Rubis Sector

A01 ● Introduction

The present session illustrates the interaction between Rubis and the well test analysis module Saphir.

A sector model will be created, copied over and analysed in Saphir, and the interpretation results will be used to improve the history match in Rubis.

A basic knowledge of well test analysis concepts is required to fully appreciate the exercise.

B01 ● Creating the Rubis Sector

B01.1 ● Motivation for a Rubis sector analysis

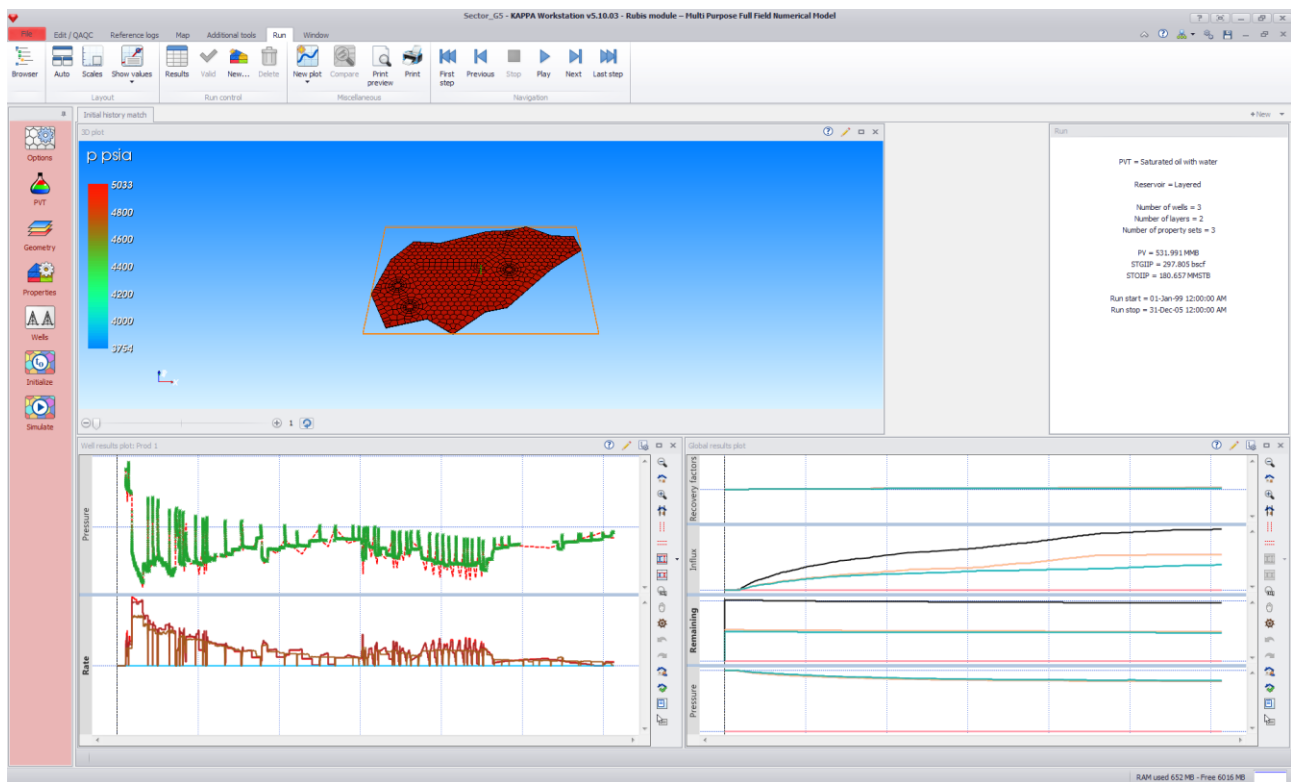Load the file "Sector.krp":

Fig. B01.1 • Sector.krp file content

This file contains a single run named "Initial history match", in which a simple 3 phase black-oil model has been built and simulated. The reservoir contains three wells: one producer named "Prod 1", and two water injectors "Inj 1" and "Inj 2":
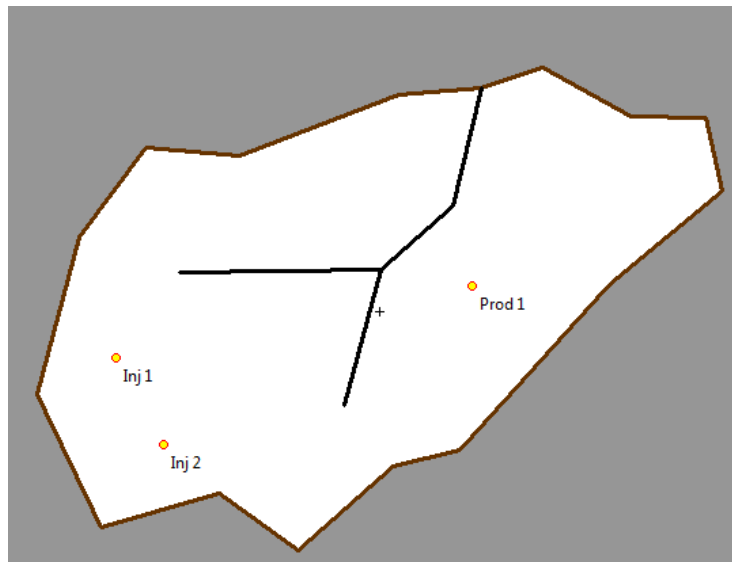
Fig. B01.2 • Reservoir geometry

Long-term monitoring bottomhole pressure gauges are available at all wells, as well as daily measurements of the oil rate at the producer and water rates at the injectors. In the simulation the producer target is the pressure gauge, whereas both injectors are controlled by the water injection rates.

