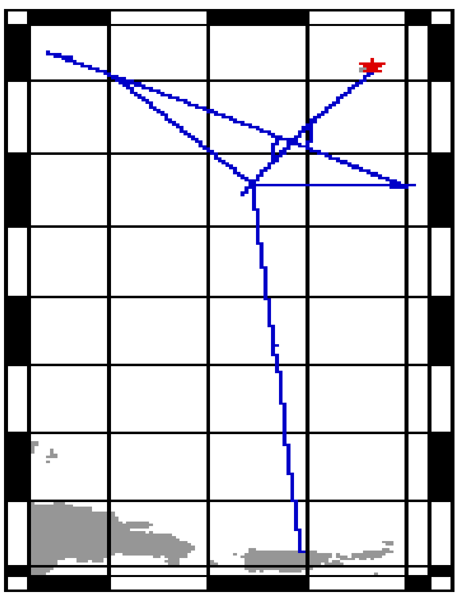
Lamont– Doherty Earth Observatory
Office of Marine Affairs
61 Route 9W
Palisades, NY 10969

Prepared By:Richard Oliver–Goodwin
richardo@ldeo.columbia.edu
845 365–8677

R/V Maurice Ewing Data Reduction Summary

EW−0106 San Juan, Puerto Rico − St. George, Bermuda

Date	Julian Date	Time	Port
May 31, 2001	151	14:30:00	San Juan, Puerto Rico
June 29, 2001	180	14:00:00	St. George, Bermuda



Project Summary

The process of mantle flow, melting and crust formation at mid−ocean ridge spreading centers are fundamental to our understanding of the composition and dynamics of the Earth's mantle. We have a sound understanding of many aspects of these processes, primarily due to extensive geologic and geophysical studies focused on oceanic crust. Basic questions remain, however, because we have very little knowledge of the structure of the complementary product of crust generation: the residual mantle. Crust extraction leaves behind in the mantle a layer of residuum depleted of basaltic constituents and volatiles, with an embedded structural fabric associated with melting and mantle flow beneath a spreading center. This basic layered structure should remain in the lithosphere as it cools and translates from the ridge, providing a fingerprint of mid−ocean ridge processes over time.

We propose to investigate the seismic structure of oceanic mantle lithosphere using an active−source seismic refraction experiment along an 800−km−long transect in the western Atlantic. The transect extends along a plate kinematic flow line which lies entirely with a single spreading−center segment, on lithosphere ranging in age from 87 to 147 Ma. The restriction to a single, stable segment minimizes the effects of lateral variability and will enable us to interpret the resulting images of seismic structure in terms of normal ridge processes. The slow spreading rate of the Atlantic enables us to investigate layering over a relatively large age span. The experiment will consist of 14 ocean−bottom seismometers (OBSs) deployed in pairs spaced 133 km apart recording multiple, co−located shots from R/V *Maurice Ewing's* 8,850−cubic−inch (140−liter) airgun array. In addition, the shots will be recorded by a land station located on Bermuda and an off−line OBS. By stacking the co−located shots, we expect to record mantle *P* an *Pn* phases to much larger distances than typically observed in marine wide−angle seismic surveys aimed at studying crustal structure. We will apply tomographic and waveform modeling techniques to the refraction profile to produce a unique image of oceanic lithosphere structure. The off−line instruments will record the airgun shots at azimuths spanning nearly 180 degrees, and the travel times from these recordings will be used to constrain anisotropy in the Atlantic upper mantle. The waveforms of *Pn* and associated coda, recorded on the OBSs and the land instrument, will be analyzed for constraints on the hetereogeneity characteristics of the lithosphere. Using these results, we will address the following questions:

1. Is the lithospheric mantle in the Atlantic observably stratified? If so, how laterally uniform is this layering, and how is it related to stratification in composition and volatile content? What does this imply about the pattern of mantle melting and flow though the melting region?
2. What is the magnitude and form of anisotropy in the Atlantic lithosphere over length scales of a few hundred kilometers? How does this compare to anisotropy observed in the Pacific? What does this say about flow patterns beneath the ridge?
3. Does the character of oceanic *Pn* coda place constraints on the nature of small−scale lateral heterogeneity in the oceanic lithosphere? What is the likely source od observed hetereogeneity? How does it compare with hetereogeneity inferred for continental lithosphere?
4. What are the parameters which maximize the range at which mantle phases can be recorded using airgun source and ocean−bottom receivers in order to investigate oceanic mantle structure?

By addressing these questions, this project will establish a reference profile of the detailed upper mantle structure of normal ocean lithosphere, while at the same time demonstrating the applicability of an experimental technique that can extend our understanding to more complex

upper mantle structure and processes throughout the world's oceans.

