

FMS Processing Cookbook

A guide to processing ODP FMS, RAB, and UBI image logs with Geoframe

Any opinions, findings, and conclusions or recommendations expressed in this document are those of the author(s) and do not necessarily reflect the views of the National Science Foundation, Joint Oceanographic Institutions, Inc., or ODP member countries.

Contents

Contents.....	2
Introduction	3
Quick Summary.....	4
Set-up	5
Process Manager	8
Data Manager	9
Data Load	11
BorEID.....	13
Ascii Load.....	16
WellEdit.....	18
Depth Match (WellEdit)	19
BorNor	21
Data checking	23
DLIS Data Save.....	25
FMS averaging	29
RAB (LWD) Data Processing.....	31
UBI Data Processing.....	37
Appendix A. Scripts for making Gif files in a batch	40
Appendix B. Example Processing Documents for FMS, RAB and UBI	42
Appendix C. Blank FMS processing summary table.....	48
Appendix D. GPIT offset phenomena	49

Introduction

These notes are a ‘cookbook’ of recipes for processing ODP FMS data using Geoframe (Version 4.0.2, but other Geoframe versions will be similar). Some familiarity with Geoframe is assumed – it would be impossible to give a full introduction to Geoframe here. Some complementary GeoFrame instruction is given in the IESX Cookbook (www.ldeo.columbia.edu/BRG/ODP/ODP/IESX/index.html) and the Conventional Log Processing Cookbook. It is written so that someone who hasn’t processed FMS before would be able to try it – of course it would be better if someone who has done it before showed you and gave you a start. The steps described here are the ones we use to get the ‘official’ FMS images that go into the online log database, but you only need the basic steps to produce usable FMS images.

Quick Summary

1. Create one project for each leg, named like Leg 207_FMS.
2. Create Unix directories like: ~gf_data/FMS_proc/Leg207/1261B/p1_stat
3. Use a separate processing chain for each borehole in the **Process Manager**.
4. **Data Load** proprietary DLIS directly from Schlumberger CD.
5. Run the **BorEID** corrections. Get the water depth from conventional log processing document; slimhole FMS4; check speed correction (use sticking detection with a recovery speed = 3.0 first).
6. **Ascii Load** conventionally processed data: DIT (SFLU), GPIT (P1AZ), FMS calipers (C1,C2).
7. Start **WellEdit** with an FMS track and a conventional track for each pass. Shift Ascii-Loaded P1AZ up by 0.4572m (18 in.). Depth match BorEID P1AZ output (P1AZ.crc) to the shifted P1AZ. Pay attention when the P1AZ shifts between 360° and 0°. Save initial, DM, and Stat/Dyna WellEdit lgp templates.
8. Do normalizations in **BorNor**: dynamic (2m window) and static (establish start/stop depths from WellEdit).
9. Save the processed FMS as DLIS with **Data Save**. Select the Depth-Matched BorEID FMS4 collections and then edit out the unnecessary arrays.
10. Save the normalized FMS4 arrays as Ascii with the Data Manager 'Log Curve Viewer'. Save to files named like 'Leg207/1261B/p1_stat/1261B_p1_stat.dat'. Run **FMS_ascii2binary** and **fmaxgif.2.0** to make the gif files of the images.
11. Run **Average_FMS_2** to make hi-resolution resistivity curves from the FMS data.

Set-up

To set up a new GeoFrame Project, e.g. Leg206 FMS:

1. Start GeoFrame from the Geonet window – the Project Manager window will appear.
2. Press the ‘Project Management’ tab, and press ‘Create a new project’.
3. Enter a project name and password (set the password to be the same as the project name).
4. After a few minutes, the ‘Edit Project Parameters’ window will appear (below).
 - a. Set the Display Units to Metric, and edit them according to Table 1 (below). Save the Display Units as ‘ODP’ (to be consistent with the conventional processing Projects).

Edit Project Parameters

Project

Project Name: Leg192 Client: SLB

Creation Date: Oct 30 2000 Last Backup Date:

Reference Datum: Mean Sea Level Seismic Ref Elevation (m): 0.00

Description:

Unit/Coordinate System

Display Storage

Unit: Metric/ Metric_ODP Set Units...

Projection: Mercator Set Projection...

Datum: World Geodetic System 1984 Ellipsoid: WGS84

Compute Well Region

Min. Longitude (deg): 0.000000 OK Cancel

Min. Latitude:

Set Units

Unit: Metric/ Metric_ODP Inspect...

Unit System: Metric_ODP

Base Unit System: Metric Base Measurements Unit Synonyms

OverRide	Measurement	Unit
<input type="checkbox"/>	Acceleration	m/s2
<input type="checkbox"/>	Acoustic Impedance	kPa.s/m
<input type="checkbox"/>	Acoustic Slowness	us/ft
<input checked="" type="checkbox"/>	Acoustic Velocity	km/s

Save Save as ... Cancel

Table 1. Changing units from their default settings

Property	Unit	Log curve
Acoustic Velocity	km/sec	VELP, VELS
Count Rate	cps	GR
Force	lbf	TENS, DF
Magnetic Field Strength	Oe	FX, FY, FZ
Porosity	%	APLC
Short Length	Inches (in)	STOF
Velocity (for LWD ROP)	m/hr	ROP*

b. Press Set Projection, then press Create. Choose the World Geodetic System 1984 as the datum, and WGS84 as the ellipsoid. Choose Mercator projection. For FMS log processing, the projection settings don't matter, except that it is not possible to leave the settings blank. Press OK.

5. The Storage Settings window will appear. Choose /data/spaceman/gf_data (or whichever disk is available on the local system). The Geoframe administrator will have to set up a disk if none appear in the top list. The project is now set up, and you are connected to it.

6. Start the Application Manager. From there, open the Process Manager and the Data Manager.

Set up a directory for the leg data in Unix

A directory and subdirectories should be set up to take the gif image output of the FMS processing, as well as other files such as Welledit template files, FMS button average files, etc. The directories should be structured like:

```
/data/spaceman/gf_data/FMS_proc/
```

```
  Leg206/
```

```
    1256D/
```

```
      p1_stat/
```

```
      p1_dyna/
```

```
      p2_stat/
```

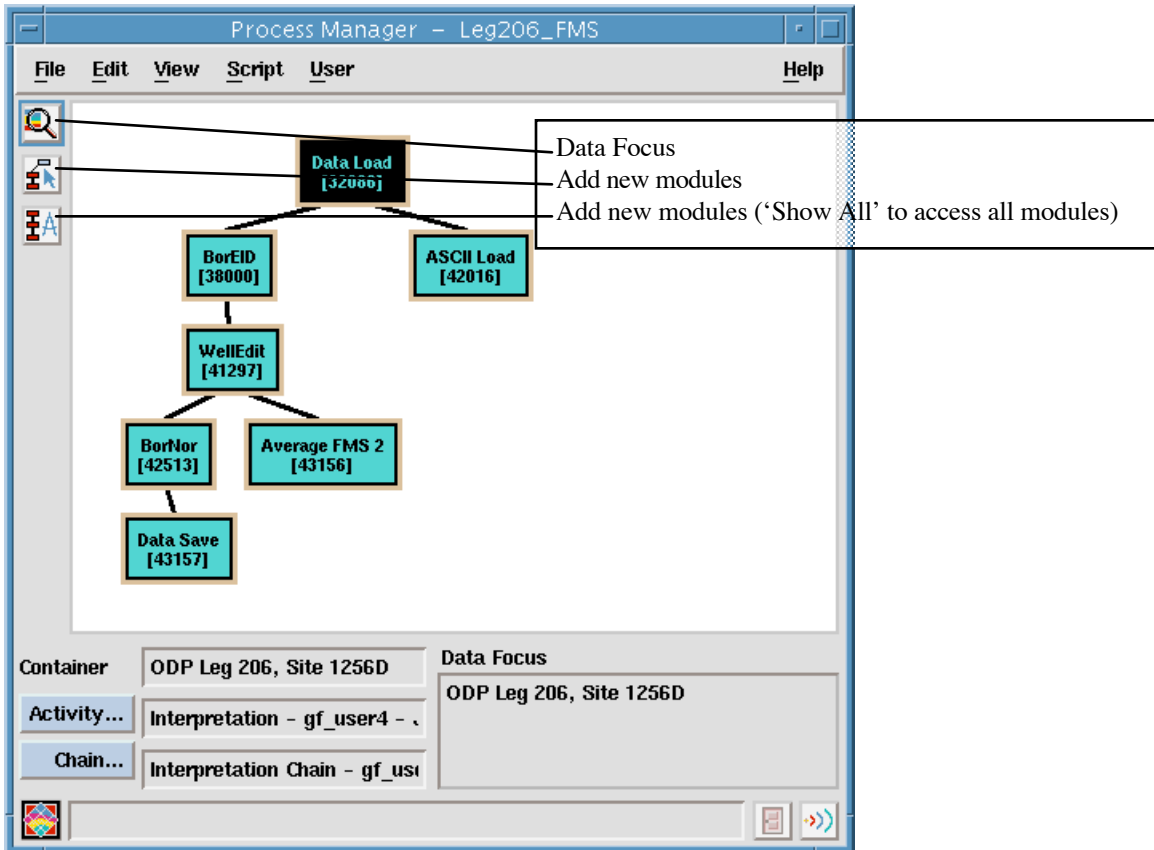
```
      p2_dyna/
```

```
      lgp_templates/
```

Output from the static normalization of pass 1 will go into the p1_stat directory, and so on.

Process Manager

The module chain used for FMS processing is shown below. In the Process Manager, set the 'Data Focus' of each module before you start the module, by using the magnifying glass icon in the left margin of the window. The Data Focus should normally be set to the Borehole level. A click with the left mouse button will select a module, and the right mouse button pops-up a menu from which you can start ("inspect" or "run") the module.



Data Manager

The hierarchy of data in Geoframe goes something like this:

e.g.

Project	Leg 181
Field	SW Pacific
Well	1123B
Borehole	1123B
Activity	e.g. Loaded data, depth-matched data, Interp. Chain
Service Run	Toolstring, Interpretation Chain
Tool Run	Tool
Module Run	Module

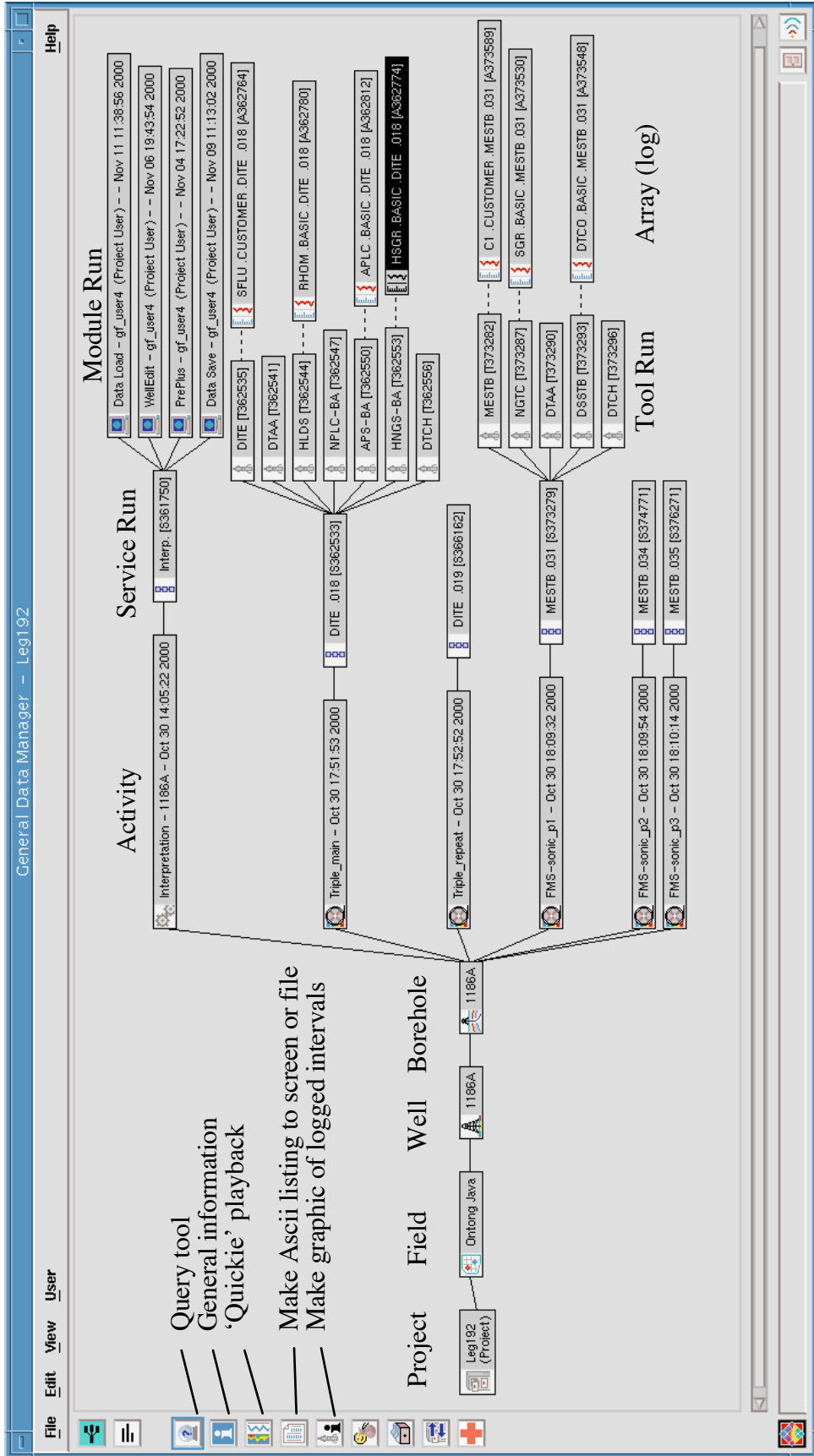
The Tool Run contains the arrays (logs) (e.g. SGR, POTA, etc) collected by an individual logging tool (e.g. NGT).

