Rock Flow Dynamics

tNavigator 21.4

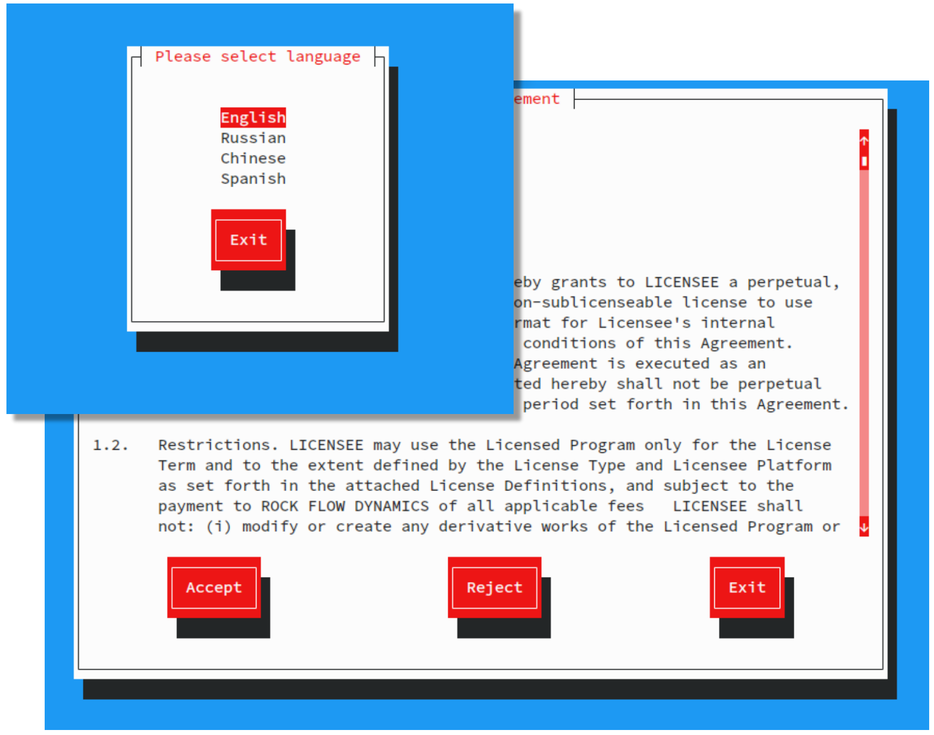
Rock Flow Dynamics

December 2021

Key new features in 21.4

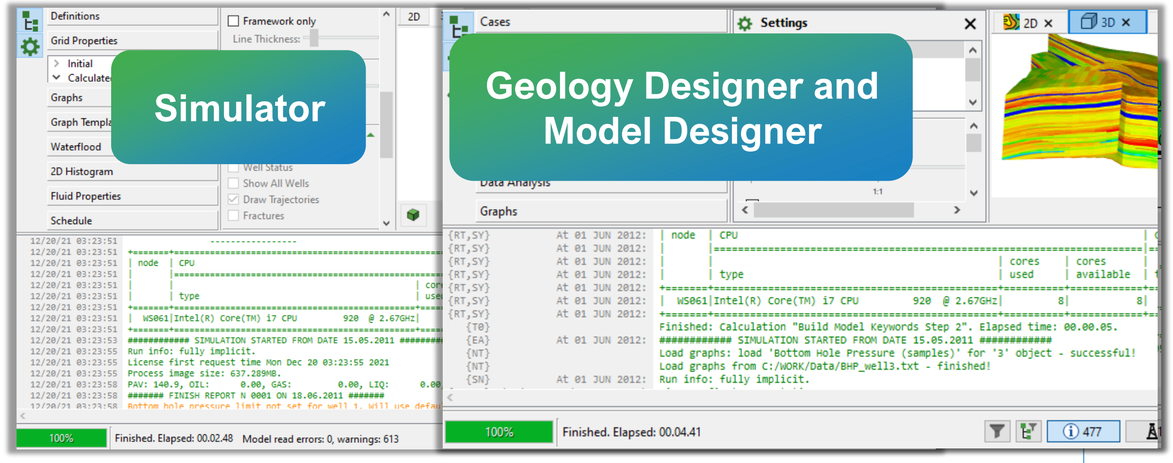
tNavigator installation:

- **Setup software (an installer) for the Linux version of tNavigator has been added. The installer runs in the console and is implemented as a sequence of ASCII graphic screens. The program also installs the user documentation.**



Log panel:

- **A common view of the log panel with an option to search and filter messages by tags or mask is now supported for Simulator, Geology Designer, Model Designer, Network Designer, and PVT Designer.**



Key new features in 21.4

In the Simulator kernel:

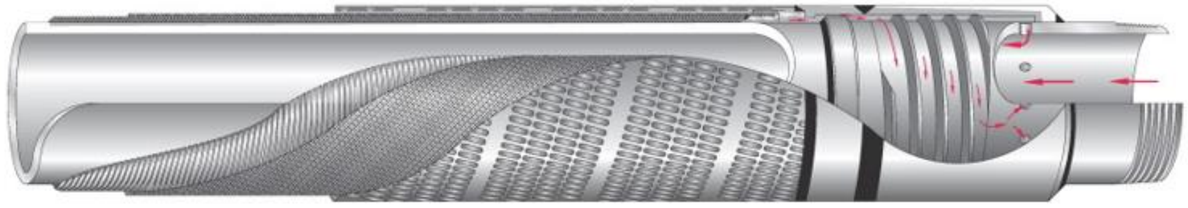
- **The calculation of polymer options on GPU is now supported.**