The proposed experiment is a collaborative effort between scientists at Georgia Institute of Technology and Woods Hole Oceanographic Institute. Collection, processing, analysis, and publication of all data and results will be entirely cooperative.

Science Party

Daniel Lizarralde	Chief Scientist	danl@eas.gatech.edu
Jim Gaherty	Co Chief Scientist	gaherty@eas.gatech.edu
Crispin Hollinshead		chollins@igpp.ucsd.edu
Sang Kim		dkim@eas.gatech.edu
Roderick Milan		rmilan@igpp.ucsd.edu
Jillian Nimblett		jill@hydrate.eas.gatech.edu
Fatimah Raheem		gt6223a@prism.gatech.edu
Stephen Scharf		scscharf@hotmail.com
David Willoughby		dwilloughby@ucsd.edu

Ship's Science

Joe Stennet	Science Officer	sci@ewing.ldeo.columbia.edu
John DiBernardo	PSSO	gunners@ewing.ldeo.columbia.edu
Karl Hagel	ET	hagel@ldeo.columbia.edu
Ropate Maiwiriwiri	Gunner	gunners@ewing.ldeo.columbia.edu
Richardo Oliver−Goodwin	Data Reduction	richardo@ldeo.columbia.edu
Justin Walsh	Gunner	cabinboy@ldeo.columbia.edu

Ship Crew

Mark C. Landow	Captain	captain@ewing.ldeo.columbia.edu
Karlyn, Albert	Chief Engineer	engine@ewing.ldeo.columbia.edu
Stan Zeigler	1st Mate	
Dave Wolford	2nd Mate	
Richard Thomas	3rd Mate	
Matthew Tucke	1st A/Engineer	
Miguel Flores	2nd A/Engineer	
Michael Spruill	3rd A/Engineer	
Tomas, Kelly	A/B	
Bailey, James	A/B	
Florendo, Rodlofo	Oiler	
Matos, Francisco	Electrician	
Mecketsy, Meredith	A/B	
Moqo, Luke	Utility	
Ruegg, Bryan	A/B	
Smith, John	Steward	
Sypongco, Arnold	O/S	

Taylor, Kelly	Cook
Uribe, Fernando	Oiler
Walker, Wakefield	A/B
Wyatt, Richard	Oiler

Cruise Notes

All data in this report is logged using GMT time and Julian days in order to avoid confusion with local time changes.

Spectra

Spectra logs data to files in UKOOA[1] P1/90 format and P2/94 Format. The file formats are included in separate PDF documents on the tape. The contents of these files contain all the parameters used during shooting each of the lines, as well as the positions of all the sensors. I have included perl scripts for extracting shot times and positions from the P1 and P2 files on the tape.

This was the third cruise running the Spectra navigation and seismic shooting system.

Positioning of Sensors

The Spectra system defines a reference point which is used as a reference to all points which need an offset (range and bearing to TB, for example). This reference point has been defined as the center of the ship's mast, at sea level.

Any documentation included herein that refers to the vessel reference or reference or master will be referring to this reference point.

However, daily navigation files that are not related to spectra (i.e. n., hb.n, mg.n, files) are referenced to the Tasmon P−Code GPS filtered positions.

Offset information can be found under the **Ship Diagrams** section of this document.

Data Reduction

Since spectra positions its shots precisely based on a Kalman filtering algorithm, we will assume that it has the correct shot location. However, as a fallback measure, I have also processed the shots using our normal navigation filtering.

Therefore you will find the following shotlog files:

- nb0.r		Contains shot times and positions based on Spectra positioning.
- nb2.r		Contains shot times and positions based on Spectra navigation
- ts.n		Contains shot times and positions based on Ewing navigation

Please see the File Formats section for more information on these files.

1 *United Kingdom Offshore Operators Association*

Hydrosweep

This cruise was the maiden voyage of our Hydrosweep multibeam sonar DS−2 system. The upgraded 59 "hard" beam version of HSDS−2 worked reliably and produced significantly improved data..

There are, however, some unresolved issues:

1. When hydrosweep data acquisition is paused or stopped , the "draft" is reported as centerbeam depth.
2. When hydrosweep data acquisition is paused or stopped, the frequency of the udp broadcast increases to once per second creating files of considerable size.
3. Mbinfo reports data acquired during the above mentioned "pauses" as drops, so an accurate determination of total bathymetry counts cannot be made.

Gravity

There were no gravity data interruptions.

Seismic Acquisition

There were minor but chronic problems with the Syntron system incorrectly reporting air−gun auto fires. In an effort to investigate and correct these false reports, two shots were missed. Both shots (#178, #324) occurred during FAIMLine7.

Shot #401 on FAIMLine5 was also missed.

Streamer configuration files are included on the tape in Excel 97 format.

