

	<h2 style="margin: 0;">B07 – Guided Interpretation #7: Formation Testers</h2>	
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This example gives an overview of the Formation Tester module. The objective of this session is to learn how to load and process data from formation tests and the results of their interpretation (i.e. discrete values of reservoir pressure, and mobility or permeability).

B07.1 • Loading the data

B07.1.1 • Formation tests specific data types and mnemonics

Calling the 'Formation testers' option amounts to creating a specific object in the data hierarchy, below the 'Survey' level. A 'Formation Testers' object comprises a number of channels, for the reservoir pressure, mobility, and permeability. Specific data types in the Emeraude database are:

Data Type	Default built-in mnemonic	Units
Formation pressure	RESP	Pa, kPa, psia, psig, atm, bara, barg, kg/cm2, m
Formation mobility	RESM	md/Pa.sec, md/cp, Darcy/Pa.sec, Darcy/cp, m2/Pa.sec, m2/cp, cm2/Pa.sec, cm2/cp, μm2/Pa.sec, μm2/cp
Formation permeability	RESK	md, Darcy, m2, cm2, or μm2

Fig. B07.1 • Formation tests specific data types and mnemonics

B07.1.2 • Loading

- Start Emeraude and create a new document, a new survey and load the data from the file B07ft.las. This file contains the following curves: Wellbore Temperature and Pressure, Reservoir Pressure, and Reservoir Mobility.

Remarks: Although formation tests data are acquired as stationary measurements, all depths of interest should be loaded in one go, i.e. do not load the data as multiple discrete stations, but as a versus depth information. You could load from distinct sources; for instance the wellbore pressure vs. depth could be in one file, and the reservoir mobility (or permeability) and reservoir pressure vs. depth in another one.

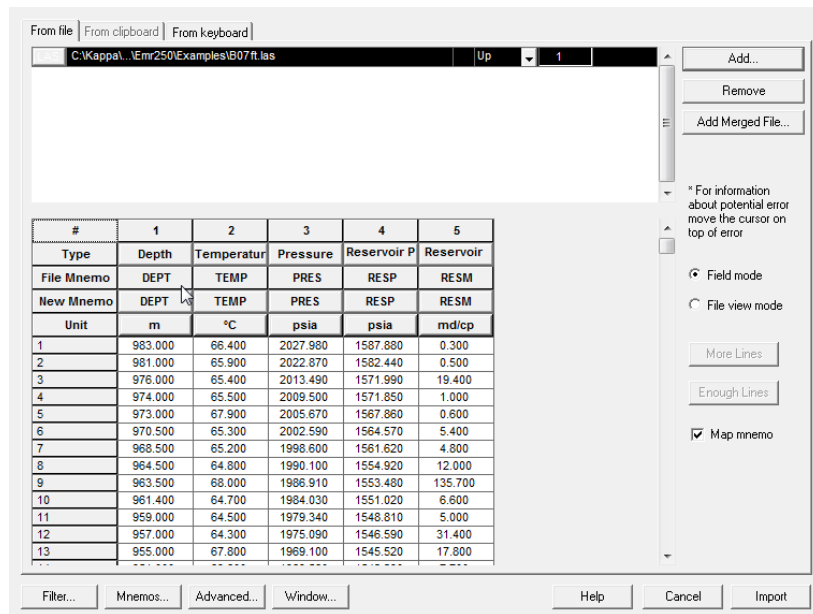


Fig. B07.2 • Loading Data

- Accept the default mnemonics and units and import the data.

Wellbore temperature and pressure log channel are generated automatically after loading; you will see later in this session how the reservoir pressure and mobility are displayed once they are defined within the 'Formation Testers' analysis.

- Hide the Pressure and Temperature log channel views and go to the 'Special' control panel.

B07.2 • Creating the FT analysis

B07.2.1 • Calling the FT option

When the survey contains at least a 'Formation permeability' or a 'Formation mobility', AND a 'Formation pressure', the 'Formation testers' option of the 'Special' panel is enabled.

Click on this option, and access the dialog below to select the input data.