  - PMIXLIN
  - PMIXNLIN
  - PMIXTAB
  - PMIXVTAB
  - PLYELVSVCS
  - PLYSHEARA
  - PLYELVSVA
  - PLYELVMAXA

- **For black oil models, the option of multicomponent water is now supported.**

  GASWAT

- **Labyrinth inflow control devices for multisegment wells are now supported.**



Key new features in 21.4

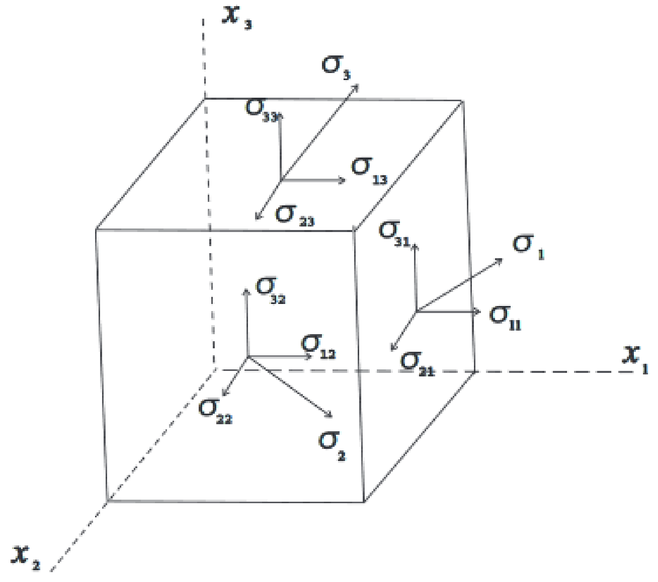
In the Simulator kernel:

- **For isothermal compositional models in E3 format, the option of modeling a two-phase gas-water system using an equation of state is now supported (the GASWAT keyword).**

GASWAT_AQU_REAC.DATA

```
72
73  CNAMES
74  C1 C2 CO2 H2O ADS /
75
76  TCRIT
77  190.6
78
```

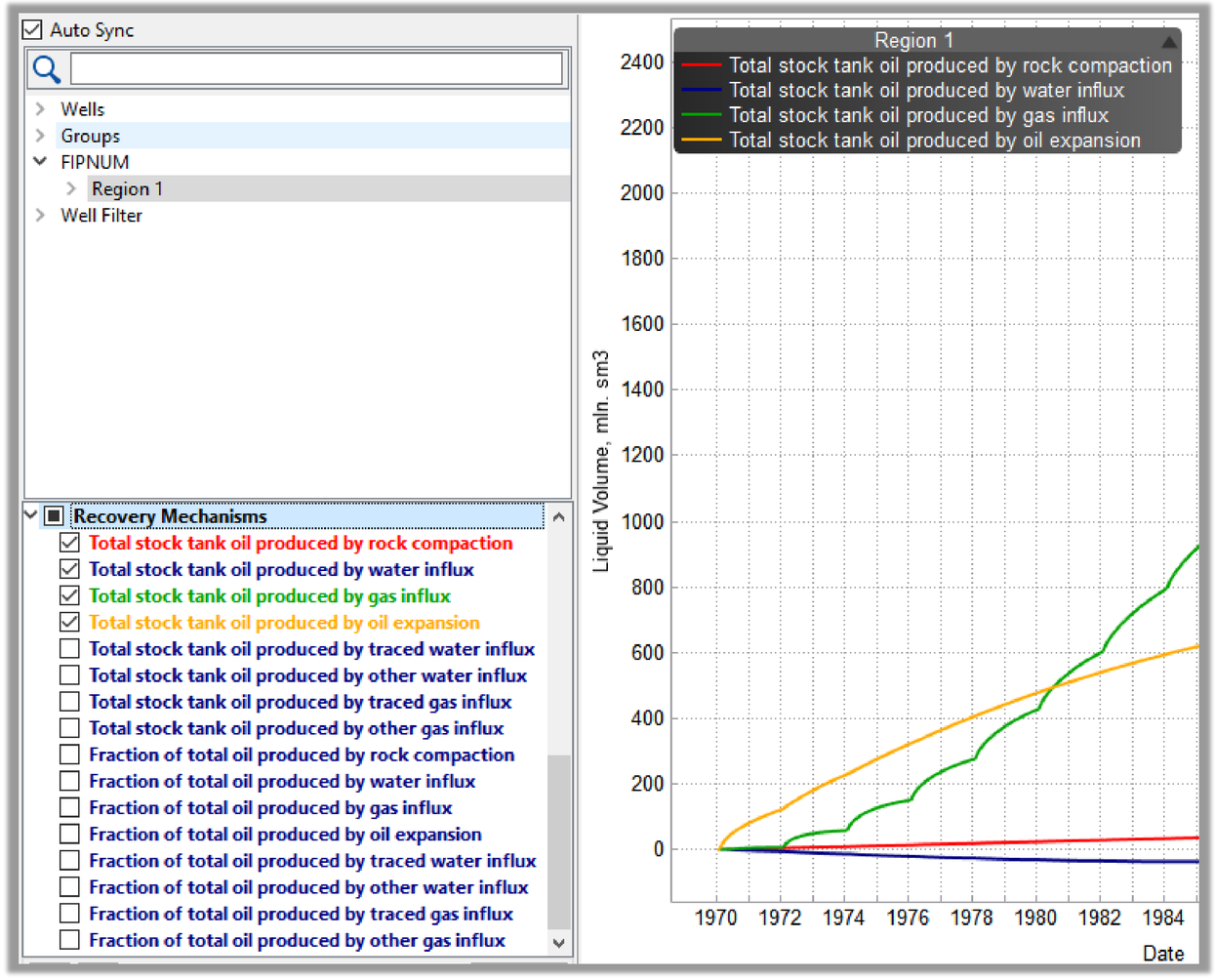
- **For geomechanical modeling, the linear isotropic plasticity model is now supported. The tensor of plastic deformations for such a model can be implemented as a function of the parameters of the dynamic model.**