Data Logging

The R/V Maurice Ewing data logging system is run on a Sparc Ultra Enterprise Server. Attached are 48 serial ports via 3 16−port Digi International SCSI Terminal Servers. Generally, all data logged by the Ewing Data Acquisition System (DAS) is time stamped with the CPU time of the server, and broadcast to the Ewing network using UDP packet broadcasts. The CPU time of the server is synchronized once every half hour to a Datum UTC gps time clock.

GPS times are also time−tagged with cpu time, although the time of the GPS position is from the GPS fix itself.

The following tables describe the data instruments which performed logging during this cruise. The tables associated with the instruments describe logging periods and data losses for that instrument.

Time Reference

Datum StarTime 9390−1000

logging interval: 30 minutes
file id: tr2

Used as the CPU synchronization clock. This clock is polled once every half hour to synchronize the CPU clock of the data logger to UTC time. The logger (octopus) is responsible for updating the times of the other CPUs.

There were chronic problems with the Ewing time daemon, particularly at the end of the cruise.

Note that the Spectra system uses its own Trimble gps receiver for synchronizing its hardware to UTC time. This is the time the shot points are referenced to; not the CPU time.

Interruption s greater than 30 minutes are displayed in the following table

Log Date	LogDate	Comment
2001+151:02:41:30.185		Logging officially started
2001+151:02:41:30.185	2001+151:16:33:30.190	Data interruption
2001+159:03:33:29.729	2001+160:00:05:29.734	Data interruption
2001+176:20:35:29.737	2001+177:14:49:29.164	Data interruption
2001+177:14:49:29.164	2001+177:15:25:16.696	Data interruption
2001+177:15:29:30.068	2001+178:05:41:39.909	Data interruption
2001+178:05:41:39.909	2001+178:06:17:27.497	Data interruption
2001+178:06:17:27.497	2001+178:06:53:14.832	Data interruption
2001+178:06:53:14.832	2001+178:07:29:01.967	Data interruption
2001+178:07:29:01.967	2001+178:08:04:49.110	Data interruption
2001+178:08:04:49.110	2001+178:08:40:36.249	Data interruption
2001+178:08:40:36.249	2001+178:09:16:22.262	Data interruption

Log Date	LogDate	Comment
2001+178:09:16:22.262	2001+178:09:52:09.421	Data interruption
2001+178:09:52:09.421	2001+178:10:27:56.565	Data interruption
2001+178:10:27:56.565	2001+178:11:03:43.709	Data interruption
2001+178:11:03:43.709	2001+178:11:57:01.262	Data interruption
2001+180:14:00:00		Logging officially ends

Spectra

Spectra uses its own Trimble gps receiver for synchronizing its hardware to UTC time. This is the time the shot points are referenced to; not the CPU time.

GPS Receivers

GPS data is usually logged at 10 second intervals. The NMEA strings GPGGA and GPVTG are logged for position, speed, and heading fixes. This data was logged constantly throughout the cruise.

The Tasmon GPS was the primary GPS for this cruise.

Trimble Tasmon P/Y Code Receiver

logging interval: 10 seconds
file id: gp1

The Tasmon is the primary GPS receiver for the Ewing Logging system and the primary GPS for Spectra fixes. The accuracy is around 15 meters. There were no interruptions during this cruise.

Interruptions greater than 10 minutes are displayed in the following table

Log Date	LogDate	Comment
2001+151:02:43:08.612		Logging officially starts
2001+151:15:05:17.526	2001+151:16:51:48.880	Data interruption
2001+180:14:00:00		Logging officially ends

Trimble NT200D

logging interval: 10 seconds
file id: gp2

The Trimble is the secondary receiver for GPS data. Data is logged at 10 second intervals and is also used as an input to Spectra, although it is weighed at a lower value than the Tasmon receiver.

Interruptions greater than 10 minutes are displayed in the following table

Log Date	LogDate	Comment
2001+151:02:43:15.457		Logging officially started

Log Date	LogDate	Comment
2001+151:15:05:12.294	2001+151:16:56:23.902	Data Interruption
2001+180:14:00:00		Logging officially ends

Tailbuoy Garmin GP8

logging interval: 10 seconds
file id: tb1

The tailbuoy receiver was working during all lines with the exception of minor blackouts during deployment and turns.

Interruptions greater than 30 minutes are displayed in the following table

Log Date	Log Date	Comment
2001+178:10:55:40.302		Tailbouy logging starts
2001+179:13:05:44.549		Tailbuoy logging officially ends

Speed and Heading

Furuno CI−30 Dual Axis Speed Log
Sperry MK−27 Gyro

logging interval: 6 seconds
file id: fu

The Furuno and Gyro are combined to output speed, heading and course information to a raw Furuno file, as well as an NMEA VDVHW signal used as an input to various systems including steering and Spectra.

