B02 – Guided Interpretation #2

This chapter assumes that you have followed the first guided interpretation and are familiar with the basic facilities of Emeraude. This second example is for oil-water flow in a deviated well. Both shut-in and production surveys are available.

B02.1 • Starting the session and loading the General Well Data

- Start Emeraude and create a new file. In the Units page select Oil Field
- Go the Document page and select Load Well Data
- Click on Add.
- In the Examples sub-directory of the Emeraude installation select the file B02oh.lis

Emeraude scans the file and issues the message “Some Mnemonics or units in the file are unrecognized. Do you want to define them now?”.

- Click on Yes, the Mnemo Definition dialog is displayed, Fig B02.1.

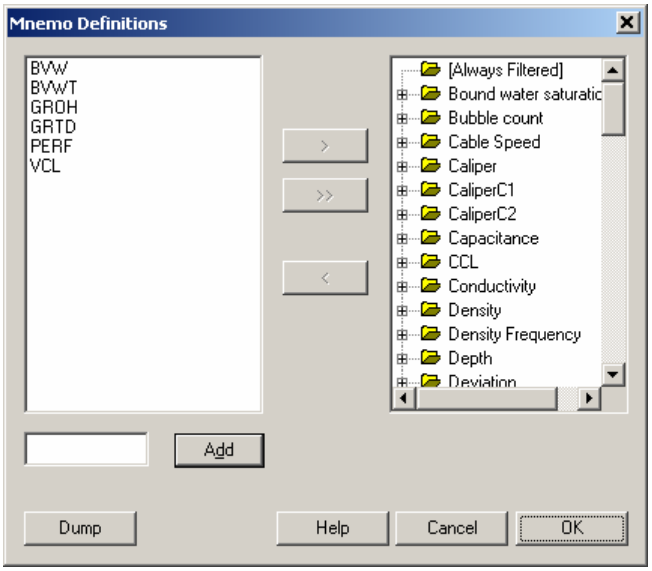


Fig. B02.1 • Mnemo definition dialog

When a mnemonic is unrecognized you may want to ignore the data, associate them to a known type for the duration of the load only, or create a permanent association between the mnemonic and a type on this Emeraude installation. The Mnemo definition dialog is used to view/edit the permanent associations.

They are made of software defaults together with user definitions, stored in the Windows registry table of your computer.

On the left of the dialog is the list of mnemonics that are unrecognized: BVW, BVWT, GROH, GRTD, PERF, VCL. On the right is a list of valid data types for Emeraude, and the mnemonics currently associated with those types. The first item in the list, called "Always filtered" contains the mnemonics that will be systematically ignored, i.e. next time such data are detected in a file they will not even show at load time. Initially, the "Always filtered" list is empty and the other items contain the Emeraude built-in list of mnemonics. Additional definition made by the user in this dialog will be recovered in future sessions.

All manipulations in this dialog box are done in the same manner:

> Move a selected list of mnemonics to a selected data type. Requires both selections active.
>> Move all mnemonics on the left side to a selected data type. Requires a non-empty left window and right selection active.
< Remove a user-defined mnemonic. Note that Emeraude internal definitions cannot be removed.
Add Manual addition of user-defined mnemonics. When the Mnemo definition dialog is called from the Mnemonic option of the Settings panel.

- Exit the dialog with OK. We could have defined certain mnemonics, for instance VCL as "Volume of dry clay", BVW as "bound water saturation", both of which are valid Emeraude types. We will instead filter them out, for this session alone.

- Click on the **Filter** button at the bottom left of the Load dialog, Fig. B02.2. Use the buttons in the center part of this dialog to load only DEVI and GROH.

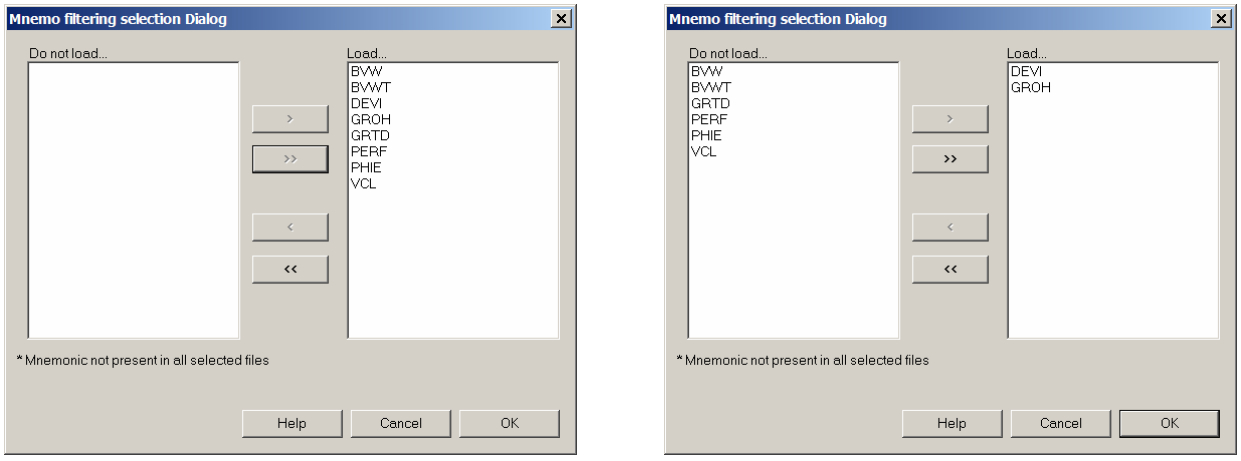


Fig. B02.2 • Filter dialog, before and after mnemonic selections

- Exit the Filter dialog with OK.

The columns corresponding to filtered mnemos are empty, the mnemo is in red, and a red "Skip…" string indicates their status. Only three columns appear with values: DEPT, DEVI and GROH. The Import button is disabled and a yellow exclamation mark appears at the top of the dialog. This is because GROH is still undefined. In fact, if you move the mouse on top of this icon a message pops up explaining the conflicts/errors.

- Scroll to the right to see the GROH column.

- Click on the cell labeled **GROH** in the New Mnemo header line, select **Define Name** and change the mnemonic to **GR**.

The Import button is now enabled since GR is part of the built-in Gamma-Ray mnemonics. Furthermore, GR was selected because in the Log Data all Gamma-Ray channels use this mnemonic, and they will thus be plotted on the same track automatically.

- Select **Import** to load.

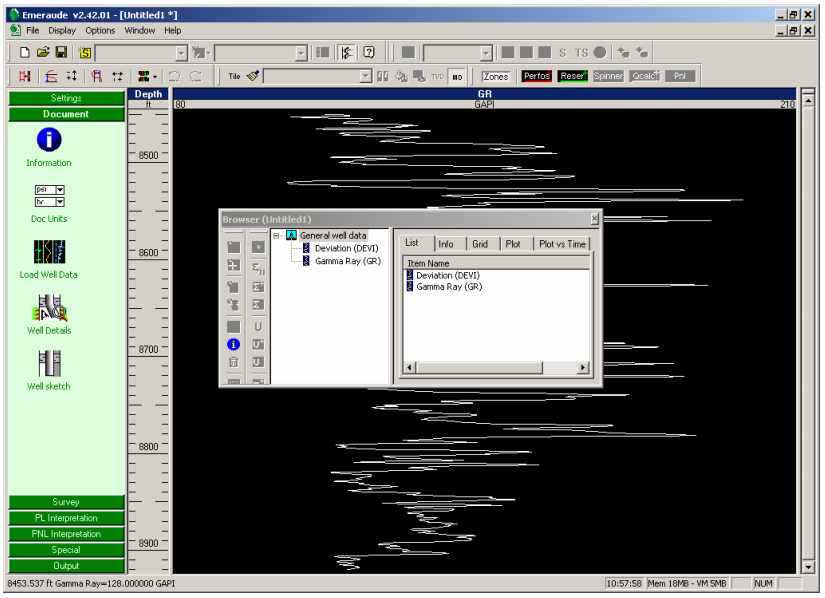


Fig. B02.3 • General well data loaded: browser opened

The following data is loaded: DEVI, GROH (as GR). The screen displays one plot for GR. The default color of the “Well Data” curves is white. This can be changed in the data browser or in the Settings panel. Open the browser, select the “Well data”, right click “Properties” or use the browser toolbar  to change the aspect. The deviation channel DEVI is not plotted by default, but has been loaded, this can be seen in the browser, Fig B02.3.

