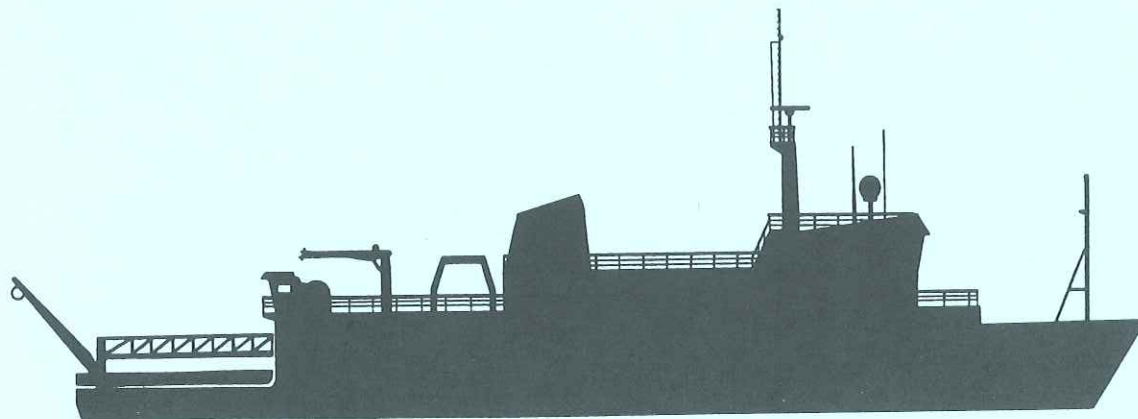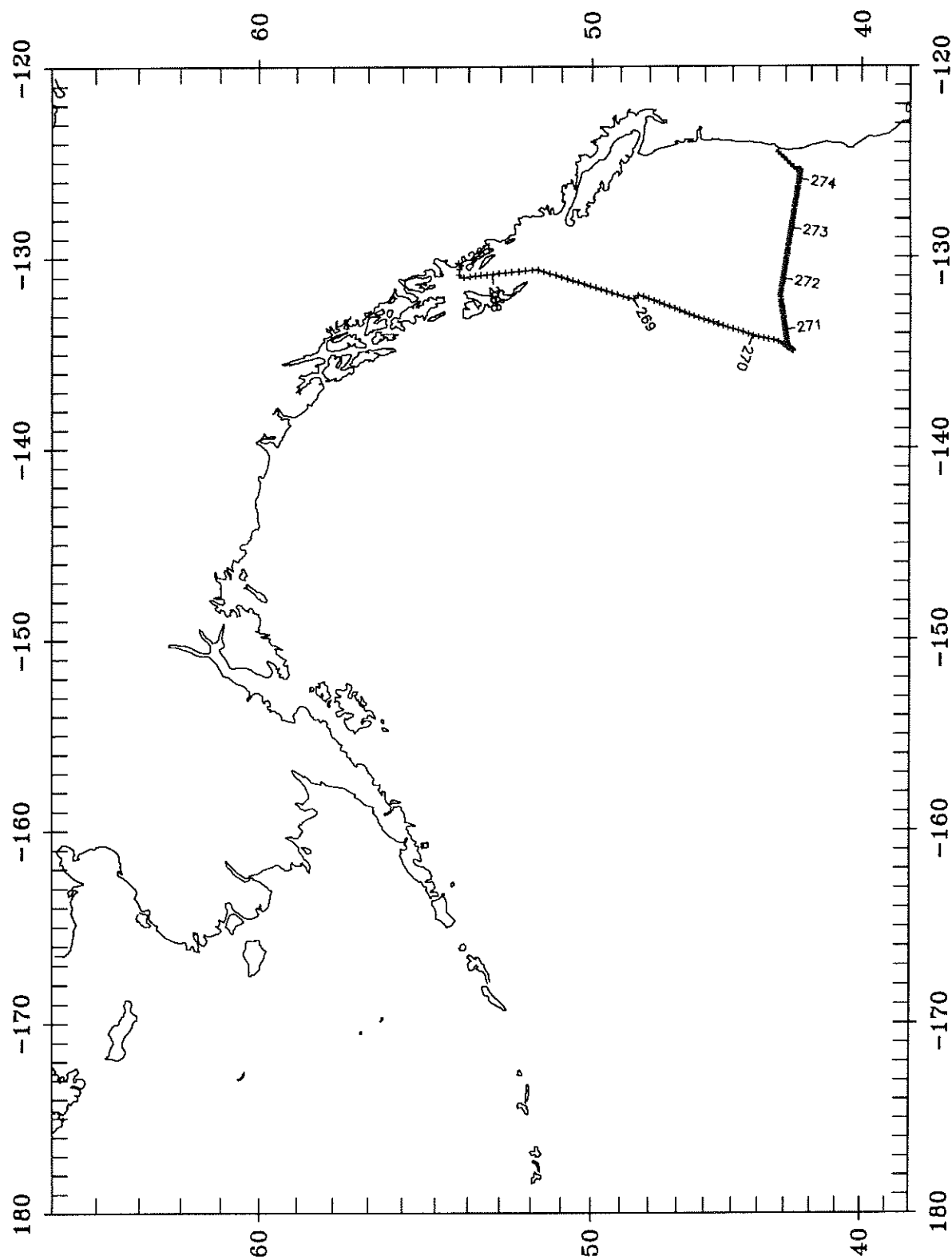# EW9413

