# Quick and Dirty Instruction Manual for the HMG Navigator

Introduction

The HMG Navigator geosteering program was written to be a fast and easy geosteering program. The principal is that the different aspects of geosteering are divided into different pages. I have written this manual so that people can learn to use the program in a couple of hours.

Finally, this program is a work in progress. Or in other words this is a beta version. I plan on spending the next year expanding the programs capabilities so please send all comments to me. I look forward to hearing your ideas and incorporating then into this program!
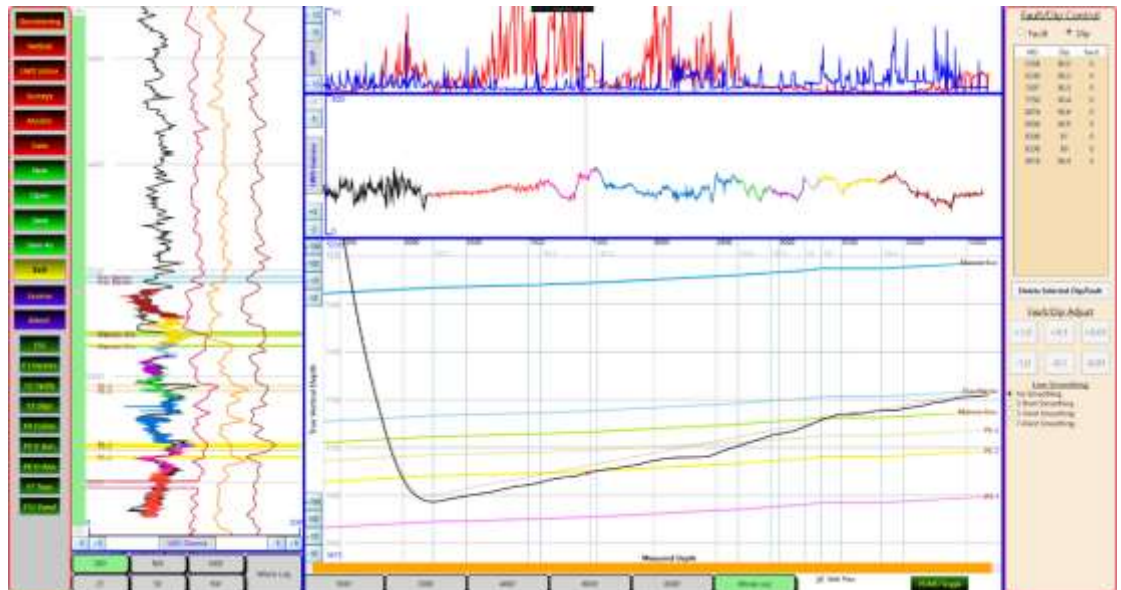
Happy Geosteering!

Overview

Red Buttons – Geosteering, Vertical, LWD Editor, Surveys, LWD Editor, Model Logs, Data

The left side of the Navigator program has a control panel with buttons that are divided into colors. The red buttons represent the different pages. Each page handles a different operation. The **Data** page opens the page where Gas and ROP data is loaded and edited. The **Model** page handles everything to do with the models (offset logs) used in geosteering. The **Survey** page handles everything to do with surveys and well plans. The **LWD Editor** handles the loading and editing of the LWD data including setting color schemes to help with geosteering. The **Vertical** page is where correlation prior to active geosteering (usually after KOP) is done. Finally, the **Geosteering** page (is where most the fun happens) and is where dips and faults and active correlation during the build and lateral are accomplished. This panel is visible all the time, although this panel can be "hidden" by clicking (toggling) the F12 key (or the dark green (F12 Panel button).

Light Green Buttons – New, Open, Save, Save As

These buttons are for creating new files, opening saved files, or saving files.

Blue Buttons – License and About

These buttons open the **Licensing** and **About** windows.

Exit Button

Will exit the program.

