LAMONT-DOHERTY GEOLOGICAL OBERVATORY

DATA REDUCTION CRUISE SUMMARY

" DETAILED BATHYMETRIC AND GRAVITY SURVEY OF A SECTION OF THE `SUPERFAST` SOUTHERN EAST PACIFIC RISE AND WILKES TRANSFORM 7^{o}S-10^{o}S"

VALPARAISO, CHILE -- EASTER ISLAND, CHILE

08/04/91 (JD 216) -- 09/11/91 (JD 260)

CHIEF SCIENTIST: James R. Cochran

DATA REDUCTION: Suzanne O'Hara

R/V *MAURICE EWING*

EW-9105

SCIENCE OVERVIEW:

The purpose of the field program carried out on R/V Maurice Ewing cruise EW9105 was to conduct detailed bathymetry and gravity survey of a section of the "superfast: southern East Pacific Rise between roughly 7ºS and 9ºS and of the 150 km offset Wilkes transform which bounds that ridge segment to the south.The objectives of the survey were to investigate:

1. the relationship between anomalous gravity and anomalous bathymetry (not explained by a cooling plate model) along the ridge crest, and the manner in which these parameters and their variation along the ridge axis are related to the mass and temperature distribution and to dynamic processes under the axis.
2. changes in the in isostatic mechanism with distance from the ridge axis.
3. distribution and size characteristics of abyssal hills and off-axis volcanic features.
4. characteristics of a fast-slipping transform fault.

TRUE TIME CLOCK:

Instrument: *Kinemetric/TrueTime Division Model 468-DC*
Kinemetric/TrueTime Division Model GPS-DC GPS Synchronized Clock
Logging: 1 minute intervals
Checking: visual check of plot of data

Note:
Both true time are connected to a 5065A Rubidium Vapor Frequency Standard and GPS-DC true time is being used throughout the cruise to calibrate the data.

SPEED AND HEADING:

Instrument: *Furuno CI-30 2-axis Doppler speed log, Sperry MK-27 gyro*
Logging: 3 second intervals
Checking: visual check of plot of data
Smoothing: mean value of all good values within the same minute

TRANSIT SATELLITE FIXES:

Instrument: *Magnavox MX-1107RS dual frequency Transit satellite receiver*
Logging: all fixes
Checking: reject receiver flagged fixes, fixes with high drifts in navigation

GPS SATELLITE FIXES:

Instrument: *Magnavox T-Set Global Positioning System receiver*
Logging: 2 second intervals on GPS set #1 and
20 second intervals on GPS set #2
Checking:
minimum number of sats: 2
dilution of precision maximum: north = 6.0, east = 6.0
carrier signal-noise ratio minimum: 35.0
standard deviation maximum: north =6.0, east = 6.0
time step maximum: 3
speed maximum: 15.0
compared GPS speed and course with Furuno smooth speed and heading
compared positions with Transit-Furuno navigation
reject fixes with high drifts in navigation
reject fixes producing Eotvos correction errors in gravity
Interpolation: interpolated positions at 00, 30 seconds of each minute
Smoothing: smoothed interpolated positions with 9 point running average

Note:
GPS Set #1 was used on both URI navigation and LAMONT navigation

NAVIGATION:

A "1 minute navigation" is produced from the above sources. Acceptable fixes are merged at 1 per minute with priority given to GPS.The smooth speed and heading data is used to fill any gaps of 2 minutes or longer between fixes by computing 1 minute DR'ed positions corrected for set and drift between fixes. The DR'ed positions are produced at 00 seconds of each minute.

Chief scientist's final data: 1 minute navigation.

FORMAT: 9106n.ddd
yy+ddd:hh:mm:ss.mmm N 12 12.1234 E 123 12.1234 id 123.1 12.1
yr day time lat lon id set drift

Lamont database: 1 minute navigation.

Note :
The final navigation was processed by Suzanne O'Hara during the cruise.

BATHYMETRY:

Instrument: *Krupp Atlas Hydrosweep Center Beam*
Logging: At each ping of *Hydrosweep*, data is being broadcasted real time to the network, which is received by data logger. The logger computer then extracted the center beam depth.
Checking: minimal visual check of plot of the interpolated data

Chief scientist's final data: final calibrated and cleaned data
Depth is in meters.

FORMAT: 9106hb.nddd
yy+ddd:hh:mm:ss:mmm N 12 12.1234 E 123 12.1234 2222.0
yr day time lat lon depth_in_meters

Lamont database: final calibrated and cleaned data.
Depth is in fathoms.

Note:
The *Hydrosweep* instrument hasn't been performing very well. It is apparent in the number of spikes and the general noise seen in the data.The data was cleaned minimally to preserve its contour.