R/V MAURICE EWING

LAMONT-DOHERTY GEOLOGICAL OBSERVATORY

COLUMBIA UNIVERSITY

EW9413 Prince Rupert – Coos Bays September 24 – October 1 1994

LAMONT DATA REDUCTION CRUISE SUMMARY
==

CRUISE: EW9413

START: 24 September 1994 [267]   Prince Rupert, Canada

END: 1 October 1994 [274]   Coos Bay, Oregon

SURVEY AREA: Multi-channel seismic transect of the Gorda Rise

CHIEF SCIENTIST: John Diebold – Lamont-Doherty Earth Observatory

DATA REDUCTION: William J. Robinson

****

TIME:

Instrument: Kinemetrics GPS Synchronized clock, Model GPS-DC
Logging: 60 second intervals

SPEED AND HEADING:

Instrument: Furuno CI-30 2-axis doppler speed log
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 from Transit #2 (bridge)
Notes:
        (1) NO Transit fixes were used in the navigation

GPS SATELLITE FIXES:

Instrument: Magnavox MX-4200D Global Positioning System receiver
Logging: 10 second intervals
Checking:
    minimun number of sats: 3
    dilution of precision (DOPs) maximum: north = 4.0, east = 4.0
    compared GPS speed and course with Furuno smooth speed and heading
    compared positions with Transit-Furuno navigation
    checked that GPS was satisfactory for gravity eotvos correction
Interpolation: interpolated positions at 00, 30 seconds of each minute
Smoothing: smoothed interpolated positions with 41 point running average
Notes:
    (1) The GPS data has a sinusoidal-like wave in it which is assumed to come
        from some degrading of the GPS quality for civilian users. This wave
        seems to vary in period and shape and is not a perfect sine curve. The
        periods are less than 20 minutes. The amplitudes and period will
        vary over 24 hours but always seem to be present in the data.
        This degrading produces a false ship's track for realtime navigation
        and introduces large errors, up to 4-5 mGals, in the Eotvos
        correction for the gravity. To handle this problem the following steps
        have been used to process the GPS:
        1. the smoothing has been increased from a 9 point (4 minute) running
           average of the interpolated positions to a 41 point (20 minute)
           running average.

2. this smooth GPS data is deleted at turns because the heavy smoothing greatly "widens" the turns.
3. the remaining smooth GPS data is decimated to 20 minute intervals

These GPS processing steps, together with using the smooth speed and heading data from the Furuno for DR'ing between the decimated GPS positions produces good navigation and gravity data.

NAVIGATION:

A "1 minute navigation" is produced from the GPS and Furuno sources.
The smooth speed and heading data is used to fill the gaps between the
processed GPS positions by computing 1 minute DR'ed positions corrected
for set and drift. The DR'ed positions are produced at 00 seconds of each
minute.

