Lamont-Doherty Earth Observatory of Columbia University

DATA REDUCTION CRUISE SUMMARY

EW-9505

Heat Flow, Pore Pressure Chemical Gradients and Physical Survey of Middle Valley, northern Juan de Fuca Ridge

Eureka, CA - San Franscisco, CA, U.S.A.

06/10/95 (JD 161) - 07/08/95 (JD 189)

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R/V MAURICE EWING

Participants:

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Science Crew

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R/V EWING Crew

Jim O'Loughlin - Master R/V EWING
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David Phillips - 3rd Mate
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Blaine Heinze - A/B
David G. Graham -A/B
Darrell A. Hanna - A/B
Rick Wyatt - O/S
John ??? - O/S

Al Karlyn - Chief Engineer R/V EWING
Matt Tucke - First Engineer
David Reid - 2nd Engineer
Sport ??? - 3rd Engineer
Miguel ??? - Oiler
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Fernando Uribe - Oiler
Francisco Matos - Electrician

Andrew Blythe - Steward
John Smith - Cook
Luke Moqo - Utility
Peter Martin - Radio Operator

SCIENCE OVERVIEW:

EW-9505 is to be a detailed survey of heat flow, pore pressure, chemical gradients, and physical properties of the shallow sediments within and adjacent to 'areas of active venting' (AAVs) in Middle Valley, a sediment drift on the northern end of the Juan de Fuca Ridge.

TRUE TIME CLOCK:

Instrument: *Kinemetric/TrueTime Division Model GPS-DC GPS Synchronized Clock*
Logging: 1 minute intervals
NOTE: The True Time clock is used to adjust the CPU clock of the logging computer. The logging computer captures the continuous time records from the clock and provides these as a service to the rest of the network via a UDP broadcast. This enables the computers on the network to adjust their CPU times to UTC time.

DAY	TIME	COMMENTS
161	1900	start of cruise, started logging/processing
189	1300	end of cruise, stopped logging/processing

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

DAY	TIME	COMMENTS
161	1900	start of cruise, started logging/processing
184	0400	gyro stopped working, logging suspended.

NOTE:
A major problem was found in our gyro unit during this cruise. Unfortunately, we lacked the spare parts necessary to fix it while underway. As a temporary solution, we used our Ashtec 3DF to supply our heading over the water. So, in reducing the navigation from JD184 on, data from Ashtec 3DF was substituted in place of the Furuno data.

GPS SATELLITE FIXES:

Instrument: *Magnavox MX-4200 Global Positioning System receiver*
GPS Trimble NT200D
Logging: 10 second intervals on GPS MX-4200 #1
10 second intervals on GPS MX-4200 #2
Checking:
minimum number of SATs: 3
dilution of precision maximum: north = 4.0, east = 4.0
carrier signal-noise ratio minimum: 35.0
standard deviation maximum: north =4.0, east = 4.0
time step maximum: 3
speed maximum: 30.0
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 larger than 5 mGals
Interpolation: interpolated positions at 00, 30 seconds of each minute
Smoothing: smoothed interpolated positions with 9 or 41 point running average depending on the quality of GPS data and the sea state.

Note:
The GPS data has a sinusoidal wave which is assumed to come from some degrading of the GPS quality for civilian usage. This wave seems to vary in period and shapes and is not a perfect sine curve. The periods are less than 20 minutes. The amplitudes tend to vary over 24 hours and the sea state condition. This degrading produces a false ship's track in real-time navigation and introduces extreme errors, up to 10 mGals, in the Eotvos correction for the gravity. As this problem varies in its intensity depending on the sea state and GPS data quality itself, several methods of data reduction has been developed to achieve the best possible navigation.

1. A 9 point (4 minutes) GPS smoothing
2. A 9 point (4 minutes) GPS smoothing, decimated to a 20 min. fixes
3. A 41 point (20 minutes) GPS smoothing
4. A 41 point (20 minutes) GPS smoothing, decimated to a 20 min. fixes

It should be noted that the use of 41 point smoothing causes the turn to "widens". Hence, in the instances where a 41 point smoothing is called for, the GPS data at and around the turn are decimated to 20 minutes.

