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R/V Maurice Ewing

Data Reduction Summary

EW0001 – Lyttelton, NZ - Lyttelton, NZ

January 9, 2000 - January 29, 2000

Port Dates

Date	Julian	Time	Port
01/09	009	13:00 NZDT	Depart Lyttelton, NZ
01/29	029	09:00 NZDT	Arrive Lyttelton, NZ

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Project Summary

"Global and Local Controls on Depositional Cyclicity: the Canterbury Basin, New Zealand"

Dr. Craig S. Fulthorpe, University of Texas Institute for Geophysics (NSF OCE97-31031)

Objectives of this high-resolution MCS survey are:

1. Develop a more detailed sequence stratigraphic framework than has been possible with lower-resolution commercial MCS data currently available.

2. Map sequences across the new grid to document their three-dimensional geometries and identify depositional processes active during sequence development. Spatial and temporal changes in sequence geometry, which are related to changes in subsidence rate and sediment supply, are the keys to deconvolving eustasy from regional and local controls on sequence architecture.

3. Evaluate relative importance of controls by forward stratigraphic modeling.

4. Map the 3-D morphologies of the distinctive sediment drifts within the basin with a view to incorporating them within the sequence stratigraphic model.

5. Develop predictive models of lithology and facies by seismic facies analysis, in concert with existing outcrop and commercial well control.

6. High-resolution imaging of the Marshall Paraconformity, a regional surface thought to be associated with the postulated mid-Oligocene eustatic fall.

7. Provide high-resolution seismic ties to nearby exploration wells to improve existing age control.

8. Support a companion ODP drilling proposal (JOIDES Proposal No. 511). Such a high-resolution survey, in association with sidescan-sonar surveying and surficial piston coring, are essential prerequisites to ODP drilling, both by providing detailed stratigraphic characterization and by documenting the absence of shallow-gas hazards.

The survey involves acquisition of ~2120 km of seismic data during an 18-day cruise. The grid is located in the central part of the offshore Canterbury Basin, where clinoform sequences are best developed (along the transect of the proposed drill sites NZDB 01A-07A) and also where the most prominent sediment drifts are located (to the north of the primary transect, landward of site NZCB 09A). Dip line spacings are maintained at ~2 km, with even closer spacing along the drilling transect. Strike line spacing is more variable. R/V *Ewing*'s high-resolution MCS system has been demonstrated to have a vertical resolution of ~5 m. In contrast, the commercial seismic data on which existing Canterbury Basin interpretations are based have a vertical resolution of ~20 km with line spacings of ~5 km or more over much of the grid.

We will use R/V *Ewing*'s streamer with its hydrophones configured to 12.5 m group intervals and record 96 channels. Two 45/45 in^3 GI guns will be fired simultaneously to provide the necessary penetration (up to 1.7 seconds below seafloor is desireable).

Cruise Members

Ship Staff

Name	Position	Email
James O'Loughlin	Master	captain@ewing.ldeo.columbia.edu
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Science Party

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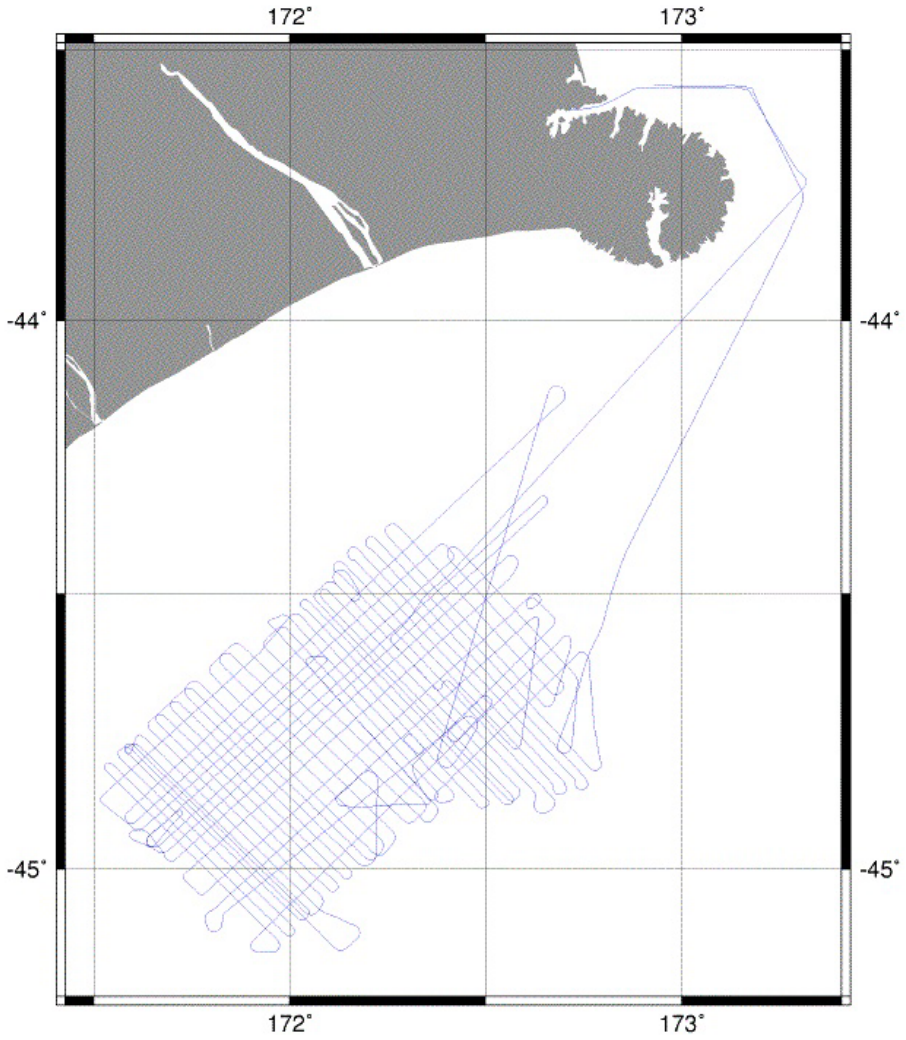
Track Map