BATHYMETRY:

Instrument: Atlas Hydrosweep DS
Logging: every ping
Checking: visual check of plot of data. Bad data points removed with
    an interactive graphics editor.
Sound Velocity: All days use a sound velocity of 1500 meters per second
Final data: interpolated depth value (meters) at 00 seconds of each minute

MAGNETICS:

Instrument: Varian V75 magnetometer
Logging: 6 second intervals
Checking: visual check of plot of data. Bad data points removed with
    an interactive graphics editor.
Reference field: International Geomagnetic Reference Field 1990 (IGRF 1990)
    model of the main field at 1990.0 and a predictive model of the
    secular variation for adjusting to dates between 1990.0 and 1995.0
Final data: median values at 00 seconds of each minute calculated from
    the values +-30 seconds of this time.
Notes:

(1) day	time	comment
267	2359	no data collected
268	0000-2359	no data collected
269	0000-2359	no data collected
270	0000-1917	no data collected
270	1918	magnetometer deployed for first time
274	0400	magnetometer onboard

GRAVITY:

Instrument: Bell Aerospace BGM-3 marine gravity meter
Logging: 1 second "counts"
Filtering: an observed gravity value in mGal is calculated by filtering
    the 1 second counts with a 360 second Gaussian filter, scaling the result
    and adding a bias. A value in mGal is calculated at 6 second intervals.
Smoothing: mean gravity values at 00 seconds of each minute calculated from
    the milligal values +-30 seconds of this time.
Merge with navigation: calculate Eotvos correction and Free Air Anomaly.
    The velocities, from the navigation, used in the Eotvos correction
    are smoothed with a 5 point running average for all days.
Checking: visual check of plot of data to determine satisfactory Eotvos
    corrections, delete spikes of data at turns

Dc shift: 10.9 mGal from pre-cruise tie
Drift rate: 0.0216 mGal per day
Pre-cruise Tie date: 02 September 1994 (day 245) at 2100 Z
        Dutch Harbor, Alaska
Post-cruise Tie date: 23 October 1994 (day 296) at 1920 Z
        San Diego, California
Final data: Free Air Anomaly value at 00 seconds of each minute.
        1980 theoretical gravity formula.

Instrument: Bodenseewerks KSS-30 Marine Gravity meter
Logging: mGal values at 6 second intervals
Smoothing: mean values at 00 seconds of each minute calculated from
        the logged values +-30 seconds of this time. This stage also adjusts
        the times of the smoothed values for a 75 second delay due to the
        filtering of the gravity by the KSS-30.
Merge with navigation: calculate Eotvos correction and Free Air Anomaly.
        The velocities, from the navigation, used in the Eotvos
        correction are smoothed with a 5 point running average for all days
Checking: visual check of plot of data to determine satisfactory Eotvos
        corrections, delete spikes of data at turns
Dc shift: -980158.11 mGal from pre-cruise tie
Drift rate: -0.0171 mGal per day
Pre-cruise Tie date: 02 September 1994 (day 245) at 2100 Z
        Dutch Harbor, Alaska
Post-cruise Tie date: 23 October 1994 (day 296) at 1920 Z
        San Diego, California
Final data: KSS-30 data was not finalized; See note 1 below
Notes:
    (1) KSS-30 data was not finalized; DO NOT USE THE KSS-30 GRAVITY DATA
        There are tares in the KSS-30 gravity data of 8 mGals and other
        smaller jumps of 3-4 mGals. These tares will persist for varying
        lengths of time of several hours to a couple of days. The KSS-30
        recovers from these events and resumes agreement with the BGM-3
        data but the tares have been repeating.

```
EW9413    1994
=============
245 -- Sept    2 Pre-cruise gravity tie - Dutch Harbor
265 -- Sept   22 Arrival Prince Rupert 2
266 -- Sept   23
267 -- Sept   24 Depart Prince Rupert 2
268 -- Sept   25
269 -- Sept   26
270 -- Sept   27
271 -- Sept   28
272 -- Sept   29
273 -- Sept   30
274 -- Oct     1 Arrival Coos Bay
296 -- Oct    23 Post-cruise gravity tie - San Diego
```

Lamont Gravity Tie Report
==========================

R/V Ewing gravity meters:
        Bell Aerospace BGM-3 marine gravity meter
                scale factor = 5.0940744
                bias = 852680.0

        Bodenseewerk KSS-30 marine gravimeter

Port: Dutch Harbor, Alaska

Date: September 2, 1994   (day 245)

Operator: Joe Stennett

Reference Station:
        ACIC 2178-1

        reference value = 981552.07 mgals

Pier/Ship's position:
        R/V Ewing is at the "Arctic Ice" facility in Captain's Bay

Portable gravity meter:
        LaCoste & Romberg model G 237

Readings and calculations: Pier & Ref readings taken on September 2, 1994
        Readings on a wooden pier with some jiggle;
        probably +-0.1 mGal accuracy.