- Click on **Well Details**
- Select the **Internal Diameter** and enter: **8440 ft - 6.184 in**.
- Select the Roughness icon and enter: **8440 ft - 0.0006**
- Activate the **Perfos** tab. Enter the following perforated intervals, in ft: **8517-8586**; **8593-8686**; **8693-8775** (note that perfos must be entered by increasing depth)**.**

B02.2 • Loading the log data

The well was logged twice, once during production and once during the shut-in. All log data are contained in a single LIS file with 12 logical files, as follows, Files 1-6 = Production; Files 7-12 = Shut-in.

File index	Survey	Pass type	Pass number
1	Production	Down	1
2	Production	Up	1
3	Production	Down	2
4	Production	Up	2
5	Production	Down	3
6	Production	Up	3
7	Shut-in	Down	1
8	Shut-in	Up	1
9	Shut-in	Down	2
10	Shut-in	Up	2
11	Shut-in	Down	3
12	Shut-in	Up	4

Pass numbers do not matter as long as there is no conflict. Numbers above comply with the usual convention, ordering passes by increasing cable speed. The provided LIS file does not define the pass type in the usual LIS field, therefore both pass type and index in the type have to be defined manually.

- Go to the Survey panel
- Click on the “Create a new Survey” icon in front of the drop list survey of the main toolbar.
- Change the dialog values to read: Name **Production #1**; Short name **P1**
- Select Load and in the Load dialog **Add** the file B02plt.lis
- Scroll down in the logical file list to see the line for file 7
- Click on the line header button to make it active and select Remove
- Do the same for files 8,9,10,11,12.
- Edit the file type and number for compliance with the list at the beginning of this section.

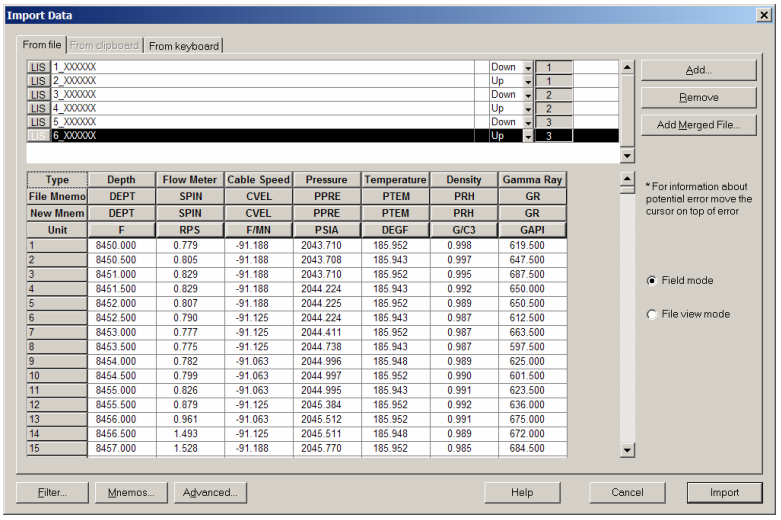


Fig. B02.4 • Production logical files: type + number edited

- Select Import. The survey data is displayed automatically for the entire data range
- Right click on the Gamma Ray plot. Select Horizontal scale and Reset. Click OK.

This plot existed before the current load (open-hole gamma-ray in Well Data) and the scale was not reset automatically. The open-hole gamma-ray (GROH changed to GR), is plotted together with new GR survey data.

- Hide the ID plot by dragging its title bar outside the plot area and select Tile, Fig. B02.5.

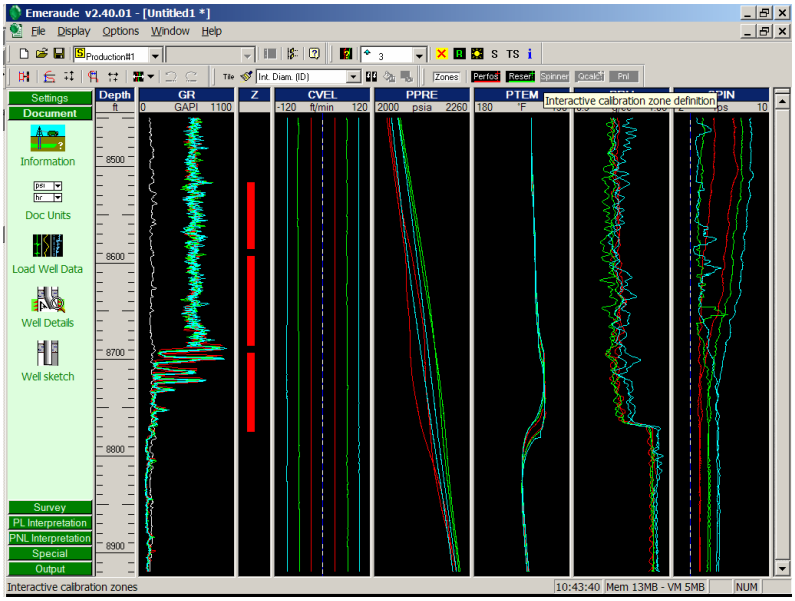


Fig. B02.5 • Production data loaded: Gamma ray plot rescaled: ID hidden

- Select the Infos/new option of the Survey panel again

The properties of Production #1 are displayed and could be edited if required.

- Click on “Create a new Survey” icon in front of the survey drop list of the main toolbar to create the second survey (Survey #2 by default).

- Edit the dialog values to read:
  Name **Shut-in #1**
  Short name **S1**
- Select Load to import the logical files from 7 to 12 from B02plt.lis

File index	Survey	Pass type	Pass number
7	Shut-in	Down	1
8	Shut-in	Up	1
9	Shut-in	Down	2
10	Shut-in	Up	2
11	Shut-in	Down	3
12	Shut-in	Up	3

- In the Shut-In #1 survey, hide the ID plot, and rescale the Gamma Ray plot

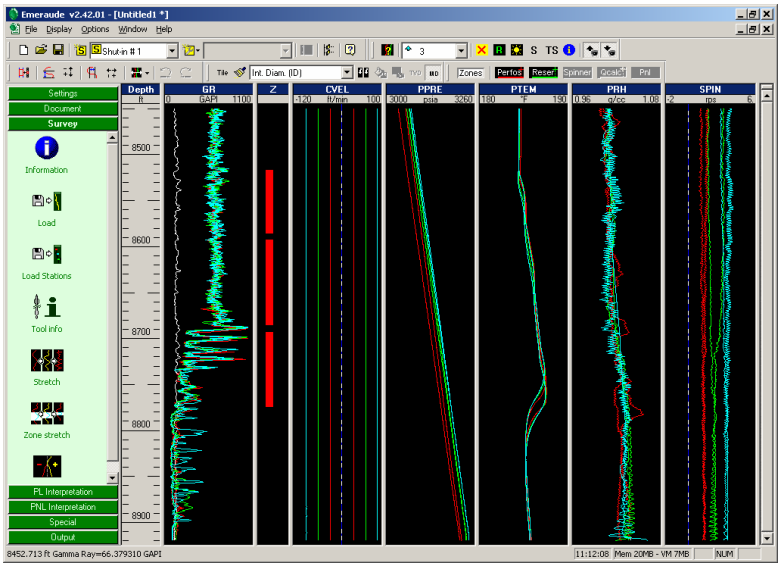


Fig. B02.6 • Shut-in data loaded: ID hidden

At any time, the displayed survey (or active survey) is indicated in a drop list on the main program toolbar. The list is also used to change the active survey.