Cruise Notes

Seismic Notes

There were a total of 317,101 survey shots from 009/10:09 to 028/06:21 .

Time	Shot	Comment
009/10:09	000001	start shooting
009/10:40	000312	stop shooting (fix guns)
009/12:32	000001	start shooting
009/14:23	001331	stop shooting (acquisition problem)
009/14:28	000001	start shooting
011/22:30	040348	stop shooting (modify array)
012/02:26	000001	start shooting
015/19:10	063884	stop shooting (acquisition problem)
015/19:20	000001	start shooting
015/21:52	001817	telemetry problems
015/22:43	002433	telemetry ok
018/10:06	045190	streamer retrieved
018/10:58	045813	streamer deployed
021/16:18	101387	telemetry problems
021/16:30	101530	telemetry ok
022/13:51	116901	stop shooting (acquisition problem)
022/14:06	000001	start shooting
022/22:31	006064	stop shooting (acquisition problem)
022/22:36	006100	start shooting
024/05:25	028296	stop shooting (rough seas)
024/10:31	028298	start shooting
027/21:31	088059	stop shooting (acquisition problem)
027/21:34	088053	start shooting
028/06:21	094368	stop shooting

Logging Notes

Instruments logged:

- Kinemetrics TrueTime GPS UTC time receiver
- Syntrak 480 multi-channel seismic system
- Furuno CI-30 doppler speed log w/ Sperry MK-27 gyro
- Trimble Tasman GPS receiver w/ Racal differential input
- Trimble NT200D GPS receiver w/ Racal differential input
- Bell BGM-3 gravimeter
- Krupp Atlas Hydrosweep–DS swath bathymetry
- Omega DP-10 sea temperature
- RM Young 26700 weather station

Data Instruments

Time Reference

The Kinemetrics Truetime UTC clock is logged at 60 second intervals. CPU time is synchronized every 60 seconds to this clock.

Date	Comment
009/10:09	Start Logging
028/20:04	Stop Logging

Speed and Heading

The Furuno CI-30 dual axis speed log and Sperry MK-27 gyro are logged at 3 second intervals.

Date	Comment
009/10:09	Start Logging
028/20:04	Stop Logging

GPS Receivers

gp1 = Trimble Tasman (w/differential starting day 015)
gp2 = Trimble NT200D (w/differential for entire cruise)

Both GPS receivers were logged at 10 second intervals. Navigation is processed and reduced to 60 second intervals, which is later applied to the gravity, magnetics, bathymetry, and seismic shot data. All data for this cruise was processed using the Trimble NT200D (gp2).

Date	Comment
009/10:09	Start Logging
015/03:07	Tasman upgraded to differential
028/20:04	Stop Logging

Gravimeter

The Bell BGM-3 gravimeter is logged at 1 second intervals.

Date	Comment
009/10:09	Start Logging
028/20:04	Stop Logging

Magnetometer

The Geometrics G-886 Marine Magnetometer is logged at 12 second intervals.

