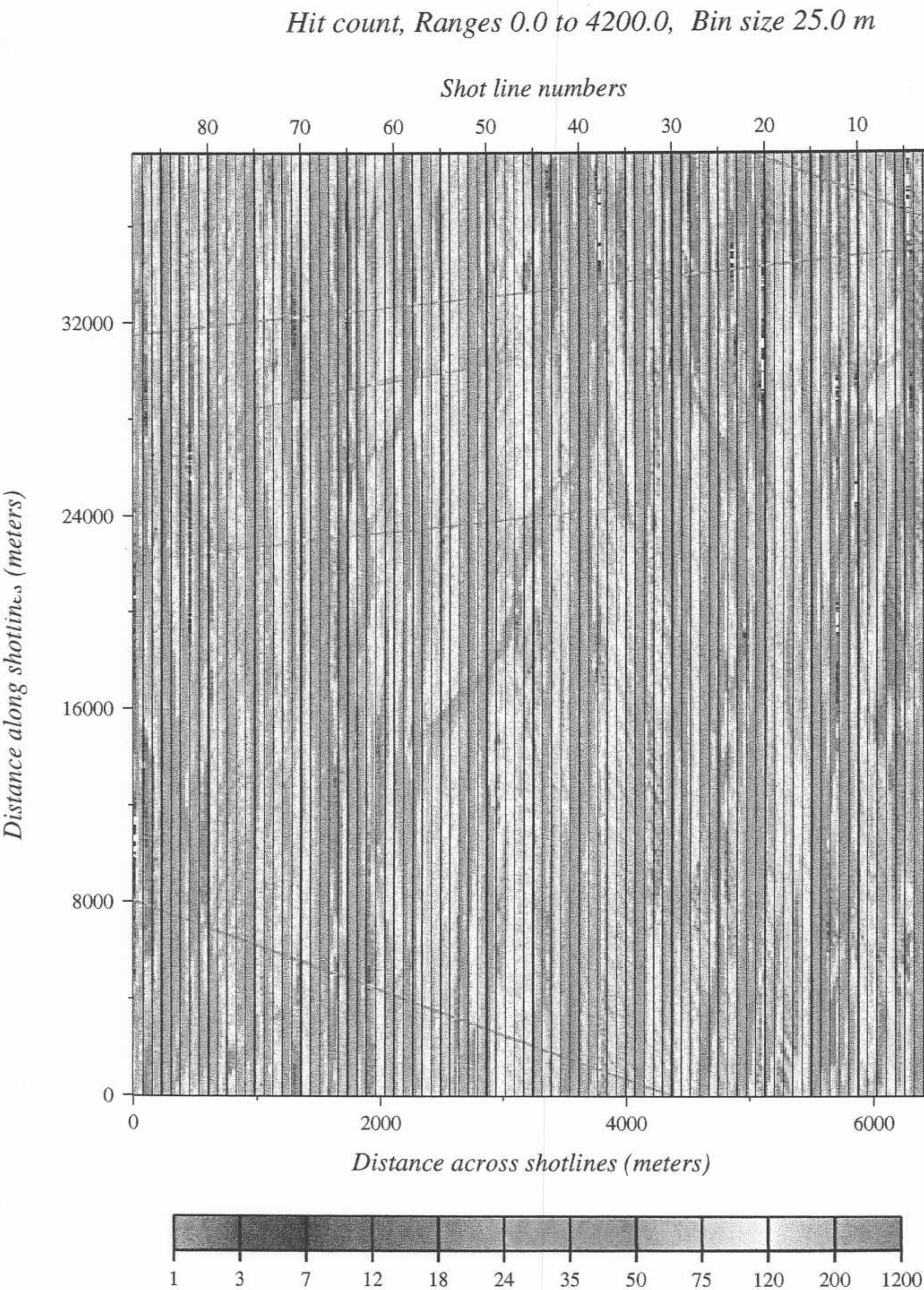
40
38
36
34
32
30
28
26
24
22
43000
42000
41000
40000
39000
38000
37000
36000
35000
34000
33000
32000
3600
4000
4400
4800
1
3
6
10
14
18
24
32
45
70
120
800

Figure 6a



Hit count, Ranges 0.0 to 4200.0, Bin size 12.5 m
Shot line numbers
80
70
60
50
40
30
20
10
32000
24000
16000
8000
0
Distance along shotlines (meters)
0
2000
4000
6000
Distance across shotlines (meters)
1
3
6
10
14
18
24
32
45
70
120
800

Figure 7a



Hit count, Ranges 0.0 to 4200.0, Bin size 25.0 m
Shot line numbers
80
70
60
50
40
30
20
10
32000
24000
16000
8000
0
Distance along shotlines (meters)
0
2000
4000
6000
Distance across shotlines (meters)
1
3
7
12
18
24
35
50
75
120
200
1200

Figure 7b

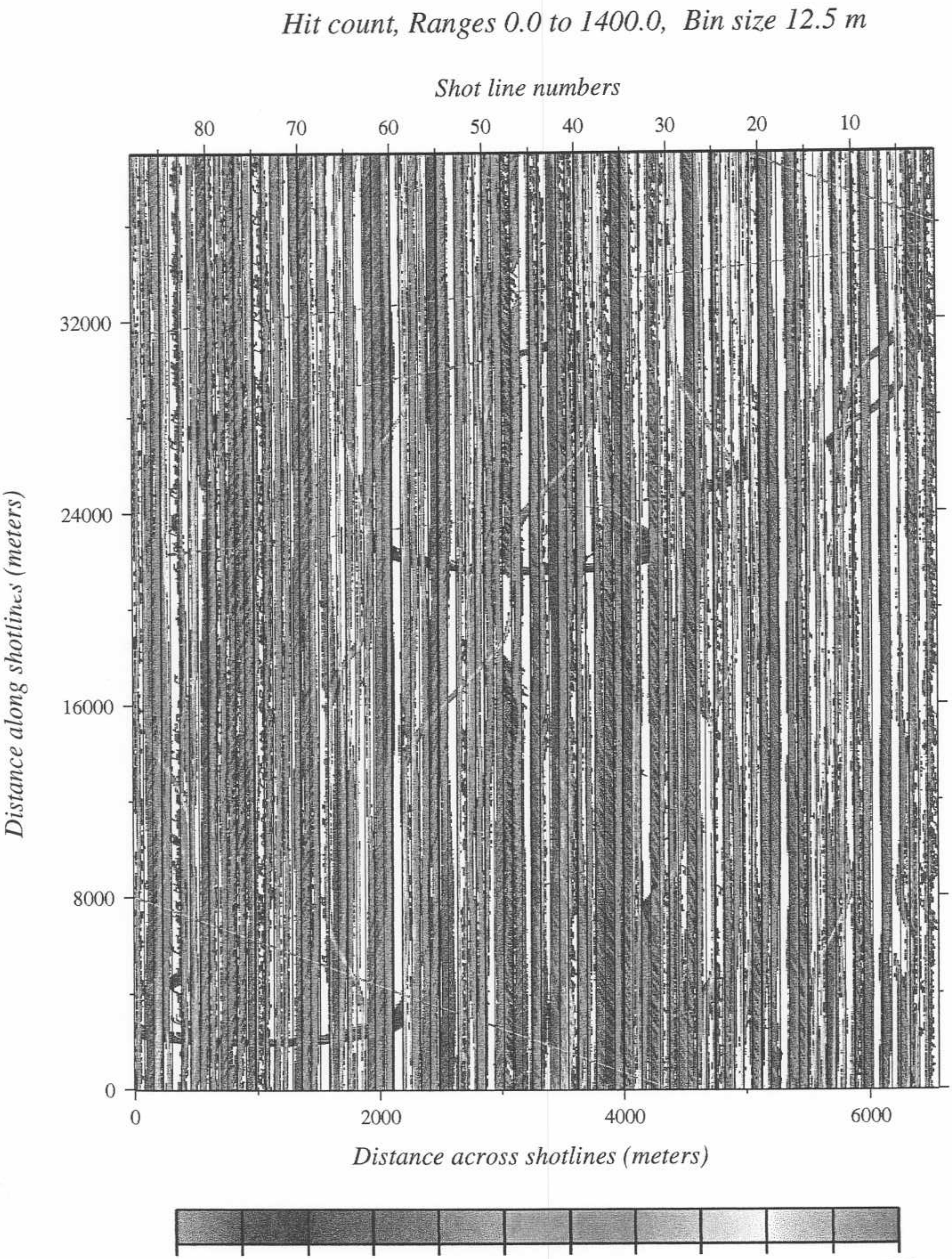

Hit count, Ranges 0.0 to 1400.0, Bin size 12.5 m
Shot line numbers
80
70
60
50
40
30
20
10
Distance along shotlines (meters)
0
8000
16000
24000
32000
Distance across shotlines (meters)
0
2000
4000
6000
1
3
6
10
14
18
24
32
45
70
120
800