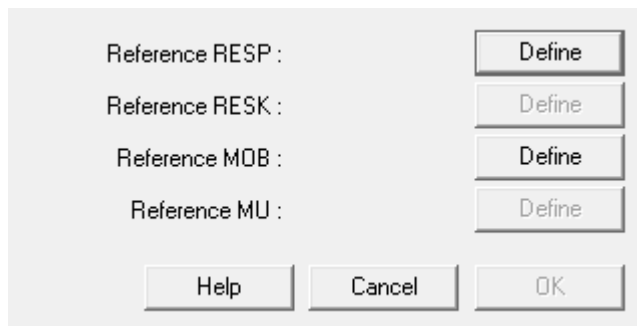
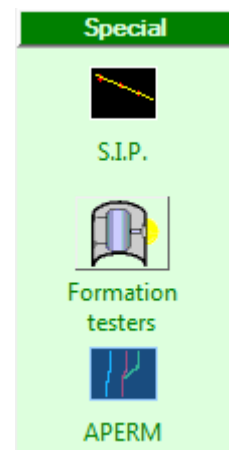


Fig. B07.3 • Data input selection dialog



B07.2.2 • Defining the reference channels

The 'Define' buttons are used to select the desired channels. They open a selective data browser indicating only the candidate locations/channels. Those options/dialogs can be used to select or unselect. Define the reference pressure and mobility by selecting the candidates from the 'Search' dialogs as shown in Fig. B07.4 below:

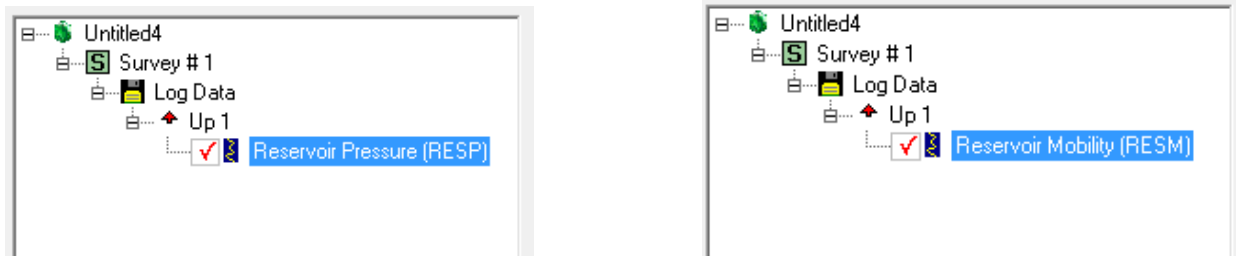


Fig. B07.4 • Selecting reference channels

B07.2.3 • Formation testers main dialog

	Depth	RESP	RESM	Label	Status
	ft	psia	md/cp		
1	3103.675	1588.510000	0.200000		Good
2	3111.877	1541.560000	9.500000		Good
3	3120.079	1542.230000	7.700000		Good
4	3133.202	1545.520000	17.800000		Good
5	3139.764	1546.590000	31.400000		Good
6	3146.325	1548.810000	5.000000		Good
7	3154.199	1551.020000	6.600000		Good
8	3161.089	1553.480000	135.700000		Good
9	3164.370	1554.920000	12.000000		Good
10	3177.493	1561.620000	4.800000		Good
11	3184.055	1564.570000	5.400000		Good
12	3192.257	1567.860000	0.600000		Good
13	3195.538	1571.950000	1.000000		Good

Layers

Layer 1

Results

Lines

Name =

Slope = N/A

*Vertical gradient = N/A

Intercept = N/A

Contacts

Pressure = N/A

Measure Depth = N/A

True Vertical Depth = N/A

* No Deviation or Tvd in General Well Data

Delete

Insert

Add

Select data

Copy

Help

Cancel

OK

Fig. B07.5 • Formation Testers main dialog

Once the channels have been selected, the main dialog is automatically displayed. It shows a grid summarizing the information associated with each of the formation pressure tests:

- Depth, Reservoir pressure, and Reservoir Mobility values (those values are editable).
- The 'Label' column can be used to assign a label to each point ('Normal' – 'Supercharged' – 'Dry' can be accessed with a right click, or anything else can be typed in directly).
- The 'Status' column is also included and the content of the cells can be changed by repeated clicks between 'Good' – 'Medium' – 'Bad'.