Interruptions greater than 30 minutes are displayed in the following table

Log Date	Log Date	Comment
2001+151:02:43:50.360		Logging officially starts
2001+151:15:05:18.686	2001+151:16:52:23.232	Data Interruption
2001+180:14:00:00		Logging officially ends

Gravity

Bell Aerospace BGM−3 Marine Gravity Meter System

logging interval: 1 second
file id: vc. (raw), vt. (processed)
drift per day: −0.456

The BGM consists of a forced feedback accelerometer mounted on a gyro stabilized platform. The gravity meter outputs raw counts approximately once per second which are logged and processed to provide real−time gravity displays during the course of the cruise as well as adjusted gravity data at the end of the cruise.

Interruptions greater than 10 minutes are displayed in the following table

Log Date	Log Date	Comment
2001+151:02:44:02.843		Official start date
2001+151:15:05:18.526	2001+151:16:52:54.059	Lost BGM output
2001+180:14:00:00		Logging officially ends

Bathymetry

Krupp Atlas Hydrosweep−DS−2

logging interval: variable based on water depth
file id: hb (centerbeam), hs (swath)

The hydrosweep full swath data is continuously logged for every cruise, and centerbeam data is extracted and processed separately. The centerbeam operates at a logging frequency dependent on the water depth.

The full swath data is not routinely processed, but can be processed with the MB−System software which can be downloaded for free. For instructions, use the website: http://www.ldeo.columbia.edu/MB−System.

MBSystem, version 4.6.10 is necessary to process data after Jan 1, 2000.

Note: During OBS deployment, the hydrosweep was routinely suspended to avoid interference with the standard wide beam profilers. As the new DS−2 system falsely reports paused or stopped periods of data acquistion, it has proved most difficult to distinguish periods of OBS deployment from "real" data interruptions..

Log Date	LogDate	Comment
2001+152:12:00:17.000		Logging officially starts
2001+180:14:00:00		Logging officially ends

Weather Station

RM Young Precision Meteorological Instruments, 26700 series

logging interval: 1 minute
file id: wx

The weather station is used to log wind speed, direction, air temperature, and barometric pressure. We log this information at 1−minute intervals.

Log Date	LogDate	Comment
2001+151:02:45:42.915		Logging officially starts
2001+151:15:05:00.682	2001+151:16:54:54.432	Data Interruption
2001+180:14:00:00		Official end logging

Seismic Lines

As this was the third cruise using Spectra to fire the guns and log the shot times, we are still in the process of learning all aspects of the system and integrating Spectra into the Ewing system.

The ability to shoot concentric circles in addition to traditional survey lines was critical to the success of this cruise. Since Spectra had no facility to use a circle as an aim point, we excercised a previously unused shooting mode, the "cycle test", to accomplish this. The "cycle test" mode is basically a testing mode, as the name might suggest, and required some massaging to perform as if "on−line". This has resulted in some compromises in shot logging.

The following items were of concern during this cruise:

1. The P2 and P1 formats do not store the shot time in millisecond range.
2. Where Spectra P2 and P1 logging normally continue without interruption, constant switching from "cycle test" mode to "normal" mode apparently required manual intervention. As a result, P1 and P2 files were not logged for FAIMLines 1b, 2, 3, 4, 5, 6, 7, and 8. Note: Since shottimes for all shots were logged via conventional Ewing system logging and P2 and P1 formats do not store times in millisecond range, data loss was minimized.
3. An incorrect "shot layback" parameter of −53.4 meters was entered in the Spectra System. This setting effectively shifted the ship offsets and severely compromised our efforts to shoot at identical positions on the forward and reversed lines.
4. SIOSEIS cannot handle the Spectra output header for SEG−D.

A system has been created where the Spectra header, data from the Digicourse cable output, data from the gun depths, and real−time data from the Ewing logging system are all used to create a Ewing standard SEG−D header readable by SIOSEIS to place on the 3490 tape for each shot.

Unfortunately, due to human error, I was unable to produce the Ewing standard SEG−D header for most of the shots of FAIMLine1a.

There are several files for each line reflecting the line status:

File	Description
ts.n	Shot time is merged with Ewing navigation to determine shot location
nb2.r	Navigation is from Spectra, and includes tailbuoy, tailbuoy range and bearing

