Scientific Report on Cruise NBP0607C
10 October to 23 October 2006
Lyttelton, New Zealand to Lyttelton, New Zealand

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CONTENTS

ABSTRACT

This report discusses the underway geophysical data acquired on a cruise leg from Lyttelton, New Zealand, to Lyttelton, New Zealand, between 10 and 23 October 2006 by the *R/VIB Nathaniel B. Palmer* (NBP0607C). We collected swath bathymetric data over more than 3800 km of track. Underway gravity was obtained along the whole cruise track, and magnetic data collected during much of the cruise. Bathy-2000 subbottom echo sounder data were also collected. Seismic reflection equipment was being tested during most of the cruise. Principal seismic lines obtained were: NZ-1 and NZ-2 using the reconditioned Teledyne 48-channel oil-filled streamer and 6 Bolt guns for a seismic source; NZ-3, NZ-4, and NZ-5 using the same streamer and 6 GI guns as a seismic source; NZ-6 using the 6 GI guns as a source and the old S/N Tech (solid) 48-channel streamer. As a cross-check of source performance parts of NZ-2 were duplicated on NZ-5. Several sets of sonobuoy data were collected. Funding was provided by the NSF OPP under grant OPP-0338317 to Stock and OPP-0338346 to S. Cande, UCSD.

KEYWORDS

NBP0607C, marine geophysics, swath bathymetry, magnetic, gravity, multichannel seismic, Hikurangi Plateau, Chatham Rise.

TABLE 1. NBP0607 CRUISE SCIENCE PARTICIPANTS

NAME	**ROLE**	**Institution**
Joann Stock	Chief Scientist	California Institute of Technology, Pasadena CA
Robert Clayton	Shipboard scientist	California Institute of Technology, Pasadena CA
Bryan Davy	Shipboard scientist	IGNS, New Zealand
Bruce Luyendyk	Shipboard scientist	University of California, Santa Barbara
Jon Rotzien	Watchstander, REU	Colorado College
Meredith Bush	Watchstander, REU	Colorado College
Irma Caraballo-Alvarez	Watchstander	University of Puerto Rico
Jeanette Hagan	Watchstander	UCSB
Chris Burt	Watchstander, REU	UCSB
Ashlee Henig	Watchstander, REU	UCSB
Ryan Wiedert	Watchstander, REU	UCSB
Andrew Poskaitis	Watchstander, REU	UCSB
Kathryn Lucas	Watchstander, REU	Pasadena City College
Natanya Black	Watchstander	UCLA
Michelle Stempel	Watchstander	California Institute of Technology, Pasadena CA
Daoyuan Sun	Watchstander	California Institute of Technology, Pasadena CA
Angel Ruiz Angulo	Watchstander	California Institute of Technology, Pasadena CA
Nathalie Vriend	Watchstander	California Institute of Technology, Pasadena CA

The above members of the science party conducted the geophysical watch and marine mammal watch during the time of data logging for cruise NBP0607C. Paper (carbon) copies of geophysical watch logs were filled out every 15 minutes with relevant data values. Events at other times were noted as needed. An electronic version of the watchstander's log was also maintained. This electronic version was saved as a Microsoft Excel spreadsheet file which is included as an electronic document on the DVD of the cruise data distribution. Paper copies of the watchstander's logs are held by the PI (Stock) at Caltech and the Co-PI (Cande) at UCSD.

OTHER PARTICIPANTS

We were ably assisted by the following personnel of Raytheon Polar Services Corporation: Jesse Doren, Marine Projects Coordinator; Kathleen Gavahan, swath bathymetry and IT support; Jim Dolan, vessel IT manager; Chris Linden, network administrator and IT support; Sheldon Blackman, Kathy Blackman, Valerie Park, Walter Gallagher, Dan Elsberg, and Victor Shen, Electronics Technicians; Bruce Felix, ET supervisor; Meghan King, Greg Buikema, Josef Kuehnast, Jeremy Lucke, Andrew McKee, Justin Smith, and Stian Alessandrini**,** Marine Technicians; Jenny White, MT supervisor; Tim Bjokne, Tech Writer; Mark Pomeroy, Lab

Supervisor. We thank Captain Michael Watson, Engineer Dave Munroe, and the mates and crew of Edison Chouest Offshore for their support during the cruise.

SUPPORTING AWARDS

The cruise was supported by the following grants from the US National Science Foundation, Division of Polar Programs: OPP-0338317 to J. Stock of the California Institute of Technology; OPP-0338346 to S. Cande of Scripps Institution of Oceanography. Additional funding for the Caltech participants was provided by Caltech.

SECTION 1: DAILY ACTIVITY SUMMARY

GMT Day	Day of Year	Cumulative distance (km) of logged data	Data Collection Activities and Findings (For class activities see section 7)
WEEK 1			
10 October	283	479	Departed from the dock at Lyttelton at about 10 a.m local time. Began transit, swath mapping and Bathy2000 echo-sounder after exiting Lyttelton Harbour. Started data logging 16:00 local time.
11 October	284	846	Transit NE, swath mapping and echo sounder. Deployed magnetometer.
12 October	285	1033	Airguns and streamer deployed in the a.m. Performed marine mammal check and ramp-up. Began shooting multichannel seismic data "Line NZ1" at 0217 GMT (3:17 p.m. local time). Magnetometer was out of the water at certain times due to instrument deployments.
13 October	286	1230	Took Bolt guns out of the water at about 8 a.m. local time (19:15 GMT on Oct. 12) because the 3rd gun was apparently not firing. Guns were rebuilt and put back in the water at 5:30 p.m. Local time. Continued on seismic line NZ2 at 04:30 a.m. GMT (5:30 p.m. local time). Sonobuoy launched at 23:15 GMT.
14 October	287	1421	Continued seismic line NZ2 until we lost 2 of the Bolt guns. At this time we decided to pull the Bolt guns and replace them with the GI guns. Sonobuoy launched at 05:38 GMT (16:38 p.m. local time). Stopped seismic line 2 at 06:54 GMT or 19:54 local time.
15 Oct.	288	1628	Started seismic line 3 at 00:30 GMT time (13:30 local time). The name of this line was incorrectly listed as 101 in the Oyo files.
16 Oct.	289	1846	We continued to shoot seismics all day along line NZ-3 with the GI guns. Switched to seismic line NZ- 4 at 08:00 GMT (9 p.m. local).
WEEK 2			
17 Oct	290	2055	Continued collecting seismic line NZ-4.
18 Oct	291	2353	Rough weather, end line 4; transited over to where we would start seismic line NZ-5.
19 Oct	292	2715	Started collecting seismic line NZ-5 over the same line as NZ-2 in order to compare the performance of the GI guns and the Bolt guns.
20 Oct	293	3075	Finished line NZ-5. Proceeded to calmer water near Chatham Island to transfer the old seismic streamer from the helo deck to the main back deck, using a crane.
21 Oct	294	3467	Conducted a test of the old multichannel streamer (line NZ-6).
22 Oct	295	3858	Conducted a short swathmap survey at ca. 500 meters water depth on the N side of the Chatham Rise. Tested the DataSonics deep tow sidescan sonar instrument.
23 Oct	296		Transit to port of Lyttelton. Swathmap survey along the track and to survey a canyon that is tributary to the Hikurangi Channel.