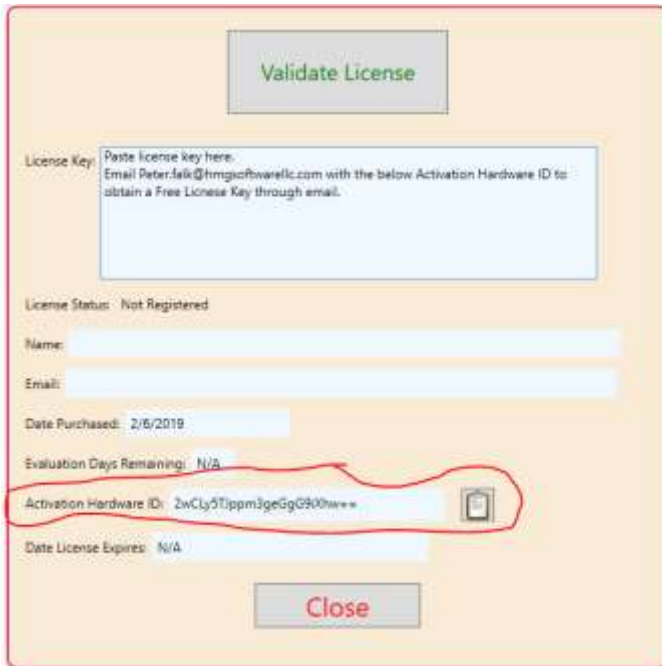### Dark Green Buttons (Formatting the Geosteering window)

These buttons are for formatting the pages and presently are only used on the **Geosteering** page. For example, the **ESC** button (or key) will toggle back the selected fault or dip selection. The **Params** button (or F1 key) will toggle whether the parameters will be displayed or hidden. The **Faults** and **Dips** buttons toggles displaying the location each fault or dip location with a green or blue line next to the new dip and the

amount of fault throw. The **V-Axis** and **H-Axis** buttons toggles through a selection of increasing vertical depth divisions. The Tops button toggles display/hidden the formations/tops names.

Licensing Tab

For the present and for people who are using my program in its initial "beta" version, use of this software is free. However, you will still need an activation key to operate the program. To obtain a key from me please email me the "Hardware Activation Key" to peter.falk@hmgsoftwarellc.com. I will send back a key code good for 2019. Paste key code into the License Key area and click Validate License. You should be good to go.

The Activation Hardware ID can be obtained by opening the License window where it will be displayed near the bottom (see red circle below). Save the activation key to the clipboard by clicking the clipboard icon and then email me that Activation Hardware ID. I will then be able to create a key that will allow the program to run on your computer.

Presently, I am not charging for use of this software. However, I still want to know who and how many people are using this program.

Free?

I have been asked if in the future if I will start charging for use of this program. The answer is: that depends on the use of this program. Currently I wrote this program as an answer to my geosteering problem of very expensive geosteering software, most of which are very good with many excellent features. But sometimes you don't need all the bells and whistles, but rather a simple geosteering program that does the basics of gamma correlation. I have invested my spare time in writing this program and if it there is a space for this program out there and I start getting lots of requests for updates and improvements then the yes I will start charging for this software to compensate me for my time.

If I do start to charge for this the HMG Naviagator, I will price it so that independent geologists/geosteerers will still have a low-cost option to what can be an expensive piece of software.

How to Use this Program in One Paragraph

1) **Models** Page: Create and load offset gamma logs. Edit and markup up offset gamma logs with tops and formations. These "marked up" logs will be used for correlation in the **Vertical** and **Geosteering** pages
2) **Survey** Page: Enter the Survey data for the Lateral starting above the KOP. Well plan can also be loaded but is optional.
3) **LWD Editor** Page: Load LWD Gamma data and click anywhere to add different colors. Color schemes can be automatically added by clicking buttons. For example, the Dip/Fault button will change the LWD Gamma curve color every location of a fault and or dip change. Color changes in the LWD Editor page are for the geosteering page to make correlation easier.
4) **Vertical** Page: Select models from the right list by left-clicking mouse to display. Up to three models can be displayed at one time. Right click selected models to display tops and formations. Use scrollbar to correlate the LWD Gamma curve with the model curves either above the KOP or through the build. Then click on the graph to set a Geosteering start point. This will activate the Geosteering page. Models selected for the Vertical page will also be displayed in the Geosteering page.