Under the data browser, a new node has been created and materializes the Formation Testers Analysis that contains the previously defined reference channels RESP and RESM – see opposite.

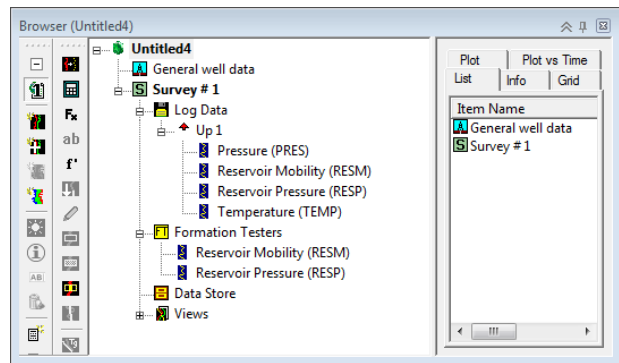


Fig. B07.6 • Formation Testers Node

You can enter labels and change the status according to Table B07.7 below. Note you can select several cells together, and then right click to access the desired label/status for all of them. Also, a single click in the Status cells will change the content.

	Depth, ft	RESP, psia	RESM, md/cp	Label	Status
1	3103.67	1588.51	0.2	Supercharged	Bad
2	3111.87	1541.56	9.5	Normal	Good
3	3120.07	1542.23	7.7	Normal	Good
4	3133.20	1545.52	17.8	Normal	Good
5	3139.76	1546.59	31.4	Normal	Good
6	3146.32	1548.81	5	Normal	Good
7	3154.19	1551.02	6.6	Normal	Good
8	3161.08	1553.48	135.7	Normal	Good
9	3164.37	1554.92	12	Normal	Good
10	3177.49	1561.62	4.8	Normal	Good
11	3184.05	1564.57	5.4	Normal	Good
12	3192.25	1567.86	0.6	Normal	Good
13	3195.53	1571.85	1	Supercharged	Bad
14	3202.10	1571.99	19.4	Normal	Good
15	3218.50	1582.44	0.5	Supercharged	Bad
16	3225.06	1587.88	0.3	Supercharged	Bad

Table B07.7 • Assigning Label and Status

B07.2.4 • Plotting

The Formation tester option automatically creates views to display the reservoir permeability/mobility and pressure. On this views the channels appear with markers, with their label, and each point is displayed with a color representative of its status (green=good, orange=medium, red=bad). The reservoir pressure is displayed on a standard linear scale while the reservoir permeability/mobility track view has a logarithmic scale.

- Exit the 'Formation testers' dialog with OK, and organize (Tile) the Emeraude main display as in the figure below:

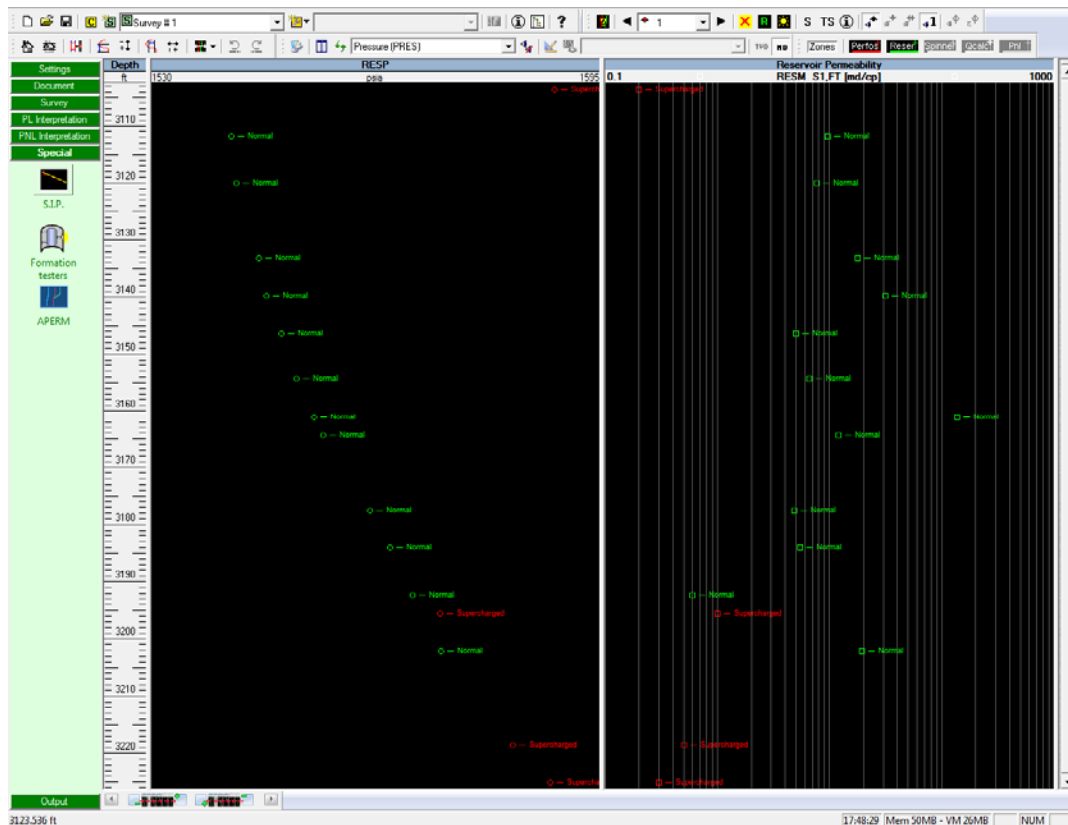


Fig. B07.8 • Formation tester plots

If the survey contains others permeability/mobility channels, they will also appear on the view as seen in Fig. B07.9 (white curve).

- From the 'Survey' control panel, open the 'Load' option and import the 'B07oh.las'. This file includes a permeability curve from a previous open-hole logging session. This curve appears on the same track as the loaded mobility curve.
- Make the permeability curve active (clicking on curve name in header) and reset the horizontal scale from 0.1 to 1000 in order to show the logarithmic scale vertical lines (the same scale is required for both channels).

Note: you can modify the Plot and lines aspects in the dialog accessible in the control Panel Settings Default Display, in the tab Views / Formation testers views.

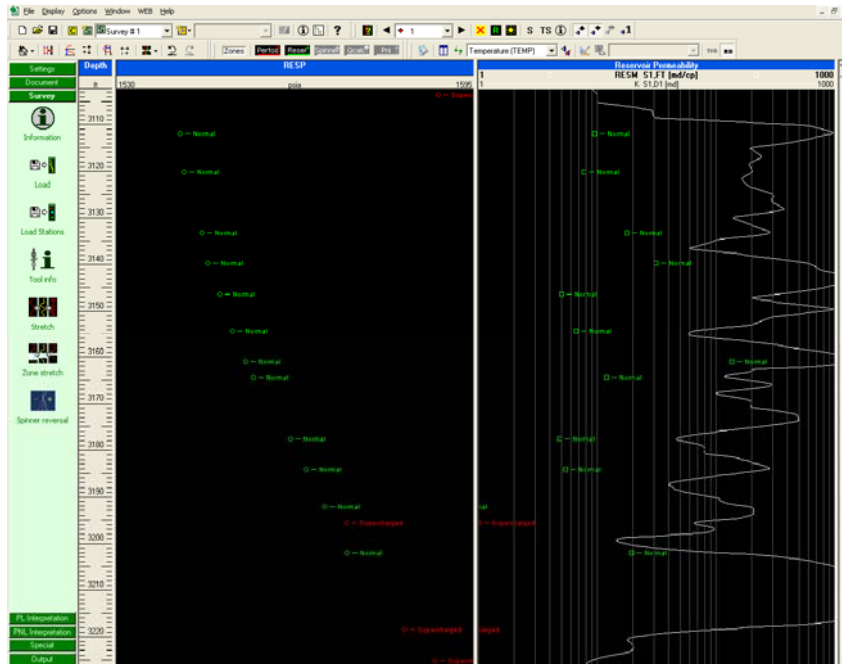


Fig. B07.9 • Formation testers plots and Open-hole permeability

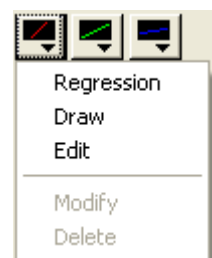
B07.2.5 • Defining the gradients and contacts