B02.3 • Analysis of the Shut-in survey

B02.3.1 • Depth match

➢ Make sure that the Shut-in survey is active using the above drop list.

Because of radioactive scale the Shut-in gamma ray does not compare well with the open-hole curve (Well data). Some correlation is seen below 8770 onwards and can be used for the depth match. The process of depth matching was covered in Guided interpretation #1.

B02.3.2 • Tool Information

➢ Click on the Tool Info option and change the following settings (Fig. B02.7):

• Apply deviation correction **Schlumberger PTS**
• Spinner blade diameter **3.5 in**

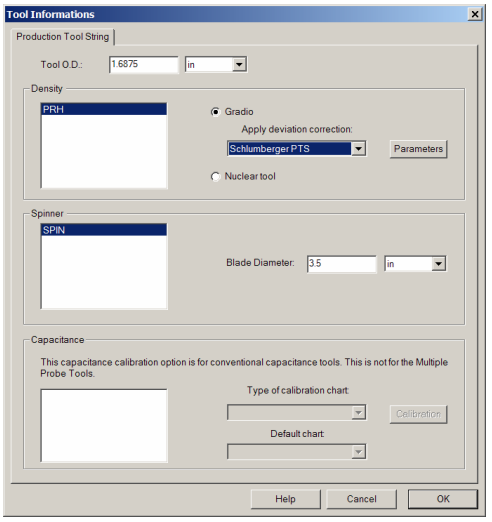


Fig. B02.7 • Tool information dialog

In the Schlumberger PTS tool string, PRH usually refers to a channel on which the necessary deviation correction has already been applied, hence the default (no correction) is suggested by Emeraude based on the mnemonic. However, this is an old data set and the mnemonic is misleading as no deviation correction had been performed, thus the change.

Tool information will not need redefinition for Production #1 as all mnemonics are identical in both surveys.

B02.3.3 • Spinner reversal

The spinner responses in this example were all stored as positive numbers, and must be changed before proceeding with the interpretation. The procedure to decide if and where a spinner should be negative is beyond the scope of this session. However, in the case of the shut-in period (and in the absence of any cross-flow) it is quite straightforward: up passes must be inverted.

➢ Click the right hand mouse button in any plot, select Depth Scale.
➢ Define the Total log range as 8400-9000 ft.
➢ Click on the Total range button to set the size of the display window.

➢ Make the “SPIN” plot visible if it was previously hidden.
➢ Select pass Up1 in the pass toolbar. (You can use highlight to confirm selection of pass)
➢ Click on the Spinner Reversal icon in the Survey panel (last option down - scroll if necessary).

➢ Click in the flowmeter view above the first data point. A dialog appears where the reversal depth can be changed, as well as the reversal direction (i.e. above or below the selected depth).

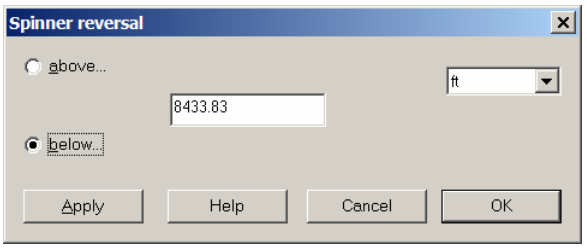


Fig. B02.8 • Spinner reversal dialog

➢ Accept the current settings. The flowmeter channel for Up 1 is now displayed with negative values.

Note: The option of the pass toolbar accesses a page where reversal depths can be viewed and edited.

➢ Revert the remaining Up passes, 2, and 3:

- activate the pass in the pass drop list
- click on the Spinner reversal option
- click in the SPIN view above the first data point: accept values in the subsequent dialog.

The horizontal scale of the Flowmeter view is not reset automatically when inverting the spinner response but the “Reset” will take the reversal into account:

➢ Click the right mouse button in the SPIN view, select Horizontal scale then Reset.

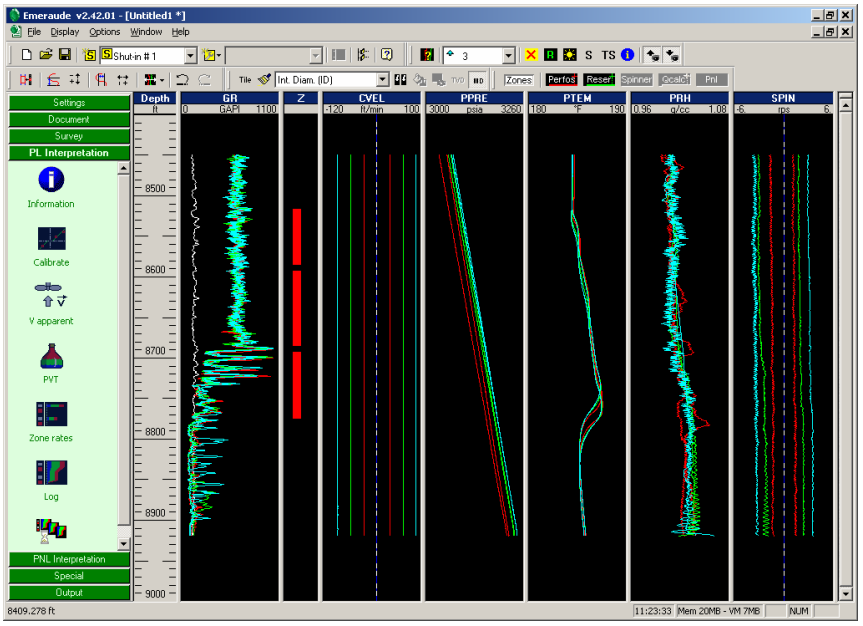


Fig. B02.9 • Shut-in spinners reverted

B02.3.4 • Creating a new interpretation

- Move to the PL Interpretation panel
- Select the “Information” icon.

This is the first interpretation for the active survey: an interpretation is created automatically, called Interpretation#1.

Note: To create a new interpretation after one exists, you need to use the “Create a new Interpretation” icon in front of the interpretation drop list of the main toolbar.

- Leave this name unchanged and validate with OK
- In the Interpretation Settings dialog, Define the reference Temperature as that of Down#1
- Define the reference Pressure as an average of All pressure passes during the Shut-in
- Define the reference Density as an average of All the density passes except Up3 and Down3

B02.3.5 • Spinner calibration and apparent velocity

- Use the Spinner Calibration zone option of the zone toolbar to define one zone above the top perfo and one below the deepest (Fig.B02.10, next page).
- Click on Calibrate
- In the calibration, Action for all zones, set all positive slopes to the average positive slope
- Also set all negative slopes to the average of the negative slopes (Fig B02.11)

There is a discrepancy between the estimation of apparent velocity from the Up and Down passes because of the well deviation. It is not possible from the calibration alone to determine the value of the thresholds and in this case, we will leave them both at 0.