The Module Run contains the arrays (logs) that are output by a particular module (e.g. the BorEID output FMS4.EID will be found here).

In the general Data Manager, make good use of the 'Query Tool' (it's the crystal ball icon in the left margin of the window). It's the best way to find the locations of useful arrays (logs) such as FMS4, *SGR, P1AZ, etc. Select Find All 'Arrays' with 'Code' (then enter the code, like SGR).

Also be aware that FMS images are also listed as "collections", which contain the FMS image array (FMS4), all the associated inclinometry, the caliper logs, sometimes the gamma ray log, and some parameters like the bit size.

Illustrating the basic layout of the data items in the General Data Manager.



Data Load

Data from the drilling leg arrives at Lamont on a CD made by the Schlumberger engineer.

The data is copied to the data archive

(/data/web_brg0/WWW_BRG/archive/ODP_data_prop).

- 'Inspect' the Data Load module (from the right mouse button pup-up menu) and enter the path and filename of the dlis files you want to load.

- Leave the Field, Well, and Borehole blank if this is the first data load of the borehole; they will be taken from the headers in the DLIS file. If the borehole already exists in Geoframe, enter the existing Field, Well, and Borehole names into Data Load.

- Enter SLB (Schlumberger) for the Producer; use the Default Merge template; make sure no array filters are set. Run the module.



Loading data from a DLIS tape:

You can load the Schlumberger proprietary DLIS tape directly into Geoframe (a), or you can save it first to disk, and then import it into Geoframe (b).

(a) Choose Source: 'Tape'; enter '/dev/rmt/2lbn' as the path (may be different for different computers. The 'lbn' seems to be important). N.B. there is no tape drive on spaceman, you have to rlogin to brg0 as the same user, and run Geonet, Geoframe, and data load from there.

(b) Run DLISU from the Geoframe Xterm window. Open a Geoframe Xterm from the Geonet menu, navigate to the directory containing the dlis file (e.g. the archive, /data/web_brg0/WWW_BRG/archive/ODP_data_prop/Leg206/1256D). Type dlisu at the prompt:

```
DLISU> a i=/dev/rmt/0lbn      (assign input = )
DLISU> a o=1234A.dlis        (from the directory you want the file placed in)
DLISU> copy
DLISU> exit
```

DLISU can also be used to check the contents of the DLIS file:

```
DLISU> a i=1234A.dlis        (assign input = )
DLISU> display static file
DLISU> display frame summary
DLISU> list                  (lists a summary of the contents of DLIS file)
DLISU> exit
```

Then run Data Load: choose Source: 'File'; enter the path to the file.

If you have a tar tape with a DLIS file on it

- Do 'tar tvf /dev/rmt/0' to get a listing of what is on the tape, and 'tar xvf /dev/rmt/0' to extract the files from the tape.
- Check the DLIS file using DLISU, as above.
- Run Data Load – choose Source: 'File'; enter the path to the file.

BorEID

BorEID is used to perform the basic corrections on the FMS data, including:

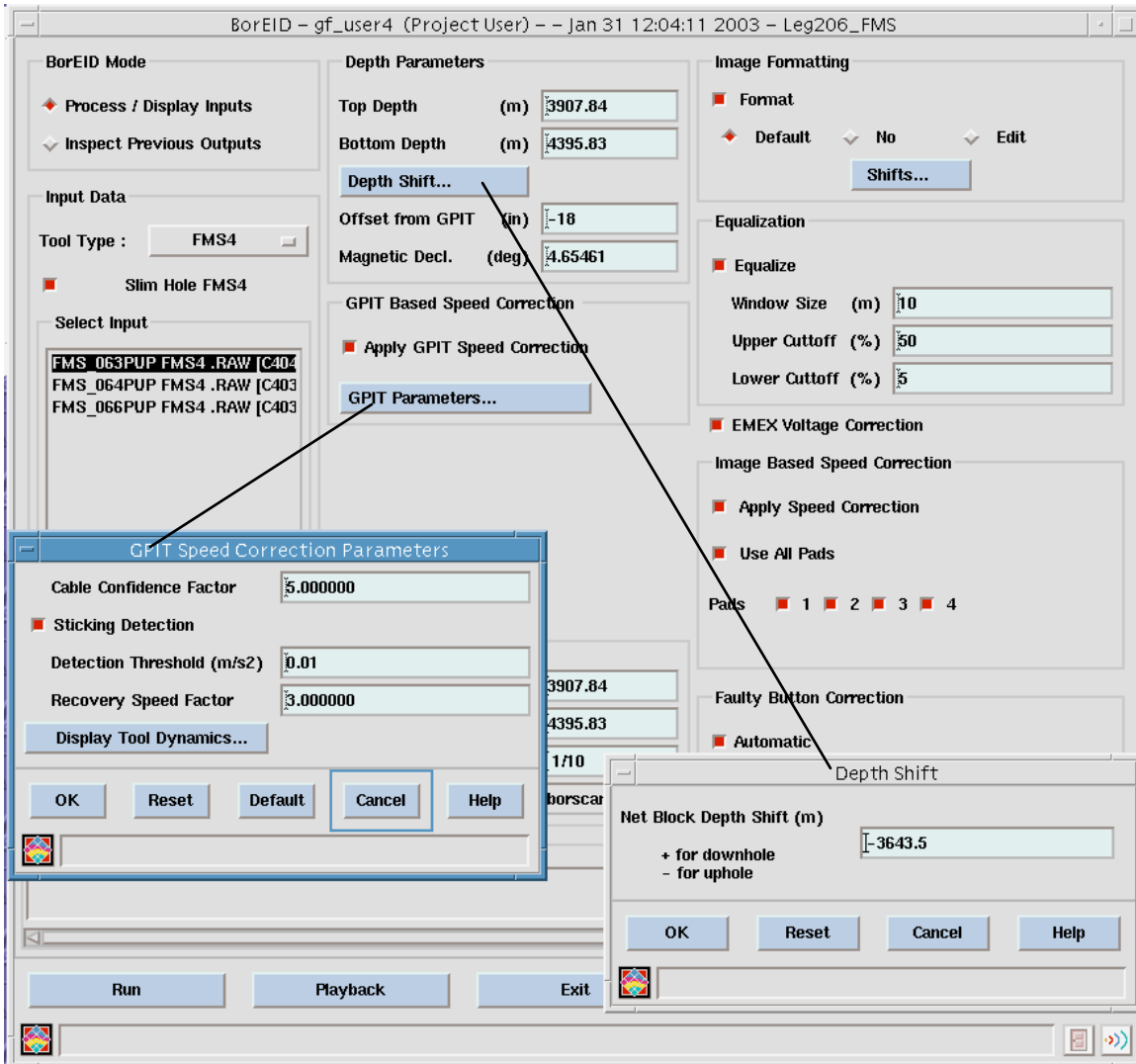
- Speed Correction. The data from the z-axis accelerometer is used to correct the vertical position of the data for variations in the speed of the tool ('GPIT speed correction'), including 'stick and slip'. In addition, 'image-based speed correction' is also applied to the data: the principle behind this is that if the GPIT speed correction is successful, the readings from the two rows of buttons on the pads will line up, and if not, they will be offset from each other (a zigzag effect on the image).

- Equalization: Equalization is the process whereby the average response of all the buttons of the tool are rendered approximately the same over large intervals, to correct for various tool and borehole effects which affect individual buttons differently. These effects include differences in the gain and offset of the pre-amplification circuits associated with each button, and differences in contact with the borehole wall between buttons on a pad, and between pads.

- Button Correction. If the measurements from a button are unreasonably different from its neighbors (e.g. 'dead buttons') over a particular interval, they are declared faulty, and the defective trace is replaced by traces from adjacent good buttons.

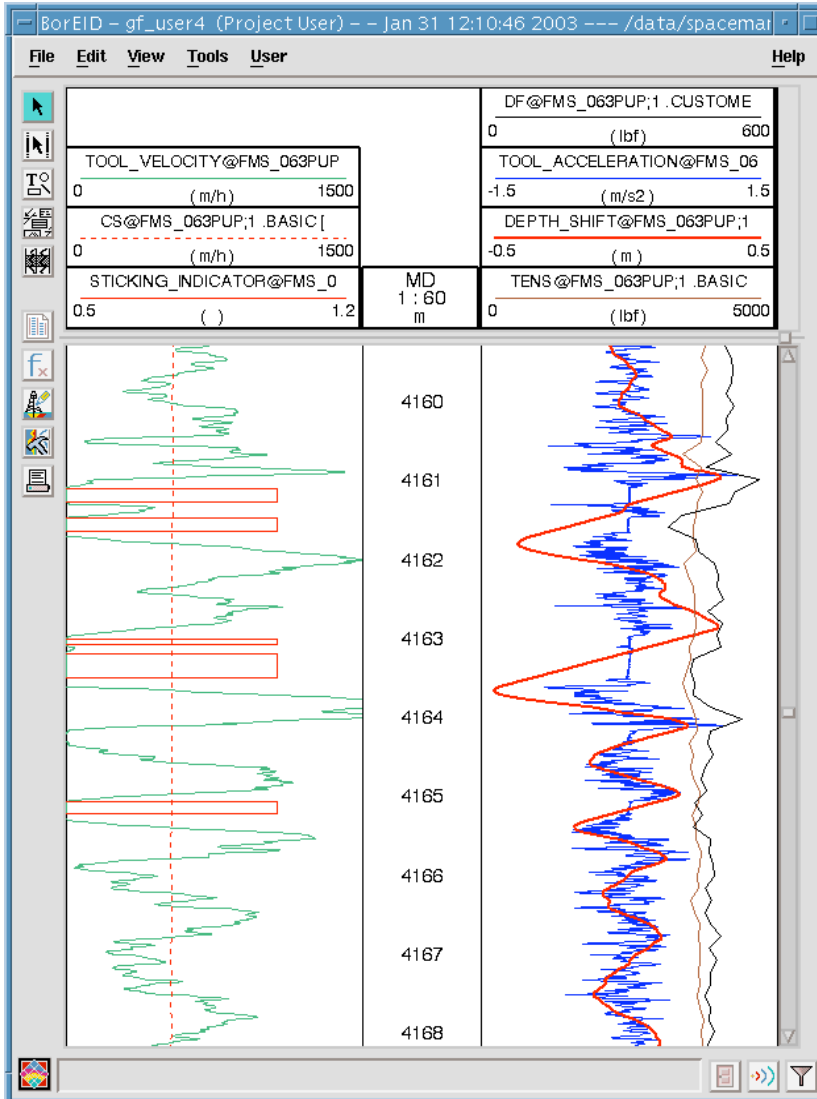
- EMEX voltage correction. The button response (current) is controlled by the EMEX voltage, which is applied between the button electrode and the return electrode. The EMEX voltage is regulated to keep the current response within the operating range. The button response is divided by the EMEX voltage so that the response corresponds more closely to the conductivity of the formation.

To perform these corrections, open BorEID (remember to set the data focus to the borehole level first) and fill out the fields as described below.



- Tool type: FMS4
- Slimhole: check
- Depth Shift: enter value that was applied to the standard logs.
- GPIT speed correction:
 - Cable confidence factor: 5.0 (default)
 - Sticking detection: check
 - Detection threshold: 0.01 (default)
 - Recovery speed: 3.0 (default = 1.5)
- Equalization:
 - Window size: 10m (default = 4.something)
 - Upper cut off: 50% (default)
 - Lower cut off: 5% (default)
- EMEX voltage correction: check all boxes
- Faulty button correction: check all boxes

Always check the GPIT speed correction (by pressing the ‘Display Tool Dynamics’ button) to check if the depth shifts that will be applied are reasonable (i.e. shifts should not be greater than about 1m). The suggested parameters most often yield good results, but if the shifts are too big, try without sticking detection, or perhaps increasing the recovery speed. The Tool Dynamics are shown below. Do not be alarmed that the tool motion appears so irregular - this is normal and is corrected for remarkably well.



Ascii Load

Some of the conventional (ascii) logs must be loaded into Geoframe, so that the FMS can be compared to, for example, the resistivity and density logs. This step is essential when the FMS logs are to be depth matched to the other logging runs.

Usually, the ascii log file will be in the standard processing directory; otherwise, download the file from the online database and place it in the hole directory.

Start the Ascii Load module, and enter the following settings:

- Input Files, e.g. ~STANDARD_proc/Leg206/1256D/1256D-cali-fms1.dat
- Control File: select from the list, or create a new control file, e.g. ~gf_user4/geoframe402_sun/CALI-FMS.ctl
- Ignore the error file, alias files, unit system
- Set the Target Field, Target Well, and Target Borehole.