Figure 7c

Hit count, Ranges 0.0 to 1400.0, Bin size 25.0 m

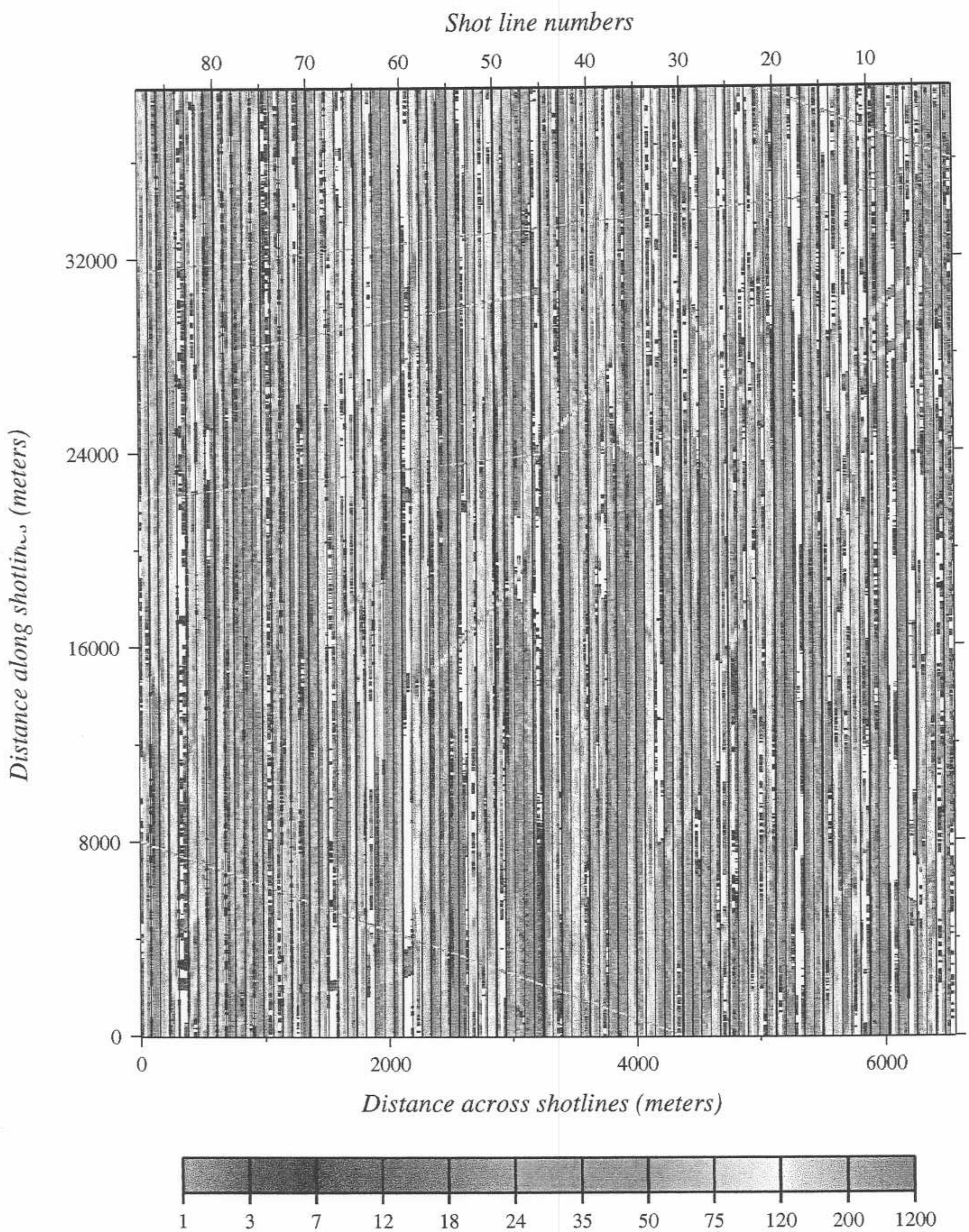


Figure 7d

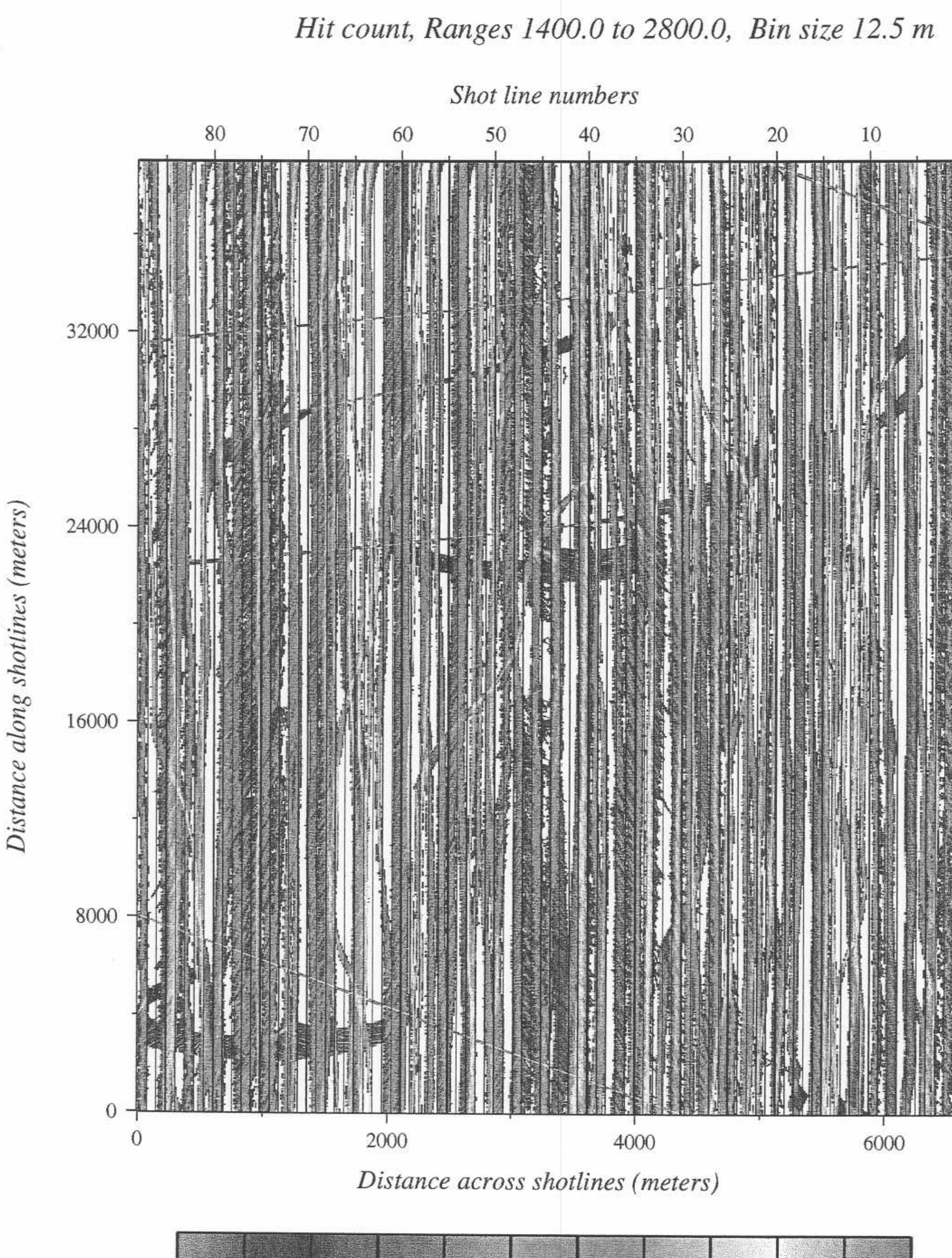

Hit count, Ranges 1400.0 to 2800.0, Bin size 12.5 m
Shot line numbers
80
70
60
50
40
30
20
10
Distance along shotlines (meters)
0
8000
16000
24000
32000
Distance across shotlines (meters)
0
2000
4000
6000
1
3
6
10
14
18
24
32
45
70
120
800

Figure 7e

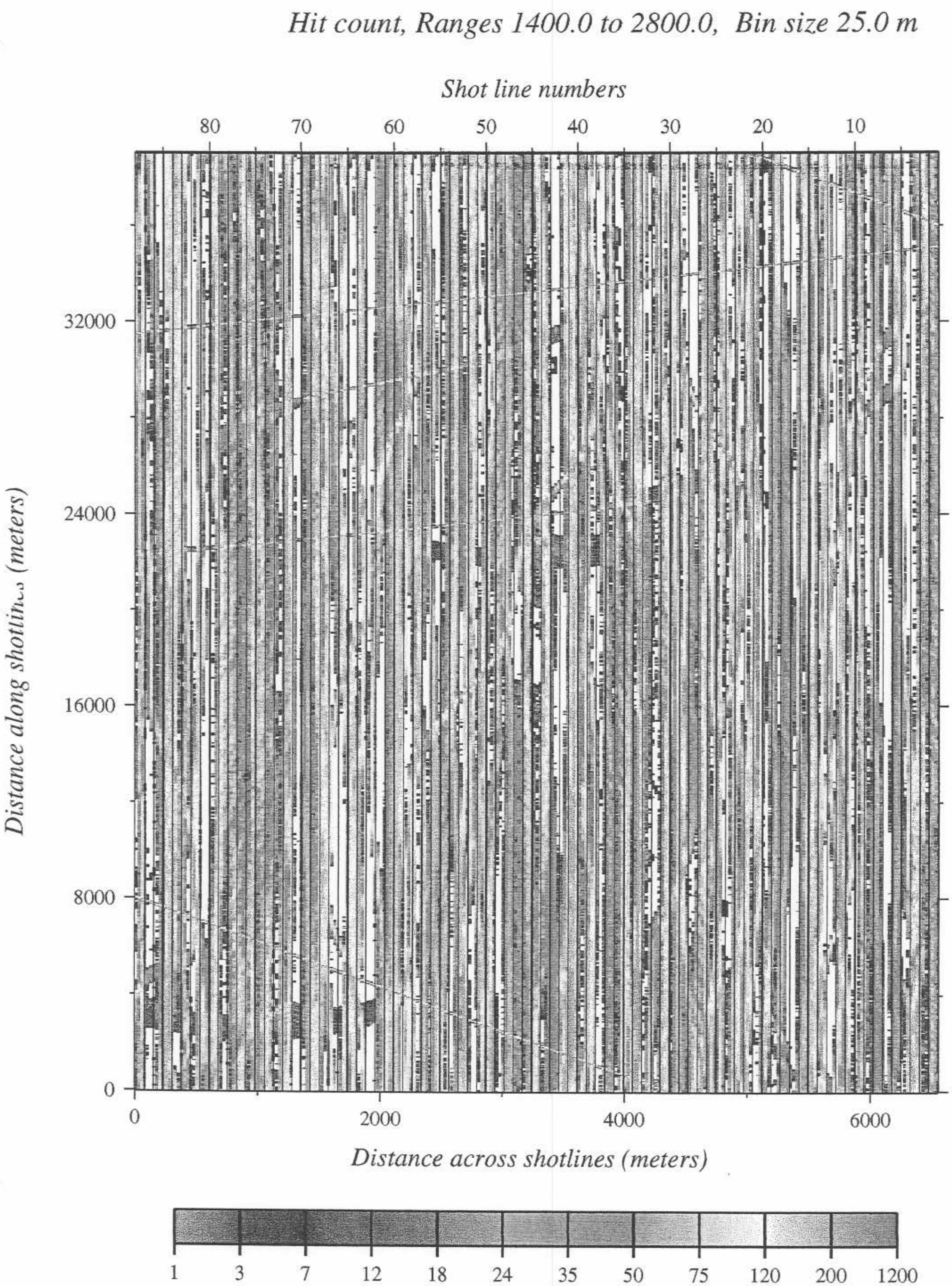

Hit count, Ranges 1400.0 to 2800.0, Bin size 25.0 m
Shot line numbers
80
70
60
50
40
30
20
10
Distance along shotlines (meters)
32000
24000
16000
8000
0
0
2000
4000
6000
Distance across shotlines (meters)
1
3
7
12
18
24
35
50
75
120
200
1200