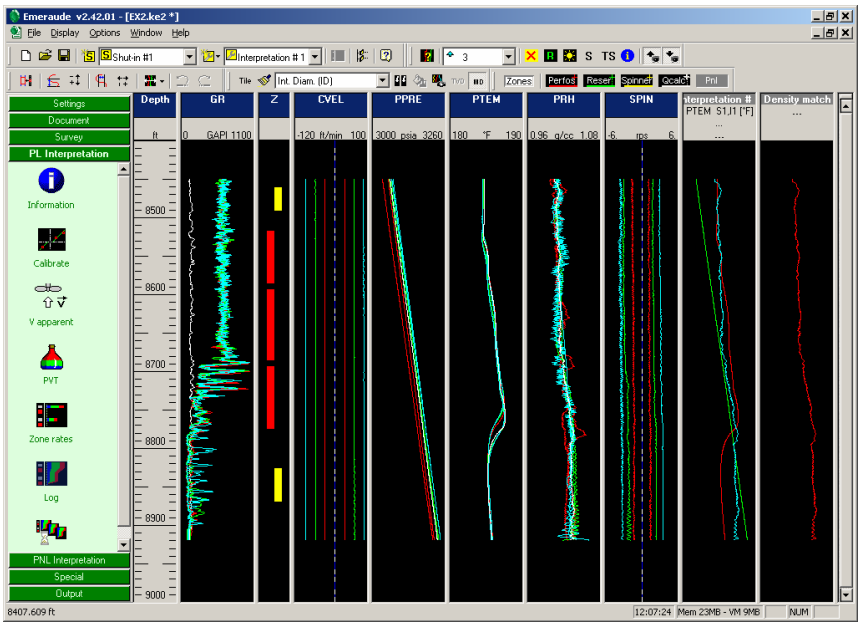


Fig. B02.10 • Two calibration zones defined

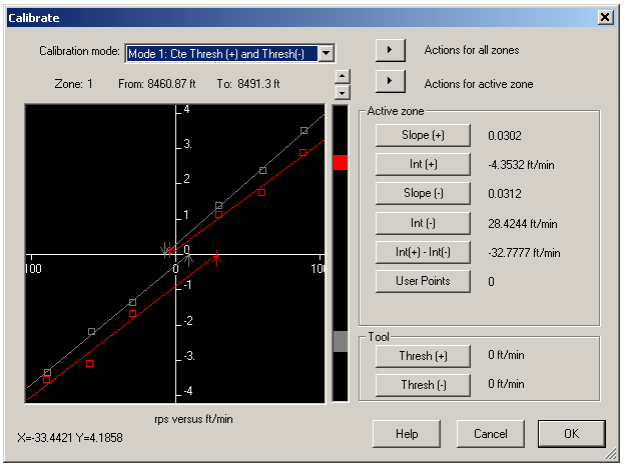


Fig. B02.11 • Calibration

- Validate the calibration with OK
- The V apparent option is selected. Generate the apparent velocity channel with all passes and equal weighting

A plot labeled “Velocity match” is created showing the result, Fig B02.12. You can hide some plots: keep the Gamma Ray and Z views, the interpretation and the match views.

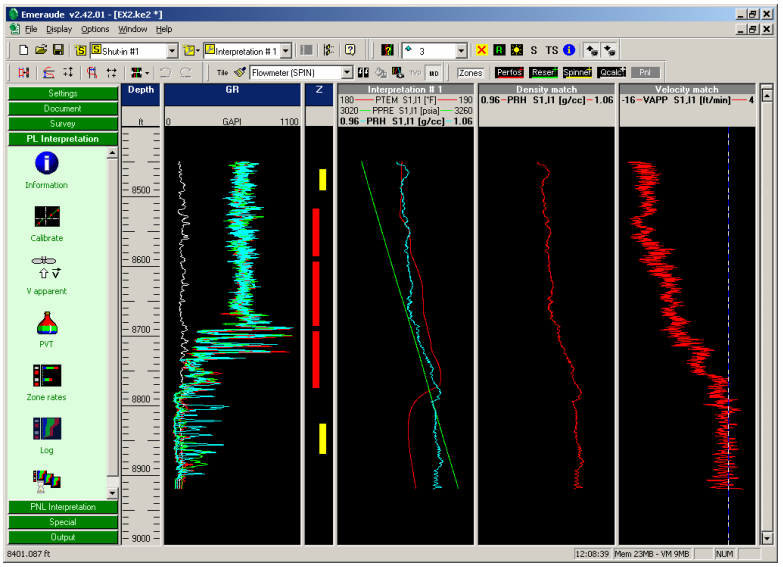


Fig. B02.12 • Apparent velocity calculated

From the top of the log down to approximately 8760 ft the VAPP channel seems to indicate down flow. It is quite possible that the down flow be only apparent since the well is deviated, in which case Emeraude can estimate the light phase up flow (you can check the on-line help for the Apparent Down flow option of Emeraude). Another possibility would be to use the temperature, see Guided session #6.

B02.3.6 • PVT

- In the PVT option define the model as saturated oil with Water using the following parameters:

Solution GOR=135 scf/stb
For Water: **salinity=80000 ppm**;
For Gas: **Gravity=0.82, %N2=0, %CO2=0, %H2S=0;**
For Oil: **Gravity=39 API, Pb=638 psia@174°F** (define as a constraint and use Match to fit the correlation. Keep the entered GOR);

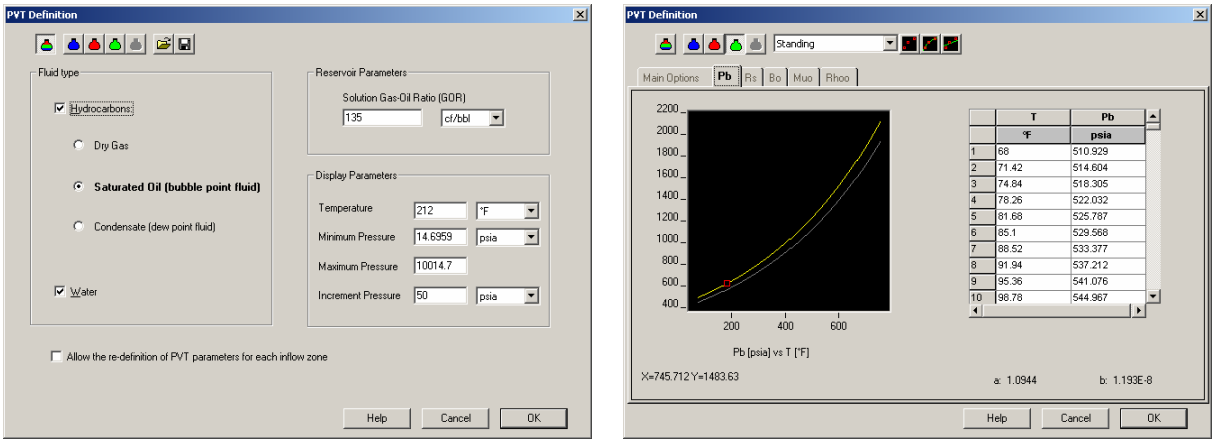


Fig. B02.13 and B02.14 • PVT

The pressure during the shut-in is well above the bubble point. Also, from the surface rates during production#1 (Qo=1670 Stb/d and Qg=225 Mscf/d) the production GOR is 134.7 scf/stb indicating that no free gas exists.