Figure 1. *Final track of cruise NBP0607 in black. Colored background is satellite gravity data (Sandwell and Smith, 1997). Blue line is the limit of the New Zealand EEZ.*

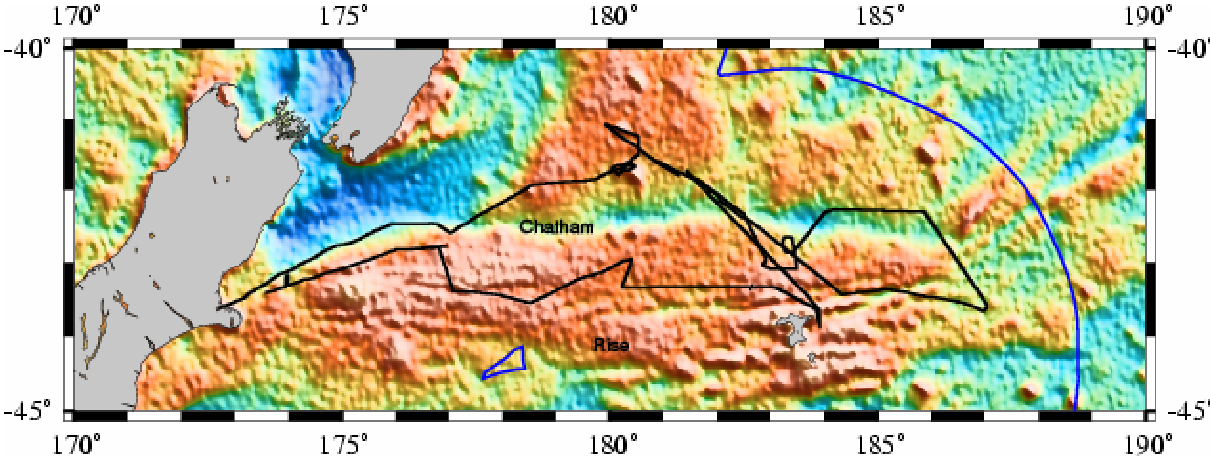
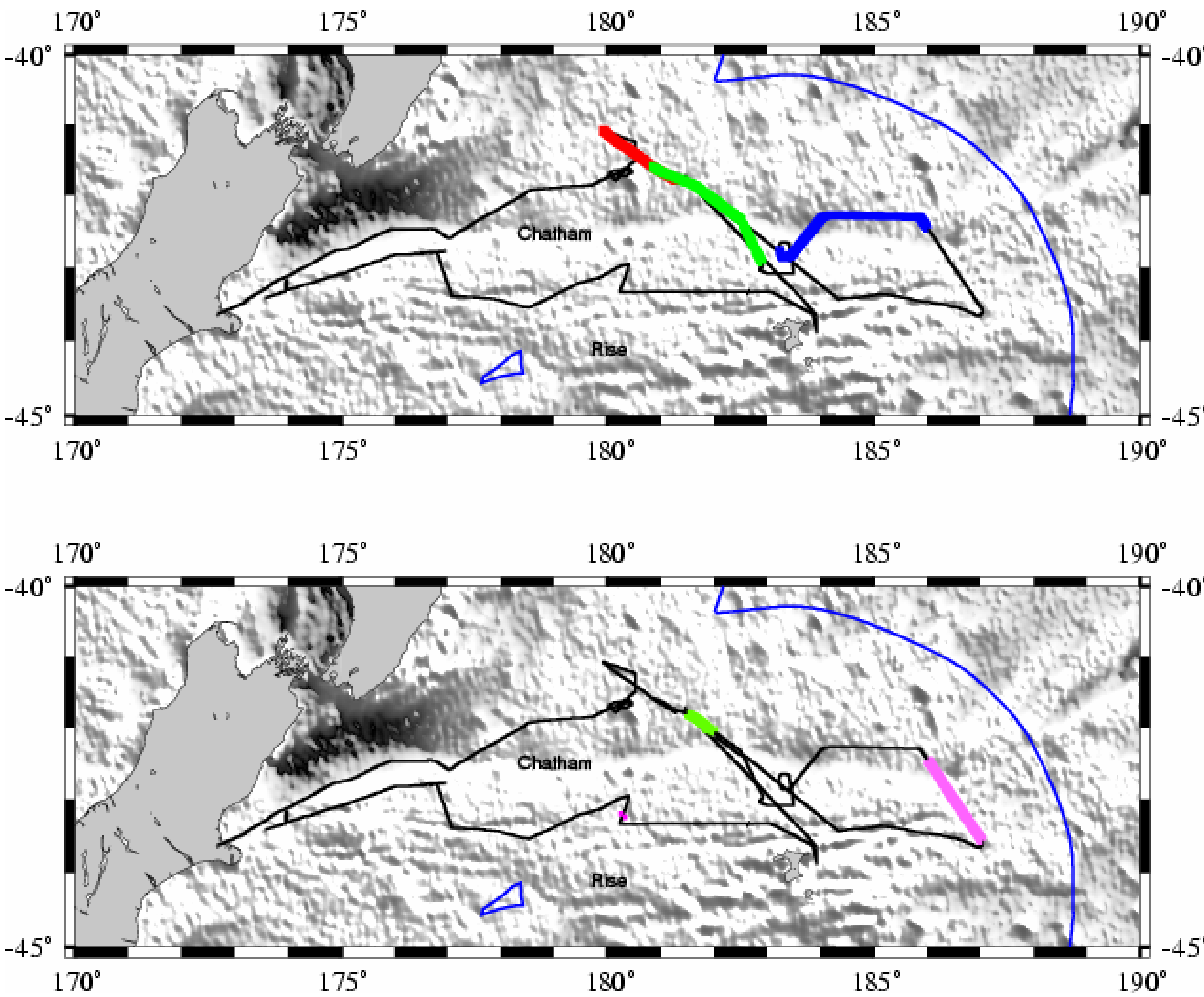


Figure 2. Seismic lines recorded during NBP0607C. Top panel: red = line 1, green = line 2, blue = line 3. Bottom panel: pink = line 4, green = line 5, purple = line 6.



SECTION 2: WEEKLY CRUISE REPORTS

Weekly science summary – NBP0607C – Oct. 10-16, 2006

The G-071-N science party embarked on Monday, October 9 at lunch time. A gravity tie was done on the afternoon of October 9th. The ship departed Lyttelton at 10 a.m. on October 10th. Since that time, we have been testing equipment and surveying in New Zealand waters, on the north side of the Chatham Rise and on the adjacent Hikurangi Plateau.

Seismics. This cruise is primarily a seismic test cruise in preparation for the NBP0701 cruise. We deployed the 48-channel oil-filled streamer and the Bolt guns on October 12th. The streamer has performed well, with no major problems. The streamer birds (leveling devices attached to the streamer) are keeping it at a depth of 30 feet (10 meters) at ship speeds of 4.5 to 5 knots.