➤ Go back to the 'Formation testers' main dialog.

Once the linearities have been decided on the screen, it is possible to create lines, by least square, or by drawing on the reservoir pressure view. Provision has been made for an unlimited number of layers, and within each layer for three lines representative of water, oil, and gas. In this session, it is assumed that the well is vertical and therefore we do not worry about deviation/TVD. If the well was deviated, and with loaded data supplied versus MD, you should load a TVD channel in the General Well Data (using the 'Load Well Data' option of the 'Document' panel). Once the TVD channel is loaded, the display can be dynamically switched to TVD using the last 2 icons of the Display toolbar:



At startup, only one layer is created but you can add as many as required clicking on the button next to the layer drop list. For a given layer, the 3 lines for gas, oil, and water are created, modified, or deleted using the corresponding buttons as seen in opposite.



When selecting 'Regression' 'Draw' or 'Modify', the dialog is hidden and the operation is conducted directly on the formation pressure view as follows:

- Regression: click for the first limit, drag, and then release for the second limit. After the range is selected a dialog pops up that gives the option to either select all the points, the good only, or the good + medium only.
- Draw: click for the start point of the line, drag and then release for the end point.
- Modify: a central cursor can be seized that moves the line up and down. At each extremity, two more cursors can be grabbed to rotate the line.

In order to define the gas pressure gradient, pick the 'Red line' icon and select the 'Regression' option; compute the line from 3103 ft to 3135 ft:

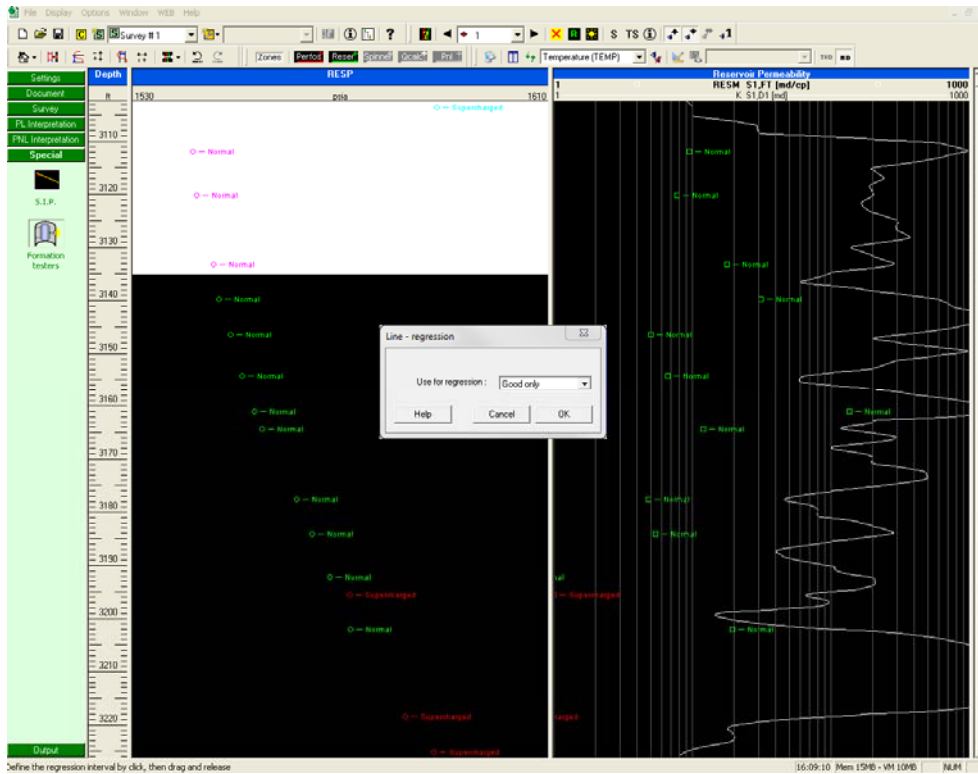


Fig. B07.10 • Defining the gas gradient

- Select the 'good only' points.
- Exit with OK.