B02.3.7 • Zone Rates

- Click on the “Qcalc” button of the Zones toolbar .
- In the “Init Calculation zones” dialog accept the default (top of perforated intervals)
- Resize/move the bottom zone to a lower position. To do so, click on that zone in the Z view, then drag its handles (on the top and bottom of the zone), Fig B02.15

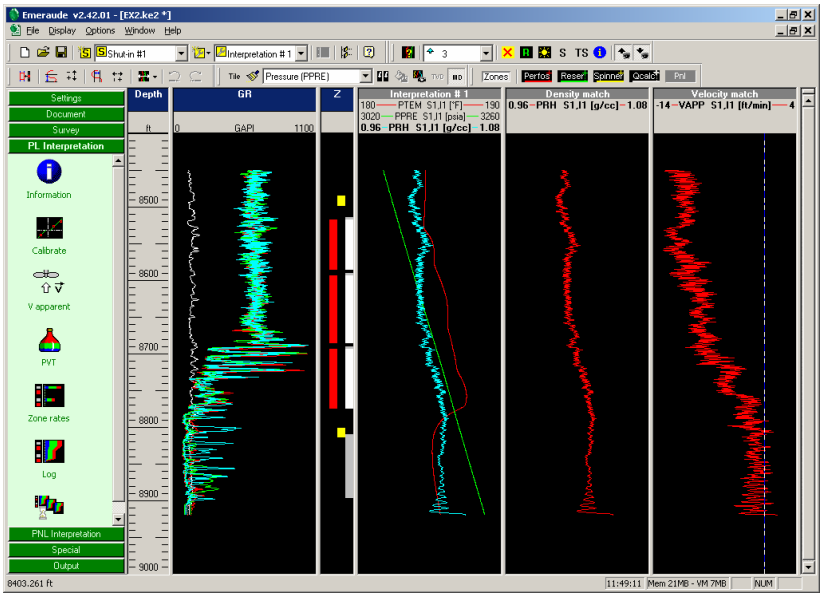


Fig. B02.15 • Bottom calculation zone moved down and extended

➢ Select Zone Rates.

The “Init” page is displayed and a flow model and correlation must be defined. There are two possible choices with the selected PVT model: Liquid-Gas or Water-Hydrocarbons (L). The second model is the default as we only have a density measurement. Furthermore, we know from the saturation pressure and producing GOR that no gas is present during the build-up.

➢ Accept the default model and correlation, and click on the Rate Calculation tab.

The main objective of analyzing this shut-in data is to check the density tool reading in a known fluid type by comparing measured density with predicted values. The density tool (except for a nuclear tool) does not output the straight density value, but some function of it; therefore we cannot simply compare PVT predicted densities and tool readings. The zone rate dialog gives the option to see predicted tool response in 100% oil or 100% water. You can do this as follows:

➢ Make the bottom zone active, by clicking on the zone in the schematic to the left of the plot, or use the small arrows above that schematic to move to the required zone.
➢ If Qo is not 0, Click on Edit and set it to 0 (Qg is disabled with this particular model as p > pb).
➢ Set the page to “Plot” mode
➢ Zoom in (with a right click on the plot) as shown on the figure below:

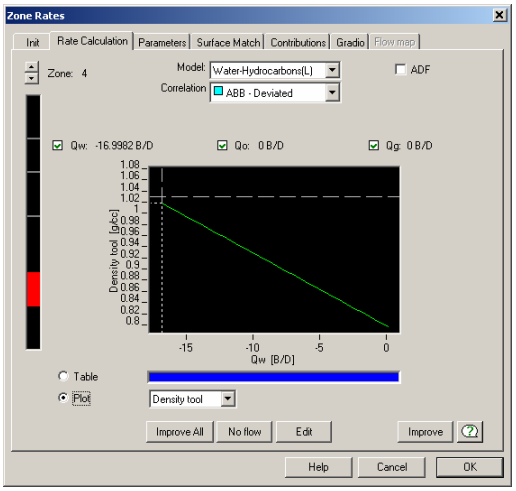


Fig. B02.16 • Zoom in for bottom zone after setting 100% water

The current solution is for single-phase water and the predicted density tool response should be at most equal to the measured density. This is not the case here and if we trust the PVT we may decide to offset the measured density channel.

Note: Depending on the position of the bottom calculation zone the apparent velocity for this zone will be positive or negative. When it is negative, the slippage for all correlations is 0 and they are displayed as a straight line. When Vapp is positive, some correlation may predict a slippage values much bigger than the current Vm. Here we simply look at single-phase situations, and this is not a problem. However a maximum limit for the ratio of the slippage to the mixture velocity can be set in the Vslip/Vm option in the Edit dialog (leave the field empty for no limit).

- Revert to "Table" mode
- Click on the "**>**" button of the Density line to shift the measured value, Fig B02.17

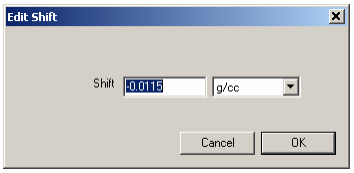


Fig. B02.17 • Shifting the reference density

The interpretation reference density has been shifted by -0.0115 g/cc (*your value could be different depending on your calculation zones)* It can be that measured and simulated values now coincide.

- Exit the Zone rate dialog. Do not generate logs (Cancel)

The applied shift can be later viewed/edited inside the data browser using the Edit, y->a.y+b option:

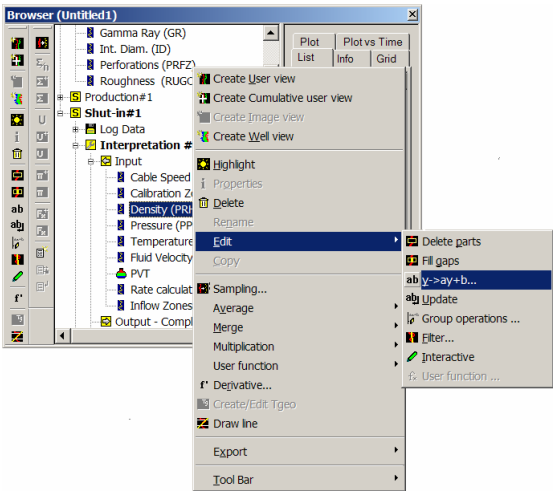


Fig. B02.17b • Using the browser to view/edit the shift

B02.4 • Analysis of the Production survey

B02.4.1 • Creating the interpretation

- Make Production #1 the active survey (drop list in the main toolbar).
- Select the Interpretation panel and click on the “Info” icon. Interpretation #1 is created automatically.

Access is provided to existing interpretations from all surveys. We will use the information already input for the build-up survey.

- Select Interpretation#1[S1] in the list, i.e. the shut-in interpretation and leave all the boxes checked, Fig B02.18:

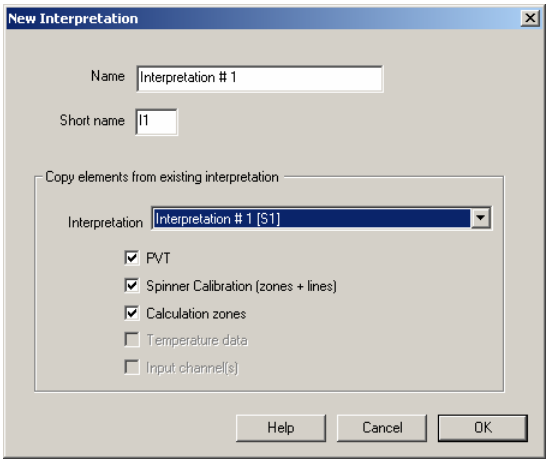


Fig. B02.18 • initializing the Production #1 interpretation

Note: In some situations several interpretations may be carried out simultaneously and it may be desirable to copy some elements from one to another, after initialization. This can also be done with drag and drop operations in the browser (PVT, calibration zones, and calculation zones).