Key new features in 21.4

In the tNavigator graphical interface:

- **Oil production graphs for various recovery mechanisms are now available in black oil models (oil produced due to rock compaction, due to water influx, etc.)**



Key new features in 21.4

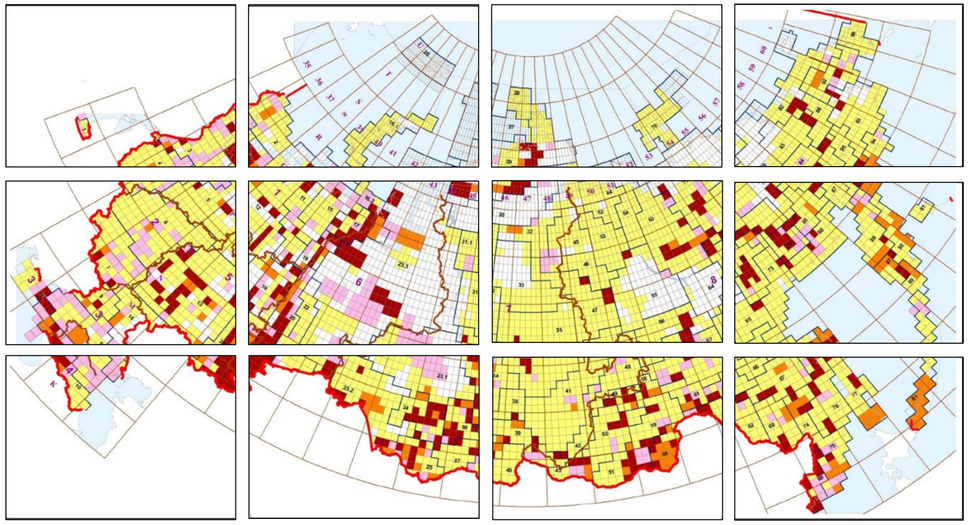
In the Assisted History Matching and Uncertainty module:

- **A new mode to create a neural network for a large number of parameters has been implemented. In that case, a single neural network is built, which helps reduce the training time.**

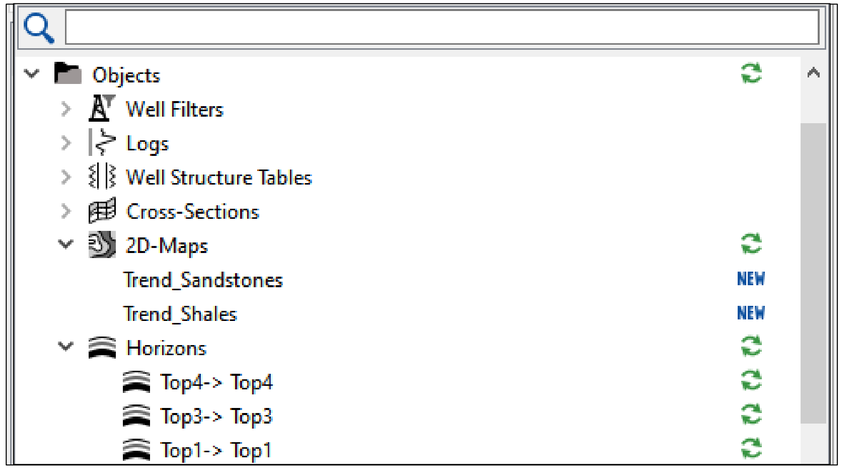
Key new features in 21.4

In Geology and Model Designers:

- **It is now possible to create Page Layout with several pages. This option allows the visualization of objects that do not fit on one page. 2D-Maps of any size can be printed using a simple A4 printer.**



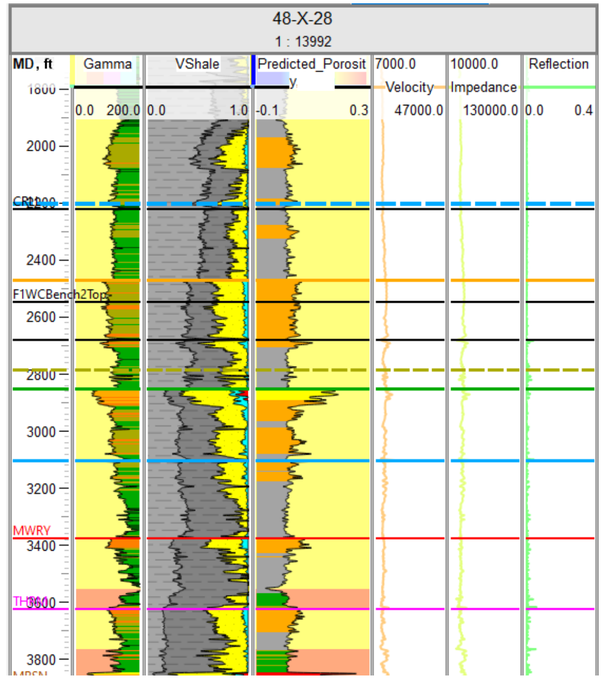
- **The Preview option is now available to control the data exchanging process in the Project Data Exchanger.**