        Time   Location   L-R Reading
        1825Z   Pier   5035.35
        1855Z   Ref   5046.48
        2021Z   Pier   5035.25

        Lacoste difference in LR units:
                delta_LR = pier_LR - ref_LR
                delta_LR = 5035.25 - 5046.48
                delta_LR = -11.23

        Difference in mgal:
                note: 1 LR unit = 1.06 mGals
                delta_mgal = delta_LR * constant
                delta_mgal = -11.23 * 1.06
                delta_mgal = -11.90

        Pier gravity value:
                pier_grv_val = ref_val + delta_mgal
                pier_grv_val = 981552.07 + (-11.90)
                pier_grv_val = 981540.17 mgal

        Height correction:
                At 2100 Z on September 2, 1994 (day 245) Pier reading
                is 1.5 m above "C" Deck. It is 5.5 m between "C" deck
                and the gravity lab.

                Difference between pier and gravity lab = 7.0 meters

                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 * constant

```
                  hgt_corr = 7.0 m * 0.31 mGal/m
                  hgt_corr = 2.17 mGal


Gravity at BGM/KSS level:
                  grv_at_BGM/KSS_level =  pier_grv_val + hgt_corr
                  grv_at_BGM/KSS_level =  981540.17 + 2.17
                  grv_at_BGM/KSS_level =  981542.34 mgal



BGM-3 reading:
                  On September 2, 1994 (day 245) at 2100 Z
                  BGM_grv_val = 981553.20 mgal


BGM-3 Mistie:
                  BGM_mistie = BGM_grv_val - grv_at_BGM_level
                  BGM_mistie = 981553.20 - 981542.34
                  BGM_mistie = 10.86 mgal
                  BGM_mistie = 10.9 mgal


BGM-3 DC shift:
                  BGM_dc_shift = 10.9 mgal


BGM-3 Drift:
                  prev_BGM_mistie: 9.9 mgal on August 6, 1994 (day 218)

                  BGM_drift = BGM_mistie - prev_BGM_mistie
                  BGM_drift = 10.9 - 9.9
                  BGM_drift = 1.0 mgal

                  num_days = day - pre_day
                  num_days = 245 - 218
                  num_days = 27

                  BGM_drift_per_day = BGM_drift / num_days
                  BGM_drift_per_day = 1.0 / 27
                  BGM_drift_per_day = 0.0370 mGal / day


KSS-30 reading:
                  On September 2, 1994 (day 245) at 2100 Z
                  KSS_grv_val = 1384.23 mgal


KSS-30 DC shift:
                  KSS_dc_shift = KSS_grv_val - grv_at KSS_level
                  KSS_dc_shift = (1384.23) - (981542.34)
                  KSS_dc_shift = -980158.11 mgal


KSS-30 Mistie:
                  BIAS = 980170.29
                  KSS_mistie = BIAS + KSS_grv_val - grv_at_KSS_level
                  KSS_mistie = (980170.29 + (1384.23)) - 981542.34
                  KSS_mistie = 12.18 mgal


KSS-30 drift:
                  prev_KSS_mistie: 11.84 mgal on August 6, 1994 (day 218)

                  KSS_drift = KSS_mistie - prev_KSS_mistie
                  KSS_drift = 12.18 - 11.84
                  KSS_drift = 0.34 mgal

                  num_days = day - pre_day
                  num_days = 245 - 218
                  num_days = 27
```

```
KSS_drift_per_day = KSS_drift / num_days
KSS_drift_per_day = 0.34 / 27
KSS_drift_per_day = 0.0126 mGal / day
```

EW9413.README
===============

Files:

Daily files:
        The logged and reduced data are organized as sets of daily files.
        A filename is composed of 3 parts:
                (1) cruise id "ew9413" or NULL
                (2) data id   "mg.n"
                (3) dayofyear "258"

        example:
                ew9413mg.n258

        Note: The cruise id is NULL for the data files for ew9413.

".Z" files: files that end with a ".Z" have been compressed with
        the UNIX "compress" command. Use the "uncompress" command
        to make them readable

Directories:

LOGGER - contains the data files logged during the cruise with some
        minor editing or cleaning. These are referred to as the
        ".d" files.

SCCS - the directory holds the reduced files in the "sccs" format.
        The Source Code Control System (SCCS) that is used for program
        source files is also used for maintaining the data files. The
        SCCS facility serves as a backup and history mechanism for
        the data reduction process. Most files in SCCS are compressed,
        use the uncompress command and then issue the sccs command
                sccs get filename
        to get a copy of the file.

