Lamont-Doherty Earth Observatory
Office of Marine Affairs
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R/V Maurice Ewing

Woodlark Basin OBS Recovery
Data Reduction Summary

EW0002 - Lyttelton, NZ - Suva, Fiji

February 5, 2000 - February 28, 2000

Port Dates

Date	Julian	Time	Port
2/5/2000	036	0100	Depart Lyttelton
2/10/2000	041	0030	Arrive New Caledonia
2/10/2000	041	2200	Depart New Caledonia
2/28/2000	059	1840	Arrive Suva, Fiji

Contents

Project Summary

Natural Seismicity Investigation of Active Continental Breakup in the Western Woodlark Basin

Active low-angle normal faulting has been conjectured to be a fundamental process in passive margin evolution but presents a major paradox in which observational evidence for low-angle deformation conflicts with the basic Andersonian theory of frictional slip. In the Western Woodlark Basin, extensive geophysical and geological studies show that propagation of seafloor spreading is inducing active continental rifting and is providing a unique setting to study extensional processes. In particular, evidence from several moderate shallow earthquakes permit slip on low-angle normal planes dipping at 24 to 25 degrees. One earthquake in particular has been recently modeled and may lie on or very close to a north-dipping plane in the upper and middle crust which has been imaged by multi-channel reflection profiling. This the Western Woodlark Basin provides perhaps the best opportunity to determine what special circumstances, if any, are required for active low-angle seismic deformation. Recorded earthquakes, which are necessarily large in magnitude, form a distinct brand of seismicity suggesting strain localization where intra-continental rifting is transitioning to sea floor spreading. These conditions may create unusual boundary forces that favor low-angle normal faulting, but these circumstances cannot be determined unless close-in high-fidelity recordings of the seismicity are obtained, yielding precise locations, and well resolved estimates of kinematic and dynamic source properties.

Results from this study, together with those from funded ODP drilling and previous geophysical work, have the potential to resolve the paradox of low-angle normal faulting in the deformation of continental lithosphere.

Cruise Members

Ship Staff

Name	Position	Email
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Science Party

Name	Position	Email
Brian Taylor	Chief Scientist	
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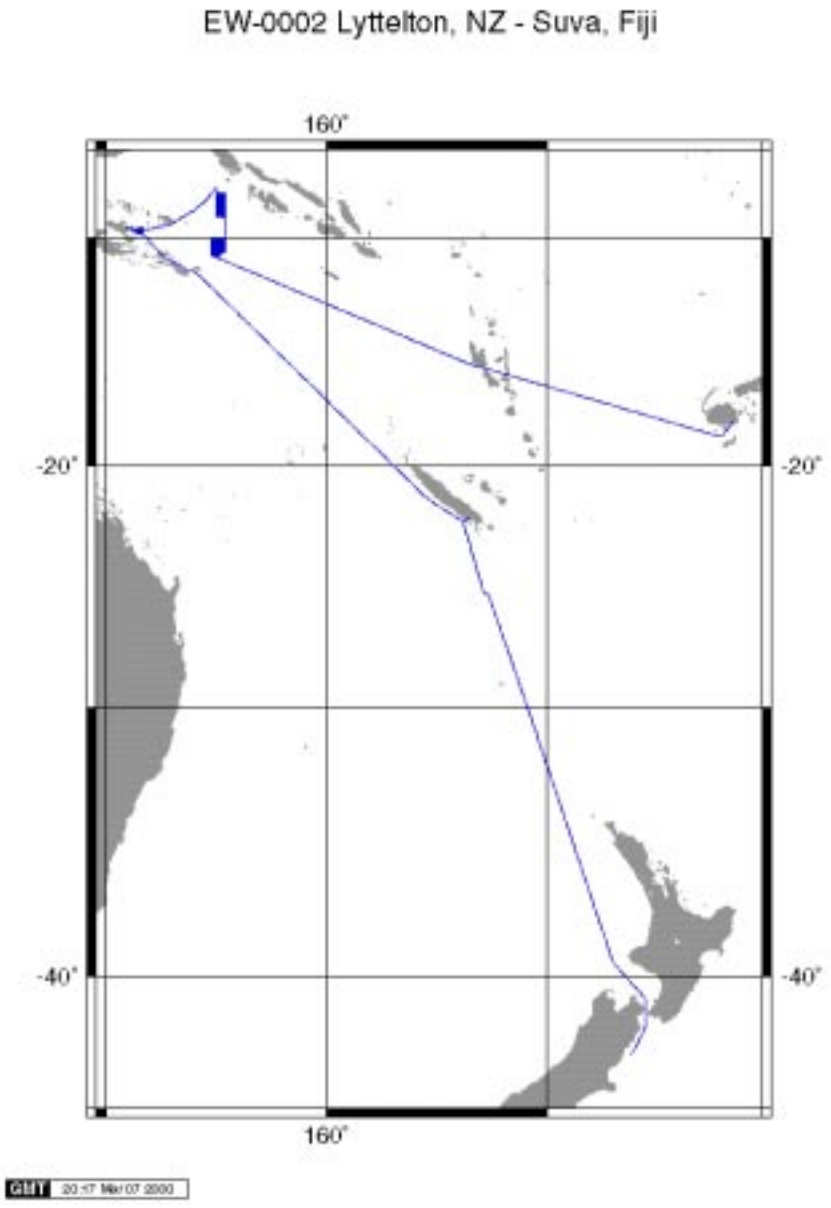
Paul Zimmer	Technician	

Track Map


EW-0002 Lyttelton, NZ - Suva, Fiji
160°
-20°
-20°
-40°
-40°
160°
GMT 20:17 Mar 07 2000

Cruise Notes

Data Acquisition Notes

This cruise was not attended by a data processor, so this report is based on the processing of the data after the cruise. This report and processing were performed by Jeff Turmelle [*jefft@ldeo.columbia.edu*]

Hydrosweep was affected by Y2K problems. Version 4.6.6 of MB-System is necessary to process the hydrosweep.