5) **Geosteering** page: Click on the Cross-Section Panel (Center bottom) to select a new dip or fault location. Select dip or fault from the right list to make active that dip/fault segment. Use the buttons below fault dip or the mouse in the left correlation panel to move adjust faults or dips. Use the **ESCAPE** key/button to deselect fault/dip segment.
6) **Data** page (optional): Load ROP and or Total gas data to be displayed in the geosteering page. Data can also be edited in this page.

Data Page

The data page is where the non-gamma data is entered. Currently, the only non-gamma data that can be displayed on the **Geosteering** page is ROP and Total Gas. This page allows the user to load the data through an LAS file and then to edit the data.

Models Page

The **Models** page is where offset logs or pilot hole gamma logs are loaded and marked up with tops and formations. It is these logs that will be used in correlation in the other pages of the program. There is no limit to how many logs can be loaded into the **Models** page. The **Models** page is divided into three columns. The far-right column titled **Models**:, lists the models that have been loaded or created into this file. The second column shows the tops/formations that have been annotated to the selected model. And the left column displays the gamma log with the tops/formations.

Models List

Loading a model gamma file into Models: list is a two-step process. The first step is to create a new model by clicking the **Create** button. This will create an empty model called "no name". The second step the the user has two choices: to load a gamma log from a LAS file, or to load a previously marked up file that has been created and saved previously. There is no limit to how many models can be added to the "Models:" list. Below the Create green button at the base of the "Models:" list is a pink **Delete** button which clicked will delete the selected model.

Depth Scales and Gamma Scales

Light blue shaded buttons on the bottom of the page allow the user to select a depth scale that ranges from Whole Log to "25". The default gamma scale is from 0 on the left to 300 API units on the right. However, this scale can be easily edited with the +5/-5 buttons on either side at the base of the window. Note, this method for changing the gamma scale and other scales, other than the depth scale, is consistent throughout the program.
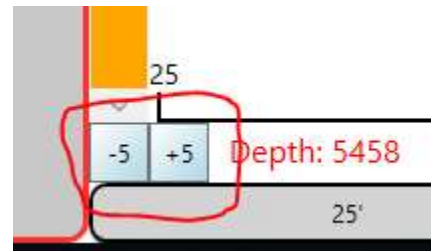
Markup Log

To markup a model with tops and formations, select the model from the list of models to display the log in the main column. This will display the gamma curve in the main column as a red line. Draw the formation by placing the mouse at the top of the formation and while holding the mouse button down drawing down. Release the mouse at the bottom of the formation. For a top simply click the mouse at the location of the top. New tops or thicker formations are displayed in the default color of orange. The new top or formation, which I call markups, will be displayed in the middle column under the heading "Log Markups (Tops/Formations):". To edit the Markup, select the formation from the list of Markups and select the **Edit** button at the bottom of the screen. This will open the

Markup editor which allows the user to fine tune the top and bottom of the markup, change the name of the markup and change the color of the markup.

Saving Markup Files

Markup files can be saved so that they can be reused in a different file. To save the markup simply click the **Save Markup File (*.mkp)** button underneath the list of Markups.

Changing Name of Log

Log names are displayed at the top of the log in the column that holds the gamma curve. This title is also a textbox that can be clicked, and a new name entered. As the new name is entered you will see the name change in the "Models:" list.
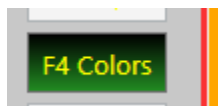
Changing Color of Model Curve

Clicking the **F4 Colors** button or the **F4** key will toggle the curve of the selected model through the available colors: Crimson, Dark Orange, Brown Black and Dark Green. More colors to be added later.

Surveys Page

The survey page is where the surveys for your lateral and well plan are entered and or edited. Choose either **Well Plan** or **Lateral** from the drop-down menu. Survey's are shown in the left column. Below the Survey's list are 6 buttons: **Edit**, **Add**, **Load (*.csv)**, **Export (*.csv)**, **Delete**, and **Change Direction (VS Azimuth)**. Use the **Edit** button to edit the selected survey from the survey list, the **Add** button to add a new survey, the **Delete** button to delete the selected survey from the survey list, and the **Change Direction (VS Azimuth)** button to enter the correct direction/VS Azimuth.
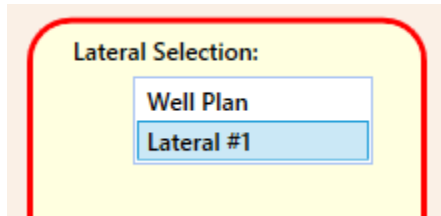
Importing Surveys