Date	Comment
	NOT LOGGED

Bathymetry

The Krupp Atlas Hydrosweep-DS full swath data is logged for each ping, and the center beam data is extracted and processed separately. The Hydrosweep operates at varying intervals based on water depth, ranging from 3 seconds (depth < 100m) to 7 seconds (depth > 1000m).

The full swath data can be read and processed using the MB-System software, which can be found at the Web site http://www.ldeo.columbia.edu/MB-System/.

Date	Comment
009/10:09	Start Logging
028/20:04	Stop Logging

Sea Temperature

The Omega DP-10 sea temperature gauge is logged at 60 second intervals.

Date	Comment
009/10:09	Start Logging
028/20:04	Stop Logging

Weather Station

The R.M. Young Precision Meteorological Instruments 26700 Series is used to log a variety of meteorological events at 60 second intervals.

Date	Comment
009/10:09	Start Logging
028/20:04	Stop Logging

Data Processing

GPS Processing

Navigation data is post-processed in order to accurately determine the position and remove GPS accuracy errors. We perform slightly different processing depending on the type of receiver.

1. Check data for mutant records and non-sequential times.
2. If we have speed and/or DOP information, remove records that have excessive speed or too high of a DOP1
3. Convert from NMEA or proprietary format to a standard format
   2000+009:00:28:50.091 N 42 14.1536 W 063 25.5897 P-trimble
4. If we are processing known differential data, remove non-differential fixes from the file.
5. Interpolate and reduce data. Fixes are reduced to 30 second fixes and any minor gaps (< 3 minutes) are linearly interpolated.
6. Smooth data using a 9 point running average algorithm and further reduce data to 60 second fixes.
7. Perform dead reckoning using the smoothed Furuno speed and heading to fill in major gaps (> 3 minutes) and to insure the accuracy of the GPS data

Furuno Processing

Furuno speed and heading is processed by smoothing the data using a vector summing algorithm. Data is reduced and output at 60 second intervals by taking the smoothed values and calculating the mean value for the 30 seconds before and after the whole minute.

Hydrosweep Processing

Center Beam Processing

1. Remove all survey and calibration records from the raw data and all *0* level depths.
2. Reduce data to one minute intervals on 00 seconds of the minute by computing the median values from the raw values that lie between +-30 seconds of 00 seconds of the minute.
3. Merge the data with the processed navigation to end up with one minute hydrosweep centerbeam fixes with navigation.

[1] Dilution of Precision, a term used to measure the accuracy of the fix based on the number of Satellites the GPS receiver is tracking, and the position of the satellites.

Full Swath Processing

Hydrosweep swath data is processed using the MB-System software, and consists primarily of hand-editing the beam data. Source code and documentation for MB-System may be found at the Web site: http://www.ldeo.columbia.edu/MB-System/.

The full swath data was not requested or processed for this cruise.

Gravity Processing

```
bias  = 852645.3;    Dec  5, 1997
scale = 5.0940744   July 9, 1992
mGals = raw_gravity_count * scale + bias;
```

Logging

- Raw gravity is logged to disk (roughly 1 sample/second) and broadcast to the network.
- A real-time gravity process reads the sampled data and applies a 6 minute gaussian filter to the raw sample to provide a running display of the current gravity. This value is used in the gravity ties to determine the local gravity. (Gravity Meter Value (BGM Reading))

Reduction

1. Raw gravity is filtered using a 6 minute gaussian filter and mGals are output. The raw mGals are represented by
   ```
   mGals = gravitycount * scale + bias;
   ```
4. A second filter is then applied; an 8 minute Gaussian filter using the GMT system:
   ```
   filter1D -G480 -R -E
   ```
5. The filtered output is then reduced to 1 minute intervals by using the mean values of all data +/- 30 seconds from the 00 second mark of the minute to output:
   ```
   98+254:00:07:00.000 980422.37
   98+254:00:08:00.000 980422.38
   ```
6. The data is merged with the navigation. **See** *Processed File Formats.*
   At this point eotvos corrections are determined by merging the daily navigation and raw gravity files and calculating the Eotvos correction as:
   ```
   Eotvos correction = 7.5038 * vel_east * cos(lat) + .004154 * vel*vel
   ```
7. The velocities used in the Eotvos calculation are smoothed to reduce the jitter in the corrected gravity and FAA values. The smoothing is done using a 9 point running average.

Gravity Tie

It is usual practice to have a gravity "tie" to a gravity reference base station during the port stay. A portable gravity meter, e.g. the Lacoste Model G #70, is used to make 1) a pier-side reading; 2) a reading at the base station; 3) an additional pier-side reading. The pier-side gravity value, adjusted in value to correspond to the height of the BGM gravity meter, is compared to the real-time **BGM Gravity Reading** discussed previously.