We deployed an array of 6 Bolt guns as a seismic source. This ran for about 20 hours (seismic line NZ-1), by which time 2 of the guns had failed, so they were all retrieved on deck and fixed. They were redeployed on Oct 13th and data collection continued (seismic line NZ-2). After about 24 hours we had additional Bolt gun failures so they were retrieved and we determined that this phase of the testing had been completed. Our next phase of testing involved using a 6-gun array of Generator-Injector (GI) guns. In order to switch to these other guns, considerable work had to be done in terms of swapping out electronics boards and re-programming the gun control unit (Syntron). This was completed and the GI guns were deployed on the afternoon of October 15th. We then began recording seismic lines NZ-3 and NZ-4. The data quality on all four of these lines has been very good. The shot pulse (blast phone) recording on the Syntron was only partially operable; less so for the GI than the Bolt guns, pointing to a need to check and rewire the gun umbilical.

Sonobuoys. We have been deploying OMNI sonobuoys as needed during the ramp-up process of firing the Bolt guns and the GI guns. These are used to listen for marine mammals in the vicinity of the ship. We tried to deploy the lower-frequency DiFar sonobuoys for constraining seismic wave speeds but we had 6 failures of these in a row, so we have not been trying to use them further. We deployed a few of them in a water tank in the aquarium room (to determine the cause of the persistent failures) and they would not even deploy correctly in a seawater tank on board. It appears that the internal sealants are so brittle that they crack and the water floods the electronics. Therefore we have been using the OMNIs for recording of seismic wave speeds. Because of the extremely high failure rate of the DiFars we don't think these will be at all useful on the upcoming NBP0701 cruise.

Of the sonobuoys successfully deployed, a significant fraction is believed to be killed following snagging on the streamer, which is often difficult to avoid.

Magnetics. The new SeaSpy magnetometer has been performing very well. We have had it deployed intermittently during this cruise. During streamer deployment and recovery operations the magnetometer has been brought in on deck. There have been occasional rare spikes in the data, possibly due to contact with the streamer when the ship is turning.

Bathymetry: Depth values from both the Simrad EM 120 and the Bathy2000 were generally good because the seas were relatively calm through October 16th. Our science party (18 people) has been doing the ping editing. Kathleen Gavahan of RPSC has been doing the quality checks on the ping editing and processing the daily multibeam data files. XBTs have been launched generally once per day.

Gravity: There are some spikes in the gravity that seem to be caused by abrupt or excessive ship motions (i.e. waves hitting the ship or rolls of 11 degrees). We have gone to check on the gravimeter regularly and it seems to be behaving normally inside the gyro-stabilized frame. A problem with the calibration constants for the G 807 land meter was discovered and a current calibration sheet was obtained from LaCoste and Romberg.

Class activities: We have 14 student participants on board taking a marine geophysics class: 7 undergraduates and 7 grad students. The students are taking turns doing watch standing and ping editing data files, and doing marine mammal watch. We have had formal class meetings 1 hour per day.

Other issues: RPSC and ECO personnel have been very helpful in all respects. Our science party is impressed with all of the help they have provided to us, in support of our science. We are especially appreciative of the Raytheon personnel taking over the geophysics watch and the marine mammal watch for 1 hour per day so that our entire science party could attend the marine geophysics class.

MAJOR CONCERNS:

More sonobuoys (for both listening to marine mammals and for seismic data collection) will be needed for the NBP0701 cruise. It will be important to find some that do not have such a high failure rate.

The Bolt guns do not appear capable of running continuously for more than 24 hours at a time. When they are brought on board to be fixed, this entails many hours of down time. This will make it difficult to use them for the amount of seismic surveying that is planned for NBP0701. It may be that the GI guns can be used instead, but we still have to determine this. We will be running a comparison of the GIs and the Bolts by re-shooting part of line NZ-2 or NZ-1 with the GI guns as soon as it is feasible. If the data quality is not comparable, then a different towing configuration of the Bolt guns may be needed (some kind of solid hanger so that they do not get thrashed around so much in the water).

The wiring in the gun umbilical needs to be checked out and repaired.

We also recommend looking at the number of RPSC Marine Technicians who are expected to deploy for NBP0701. Given the amount of work that the Bolt guns entail, extra MTs may be needed in order to have reasonable turn-around times on fixing the equipment.

MINOR CONCERNS

The photocopy machine in the forward dry lab does not work and needs to be replaced. Non-skid tabletop rubber mats are in short supply, and more need to be purchased and made available in the science labs.

Respectfully submitted by

Joann M. Stock
Chief Scientist, NBP0607

Weekly and final science summary – NBP0607C – Oct. 17-23, 2006

The G-071-N science party continued testing seismic equipment this week, in New Zealand waters, on the Chatham Rise and on the adjacent Hikurangi Plateau. We closed out the data logging at 1 p.m. local time (2400 GMT) on Monday, Oct. 23, and came in to port in Lyttelton around 5 p.m. the same day.

Weather. We had rough weather on Oct. 17th (over 50 knot winds and 15-20 foot seas at times), which produced noisy gravity data and extremely poor quality multibeam data. We lost some time because we could only go 5 knots for a while when we were towing the streamer, and the back deck conditions were such that it could not be retrieved safely from the water until the weather improved.

Seismics. On October 19th we ran seismic line NZ-5 over a portion of last week's seismic line NZ-2. Seismic line NZ-2 had been collected using the Bolt guns, and seismic line NZ-5 was collected using the GI guns. Both lines were collected using the oil-filled streamer. The purpose of running seismic line NZ-5 was to compare the quality of the data obtained using the two different sources. Our comparison showed that although the GI guns (6 x 210 cubic inches) give a good signal, the penetration is not as good as that achieved with the Bolt guns. We tested the old, solid MCS streamer on seismic line NZ-6 on the Chatham Rise, using the GI guns as a source. This test showed that of the 48 streamer channels, 18 were either noisy or very weak. The oil-filled streamer is clearly much better than this old solid streamer although the old solid streamer could be kept as a backup since it would still be better than using a single-channel streamer.

Sonobuoys. We completed one more successful seismic sonobuoy (sonobuoy #3) on seismic line NZ-5. We also attempted to collect seismic sonobuoy data at the start of seismic line NZ-6 but two launches of sonobuoys were unsuccessful so we did not try to deploy any more.

Magnetics. We collected additional magnetic anomaly data over the Chatham Rise at times when it did not interfere with the streamer or airgun deployments. Some small positive anomalies were seen in regions of flat bathymetry. These may be due to intrusions or dikes below the sedimentary cover. The magnetometer lost power twice due to a Ground Fault Interruption that was caused by other electrical machinery on an adjacent outlet.

The magnetometer data showed more noise in rough sea conditions. There were occasional negative spikes in the data that did not correlate with excursions in the gravity data. We do not know the cause of the noise or the spikes. We speculate that the spikes could be due to the magnetometer hitting the streamer, something to do with stretch along the cable, or an abrupt and temporary change in the relative position of the magnetometer and the ship (i.e. a change in the ship effect).