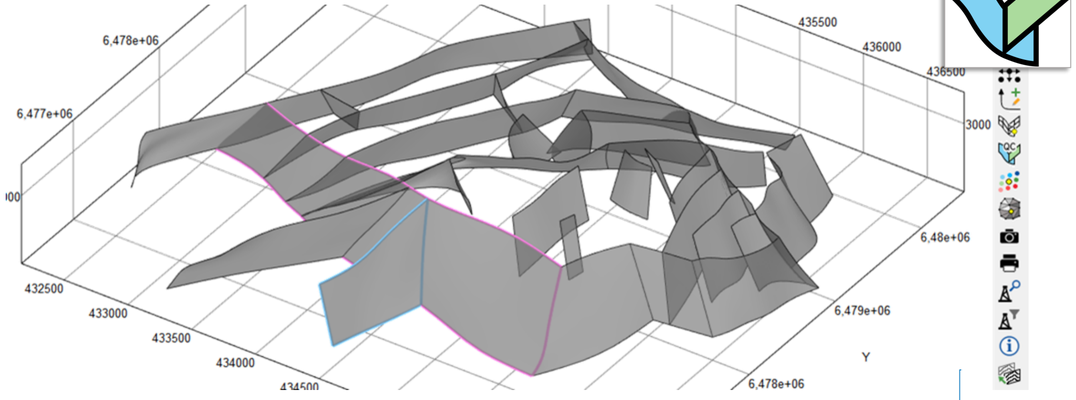
Key new features in 21.4

In Geology Designer:

- It is now possible to set a custom name for each imported well log. A dictionary of log names (mnemonics) can be predefined and applied to all imported logs.



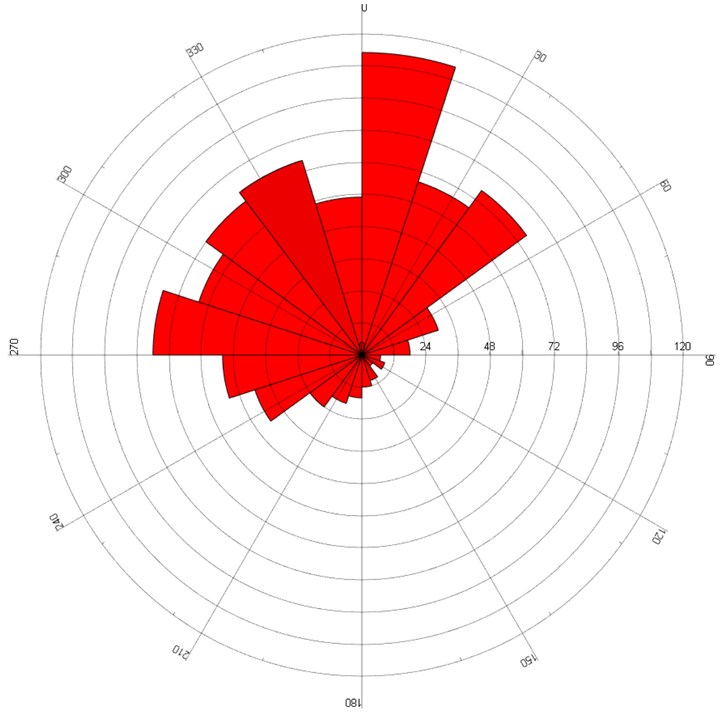
- An interactive tool for quality control of fault creation has been added: Fault QC.



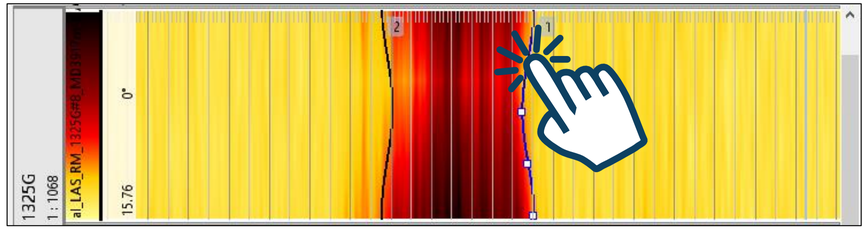
Key new features in 21.4

In Geology Designer:

- New tools are available to model Discrete Fracture Networks (DFN). New settings are available to control fracture orientation within the modeling area. In the list of available windows and tabs, a new object has been introduced: Stereonet/Directional Rose.



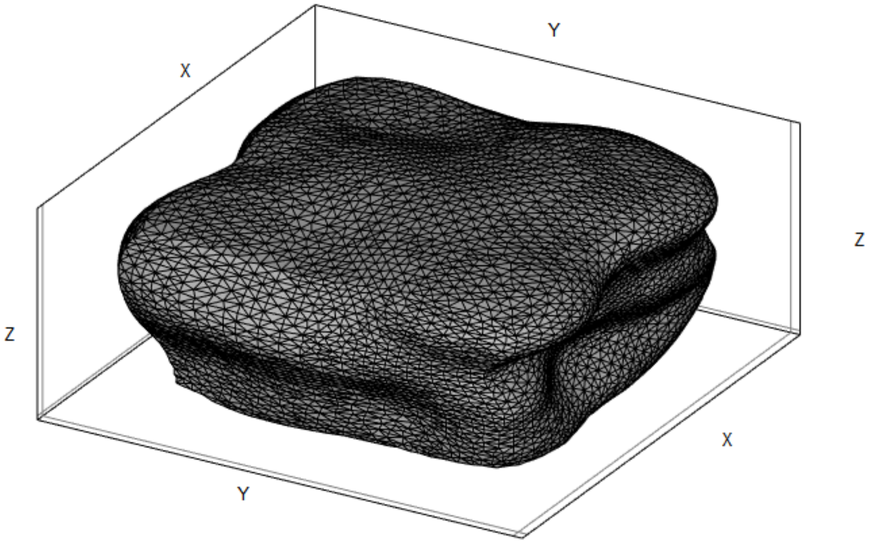
- An option for azimuthal images visualization and interpretation during well navigation is now available. An option to generate synthetic images for the drilled well based on the reference well data has been added.