A closer look at the simulation result shows that, although a relatively good match has been globally achieved, the oil production is overestimated during the first two years:
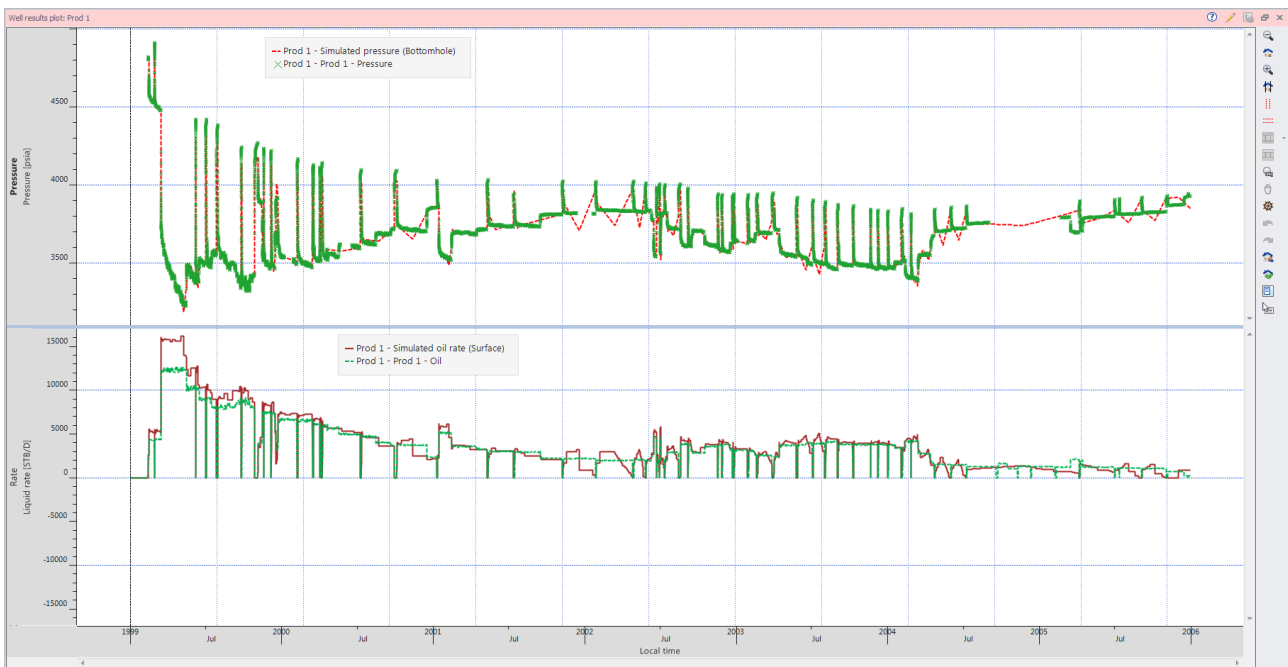

Fig. B01.3 • History match at well Prod 1: the well is controlled by the bottomhole pressure (top, fast modelling option is used), whereas the surface oil rates (bottom) are fitted.

Production shut-ins are present throughout the well history – for instance 8 buildups are visible during the year 1999, as can be seen in the Well Data page[1]:
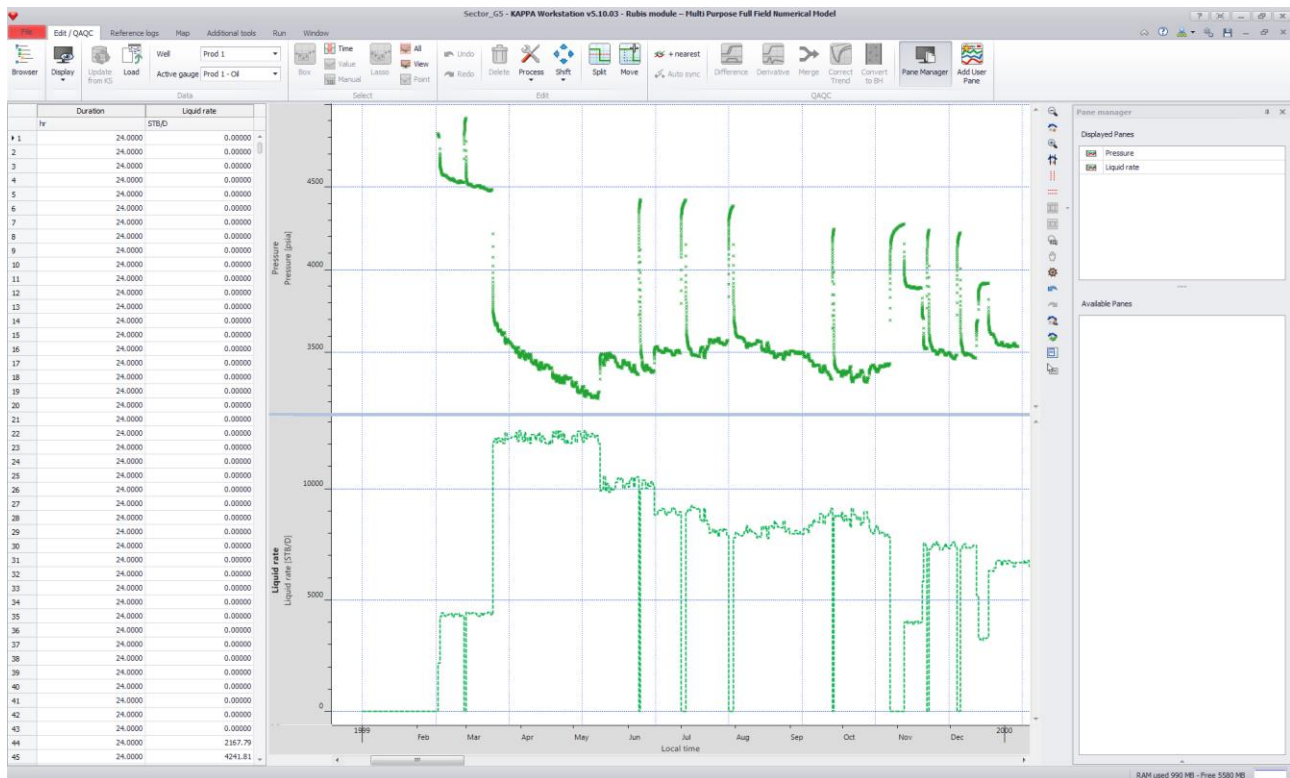

Fig. B01.4 • Looking at the first year of production of "Prod 1"
in the Well Data page: 8 buildups are clearly visible.

In the following, we will import the buildup measurements in Saphir and perform a rudimentary well test interpretation in order to better understand the flow behavior around the well Prod 1, and possibly use its outcome to improve the history match. The Saphir interpretation file will be automatically created by the Rubis sector to PTA option.

B01.2 • Creating the Rubis sector file
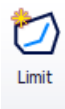
Move to the Map tab and create a composite limit   and a composite anchor   in order to define a region around the well Prod 1.