DAY	TIME	COMMENTS
216	0500	started logging
260	0208	end of cruise ; stopped processing data

MAGNETICS:

Instrument: *Varian V75 magnetometer*
Logging: 6 second intervals
Checking: visual check of plot of data
Reference field: International Geomagnetic Reference Field 1985 (*IGRF 1985*) model of the main field at 1985.0 and a predictive model of the secular variation for adjusting to dates between 1985.0 and 1990.0.
Residual field: Applied by bi-linear interpolation across a 1 degree square.

Chief Scientist's final data: final calibrated and cleaned data.

FORMAT: 9106mg.nddd
yr+ddd:hh:mm:ss.mmm N 12 12.1234 E 123 12.1234 41200.8 -367.1
yr day time lat lon total_intensity anomaly

Lamont Database: interpolated total intensity value at 00 second of each minute

NOTE:

DAY	TIME	COMMENTS

217	0120	started logging
260	0208	maggie off the water, end of logging

BGM-3 GRAVITY:

Instrument: *Bell Aerospace BGM-3 marine gravity meter*
Logging: 1 second intervals
Merge with navigation: calculate Eotvos correction and Free Air Anomaly.
Checking: visual check of plot of data to determine satisfactory Eotvos corrections.
Velocity smoothing: 5 point running average throughout the cruise

Chief scientist's final data: none.

1980 theoretical gravity formula:

$$Y_0 = 978.0327 \times (1 + .0053024 \times \sin(\Theta) \times \sin(\Theta) - .0000058 \times \sin(2 \times \Theta) \times \sin(2 \times \Theta))$$

FORMAT: 9106vt.nddd

yy+ddd:hh:mm:ss.mmm N 10 20.1234 W 120 23.1234 1980 77.1
yr day time lat lon theog FAA
979317.5 64.1 1.5 10.2 -1.7 9.7 -1.6 9.8
raw_grav eotvos drift dc_shift raw_vel smo_vel

Lamont database: none.

Note:

The BGM-3 data was determined to be inaccurate through out the entire cruise. The data was collected and processed by Suzanne O'Hara, but not used as the final data.

As a result of the discussion amongst the MG&G group, it is decided that Lamont Data Reduction will use gravity Ref. value without Potsdam correction for gravity data sent to MG&G data base at Lamont.

Further discussion also revealed that *1980 theoretical gravity formula* has incorporated Potsdam correction in its formula.

DAY	TIME	COMMENTS
216	0024	started logging
260	2359	end of cruise; stopped processing

KSS-30 GRAVITY:

Instrument: *Bodenseewerke KSS-30 marine gravity meter*
Logging: 6 second intervals
Merge with navigation: calculate Eotvos correction and Free Air Anomaly.
Checking: visual check of plot of data to determine satisfactory Eotvos corrections, reject spikes of data at turns.
Velocity smoothing: 5 point running average throughout the cruise

Chief scientist's final data: Observed, Eotvos, Free Air Anomaly value
at 00 seconds of each minute.
1980 theoretical gravity formula:

$$Y_0 = 978.0327 \times (1 + .0053024 \times \sin(\Theta) \times \sin(\Theta) - .0000058 \times \sin(2 \times \Theta) \times \sin(2 \times \Theta))$$

FORMAT: 9106vk.nddd

```
yy+ddd:hh:mm:ss.mmm N 10 20.1234 W 120 23.1234 1980  77.1
yr   day     time                lat              lon              theog  FAA
979317.5   64.1   1.5  10.2  -1.7  9.7  -1.6  9.8
raw_grav eotvos drift dc_shift raw_vel  smo_vel
```

Lamont database: Free Air Anomaly value at 00 seconds of each minute.
1930 International gravity formula.

Note:

KSS-30 is used as the primary gravity source.

As a result of the discussion amongst the MG&G group, it is decided that Lamont Data Reduction will use gravity Ref. value without Potsdam correction for gravity data sent to MG&G data base at Lamont.

Further discussion also revealed that *1980 theoretical gravity formula* has incorporated Potsdam correction in its formula.

DAY	TIME	COMMENTS
216	0103	started logging
260	0206	end of cruise; stopped processing

PRE-CRUISE GRAVITY TIE-IN:

Port: Valparaiso, Chile
Date: July 27, 1991 (JD 208)
Operator: Joe Stennett
Reference Station: ACIC 0301-1, 33 02' S 71 37' W
Pier/Ship's position: at pier, 33 02' S 71 37' W
Gravity meter: *L & R Model G, serial number 237.*
Temperature of meter: 49 C.
Readings and Calculations:

TIME	LOCATION	L&R READING	G	Potsdam Corr?
1406Z	Pier	3242.5+- .05		
1431Z	Ref	3241.5+- .05	979632.5	NO
1445Z	Pier	3242.5+- .05		

TIME	GRAVITY	G READING
1720Z	BGM-3	979720.4
1720Z	KSS-30	-533.51

Pier reading 1.5 m above waist deck. Waist deck is 5.5 m above gravity lab.
Difference between pier and gravity lab : 5.5 + 1.5 = 7.0 m.