ADCP - Acoustic Doppler Current Profiler data

REPORT - cruise report files

PLOTS - PostScript plot files

shells - shell scripts that drive the data reduction

tmp - a temporary working directory

Time tagging:

During the logging process each record is tagged with the CPU's time.
This tag appears at the beginning of the record as

        yy+ddd:hh:mm:ss:mmm

where "yy" is the year, "ddd" is the day of year, "hh" is the hour,
"mm" is the minute, "ss" is the second and "mmm" is the millisecond
of the CPU time.

One of the preocesses on the logging computer logs the GPS True Time
clock once a minute and continuously sets the CPU clock to UTC time
from the true time clock.

The following data sets use this CPU time tag as their "offical"
time: magnetics, Furuno, Hydrosweep center beam, BGM-3 gravity,
KSS-30 gravity, sea temperature, wire/streamer data, meterological
data.

These data sets include their own internal times: GPS and Transit sat.

Flag field:

The third column is used as a flag field to indicate a bad or rejected
record.
        "+" = initial field
        "-" = rejected record

```
GPS MX-4200 Sat Fix (gp):
--------------------------

gp3 = GPS MX-4200D "3"
gp4 = GPS MX-4200D "4"

gp3.d - logged data (multiple records)

   93+258:00:22:12.282 $PMVXG,000,NAV,9,6,0000,0*02
   yy day    time                      status

   93+258:00:22:20.834 $PMVXG,001,002220,1832.421,S,03837.602,W,00026.1,2*4E
   yy day    time                      time        lat          lon

   93+258:00:22:21.066 $PMVXG,011,233.5,012.3,,,,,,,,*4F
   yy day    time                      course speed

   93+258:00:22:21.467 $PMVXG,022,260539.67,00.8,00.8,00.0,20,17,03,16,25,23*74
   yy day    time                      fix time   EDOP NDOP VDOP PRN 1-6

gp3.r - gps 4200 after cleaning

   same as gp3.d


gp3.i - interpolated positions at 00,30 sec of each minute

   yy+ddd:hh:mm:ss.mmm N 12 12.1234 W 123 12.1234   gp3
   yy day    time            lat          lon        id


gp3.s - smoothed postions at 00,30 sec of each minute

   yy+ddd:hh:mm:ss.mmm N 12 12.1234 W 123 12.1234   gp3
   yy day    time            lat          lon        id
```

Transit Sat Fix (sf):
----

sf2 = Transit Sat fix receiver #2

Furuno Speed and Heading (fu):
----

fu.d - speed & heading logged data (before cleaning stage)