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[1] Although the rates are provided as 'daily rates' in this exercise, it is implicitly assumed that they have been already corrected for shut-ins, so that no time synchronization problem will be encountered later in Saphir.
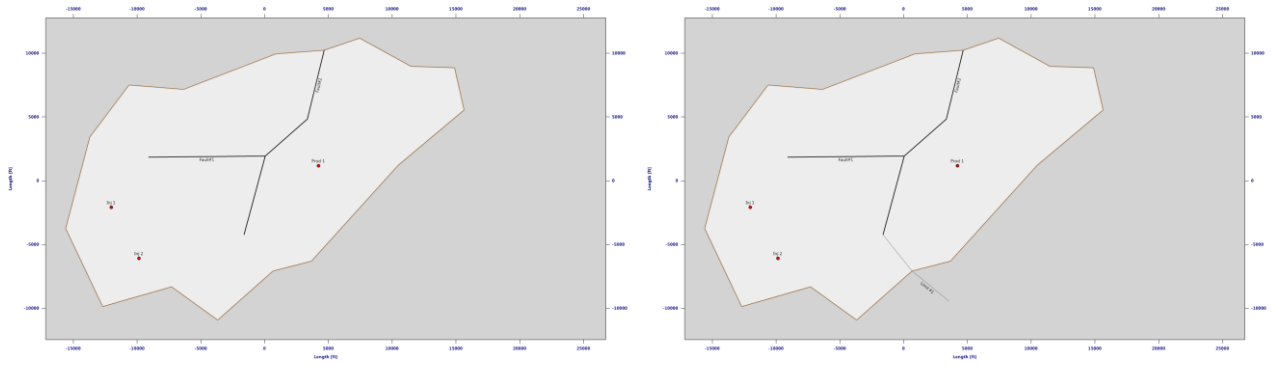
*Fig. B01.5 • 2D view of the reservoir before (left)
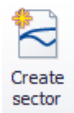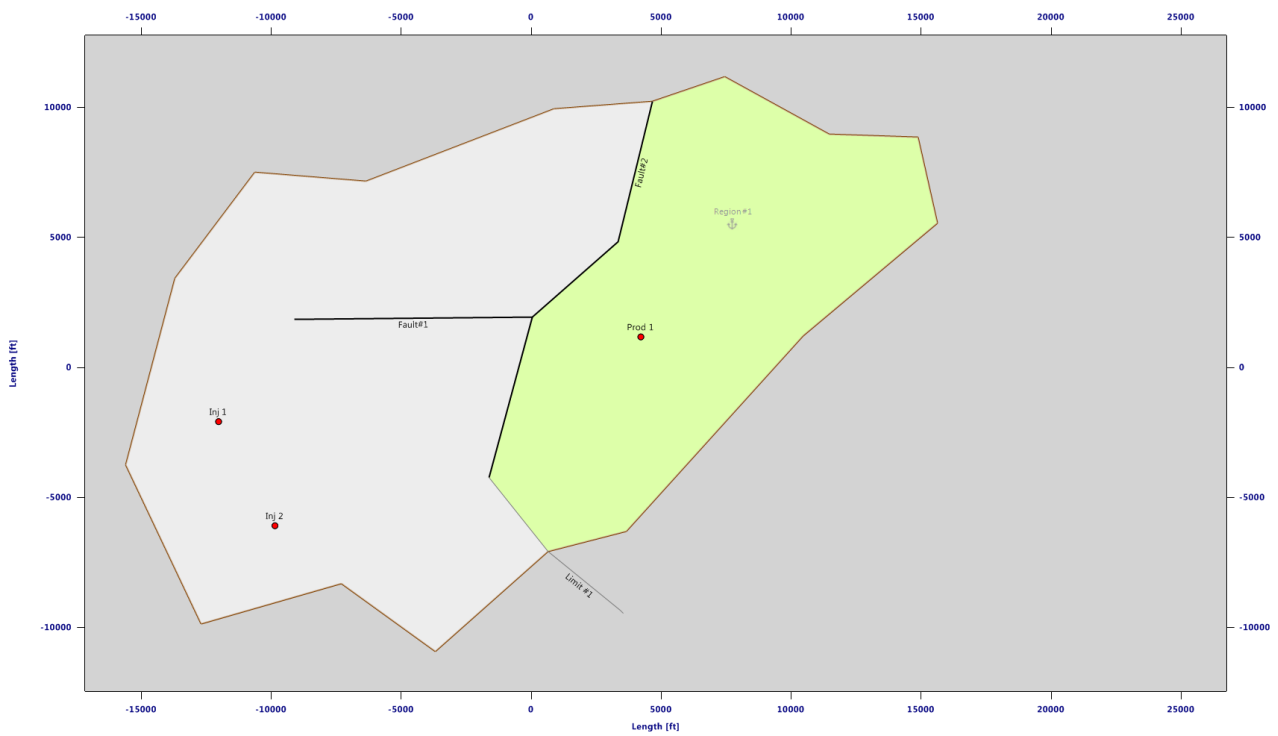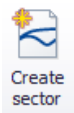and after (right) the creation of the composite limit.*

Fig. B01.6 • 2D view of the reservoir after creation of the region.

Create a Saphir sector (Create sector) in the Region#1 containing Prod 1:
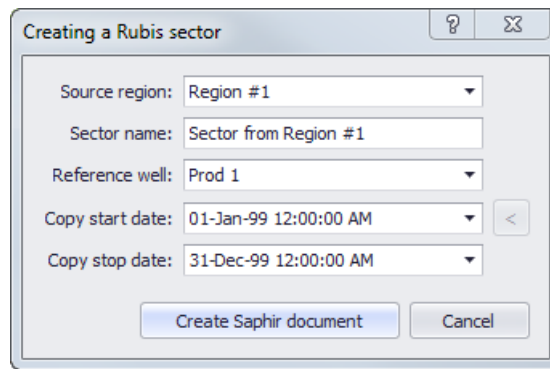
Fig. B01.7 • Sector edition dialog.

This dialog defines the basic settings required for the creation of the Saphir interpretation file (which well should be taken as reference well, which productions are to be transferred, etc...). In our case:

Prod 1 will be the reference well of the Saphir file (it is the only well in the sector anyway):