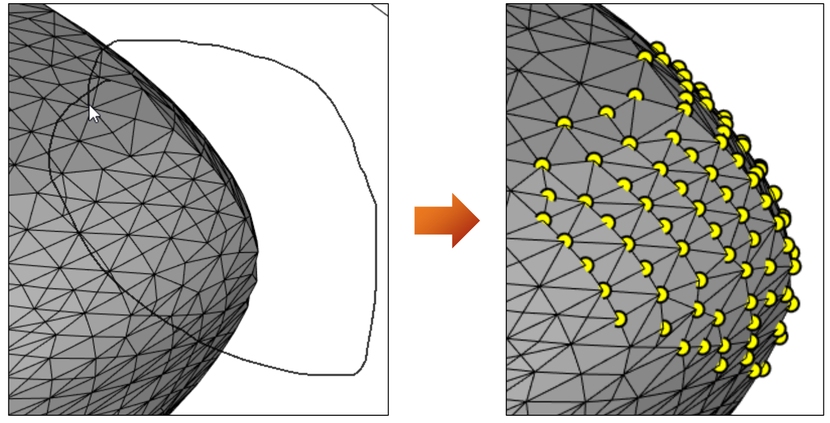


Key new features in 21.4

In Geology Designer:

- **New tools are available to work with geobodies and triangulated surfaces:**
- **automatic creation of geobodies based on point sets or fence polygons,**
- **interactive editing of geobodies' triangulated surfaces in 3D,**
- **properties creation by geobodies,**
- **import/export of triangulated surfaces and geobodies in .tsurf, .ply, .dxf formats.**



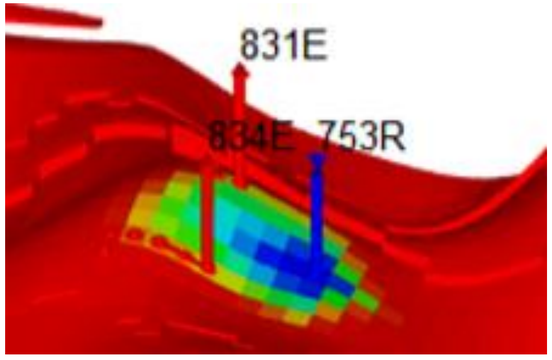


Key new features in 21.4

In Model Designer:

- **The following fluid properties associated with the analytical model of polymer injection are now supported:**
- **the elongational viscosity multiplier as a function of the polymer concentration in a table,**
- **the elongational viscosity multiplier as a function of the stream velocity,**
- **the temperature-dependent polymer half-life period,**
- **etc.**

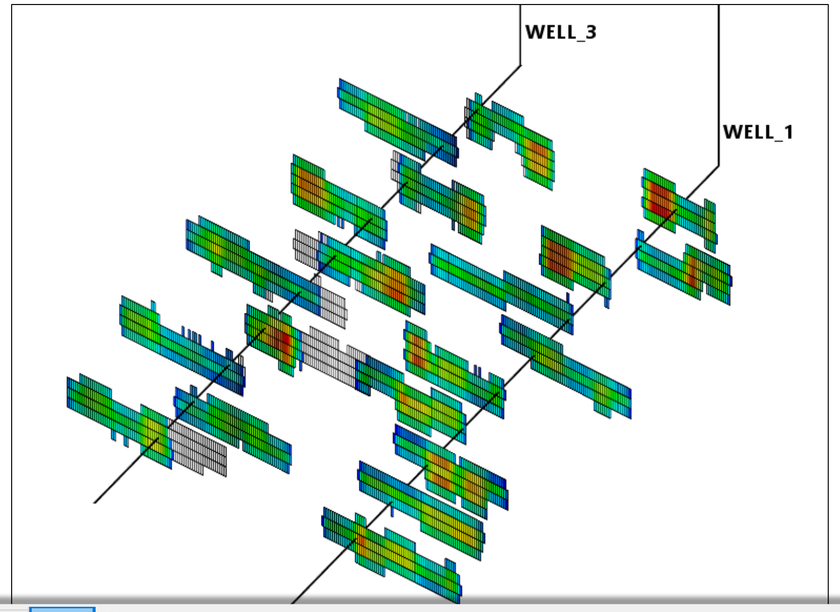
- PLYELVSC
- PLYELVSV
- PLYELVMAXA
- PLYELVSVA
- PLYDHFLF
- PLYSHEARA
- PLYKRRF
- PLYSHLOG