The 'Formation testers' dialog pops up back on the screen and a red line corresponding to the computed gradient is being drawn. The results are seen in the lower part of the dialog, with a section where a name can be given to the line.

- Type in 'Gas', as seen below.

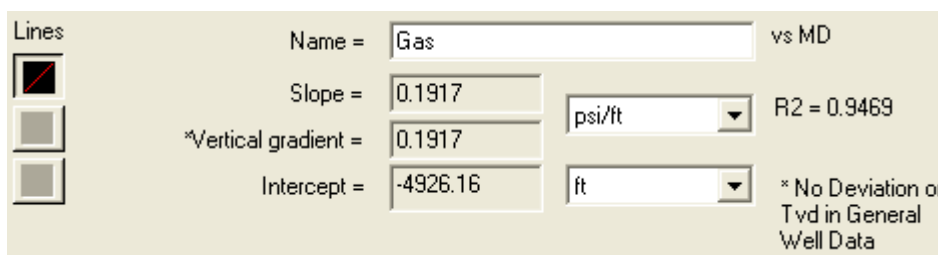


Fig. B07.11 • Lines section for Gas

Next to the line name is the indication of the scale where the line was created (MD or TVD). The slope is the actual slope on the line native scale. The vertical gradient is either the slope, if the line is created versus TVD, or the actual slope divided by the cosine of the average deviation in the line interval otherwise. Once again, let us insist on the fact that if the deviation is significant and not constant, you should load a TVD channel in the General Well Data, and toggle the display to TVD before defining the lines.

For a line defined by regression, R2, the determination coefficient is displayed. Recall that a value of 1 is indicative of a good fit, whereas 0 is the opposite. To change the line, you can select among the following options:

- Edit and change the slope/intercept values directly. This option is enabled only if the display mode (TVD or MD) is the mode where the line was created.
- Modify the line interactively.
- Delete the current line and re-perform a Regression/Draw action.

- Use the 'Regression' option to compute the oil line -green- (from 3135 ft to 3160 ft); and the water line -blue- (from 3160 ft to 3210 ft) in a similar manner. Selecting the 'Good only' points for all lines should lead you to the following results:

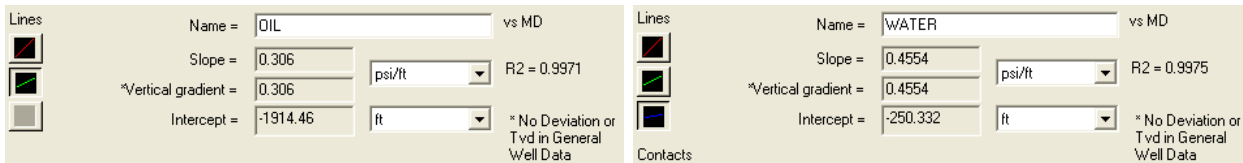


Fig. B07.12 • Lines section for Oil and Water

Once at least two lines have been defined (on the same scale), Emeraude will automatically compute their intersection and display the results under the 'Contacts' section:

Oil Gas Contact:

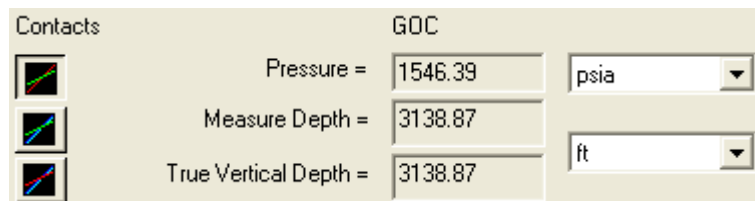


Fig. B07.13 • GOC Contacts section

Water Oil Contact:

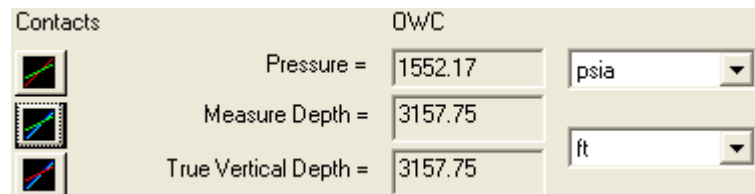


Fig. B07.14 • OWC Contacts section

Annotations are automatically created to display the pressure gradient for each line and contact depth values on the reservoir pressure view. Those annotations are moveable (right click on top and edit) as seen in Fig. B07.15:

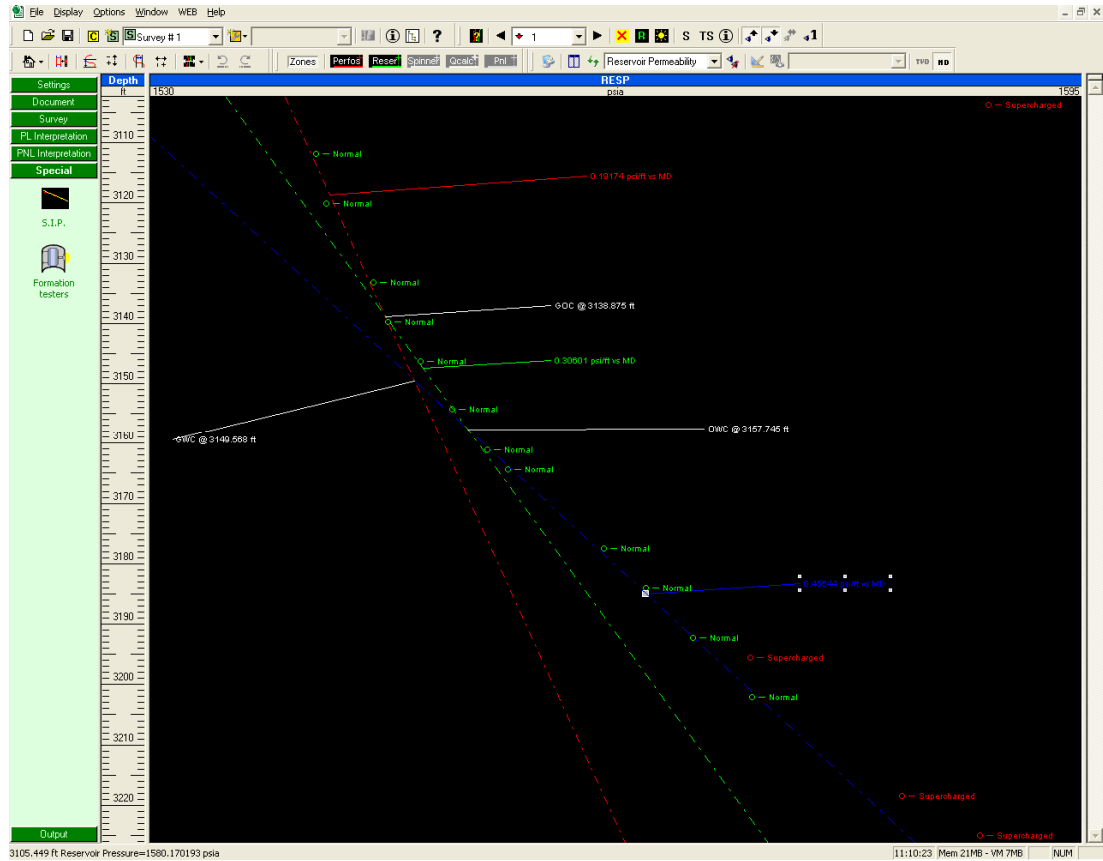


Fig. B07.15 • Gradient lines and Contacts

This concludes Guided Interpretation#7.