The practice is not to adjust the BGM-3 so that its reading agrees with the pier-side gravity value, but to establish a "dc shift", which represents a constant correction to be applied to all gravity values on the next cruise.

For example, suppose the pier-side value equaled 980274.7 mGal and the BGM reading was 980279.9, the dc shift would be 5.2 mGal. In other words, the BGM is 5.2 mGal high. This value is subtracted from observed values of gravity following the cruise as a constant correction. The "drift" of the Bell gravity meter is determined from the two in-port gravity station ties. In the pre-cruise tie the BGM might have been found to be 5.3 mGal high and during the post-cruise tie it is 8.4 mGal high. The drift during the cruise is therefore equal to 3.2 mGal (8.4 - 5.2). The amount of drift per day is then calculated and gravity data is processed with the drift values corrected for the length of the cruise.

Thus, for daily reduction at sea the drift correction option cannot be used. However, the drift rate of the Bell gravimeter is very low, usually much less than 0.1 mGals/day; thus useful analysis of the FAA values while at sea is possible

A corrected gravity value is computed as:

> *corrected_grv = raw_grv + eotvos_corr - drift - dc_shift*

The theoretical gravity value is based upon different models for the earth's shape.

> *1930 = 1930 International Gravity Formula*
> *1967 = 1967 Geodetic Reference System Formula*
> *1980 = 1980 Gravity Formula*

The FAA is computed as: faa = corrected_grv - theoretical_grv

EW-9914 Christchurch, NZ Gravity Tie

Pier/Ship	Latitude	Longitude	Reference	Latitude	Longitude
	43 36.4S	172 43.2 E		43 31.77 S	172 37.18 E

Using Reference point from March 1992, and again in February 1996:

Marker ***1962*** on walkway across from RR tracks.

	Id	Julian	Date	Mistie	Drift/Day	DC Shift
Pre Cruise	EW9912	336	1999.12.02	3.87	0.04	2.28
Post Cruise	EW9914	363	1999.12.29	**4.16**	**0.011**	**3.87**
Total Days			**27.00**	**0.29**		

Time	Entry	Value	
	CDeck Level BELOW Pier	1.50	**meters**
	Pier 1 L&R Value	4095.00	**L&R**
	Reference L&R Value	4064.90	**L&R**
	Pier 2 L&R Value	4095.00	**L&R**
###########	**Reference Gravity**	980508.06	**mGals**
	Gravity Meter Value (BGM Reading)	980546.30	**mGals**
	Potsdam Corrected	0	**1 if corrected**

*Gravity meter is **5.5** meters below CDeck*

	Difference in meters between Gravity Meter and Pier				**7.00**	meters
Height Cor =	Pier Height*	FAA Constant				
	7.00	**0.31**			**2.17**	mGals/min
Difference in mGals between Pier and Gravity Meter						
	Pier (avg) -	Reference *	1.06 L&R/mGal		**Delta L&R**	
	4095.00	**4064.90**	**1.06**		**31.91**	mGals
Gravity in mGals at Pierside						
	Reference + Delta mGals [+ Potsdam]				**Pier Gravity**	
	980508.06	**31.91**	**0.00**		**980539.97**	mgals
Gravity in mGals at Meter						
	Pier Gravity+	Height Correction			**Gravity@meter**	
	980539.97	**2.17**			**980542.14**	mGals
Current Mistie						
	BGM Reading-	Calculated Gravity			**Current Mistie**	
	980546.30	**980542.14**			**4.16**	mGals

A gravity tie for cruise EW0001 taken at time 029/02:00 (at the same marker as for cruise EW9914) yielded the values:

980544.1 observed
980542.9 calculated
1.2 mistie ÷ 20 days = 0.06 mgal/day drift

File Formats

Raw Compass Block **cb1.d*jjj***

CPU Time Stamp	Line	Shot	GPS1 Position
2000+009:00:01:29.572	LAU1	021144	S 19 26.4331 W 176 16.3491

GPS2 Position	Tailbuoy Position	Compass Positions/Compass# …
S 19 26.4393 W 176 16.3198	S 19 25.2864 W 176 19.7897	107.0 C01 97.8 C03

No processing is performed on compass block data since the compasses are directly related to the GPS position at the given time.