- In the Interpretation Settings dialog define the temperature and pressure interpretations as:
  - Temperature: Down1
  - Pressure: average all except Up 1 and Down 1
  - Density: average all except Up3 and Down3

- Create a user view in the browser that contains the flowing and Shut-in reference density. To do this:
- open the data browser,
- select the user view creation icon,  (or right click in the browser and in the popup menu select create user view). A new empty view appear on the screen (rightmost)
- Scroll in the tree view and open nodes as necessary to select the PRH channel inside the Shut-in Interpretation.
- Drag it and drop it on the user view
- Do the same with the PRH channel in the Production Interpretation
- Tile the tracks

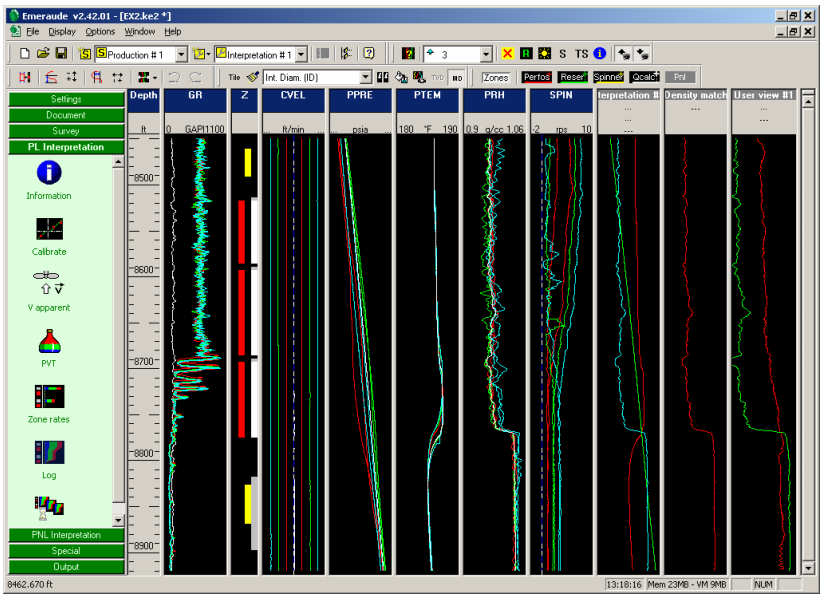


Fig. B02.19 • Production reference channels defined; user view created

By overlaying the shut-in and flowing densities one can see that there is a difference between them below 8800 ft. To check this difference you can maximize the newly created user view by a double-click on its title bar. The value of the difference can be found reading the mouse coordinates in the status bar while moving the cursor on top of them inside the view. *Note that for a user view, the displayed scale corresponds to the active channel in the view. This active channel, in bold in the header, can be changed by clicking directly inside the header.*

- If you maximized the user view, double-click once again on its title bar to restore the previous position and screen layout.

The shut-in density was offset by -0.0115 g/cc. We can apply the same value to the production density. *Use your value if you found something different.*

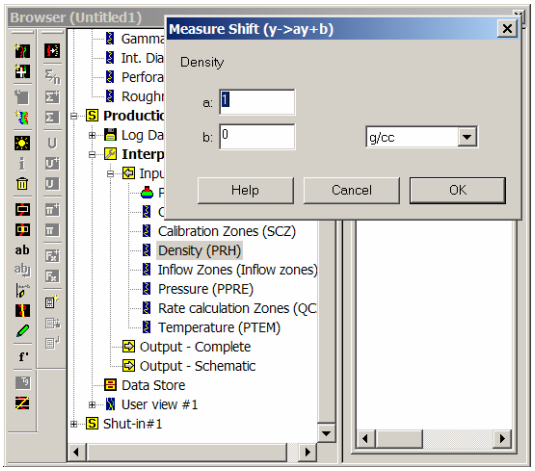


Fig. B02.20 • Shifting the production density

- Open the data browser, and open the nodes as required to see the Production#1, Interpretation#1, Input Density channel.
- Access the browser popup menu with a right click inside the browser area and then Edit, y->a.y+b. Leave a = 1, and enter b=-0.0115 g/cc (Fig. B02.20).

  You can also access the shift option using the browser toolbar **ab** *icon.*

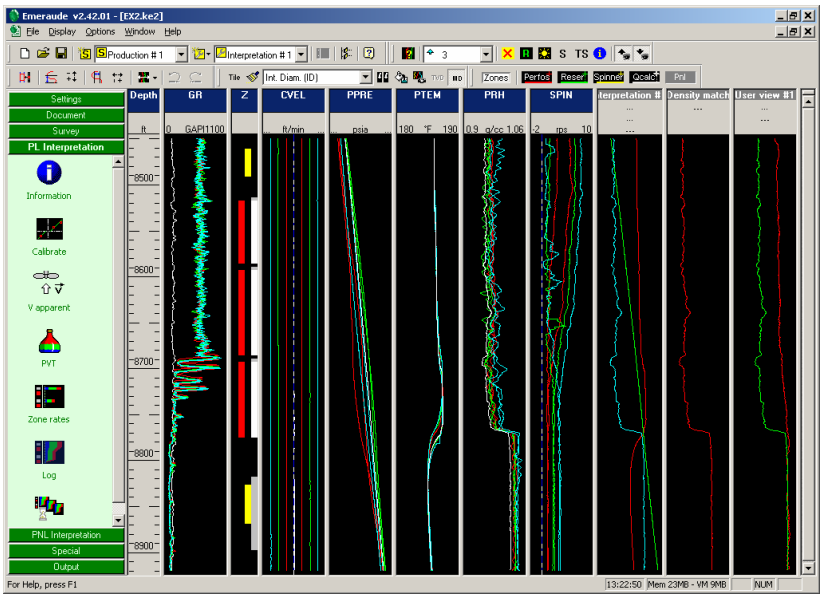


Fig. B02.21 • Production and Shut-in density overlaid

B02.4.2 • Spinner calibration and apparent velocity

- Select the Survey panel.

The Up spinner passes need to be reverted, but the reversal is not for the entire pass. Note that spinner reversal is for non-directional spinners only. The reversal could be defined around the following depths: **Up1=8640 ft**, **Up2=8580 ft**, **Up3=8560 ft**.