The easiest way to enter a large amount of survey data is to use a formatted *.csv file. Formatting *.csv file to be imported into the survey editor is simple. Cell A1 is used for Direction, or Vertical Section along Azimuth (surface hole location to bottom hole location.) B1 is simply "Direction". Row 2 is used as header for the survey columns. Row 3 holds the Tie-In value. Rows 4 and onward are used for survey parameters MD, INC, and AZ. The other

	A	B	C	D	E	F	G	H
1	270	Direction						
2	MD	INC	AZ	TVD	VS	NS	EW	DLS
3	0	0	0	0	0	0	0	0
4	492	1.76	173.71	491.92	-0.8	-7.51	0.83	0.36
5	525	1.76	171.51	524.91	-1	-8.52	0.96	0.2
6	587	0.35	128.44	586.9	-1.2	-9.57	1.25	2.46
7	648	0.62	10.95	647.89	-1.5	-9.37	1.46	1.38
8	709	2.02	356.8	708.88	-1.5	-7.97	1.46	2.34
9	770	3.08	353.54	769.82	-1.2	-5.27	1.21	1.75
10	832	4.13	352.83	831.69	-0.7	-1.4	0.75	1.7

columns (TVD, VS, NS, EW, and DLS) will be calculated by HMG Strata Log when the survey .csv file is imported. See the above example for proper formatting of the survey file to be imported. After the file is formatted and all available or desired values are added, be sure to save the file as a *.csv (comma delimited). Close the spreadsheet file before using the **Load (*.csv)** button. Importing a .csv file will delete and replace previous values, including the tie-In.

Exporting Surveys and/or Creating Survey File Template

To export the survey values which have been added to the Survey Editor as a *.csv file, just click the **Export (*.csv)** button and save it to your computer.

Note, exporting surveys is a quick and easy way to create a survey file template that can easily be opened and edited in excel.

LWD Editor Page

The LWD Editor page is where the LWD data is loaded and where color segments for the LWD gamma curve can be edited, reset and managed.

Loading LWD Data

The process for loading LWD data is comparable to how data is loaded into the Data Pages and the Model pages. Use the **Load LWD File (*.las)** button or **the Quick Load (Update)** button to load LAS files into the program. The **Load LWD File (*.las)** button will open a window that allows the user to select the appropriate file and the correct gamma curve. Once a file is selected, the **Quick Load (Update)** button can be used to quickly load a file with new data assuming the file name and the curve selection are the same. Use this button only if the MWD personnel are using the same file name and format for updated data. The default setting for loading data is too have the **Overwrite File** unchecked so that only new data past the last MD of the current loaded data will be added. If there is new or corrected data, then check the **Overwrite File** box and the new data loaded will overwrite the LWD data. The Overwrite check box will automatically uncheck after data is loaded to minimize the possibility of accidentally overwriting previously loaded data.

Geosteering Start

Once a "Geosteering Start" depth is selected in the **Vertical** page, a geosteering start line will be displayed on the LWD Gamma graph with the area before the Geosteering Start depth being demarked in a gray shade. Changing the gamma scale on the LWD graph is the same as on the **Model** page. Light blue buttons on the left side of the graph can be pressed to quickly change the scale to the desired values.

Changing LWD Gamma Colors

There are a few different ways to add, edit or change a color segment on the LWD gamma curve. To manually add a color change to the LWD Gamma Color curve, click on the LWD gamma graph at the desired depth to add a color. This will add the new color depth segment to the Colors List on the right side of the page. To change color or delete a color segment select the color segment from the list and click either the **Delete** button (to delete the segment) or the edit button. Clicking the **Edit** button will open the edit window which will allow the user to select a different color. There are also some preset buttons that can be employed to automatically add colors according to an algorithm.

Dip/Fault Button

The **Dips/Faults** button will clear all the colors then add a color change at every depth where there is a new dip or fault change.