The variation in total magnetic field strength during our survey was small – 54000 to 57400 nT -- because we were surveying in a fairly small region. Thus, we did not run into any difficulty with the tuning circuit on the magnetometer on this cruise (even though it had been an issue for the previous cruise).

Bathymetry: Multibeam data quality was variable because of the rough seas. We continued to launch XBTs generally once per day.

Gravity: There were a few more spikes in the gravity data due to rough seas, particularly on October 17th when the weather was the worst.

Sidescan sonar: On Oct. 22 the MTs and ETs tested the Datasonics deep-towed sidescan sonar. It was towed at 4-5 knots and kept about 70 m off the bottom in about 500 m of water on the Chatham Rise. The instrument appeared to work properly, but it was surveying over a very featureless piece of seafloor so there were not really any geological features visible in the data. The subbottom profiler data seemed noisy and had some mystery echoes that could have been complex multiples.

Class activities: We continued to have formal class meetings 1 hour per day.

Other issues: RPSC and ECO personnel have been very helpful in all respects. Our science party is impressed with all of the help they have provided to us, in support of our science. We are especially appreciative of the Raytheon personnel taking over the geophysics watch and the marine mammal watch for 1 hour per day so that our entire science party could attend the marine geophysics class.

MAJOR CONCERNS:

The comparison of the GIs and the Bolts showed that the Bolt guns get better penetration. Thus, a different towing configuration of the Bolt guns may be needed so that they can run for longer than 1 day at a time (some kind of solid hanger so that they do not get thrashed around so much in the water during towing).

The Syntron gun controller still does not work entirely correctly. This is thought to be due to damaged wires near the deck lead. RPSC personnel plan to repair these during the port call.

Both of the SeaSpy magnetometers still need to be fixed by the manufacturer. Although we had no problems with the magnetometers on this cruise, they will be used again on cruise NBP0701, where much larger magnetic field variations are expected (from 55,000 to 66,000 nT as the ship goes from Lyttelton down to the Ross Sea). This much field variation during the cruise will require the instruments to be frequently re-tuned. If the tuning circuit fails (as happened on the NBP0607A cruise) then with the present configuration of the instrument, the ETs have to take the electronics module apart and work on the circuit boards (putting in jumpers and re-tuning the instrument manually with an oscilloscope connected to it, delicate work which takes time and can only be performed if the seas are calm). Apparently the manufacturer will replace this circuit with something else that would reduce or prevent the failures from occurring. Because of concerns with turn around time at the manufacturer, and the less than two month lead time before NBP0701 sails, we recommend that one of the magnetometers be sent back to the manufacturer ASAP so that it can come back in time for NBP0701 and be used as the main magnetometer for that cruise. The other magnetometer should not be sent back at this time, just so there will be one on board in case the first instrument does not come back in time for the NBP0701 cruise.

MINOR CONCERNS:

It would be useful to have a more powerful launcher to send the sonobuoys farther from the ship so that they are less likely to fail by hitting the equipment being towed.

Respectfully submitted by

Joann M. Stock
Chief Scientist, NBP0607C

SECTION 3: Multibeam surveys

Multibeam swath data were collected from 09 October 2006 (GMT) through 22 October 2006 (GMT). The cruise data distribution included data collected through the end of GMT day 295; however, the data from this final day were not ping edited. The raw multibeam data were logged in approximately one hour-long files in the Kongsberg-Simrad EM120 raw format that includes all navigation and ship motion data. The MB-System software package[1] (version 5.0.7) was used onboard for editing and processing of the raw data. The science participants ping edited to remove bad data points from these files. The details of data processing and archiving are described in a separate Multibeam Data Report for the cruise.

We ran the multibeam system continuously during this cruise. However, there were a few instances of useless data due to bad weather and excessive ship motions. Data collection at “full” speed, generally ~ 10 kts, worked well if there were not too many high winds. If we got bad data the beam width would need to be narrowed to 30˚ so that the multibeam system could then re-find the bottom and the beams could then be brought back out to 56 or 60˚. The maximum angle is 75º but we normally never got returns from the outer beams at this setting, so generally we used something smaller – 65º or less. We shot XBTs (normally T-5s but some T-7s) once per day in order to constrain the sound velocity profile used to process the multibeam data. The list of XBT measurements is included in a table in the final cruise Multibeam data report.

SECTION 4: SEISMIC REPORT

The main objective of the NBP0607C cruise was to test the new oil-filled multichannel streamer and Bolt guns and compare the results with surveys using the same streamer with GI guns. xx km of multichannel seismic data were collected during the survey.

4.1 Source and streamer configuration

The Bolt gun array (850, 500, 350, 200, 145, and 80 in^3 airguns) was towed linearly with 4 m separation and at a distance of 35 m (closest gun) behind the ship. The GI guns were towed in this same configuration (6 GI guns, 210 in^3 each). The Teledyne oil-filled multi-channel streamer was a 48 channel passive streamer with 12 sections of 100 meters and 4 hydrophone groups each. The oil-filled multi-channel streamer was towed at 30 ft below the surface (using 12 I/O Digicourse 5100 series birds). The solid multichannel streamer, which consisted of eight 150-m sections with 8 hydrophone groups each, was towed at 30 feet (10 meter) water depth using 8 of the birds. The oil-filled streamer was towed with channel 1 closest to the ship and a 175-m lead-in initially (for seismic lines NZ1 and NZ2) which was shortened to 150 m lead-in for lines NZ3 to NZ5. Figures A1 and A2 were provided by RPSC employee Tim Bjokne to illustrate the

[1] The MB-System 5.0.7 software package was used for all multibeam data handling. To obtain more information about the MB-System programs or to obtain a copy of the current distribution, contact the authors David W. Caress (caress@mbari.org) and Dale N. Chayes (dale@lamont.Ideo.columbia.edu).

streamer and gun configurations used.

4.2. Software and seismic data recording

Seismic data were initially recorded on an OYO DAS-1 48 channel recorder with two Fujitsu 3490E SCSI drives. A 10 megabit Ethernet connection to a PC shared disk transfers a shot gather, via serial output, at the end of each record and tape I/O sequence. After about a day we decided to record the data only to the hard disk and not actually to the tapes.

Elics DelphSeismic software receives data in real time from the OYO and translates SEG-2 format data to SEGY, with time and navigation stamps placed into the SEGY headers, in addition to line name and shot number from the Syntron. The key to a successful translation of the SEG-2 data is the synchronization of Syntron shot number and OYO record number. The closest navigation point from the primary NMEA GPS source (Simrad Seatex Seapath 200), to the time stamp is applied to the data. The data are also displayed in real time on the Windows screen. A single channel was plotted on two EPC paper recorders; in the case of the multi-channel seismic (MCS) data this was either channel 12 or channel 1. Watchstanders annotated these EPC records every hour. One set of the paper charts was taken to Caltech after the cruise and the other set was taken to UC Santa Barbara.