Key new features in 21.4

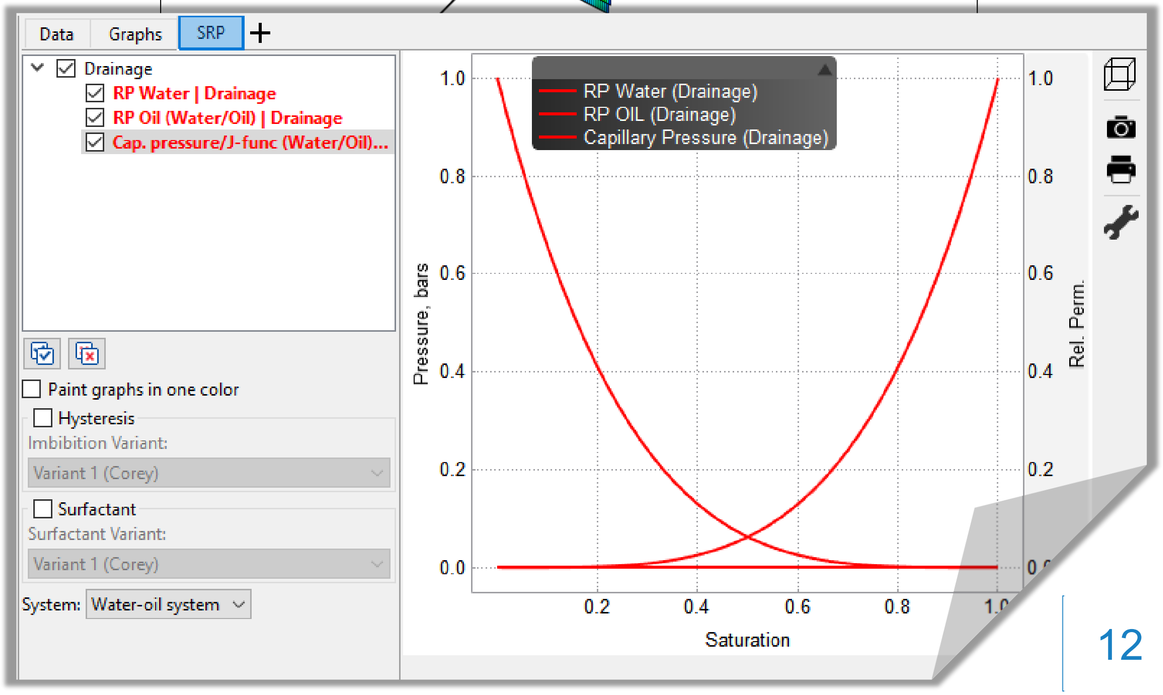
In Model Designer:

- In Fracture Simulator, it is now possible to take into account the mutual influence of fractures implemented at different wells to model the fracture stage at the current well.



- In RP Designer, a new tab titled “SRP” (scaled relative permeabilities) has been added to calculate the hysteresis effect and RP curves in the presence of surfactants.

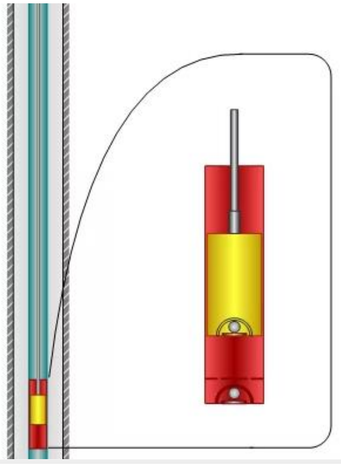
  It is now possible to visualize RP curves by changing endpoints.



Key new features in 21.4

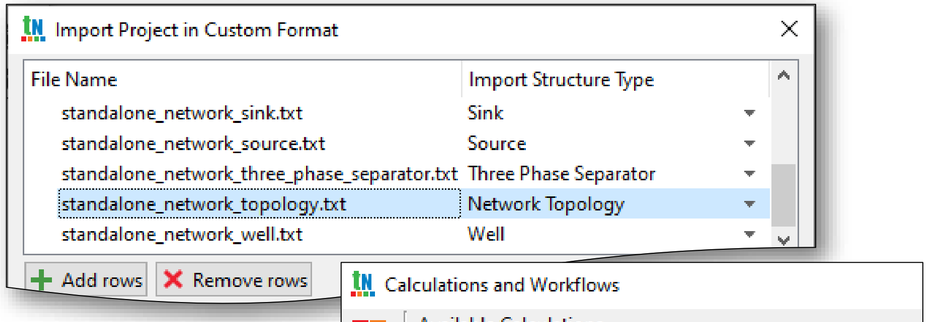
In Well Designer:

- **A new object—Sucker Rod Pump—has been added.**



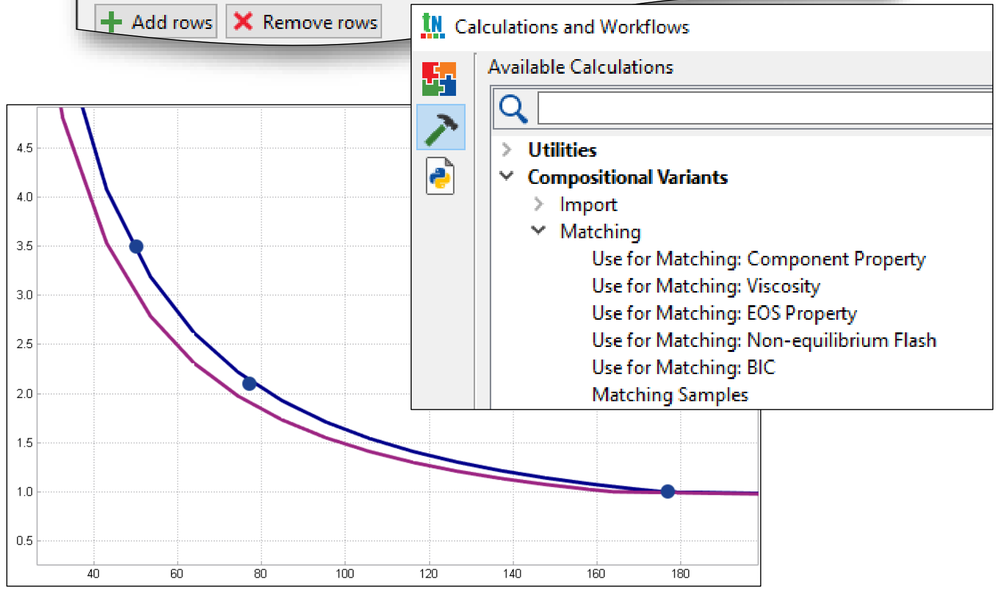
In Network Designer:

- **It is now possible to import and export data for network objects in tabular form in a user-specified format.**



In PVT Designer:

- **In the workflow, compositional and black oil variants can now be matched to samples.**



tNavigator® Rock Flow Dynamics

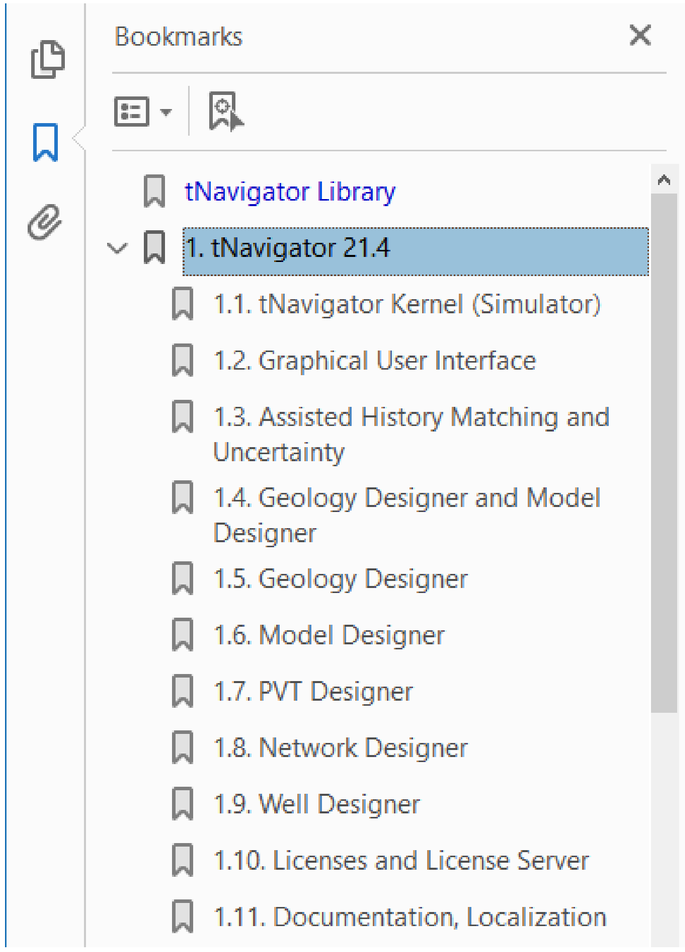
Cross-module changes

Many changes involved in tNavigator modules integration influence multiple modules, but are only mentioned once in this presentation. These include:

- **A common view of the log panel;**
- **Highlighting of calculations with variables in workflows;**
- **New grid properties in Model Designer and Simulator;**
- **…etc.**

For the full list of changes to each particular module, please read the Release Notes.

This presentation contains only the main changes to every module. The complete list of changes, together with the new keywords and options, are likewise available in the Release Notes.



tNavigator Kernel

GPU calculations

The following calculations are supported on GPU:

- **Baker's model for relative phase permeabilities of gas and water (BAKER1, BAKER2).**
- **The calculation of rock hysteresis (ROCKCOMP HYSTER/BOBERG + ROCKTABH).**
- **The calculation of polymer options (PMIXLIN, PMIXNLIN, PMIXTAB, PMIXVTAB, PLYELVSVCS, PLYSHEARA, PLYELVSVA, PLYELVMAXA).**

In full GPU mode (GPU_MODE 4, 5):

- **The calculation of aquifers for compositional models with multicomponent water.**
- **The simultaneous chopping of pressures and saturations (RUNCTRL CHECKP 2).**
- **The export of boundary conditions for split models.**
- **The calculation of variables that are taken from the previous timestep in the AIM scheme.**

Options of multicomponent water and chemical reactions in black oil models

- For black oil models of E3 format, the option of multicomponent water is now supported (the COMPW keyword).