Up/Down Button

The **Up/Down** button divide the LWD gamma curve into blue segments and green segments. Blue segments exist where the Inclination of the hole is higher than the dip of the corresponding location on the log. The green segments will show where the inclination of the hole is less than the dip of the corresponding location. Hence blue segments show where the hole is descending in the stratigraphic section while green segments show where the hole is climbing in the stratigraphic section. If dips are changed in the geosteering page of the program, the user must come back to **LWD Editor** page and click the **Up/Down** button to reset the blue and green line segments. At present, the program will not automatically add or change blue/green segments as dips are changed during correlation.

TP 1000 Button (Transparent 1000)

If the log correlation window in the Geosteering page becomes too crowded then this button may be handy. It keeps the build portion of the LWD curve but then makes transparent every part of the lateral except the last 1000'

The **Clear** button will clear all colored line segments. When new dips or faults are added in the geosteering section of the program, new colors are automatically added to the LWD gamma curve outside of the **LWD Editor** page.
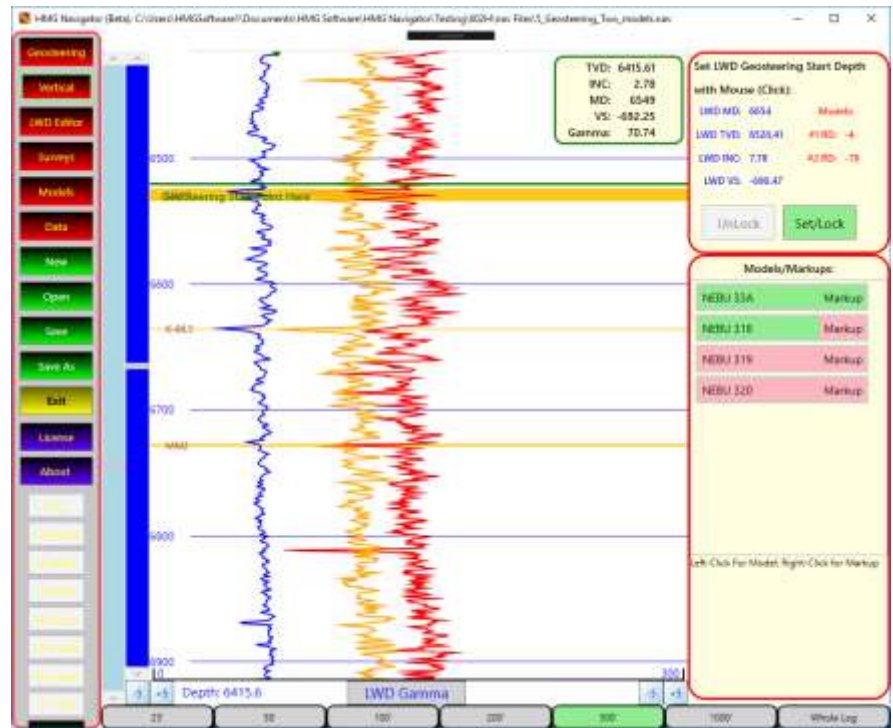
Vertical Page

The Vertical page has three main uses. First, correlation of the LWD gamma data with offset logs during the vertical portion of the drilling up to and including the build section of the lateral.

Second, selection of a geosteering start point, which is the start point for geosteering on the **Geosteering** page.

Third, selection of the correlation logs and the corresponding markups to be used on the **Geosteering** Page

Models/Markups

On the right side, lower half of the **Vertical** page window is the location of the lists of models that have been created in the **Models** page. Initially, each model in the list is pink. To select a model to be displayed on the vertical graph component of the **Vertical** page, left click the desired model. This will turn the left half of the selected model green in the Models/Markups list, and the gamma curve of that model will appear on the vertical graph in red. The right side of the Models/Markups list display the words "Markup" and by default is unselected (pink). Right-click the mouse and the right side will turn green and the markups(tops/formations) will be displayed on the left-side graph. Three models and their accompanying markups can be displayed at one time.

Note, use the **Vertical** Page to display the offset log and the associated markups that you want displayed in the **Geosteering** page

Correlation using the Vertical Page

The LWD gamma data is displayed on the **Vertical** page graph as a blue line (always). The left scale of the graph is TVD which means the LWD will only be displayed if there is survey data available so that a TVD depth can be generated.