Shot Files Table

Line Name	Times ()	Ewing(ts.n, nb2.r)		Spectra (shots.p1, shotlog.p2)		
		Shots	Missing	P1 Shots	P2 Shots	Missing
FAIMLine1a	159:03:53:28.980 163:09:35:28.980	001−679		0001−0679	0001−0679	
FAIMLine1b	163:09:44:35.794 163:15:18:31.304	001−051		None recorded	None recorded	
FAIMLine2	163:16:25:51.157 163:21:47:22.153	001−051		None recorded	None recorded	
FAIMLine3	163:22:53:44.572 165:00:01:27.839	001−351		None recorded	None recorded	
FAIMLine4	165:13:48:39.452 167:06:33:33.709	001−351		None recorded	None recorded	
FAIMLine5	167:07:38:00.631 169:02:53:59.740	001−400	401	None recorded	None recorded	
FAIMLine6	169:04:03:38.461 171:01:02:03.581	001−401		None recorded	Not recorded	
FAIMLine7	171:02:03:05.029 173:15:17:30.860	001−563	178, 324	None recorded	Not recorded	
FAIMLine8	173:15:30:50.980 174:08:44:20.980	001−109		None recorded	None recorded	
FAIMMCSLine	178:13:28:51.424 179:07:00:45.677	014−520		013 −520	013−520	
FAIMTestLine	165:12:41:28.980 165:13:09:28.980; 167:06:41:14.980 167:07:16:14.980; 169:03:09:32.980 169:03:44:32.980; 171:01:09:36.980 171:01:51:36.980;	001−005 001−006 001−006 001−007				

San Juan, Puerto Rico

EW0105 San Juan, Puerto Rico

Pier/Ship	Latitude	Longitude
	18 27.84N	66 06.36W

Pier 8

Reference	Latitude	Longitude
	18 27.8N	66 05.5W

Cruise Ship terminal

	Id	Julian	Date	Mistie	Drift/Day	Prev Mistie
Pre Cruise	EW0104	139	19. May 01	9.82	0.02	8.99
Post Cruise	EW0105	151	31. May 01	11.63	0.151	9.82
Total Days			12.00	1.81		

Time	Entry	Value	
1446	CDeck Level BELOW Pier	0.00	
1446	Pier 1 L&R Value	2332.11	L&R
1446	Reference L&R Value	2334.21	L&R
	Pier 2 L&R Value	2332.11	L&R
	Reference Gravity	978680.69	mGals
	Gravity Meter Value (BGM Reading)	978691.80	mGals
	Potsdam Corrected	0	1 if corrected

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

	Difference in meters between Gravity Meter and Pier				5.50	meters
Height Cor =	Pier Height*	FAA Constant				
	5.50	0.31			1.71	mGals/min

Difference in mGals between Pier and Gravity Meter

Pier (avg) −	Reference *	1.06 L&R/mGal		Delta L&R	
2332.11	2334.21	1.06		−2.23	mGals

Gravity in mGals at Pierside

Reference + Delta mGals [+ Potsdam]				Pier Gravity	
978680.69	−2.23	0.00		978678.46	mgals

Gravity in mGals at Meter

Pier Gravity+	Height Correction			Gravity@meter	
978678.46	1.71			978680.17	mGals

Current Mistie

BGM Reading	Calculated Gravity			Current Mistie	
978691.80	978680.17			11.63	mGals

St. George, Bermuda

EW0106 St. George, Bermuda

Pier/Ship	Latitude	Longitude
	32 22.71N	64 40.89W

Pier 8

Reference	Latitude	Longitude
	32 15.00N	64 41.67W

Tiger Bay Wharf

	Id	Julian	Date	Mistie	Drift/Day	Prev Mistie
Pre Cruise	EW0105	151	31. May 01	11.63	0.15	9.82
Post Cruise	EW0106	180	29. Jun 01	−1.60	−0.456	11.63
Total Days			29.00	−13.23		

Time	Entry	Value	
1850	CDeck Level BELOW Pier	−0.30	
1850	Pier 1 L&R Value	3417.80	L&R
1850	Reference L&R Value	3418.10	L&R
	Pier 2 L&R Value	3418.00	L&R
	Reference Gravity	979821.40	mGals
	Gravity Meter Value (BGM Reading)	979821.20	mGals
	Potsdam Corrected	0	1 if corrected

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

Difference in meters between Gravity Meter and Pier: 5.20 meters

Height Cor =	Pier Height*	FAA Constant			
	5.20	0.31			1.61 mGals/min

Difference in mGals between Pier and Gravity Meter

Pier (avg) −	Reference *	1.06 L&R/mGal		Delta L&R
3417.90	3418.10	1.06		−0.21 mGals

Gravity in mGals at Pierside

Reference +	Delta mGals	[+ Potsdam]		Pier Gravity
979821.40	−0.21	0.00		979821.19 mgals

Gravity in mGals at Meter

Pier Gravity+	Height Correction			Gravity@meter
979821.19	1.61			979822.80 mGals

Current Mistie

BGM Reading	Calculated Gravity			Current Mistie
979821.20	979822.80			−1.60 mGals

File Formats

For all formats, a **–** in the time field means an invalid value for some reason.

Streamer Compass/Bird Data — cb.r

This data is not processed, but can still be found in the "processed" data directory.