870 km of multichannel seismic data were collected during NBP0607C. For all of these lines, 8 sec of data were recorded at 2 ms sample rate with a shot firing interval of 12 s and a ship speed of 4.5-5.0 knots (nominal CDP fold of 24). We found that a 12 second firing rate allowed the Bolt guns to cycle to full pressure (2000 psi) and allowed the OYO and Elics systems to write the data. A faster cycling rate was tested but could not be maintained with the 8 second records.

Seismic Line & length	Start lat/long	End lat/long	Start day / time	End day/ time	Streamer	Guns
1 151 km	-41.40751, -179.98904	-41.76529, -178.74723	285/ 02:57:05	285/ 20:34:06	Oil-filled	Bolt
2 237 km	-41.5891, -179.12826	-42.94831, -177.09023	286/ 04:16:22	287/ 06:55:22	Oil-filled	Bolt
3 281 km	-42.70628 -176.77219	-42.46044 -173.98719	288/ 00:21:48	289/ 07:53:53	Oil-filled	GI
4 148 km	-42.47048 -173.97843	-43.56834 -172.96310	289/ 08:01:47	290/ 01:00:18	Oil-filled	GI
5 50 km	-42.05549 -177.99969	-41.81620 -178.50616	291/ 21:28:08	292/ 03:31:55	Oil-filled	GI
6 3 km	-43.22953 -179.71541	-43.20191 -179.70100	293/ 21:50:50	293/ 22:19:50	Solid core	GI

Table 2. Seismic reflection data collected during NBP0607C. See Figure 2 for locations of lines.

4.3 Comparison of GI guns and Bolt guns

One of our objectives during this cruise was also to evaluate and compare the penetration of the GI guns and the Bolt gun array. We ran a comparison test of the penetration by returning to line NZ-2 (which had been run with the Bolt guns) and re-surveying it in the opposite direction with the GI guns. This survey with the GI guns was labelled seismic line NZ-5 (see table 2, above, and Figure 2).

The comparison was run along a part of line NZ-2 where the two-way travel time (TWTT) to the seafloor was approximately 3.3 seconds (Figures 4.3a, 4.3b). The weather conditions were slightly worse during line NZ-5 than during line NZ-2. To remove the wave noise, data from line NZ-5 were filtered, in order to facilitate comparison with the results of line NZ-2.

The strata visible in the seismic section comprised transparent sediments near the seafloor, with large-scale slightly wavy bedding below, down to a TWTT of 0.6 seconds below the seafloor. A set of strong reflectors at 0.7-0.8 sec subbottom time overlies a bedded sequence with some transparent layers, down to a strong reflector at 1.6 seconds subbottom time. This strong reflector was seen on both line NZ-2 and line NZ-5, and is believed to represent the top of "basement" or at least of a thick volcaniclastic section. This strong reflector has 0.5 sec TWTT of relief in the time section and is seen more clearly on line NZ-2. Below this strong reflector, reflections were generally incoherent, except for a set of reflectors at 2.7-3.0 seconds subbottom time, which are seen in line NZ-2 but not in line NZ-5, and are described next.

Line NZ-2 has greater penetration than line NZ-5. On line NZ-2, in which the Bolt guns were being used, an irregular reflector within the basement can be seen at about 3 seconds subbottom time. (From comparison with some proprietary New Zealand seismic lines, it appears that this reflector represents the top of the basement of the Hikurangi Plateau, which was subducted beneath the continental crust of the Chatham Rise during Cretaceous time.) This reflector could not be seen in line NZ-5, when the GI guns were used. (See figures immediately below).

Unfortunately the seafloor multiple shows up in the section just below 6.5 sec TWTT (~3.25 sec subbottom) and thus we cannot assess penetration of the signal from the Bolt guns below this depth. It seems likely that the actual penetration of the Bolt guns will vary according to the composition of the layered sedimentary rocks or the volcanic rocks that are present in the section. In the region of our survey there were no appropriate deep basins in which to test the streamer penetration.