There are two scroll bars on the left side of the graph. The light blue scroll bar on the far left controls the TVD and will move the whole log up and down. The scroll to the right will be initially dark blue. When this scroll bar is clicked it will move the model curves up and down to allow the user to correlate models logs with the LWD TVD-corrected blue gamma curve.

Note, since the **Vertical** page is only for correlation of the logs during the vertical and build section of the well, it will only display the LWD curve corrected for TVD up to an inclination of 88 degrees. Once past 88 degrees, no more LWD gamma will be displayed.
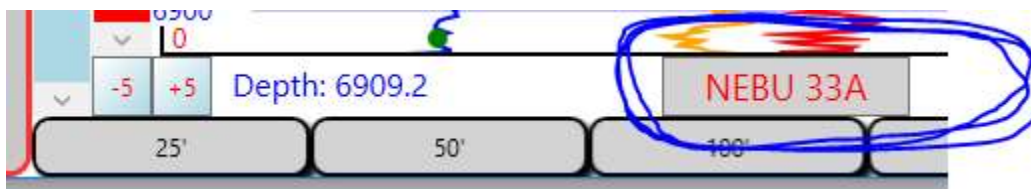

Toggle Models

At the bottom of the graph is a button (shown circled in blue) that can be clicked to toggle

through the LWD Gamma curve and the selected Model Curves. If the button displays in blue "LWD Gamma" then the scroll bar will be blue and will move all the selected model gamma curves up and down. Click the button and it will change titles and colors (as will the scrollbar)
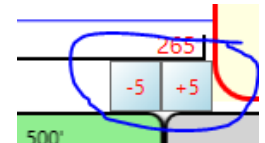
to the name of the selected model curve. The scroll bar will then only move the selected model up and down allowing the user to correlate individual models separately. The button will only scroll through the selected models displayed on the graph. In the example above the scroll bar is red matching the model curve log called NEBU 33A and the scroll bar will only move that curve.
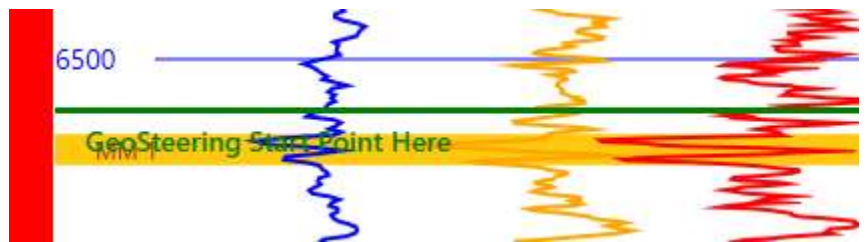
Also use the **Toggle Models** button to select which model or LWD gamma curve will be adjusted by the scale buttons on the lower left and right of the graph.
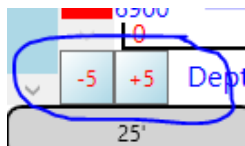
Selection of a Geosteering Start Point

Once you have a good correlation the second use of the **Vertical** page is to select a geosteering start point. Selecting a geosteering start point will activate the **Geosteering** page. Select a geosteering start point that is close or slightly past the KOP but of the lateral. This will allow correlation of the log during the build. To select a Geosteering start depth click the mouse at the TVD depth. A green line annotated with the words "Geosteering Start Point Here" will appear.

When a geosteering start point is selected, the geosteering start point will be locked so that another geosteering start point cannot inadvertently be selected. Scrolling of the model logs will also be locked. If you would like to change the correlation or select a different geosteering start depth, select the Unlock button in the upper left. Once the Unlock button is pressed a new geosteering start depth can be selected and/or the models can be moved up and down.

In the upper left is a box outlined in red shows the LWD gamma geosteering information in blue and the reference depths for the selected models in red on the right. The reference depths (i.e. #1 RD -4) shows the difference in depths between the correlated models and the LWD gamma curve. These numbers will change as the models are moved up and down when correlating.

## Selection of Models/Markups for Geosteering Page

Once the models are correlated and the geosteering start depth is selected, the last purpose of the **Vertical** page is to select the models that will be displayed on the **Geosteering** page. The models that are selected and shown on the **Vertical** page are the same models that will be displayed on the geosteering page. However, the models need to be correlated to the Vertical LWD gamma log on the **Vertical** page and can not be adjusted on the **Geosteering** page in relation to their start position.