- Create Control File (most of the values don't need to be changed if the file already exists):

Ascii Format Info

- Click 'Display All Lines'.
- Click 'Stop Row', then click on the last good row in the Data Preview; the number of the Stop Row will be changed to this row.
- Do the same for the 'Start Row'.
- Set the record length long enough to cover all the data (256, the default, is OK).
- Set the number of columns (count them).
- Set the column delimiter (usually Tab).

Index Information

- Type MD (= measured depth).
- Implicit depth labeling (this is safer than Explicit, because only Implicit will work for some Geoframe procedures, e.g. depth matching).
- Type in the depth values for the Start and Stop Rows (read them off the Data Preview).
- Type 0.1524 as the Sampling interval for most data. The interval is 0.0508 m for some GHMT and high-resolution APS data. DO NOT mess up the sampling interval.

Log Information

- Click 'Add Arrays', enter the log name and the number of the column it appears in.
- Click OK
- Run.

Control File example:

Data Preview

HOLE:	12860
LEG:	206
TOP:	265.8649
BOTTOM:	749.8873
DEPTH	C1 C2
265.8649	15.3049 15.3198
265.0173	15.3008 15.3200
265.1697	15.3011 15.3202
265.3221	15.3052 15.3200
265.4745	15.3184 15.3198

Control File... /users/spaceman/gf_user4/geoframe402_sun/CALI-FMS.ctf

ASCII Format Information

Start Row: 5
 Stop Row: 3182
 Record Length: 256
 Number of Columns: 3
 Comment: []

Column Delimiter: TAB
 Multi Borehole UWI: Column [] Position [] Length []

Absent Value Info
 Value: 999.25
 Replacement: []

Index Information

Type... MD
 Unit... m
 Start: 265.8649
 Stop: 749.887024
 Sampling: 0.152400

Log Information

Reverse Arrays []

Input Array	Input Name	Input Unit	Column	Position	Length	Format	Lower Limit	Upper Limit	Replace Value
C1	C1	in	2			Float			999.25
C2	C2	in	3			Float			999.25

Add Arrays... Remove Array Units... OK Cancel Help

Ascii Load is quite a lot of work if you start from scratch, especially if you have a few files to load. However, once the initial control file (e.g. CALI_FMS.ctf) is set up, you can use it again for other passes and other boreholes, just altering the start and stop values.

WellEdit

WellEdit is used to display the FMS image and log data (see example figure in the data checking section, below). You can also use WellEdit to manipulate the logs and images. In the ODP FMS processing it is used to depth match the FMS to the standard logs. This step is not required if the FMS images are on depth, within tolerance, to the other logs. Generally, the conventionally processed P1AZ log is used as the ‘base’ curve and the P1AZ output from BorEID is used as the ‘match’ curve. The match is always cross-checked with the caliper data. Gamma ray data can also be used for matching.

Set the data focus (in the Process Manager) to the borehole level before opening WellEdit.

(a) A window will come up when you ‘inspect’ WellEdit:

- Select the borehole.
- Make sure the depth range corresponds to the mbsf depth range.
- For the template file, choose ‘wu_coremain’, or a template you have previously saved.
- Click ‘Run’.

(b) In the main window, add tracks using the “add track” option from the edit menu. To add objects (logs and FMS images) select the track and “add object” from the edit menu (make sure you have the track selector cursor active). Change to the object selector cursor (top right icon in the WellEdit window) , and double clicking on an object will allow you to edit it (change color or log curve version). The display should look something like this, and it is always good to add a resistivity log and the caliper logs too.

Track	Position of track (inches)	Width of Track (inches)
Depth	0.0	0.5
SGR (.crc) (BorEID)	0.5	1.5
SGR (ascii load)	2.0	1.5
FMS (BorEID)	3.5	2.5
FMS (after shift)	5.0	2.5

The depth match icon is among the icons of the WellEdit window (it has two curves joined by lines). See the next section for the operation of Depth Match.

c) After you have made the plot to your satisfaction, save the template (file menu, save presentation as, then navigate to the lgp_templates in the hole directory).

Depth Match (WellEdit)

The principle of depth matching is to match the FMS depths (the output of BorEID) to the conventional processed logs, by lining up the features of common curves. P1AZ, C1/C2, and ECGR are generally the curves that are used.

The screenshot displays the WellEdit software interface for depth matching. The main window shows three log panels with depth (MD) on the y-axis (0 to 360) and various curves. The 'Depth Match' button in the toolbar is circled in red. The 'Depth Matching' dialog box is open, showing the following details:

- Data Selection:**
 - Select Borehole...: ODP Leg 206, Site 1256D
 - Previous Results...: P1AZ@ASCII_Load:16 .p1az_p1_18mch
 - Base Curve...: P1AZ@FMS_064PUP:7 .CRC [A40859]
 - Match Curve...: P1AZ@FMS_064PUP:7 .CRC [A40859]
 - Equate Curves...:
 - GR@FMS_064PUP:8 .CRC [A40875]
 - EV@FMS_064PUP:5 .CRC [A40865]
 - C1@FMS_064PUP:5 .CRC [A40859]**
 - C2@FMS_064PUP:5 .CRC [A40850]
 - DIPMETER_CALIPER@FMS_064PUP:5 .CRC [A40854]
 - RB@FMS_064PUP:7 .CRC [A40842]
 - PTNO@FMS_064PUP:2 .CRC [A40836]
 - HAZI@FMS_064PUP:7 .CRC [A40833]
 - DEVI@FMS_064PUP:5 .CRC [A40830]
 - SDEV@FMS_064PUP:7 .CRC [A40827]
 - FMS4@FMS_064PUP:5 .SLIM .EID .EMX [A40812]
- Depth Matching:**
 - Top Depth (m): 264.4928
 - Bottom Depth (m): 752.4776
- Automatic:**
 - Match Parameters... (button)
 - Automatic Matching (button)
 - Depth Match Display (button)
 - Remove Depth Match Display (button)
 - Display Preferences... (button)
 - Correlations... (button)

The depth match is done by the following steps:

- First, shift the ascii-loaded P1AZ curve upwards by 0.4572m (-18 inches). You have to do this because the P1AZ curve was moved up by the same amount in the BorEID module. The origin of this correction is the distance between the measurement depth datum at the base of the tool string and the vertical location of the FMS pads.
- Base Curve Choose the P1AZ (-18 inches) Ascii Load curve .
- Match Curve Choose the P1AZ curve that is output by BorEID.
- EquateCurves Choose 'Curves in same container'; click 'query and add'; check that FMS4 is in the list of Equate curves.
- Automatic Matching Do Not use automatic matching.
- Depth Match Display Change the data value range so that the log features can be well seen. Add the caliper logs (see figure above) (highlight the C1/2 log in the depth match window to get it to appear in the 2 right hand tracks; the Base C1/2 log must be added manually). Use the icons on the left side of the Depth Matching Window (see figure below) to add, alter, or delete correlations.

Some rules for creating the depth-match ties:

1. Make sure that the ties make both the P1AZ and the Calipers line up. Give priority to the Calipers, because they are more indicative of how the match between the FMS images will look.
2. When the P1AZ curve moves between 360 and 0 degrees (i.e. goes off one side of the track and comes back on the other), you must have ties of EXACTLY the same offset above and below (Otherwise, 'jaggies' result in the shifted FMS image, because Geoframe tries to interpolate between P1AZ values of, say, 359° and 1°). Do this by duplicating one tie and dragging it above the 0/360 transition. Even this has to be checked: when all the ties have been made, press the 'Correlations' button and look at the actual values of the shifts – it sometimes happens that they are slightly different, e.g. 0.6090m and 0.6091m. Cancel the correlations window (don't edit the numbers directly!), and re-make the ties that are causing the problem. Re-check and repeat as necessary.
3. Don't over-correlate; try to keep the offset in adjacent ties similar and avoid sudden changes.

- Press the Save Icon (left hand side of the Depth Match Window) to apply the correlations to the Equate curves. Enter a name (e.g. FMS_DM_p1). It will take a minute or two to apply the correlations to the FMS4 and the other logs. If this takes an excessively long time, you can exit the modules and Geoframe, and then log back in again, to clear the jam.

BorNor

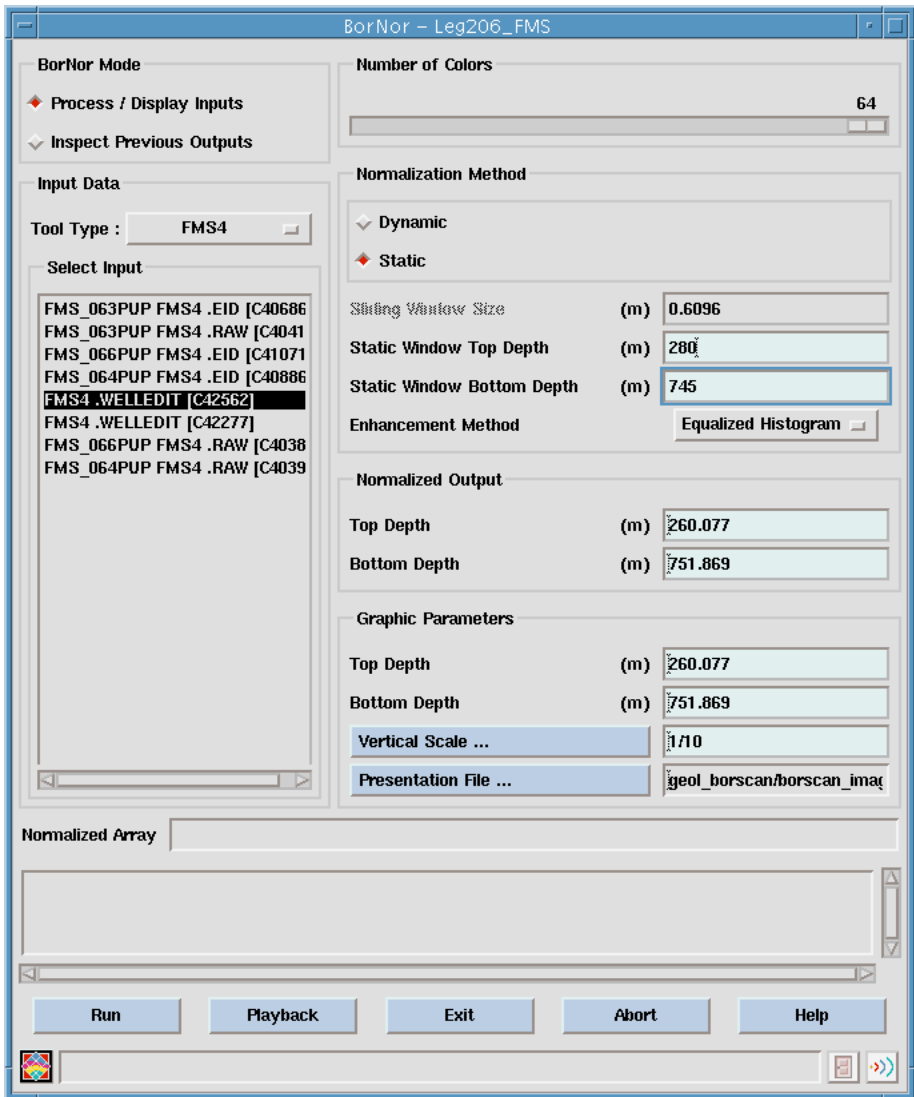
BorNor is the module which produces the static and dynamically normalized images.

In "static normalization", a histogram equalization technique is used to obtain the maximum quality image. In this technique, the resistivity range of the entire interval of good data is computed and partitioned into 256 color levels. This type of normalization is best suited when you want to examine hole-scale resistivity variations.

The image can be enhanced when it is desirable to highlight features in sections of the well where resistivity events are relatively subdued when compared with the overall resistivity range in the section. This enhancement is called "dynamic normalization". By rescaling the color intensity over a smaller interval, the contrast between adjacent resistivity levels is enhanced. It is important to note that with dynamic normalization, resistivities in two distant sections of the hole cannot be directly compared with each other. A 2-m normalization interval is used.

To apply the BorNor corrections:

- Select Process/Display Inputs
- Tool Types: FMS4 or All Tool Types
- Select Input: Select FMS4.Welledit (or .EID if no Depth Match was performed).
Note that the list is made up of FMS collections and not the individual FMS4 log arrays.
- Number of Colors: 64 (to make the gif images, the fmaxgif.2.0 program requires 64 colors)
- For Static Normalization, set the Static Window Top and Bottom depths to be close to the upper and lower limits of the logs, but don't include any black (very conductive) intervals that occur where the calipers are closed.
- For Dynamic Normalization, set the Sliding Window Size to 2m.
- Run.