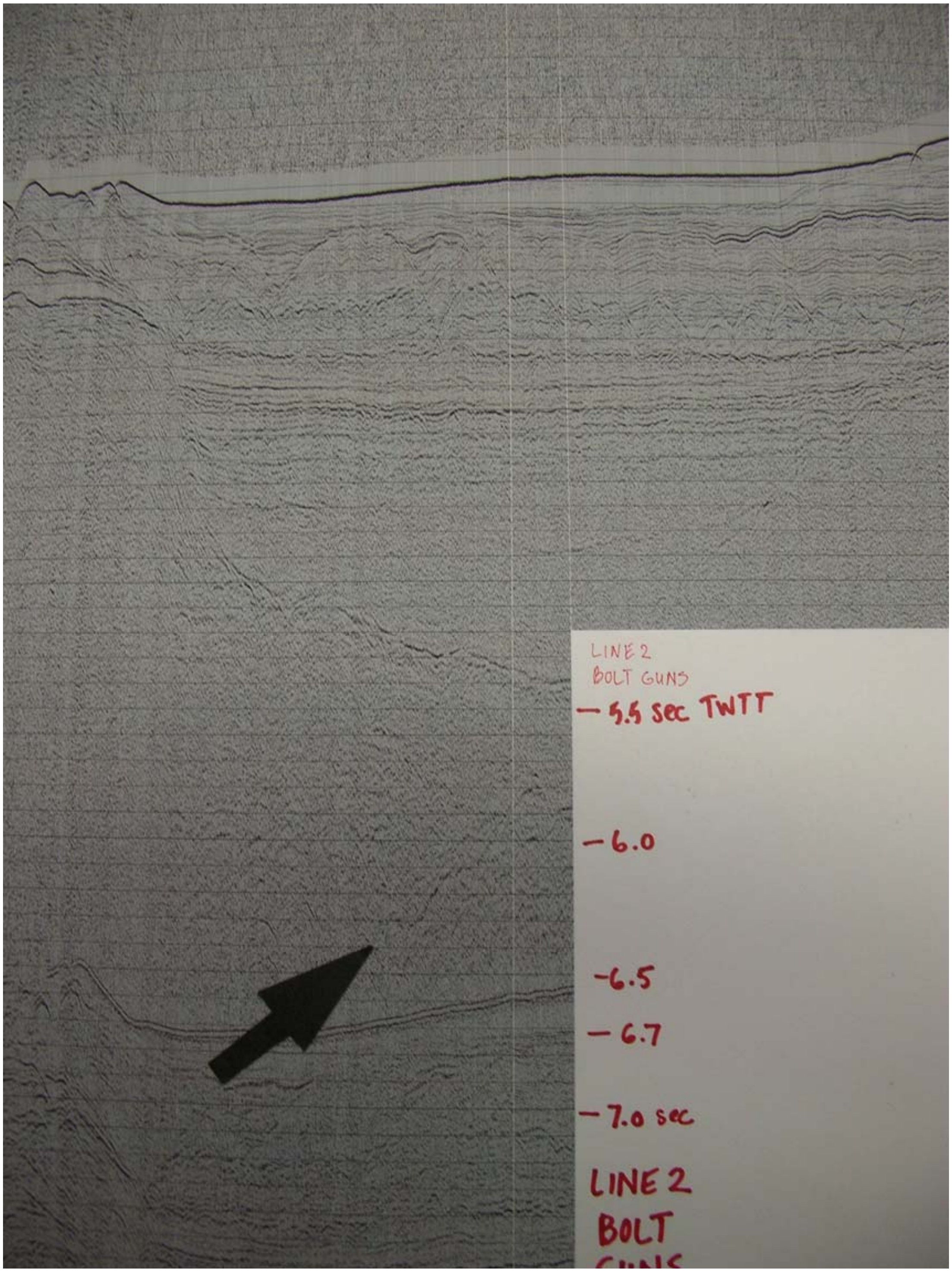


Figure 3. Seismic section from Line NZ-2 (Bolt gun array), shot from west to east, showing an irregularly dipping reflector at about 6.3 seconds total TWTT (about 3 seconds subbottom time). The strong set of reflectors below 6.4 seconds is the seabottom multiple. Note top of "basement" at less than 5.5 sec TWTT.

Figure 4. Photograph of a portion of seismic line NZ-5, showing the same survey area as in figure 4.3, but shot in the opposite direction (E to W). The reflector at 5.3-5.5 sec is the top of the volcanic basement. Thin black lines are at 0.1 sec intervals of TWTT. Note distortion of the right side of the photo.

4.4. Sonobuoys

We launched OMNI sonobuoys each time we had to ramp up the use of the seismic sources (Bolt Guns or GI guns). These were used to listen for marine mammals as part of the marine mammal mitigation efforts. In addition, 3 seismic sonobuoys were successfully deployed (Table 2). Sonobuoy data were recorded on auxiliary channel 1 or 2 as well as being displayed on an EPC paper recorder. Sonobuoy types were DiFars (range 0-2.5 KHz) and Omnis (range 0-20 KHz, for listening to marine mammals). The estimated success rate of the Omnis was >60% and the success rate of the DiFars was zero. It was later determined that our sonobuoy radio antenna did not have the right characteristics to properly hear the signal from the DiFars.

Sonobuoy #	Latitude	Longitude	Day & time	Seismic line	duration
1	-42.85494	-177.15375	287/ 05:38:34	2	Shot point 7717 + 1200 shots (> 4 hours)
2	-42.47197	-175.73377	288/ 15:16:41	3	S.P. 4181 + 1200 shots
3	-42.05549	-177.99969	291/ 21:28:08	5	Approx 30 minutes (?)

Table 3. Sonobuoys deployed for control on seismic velocities, NBP0607C cruise.

Students Michelle Stempel and Nathalie Vriend analysed the longest active sonobuoys. The results were as follows;

Sonobuoy 1: layered structure with apparent velocities of 1495 m/sec, 2500 m/sec, 3250 m/sec, 4800 m/sec, and 7500 m/sec. The inferred depth to the fastest layer was about 3.8 km below the sea surface.

Sonobuoy 2: layered structure with apparent velocities of 1495 m/s, 1700 m/s, 2400 m/s, 4000 m/s, 4800 m/s and 6500 m/s. The top of the 6500 m/sec layer is at a depth of about 7 km below the sea surface.

SECTION 5 BATHY2000 ECHOSOUNDER DATA

Continuous Bathy2000 chirp data (3.5 kHz) were recorded during NBP0607C. In addition to paper records the instrument also collected SEGY data. Performance was good with minimal signal loss in bad weather.

A conversion factor of 1500 m/sec was used throughout the cruise as the sound speed in water, to convert from two-way travel time to depth. Bathy2000 data were also plotted in real time on an EPC recorder.

SECTION 6: MAGNETIC AND GRAVITY DATA

6.1 Magnetics Data

A Marine Magnetics SeaSpy Marine magnetometer was deployed on Oct. 10 (see Table 3) in open seas. It was towed behind the ship at 300 meters distance from the stern and at a depth of 20 meters (at 5 kts ship speed). When it was deployed and run at full ship speed (10 kts) then it was at a depth of 8-7 m behind the ship. In higher seas it was retrieved and it was not towed for certain parts of the cruise over portions of Chatham Rise.

Instrument performance was good. In higher seas noise of a few nT was superimposed on the signal. The instrument was plugged into a ship's power GFI outlet that tripped twice during the survey.

Table 4. Magnetic Data Acquired on NBP0607

YEAR	Day	H	M	LONG	LAT	ON/ OFF	distance
2006	Oct 10	18	59	177.0263	-42.5961	ON	427 km
2006	Oct 11	19	23	180.5332	-41.3005	OFF	
2006	Oct 12	05	01	179.9823	-41.1189	ON	973 km
2006	Oct 17	00	59	187.0356	-43.5671	OFF	
2006	Oct 18	04	43	184.2733	-43.3966	ON	227 km
2006	Oct 18	18	58	182.0673	-42.1561	OFF	
2006	Oct 21	05	24	179.8254	-43.1427	ON	342 km
2006	Oct 22	00	57	176.3386	-42.8133	OFF	
2006	Oct 22	07	48	176.929	-42.7792	ON	239 km
2006	Oct 22	20	12	174.1051	-43.2846	OFF	

6.2 Gravity Data

Gravity was measured continuously during the cruise. The pre-cruise gravity tie was done at the botanical gardens in Christchurch on October 10, 2006. A final gravity tie was done in

Christchurch on October 25th. This showed a net drift of less than 0.2 mgals over the course of the cruise. This was considered small enough that the gravity data were not re-processed for drift. Details of the pre-cruise gravity base station ties are given in the NBP0607 Data Report (a separate document from this Science Report, included in the data distribution).

Initial QC was performed as part of daily data processing. The gravity data values showed some excursions in rough seas, due both to increased platform accelerations and also due to the gravimeter frame hitting the edge of the mounting system a few times and the instrument taking some time to adjust itself back to horizontal. Spurious spikes appear in the data set at times of turns and changes in ship speed. These are due to the method of applying the Eotvos correction in the gravity reduction software. They have not been edited out of the data set in order to maintain consistency with the data reduction protocols that have been used on previous Palmer cruises.

It should be noted that during this cruise, several errors were found in the way the gravity ties were being processed. Both errors had to do with the data from the portable Lacoste-Romberg land gravimeter. First, the correction factor (to change counts to mgals) was being used as a divisor instead of as a multiplication factor. Second, this factor should vary from place to place (since the spring constant changes depending on the absolute gravity). This required use of a table (specific to this particular gravimeter) to look up the correct factor for each location where a gravity tie was being conducted. However, there was no copy of the table on board the ship, so a constant value of this factor had been used for all previous gravity ties. A copy of this table was obtained, and the RPSC gravity tie procedures were modified to indicate the correct factor to be used at each of the major ports where the NBP typically does the gravity ties (Christchurch, Punta Arenas, McMurdo, etc).