NOTE:
The scientist had brought along with them an Omnistar Differential Unit which was interfaced with one of our MX-4200. So, for this cruise, and also due to the malunction in the Furuno gyro, we are using a one minute differential fix to reduce the data, and while not available, we are using a 9 point (4 minutes) GPS smoothing, decimated to a 20 min. from GPS Trimble.

DAY	TIME	COMMENTS
161	1900	start of cruise, started logging/processing
189	1300	end of cruise; stopped logging/processing

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: n.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, in MGG format.

DAY	TIME	COMMENTS
161	1900	start of cruise, started logging/processing
189	1300	end of cruise; stopped logging/processing

SEA TEMPERATURE:

Instrument: *Omega DP10 Series*
Logging: 1 minute intervals
Checking: none
Smoothing: none

Chief scientist's final data: none.
Lamont database: one minute data, merged with navigation.

FORMAT: ct.nddd

yy+ddd:hh:mm:ss:mmm N 12 12.1234 E 123.1234 26.3
yr day time lat lon sea_temp (in ^{o}C)

DAY	TIME	COMMENTS
161	1900	start of cruise, started logging/processing
189	1300	end of cruise; stopped logging/processing

ADCP (Acoustic Doppler Current Profilers):

Instrument: *RD Instrument RD-VM Model ADCP*
Logging: logging is done by a 386 IBM PC compatible
Checking: none
Smoothing: none

Chief scientist's final data: none.
Lamont database: processed data file format and navigation data file format.

FORMAT: Refer to Transect User's Manual for Narrowband ADCP Appendix B.

DAY	TIME	COMMENTS
161	1900	start of cruise, started logging/processing
184	0500	stopped logging, been in one area too long

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: Visual checking aided by graphic editor to remove major spikes.

Chief scientist's final data: final calibrated and cleaned center beam data, two nearest point to the minute interpolated to even minute.
Merged with final navigation.
Depth is in meters.

FORMAT: hb.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, interpolated to even minute.
Merged with final navigation. MGG format.
Depth is in fathoms.

NOTE: The survey are covered in this cruise is less than 1 sq. mile. Due to many accoustic instruments that the scientists brought onboard, Hydrosweep was shut off for most the the time station work was done.

DAY	TIME	COMMENTS
161	1900	start of cruise, started logging/processing
189	1300	end of cruise; stopped logging/processing

WEATHER STATION:

Instrument: *R.M/. Young Precision Meteorological Instruments 26700 Series*
Logging: 1 minute interval
Checking: none

Chief scientist's final data: none.
Lamont database: as is.

FORMAT: wx.rddd

Port bird is bird #1; starboard bird is bird #2.

94+022:00:00:00.244 9.3 15.4 13.2 21.1 271 261
date time wsi1 wss1 wsm1 wsx1 wdc1 wds1

6 12.6 15.9 15.6 20.7 261 253 6 66.7 66.7
wdm1 wsi2 wss2 wsm2 wsx2 wdc2 wds2 wdm2 tcur tavg

66.5 67.0 66 58 68 1016.8
tmin tmax rh rhn rhx baro

wsi1/2 = wind speed, instantaneous, bird #1/#2
wss1/2 = wind speed, 60 second average, bird #1/#2
wsm1/2 = wind speed, 60 minute average, bird #1/#2
wsx1/2 = wind speed, 60 minute maximum, bird #1/#2
wdc1/2 = wind direction, current, bird #1/#2
wds1/2 = wind direction, 60 second average, bird #1/#2
wdm1/2 = wind direction, 60 minute average, bird #1/#2

tcur = temperature, current
tavg = temperature, 60 minute average
tmin = temperature, 60 minute minimun
tmax = temperature, 60 minute maximum

rh = relative humidity
rhn = relative humidity, 60 minute minimum
rhx = relative humidity, 60 minute maximum

baro = barometric pressure

DAY	TIME	COMMENTS
161	1900	start of cruise, started logging/processing
189	2100	end of cruise; stopped logging/processing

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, reject spikes of data at turns.
Velocity smoothing: 5 point running average throughout the cruise.
Processing:

Since current BGM-3 output has double counts every few minutes the following scheme has been implemented until the hardware and interface code has been fixed:

(1) Run a 1 minute Gaussian filter through the data. This will narrow the output spikes and make them stand out better. Output interval has been hard-wired to every 15 seconds.