The procedure for each pass is the same as applied for the shut-in:

- Make the pass active in the drop list of the top toolbar
- Click on Spinner reversal
- Click in the flowmeter plot around the indicated depth
- Accept the defined depth + reversal direction (below)

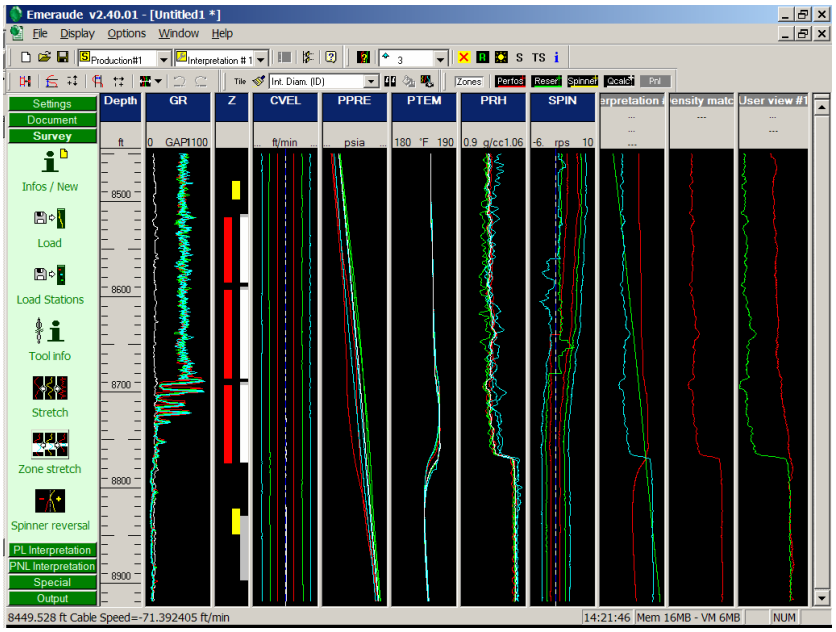


Fig B02.22 • Reversal defined

- Return to the Interpretation panel. The Calibration can be done directly since the calibration zones have been copied from the Shut-in interpretation.
- Click on Calibrate.
- With the top zone active, click on the leftmost data point on the crossplot with the left mouse button.

A dialog appears indicating that this point is from Up3

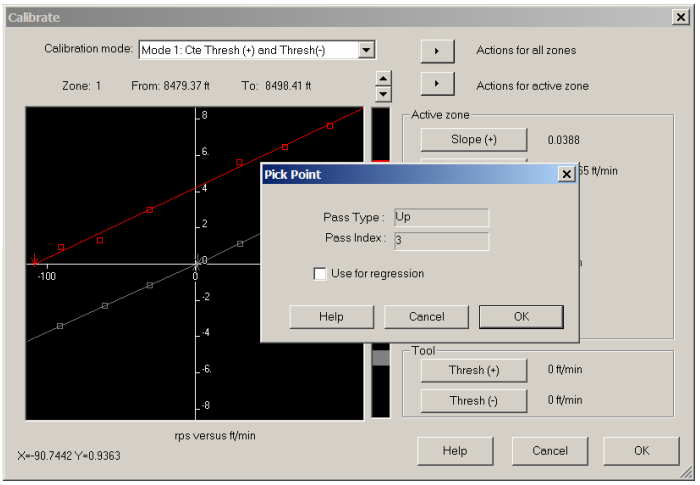


Fig B02.23 • Disabling calibration points

- Disable the point by turning off the toggle “use for regression”, Fig B02.23.

- Do the same with the next point to the right, i.e. for pass Up2.
- In Actions for active zone, select Recompute positive line

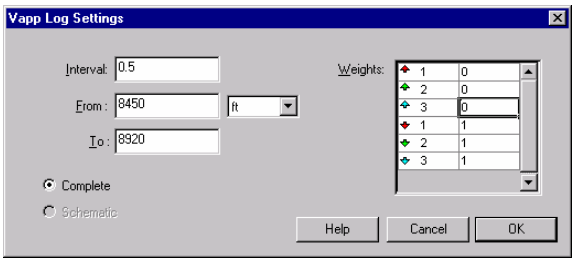


Fig B02.24 • Generating Vapp with 0 weight on Up passes

- Generate the apparent velocity channel with weights, Fig B02.24: 0 on Up passes, 1 on Down passes

On OK the velocity log is calculated, Fig.B02.25 (we have hidden the views for cable speed, spinner, temperature, pressure, and density).

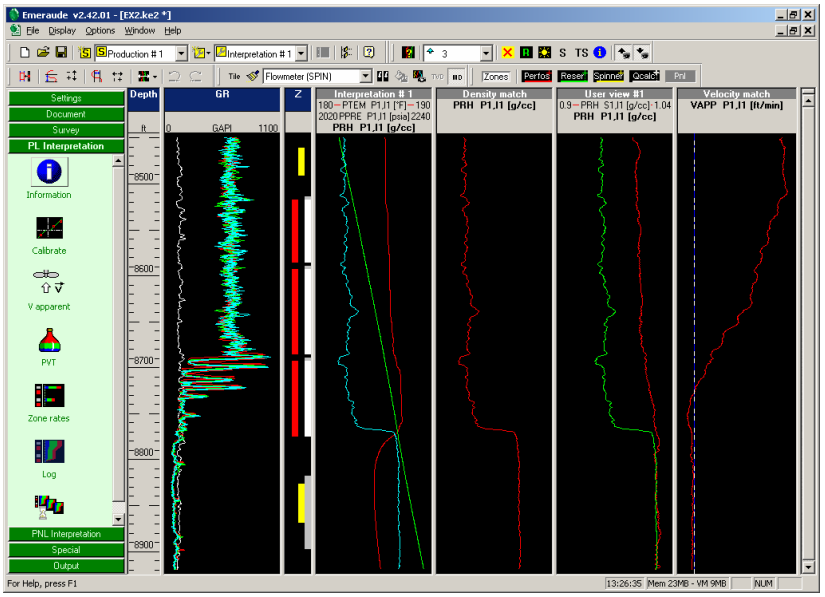


Fig. B02.25 • Apparent velocity log calculated

B02.4.3 • Zone Rate

The top calculation zone was created at the very top of the perfos, in a zone where the apparent velocity is not stabilized.

- Resize this zone interactively or use the Zones button of the zone toolbar to change its position to about 8469-8505 ft
- Click on Zone rates
- Accept the default model and correlation: Water-Hydrocarbons (L), “ABB Deviated”
- Go to the Rate calculation page

- Go to Surface Match. Enter the surface rates as follows: qw=3265 STBD; qo=1670 STBD; qg=225 MSCFD.
- Select Match Surface (Fig. B02.26).

Note that the slip multiplier could be reset to 1 using the button in front of the value. It could be seen that the density error would remain fairly low. Also we could decide that the solution should not at all be constrained by the surface rates at all and reset the Vpcf multiplier to 1 as well.

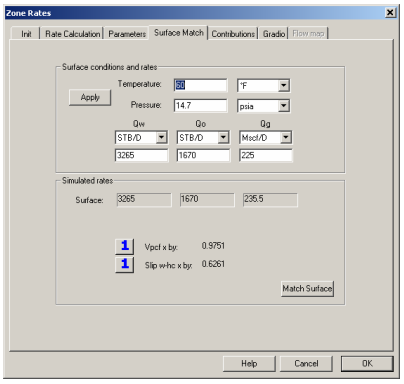


Fig. B02.26 • After Match Surface

- Go back to the Rate Calculation tab, move to the bottom zone and set it as “NoFlow”
- Validate with OK and generate the schematic and complete logs for this interpretation, Fig B02.27. You can hide the user view here the densities were compared