SECTION 7: ACOUSTIC DOPPLER CURRENT PROFILER (ADCP) DATA

The Acoustic Doppler Current Profiler (ADCP) is a hull-mounted system on the *R/VIB Nathaniel B Palmer* that has been in place for several years. The transducers are RD Instruments narrowband VM-150 profilers 150 kHz, with precision (PPS, or P/Y-code) GPS navigation and with heading corrections provided by Ashtech ADU-2 GPS attitude sensors. This system provides continuous current profile measurements in the top 300 m of the ocean. Dr. Teresa Chereskin at Scripps Institution of Oceanography (http://tryfan.ucsd.edu/antarctic/antarctic.htm) and Dr. Eric Firing at University of Hawaii are funded by the NSF OPP to oversee the operation of the *Palmer* ADCP systems under grants OPP-0338103 and OPP-0337375, respectively.

At sea, data are collected by a DOS PC, and are serially captured by another computer running Linux. Data streams logged by the Linux machine include the standard 5-minute ensembles ("pingdata"), and roughly one-second gyro heading, Ashtech heading, P-code position, speed of sound, and single-ping ADCP data. The Linux computer processes the five-minute ensemble data every day, creating a regularly updated, pre-processed and edited dataset. Processed data onboard are displayed as a series of vector plots and archived by the NODC JASADCP. These plots are included in the cruise data distribution and are not repeated here.

SECTION 8 CLASS ACTIVITIES

As part of this cruise we had 14 students taking a marine geophysics class. The class met for 1 hour per day. The class was taught by Stock, Clayton, and Luyendyk. Bryan Davy also participated in the class. The class was offered as Ge211, Advanced Field Geophysics, through Caltech or as GE181 through University of California, Santa Barbara. Students from Colorado College who took the course were able to arrange for equivalent credits for the experience through their home institution. The student participants are listed as “watchstanders” in Table 1, with REU next to the undergraduate names. Those not listed as REU students are graduate students.

In addition to 1 hour daily of class meetings, the students did watchstanding (geophysics watch daily, and marine mammal watch as needed), ping editing of bathymetry data files, and homework. Before departure, students participated in a gravity tie exercise at the pier and determined drift corrections. Students were required to each do one 15-minute class presentation on an assigned topic related to the geology or oceanography of the region being surveyed. These presentations and the reading list were assigned in advance so that the students prepared the presentations at their home institutions prior to the start of the cruise. The professors gave lectures (see schedule below). All Caltech students were required to do a research project and submit a final paper on this topic for their grade in the class, at the end of the academic quarter. Depending on how many units the other students had signed up for, they were also expected to continue with research projects after the cruise ended.

Table 5. Class meeting activities listed by day.

Date	**Activity**	**Leader (student names in italics)**
Monday, Oct 9th	Arrive on ship Gravity tie	 Luyendyk & S. Blackman (RPSC)
	Information security & IT orientation	C. Linden (RPSC) & J. Dolan (RPSC)
	Ping editing orientation	K. Gavahan, RPSC
Tuesday Oct. 10th	Safety meeting	Chief Mate John Souza (ECO)
	Back deck orientation	Jenny White (RPSC)
	Geophysics watchstanding orientation	Stock, Luyendyk, Clayton
	Marine mammal watchstanding orientation	Jesse Doren (RPSC)
Wednesday Oct. 11th	Cruise objectives, overview	Stock
	Hikurangi Plateau talk	Davy
	Student presentation	*Caraballo*
Thurs Oct. 12th	Gravity lecture	Luyendyk
Friday Oct. 13th	Reflection seismology lecture	Clayton
Sat. Oct. 14th	Refraction seismology lecture	Clayton
Sun Oct 15th	Sonar systems lecture	Stock
Mon Oct. 16th	Student presentations	*Wiedert, Burt, Black*
Tues Oct. 17th	Student presentations	*Stempel;Vriend;Bush*
Wed. Oct 18th	Mid-cruise data review	Stock, Luyendyk, Clayton, Davy
Thurs. Oct. 19th	Student presentation; Ocean circulation lecture	*Ruiz*; Stock
Friday Oct. 20	Student presentations; Magnetics lecture 1	*Lucas, Hagan*; Stock
Saturday Oct. 21	Student presentations	*Sun, Henig, Rotzien*
Sunday Oct. 22	Student presentations; Magnetics lecture II	*Poskaitis;* Stock

Monday Oct. 23	Final cruise data review	Stock, Luyendyk, Clayton, Davy
Tuesday Oct. 24	Lab clean-up, data archiving, students work on research projects	
Wed. Oct. 25th	Geology field trip (Quail Island, Lyttelton Harbour); depart ship	Stock

Table 6. Student Research Projects

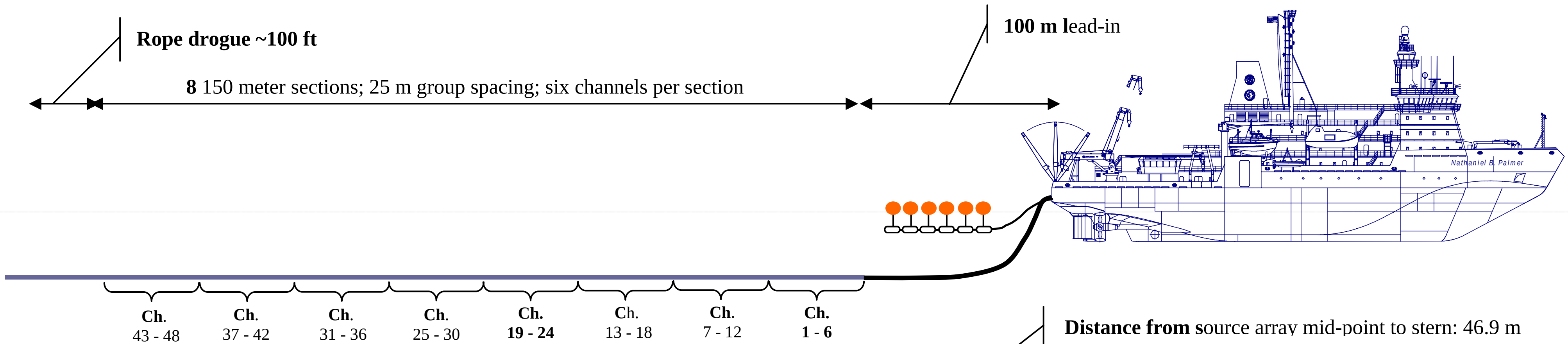
Student	***Institution***	***Topic***	***Data sets used***
Daoyuan Sun	Caltech	gravity modeling of Chatham Rise	This cruise and NGDC cruise data; satellite gravity data
Angel Ruiz Angulo	Caltech	interpretation of ocean temperature profiles and current data from ADCP and XBT measurements	This cruise and 10 previous NBP cruises in the Chatham Rise region
Michelle Stempel	Caltech	analyses of sonobuoy data	This cruise
Nathalie Vriend	Caltech	analyses of sonobuoy data	This cruise
Jon Rotzien	Colorado College	Seismic stratigraphic correlation of our seismic Line 3 (?) with nearby IODP drill hole	Seismic line NZ-3; unpublished, proprietary IGNS seismic data
Andrew Poskaitis	UCSB	Up the Chatham Rise NBP0607C: Lines 2 & 4	This cruise
Ashlee Henig	UCSB	plate reconstruction between Manihiki and Hikurangi	gravity and other data as constraints
Chris Burt	UCSB	map a region around the Emerald FZ that shows a change in	Multibeam, global bathymetry and satellite gravity data

		plate motions.	
Natanya Black	UCLA	Joint interpretation of marine gravity, bathymetry, seismic data Line NZ-3 (?)	