We do not need to copy the complete well history as we want to investigate the first available build-ups. Change the copy stop date from end 2005 to end 1999:
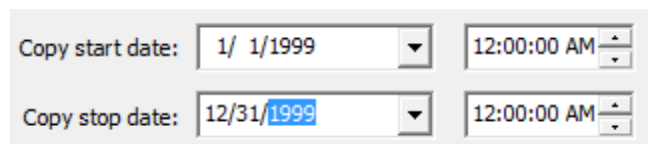
Accept all other default settings and click on >>" to switch to Saphir (make sure that Saphir application has been started in the KW launcher):
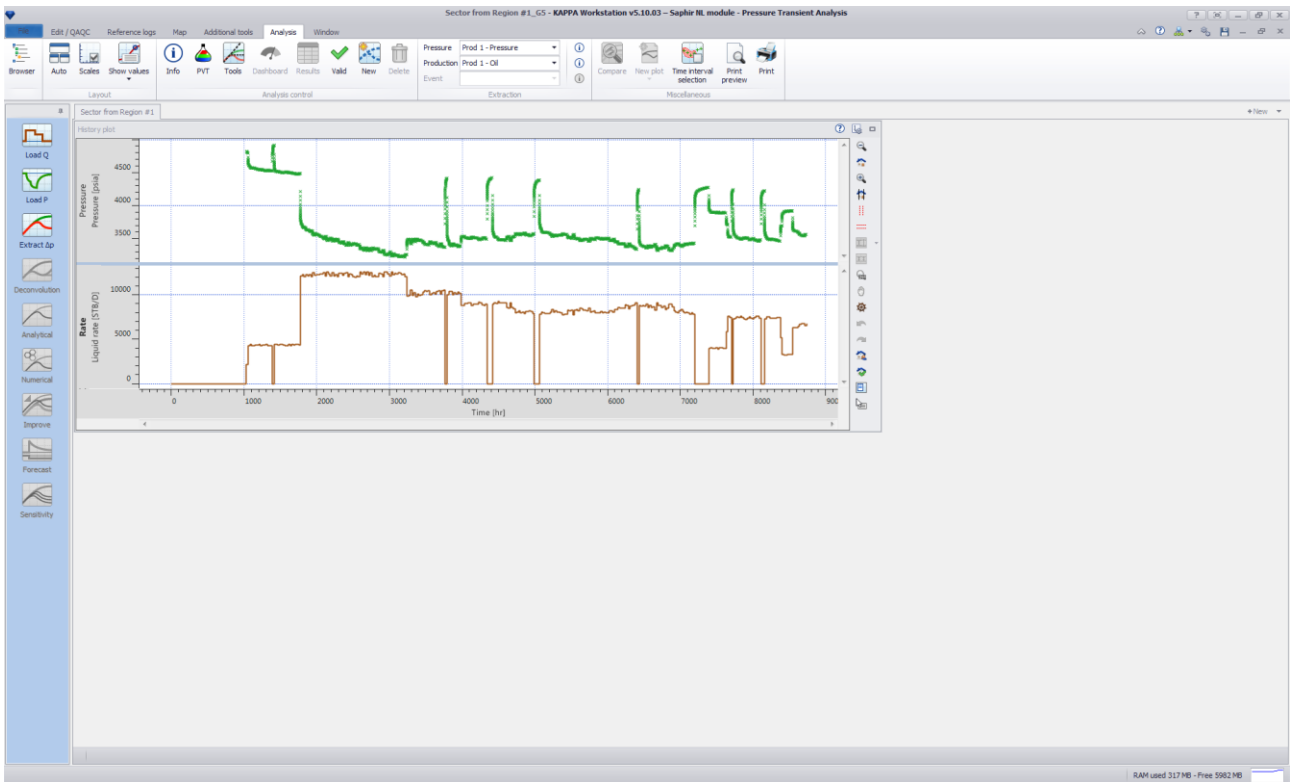
Fig. B01.8 • Saphir document built from the Rubis sector.

Save the Saphir file.

B02 ● Saphir Analysis of the Rubis Sector
B02.1 ● Generating the Rubis sector model in Saphir

The oil production and pressure data measured at the Prod 1 well during the year 1999 have been transferred to the newly created Saphir file. Because Saphir is a well test analysis tool in which the primary focus is transient flow analysis and simulation, no rate simplification algorithm (aka, "fast modelling") is available among the modelling options. On the other hand, the oil production gauge contains one data step per 24 hours and we will simplify this gauge in order to avoid a large - and useless, for the sake of the analysis - CPU overcharge.

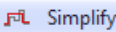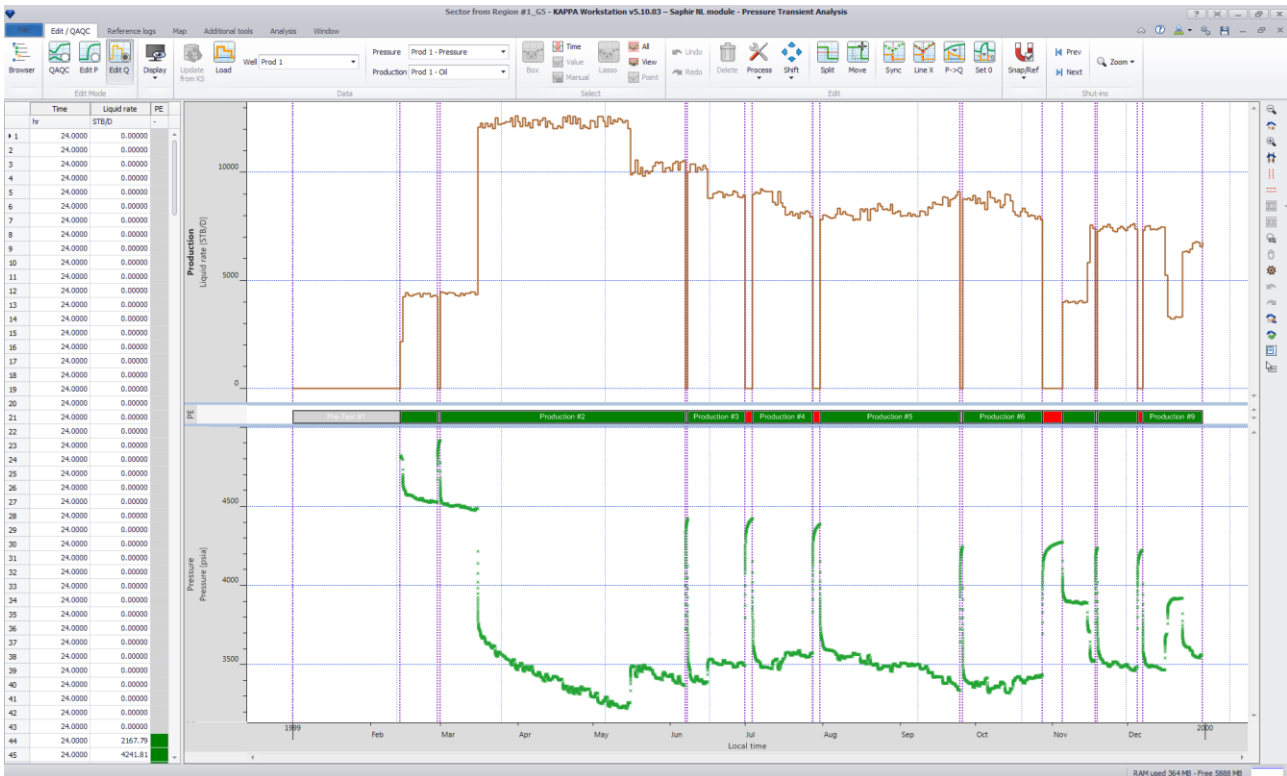To achieve this, move to the Edit/QAQC tab Edit Q mode:

Fig. B02.1 ● Saphir Edit Rates tab.

Right now the oil production contains more that 300 steps, although several long-lasting plateaus are clearly visible.