Figure 7f

Hit count, Ranges 2800.0 to 4200.0, Bin size 12.5 m

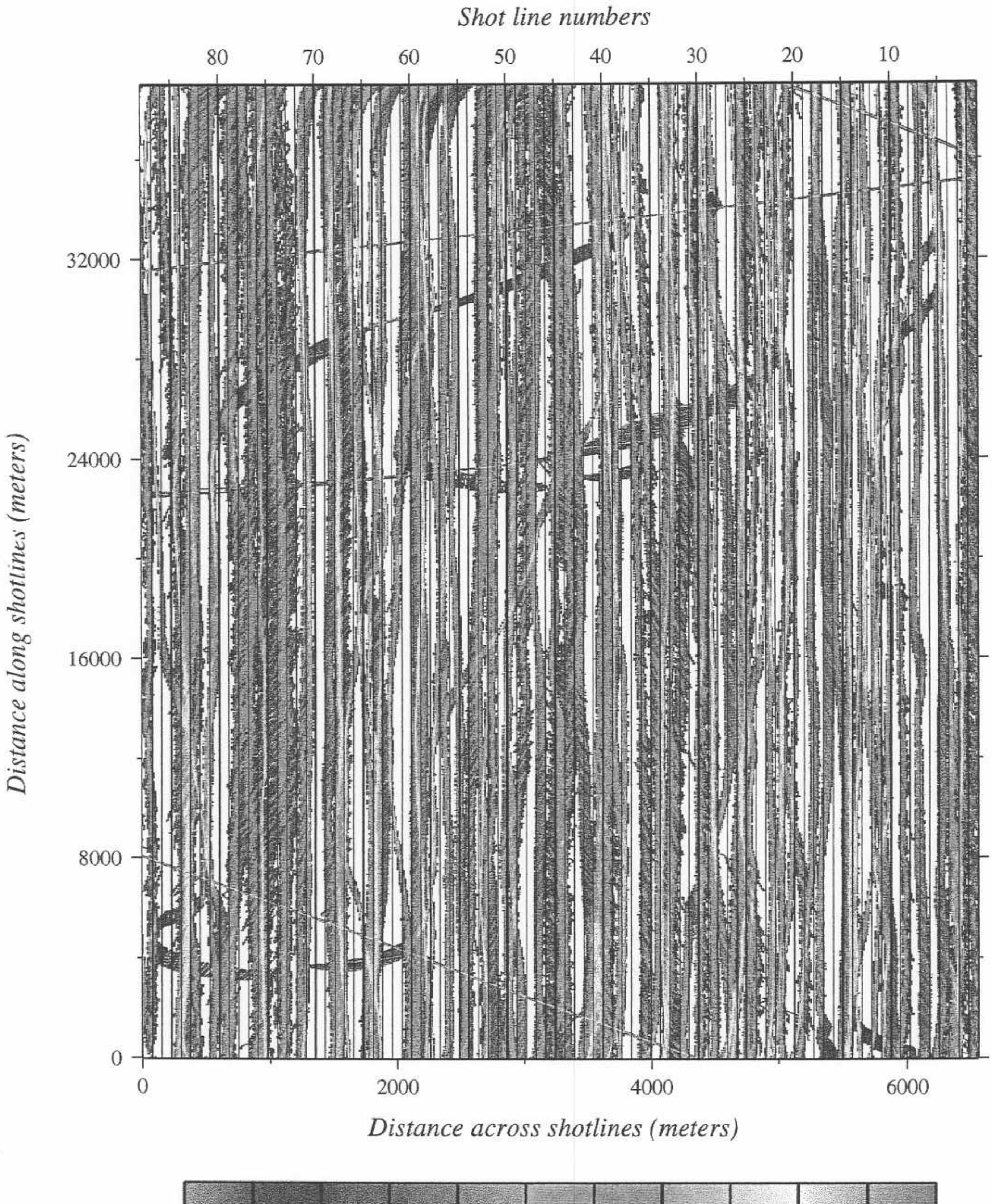


Figure 7g

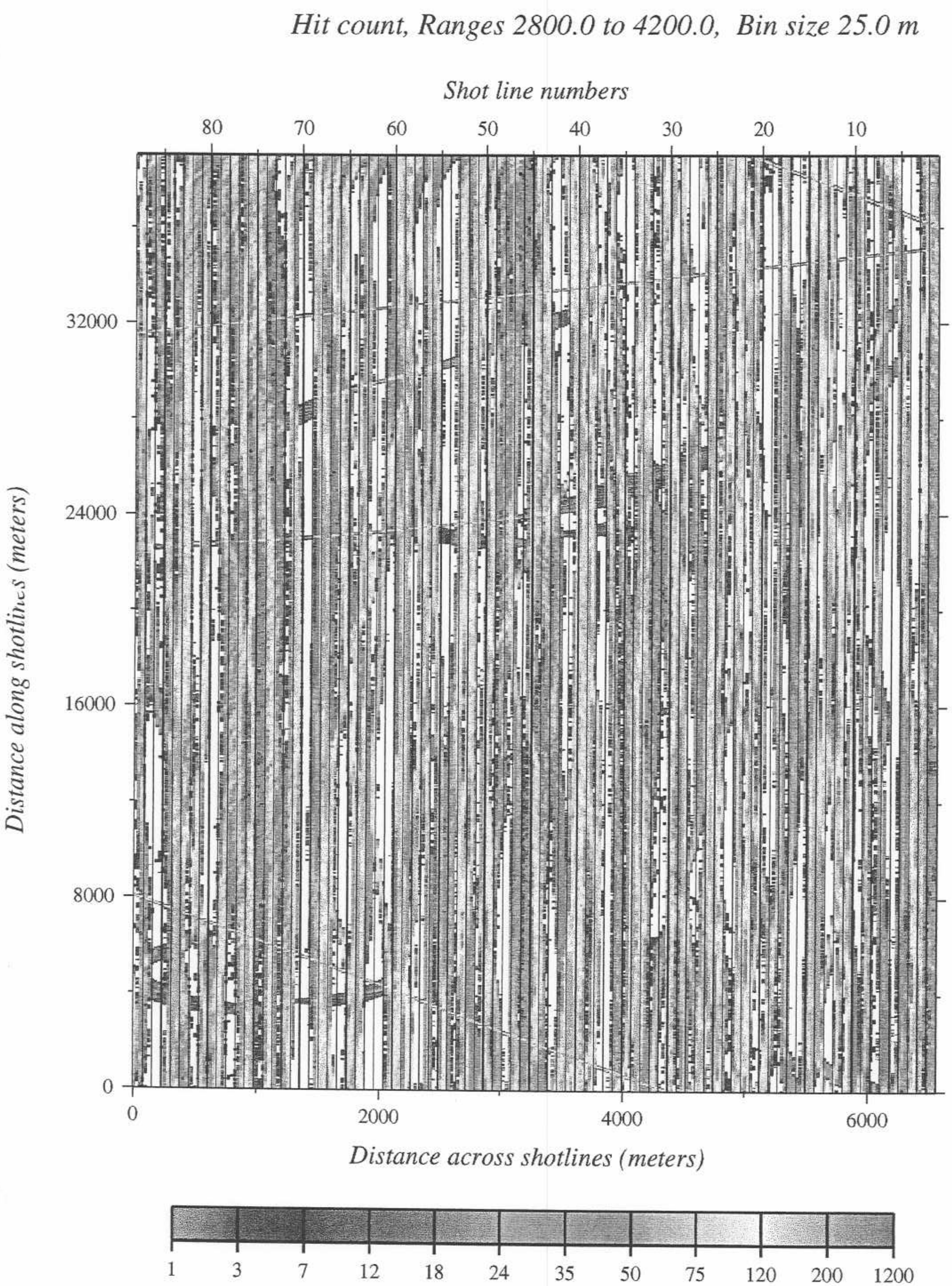

Hit count, Ranges 2800.0 to 4200.0, Bin size 25.0 m
Shot line numbers
80
70
60
50
40
30
20
10
Distance along shotlines (meters)
32000
24000
16000
8000
0
2000
4000
6000
Distance across shotlines (meters)
1
3
7
12
18
24
35
50
75
120
200
1200

Figure 7h

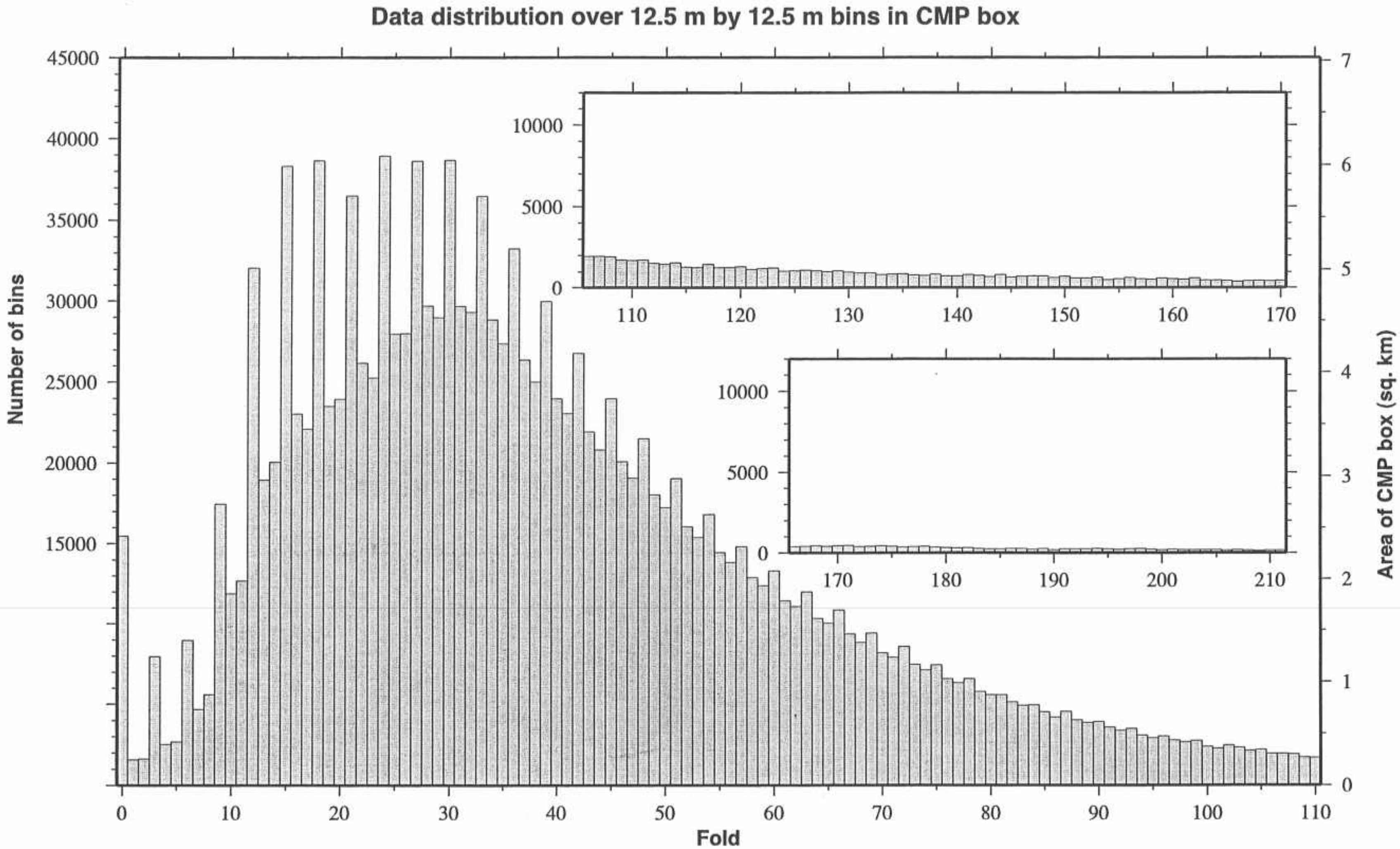


Figure Nav-8a. The variability in bin density or fold over the CMP box roughly follows a Poisson distribution. A very high fold (> 120) is rare, but so is a fold as low as 2. The two insets in this figure show the long tail of this distribution. The average and most common fold in the 12.5 m bin map is about 30. Superimposed on the general trend of the distribution is a fluctuation with a period of precisely 3 bins. This variation is due to the fact that the shot interval (37.5 m) is exactly 3 times larger than the bin spacing (12.5 m). The right-hand scale shows the area of the CMP box covered by any fold. The area of the CMP box (a total of 154 s q. km) is not covered by any reflection points over 2.1 sq. km, or 0.9%.

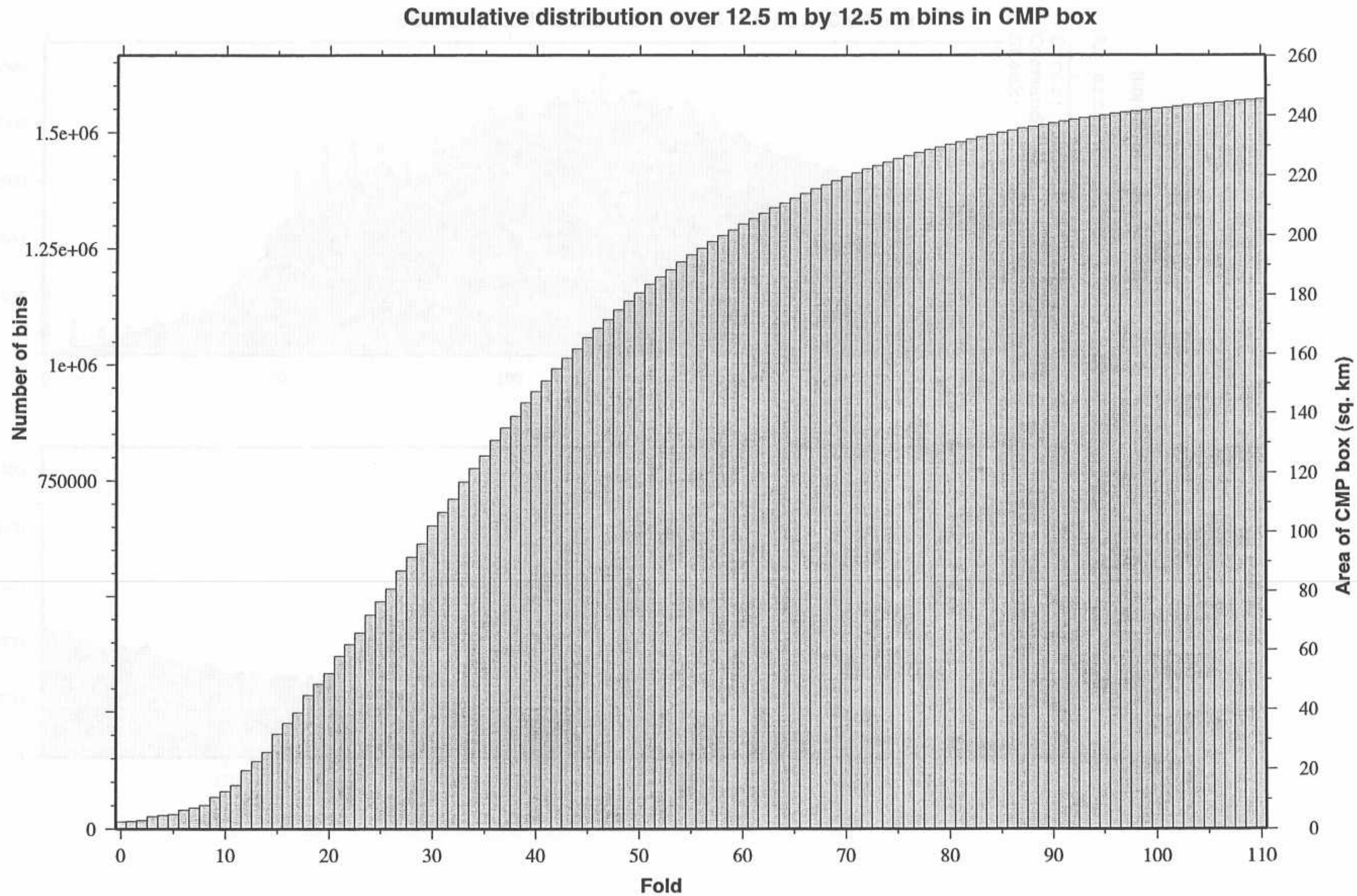


Figure Nav-8b. The cumulative distribution of fold in the 12.5 m CMP bin map

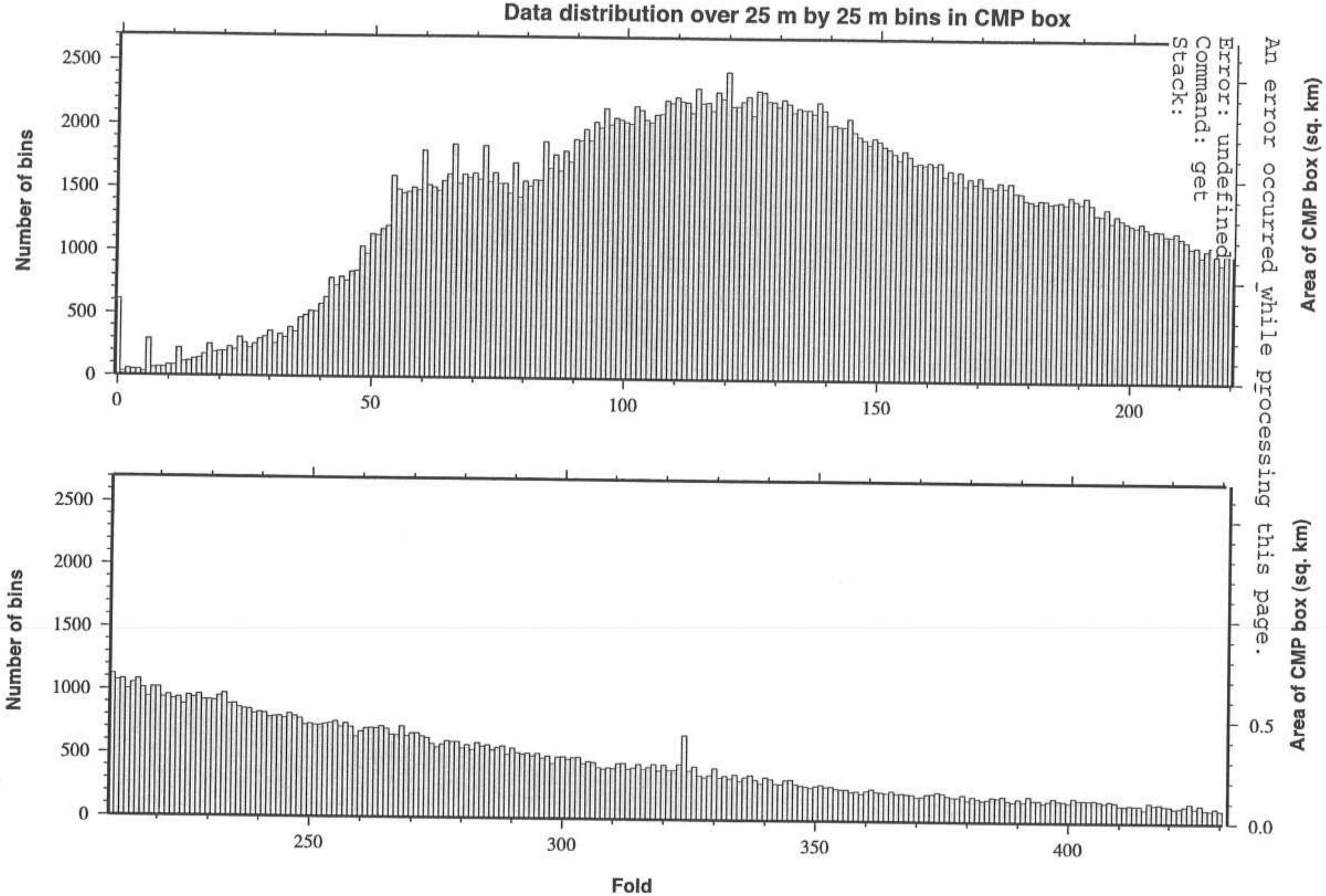

Data distribution over 25 m by 25 m bins in CMP box
Number of bins
Area of CMP box (sq. km)
An error occurred while processing this page.
Error: undefined
Command: get
Stack:
Fold
0
50
100
150
200
250
300
350
400
500
1000
1500
2000
2500
0.0
0.5