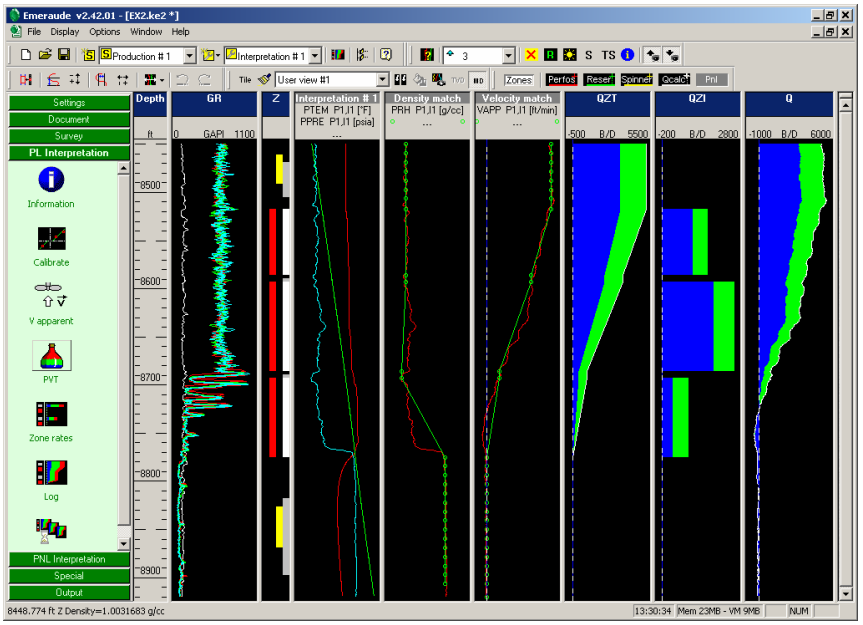


Fig. B02.27 • Logs generated

B02.5 • Additional editing features

Fig B02.28 illustrates the SPIN plot of the up and down passes during the production phase, the three up passes (the three leftmost curves) have several kinks around 8600 ft. In this chapter we will illustrate how this can easily be edited and deleted.

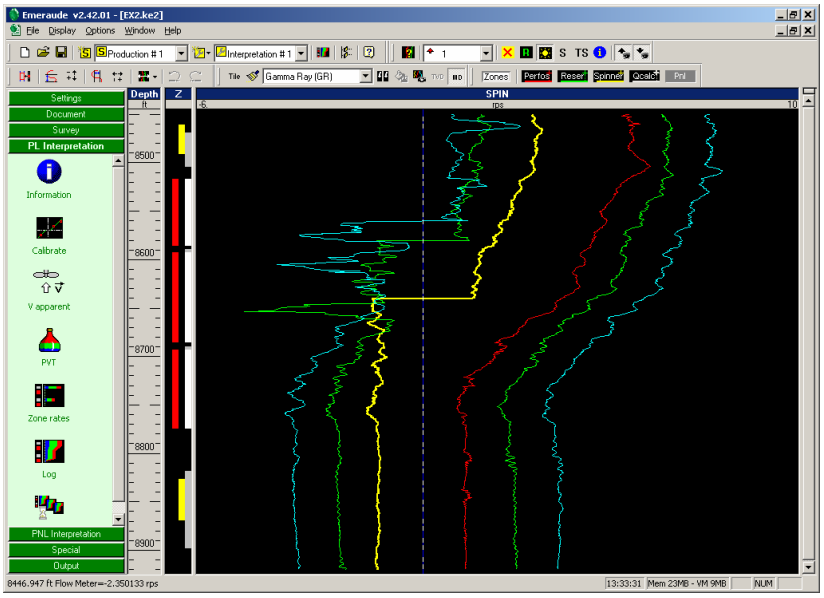


Fig. B02.28 • Spinner response with noise

Interactive Editing

- Make sure the SPIN log is displayed (if not get it back from the pass drop list)
- Activate pass Up2 and highlight it
- Get the SPIN plot to full page by double clicking on its header, as on the figure above
- Open the Data Browser
- Resize it so that both the Browser and the SPIN plot can be seen on the screen
- Select the SPIN channel in the pass Up2, Production #1, Log Data, Up2
- Select the “Edit” “Interactive” option of the browser pop-up (or). Note that the edit option applies to the current selection.
- Directly click on the curve to edit it
- When finished click OK, Fig B02.29.

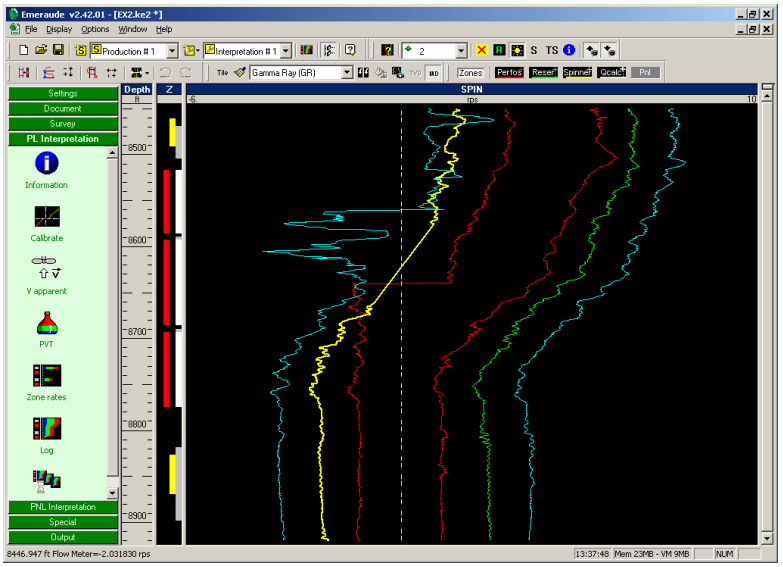


Fig. B02.29 • Interactive editing over

Delete Parts and Fill Gaps

- From the browser, activate the SPIN channel in pass Up3
- Right click in the Browser and choose Edit, Delete Parts, or use the  icon.
- On the log, define a windows, by dragging from 8550 ft and 8650 ft

Data in this range have disappeared in pass Up3. This will leave a gap in the data that needs to be filled in.

- Select the “Fill Gaps” option in the Browser, Edit Fill Gaps, or  in the toolbar. Enter a large value for “Fill gap inferior to…”, say 100 ft. The resulting SPIN plot is illustrated in Fig B02.30.

Note: The Delete Parts” option were presented in graphic mode. The same options may be performed in grid mode, by selecting rows in the Grid page of the data browser.

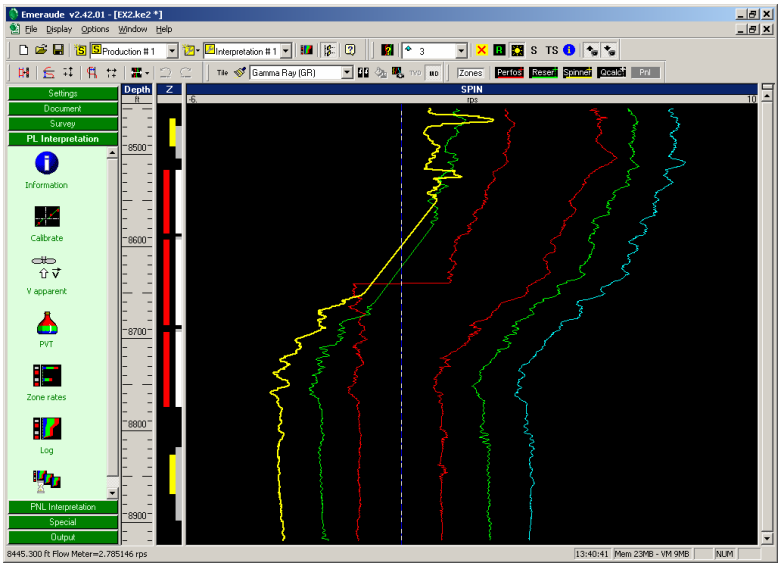


Fig. B02. 30 • Up3 Flowmeter edited with “Delete parts” and “Fill gaps”

This concludes Guided Interpretation#2.