Geosteering Page

The Geosteering page is the heart of this program and where most of the geosteering action will take place.

Resizing Panels

The **Geosteering** page is divided by thick blue lines. The blue lines are splitters which can be moved left and right (vertical splitter) or up and down (horizontal splitters) to increase or decrease the size of the panels dependent on your
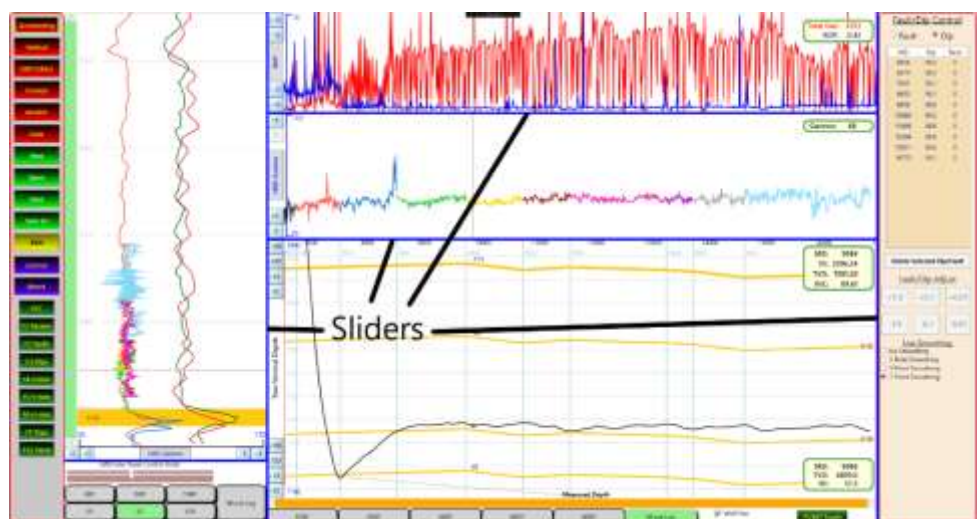
preference. The top horizontal panel holds the ROP and Total Gas data, the horizontal below that holds the LWD Gamma data, and the Horizontal Panel at the bottom holds the Cross-section. By default, the cross-section has TVD for the vertical axis and the Measured Depth for the horizontal axis. A toggle button at the bottom allows the user to switch the Horizontal axis to Vertical Section. When the horizontal axis is in vertical section, ROP and Total gas data will not be displayed in the top panel. The left most Panel holds the correlation of the LWD data with the model logs. Finally, the right-most panel holds the dip / fault control.

Fault/Dip Control

The Fault/Dip control is a list that holds the locations of changes in either dip or whether there is a fault or both. The list displays the measured depth of the fault or dip and the change in dip and how much throw there is on the fault. It is possible to have both a fault and a dip change at the same measured depth location. The first entry in the fault/dip list corresponds to the Geosteering Start Depth and is automatically created when a Geosteering start depth is selected in the **Vertical** Page. To add a new fault or dip point click on the Cross-Section with the mouse and a new fault/dip selection will appear in the list.

Above the list of Fault/Dips are radio buttons which either show that you are in fault mode or dip mode. The example on the left shows that we are in dip mode.

Selected Fault/Dip

When a fault/dip is selected from the Fault/Dip list, the beginning and end points will be marked on both the XSection Panel and the Correlation Panel by dotted green and red lines respectively. The green line is the measured depth (vertical section if in toggled vertical section mode) where the dip change begins, and the red line represents the next dip/fault change or the end of the loaded surveys (borehole). If you select the last selection in the list there the red line will appear at the end of the surveys. On the correlation panel on the left, the selected segment between the dashed green and red line will appear as a dashed purple line and the rest of the LWD curve beyond the end of the selected segment will disappear so as to make correlation easier.

Deselect Segment

To deselect the fault/dip segment and bring back the entirety of the LWD line on the correlation panel click or press the ESCAPE key.

Changing Dips

There are two ways to change the dip of a selected dip segment. The first way is to use the buttons under the Fault/Dip control.