        yy+ddd:hh:mm:ss.mmm - 12.1 123.1 123.1
        yr day   time   trk spd hdg gyro

        trk: "-" = water track, "+" = bottom track

fu.r - speed & heading data after cleaning stage

        same as fu.d

fu.s - smooth speed and heading data

        yy+ddd:hh:mm:ss.mmm - 12.1 123.1 20
        yr day   time   trk spd hdg number_pts
                                              in minute

```
Fix File (x):
-------------

x.   - fix file

        yy+ddd:hh:mm:ss.mmm N 12 12.1234 W 123 12.1234  id
        yy day    time               lat         lon            id_string

        id strings: "gp3" = GPS


One Minute Navigation (n):
--------------------------

n.   - 1 minute navigation from the "x." file and "fu.s" file

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


        id strings: "gp3" = GPS #1
                    "dr"  = Dead Reckoned position corrected
                            for set and drift error
```

```
Magnetics (mg):
-----------------

mg.d - total intensity logged data

        same as mg.r below

mg.r - total intensity magnetics after cleaning stage

        yy+ddd:hh:mm:ss.mmm 41200.8
        yr day    time         total_intensity

mg.m - median total intensity magnetics values at 00 seconds.
        (median of values +-30 seconds)

        yy+ddd:hh:mm:ss.mmm 41200.8
        yr day    time         total_intensity

mg.n - median values merged with navigation; anomalies 1990 IGRF

        yy+ddd:hh:mm:ss.mmm N 12 12.1234 E 123 12.1234 41200.8  -367.1
        yr day    time           lat          lon         total    anomaly
                                                          intensity



Hydrosweep center beam bathymetry (hb):
------------------------------------------

hb.d - center beam logged data

        same as hb.r below

hb.r - center beam data after "cleaning" of hb.d file

        yy+ddd:hh:mm:ss.mmm hh:mm:ss.mmm S 3445
        yr day    time           2nd_time   mode depth_in_meters

        mode: "S" for survey
        note: 2nd time is ignored

hb.i - interpolated center beam depth at 00 sec of each minute

        yy+ddd:hh:mm:ss.mmm 3445
        yr day    time         depth_in_meters

hb.n - interpolated center beam merged with navigation

        yy+ddd:hh:mm:ss:mmm N 12 12.1234 E 123.1234  2222.0
        yr day    time          lat          lon       depth_in_meters
```

```
BGM-3 Gravity (vt):
-------------------

vc.d - BGM-3 "counts" logged data

        same as vc.r below

vc.r - BGM-3 "counts" after "cleaning" of vc.d file

        yy+ddd:hh:mm:ss.mmm 01:025069 00
        yr day      time     int count  status

        int - count interval; 01 = 1 second

vt.r - mGal gravity values calculated from the counts

        yy+ddd:hh:mm:ss.mmm 979171.448000
        yr day      time      grav

vt.s - smooth BGM-3 values at 00 secs of each minute.
       (mean of values +-30 secs)

        yy+ddd:hh:mm:ss.mmm 979171.448000
        yr day      time      grav

vt.n - "vt.s" merged with nav with EOTVOS correction and FAA
       Note: "vt30.n" is merged data using 1930 theoretical formula

        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    raw_vel    smo_vel
                              shift   N    E     N     E
```

```
KSS-30 Gravity (vk):
--------------------

vk.d - logged data

        same as vc.r below

vk.r - data after "cleaning" of vk.d file

        yy+ddd:hh:mm:ss.mmm 90 365 2358 27C 3 -1018.25  0.0014  0.0046
        yr day      time      yr  day time    sea  grav    velocity velocity
                             (grv clock)   state

        note: grv clock not used

vk.s - smooth KSS-30 values at 00 secs of each minute. time adjusted
        for filter lag. (mean of values +-30 secs)

        yy+ddd:hh:mm:ss.mmm  0468.18
        yr day      time        grav

vk.n - "vk.s" merged with nav with EOTVOS correction and FAA
        Note: "vk30.n" is merged data using 1930 theoretical formula

        yy+ddd:hh:mm:ss.mmm N 10 20.1234 W 120 23.1234 1980   77.1
        yr day      time        lat            lon         theog  FAA

        0317.5    64.1   1.5  -980164.0   -1.7  9.7   -1.6  9.8
        raw_grav eotvos drift   dc        raw_vel      smo_vel
                               shift       N    E      N    E
```

```
Gun depths (dg):
----------------

dg.d - gun depths logged data

        same as dg.r below

dg.r - gun depths after cleaning stage

        yy+ddd:hh:mm:ss.mmm  63  72  74  ...  76  74  61  68  59
        yr day   time        gun depths (in meters x 10)



Shot times (ts):
----------------

ts.d - shot times logged data

        same as ts.r below

ts.r - shot times after cleaning stage

        yy+ddd:hh:mm:ss.mmm 00:02:30.113
        yr day cpu_time      shot time


Partial Nav Block data (nb):
----------------------------

nb.d - nav block logged data

        same as nb.r below

nb.r - nav block after cleaning stage

        yy+ddd:hh:mm:ss.mmm 15913 N 53 17.4460 W 166 59.4243 MCS1234c
        yr day shot_time    shot #  latitude   longitude     line

        latitude and longitude are those values at shot time


Shot time/Nav Block data remerged with final nav (ts.n):
--------------------------------------------------------

ts.n - shot time data merged with post processed navigation

        94+195:00:02:50.371 15913 N 53 17.4459 W 166 59.4171 MCS1234c
        yr day shot time    shot #  latitude   longitude     line

        latitude and longitude are from the post processed navigation
```

```
Streamer tension (wi):
----------------------

wi.d - streamer tension logged data

        same as wi.r below

wi.r - streamer tension after cleaning stage

        94+195:00:01:54.775 +3020.
        yr day cpu_time     tension (lbs)


Sea temperature (ct):
--------------------

ct.d - sea temperature logged data

        same as ct.r below

ct.r - sea temperature after cleaning stage

        yy+ddd:hh:mm:ss.mmm 0007.6 00
        yr day    time         temp (degrees C)
```