Figure 8c

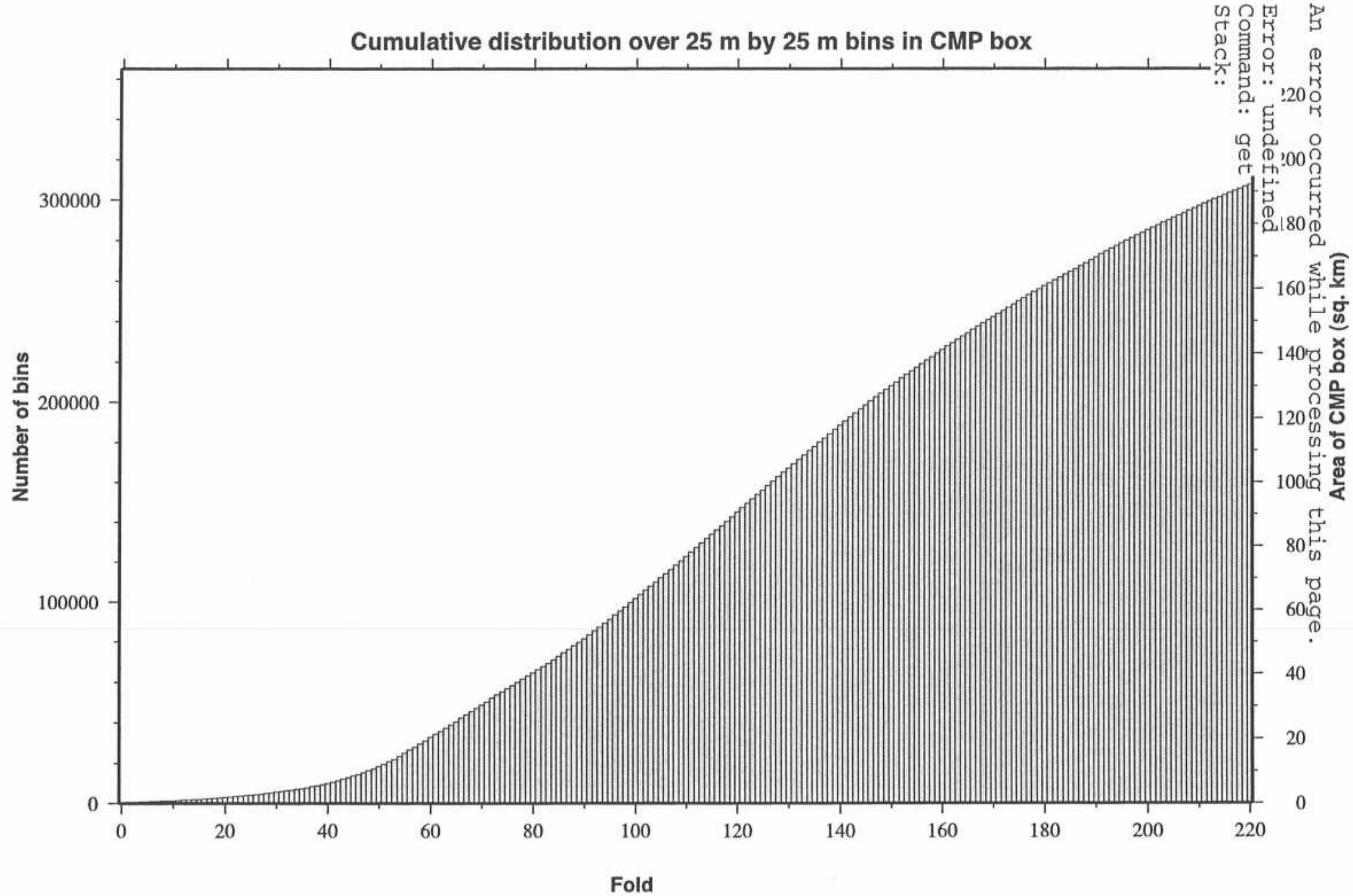

Cumulative distribution over 25 m by 25 m bins in CMP box
Number of bins
Area of CMP box (sq. km)
Fold
An error occurred while processing this page.
Error: undefined
Command: get
Stack:

Figure 8d

SIOSEIS Updates during EW0008

263) ver 2000.9 (16 Oct..2000)

0) Atlantek - 3 Sept 00 - Was dropping 3/4 of the rasters

1) output - Add TRACE0, preset = no, for optional trace0.
   - Add OUNIT2 for optional copy of the tape.

2) segdin - When LDEO Hydrosweep water depth goes bad, so use the last.
   - ffilen/lfilen without ftr/ltr didn't work.
   - reverse lat/long in SEGY header. Should be long/lat
   - Honor ffilen/lfilen & Syntron's weird file numbers when > 16665
   - Change some recording error checks

3) despike - SES/SEL didn't work.

4) contro - Add process TREDIT
   - Add warning if a processes parameters are give twice.

5) tredit/despike - Add LIMITS and KILL INSIDE and KILL OUTSIDE.

6) plot - Add parameter RECSP YES

7) input, segdin, output - Close the tape file during tape changes.

8) geom - Add type 9; calculate DFLS using SEGY long/lat
   - type -9 uses lat/long rather than long/lat
   - Use the range from the SEGY header if GXP is not given.

9) diskin - fno/lno and sort didn't work right

10) ALL, - Allow 200 characters on a parameter line (rdline bug)

11) SIOPLT - Black & white plots were reverse video

12) gains - Add parameters TADD and TMULT

****

Deployment 1 - 24 channels, 7 birds

OBS Lines. JD249-JD251

Distance from booms to 6 air guns array is 115ft or 35m

Distance from booms to transom is 2m

Distance from transom to 6 air guns = 33m

Distance from connector and deck clamp to section 5 is 150m

Distance from connector to transom is 1.8m

Distance from transom to section 5 is 148.2

Distance from section 5 connector to center of group 24 is 6.25m

Distance from transom to center of group 24 is 154.45m

Distance from guns to group 24 119.45

****

```
/home/henkart/bin/sioseis << eof
# Don't use sioseis.fast since it doesn't use IEEE
procs segdin geom diskoa output end
segdin
  ffilen 99999  # take all shots (this is the preset!)
  ftr 1 ltr 24  # throw out traces 25-36
  fcset 1 lcset 1
  offline yes  # eject after the rewind after EOT
  newfile yes  # start a new SEG-Y file on every SEG-D tape
  iunit 4 end
end
geom
 fs 1 ls 999999 type 2
 gxp 240 -117.35 ggx -12.5 dfls 37.5 dbrps 6.25 smear 6.25
 bgp 2 1 3 6 4 12 5 18 6 14 7 30
 end
end
diskoa
# write every 20th shot to a "circular" file
   fno 1 lno 999999 noinc 20 rewind 1
   opath /export/home/EW0008/Realtimestack/latest.shot.segy end
end
output
 ontrcs 24 # force 24 traces per shot
  rewind 0  # leave the tape alone!
```

```
  ounit 35 # dlt
  end
end
end
eof
```

****

Deployment 2 - 480 channels, 23 birds

Lines R0,1   JD 254

Distance from booms to 2 GI guns array is 130ft or 39.6m

Distance from booms to transom is 2m

Distance from transom to 2 GI guns = 37.6m

Streamer leader (measured from where?) 115m

Two stretch sections 100m

Center of group 480 6.25m

Distance transom(?) to group 480 221.25m

Distance from guns to group 480 (221.25 - 37.6) 183.65m

Note BIRD 24 in place of BIRD 14

****

```
/home/henkart/bin/sioseis << eof
# Don't use sioseis.fast since it doesn't use IEEE
procs segdin geom diskoa output end
segdin
  ffilen 99999  # take all shots (this is the preset!)
  fcset 1 lcset 1
  offline yes  # eject after the rewind after EOT
  newfile yes  # start a new SEG-Y file on every SEG-D tape
  tr0 yes  # needed for streamer depths and compasses
  iunit 4 end
end
geom
 fs 1 ls 999999 type 2
 gxp 480 -184.25 ggx -12.5 dfls 37.5 dbrps 6.25 smear 6.25
# Note BIRD 24 in place of BIRD 14
 bgp 1 6 2 18 3 30 4 42 5 66 6 90 7 114 8 138 9 162 10 186 11 210
   12 234 13 258 24 282 15 306 16 330 17 354 18 378 19 402 20 426
   21 438 22 459 23 462
 end
end
```

```
diskoa
# write every 20th shot to a "circular" file
   fno 1 lno 999999 noinc 20 rewind 1
   opath /export/home/EW0008/Realtimestack/latest.shot.segy end
end
output
  rewind 0   # leave the tape alone!
#   ounit2 36  # dat
  ounit 35 # dlt
  end
end
end
eof
*****************************************************************
     Deployment 3 - 480 channels, 24 birds
Lines R3-12   JD255 - JD257
Same leader and guns as Deployment 2
NOTE All 24 birds in place
*****************************************************************
/home/henkart/bin/sioseis << eof
# Don't use sioseis.fast since it doesn't use IEEE
procs segdin geom diskoa output end
segdin
  ffilen 99999   # take all shots (this is the preset!)
  fcset 1 lcset 1
  offline yes  # eject after the rewind after EOT
  newfile yes  # start a new SEG-Y file on every SEG-D tape
  tr0 yes  # needed for streamer depths and compasses
  iunit 4 end
end
geom
  fs 1 ls 999999 type 2
  gxp 480 -184.25 ggx -12.5 dfls 37.5 dbrps 6.25 smear 6.25
  bgp 1 6 2 18 3 30 4 42 5 66 6 90 7 114 8 138 9 162 10 186 11 210
    12 234 13 258 14 282 15 306 16 330 17 354 18 378 19 402 20 426
    21 438 22 459 23 462 24 474
  end
end
diskoa
```

```
# write every 20th shot to a "circular" file
   fno 1 lno 999999 noinc 20 rewind 1
   opath /export/home/EW0008/Realtimestack/latest.shot.segy end
end
output
  rewind 0   # leave the tape alone!
#   ounit2 36  # dat
  ounit 35 # dlt
  end
end
end
eof
```

****

Deployment 4 - 324 channels, 24 birds

Lines R14 through 3D-57; JD258 - JD265

Distance from booms to 2 GI guns array is 130ft or 39.6m	
Distance from booms to transom is	2m
Distance from transom to 2 GI guns =	37.6m
Streamer leader (measured from where?)	85m
Center of group 324	6.25m
Distance transom(?) to group 324	91.25m
Distance from guns to group 324 (91.25 - 37.6)	53.65m