Shot Time	Line	Shot	Latitude	Longitude
2000+079:00:08:40.085	strike1	000296	N 15 49.6217	W 060 19.8019

2nd GPS Position		Tailbuoy Position	
Latitude	Longitude	Latitude	Longitude
N 15 49.6189	W 060 19.8101	N 15 47.1234	W 060 20.1901

Furuno Gyro	Streamer Compasses & Heading
344.1	C01 2.3 C02 1.7 ...

Gun Depths — dg

Gun depths in tenths of meters. There will always be 20 gundepths even if only one gun was configured and shooting.

	Gun Depths										
Shot Time	1	2	3	4	5	6	7	8	9	...	20
2001+089:06:47:05.909	189	068	005	005	096	005	060	054	005	...	6

Raw Furuno Log — fu.s

This data has been smoothed and output 1 fix per minute.

CPU Time Stamp	Track	Speed	Hdg	Gyro
2000+166:00:01:53.091	–	4.4	140.5	148.3

Hydrosweep Centerbeam — hb.n

Hydrosweep data merged with navigation

CPU Time Stamp	Latitude	Centerbeam Longitude	Depth
2000+074:09:55:00.000	N 13 6.6206	W 59 39.3908	134.9

Merged Data — m

CPU Time Stamp	Latitude	Longitude	GPS Used	Set	Drift	Depth
2000+200:12:25:00.000	N 45 54.1583	W 42 47.1770	gp1	0.0	0.0	

Magnetic Total Intensity	Anomaly	Gravity FAA	GRV	EOTVOS	Drift	Shift
49464.7	55.5	22.2	980735.0	-8.4	-0.1	2.8

Temperature	Salinity	Conductivity
0.0	0.0	0.0

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

Temperature,Salinity and Conductivity will only be valid while logging a Thermosalinograph, which is not usually the case.

Magnetics Data mg.n

- A minus sign in the time stamp is flagged as a spike point, probably noise...
- Anomaly is based on the International Geomagnetic Reference Field revision 2000

```
CPU Time Stamp         Latitude      Longitude     Raw Value Anomaly
200+077:00:23:00.000 N 16 11.2918 W  59 47.8258 36752.2   −166.8
```

Navigation File n

```
CPU Time Stamp          Latitude      Longitude       Used  Set  Drift
2000+074:00:03:00.000 N 13 6.2214  W  59 37.9399   gp1   0.0   0.0
```

Navigation Block nb0

Navigation is a compendium of Ewing logged data at shot time. The shot position here is the shot position from the Spectra system.

```
Shot Time              Shot # CPU Time              Shot Position
2001+088:00:00:00.606 016967 2001+088:00:00:03.031 N 30 11.8324 W 042 10.8162

Water  Sea    Wind   −−−−−−−−−−−−−Tailbuoy−−−−−−−−−−−−−−−−− Line
Depth  Temp Spd  Dir Latitude     Longitude     Range Bearg Name   Speed Heading
2565.1 20.7 16.4 164 N 30 12.0427 W 042 14.7319 6296.3 93.5 MEG−10 4.2   101.1
```

Tailbuoy Navigation tb1.c

Raw tailbuoy fixes

```
CPU Time Stamp          Latitude      Longitude       GPS Precision
2001+088:00:00:02.000 N 30 12.0424 W 042 14.7309   SA
```

GPS Precision is either SA, DIFF or PCODE

Ewing Processed Shot Times ts.n

Shot times and positions based on the Ewing navigation data processing

```
CPU Time Stamp          Shot # Latitude      Longitude     Line Name
2000+079:00:08:01.507 000295 N 15 49.5703 W 060 19.7843 strike1
```

Shot Data Status ts.n.status

The ts.nxxx.status file describes the line information for that day, giving some basic statistics about the line: start, end times; missing shots; start and end shots.

```
LINE   strike1: 98+079:00:00:15.568 : 000283 .. 002286
        MISSING: 347, 410, 1727
LINE   dip2: 98+079:23:05:22.899 : 000002 .. 000151
```

This example says that on Julian Day 079 of 1998, two lines (strike1 and dip2) were run: the end of strike 1 (shots 000283 to 002286) and the start of dip2 (shots 000002 to 000151).

Line strike1 had some missing shots in the data file (probably missing on the SEG−d header as well).