Select all data (![All]) and click on icon "Process" (![Process]) and choose the option "Simplify" ![Simplify] from the drop-down list:
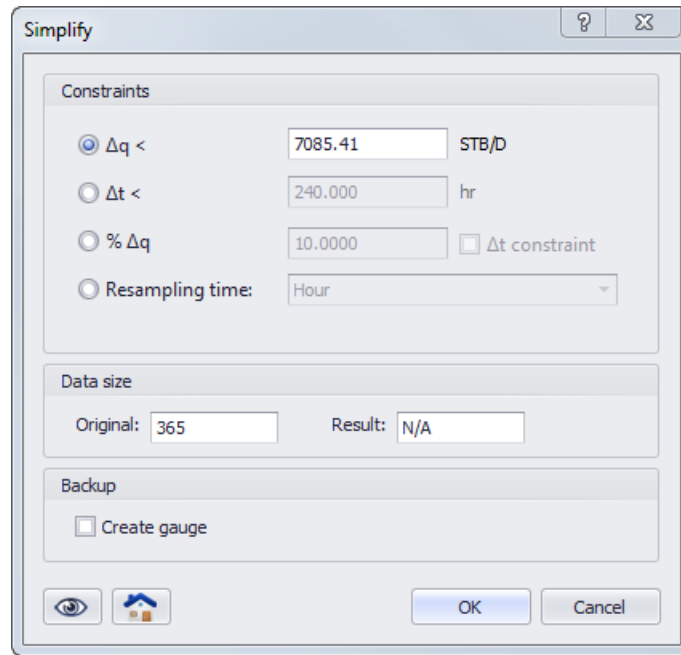
Fig. B02.2 • Processing the selection dialog.

Select the "% Delta Q" option, keep the 10% default value and click on to preview the simplified rates:
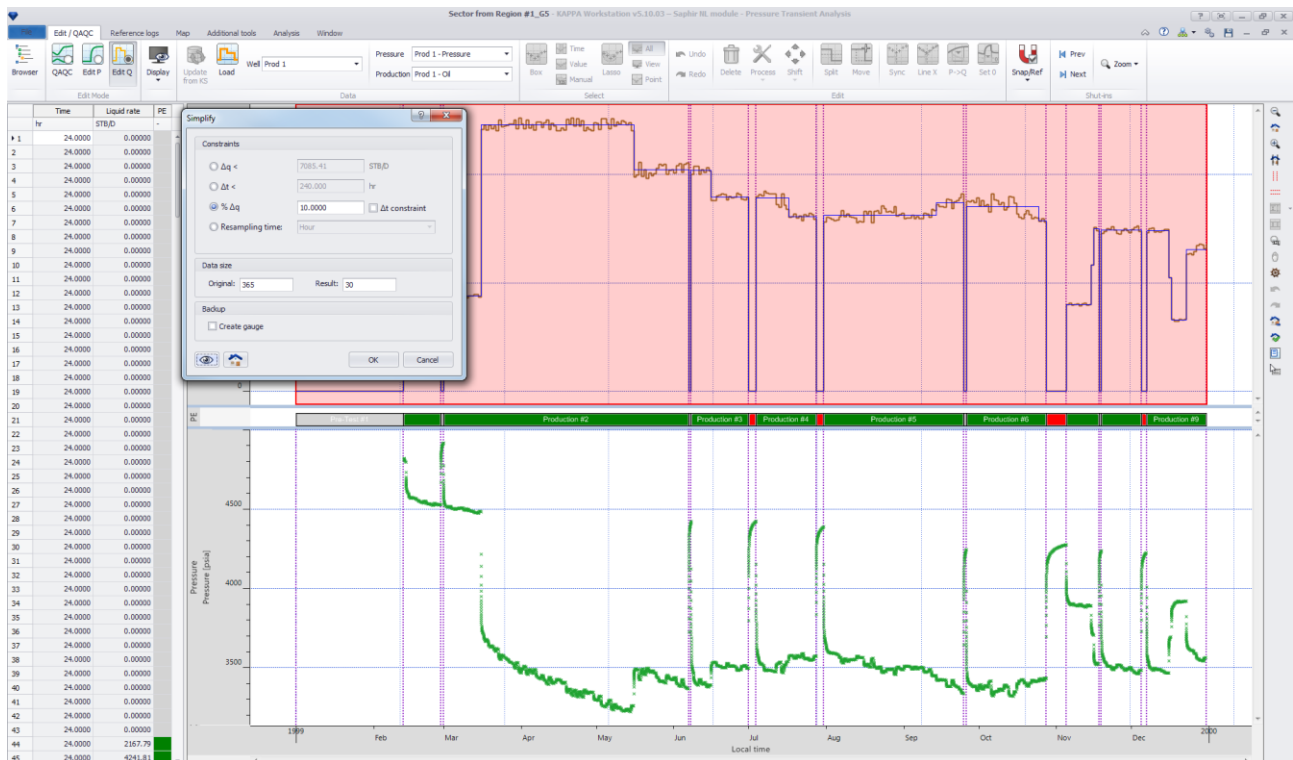

Fig. B02.3 • Preview of the simplified rate gauge

As can be seen, the rate gauge could be simplified from 360 steps to 30 without losing any important feature. Click on OK to validate the change and go back to the "Sector from Region# 1" analysis tab.
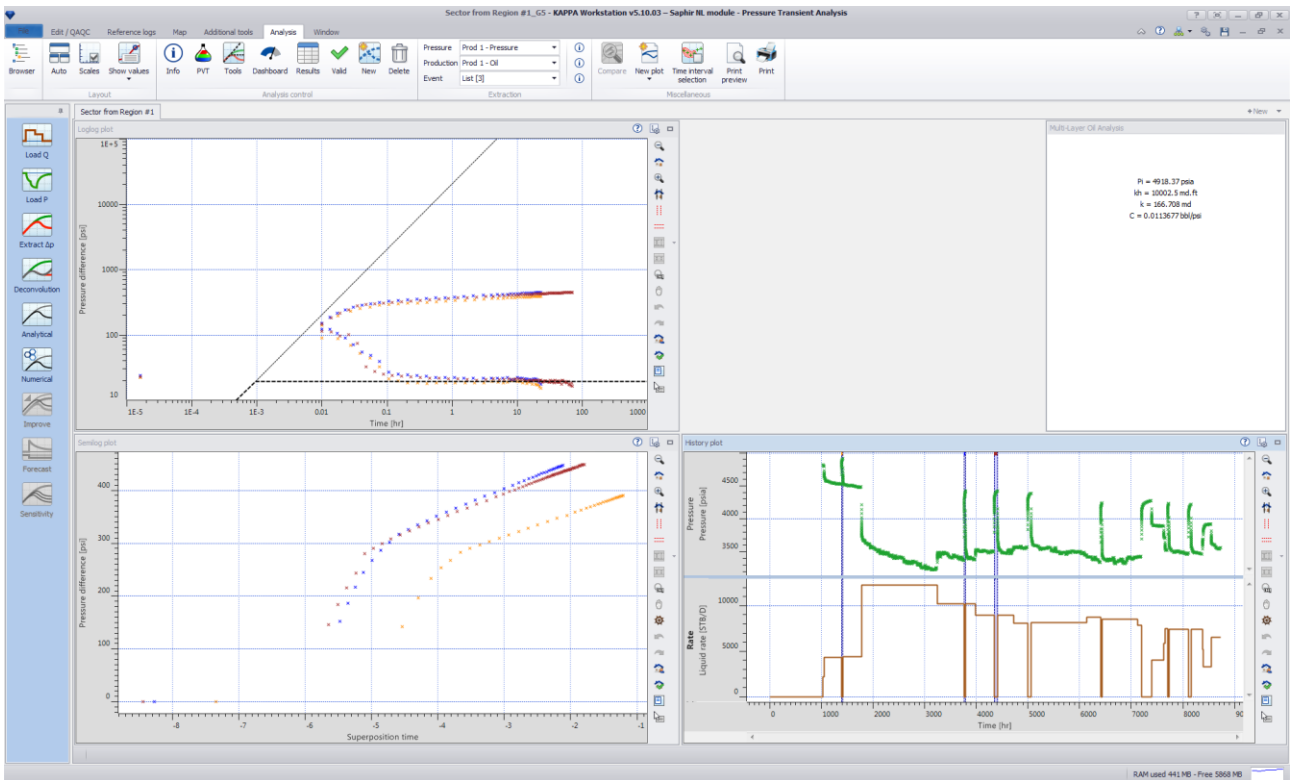
Extract the three first build-ups (#1, #2, and #3):