****

```
/home/henkart/bin/sioseis << eof
# Don't use sioseis.fast since it doesn't use IEEE
procs segdin geom diskoa output end
segdin
  ffilen 99999   # take all shots (this is the preset!)
  fcset 1 lcset 1
  ftr 1 ltr 324  # recording 325-480, but it's on the reel!
  offline yes  # eject after the rewind after EOT
  newfile yes  # start a new SEG-Y file on every SEG-D tape
  tr0 yes  # needed for streamer depths and compasses
  iunit 4 end
end
geom
 fs 1 ls 999999 type 2
 gxp 324 -54.25 ggx -12.5 dfls 37.5 dbrps 6.25 smear 6.25
```

```
 bgp 1 6 2 7 3 18 4 30 5 42 6 66 7 90 8 102 9 126 10 138
     11 162 12 174 13 186 14 198 15 210 16 222 17 234 18 246
    19 258 20 270 21 282 22 294 23 306 24 318
 end
end
diskoa
# write every 20th shot to a "circular" file
   fno 1 lno 999999 noinc 20 rewind 1
   opath /export/home/EW0008/Realtimestack/latest.shot.segy end
end
output
  ontrcs 324 # Force the shots to have 324 traces per shot
  rewind 0   # leave the tape alone!
#   ounit2 36  # dat
  ounit 35 # dlt
  end
end
end
eof
*****************************************************************
     Deployment 5 - 324 channels, 24 birds
  SAME AS Deployment 4.   BIRDS 23/24 are not reversed!
  The copy script used had bgp 306 23 294 24
Lines 3D-15x to end of 3-D.  JD266 - JD283
*****************************************************************
/home/henkart/bin/sioseis << eof
# Don't use sioseis.fast since it doesn't use IEEE
procs segdin geom diskoa output end
segdin
  ffilen 99999   # take all shots (this is the preset!)
  fcset 1 lcset 1
  ftr 1 ltr 324  # recording 325-480, but it's on the reel!
  offline yes  # eject after the rewind after EOT
  newfile yes  # start a new SEG-Y file on every SEG-D tape
  tr0 yes  # needed for streamer depths and compasses
  iunit 4 end
end
geom
 fs 1 ls 999999 type 2
```

```
 gxp 324 -54.25 ggx -12.5 dfls 37.5 dbrps 6.25 smear 6.25
 bgp 1 6 2 7 3 18 4 30 5 42 6 66 7 90 8 102 9 126 10 138
    11 162 12 174 13 186 14 198 15 210 16 222 17 234 18 246
   19 258 20 270 21 282 22 294 23 306 24 318
 end
end
diskoa
# write every 20th shot to a "circular" file
  fno 1 lno 999999 noinc 20 rewind 1
  opath /export/home/EW0008/Realtimestack/latest.shot.segy end
end
output
  ontrcs 324 # Force the shots to have 324 traces per shot
  rewind 0   # leave the tape alone!
#  ounit2 36  # dat
  ounit 35 # dlt
  end
end
end
eof
```

****

Deployment 6 - 48 channels, 8 birds

OBS Lines. Day 282 - Day 283

Distance from booms to 6 air guns array is 115ft or 35m

Distance from booms to transom is 2m

Distance from transom to 6 air guns = 33m

Group 54 is on the deck

Distance from connector and deck clamp to section is 75m

Distance from connector to transom is 1.8m

Distance from transom to connector 73.2

Distance from connector to center of group 42 is 6.25m

Distance from transom to center of group 24 is 79.45m

Distance from guns to group 42 46

**** 10 meter error on tape copy! *******

****

```
/home/henkart/bin/sioseis << eof
# Don't use sioseis.fast since it doesn't use IEEE
procs segdin geom diskoa output end
segdin
```

```
  ffilen 99999   # take all shots (this is the preset!)
  ftr 1 ltr 24  # throw out traces 25-36
  fcset 1 lcset 1
  offline yes  # eject after the rewind after EOT
  newfile yes  # start a new SEG-Y file on every SEG-D tape
  iunit 4 end
end
geom
 fs 1 ls 999999 type 2
 gxp 42 -36 ggx -12.5 dfls 37.5 dbrps 6.25 smear 6.25
  bgp 1 1 2 7 3 12 4 18 5 24 6 30 7 36 8 42
 end
end
diskoa
# write every 20th shot to a "circular" file
   fno 1 lno 999999 noinc 20 rewind 1
   opath /export/home/EW0008/Realtimestack/latest.shot.segy end
end
output
  ontrcs 48 # Force the shots to have 324 traces per shot
  rewind 0   # leave the tape alone!
  ounit 35 # dlt
  end
end
eof
```

****

Deployment 7 - 480 channels, 24 birds

Lines R13-   JD284 -

Same streamer geometry as Deployment 2. Different bird location.

Different from earlier deployments because:

1) New geom TYPE 9 using LDEO nav block lat/long rather than assuming shot numbers are 37.5m apart.
2) Save the long/lat in SEG-Y words 59 & 60
3) Also removed parameter offline so tape is not ejected after copy

****

```
sioseis << eof
procs segdin header geom diskoa output end
segdin
```

```
  ffilen 99999   # take all shots (this is the preset!)
  fcset 1 lcset 1
!  offline yes  # eject after the rewind after EOT
  newfile yes  # start a new SEG-Y file on every SEG-D tape
  tr0 yes  # needed for streamer depths and compasses
  iunit 4 end
end
header   # save long/lat in 59, 60 before geom clobbers it
   fno 0 lno 999999 ftr 0 ltr 999 l59 l19 l60 l20 end
end
geom
 fs 1 ls 999999
  type 9  ! New binning by realtime lat/long
!  type 2 ! each shot number increases dfls
 gxp 480 -184.25 ggx -12.5 dfls 37.5 dbrps 6.25 smear 6.25
 bgp 1 6 2 18 3 42 4 54 5 78 6 90 7 114 8 138 9 162 10 186
     11 210 12 234 13 246 14 258 15 282 16 306 17 330 18 354
    19 378 20 402 21 426 22 450 23 462 24 474
  rpadd 1000
 end
end
diskoa
# write every 20th shot to a "circular" file
   fno 1 lno 999999 noinc 20 rewind 1
   opath /export/home/EW0008/Realtimestack/latest.shot.segy end
end
output
  rewind 0   # leave the tape alone!
  ounit 35 # dlt
  end
end
end
eof
```

USGS Ocean Bottom Seismometers – Technical Report
Blake Ridge – 2 September – 17 October 2000
R/V Ewing Cruise EW0008

Introduction

The Lamont Doherty Earth Observatory research vessel *Maurice Ewing* departed Newark, New Jersey on 2 September, transited to the Blake Ridge area 300 km offshore Georgia where it spent 6 weeks conducting 2D & 3D multi-channel seismic (MCS) and ocean bottom seismometer (OBS) surveys, before returning to Norfolk, Virginia on 17 October 2000.

The USGS OBS

The USGS OBS utilizes an Onset Computer Tattletale Model 6 12 bit a/d datalogger to record 3-component geophone and hydrophone data. The logger's sampling and timekeeping is controlled by a Seascan Inc. precision time module. Ranging and release functions are via a Benthos Inc. acoustic transponder mated to a UGSG designed mechanical release. The datalogger, clock, release circuitry, analog circuitry, and alkaline battery power supplies are housed in a 17 inch diameter aluminum alloy sphere. A hydrophone and the recovery aids, a radio beacon and a strobe light, are mounted on the exterior of the sphere.

To improve geophone-bottom coupling the OBS, which was formerly entirely self-contained in the buoyant sphere, has been reconfiguration with an external geophone sensor package. The package consists of the gimbaled 3-component geophone assembly formerly located in the interior of the sphere, now pre-amplified and housed in an external pressure case surrounded by a sand-filled canvas bag. The sensor package is attached to the sphere via a 2-stage, pressure-activated release arm and an interconnecting cable. The additional weight of the external pressure case with its sand-filled bag, release arms, and interconnecting cable required the addition of flotation in the form of molded syntactic foam added to the outer surface of the sphere and to the geophone pressure case.

For EW0008 the TT6 was programmed to sample at the rate of 200 Hz (5 ms) and was capable of writing 2 GB datafiles for a recording window of 15+ days.

Operations

All 13 OBS were deployed at least once. A total of 20 deployments were made, a short duration deployment of 12 along a detailed line, a second short deployment of 7 along the same line, and a long-term deployment of 1 OBS in the 3D MCS grid. All deployments were in 2660-2820 meters water depth.

With the exception of the attachment to the anchor, the OBS's were entirely assembled indoors in the port-side Dry Lab and wet staging area. The electronic test equipment, GPS clock, and notebook computer were set up immediately inside the aft watertight door of the Dry Lab. In the days leading up to the deployment as each OBS was prepared it was positioned in the wet staging area immediately adjacent to the door. With the door open test leads and cables were led out, servicing and repairs made, Seascan and tattletale clocks set, and through sphere communication with the datalogger verified. The sphere was closed, vacuum pulled, and the release system tested. The anchor release hook, external geophone package arms, and syntactic flotation were installed, and the OBS was secured to the deck in the wet staging area. In the hours leading up to deployment the dataloggers were programmed with deployment parameters and start acquisition times, vacuum verified, checks made, and geophone packages attached to the release arms.

All OBS were deployed over the stern utilizing *Ewing's* afterdeck A-frame and a small hydraulic air gun winch and in all cases went very smoothly. With the wet staging area garage door opened and batter boards removed, the obs were rolled out and into position at the stern rail, lifted by the hydraulic hoist, lowered and secured to the anchor which was inserted on a stand under the raised OBS. The geophone sensor arm was secured in the upright position, final checks made, and tag lines attached. Set up at the stern rail required 4 people, the winch/boom operator, the OBS technician, and two assistants to move the OBS, set-up the anchor, and handle the tag lines. This operation took 15-25 minutes. Since the detailed deployments required precise positioning along the line, with spacing as tight as 200 meters, communication between the bridge and stern deck and timing of the launch were critical. The OBS was lifted and boomed out over the stern railing as the deployment position was 100 meters away, lowered to the waterline at 10-20 meters, and lowered into the water and let go on bridge command.

The Benthos transducer was installed in the Main Lab transducer well and the OBS final position on the seafloor was determined by ranging.

Recoveries were made using the starboard side "Waist Deck" A-frame and hydraulic hoist. The release code was sent with the Benthos deck unit set up in the starboard Wet Lab with the transducer lowered over the waist deck railing or from the Main Lab with the transducer in the lab transducer well. Recoveries were by no means as smooth as the deployments owing to gale winds and rough seas for just about all of them, but there were no major problems and all units were brought aboard within _ -1 hour of surfacing. The recovery crew consisted of 4-5 people, a winch-boom operator, the OBS technician as primary hooker, a backup hooker, and one or two others to wrestle the OBS aboard and wheel it around to the wet staging area. The releases were reset to shut off the rdf, geophone arms removed, and the OBS secured in the wet staging area. When all OBS from a deployment were aboard, they were individually moved to the location outside the Dry Lab door, the spheres were opened, clock drift measured, and dataloggers removed for download.

The *Ewing* Deck Officers became quite skilled at bringing the OBS quickly alongside and keeping it there so that the recovery crew had multiple attempts at hooking the difficult target of the OBS pickup bale. Night recoveries on the first deployment were hampered somewhat by a high number of strobe failures. Only 6 functioning strobes were available for the 7 OBS used in Deployment 2. One radio transmitter failed on the first deployment but did not create any exceptional delay. A hydraulic hose rupture on the waist deck winch necessitated recovering one OBS using the stern A-frame and winch.

Results

Data was recorded at 16 of the 20 stations.

Two OBS, D2, Station 11, and B2, Station 9 failed to start acquisition.

Two OBS, C4, Station 10, and A2, Station 19 responded to their acoustic release codes but failed to release and surface.

Details by OBS

A2
Deployment 1, Station 6
Problems with release on setup. Replaced damping resistor but release still would not reset with sphere closed. Strobe failed. All else normal operation.
Deployment 2, Station 19
Replaced strobe and batteries. Noted small spot of corrosion under main battery pack. Either battery leak or pinhole leak. OBS responded to release command by sending repetitive pings approx. 2 sec apart. DID NOT SURFACE. STUCK ON BOTTOM.

A3
Deployment 1, Station 2
No problems on setup. All systems normal operation.
Deployment 2
Not deployed but used A3 datalogger/clock in D3.

A8
Deployment 1, Station 1
Could not communicate via RS232 with sphere closed. Used for the long term deployment in MCS grid. On bottom for 30 days. Wrote entire 2 gb disk. All systems normal operation.

B2
Deployment 1, Station 9
No problems on setup. Did not start acquisition during deployment. No data.
Much corrosion on battery pack and connectors inside sphere from leak on Puerto Rico deployment. Cleaned connections, replaced RS232 phone jack connector, tested on deck, no problems with clock or program acquiring test tracks. Planned deployment 2 was cancelled when release circuit failed, was repaired by replacement of capacitor board, and then failed again.

C1

Deployment 1, Station 12

No problems on setup other than sticky air cock threads, no strobe function. Strobe failed. All else normal.

Deployment 2, Station 14

Replaced strobe and all batteries. No problems

C3

Deployment 1, Station 7

No problems on setup. Strobe failed, water inside on recovery. Sensor package did not deploy – loose sealing screw allowed water to get behind release pin. Sphere sensor bulkhead connector broken and sensor package interconnecting cable damaged on deck on recovery. Deep pitting and corrosion inside sphere base. Data collection normal.

Deployment 2, Station 15

Replaced sensor bulkhead connector and interconnecting cable with ones from D8. Replaced strobe and all batteries. Sphere corrosion and pitting attributed to previous battery leak. Pulled vacuum which held over a one week check. When making final checks prior to sealing for deployment TT6 would not communicate. Problem traced to TT6, either voltage regulator or RS232 chip. Replaced datalogger with TT6 from D3. Geophone sensor package did not deploy, cracked block. All else normal.

C4

Deployment 1, Station 9

No problems on setup. OBS failed to release from bottom despite acknowledging release command. DID NOT SURFACE. STUCK ON BOTTOM.

D1

Deployment 1, Station 8

Release command board repaired on setup. Strobe did not work on surfacing but started about 15 minutes after surfacing. TT6 clock 5 sec ahead of GPS and Seascan otherwise data collection normal.