Spectra Shot Times — nb2.r

The shot times and positions based on the Spectra positioning; with raw tailbuoy range and bearing.

```
CPU Time Stamp         Shot # Latitude     Longitude     Line Name

2001+084:00:00:05.924 009245 N 23 31.2410 W 045 25.0894

                                    Tailbuoy
Latitude     Longitude     Range  Bearing  Line Name

N 23 30.4540 W 045 21.4338 6389.8 283.2    KANE-4
```

Raw Gravity Counts — vc.r

```
sample BGM-3 gravity count record (without time tag):

pp:dddddd ss

|    |    |___________ status: 00 = No DNV error; 01 = Platform DNV
|    |                         02 = Sensor DNV;   03 = Both DNV's
|    |________________ count typically 025000 or 250000
|_____________________ counting interval, 01 or 10
                       The input of data can be at 1 or 10 seconds.
```

Gravity Data — vt.n

```
* A minus sign in the time stamp is flagged as a spike point
* m_grv3 calculates the Eotvos correction as:
  eotvos_corr = 7.5038 * vel_east * cos(lat) + .004154 * vel*vel
* 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
* Velocity smoothing is performed w/ a 5 point window

CPU Time Stamp         Latitude     Longitude     Model FAA     RAW

2000+148:00:10:00.000 N 09 34.7255 W 085 38.5826 1980  9.48    978264.16

Eotvos  Drift DC      Raw  Velocity     Smooth Velocity
Smooth  Total Shift   North    East     North    East

-74.78  0.06  4.16    1.875 -10.373     1.927 \10.166
```

Datum Time — ts2.r

```
CPU Time               Datum Time        Time Reference

2001+069:00:15:29.727 069 00 15 29.378 datum
```

Raw GPS — gp(12).d, tb1.d

Raw GPS is in NMEA Format.

Meteorological Data — wx

```
                         True
CPU Time Stamp        Spd Dir
2001+045:00:00:00.967   7.8  22

Bird1:                                        Bird 2
Speed                   Direction             Speed                    Direction
Inst  60sA   60mA  60sM  Inst 60sA 60mA       Inst  60sA  60mA  60sM    Inst 60sA 60mA

7.8   6.6    8.5   16.8  277  291  5          0.0   0.0   0.0   0.0     0    0    0

Temperature                  Humidity
Inst  60mA  60mm  60mM       Inst 60mm 60mM        Barometer

15.0  14.2  14.3  15.1       92   90   93          1027.5
```

```
Inst:       Current
60sA:       60 second average
60mA:       60 minute average
60sM:       60 second maximum
60mm:       60 minute minimum
60mM:       60 minute maximum
```

Shot Times from Spectra P1 Files — shots.p1

These files were created with the script: *extract_shots_from_p1* ***-a 1***

```
Epoch Time     Shot#  Source Lat/Lon        TB Lat      TB Lon
985788741.000 015570 30.283881 -41.854536  30.320144   -41.886642
Vessel Ref Lat/Lon    Antenna GPS Lat/Lon      Water Depth
30.283478 -41.854117 30.283531  -41.854078  2894.2
```

- Source is the Center of the Guns
- TB is the Tailbuoy, according to Spectra
- Vessel Ref is the location of the center of the Mast
- Antenna GPS is the location of Antenna 1 (-a 1 flag); in this case is the Tasmon GPS
- Water Depth is the HS Centerbeam depth

Shot Times from Spectra P2 Files — shots.p2

These files were created with the script: *extract_shots_from_p2 -o "V1 G1"*

```
Epoch Time   Shot#    Vessel Ref Lat/Lon    Source Lat/Lon
985716772.4 00015572 30.282803 -41.866136 30.283207 \41.866540
```

- Vessel Ref is the location of the center of the Mast
- Source is the Center of the Guns

I have included some scripts for extracting information out of the P1 and P2 formatted files. In order to use these scripts you will also need to install the Ewing Perl libraries I have included in the scripts directory, or at least include that directory in your PERL5LIB environment. It is not my intention to describe how to use perl in this document though.

extract_shots_from_p1 [−a antenna] [−h] filename

Given an input P1 File, create a shotpoint file with the times, and the positions of the given antenna [1 = tasmon, 2 = Trimble] and optionally the header records at the beginning of the file.

The output will be:

```
epochtime shotnumber sourcePos tbPos vesselPos antennaPos depth
```

- **epochtime** is the # of seconds since Jan 1, 1970
- **shotnumber** is the shot number
- **sourcePos** is the center position of the sound source [lat lon]
- **tbPos** is the position of the tailbuoy [lat lon]
- **vesselPos** is the position of the vessel reference (center of mast) [lat lon]
- **antennaPos** is the position of the specified antenna [lat lon]
  1 = tasmon, 2 = trimble
- **depth** is the water depth in meters

extract_shots_from_p2 [−s shotnumber] [−o "output values"]

−s define if you only want the statistics for a single shot

−o "*outputs*" defines the outputs you want from the P2 file.