Lacoste difference in LR units:
delta_LR = pier_LR - ref_LR
1.0 = 3242.5 - 3241.5

Difference in mgal: (1 LR unit = 1.06 mGals)
delta_mgal = delta_LR x constant
1.06 = 1.0 x 1.06

Pier gravity value in mgal:
pier_grv_val = ref_val + delta_mgal
979633.56 = 979632.5+ 1.06

Height correction:

Height correction in mgal:
note: free-air constant of +0.31 mgal per meter going towards the center of earth; -0.31 mgal per meter going away.
hgt_corr = hgt x constant
2.17 mGal = 7.0 x 0.31 mGal/m

Gravity at gravity lab level in mgal:
grv_at_lab_level = pier_grv_val + hgt_corr
979635.73 = 979633.56 + 2.17

BGM-3:

BGM_filt_grv = (scale factor x counts) + bias = 979720.4
using s.f. 4.952164 and bias 855758.1, filter width 480. (8 minutes)

Mistie in mgal:

mistie	= BGM_grv_val	- grv_at_lab_level
84.67	= 979720.4	- 979635.73

Drift in mgal since last tie:

prev_mistie: 65.1 mgal on date June 15, 1991

drift	= mistie - prev_mistie
19.57	= 84.67 - 65.1

KSS-30:

KSS_grav_val	= kss_unbiased_output	+ bias
979636.78	= -533.51	+ 980170.29

Mistie in mgal:

mistie	= KSS_grv_val	- grv_at_lab_level
1.05	= 979636.78	- 979635.73

Drift in mgal since last tie:

prev_mistie: 1.5 mgal on date June 15, 1991

drift	= mistie - prev_mistie
-0.45	= 1.05 - 1.5

POST-CRUISE GRAVITY TIE-IN:

Port: Nuku' Alofa, Tonga
Date: Oct. 24, 1991 (JD 297)
Operator: Robert Blaes, Sarah Kruse
Reference Station: ACIC 377-1
Pier/Ship's position: at pier, 21 08.19 S 175 10.86 W
Gravity meter: *L & R Model G, serial number 237.*
Temperature of meter: 49 C.
Readings and Calculations:

TIME	LOCATION	L&R READING	G	Potsdam Corr?
0433Z	Pier	2523.46+- .05		
0342Z	Ref	2523.02+- .05	978871.23	NO
0441Z	Pier	2523.44+- .05		

TIME	GRAVITY	G READING
0441Z	BGM-3	978985.7
0441Z	KSS-30	-1293.07

Pier reading 0 m above waist deck. Waist deck is 5.5 m above
Difference between pier and gravity lab : 5.5 + 0= 5.5 m.

Lacoste difference in LR units:
delta_LR = pier_LR - ref_LR
0.43 = 2523.45 - 2523.02

Difference in mgal: (1 LR unit = 1.06 mGals)
delta_mgal = delta_LR x constant
0.46 = 0.43 x 1.06

Pier gravity value in mgal:
pier_grv_val = ref_val + delta_mgal
978871.69 = 978871.23+ 0.46

Height correction:

Height correction in mgal:
note: free-air constant of +0.31 mgal per meter going towards the center of earth; -0.31 mgal per meter going away.
hgt_corr = hgt x constant
1.71 mGal = 5.5 x 0.31 mGal/m

Gravity at gravity lab level in mgal:
grv_at_lab_level = pier_grv_val + hgt_corr
978873.4 = 978871.69 + 1.71

BGM-3:

Mistie in mgal:

mistie = BGM_grv_val - grv_at_lab_level
112.3 = 978985.7 - 978873.4

Drift in mgal since last tie:

prev_mistie: 84.67 on date July 27, 1991
drift = mistie - prev_mistie
27.63 = 112.3 - 84.67

==> ***DC Shift*** = prev_mistie
= 84.67
Drift/Day = drift / (tot. # of day)
= 27.63 / (297-208)
= 27.63 / 89 = 0.3104

KSS-30:

KSS_grav_val = kss_unbiased_output + bias
978877.22 = -1293.07 + 980170.29

Mistie in mgal:

mistie = KSS_grv_val - grv_at_lab_level
3.82 = 978877.22 - 978873.4

Drift in mgal since last tie:

prev_mistie: 1.05 on date July 27, 1991

drift = mistie - prev_mistie
2.77 = 3.82 - 1.05

==> ***DC Shift*** = prev_mistie - bias
= 1.05 - 980170.29
= -980169.24
Drift/Day = drift / (tot. # of day)
= 2.77 / (297-208)
= 2.77 / 89 = 0.0311