UTC time reference log files are not included on this tape, but can be accessed if necessary from EW0003. If you find you need the time reference logs, please contact the Marine Office for the logs and mention that they are included on EW0003.

Although there are several days of raw magnetics data before julian day 048, this data is pretty messed up and I believe that this was a testing period for the magnetics hardware. True magnetics logging didn't start until day 048.

Hydrosweep logging doesn't start until julian day 037.

No ending gravity tie data was available, so the gravity tie from the previous cruise was used.

Gravity Tie Data:

- DC Shift: 5.07
- Drift/Day: 0.06 mGals
- Tie Date : 01/29/2000 02:00

Logging Notes

The following devices were logged during this cruise:

- Kinemetrics True Time GPS UTC receiver
- Furuno CI-30 doppler speed log with Sperry MK-27 gyro
- Trimble Tasman GPS Y-Code receiver
- Trimble NT200D GPS Differential receiver
- Bell BGM-3 Gravimeter
- Krupp Atlas Hydrosweep DS Swath bathymetry
- Varian/Geometrics? Magnetometer
- 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. Since the log files weren't included on the tape from the ship, these will need to be included on tape EW0003. There is no processing for these files, and are usually only used during the cruise to insure that the CPUs are maintaining time synchronization with UTC.

Speed and Heading

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

Date	Comment
036/01:33	Furuno logging started
059/18:39	Furuno logging stopped

GPS Receivers

gp1 = Trimble Tasman Y-Code
gp2 = Trimble NT200D

Both GPS receivers were logged at 10 second intervals. Navigation os processed and reduced to 60 second intervals which is then applied to the magnetics, gravity, bathymetry, shot data and any other acquired data. All data for this cruise was processed with the Tasman (gp1). Only outages > 10 minutes are accounted for here.

Date	Comment
036/01:33	GPS Logging starts
053/06:13 - 053/08:16	GPS logging interruption on both GPS
059/18:39	GPS Logging ends

Gravimeter

The Bell BGM-3 Gravimeter is logged at 1-second intervals.
DC Shift: 5.07 **Drift per Day:** 0.06 **Gravity Tie Date:** January 29,02:00

Date	Comment
036/01:33	Gravity logging begins
059/18:39	Gravity logging ends

Magnetometer

The Geometrics G-886 Marine Magnetometer was logged at 12 second intervals during this cruise. Although there are *raw* log files before day 048, tru magnetic logging did not begin until then. Files before that day are extremely erratic.

Date	Comment
048/07:58	Magnetics logging begins
054/09:53	Magnetics logging ends

Hydrosweep Bathymetry

The Krupp Atlas Hydrosweep-DS full swath data is logged for each ping, and the centerbeam data is extracted and processed separately. The hydrosweep operates at varying intervals based on water depth.

The full swath data can be read and processed using the MB-System software which can be downloaded from the web site: **http://www.ldeo.columbia.edu/MB-System**
MB-System 4.6.10 is necessary to process data after Jan 1, 2000.

Date	Comment
037/01:07	HS logging starts
041/22:28 - 041/23:22	HS interruption
046/02:51 - 046/03:27	HS interruption
046/16:28 - 046/18:53	HS interruption
047/04:40 - 048/07:38	HS on/off all day. (OBS pickups?)
052/15:02 - 052/15:22	HS interruption
059/18:36	HS logging ends

Sea Temperature

The Omega DP-10 sea temperature gauge is logged at 1-minute intervals.

Date	Comment
036/01:33	Logging starts
059/18:39	Logging ends

Weather Station

The R.M. Young Precision Meteorological Instruments; 26700 series is used to log a variety of weather conditions at 1-minute intervals.

Date	Comment
036/01:33	Logging starts
059/18:39	Logging ends

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 DOP[1]
3. Convert from NMEA or proprietary format to a standard format
4. 2000+009:00:28:50.091 N 42 14.1536 W 063 25.5897 P-trimble
5. If we are processing known differential data, remove non-differential fixes from the file.
6. Interpolate and reduce data. Fixes are reduced to 30 second fixes and any minor gaps (< 3 minutes) are linearly interpolated.
7. Smooth data using a 9 point running average algorithm and further reduce data to 60 second fixes.
8. 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 = 5.0940744July 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;`
2. A second filter is then applied; an 8 minute Gaussian filter using the GMT system:
   `filter1D -G480 -R -E`
3. 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`
4. 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`
5. 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
```

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*

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

CPU Time Stamp	Latitude	Longitude	Model[1]	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

1. The theoretical gravity value is based upon different models for the earth's shape: 1930 is the 1930 Intl. Gravity Gormula; 1967 is the 1967 Geodetic Referency System Formula, and 1980 is the 1980 Intl. Gravity Formula.

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

min	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.

Tape Contents

- *EW0002.pdf*
  cruise report (Adobe Acrobat PDF file)
- *ew0002.cdf*
  final processed data tied to navigation (NetCDF files) for LDEO MG&G database
- *ew0002.cdf_nav*
  final processed navigation (NetCDF files) for LDEO MG&G database
- *docs/*
  FileFormats for all the files included on tape.
- *hs/*
  Hydrosweep swath and centerbeam bathymetry (raw)
- *processed/*
  final processed data tied to navigation (day files) plus trackplots, scripts, summary files
- *raw/*
  original logged data (day files)
- *reduction/*
  intermediate processed data (day files)