Fig. B02.4 • After extraction of the build-ups #1, #2 and #3.

The Rubis sector analysis contains the full Rubis three-phase black-oil model, except that the geometry is limited to the extracted sector. The PVT and Properties icons visible in this analysis exhibit the same behaviour as in Rubis and lead to the same dialogs.

For instance, click on "Spatial data" on the "Map" tab in Saphir to display the top horizon (Dataset #1):
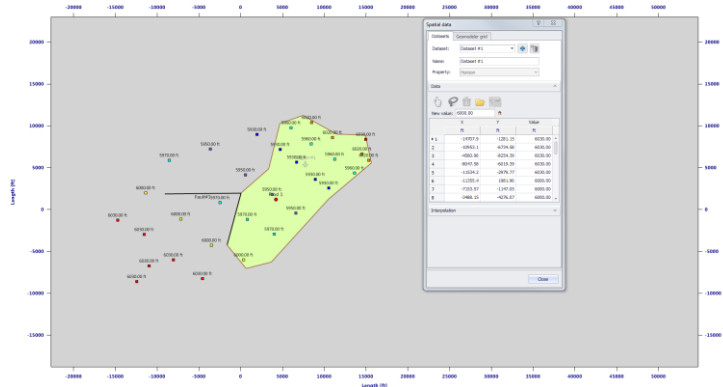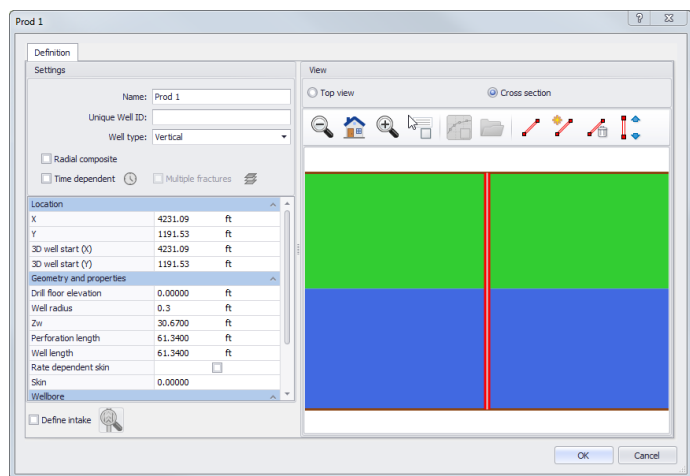
This is to be compared with the same dialog visible in the original Rubis file:
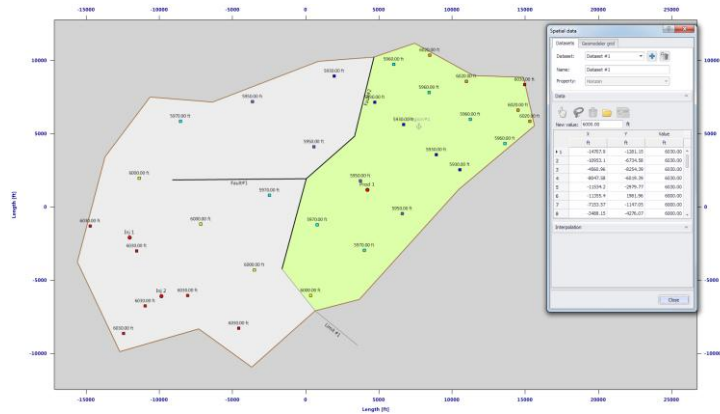
Similarly, it is possible to edit "Geometry" and "Properties".

The perforations and the wellbore model of all wells can be modified in the "Wells option" (double-click on the well on the Map tab)
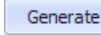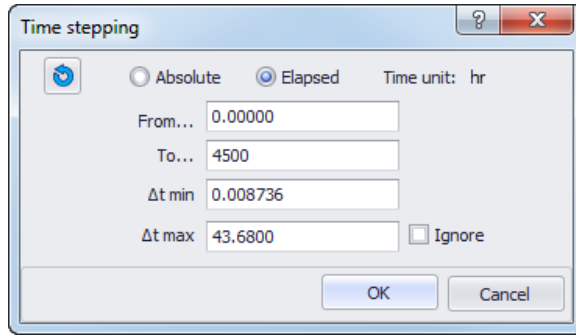
Now we move to the Analysis tab and click on the "Numerical" model on the control panel.

The Schedule tab is not accessible in the Wells dialog, but well controls may still be edited in the "Numerical" model dialog on the analysis tab, icon

"Other wells" ():
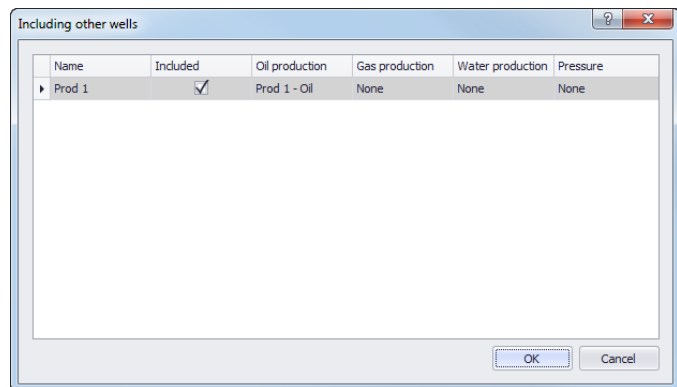
In the Numerical model dialog, click on the "Time stepping" icon (🕐) to change the End of simulation to 4500 hr:

Time stepping

○ Absolute ● Elapsed	Time unit: hr
From...	0.00000
To...	4500
Δt min	0.008736
Δt max	43.6800	☐ Ignore