Deployment 2, Station 17

Vertical geophone good deployment 1, all others low. Cleaned up corrosion in sphere bulkhead to interconnecting cable connection. Found drop of water and cracked bulkhead connector at geophone end of interconnect. Replaced geophone package with D8. Replaced main batteries. No strobe. Replaced external arm sensor release block. Pin was bent and block cracked. Rough recovery. Lost handle over vacuum port when using it as lift point to remove from water. When checking clock at end calibration observed tattletale clock go from –6 seconds to +40 seconds over about 15 minute period. Seascan clock ok. All else normal.

D2

Deployment 1, Station 11

No problems on setup except strobe inoperative. On recovery OBS was slow to surface. Found ~16oz seawater inside. Leaked through sensor bulkhead connector. Main batteries flooded & shorted. Voltages >5v. Datalogger and clock shut down. Severe corrosion on lower sphere including sensor connector o-ring surface. Sensor package did not deploy -

cracked release pin block. Tried to use D2 datalogger/clock package with D3 for deployment 2. Failed to start acquistition in bench trials. Either clock or program malfunction.

D3

Deployment 1, Station 13

No problems on initial setup. When tried to reset datalogger clock prior to deployment unit reset to the initial setup time indicating a Seascan clock malfunction. Deployed by inserting an artificial start acquisition time. Other than clock malfunction normal data recovery. Data best quality of all units.

Deployment 2, Station 18

Unable to communicate with Seascan clock. Replaced datalogger/clock package with A3. Replaced all batteries. At time of deployment noticed loose and cracked sensor sphere bulkhead connector. Removed shell and connector fell apart. Replaced with connector from A8 and deployed. No problems.

D4

Deployment 1, Station 3

On initial hookup diode in battery circuit heated and smoked. Must hookup datalogger to analog board ribbon after connecting datalogger battery supply. Reversal of sequence causes ground loop. Unit has one dead horizontal geophone channel. All systems operated normally.

Deployment 2

Cleaned corroded connectors in sensor bulkhead and sensor interconnecting cable. Repaired loose connection on hydrophone –15v input wire wrap pin. Replaced all batteries. Repaired broken diode probably brittle from overheating (see above). Still has dead horizontal geophone. No problems.

D8

Deployment 1, Station 5

Sometimes requires rebooting TT6 for disk to spin up. No problems on setup except strobe inoperative. At recovery would not reset release. Clock had stopped & disk would not spin up. Data was recorded and was good. Found ~6 oz seawater in base of sphere. Mechanical release is frozen. Water entered past sensor bulkhead seal due to pitting & corrosion on sphere o-ring surface. Cleaned up and resoldered ribbon cable and used bulkhead connector to replace damaged one on C3.

D9

Deployment 1, Station 4

No problems on setup other than noisy pinger and inoperative strobe. Strobe and radio beacon failed on recovery but was spotted quickly and brought aboard without delay. All other systems operated normally.

Deployment 2

All signals over-driven and clipped on deployment 1. Shifted to low gain setting on input to tattletale a/d. Replaced radio transmitter board with one removed from D2. Transmitter board from D9 and spare both defective. Replaced all batteries. Used strobe from A8. Arm did not lower but it appears that sensor package deployed. Came to surface in horizontal position from sensor weight suspended from undeployed arm.

Partcipants

Cruise Chief Scientist was Steve Holbrook, U. Wyoming, co-chiefs were Dan Lizarralde, Georgia Tech, and Ingo Pecher, U. Texas. Ingo Pecher arranged for use of the U.S. Geological Survey's OBS's with Uri tenBrink, USGS, and planned and directed the OBS work. The OBS's were operated shipboard by Robert Iuliucci of Bear Cove Resources, under contract to U.Wyoming. The Woods Hole based mobilization and the delivery of 13 USGS OBS to the *Ewing* at Port Newark were carried out by Greg Miller, USGS, who supervised the assembly and mobilization of the OBS's dockside Port Newark with assistance from Jeff Nealon, USGS, and Robert Iuliucci. Greg Miller provided shore support and advice during all phases of shipboard operations. The *Ewing* officers and crew and Lamont Doherty and visiting scientific staff assisted in various capacities during OBS deployments and retrievals.

OBS Deployment Strategy

We planned two deployments. During the first deployment, we deployed one instrument in the 3-D box and all the remaining 12 instruments along the ODP Leg 164 drilling transect. During the second deployment, we filled gaps caused by problems with some instruments during the first deployment (figs. OBS-1-3).

Deployment 1

We deployed instrument A8 at OBS station 1 in the 3-D box. The maximum recording time of the OBSs at their maximum sampling rate (5 ms, four channels) is about 15 days, whereas the 3-D shooting was expected to last for over 20 days. We therefore set the start time of the acquisition to one day after the expected start of the 3-D shooting. Because of a delay caused by Hurricane "Florence", recording started one day before the actual 3-D survey. We therefore estimate we recorded 14 out of 22 days of 3-D shooting, i.e., approximately 56 of the 89 shooting lines.

The other OBS stations were located along the ODP Leg 164 drilling transect. OBS stations 2 and 4 (A3 and D9) were at Sites 997B and 885B, respectively, OBS station 3 (D4) half-way between both locations, OBS station 13 (D3) 1 km to the southwest of Site 994D. The other eight instruments (OBS stations 5-12) were deployed at 200-m spacing from at Site 994D to the northwest. The 1.4 km covered by those instruments extended over the step of the top of free gas between Sites 994 an 995 (fig. OBS-1).

The high accuracy of the differential GPS and favorable weather conditions allowed dropping the instrument with the stern of the ship (from where we deployed the OBSs) at the planned drop locations within a few meters. THe instruments could drift signficantly, however, due to currents before reaching the ground at 2800 m water depth. We assumed that the drift would be similar for all the instruments and hence, the instruments would have a spacing of about 200 m on the ground. However, we wanted to ensure that our dense-deplyoment-transect extended across the step of the top of free gas. We therefore planned to apply a correction along the ODP Leg 164 transect prior to deployment based on ranging to the OBSs at stations 2 and 3.

The ranging was performed by sending an acoustic signal with the Benthos transceiver to which the OBSs replied. Based on the time difference between sending and receivng, the distance to the OBS was calculated (this was done by the control unit for the transceiver, assuming a water velocity of 1500 m/s). The transceiver was mounted in the ship's transducer well. We measured the distance about every minute while the ship was moving at about 2 knots over the OBS. We estimated the drift of the OBSs along the Leg 164 transect based on the closest distance from ranging and corrected the drop locations for stations 5-12 accordingly.

After deploying OBSs at stations 5-12, we ranged over OBSs D8 (station 5) and C1 (station 12) perpendicularly to the Leg 164 transect to determine their drift across the transect. We planned to correct the locations of the shooting profiles if necessary to ensure the profiles cross the OBS positions on the ground. However, the drift was found to be negligible (40 m to the southeast at station 12, no drift at station 5) (fig. OBS-4). As part of the seismic processing, we late relocated the positions of the instruments based on the traveltime of the direct wave.

1	2	3	4	5	6	7	8	9	10	11	12	13
A8	A3	D4	D9	D8	A2	C3	D1	B2	C4	D2	C1	D3
14	15	16	17	18	19	20						
C1	C3	D4	D1	D3	A2	D9						

Table 1: Station and instrument numbers, both deployments

Deployment 2

A second deployment of seven instruments was necessary to fill gaps caused equipment failure/loss during the first deployment. Two instruments, OBSs C1 (station 14) and C3 (station 15), were deployed at Sites 997B and 995B, respectively.

We adjusted drop locations of these instruments based on the drift determined during the first deployment (drift 200 m to the southwest, 20 m to the southeast). Ranging revealed later that we overcompensated by $\sim$ 100 m to the northeast probably due to different currents.

Four of the instruments (stations 16-19) were deployed to fill gaps in the dense-deployment-transect (figs. OBS-2 and 3). We had to try to hit positions on the ground as accurately as possible. We therefore first determined the drift of the OBSs in deployment 1 based on the moveout of the direct wave. We accounted for this drift when determining the positions of the gaps. The drift during deployment 2 was estimated by ranging across OBS C1 (station 14) and we corrected drop locations accordingly.

OBS D9 (station 20) was deployed 2 km to the southwest of Site 994B, mainly to investigate problems with the instrument gain (see below).

OBS A8 in 3-D box

We along two perpendicular lines over OBS A8 (station 1) before recovery. This was only done to facilitate correction of timing problems (see below).

Experiences From Dense Deployment

We have demonstrated that a dense deployment of instruments is possible in this water depth. The OBSs appear to largely drift similar distances and directsion while descending (fig. OBS-5). The good seastate during both deployments facilitated this experiment. A spacing significantly below 200 m, however, is probably not feasible because of scattering of instruments on the seafloor. Ranging to the instruments is extremely helpful for correcting drop positions for drift and if necessary to determine instrument locations on the ground. The high accuracy of a differential GPS is essential for this type of experiment. The *EWING* demonstrated an extremely good maneuverability and ability for station keeping without which this experiment would have been thwarted.

OBS Data Description

The OBS records consist of $\sim$ 1 MByte blocks of continuos data preceded by a track header. Rercording

line	gun types	gun depth	streamer depth	hydrophone?
1	array	5 m	2.5, later 6 m	no
2	GI	2.5 m	2.5 m	no
3	GI	2.5 m	2.5 m	no
4	GI	2.5 m	2.5 m	yes
5	GI	5 m	5 m	yes
6	GI	5 m	5 m	yes
7	GI	5 m	5 m	no
8	GI	5 m	5 m	no
9	array	5 m	5 m	no
10	GI	2.5 m	2.5 m	no
11	GI	5 m	5 m	no

Table 2: Configurations for shooting to OBSs, both deployments. All reflection data were recorded with a 600-m long streamer

station	shot point no.	CMP no.
2, 14	3352	11738
3	3535	12324
4, 15	3689	12817
5	3772	13082
6, 16	3782	13114
7	-	13146 (*)
8	3801	13175
9, 17	-	13207 (*)
10, 18	-	13239 (*)
11, 19	-	13271
12	3841	13303
13	3900	13492
20	-	13623 (*)

Table 3: Preliminary closest shotpoints and CMPs of OBS line 2 to OBS stations, (*) estimated

stops for a short interval ($\sim$ 0.26 s) between tracks during which the data are written to disk (see table).

The data were downloaded to a Personal Computer and transferred to a SUN. An already existing program to transform data into continuous records data was modified to read the USGS OBS data. The continuous records were subsequently split into SEG-Y traces. This process revealed two major problems: 1. The gains in most instruments were set too high leading to clipping of the direct arrival. 2. The times of individual track records were not correct.

Gain

The gain problem could not be alleviated. The automatic gain scanning, that the Tattletale usually performs, had been disabled to allow sampling at 5 ms (usually, those instruments record at 10 ms). The amplifiers allowed only two hard-wired gain settings, one low-gain and one high-gain setting. The instruments had been set to high-gain for both deployments. For the second deployment, we changed OBS D9 to low gain to test whether this would lead to a better signal quality. Fortunately, reflections were not clipped in most records and except for two instruments (A3 and D9) and hence, data quality is not seriously affected by this problem.

The A/D converter has a range of $\pm$5 V at a 12-bit resolution. The pre-amplifiers are already saturated at about $\pm$4.7 V, effectively lowering the dynamic range. Given this relatively small dynamic range, it will be very difficuly to set the instrument gain properly to record both the relatively strong direct wave and weak P-to-S converted waves.

Timing Problems

Clock drifts were normal (in the range of several ms between deployment and recovery; see tables). They could not be the cause for the timing problems. The time difference between adjacent tracks varied, following semi-regular patterns (fig. OBS-6). The track time in the OBS headers therefore was probably not accurate. We first suspected that the problem was that the associated header word is only to 1 s accurate. Time differences between tracks, however, varied mostly within a range of 2 s. A simple rouding error in track times would only lead to changes of time differences by 1 s. We were also informed by Greg Miller, the USGS OBS engineer, that the recording is activated by a an impulse from the clock which is sent every second. Hence, the start times of the tracks should be full seconds. Hence, an additional problem must be present. Finding the cause for these problems will require additional testing onshore. This was, to our knowledge, the first deployment of these instruments with a 5 ms sampling rate and we suspect that the reason for the timing problems is linked to increasing the sample rate.

The arrival from the direct wave in individual tracks after breaking up the data into SEG-Y traces usually was scattered around the predicted time (fig. OBS-6). No linear trend was obvious in these timing problems. This, together with the normal clock drifts, suggested that the on average the times were correct within a $\pm$1-s range. We therefore resolved the timing problems by shifting tracks up- or downward by a constant value to achieve a smooth transition across track boundaries.