(2) Pass the output through filter1d (see gmtsystem) using -FG480 (an 8 minute Gaussian filter with robust option, i.e., ignore "outlier" points (i.e. the spikes).

Calculation:

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

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: vt.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.
1980 International gravity formula.

Note:

A '-' sign after the year in the record signifies a flagged record due to turn.
The survey are covered in this cruise is less than 1 sq. mile. Due to the type of work we did on this survey (coring, heat probe), we spent most of the time with the ship on station, and adrift. This is turn produced gravity data that is of very little. Therefore, for most of the station area, gravity data was flagged as bad.

DAY	TIME	COMMENTS

161	1900	start of cruise, started logging/processing
187	2300	pitch gyro went bad ; no data for the remainder of the cruise

PRE-CRUISE GRAVITY TIE-IN:

Port: San Diego, CA, U.S.A.
Date: May 14, 1995 (JD 134)
Operator: Bruce A. Francis
Reference Station:

Relative Station "DN9" made to an absolute benchmark at Elliot Field (20 miles away)
Date: 16 June 1989
Position: N 32º 42.003' W 117º 09.624'\
Gravity value: 979512.23
Station is located at San Diego 10'th Ave. Pier, across from berth 3 warehouse loading dock #9, at a large cleat on the berm of the pier.

Pier/Ship's position:

R/V Ewing was docked at San Diego 10'th Ave. pier, across from 10'th Ave termnal building. The tie point was taken right at 4'th bollard from the end of the pier.

Readings and Calculations:

TIME	LOCATION	L&R READING	G	Potsdam Corr?
0600Z	Pier	3136.22+- .05		
0605Z	Ref	3135.88+- .05	979512.23	YES!

TIME	GRAVITY	G READING
0600Z	BGM-3	979545.70

"C" deck was 0.3 m ABOVE the pier.
"C" deck is 5.5 m above the gravity meter.
Difference between pier and gravity lab: 5.5 - .3 = 5.2 m

Lacoste difference in LR units:

delta_LR = pier_LR - ref_LR
0.34 = 3136.22 - 3135.88

Difference in mgal: (1 LR unit = 1.06 mGals)

delta_mgal = delta_LR x constant
0.36 = 0.34 x 1.06

Pier gravity value in mgal: ref_val = G (+13.6 if Potsdam corrected)

pier_grv_val = ref_val + delta_mgal
979526.19 = 979512.23 + 0.36 + 13.6

Height correction:

Height correction in mGals:

note: free-air constant of +0.31 mGals per meter going towards

the center of earth; -0.31 mGals per meter going away.
hgt_corr = hgt x constant
1.61 mGals = 5.2 x 0.31 mGals/m

Gravity at gravity meter level in mGals:

grv_at_meter_level = pier_grv_val + hgt_corr
979527.80 = 979526.19 + 1.61

BGM-3:

BGM_filt_grv = (scale factor x counts) + bias = 979545.70
using s.f. 5.0940744 and bias 8526800.
The count was filtered with a 60 filter width, run thru filter1d -FG480, and s_bgm

Mistie in mGals:

mistie = BGM_grv_val - grv_at_meter_level
17.90 = 979545.70 - 979527.80

Drift in mGals since last tie:

prev_mistie: 15.0 mGals on date March 27, 1995 (JD 086)
drift = mistie - prev_mistie
2.90 = 17.90 - 15.0

==> ***DC Shift*** = prev_mistie
= 15.0
Drift/Day = drift / (tot. # of day)
= 2.90/ (134-86) = 0.06042 mgals/day