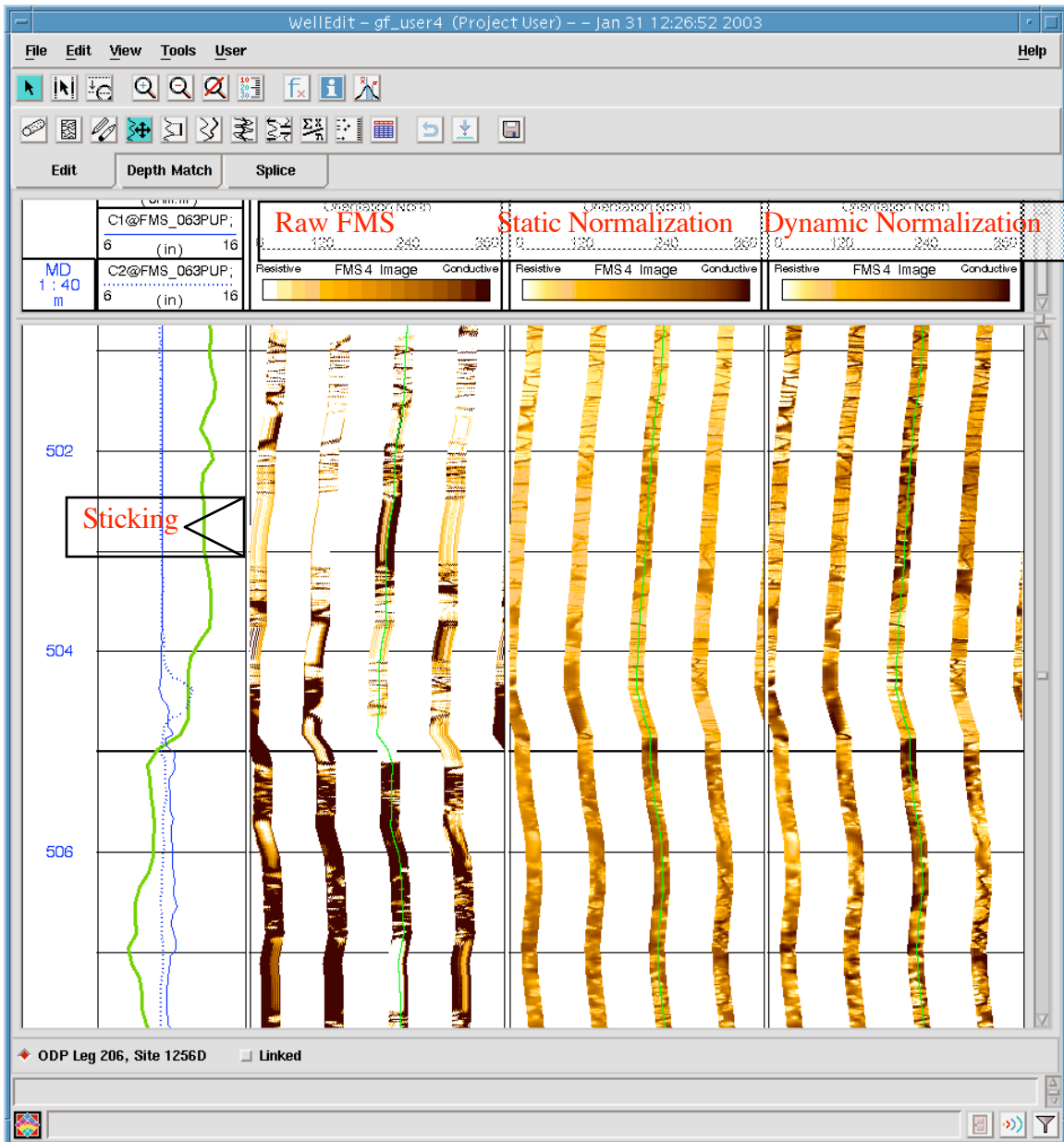
Data checking

The processed data is cross-checked with the caliper and resistivity (DIT/DLL) logs. Light intervals in the image should match in depth with high resistivity values in the SFLU logs.

Also re-check the caliper match between the conventional and the depth-matched output.

Another check to make relates to tool spin: when the hole is wider than the maximum caliper extent, the tool is free to spin, and the four pad images should show a horizontal shift at the same level as the dark, conductive, image that results from the pads not touching the borehole walls.

The example below shows the raw FMS, the static FMS, and the dynamic FMS. If there are depth-mismatches of more than a metre, or there is some kind of constant offset between the logs and images, go back to the depth matching step and figure out what the problem was. The raw FMS data is not usually plotted alongside the processed data because the raw data is in mbrf, unshifted. However, it is instructive to see that the stick and slip evident in the raw image is usually removed very well by the BorEID speed correction.



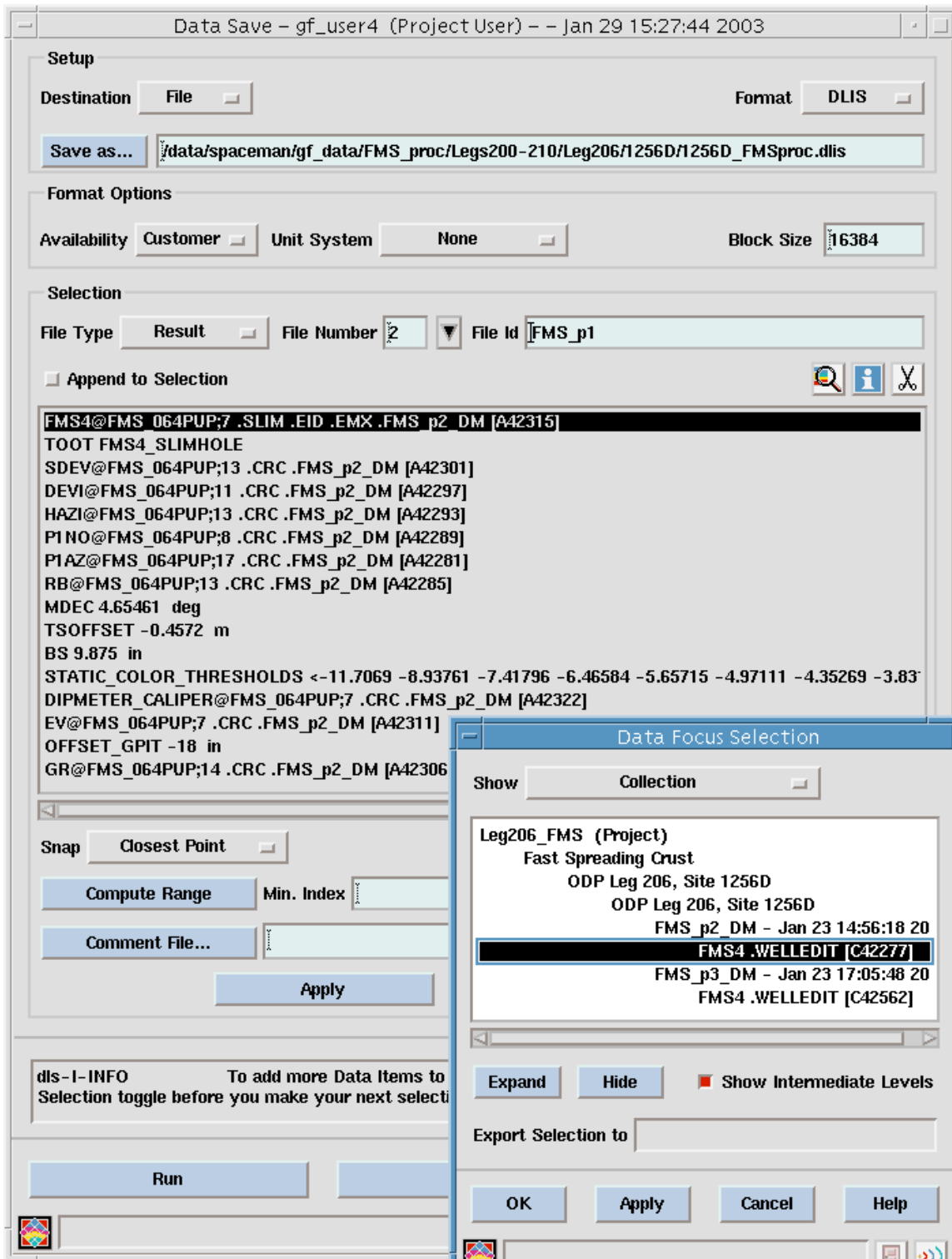
DLIS Data Save

When the above steps are complete, save the depth-matched FMS and related logs as DLIS files for archiving. The static and dynamic FMS data is not saved to DLIS.

- 'Inspect' the Data Save module to start it running.
- Select DLIS from the Format list.
- Enter the hole directory and output filename in the 'Save as...' field. For example:
`/data/spaceman/gf_data/FMS_proc/Leg206/1256D/1256D_FMSproc.dlis`
- Leave the Destination (File), Availability (Customer), Unit System (None), and Block Size (16384) at the default settings.

You must specify which arrays and parameters are saved to the DLIS file. These include the FMS array itself, the inclinometry arrays, the color information, the magnetic declination, and the bit size, all of which must be individually specified (see figure). Within the DLIS files there are a number of 'logical files', one for each toolstring pass. To do this:

- Click the Data Focus icon (it looks like a magnifying glass) and navigate down to the depth-matched FMS collection (pass 1) within the WellEdit activity (or the BorEID run if the FMS pass was the reference run). Press Apply; the list of arrays and parameters will appear in the Data Save window.
- The list of arrays and parameters have to be edited. Remove, by selecting and using the scissors icon, the following: any arrays from previous processing steps (e.g. those with .Customer extension); any repeated parameters, the parameter TOOT FMS4. Refer to the example in the figure for the arrays that should remain. You can Compute Range to check that the output is in the proper depth range (i.e. shifted to seafloor).
- The File Number will be 1; enter FMS_p1 (or similar) in the File ID field. Apply.
- Repeat the process for the next FMS pass; when you select the data, the File Number will automatically increment to 2. Press Apply after you have filled in each logical file.
- When you have entered all the FMS passes, press 'Run'. You can check the file by either using DLISU (see Data Load section) or re-loading it into GeoFrame.



Ascii data save and conversion to Gif

The FMS data is converted to Gif files by downloading the FMS data from Geoframe, and then using two programs written by Gilles Guerin to convert the downloaded ascii first to a compact binary format (FMS_ascii2binary), and then to Gif (fmaxgif.2.0). The codes are located in the directory /users/brg0/guerin/fmax. See Appendix A for Unix scripts that will run the data through the programs as one batch.

(a) Save the FMS and Pad 1 azimuth data to ascii files:

- In the Data Manager, select the static or dynamic normalized FMS4 array, and then click the 'table' icon in the left margin of the window. This pops up the Log Curve Viewer window.
- Select 'file only' and 'overwrite.'
- Select the output filename in the hole directory (e.g. 1234A_p1_stat.dat)
- Run. The array will take a few minutes to download. The resulting file is very big (e.g. 400 Mb for a 400 m interval of FMS), so remember to compress these files after the Gifs are checked.
- Repeat the above for the P1AZ array.

(b) convert the ascii files to a single binary file:

- Use the program 'FMS_ascii2binary' to compress the ascii data to a binary file (<10% the size of the original). This will take a few minutes. The resulting file is compressed to about 7% of the size of the ascii file.
- Enter the input and output files as in the example below:

```
brg0:gf_test> FMS_ascii2binary
File with buttons
1234A_p1_fms.dat
File with Pad 1 azimuth
1234A_p1_plaz.dat
Output file name :
1234A_p1_fms.bin
```

c) convert the binary FMS file to Gif.

- Use the program 'fmaxgif' to convert the binary file to tiffs of the desired interval, length, and scale, as in the example below. For the Gif files that go on the online database and the cdrom, use 100m intervals at 1:10 scale and 20m intervals at 1:1 scale. Both static and dynamic files are put online. Tip: use top and bottom depths that are multiples of 5, so that the depth numbers in the gif files are also multiples of 5 and 10.