For this, we first split the SEG-Y data into two lobes of positive and negative offset. Moving from small to large offsets, we calculated the cross-correlations across track boundaries. The time shift to achieve

type	element	bytes	description
long	serialno	0-3	tattle tale serial no.
short	trackno	4-5	track number
short	track_year	6-7	track time - year
short	track_day	8-9	track time - Julian day
char	track_hrs	10	track time - hour
char	track_min	11	track time - minute
char	track_sec	12	track time - second
long	ptspl	13-16	pointer to sample at track time (disabled)
short	start_year	17-18	data start time - year
short	start_day	19-20	data Ssart time - Julian day
char	start_hrs	21	data start time - hour
char	start_min	22	data start time - minute
char	start_sec	23	data start time - second
short	set_year	24-25	set time - year
short	set_day	26-27	set time - Julian day
char	set_hrs	28	set time - hour
char	set_min	29	set time - minute
char	set_sec	30	set time - second
short	filt	33-34	filter value - Hz
char	nch	35	no. of channels
char	buff	36	buffer size, units of 32k
char	nbad	37	no. of bad tracks
short	lo_gain_ch1	38-39	low gain channel 1
short	lo_gain_ch2	40-41	low gain channel 2
short	lo_gain_ch3	42-43	low gain channel 3
short	lo_gain_ch4	44-45	low gain channel 4
short	hi_gain_ch1	46-47	high gain channel 1
short	hi_gain_ch2	48-49	high gain channel 2
short	hi_gain_ch3	50-51	high gain channel 3
short	hi_gain_ch4	52-53	high gain channel 4
char	vers	54	software version no.
long	track_sec_year	55-58, track time in secs. of year	
char	blank[165]	59-223	blank

Table 4: Data format of USGS OBSs. Each track consists of a 224-byte header and 1015584-byte data block. Data are 2-byte-integer, at 12-bit resolution, shifted 4 bits to the left. Header defined in code usgs2obs.c which converts USGS OBS format to a continuous record.

maximum correlation was applied to all traces within each track (we subtracted the expected time shift between two traces for the direct wave assuming a 20-m shot spacing and 1500 m/s water velocity). This procedure generally lead to smooth transitions across track boundaries up to offsest of 10-15 km. At further offsets, the alignemnt of tracks was performed by picking times of the direct wave across track boundaries.

The water velocity calculated from the moveout of the direct wave after aligning the tracks was generally between 1500 and 1520 m/s, which is in the range of velocities determined from the MCS data. The relocation of OBSs based on the direct wave led to similar values for both lines 1 and 2, although both lines were shot into opposite directions. Both observations validate the approach chosen to resolve the timing problems. By the end of the cruise, we had resolved the timing problems for all stations of the first deployment that contained usable data except for station 1 (in 3-D box).

Data Quality

Apart from clipping of the direct wave, data quality of the OBSs is excellent for P-wave data (fig. OBS-7). PS-waves were in general recorded well. Some arrivals are ringy, which is a sign of poor coupling of the horizontal component to the seafloor. However, quality of the PS-arrivas is probably better than what is achieved with most other OBSs. Most instruments consistently display three distinct PS-arrivals probably from the same PS-conversion horizon. We plan to constrain the depth of the conversion horizons based on the PS-moveout. We then plan to fine-tune this depth by correlating PS-records with reflection seismic data or with known geologic interfaces such as layesr of high gas hydrate concentration. This approach should then allow us to investigate the cause of PS-conversion and to determine the lateral variation of V_s across the Leg 164 transect.

Deep-Towed Hydrophone

Robust knowledge of the source wavelet is essential for waveform analyses. We therefore deployed a hydrophone that was attached to a 300-m long cable. Two hydrophones were tested, a source monitor designed by WHOI and a Benthos hydrophone (model 502-1-1 AQ-1). Pre-amplifiers were attached to both hydrophones (external casing for the WHOI instrument and incorporated into the hydrphone casing for the Benthos hydrophne). A depressor was attached to the cable to pull down the hydrophone. The cable was originally desiged to tow hydrophones from a helicopter for detection of submarines. It is rated for a maximum strain of 1800 pounds. Hydrophones, cable, winch, and spare parts were provided by the Woods Hole Oceanographic Institution at no cost other than for maintenance.

The cable was deployed from an air-powered winch over the stern on the starboard side of the ship (between the starboard airgun and the streamer). It was led through a snatch block that was attached to the A-frame on the stern. We attached the strain gauge for the streamer to the snatch block to be able to monitor the strain on the cable.

The air-powered winch required 60-90 psi pressure. The ship's air was cleaned and lubricated through a regulator unit. Initially, the flow rate of air to the winch was not sufficient. This problem was resolved by using a hose with larger diameter between regulator and the ship's air suplly with .

The hydrophone signal was recorded through an analog channel (auxiliary channel #1) with the MCS recording system. It was necessary to connect a potentiometer to the analog input to be able to scale down amplitudes before A/D conversion. We monitored the signal before A/D conversion with an oscilloscope to ensure that amplitudes did not exceed ± 2 V, the maximum dynamic range of the A/D converter.

We tested both hydrophones several times during OBS lines 1 and 2. The WHOI hydrophone appeared to be too sensitive for this purpose – the pre-amplifier was oversaturated (the hydrophone was designed as a source monitor for vertical seismic profiles, where the source is considerably further away than the ~ 250 m during our survey). After some difficulties with properly connecting it (polarities of the connectors were mixed up), the Benthos hydrophone worked well.

We deployed the hydrophone at the beginning of each line and started recovering it about 30-45 minutes before the end of the line. Deployment and recovery took about 30 minutes each. We pulled the hydrophone at 2.5 knots. The measured strain on the cable usually was 100-200 pounds and did not exceed 500 pounds. We deployed the hydrophone during lines 2 to 5. Because of worsening sea-state, we did not deploy it during the remaining lines 6-8.

First data analysis indicated that when profiling at 2.5 knts the hydrophone was only about 50 m beneath the surface (fig. OBS-8). We estimated that the distance between source and hydrophone is about 250 m after subtracting some cable length that remained on the winch and accounting for the distance between airguns and ship. 50 m beneath the seasurface then correspond to an angle of $\sim 79^{o}$ from the vertical between guns and hydrophone. We were mostly interested in the waveform of the nearly vertically traveling signal. We could not slow down significantly while towing the streamer. Therefore, we deployed the hydrophone at the end of OBS line 8 after having recovered the streamer. We slowed down from 2.5 to 1 knts to allow the cable to sink while shooting (fig. OBS-8). The hydrophone reached a depth ~ 150. The angle between vertical and the line bewteen source and hydrophone was still $\sim 55^{o}$. The width of the source wavelet increased (fig. OBS-8). The wavelet that is being recorded is a superposition of the pulse fromthe GI gun and its ghost (reflection at the seasurface), which has a negative polarity compared to the primary pulse. Slowing down may have resulted in the guns being towed deeper which increases the time gap between primary and ghost and hence, leads to a widening of the wavelet. Also, the geometry of raypaths for primary and ghost signals should affect the time difference between both arrivals and hence, the width of the wavelet.

As a conclusion, the source monitor in its current configuration could not be towed sufficiently deep that it records the near-vertical wavelet from the airguns. We expect, however, to be able to utilize the hydrophone by investigating the seafloor reflection (which unlike streamer data is receiver-ghost free and is at near-vertical incidence, but is affected by the reflectivity series at the seafloor). Alternatively, we may attempt to model the source wavelet as a superposition of primary and ghost arrival based on the near-horizontal arrivals in the deep-towed hydrophone.

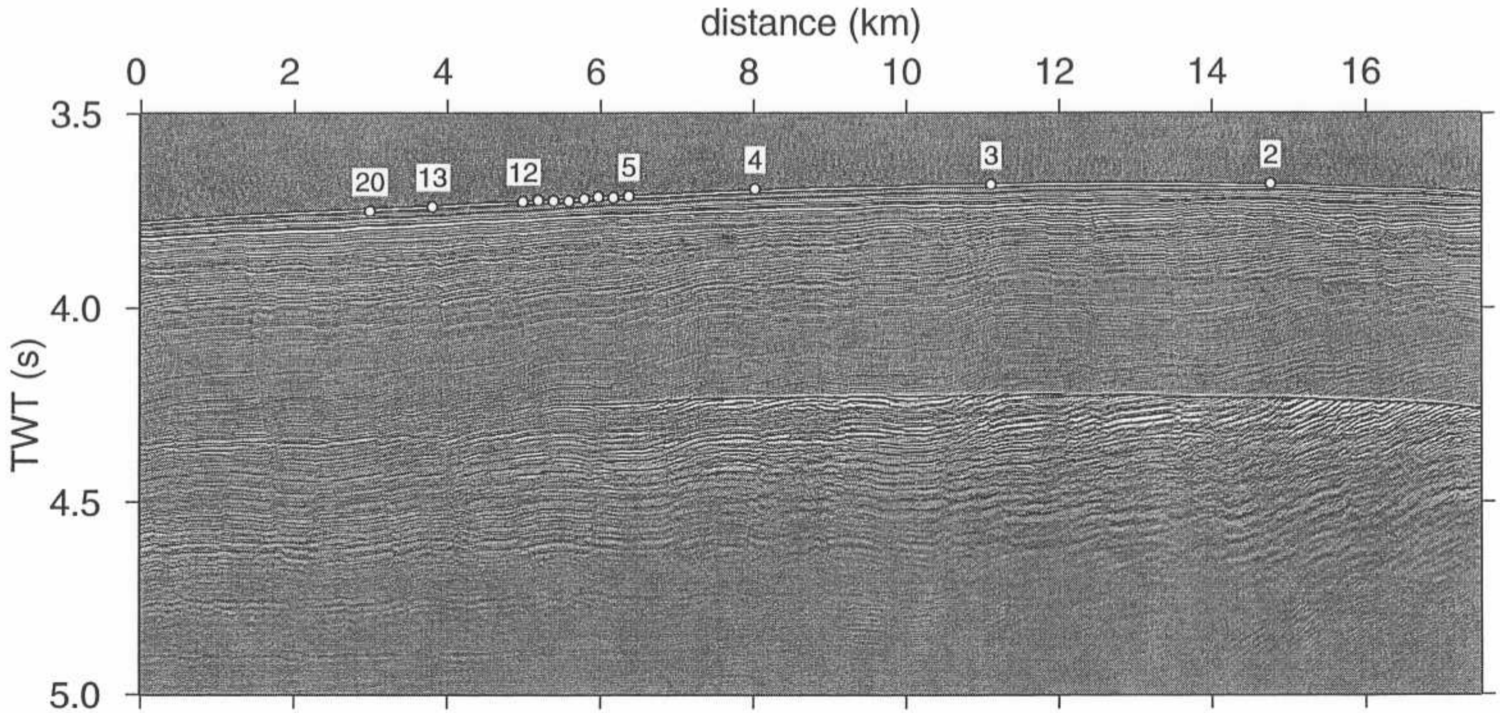


Fig. OBS-1. Section of reflection line OBS-2 over the OBS transect. Post-stack migration. t^2-time gain.
Numbers: OBS stations. Identical stations: 2&14, 4&15, 6&16, 9&17, 10&18, 11&19.
Refer to tables for instrument numbers.

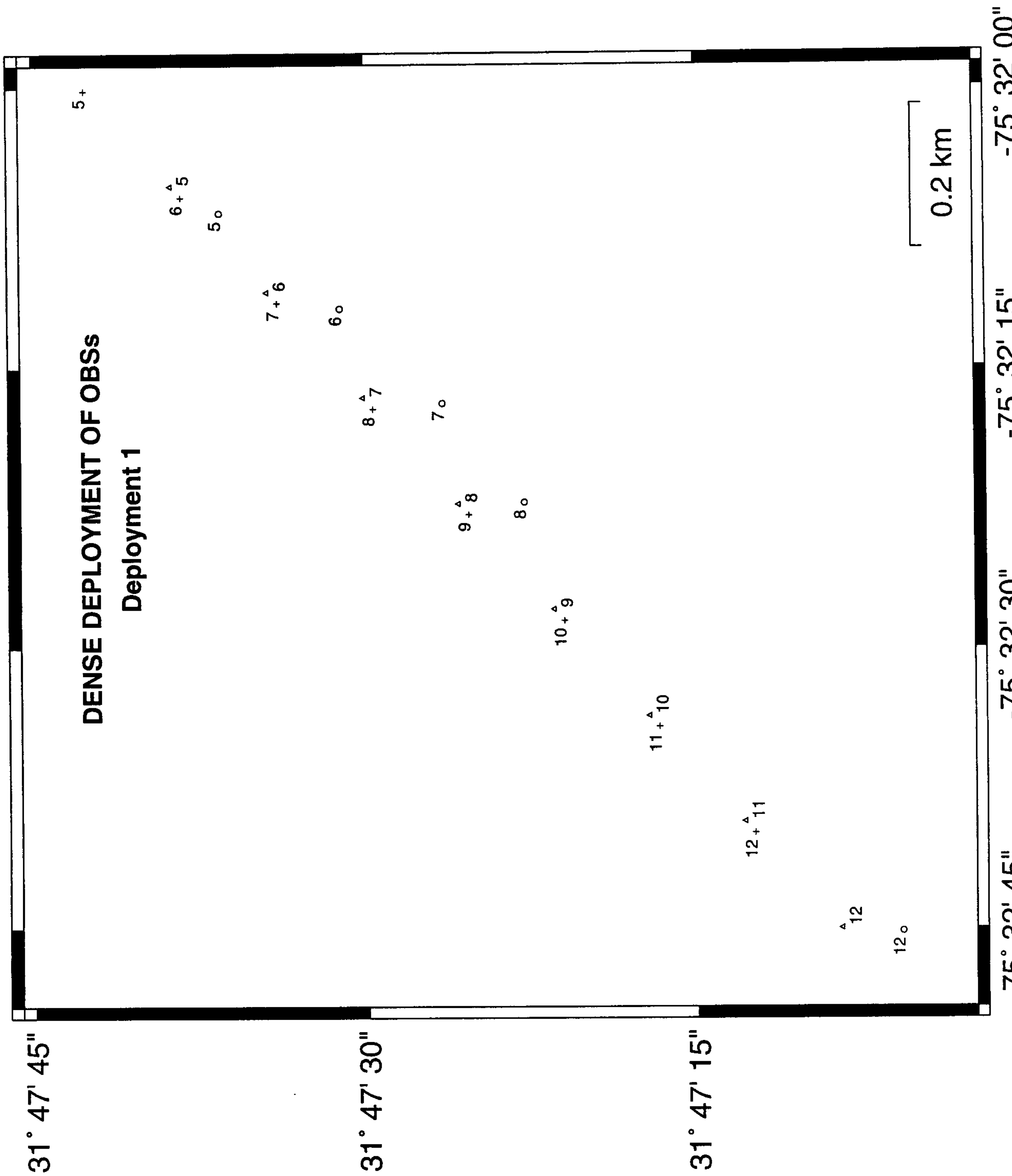


Fig. OBS-5. Dense deployment of OBSs, deployment 1.
Drop positions calculated from ranging.
Positions on ground are from relocation of OBSs
using direct wave (no data for OBS 9-11).