The second way is to use the mouse in the correlation panel. Press the mouse down and a new purple line will draw as you move the mouse up and down. The beds in the cross-section window will change and the calculated dip will appear at the top of the correlation panel.
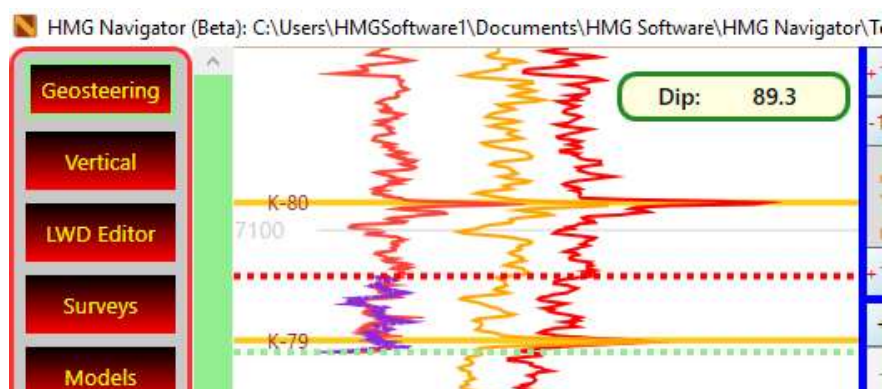

Line Smoothing

The line smoothing selections allow the line smoothing of the LWD Gamma curve using 3-point, 5-point and 7-point algorithms.

One set of Markups on XSection

As mentioned before, you can select up to three offset logs in the **Vertical** Page to display in the **Geosteering** page and their associated markups. Up to three markups can be selected in the **Vertical** page to display in the Geosteering page. However, though up to three markups can be displayed on the correlation panel in the **Geosteering** page, only the first (highest in the list) of the markups will be shown on the XSection panel. See example below where three offset logs and their associated markups/tops are displayed in the correlation window (three sets of each top for the different offset logs – red, orange and brown) but only one set of markups/tops is displayed in the XSection panel. Turn off the markup in the **Vertical** page to display the next markup selected in the list on the **Vertical** Page.
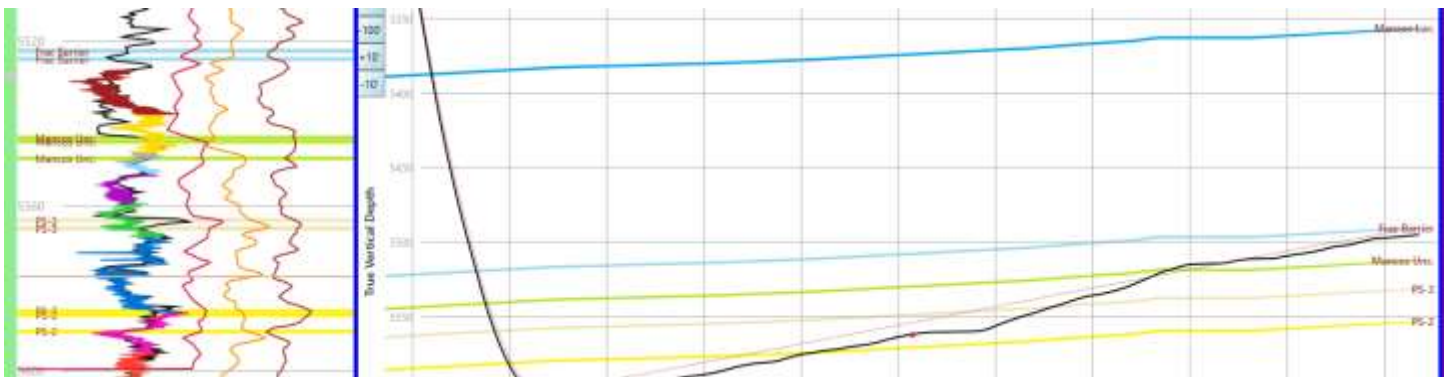
Repeat

Load new survey data, load new LWD Gamma data, add faults and dips to the geosteering page, and change those faults and dips to correlate. Use the LWD Editor Page color buttons (**Dip/Fault Button**) to mark dip changes on the correlation log. Repeat process!

Call or email me Peter Falk anytime with suggestions, bugs, questions, or stories!

Thank You,

Peter Falk