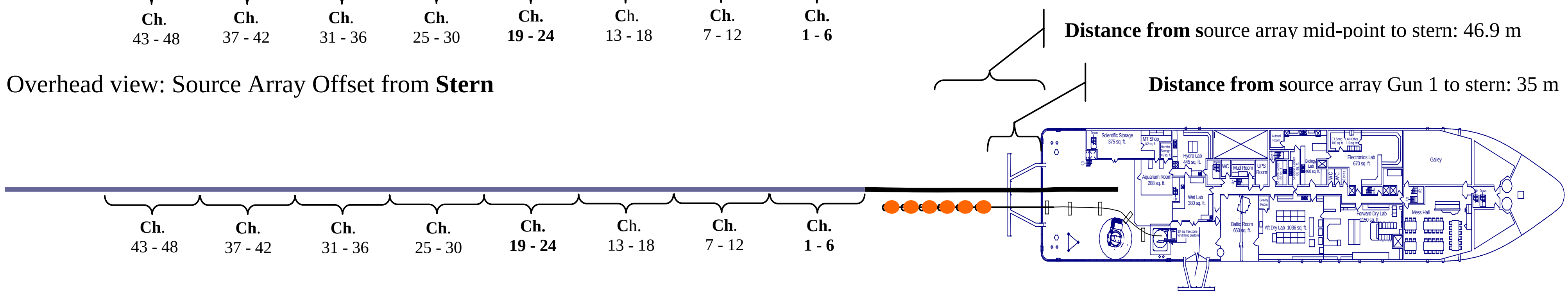
SECTION 9. REFERENCES

Sandwell, D. T., and Smith, W. F., 1997, Marine gravity anomaly from Geosat and ERS-1 satellite altimetry: *J. Geophys. Res.*, v. *102*, p. 10,039-10,054.

Profile View: **Multi-Channel Streamer Offset from Stern**

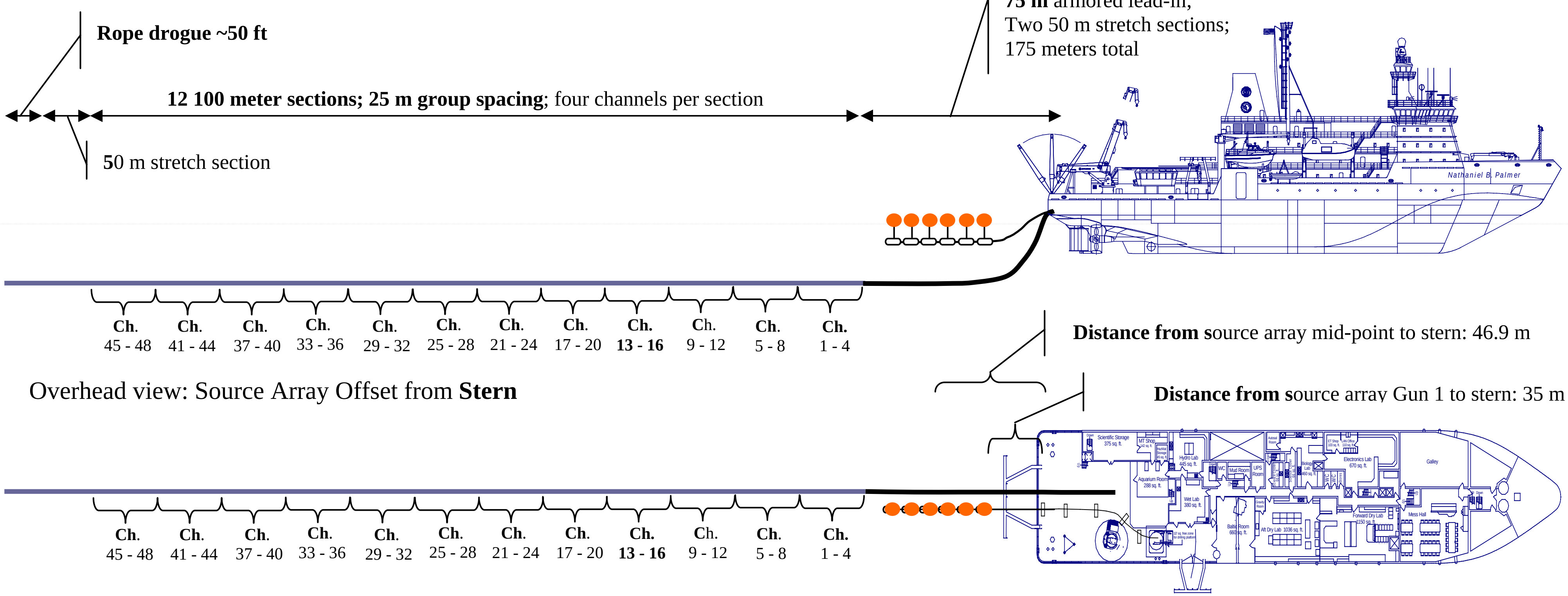


Overhead view: Source Array Offset from **Stern**



Cruise:	NBP06-07C	**Dates:**	10 October – 23 October 2006		
	Type	**Number of Guns**	**Gun Spacing (in meters)**	**Gun Array Offset from Centerline (nominal)**	**Streamer Offset from Centerline (nominal)**
Gun Array 1	G/I	6	0, 5.4, 9.9, 13.9, 17.3, 20.3	1.5 meters	
Gun Array 2	N/A	N/A	N/A	N/A	
Streamer	S/N Tech.				2.7 meters
Notes	A total of eight birds are used on the S/N Technologies streamer: one at the head of each active section.				

Profile View**: Multi-Channel Streamer Offset from Stern**



Cruise:	NBP06-07C	**Dates:**	10 October – 23 October 2006		
	Type	**Number of Guns**	**Gun Spacing (in meters)**	**Gun Array Offset from Centerline (nominal)**	**Streamer Offset from Centerline (nominal)**
Gun Array 1	BOLT	6	0, 5.4, 9.9, 13.9, 17.3, 20.3	1.5 meters	
Gun Array 2	G/I	6	0, 5.4, 9.9, 13.9, 17.3, 20.3	1.5 meters	
Streamer	Teledyne				2.7 meters
Notes	On the second deployment of the Teledyne streamer, only 50 meters of lead-in were deployed, for a total offset from the stern of 150 meters. A total of 12 birds are used on the Teledyne streamer: one at the head of each active section.				