OK   Cancel

Accept all defaults in the Numerical settings dialog, and click on OK to validate. Simulate the Rubis sector model to obtain the following match (click on **Generate**):
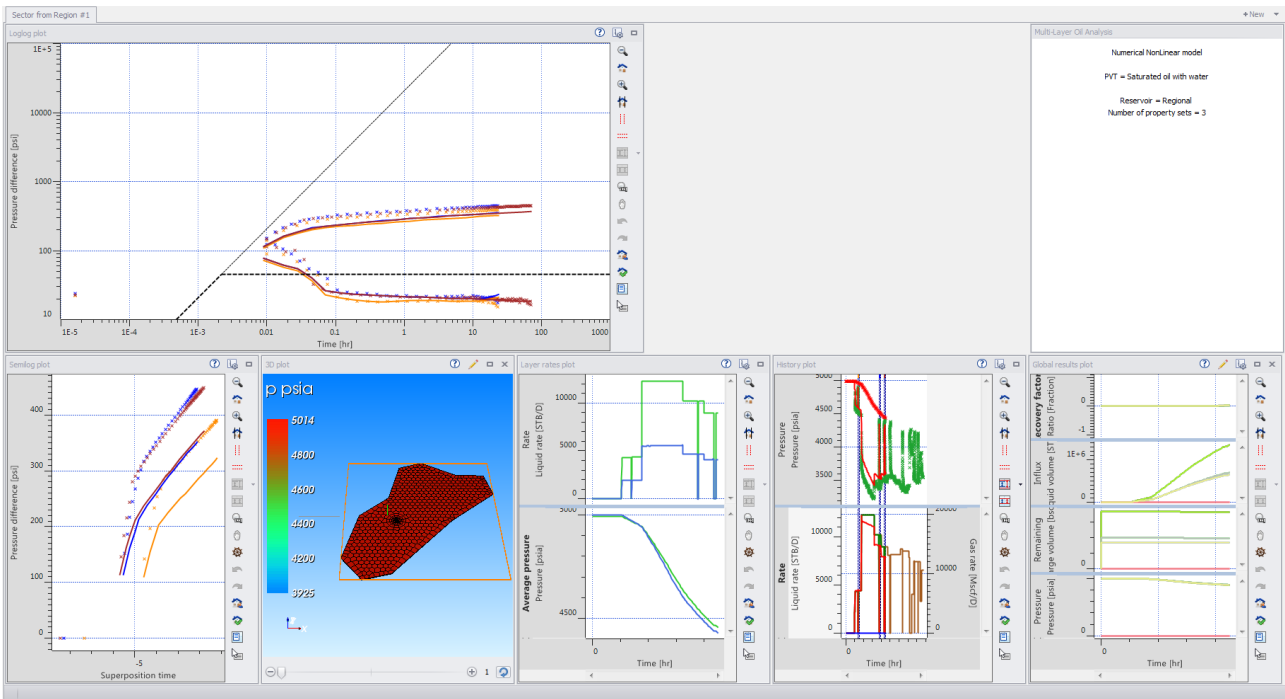

Fig. B02.5 • After simulation of the Rubis sector.

The log-log plot shows that the well skin value currently defined in the model (0) is likely to be underestimated, whereas the middle time match (permeability) is correct. Note as well that unlike the full Rubis history match, the Rubis sector has been simulated on a fine grid in order to better reproduce the early time flow features around the well, as can be seen in the 3D plot:
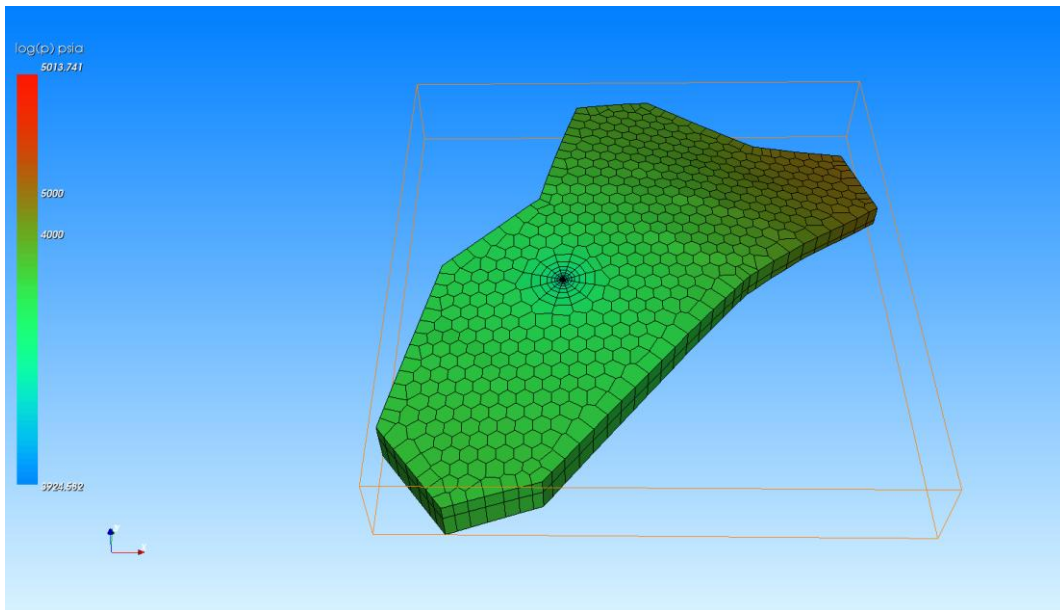
Fig. B02.6 • Final pressure field in the sector – note the fine simulation grid around the well.

B02.2 • Adjusting the well skin value

Let us now try to change the well skin value from 0 to 2.15 – (the value can be obtained in the linear models, but it is not in the scope of this example).

Go to the Map tab-double click on the well and change the skin value:

Then, visit the Numerical model dialog again, click on "Generate" and wait until the new model is completed.

