![Lamont-Doherty Earth Observatory of Columbia University]

DATA REDUCTION CRUISE SUMMARY

EW-9504

Collaborative Research:

Late Pleistocene climate-induced fluctuations in California Current: a paleoceanographic study and ODP site survey.

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

05/17/95 (JD 137) - 06/07/95 (JD 158)

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R/V MAURICE EWING

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Science Crew

Bruce Francis, L-DEO, Science Officer
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R/V EWING Crew

Jim O'Loughlin - Master R/V EWING	*Al Karlyn* - Chief Engineer R/V EWING
Louis J. Mello - Chief Mate	*Matt Tucke* - First Engineer
Bill Smith - 2nd Mate	*David Reid* - 2nd Engineer
Jeffrey Sylvia - 3rd Mate	*Sport ???* - 3rd Engineer
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Blaine Heinze - A/B	*Michael L. Spruill* - Oiler
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Darrell A. Hanna - A/B	*Francisco Matos* - Electrician

Rick Wyatt - O/S

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

SCIENCE OVERVIEW:

EW-9504 was a busy c ruise. The primary objective is to survey drillsites for ODP leg 167. The surveys at most drill sites consisted of twin 80 c.i. water gun seismic reflection surveys, 3.5 KHz subbottom profiling, hydrosweep swath mapping, and piston coring. Occasional sites were cored with a multi-corer.

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
137	1900	start of cruise, started logging/processing
143	1300-2359	emergency port stop ; logging suspended
144	0000-0300	emergency port stop ; logging suspended
155	2210-2359	emergency anchor; logging suspended
156	0000-0810	emergency anchor; logging suspended
158	2100	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
137	1900	start of cruise, started logging/processing
143	1300-2359	emergency port stop ; logging suspended
144	0000-0300	emergency port stop ; logging suspended
155	2210-2359	emergency anchor; logging suspended
156	0000-0810	emergency anchor; logging suspended
158	2100	end of cruise; stopped logging/processing

<u>GPS SATELLITE FIXES</u>:

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.

Throughout this cruise, a 9 point (4 minutes) GPS smoothing, decimated to a 20 min. fixes were used to produce final navigation data.

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137	1900	start of cruise, started logging/processing
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144	0000-0300	emergency port stop ; logging suspended

155	2210-2359	emergency anchor; logging suspended
156	0000-0810	emergency anchor; logging suspended
158	2100	end of cruise; stopped logging/processing

NAVIGATION:

A "1 minute navigation" is produced from the above sources, which in this cruise is a 9 point (4 minutes) GPS smoothing, decimated to a 20 min. fixes. 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
137	1900	start of cruise, started logging/processing
143	1300-2359	emergency port stop ; logging suspended
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158	2100	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 $^{\circ}$C)

DAY	TIME	COMMENTS
137	1900	start of cruise, started logging/processing
143	1300-2359	emergency port stop ; logging suspended
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158	2100	end of cruise; stopped logging/processing

SHOT TIME & GUN DEPTH:

IInstrument: *L-DEO Time Tagger and GunDepth Interface*
Logging: Shot Time from the Time tagger. Gun Depth from Gun Depth Interface

FORMAT: ts.nddd (shot time)
      94+173:00:04:04.333 000172 N 40 56.5884 W 125 42.6913 mcs-6a
        SHOT TIME   shotnum   lat   lon   line name
FORMAT: dg.rddd (gun depth)
      94+173:00:04:04.333 13 13 13 13 13 13 13 13 ....
        SHOT TIME   GUN DEPTH

Note:

A '-' sign following the year means that shottime was not received in time. A CPU timetag is placed instead. This sometimes happens at the beginning of the line when the computer and the DMS-2000 are trying to get in sync with each other. No gun was fired, and no data is recorded to the tape.

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.

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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: At the beginning of EW-9414, a problem was found with the swath data coming
out of the Hydrosweep to the logging computer "olive". An "Unknown data type" error
message appeared in "get_hs" log file. Upon closer inspection, this message was
generated because the data coming out of the serial line seems to be mangled if it
happens to coincide with the pop of the seismic guns. It has yet to be determined whether
this was caused by the shock of the guns, or it was an acoustic-interference problem.

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158	2100	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

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158	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.

DAY	TIME	COMMENTS
137	1900	start of cruise, started logging/processing
143	1300-2359	emergency port stop ; logging suspended
144	0000-0300	emergency port stop ; logging suspended
155	2210-2359	emergency anchor; logging suspended

156	0000-0810	emergency anchor; logging suspended
158	1630-2100	gyro went offline ; bad data
158	2100	end of cruise; stopped logging/processing

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