- An example dialog with the program is shown below:

```
brg0:gf_test> fmaxgif
Name of the hole : 1123B
How many files/passes to merge ? (default 1) : 1
(S)tatic or (D)ynamic normalization ? [Default is dynamic] : S
Pass number (default 1) : 2
File to convert : 1123B_p2_fms.bin
Depth shift to apply [Default = 0] 0
Bad pad(s) number(s) - 0 (default) if none or when done : 0

The bottom of          1123B_p2_fms.bin is at : 490.00 m
The top                is at : 88.00 m

Max. depth: 490.00 | Min. depth : 88.00

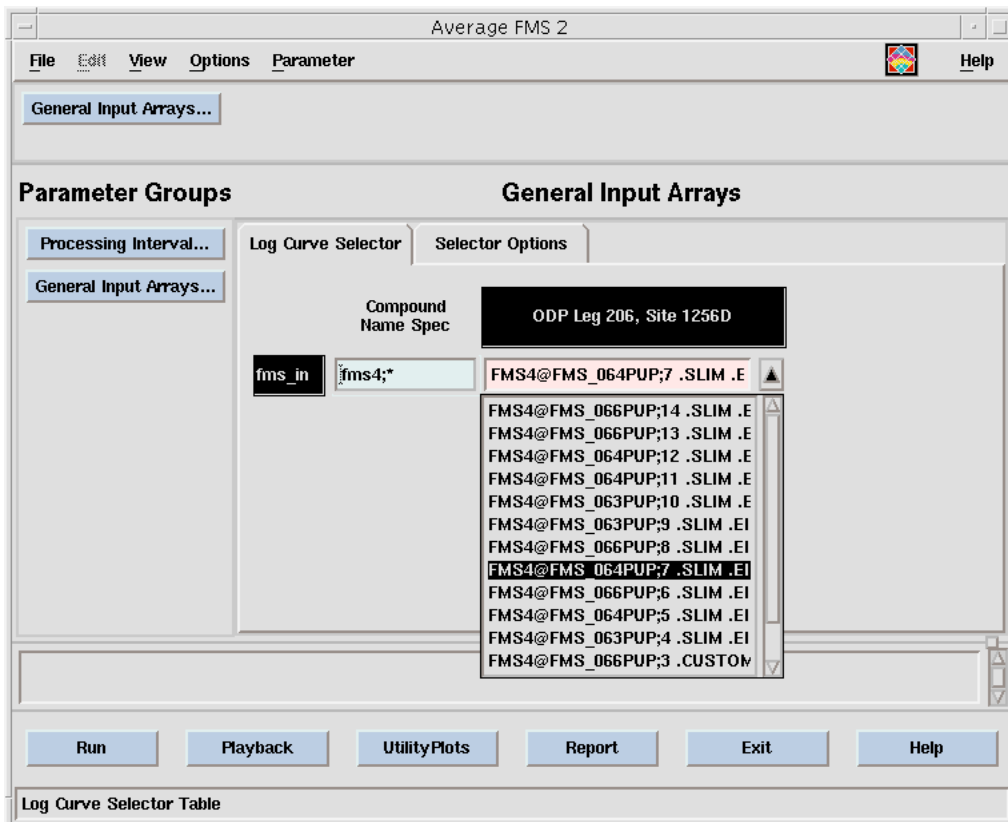
Bottom depth for the images : 490
Top depth : 88
Length of the files (in m) [default = The entire interval] :100
Vertical scale (1/n) (default is 1):10
Working on 1123B_p2_390_490_1to10_Static
Converting to gif
Nx, Ny, Ncol: 328 3977 64
Working on 1123B_p2_290_390_1to10_Static
Converting to gif
Nx, Ny, Ncol: 328 3977 64
Working on 1123B_p2_190_290_1to10_Static
Converting to gif
Nx, Ny, Ncol: 328 3977 64
Working on 1123B_p2_90_190_1to10_Static
Converting to gif
Nx, Ny, Ncol: 328 3977 64
Working on 1123B_p2_88_90_1to10_Static
Converting to gif
Nx, Ny, Ncol: 328 120 64
brg0:gf_test>
```

- Use 'imagetool' or xv to view and check the Gif files against the same images in WellEdit. Check the azimuthal orientation is correct, check the static and dynamic are static and dynamic, etc.

FMS averaging

A high-resolution resistivity log can be obtained by averaging the 64 buttons of the FMS image. There is an in-house module (Average FMS 2), created in Application Builder, which will perform this operation without the need to download the FMS data as Ascii.

- Run the Application Builder module
- in the File menu, Open the program file (listed below)
~/users/spaceman/gf_user4/geoframe402_sun/FMS_average2.fun
- Press the Build button. This will create the new module.
- In the Process Manager, find the new Average FMS 2 module by pressing the lower icon to bring up the Catalog Builder. Press the Show All button, and scroll down the list until you find Average FMS 2; press Apply. Then press Export to add the new module to the chain.
- Run the module in the usual way, using the right-button menu in the process manager.
- Press General Input Arrays
- Type FMS4;* in the Name field and press return. Select the depth shifted BorEID FMS data (be sure you have the right FMS data by checking the version number against the FMS4 array in the Data Manager).



- Press Processing Interval; press Reset Based on Input Arrays.
- Check that the sampling rate is 0.00254m, and press Run.
- Go to a terminal window and move the output file FMS_avg.out to
~/FMS_proc/Leg206/1256D/1256D_p1_FMSavg.dat
- Textedit the bogus data from the top and bottom of the output file.
- Repeat for the other passes.

Average FMS 2

The program Average FMS 2 (built into a module by Application Builder) averages the buttons in each FMS pad over 5 depth levels, resulting in an output sampling rate of 1.27 cm. The pad averages are themselves combined into a 64 button average.

```

fun_Module (average_FMS2,
  Display_Name(Average FMS 2))

fun_Array (fms_in,
  Code(FMS4),
  Curve_Set(FMS4;*),
  Dimensions(3),
  Window(3(4 4 0 0), 2(16 16 0 0), 1(5 5 0 MIDDLE)),
  In(Query(FMS4)))
  real b(4)

fun_Initial
  open (10,file='FMS_avg.out')
  fun_SkipSamples = 5
  write (10,90)
  90 format(' Depth  64_button_avg  pad1      pad2      pad3      pad4')

fun_Main
  do 30, l=1,5
    b(l) = 0.0
  30 continue
  do 5, k = 1,5
    do 10, j = 1,4
      do 20, i = 1,16
        b(j) = b(j) + fms_in(j,i,k)
      20 continue
    10 continue
  5 continue
  do 40, l=1,4
    b(l) = b(l)/80.0
  40 continue
  bav = (b(1)+b(2)+b(3)+b(4))/4.0
  write (10,'(6f10.4)') fun_xin(1)*0.00254,bav,(b(k),k=1,4)

fun_Final
  close (10)

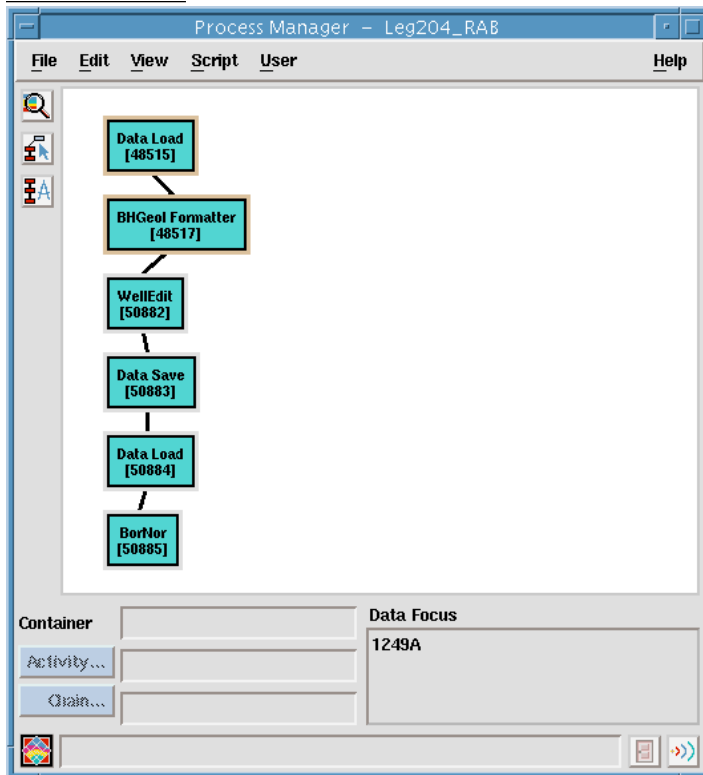
fun_End

```

RAB (LWD) Data Processing

Although both RAB and FMS processing produce resistivity images, there are several differences between the processing steps. The main one is that RAB data does not require the BorEID corrections, because the effects of irregular tool motion are already corrected for by Anadrill shortly after acquisition when the data index is changed from time to depth. Some depth discrepancies usually remain, but they can be visually identified as vertical discontinuities in the image. The RAB images cover 360° of the borehole because the sensors rotate with the drill string; however, the same terminology as the FMS is used for the inclinometry arrays, for example, the P1AZ becomes the azimuthal direction of the first of the 56 radial ‘bins’ of resistivity data.

Module chain:



Data Load.

Data is loaded in the same way as FMS data, except that it is essential that an ‘alias’ file is used, in order to convert the array names that Anadrill Ideal uses into array names that GeoFrame can recognize. The file is: ~gf2/geoframe_402_sun/wa_lwd/lwd_ideal_alias.txt

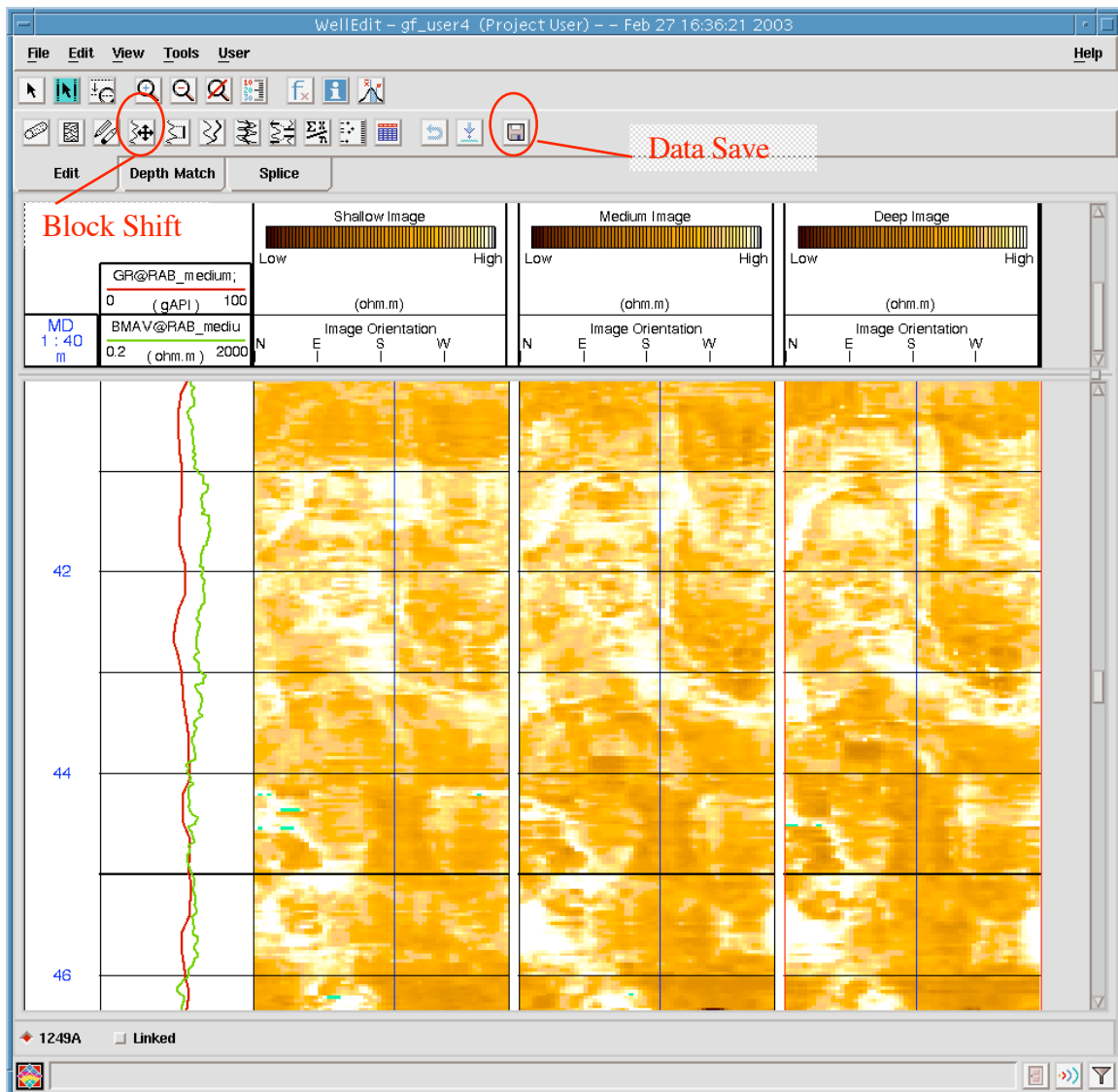
BHGeol Formatter

This module creates the RAB image 'collections' (i.e. a grouping of the RAB data itself, the inclinometry, and some parameters like Bit Size).

WellEdit

The images and logs are shifted to seafloor in WellEdit (see figure above):

- Select one of the arrays or images.
- Use the 'block shift' edit icon.