Raw Furuno Log **fu.d*jjj***

CPU Time Stamp	Track	Speed	Heading	Gyro
2000+009:00:01:53.091	-	4.4	140.5	148.3

Hydrosweep Center Beam merged w/ Navigation **hb.n*jjj***

CPU Time Stamp	Latitude	Longitude	Depth
2000+009:09:55:00.000	N 13 6.6206	W 59 39.3908	134.9

Hydrosweep is median filtered at 1 minute intervals, then merged with navigation at 1 minute intervals.

Merged Data **m.*jjj***

CPU Time Stamp	Latitude	Longitude	GPS	Set	Drift	Depth
2000+009:14:08:00.000	N 13 54.3859	W 59 43.5175	gp1	0.0	0.0	732.9

Magnetic Total Intensity	Gravity Anomaly	FAA	GRV	EOTVOS	Drift	Shift
0.0	0.0	31.3	978370.7	-3.9	0.0	4.5

The gravity drift and shift are values that have been added to the raw gravity logged to make up for drift in the meter that has been lost in accordance with a gravity check at each port stop.

Navigation File **n.*jjj***

CPU Time Stamp	Latitude	Longitude	Used	Set	Drift
2000+009:00:03:00.000	N 13 6.2214	W 59 37.9399	gp1	0.0	0.0

The raw navigation is interpolated to 30 second intervals. Then smoothed with a 9 point windowing average. The smoothed GPS points are them Fixed at 1 minute intervals. Dead reckoning is then performed across the gaps to insure proper GPS positioning.

Time Shot File **ts.n*jjj***

CPU Time Stamp	Shot #	Latitude	Longitude	Line Name
2000+009:00:15:00.000	00295	N 16 11.8600	W 59 48.0157	strike1

Gravity File merged with navigation **vt.n*jjj***

*9. eotvos_corr = 7.5038 * vel_east * cos(lat) + .004154 * vel*vel*
10. faa = corrected_grv - theoretical_grv

CPU Time Stamp	Latitude	Longitude	Model[2]	FAA	RAW
2000+009:00:15:00.000	N 16 11.8600	W 59 48.0157	1980	-175.9	978253.6

Eotvos Smooth	Drift Total	DC Shift	Raw Velocity North	Raw Velocity East	Smooth Velocity North	Smooth Velocity East
9.7	0.0	4.5	-4.350	1.282	-4.333	1.329

Raw Weather File Format **wx.d*jjj***

CPU Time Stamp	wsi1	wss1	wsm1	wsx1	wdc1	wds1
2000+009:00:00:00.244	9.3	5.4	13.2	21.1	27.1	26.1

wdm1	*wsi2*	*wss2*	*wsm2*	*wsx2*	*wdc2*	*wds2*	*wdm2*	tcur	tavg
6	*0*	*0*	*0*	*0*	*0*	*0*	*0*	26.7	26.7

tmin	tmax	rh	rhn	rhx	baro
26.5	27.0	66	58	68	10

- wsi1 = wind speed, instantaneous, bird #1
- wss1 = wind speed, 60 second average, bird #1
- wsm1 = wind speed, 60 minute average, bird #1
- wsx2 = wind speed, current 60 minute maximum, bird #1
- wdc1 = wind direction, current, bird #1
- wds1 = wind direction, 60 second average, bird #1
- wdm1 = wind direction, 60 second st deviation, bird #1
- ~~*wsi2 = wind speed, instantaneous, bird #2*~~
- ~~*wss2 = wind speed, 60 second average, bird #2*~~
- ~~*wsm2 = wind speed, 60 minute average, bird #2*~~
- ~~*wsx2 = wind speed, current 60 minute maximum, bird #2*~~
- ~~*wdc2 = wind direction, current, bird #2*~~
- tcur = temperature, current
- tavg = temperature, current 60 minute average
- tmin = temperature, current 60 minute minimum
- tmax = temperature, current 60 minute maximum
- rh = relative humidity
- rhn = relative humidity, current 60 minute minimum
- rhx = relative humidity, current 60 minute maximum
- baro = barometric pressure

Bird2 is deactivated, so all ~~*strikeout*~~ items are not valid.

[2] The theoretical gravity value is based upon different models for the earth's shape: 1930 is the 1930 International Gravity Formula; 1967 is the 1967 Geodetic Reference System Formula; and 1980 is the 1980 Gravity Formula

Tape Contents

The tape contains the following items:

- *raw/*
  original logged data (day files) including full swath bathymetry
- *reduction/*
  intermediate processed data (day files)
- *processed/*
  final processed data tied to navigation (day files) plus trackplots, scripts, summary files
- *ew0001.cdf*
  final processed data tied to navigation (NetCDF files) for LDEO MG&G database
- *ew0001.rtf*
  cruise report (RTF file)