This routine will output by default the shotpoint, the line name and the shot time. Optionally, you can output position (Lat Lon) info for a number of items:

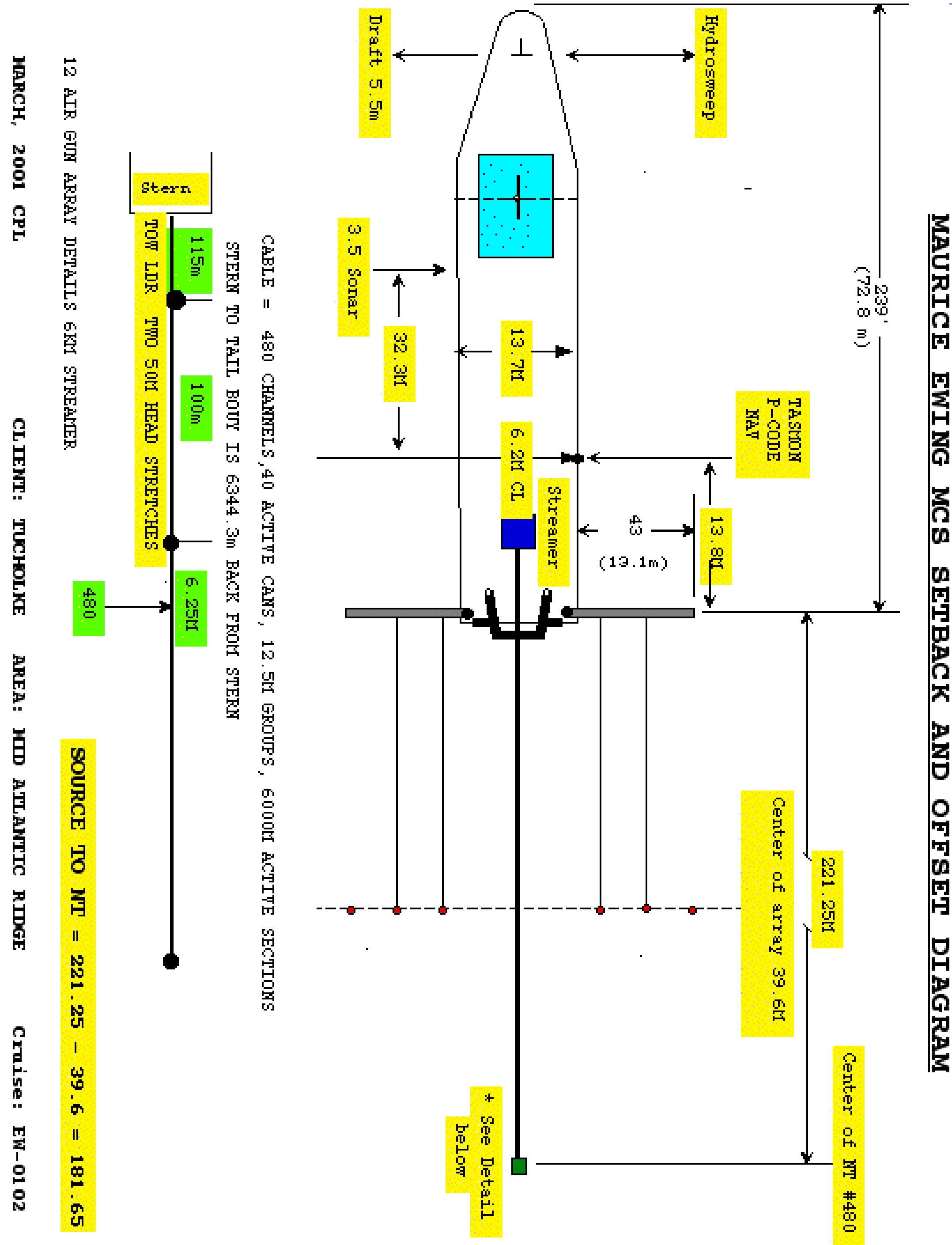
Outputs can be one or more of the following:

- V1 Vessel 1 Reference
- V1G1 Tasmon GPS Receiver
- V1G2 Trimble GPS Receiver
- V1E1 Hydrosweep Transducer
- TB1 Tailbuoy 1
- S1 Streamer 1
- V1SC Streamer Compasses
- G1 Gun Array 1

All the formats output a Lat Lon pair in decimal degrees. (*West and South being negative*)

Output will be: `epochtime   shotnumber   [output lat/lon pairs]`

Ship Diagram



Tape Contents

EW0104/

EW0104.pdf	this document
ew0104.cdf	NetCDF database file of this cruise
ew0104.cdf_nav	NetCDF database file of this cruise' navigation
docs/	File Formats, Spectra manuals
processed/	Processed datafiles merged with navigation
shotlogs/	processed Shot Files
trackplots/	daily cruise track plots (*postscript*)
raw/	Raw data directly from logger
reduction/	Reduced data files
clean/	daily processing directory, includes daily postscript plots of the data.
scripts/	Perl scripts and their friends
spectra/	P1/90 and P2/94 files from MCS lines
streamer/	Excel spreadsheets of streamer configuration