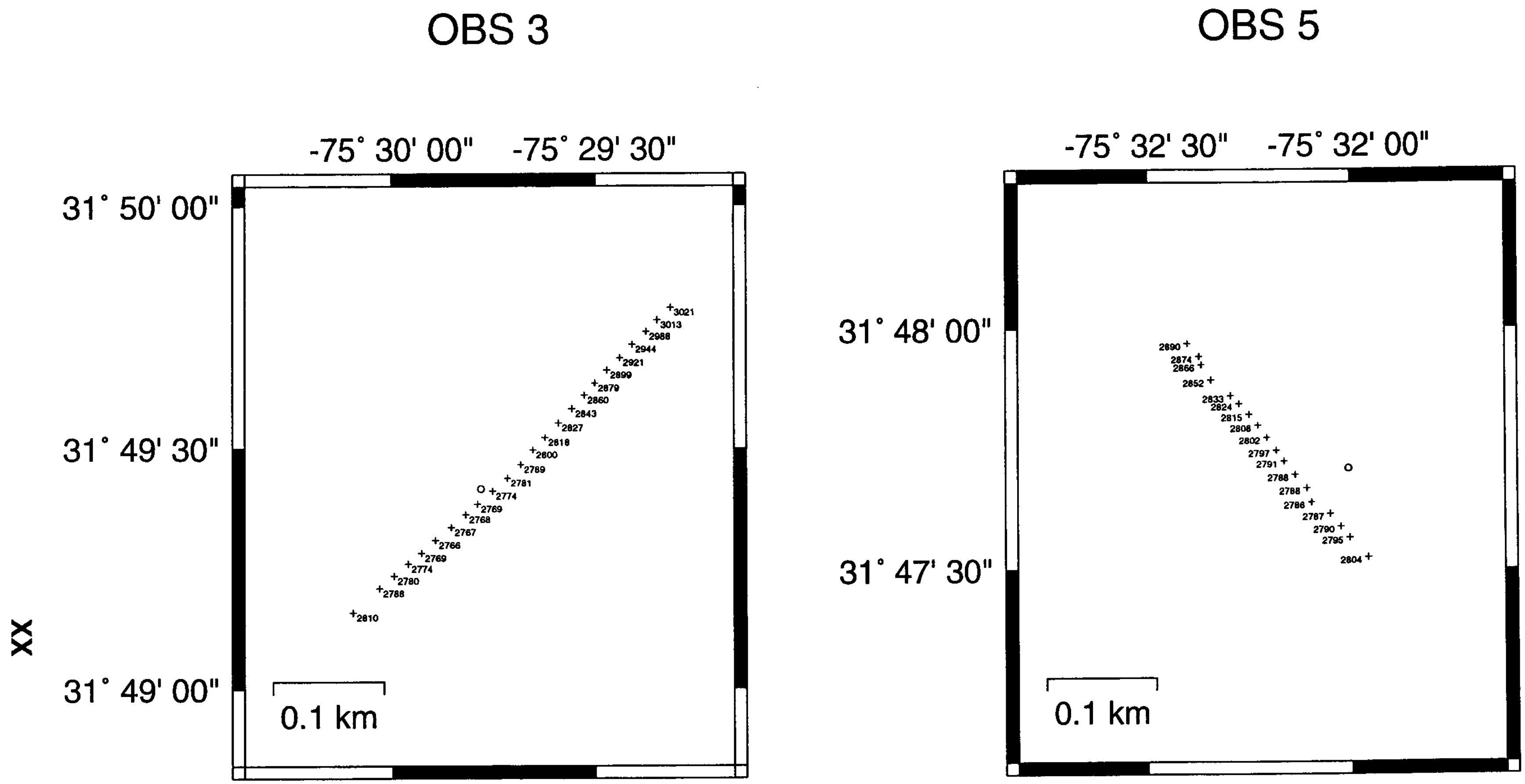


Fig. OBS-4. Ranging over OBS station 3 to estimate drift of the instrument along Leg 164 transect and station 5 to determine drift across it. Numbers: Ranges in meters. Circles: OBS drop positions. The drop position of OBS 5 has already been modified to account for the drift determined from ranging over OBS stations 2 and 3.

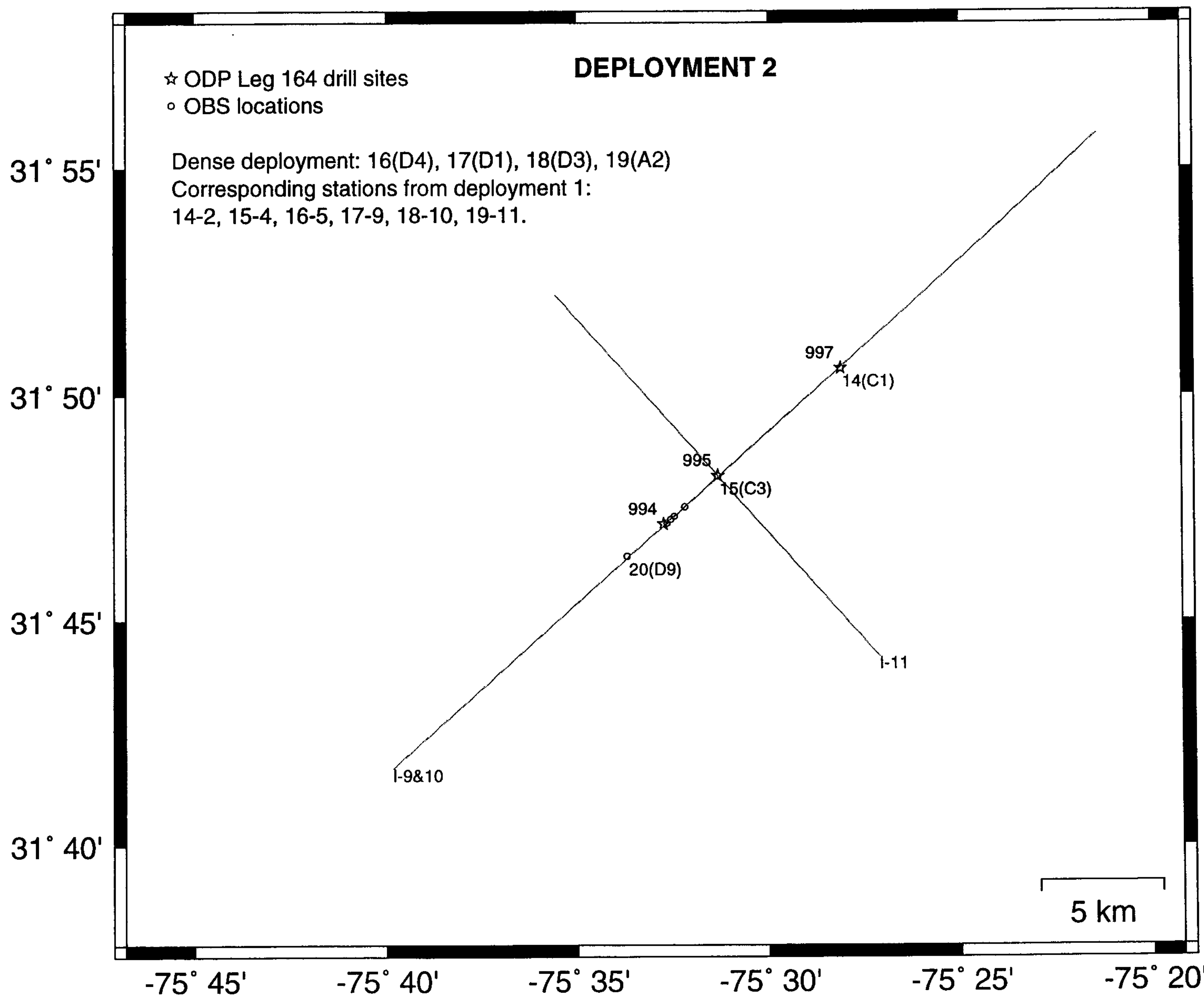


Fig. OBS-3. OBS deployment 2. 14-20: OBS stations (with instrument numbers). I-9-11: shooting profiles, I-9: SW->NE, I-10: NE->SW, I-11: label at BOL. All stations except 20 filled gaps from deployment 1.

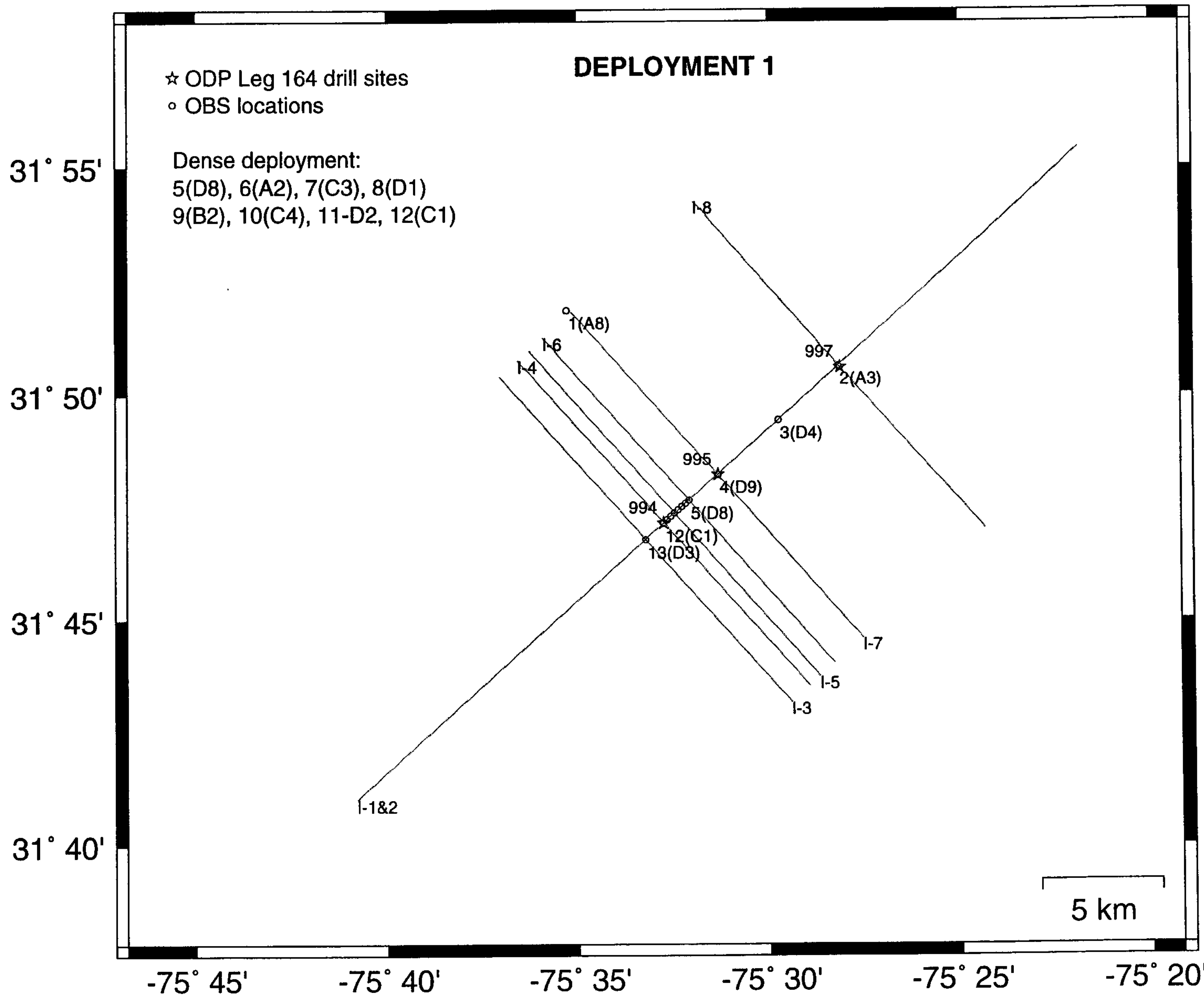


Fig. OBS-2. OBS deployment 1. 1-12: OBS stations (with instrument numbers). I-1-8: shooting profiles, I-1: SW->NE, I-2: NE->SW, other lines: labels at BOL. OBS 1 (A8) in the MCS 3D-box.