The sector that has been dragged from Rubis is appropriate for near-well (skin) and intermediate (permeability, first boundaries) interpretation, but it cannot replace the full history match built in Rubis – unless the sector is built from the complete reservoir.
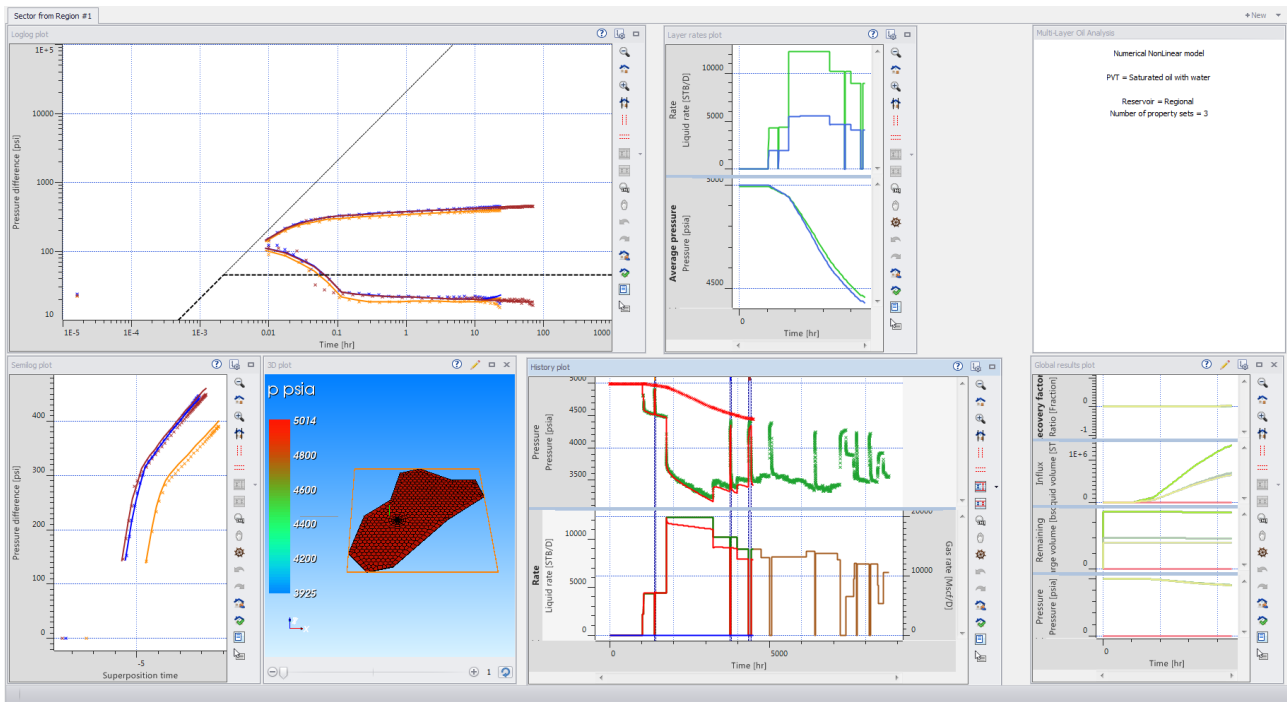
Fig. B02.11 • Rubis sector model with a skin of 2.15.

The model reproduces now more closely the features visible in the log-log plot (compare with Fig.B02.5).

B03 ● Back to the Rubis model

B03.1 ● Re-simulating the model with the adjusted skin value

We will now take the adjusted skin value into account in the full history match Rubis model. Go

back to Rubis document, and create a new run (   ) by copy of the "Initial history match" run – name it "With skin = 2.15":
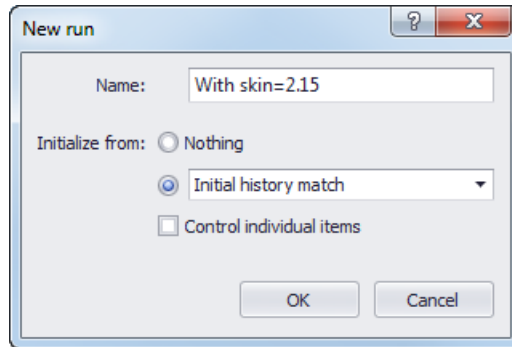

Fig. B03.1 • Creating a new run in Rubis

In this new run change the "Prod 1" skin value from 0 to 2.15 and re-simulate the model (you do not need to modify any other parameter). The simulation should be completed in about 1150 time steps and 3 to 10 minutes, depending on the machine hardware.

Use the option 'Compare' to visualize the simulated oil rates obtained in 2 different runs together with the oil production history:
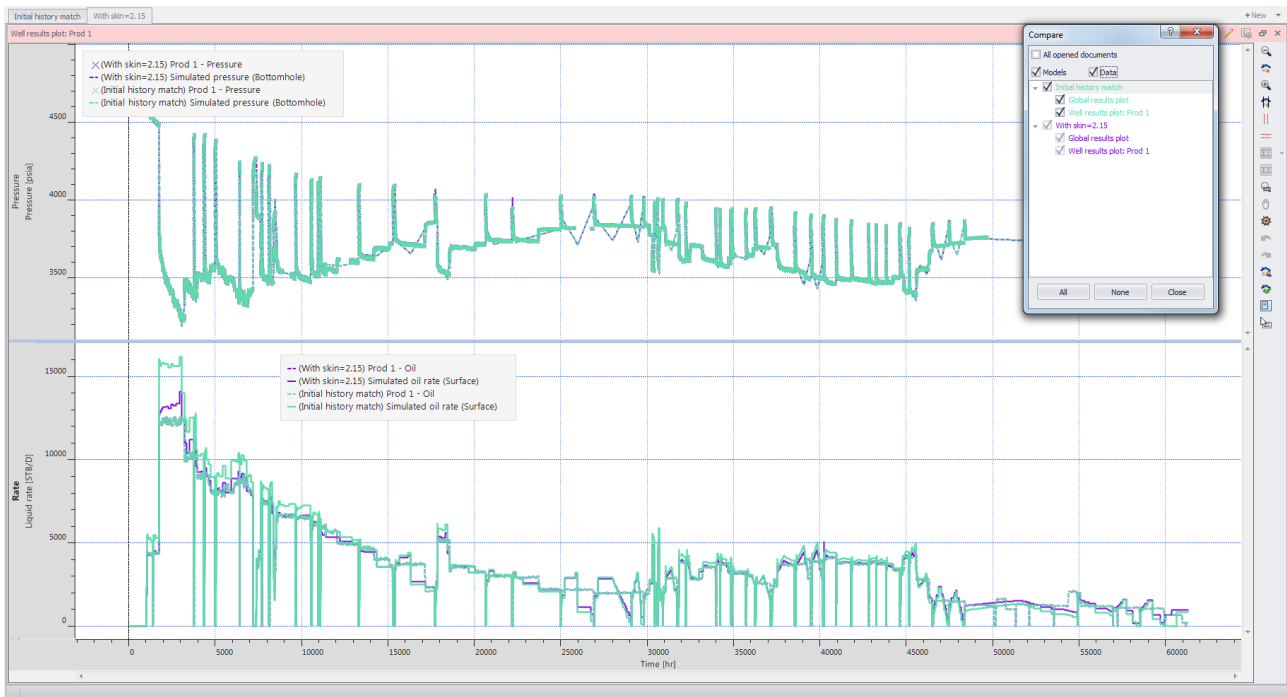

Fig. B03.2 • Comparing models with and without the adjusted skin value.

The match with the corrected skin value leads to a better global history match at the well Prod 1 – in fact, a quick comparison of the final cumulative productions shows that the total error has dropped from 5% to slightly less than 0.8%.