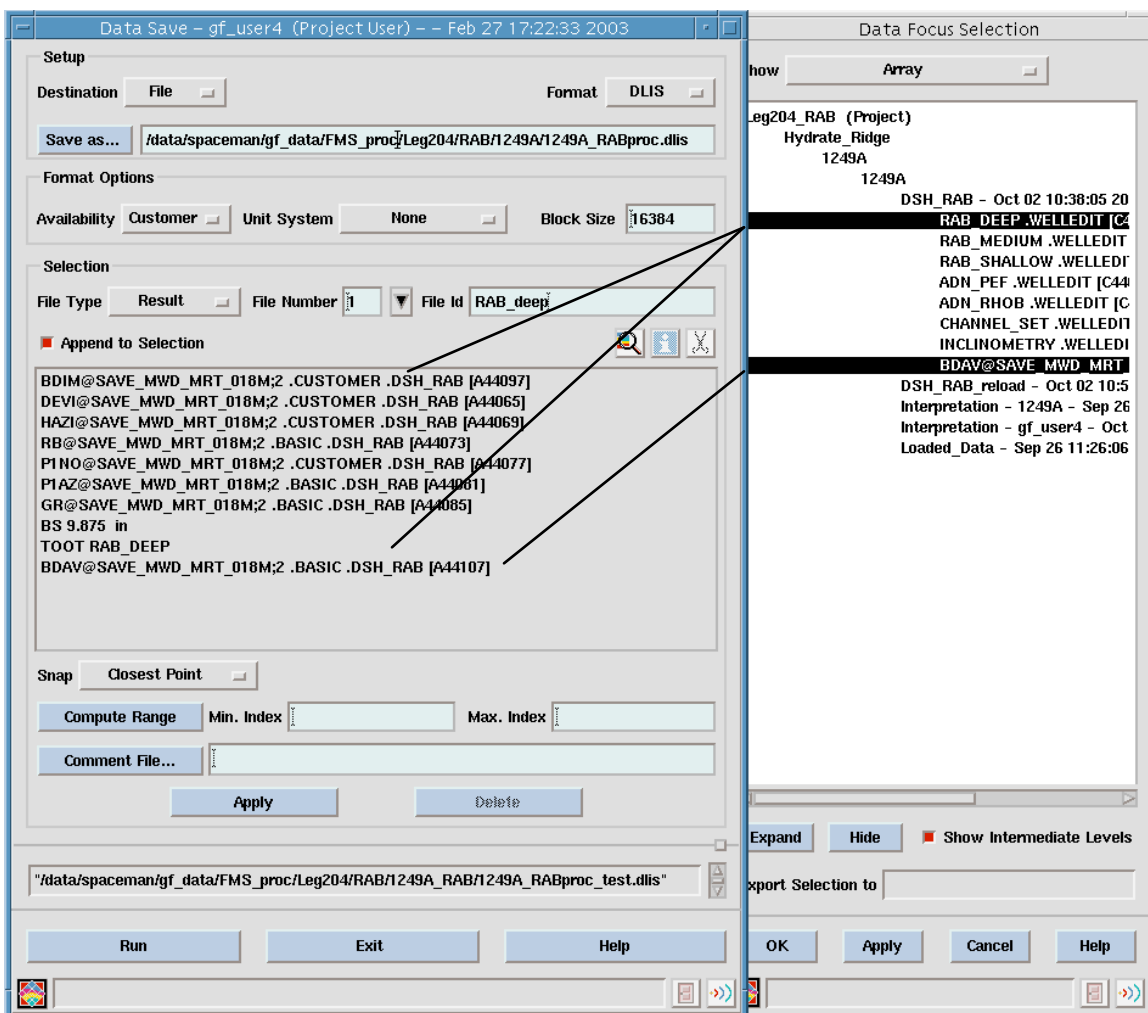


- Enter the depth shift based on the sediment-water depth from resistivity and gamma ray.
- Update. Close. Use the 'Save' (disk) icon.

- Make sure the output sample rate is set at 0.03048m (not 0.0305...)
- Set the modifier to be DSH_RAB or similar.
- Select the following arrays to propagate the shift to (or do all arrays in the container):
 - BDIM, BMIM, BSIM (the deep, medium, and shallow RAB images)
 - BDAV, BMAV, BSAV (the average deep, medium, and shallow resistivity logs).
 - All Inclinometry arrays (DEVI, HAZI, P1AZ, P1NO, RB, (SDEV))
 - GR (gamma ray). (Also the gamma ray image, if collected)
 - ROSI* (the density images, if ADN' is in the toolstring), RHOB
 - PESI* (the PEF images, if ADN' is in the toolstring), PEF

Data Save

I don't know why this happens, but if you run BorNor at this stage, the images become corrupted. Check that this still happens with the current version of GeoFrame that you, the user, are working with – if it works fine, then great. But either way, the depth shifted data needs to be saved as a DLIS. The way around the problem is to Data Save the images to a DLIS file, and then reload it back into GeoFrame. Select the RAB image collections, 1 logical file each for the RAB collections (shallow, medium, and deep). Remove the raw RAB data from the list. Add the Average resistivity curves (e.g. BDAV). (The “conventional” logs from the RAB tool are processed and saved in the Standard Processing.)



Data Load

Re-import the DLIS file to GeoFrame (if BorNor will not work on the shifted images, it should work on the re-loaded images). The shallow, medium, and deep images should appear in separate Activities. Re-run BHGeol Formatter to build the RAB image collections.

BorNor

This is run in the same way as running BorNor on FMS data. Use a 2m window for the dynamic normalization. Use 64 colours.

Making the Gif files

This is very similar to making the FMS images:

(a) Save the RAB data to ascii files:

- In the Data Manager, select the static or dynamic normalized RAB array, and then click the 'table' icon in the left margin of the window. This pops up the Log Curve Viewer window.
- Select 'file only' and 'overwrite.'
- Select the output filename in the hole directory (e.g. 1234A_shallow_dyna.dat)
- Run.
- Note down the P1AZ array value (it will be close to a constant value down the hole).

(b) convert the ascii files to a single binary file:

- Use the program 'RAB_ascii2binary' to compress the ascii data to a binary file (<10% the size of the original). This will take a few minutes. The resulting file is compressed to about 7% of the size of the ascii file.
- Enter the input and output files as in the example below:

```
[spaceman] 27> RAB_ascii2binary
File with RAB data
1249A_deep_stat.dat
Value of Pad 1 azimuth
242.745
Water depth
0
Output file name :
1249A_deep_stat.bin
3968 lines
```

c) convert the binary RAB file to Gif.

- Use the program 'fmaxrab' to convert the binary file to tiffs of the desired interval, length, and scale, as in the example below. For the Gif files that go on the online database and the cdrom, use 100m intervals at 1:10 scale and 20m intervals at 1:1 scale. Both static and dynamic images are put online.
- An example dialog with the program is shown below:

```
[spaceman] 28> fmaxrab
For CD and database (y/n) ? [default is no]: y
Name of the hole (no spaces) : 1249A
[s]tatic or [d]ynamic normalization ? : s
```

Depth of penetration ([s]hallow,[m]edium,[d]eep): d
Name of input (binary) file : 1249A_deep_stat.bin
Depth shift to apply [Default = 0] 0

The bottom of 1249A_deep_stat.bin.test is at : 91.50 m
The top is at : -29.41 m

Max. depth: 91.50 | Min. depth : -29.41

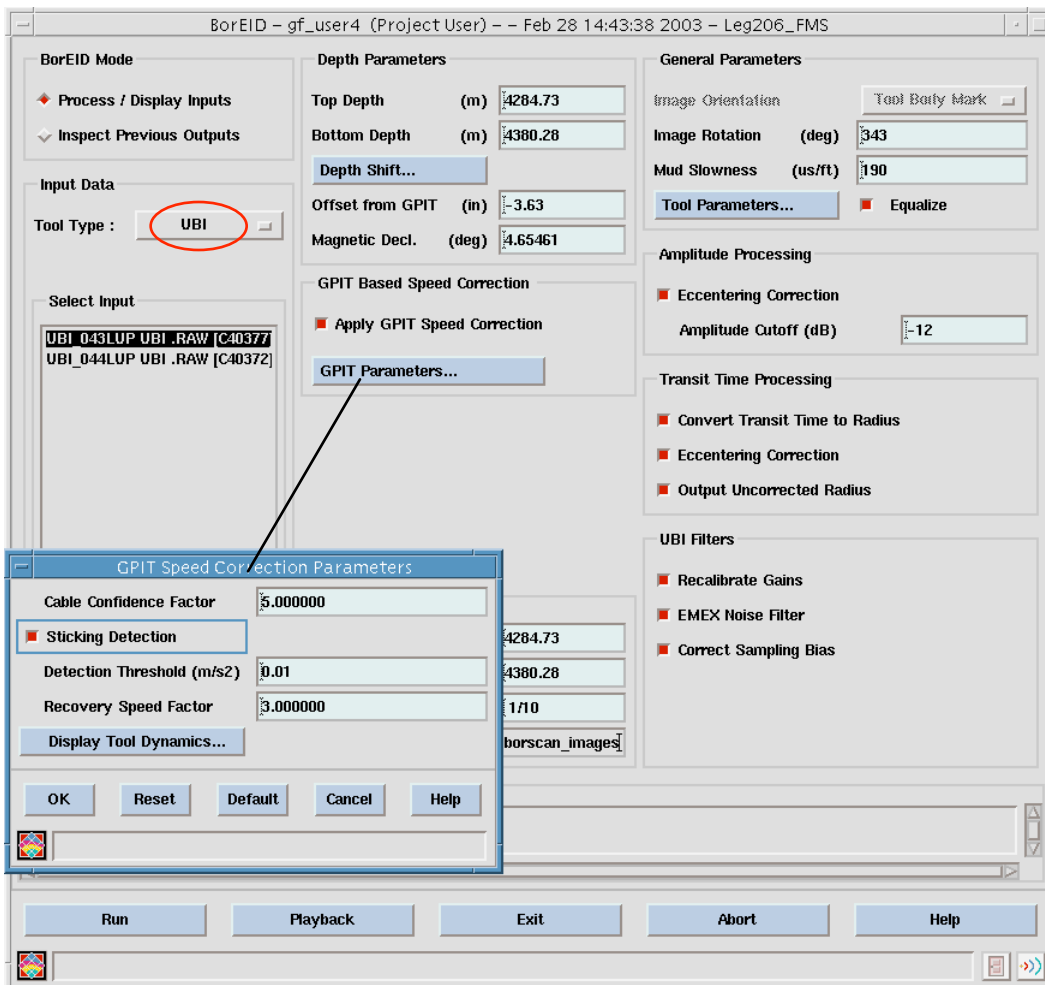
Bottom depth for the images : 92
Top depth : 0

UBI Data Processing

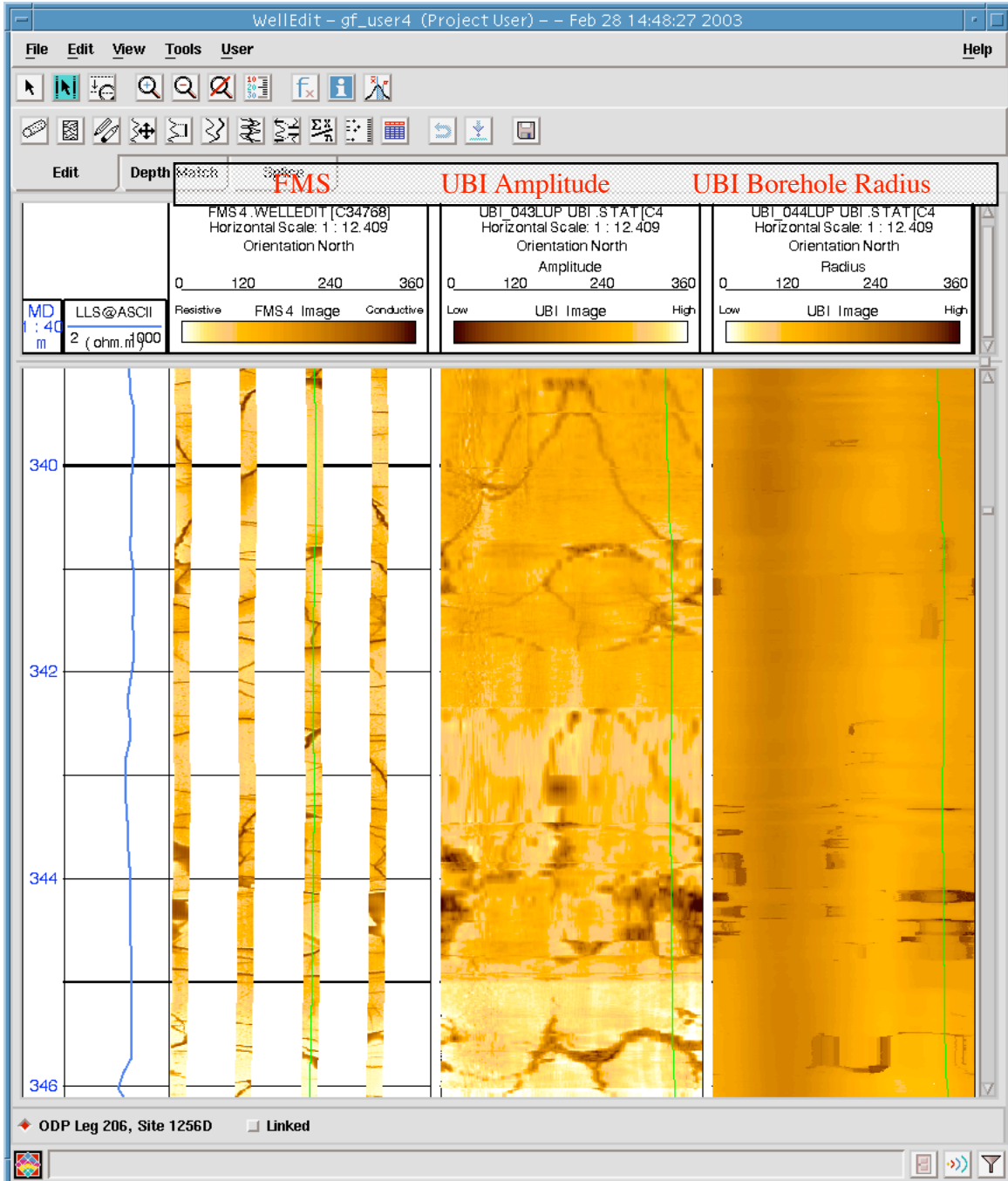
The UBI (Ultrasonic Borehole Imager) image processing is very similar to the FMS processing, despite the contrasting properties being measured. The UBI, a wireline tool, measures the amplitude and travel time of ultrasonic pulses from a rotating emitter/receiver. The reflection amplitude and borehole radius images it produces cover 360° of the borehole wall.

To process UBI data, follow the FMS procedure apart from in the places described below.

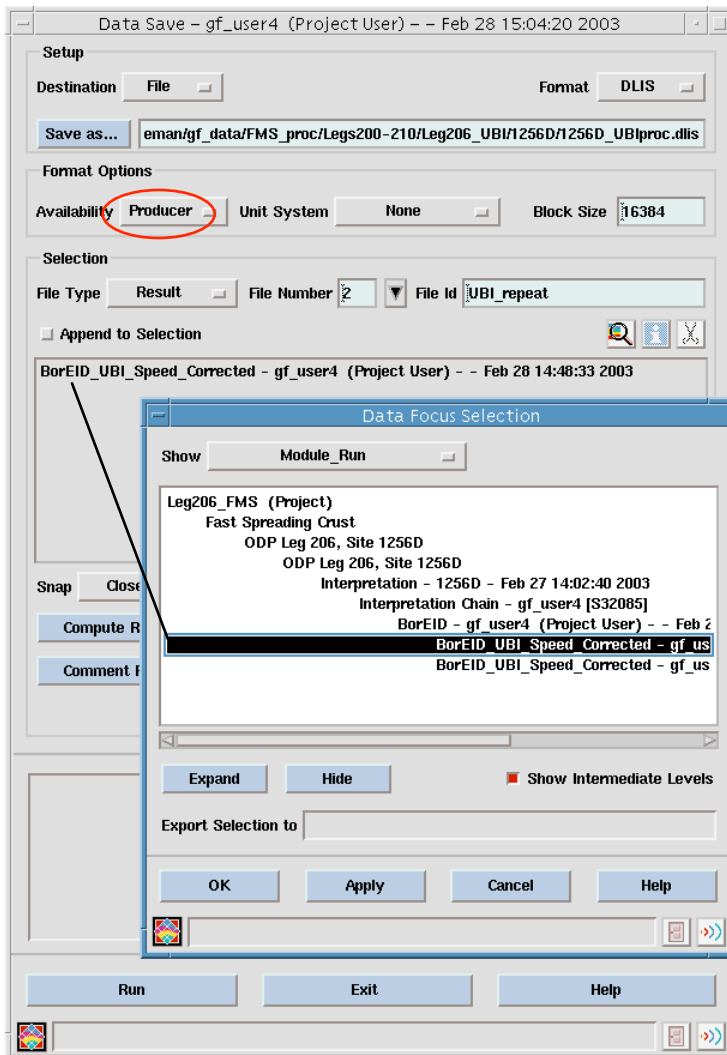
1. Use the UBI option where it is available, for example in BorEID and BorNor:



2. There are problems in depth matching the UBI images to the FMS images (jagged images result when the P1AZ moves between 360 and 0°, despite the precautions described for the FMS). Therefore use the output from BorEID without depth matching, usually it will be fine. An example from Hole 1256D is given below:



3. In order to save the UBI images to a DLIS file, set the Availability to Producer, and instead of selecting the UBI image collection, select the Module Run that contains it, as shown in the example below:



4. When saving the static and dynamic image arrays to Ascii from the general data manager, use the following:

AWBK – the amplitude image array

XRBK – the excentred radius image array

IRBK – the radius image array re-calculated so that the tool is in the centre of the hole.

P1AZ – tool azimuth.

Then run the Guerin programs ‘UBI_ascii2binary’ and ‘fmaxubi’ to make the Gif files.

Appendix A. Scripts for making Gif files in a batch

All of the little scripts/files below should go in the Leg directory, e.g. `~gf_data/FMS_proc/Leg206`. They make it a one-command operation for processing that can take half an hour.

1a. `fmsbin.com` A shell script to run the program `FMS_ascii2binary`

```
#!/bin/csh
# for doing all the FMS Gif files for one hole at once...

set parfile = "../..fmsbin.par"

cd 1256D/p1_stat
awk '{if(NR>=6 && NR<=8) print $0}' $parfile | FMS_ascii2binary

cd ../p1_dyna
awk '{if(NR>=11 && NR<=13) print $0}' $parfile | FMS_ascii2binary

cd ../p2_stat
awk '{if(NR>=16 && NR<=18) print $0}' $parfile | FMS_ascii2binary

cd ../p2_dyna
awk '{if(NR>=21 && NR<=23) print $0}' $parfile | FMS_ascii2binary

cd ..../..
```

1b. `fmsbin.par` A parameter file for use with `fmsbin.com`

```
# PARAMATER FILE FOR ENTRY INTO FMS_ascii2binary USING FMSBIN.COM
# file with buttons
# plaz file
# output binary file
-----p1_stat
1256D_p1_stat.dat
1256D_p1_plaz.dat
1256D_p1_stat.bin

-----p1_dyna
1256D_p1_dyna.dat
1256D_p1_plaz.dat
1256D_p1_dyna.bin

-----p2_stat
1256D_p2_stat.dat
1256D_p2_plaz.dat
1256D_p2_stat.bin

-----p2_dyna
1256D_p2_dyna.dat
1256D_p2_plaz.dat
1256D_p2_dyna.bin
```

2a. `fmsgif.com` A shell script to run the program `fmaxgif.2.0`

```
#!/bin/csh
# for doing all the FMS Gif files for one hole at once...

set parfile = "../..fmsgif.par"

cd 1256D/p1_stat
awk '{if(NR>=11 && NR<=19) print $0}' $parfile | fmaxgif.2.0

cd ../p1_dyna
awk '{if(NR>=21 && NR<=29) print $0}' $parfile | fmaxgif.2.0

cd ../p2_stat
awk '{if(NR>=31 && NR<=39) print $0}' $parfile | fmaxgif.2.0
```

```

cd ../p2_dyna
awk '{if(NR>=41 && NR<=49) print $0}' $parfile | fmaxgif.2.0
cd ../..

```

2b. fmsgif.par A parameter file for use with fmsgif.com

```

# PARAMATER FILE FOR ENTRY INTO      FMAXGIF.2.0      USING      FMSGIF.COM
# For CD and database (y/n) ?
# Name of the hole (no spaces)
# pass number
# [s]tatic or [d]ynamic normalization ?
# Name of input (binary) file
# Depth shift to apply [Default = 0]
# bad pad numbers
# Bottom depth, Top depth
-----p1_stat
Y
1256D
1
_S
1256D_p1_stat.bin
0
0
750
267
-----p1_dyna
Y
1256D
1
_D
1256D_p1_dyna.bin
0
0
750
267
-----p2_stat
Y
1256D
2
_S
1256D_p2_stat.bin
0
0
750
267
-----p2_dyna
Y
1256D
2
_D
1256D_p2_dyna.bin
0
0
750
267

```

3. Compress commands shell script to compress the FMS ascii files downloaded from Geoframe. These files can be huge, so remember to compress them !

```

#!/bin/csh

compress 1256D/p1_stat/1256D_p1_stat.dat
compress 1256D/p1_dyna/1256D_p1_dyna.dat
compress 1256D/p2_stat/1256D_p2_stat.dat
compress 1256D/p2_dyna/1256D_p2_dyna.dat

```

Appendix B. Example Processing Documents for FMS, RAB and UBI

1. FMS processing document

ODP logging contractor: LDEO-BRG

Hole: 1261B

Leg: 207

Location: Demerara Rise (eastern equatorial Atlantic)

Latitude: 9° 2.918' N

Longitude: 54° 19.049' W

Logging date: February 21-22, 2003

Bottom felt: 1911 mbrf

Total penetration: 674.1 mbsf

Total core recovered: 92.49 m (62.16 %)

Logging Runs

Logging string 1: TAP/DIT/HLDS/APS/HNGS/MGT (two passes without MGT, followed by 2 passes with MGT only)

Logging string 2: FMS/SGT/LSS (two passes)

Logging string 3: WST

All of the main passes except for the WST reached close to the total hole depth, despite the presence of some bridges in the upper section, particularly between 200-230 mbsf. The wireline heave compensator was used, but because of high ship heave (to > 3m), it stroked out at 563-580 mbrf (TAP/DIT/HLDS/APS/HNGS/MGT pass 1) and at 410-434 and 470-488 mbrf (TAP/DIT/HLDS/APS/HNGS/MGT pass 2). TAP/DIT/HLDS/APS/HNGS/MGT pass 1 terminated at 310 mbsf because of loss of communication with the tools.

Bottom Hole Assembly

The following bottom hole assembly (BHA) depths are as they appear on the logs after differential depth shift (see "Depth shift" section) and depth shift to the sea floor. As such, there might be a discrepancy with the original depths given by the drillers onboard. Typical reasons for depth discrepancies are ship heave, use of wireline heave compensator, and drill string and/or wireline stretch.

TAP/DIT/HLDS/APS/HNGS/MGT : BHA at 111.5 mbsf (pass 2)

FMS/SGT/LSS : BHA at 110 mbsf (pass 1)

FMS/SGT/LSS : BHA at 109 mbsf (pass 2)

Processing

Depth shift: The original logs were depth matched to the ECGR log from the second pass of the FMS/SGT/LSS tool string, and were then shifted to the sea floor (-1899 m). FMS/SGT/LSS pass 2 was chosen as the reference run because it crossed the seafloor and the wireline heave compensator operated continuously through the run. FMS/SGT/LSS pass 1 and TAP/DIT/HLDS/APS/HNGS/MGT pass 1 and 2 and were matched to the reference run by total gamma ray, with cross checking using the caliper logs.

The sea floor depth was determined by the step in gamma ray values at 1899 mbrf. For Hole 1261B, this differs by 11m from the sea-floor depth given by the drillers (see above). The large depth discrepancy here is probably due to the difficulty in picking an accurate mudline or 'bottom felt' depth when using the RCB coring system. The logger's seafloor is well constrained in this case.

Depth matching is typically done in the following way. One log is chosen as reference (base) log (usually the total gamma ray log from the run with the greatest vertical extent), and then the features in the equivalent logs from the other runs are matched to it in turn. This matching is performed manually. The depth adjustments that were required to bring the match log in line with the base log are then applied to all the other logs from the same tool string.

Environmental corrections: The HNGS and SGT data were corrected for hole size during the recording. The APS and HLDS have been corrected for standoff and hole diameter respectively during the recording.

High-resolution data: Bulk density and neutron porosity data were recorded at a sampling rate of 2.54 and 5.08 cm, respectively. The enhanced bulk density curve is the result of Schlumberger enhanced processing technique performed on the MAXIS system onboard. While in normal processing short-spacing data is smoothed to match the long-spacing one, in enhanced processing this is reversed. In a situation where there is good contact between the HLDS pad and the borehole wall (low-density correction) the results are improved, because the short spacing has better vertical resolution. SGT gamma ray was recorded at 15.24 and 5.08 cm sampling rates.

Sonic data: The transit time data were processed using an in-house program that compares the slownesses derived from the 8 different transmitter-receiver pairs at each depth, and discards those times that are significantly different from the majority as bad data. This leads to improved compressional wave velocity logs that are mostly free of the artifacts present in the velocities derived directly from DTLN and DTLF. The LSS pass 2 velocities have hardly any artifacts, but some are present in LSS pass 1.

Quality Control

null value=-999.25. This value may replace invalid log values or results.

During the processing, quality control of the data is mainly performed by cross-correlation of all logging data. Large (>12") and/or irregular borehole affects most recordings, particularly those that require eccentricization (APS, HLDS) and a good contact with the borehole wall. Hole deviation can also affect the data negatively; the FMS, for example, is not designed to be run in holes deviated more than 10 degrees, as the tool weight might cause the caliper to close.

Data recorded through casing should be used qualitatively only because of the attenuation on the incoming signal.

Hole diameter was recorded by the hydraulic caliper on the HLDS tool (LCAL) and on the FMS tool (C1 and C2). The hole was in excellent condition below 380 mbsf, generally reading between 9 and 10 inches in diameter with only a few small washouts. From 375 mbsf to the BHA, however, the hole alternates between very tight (e.g. 4 inches) and washed out (> 18 inches): the HLDS, APS, and gamma radiation logs should be used with caution in this interval.

Additional information about the logs can be found in the "Explanatory Notes" and Site Chapter, ODP IR volume 207. For further questions about the logs, please contact:

Trevor Williams
Phone: 845-365-8626
Fax: 845-365-3182
E-mail: trevor@ldeo.columbia.edu

Cristina Broglia
Phone: 845-365-8343
Fax: 845-365-3182
E-mail: chris@ldeo.columbia.edu

2. RAB processing document

Hole 1248A, Leg 204: RAB Image Processing Report

The RAB (Resistivity At Bit) LWD (Logging While Drilling) tool maps the electrical resistivity of the borehole wall at three depths of penetration. Because the tool is rotating while drilling, its three electrodes (one for each penetration depth) provide 360° data coverage of the borehole wall. These data are displayed as an electrical image of the formation in either gray or color scale. The purpose of this report is to describe the images from Leg 204 and the different steps used to generate them from the raw RAB measurements. The RAB tool also takes total gamma radiation and resistivity logs, which are presented with the 'standard' data.

Hole 1248A

Location: Hydrate Ridge-Cascadia Margin (NE Pacific Ocean)

Latitude: 44° 34.4515' N

Longitude: 125° 9.1548' W

Logging date: July 20-21, 2002

Hole depth: 197 mbsf

Water depth: 839.5 mbrf (determined from the GR and resistivity logs)

RAB depth range: 0-194 mbsf

Azimuth reference (P1AZ): 242.75°

Very good RAB images were obtained from Hole 1248A. Gas Hydrate occurrences are identified by high resistivities in the RAB image, shallower than ~125 mbsf. Resistivity and density log variation below this zone may indicate lithological changes, possibly carbonates, and possibly the presence of gas.

The RAB tool used on Leg 204 was a RAB-6 with a 9.125" button sleeve, used with a standard 9.875 in. ODP RCB bit.

Image Processing

Processing is required to convert the electrical current in the formation, emitted by the RAB button electrodes, into a gray or color-scale image representative of the resistivity changes. This is achieved through two main processing phases, the first shortly after the data is downloaded from the tool by the Anadrill engineer, and the second post-cruise at LDEO-BRG.

1) Azimuthal orientation and conversion to depth

The main processing steps are performed using Anadrill's 'Ideal' software package, just after the raw data is downloaded from the tool. An azimuth and a depth are assigned to each measurement based on measurements of the pipe orientation and position at the rig floor. The resolution of the azimuth is about 6.4°, because the resistivity measurements are assigned to 56 radial bins. The resistivity data is sampled every 10 (or 20) seconds, therefore the data density in terms of depth depends upon the rate of penetration (ROP) into the formation – the slower the penetration, the more densely sampled the formation will be. For this hole, the ROP was generally in the 5-20 m/hr range.

The RAB tool does not move with a constant velocity down the hole: new sections of drill pipe have to be added every 10 m and ship heave is never completely compensated. This means that there

will often be repeat measurements for one particular depth in the borehole. The measurement that is used is the first one taken at a particular point, before the borehole has had time to deteriorate.

The effects of ship heave are sometimes apparent as horizontal discontinuities in the image. They exist because it can be difficult, with a long drill string, to accurately determine the depth of the bit based on measurements on the rig floor.

The RAB data is output from the Ideal software as a depth-indexed DLIS file.

2) Image Normalization:

The DLIS file is loaded into the Schlumberger GeoQuest GeoFrame software at LDEO-BRG, where the depth-based image for each depth of penetration (shallow, medium, and deep) is normalized both statically and dynamically.

In "static normalization", a histogram equalization technique is used to obtain the maximum quality image. In this technique, the resistivity range of the entire interval of good data is computed and partitioned into 256 color levels. This type of normalization is best suited for large-scale resistivity variations.

The image can be enhanced when it is desirable to highlight features in sections of the well where resistivity events are relatively subdued when compared with the overall resistivity range in the section. This enhancement is called "dynamic normalization". By rescaling the color intensity over a smaller interval, the contrast between adjacent resistivity levels is enhanced. It is important to note that with dynamic normalization, resistivities in two distant sections of the hole cannot be directly compared with each other. A 2-m normalization interval is used.

The normalized images are shifted to a sea-floor reference and converted to gif files using in-house software. They are presented on this web site. The image is displayed as an unwrapped borehole cylinder. A dipping plane in the borehole will be displayed as a sinusoid on the image; the amplitude of this sinusoid is proportional to the dip of the plane. The images are oriented with respect to north, hence the strike of dipping features can also be determined.

Interested scientists are welcome to visit one of the log interpretation centers at LDEO, Aachen, Leicester, Montpellier or Tokyo (<http://www.ldeo.columbia.edu/BRG/ODP/STAFF>) if they wish to use the image generation and interpretation software.

For further information or questions about the processing, please contact:

Trevor Williams
Phone: 845-365-8626
Fax: 845-365-3182
E-mail: trevor@ldeo.columbia.edu

Cristina Broglia
Phone: 845-365-8343
Fax: 845-365-3182
E-mail: chris@ldeo.columbia.edu

3. UBI processing document

Hole 1256D, Leg 206: UBI Image Processing Report

The **Ultrasonic Borehole Imager (UBI)** measures amplitude and transit time. It provides an acoustic image of the borehole wall by scanning it with narrow pulsed acoustic beam from rotating transducer while the tool is pulled up the hole. An innovative processing technique improves accuracy, avoids cycle skips and reduces echo losses, which makes the UBI transit-time measurement as reliable as that of the amplitude. The tool is relatively insensitive to eccentricization up to 1/4 in. and yields images that are clean and easy to interpret.

The purpose of this report is to describe the images from Leg 206 and the different steps used to generate them from the raw UBI measurements. The median amplitude and radius measured by the UBI, together with inclinometry and gamma radiation logs from tools on the same toolstring are presented with the 'standard' data.

Hole 1256D

Location: Cocos plate (eastern Pacific)

Latitude: 6° 44.163' N

Longitude: 91° 56.061' W

Logging date: December 28-30, 2002

Bottom felt: 3645.4 mbrf

Total penetration: 752 mbsf

Total core recovered: 227m (47.8%)

UBI depth range: 267-746 mbsf (main pass), 641-737 mbsf (repeat pass)

Excellent quality images were obtained from Hole 1256D. Massive basalt, breccia, and pillows can all be identified in the images, especially in the amplitude image. Fractures can easily be identified; high angle fractures are much easier to identify in the UBI images than the FMS images. The FMS and UBI images are best interpreted side-by-side, as the 360 degree coverage of the UBI images complement the higher resolution of the FMS resistivity images. Moreover, the UBI and FMS respond to contrasting physical properties, enabling (for example) differentiation of open and filled fractures.

Image Processing

The following corrections are applied in GeoFrame's BorEID module:

GPIT Speed Correction

Speed correction corrects for the assumption that measurements are acquired at the cable depth; they are actually acquired at a somewhat different depth, because the tool speed is usually irregular compared with the near-constant speed of the cable at the rig floor. The data from the z-axis accelerometer is used to correct the vertical position of the data for variations in the speed of the tool, including 'stick and slip'.

Transit-Time – Radius Conversion

The transit time measurement from the UBI scanner is converted to a borehole radius measurement given v , the velocity of ultrasound in the borehole fluid, and the tool radius.

Amplitude Eccentering Correction

When the tool is eccentric in a circular borehole, the amplitude is increased in the directions where the distance to the borehole wall is decreased and vice versa. This change in amplitude can often be larger than the changes in amplitude produced by features on the borehole wall that we wish to image. To correct for

the effects of eccentricity, low order angular harmonic components of the signal with a periodicity equal to 1 and 1/2 revolution are removed.

Transit-Time Eccentricity Correction

The transit time signal is corrected in the same way as the amplitude.

Radius Eccentricity Correction

The distance and direction of points on the borehole wall are initially given with the tool axis as the origin. The geometrical centre of the points on the borehole wall is calculated, and the distance to those points is recalculated relative to the geometrical borehole centre. Both corrected (IRBK) and uncorrected (XRBK) radius images are output. The uncorrected image should be used for analyses such as breakouts and dip computations.

Azimuth Equalization

The background response for all azimuths over a large window (e.g. 3m) is equalized, removing preferential enlargement at a particular azimuth, e.g. the keyseat effect.

The following three corrections are minor and will only be apparent in good (circular) borehole sections where the signal shows very small real variations:

EMEX Noise Filter

Gains Calibration

Sampling Bias Correction

Image Rotation

A rotation of -17 degrees is necessary for the UBI to account for the alignment of the transducer.

Image Normalization

Image normalization is applied using GeoFrame's BorNor module.

In "static normalization", histogram equalization is used to obtain the maximum quality image. The amplitude or radius range of the entire interval of good data is computed and partitioned into 256 color levels. This type of normalization enables large-scale resistivity variations to be clearly visualized.

The image can be enhanced when it is desirable to highlight features in sections of the well where amplitude or radius events are relatively subdued when compared with the overall amplitude or radius range in the section. This enhancement is called "dynamic normalization". By rescaling the color intensity over a smaller interval, the contrast between adjacent amplitude or radius levels is enhanced. It is important to note that with dynamic normalization, amplitude or radius in two distant sections of the hole cannot be directly compared with each other. A 2-m normalization interval is used.

The normalized images are shifted to a sea-floor reference and converted to gif files using in-house software. They are presented on this web site. The image is displayed as an unwrapped borehole cylinder. A dipping plane in the borehole will be displayed as a sinusoid on the image; the amplitude of this sinusoid is proportional to the dip of the plane. The images are oriented with respect to north, hence the strike of dipping features can also be determined.

Interested scientists are welcome to visit one of the log interpretation centers at LDEO, Aachen, Leicester, Montpellier or Tokyo (<http://www.ldeo.columbia.edu/BRG/ODP/STAFF>) if they wish to use the image generation and interpretation software.

For further information or questions about the processing, please contact:

Trevor Williams

Phone: 845-365-8626
 Fax: 845-365-3182
 E-mail: trevor@ldeo.columbia.edu

Cristina Broglia
 Phone: 845-365-8343
 Fax: 845-365-3182
 E-mail: chris@ldeo.columbia.edu

Appendix C. Blank FMS processing summary table

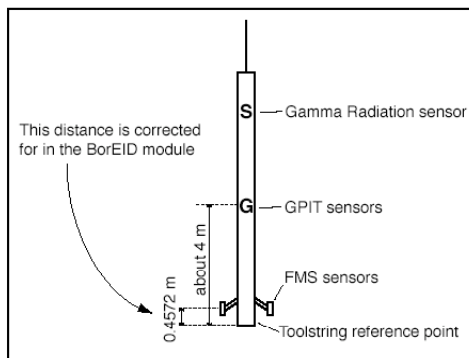
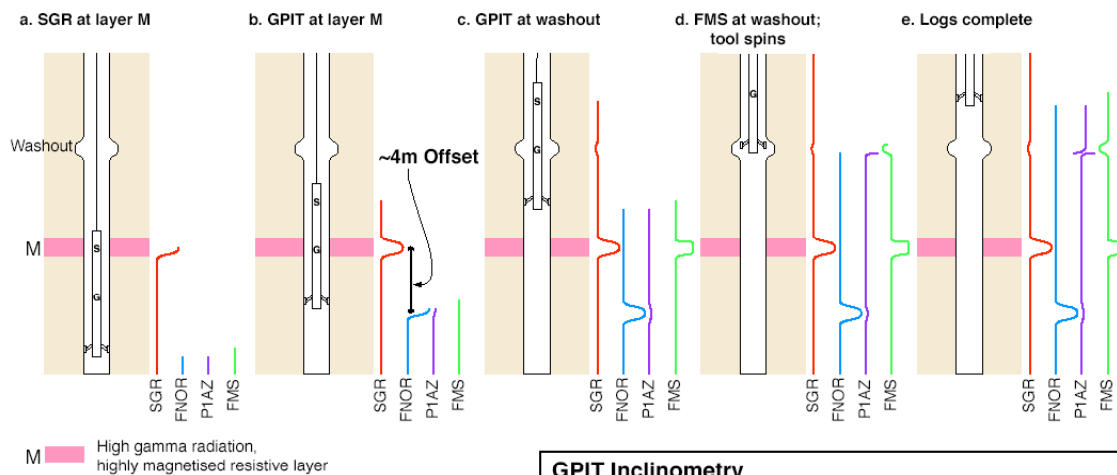
LEG	HOLE	PASS	PASS
DATA LOAD	Logical file name	MESTB.	MESTB.
BOREID	Magnetic Declination		
	Depthshift to Sea Floor (m)		
	FMS start/stop (mbsf)		
	Recovery Speed Factor		
	Detection Threshold		
	Sticking Detection (Y/N)		
WELL EDIT	Base Curve		
	Match Curve		
	Automatic Depthshifting (Y/N)		
	Manual Depthshifting (Y/N)		
BORNOR	Static & Dynamic start/stop (mbsf)		
	Static normalization depths		
DATA SAVE	Output file		
ASCII & BINARY SAVE	Static binary output file		
	Dynamic binary output file		
	P1AZ output file		
GIF FILES	Output depths		
	Number of 100 m files		
	Number of 20 m files		

Appendix D. GPIT offset phenomena

The inclinometry (azimuthal orientation and inclination from the vertical) of the tool string is measured by the 3-axis magnetometer in the GPIT tool. This inclinometry is applied to the FMS data seamlessly, and in FMS processing you don't need to worry about the GPIT sensor being offset from the FMS pads.

However, if you want to use the GPIT data to detect, say, bands of highly magnetized rock, you will find that there is an offset in this data, which has caused some curiosity in the past. This phenomenon is explained below.

Origin of the offset between peaks in the GPIT magnetic logs (e.g. FNOR) and the layers that cause them



GPIT Inclinometry

From the BorEID manual:
 "The inclinometry channels do not have a spatial measure point, in the sense that the tool orientation measured at some instant of time applies to all points on the toolstring that is rigidly connected to the GPIT, at that same instant of time. However, to record the data on tape, it is necessary to give these channels a nominal measure point (the GPIT measure point). This is never set at the GPIT sensors. It is set at the toolstring Reference Point (i.e. the lowest point on the toolstring)."

However, a highly magnetised layer will have an effect on the magnetic logs (mainly the amplitude) at the GPIT sensors. It will be assigned the wrong depth, ~4m below the actual layer.

The P1AZ will not be affected much by the magnetised layer, because P1AZ is the azimuth relative to the main field direction; the main field direction will not be strongly altered by even a strongly magnetised layer (e.g. if the total field in the bore hole is 45000 nT and the anomaly due to the layer is 450 nT).