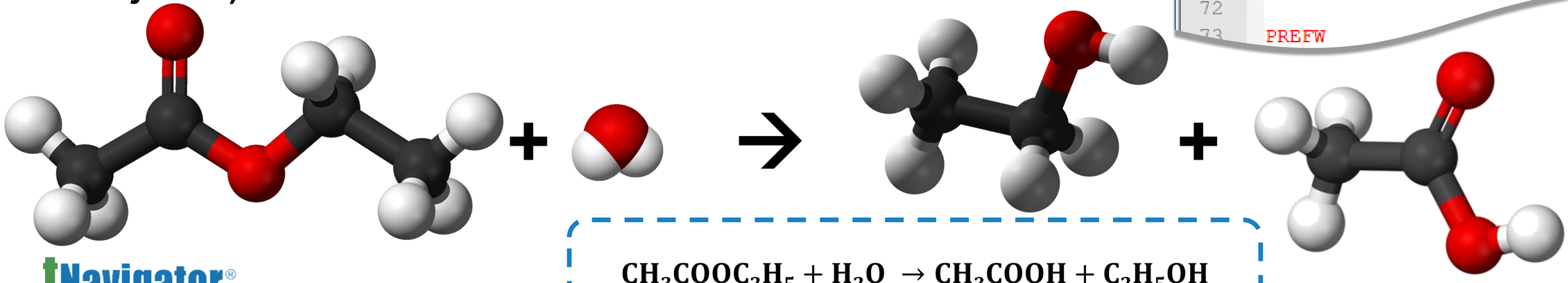
- For black oil models of E3 format (including models with the option of multicomponent water), the modeling of chemical reactions is now supported (the REACTION keyword).

MODEL.data

```
37  COMPW
38   4 /
39
40  REACTION
41   3 0 0 /
42
```

PROPS.INC

```
63  -- WATER COMPONENTS
64  WNAMES
65  WAT ALCO ACID ESTER_AQ /
66
67  CWTYPE
68  1* SURFS 2* /
69
70  MWW
71   18.0 46.0 60.0 88.0 /
72
73  PREFW
```



$$CH_3COOC_2H_5 + H_2O \rightarrow CH_3COOH + C_2H_5OH$$

GASWAT option

- For isothermal compositional models of E3 format, the option of modeling a two-phase gas-water system using an equation of state is now supported (the GASWAT keyword).

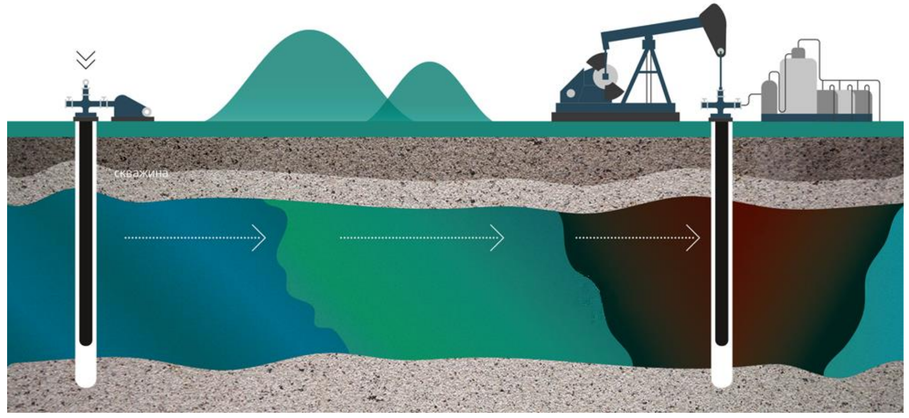
GASWAT_AQU_REAC.DATA

```
72
73  CNAMES
74  C1 C2 CO2 H2O ADS /
75
76  TCRIT
77  190.6 305.4 304.2 647.3 1000/
78
79  PCRIT
80  46.0 48.8 73.8 221.2 1000/
81
82  ZCRIT
83  0.229 0.229 0.229 0.288 0.288/
84
85  --Z-factors for viscosity adjected to get correct
86
87  ZCRITVIS
88  5*0.215 /
89
90  ACF
91  0.0108 0.0998 0.2273 0.3434 0.5 /
92
93  MW
94  16 30 44 18 132/
```

New options for models in IN, NE formats

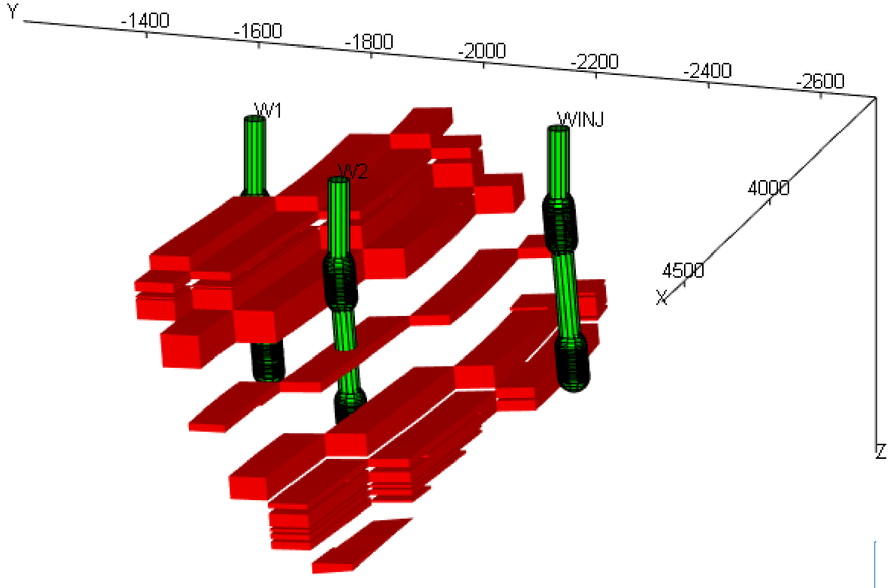
For models in NE format:

- Polymer injection, polymer adsorption, and polymer effect on permeability and viscosity are now supported (the keywords are VISCOSITY, ADSORPTION, PERM_REDUCTION, SHEAR, POLYMER, EPHIP, STREAM_POLYMER).



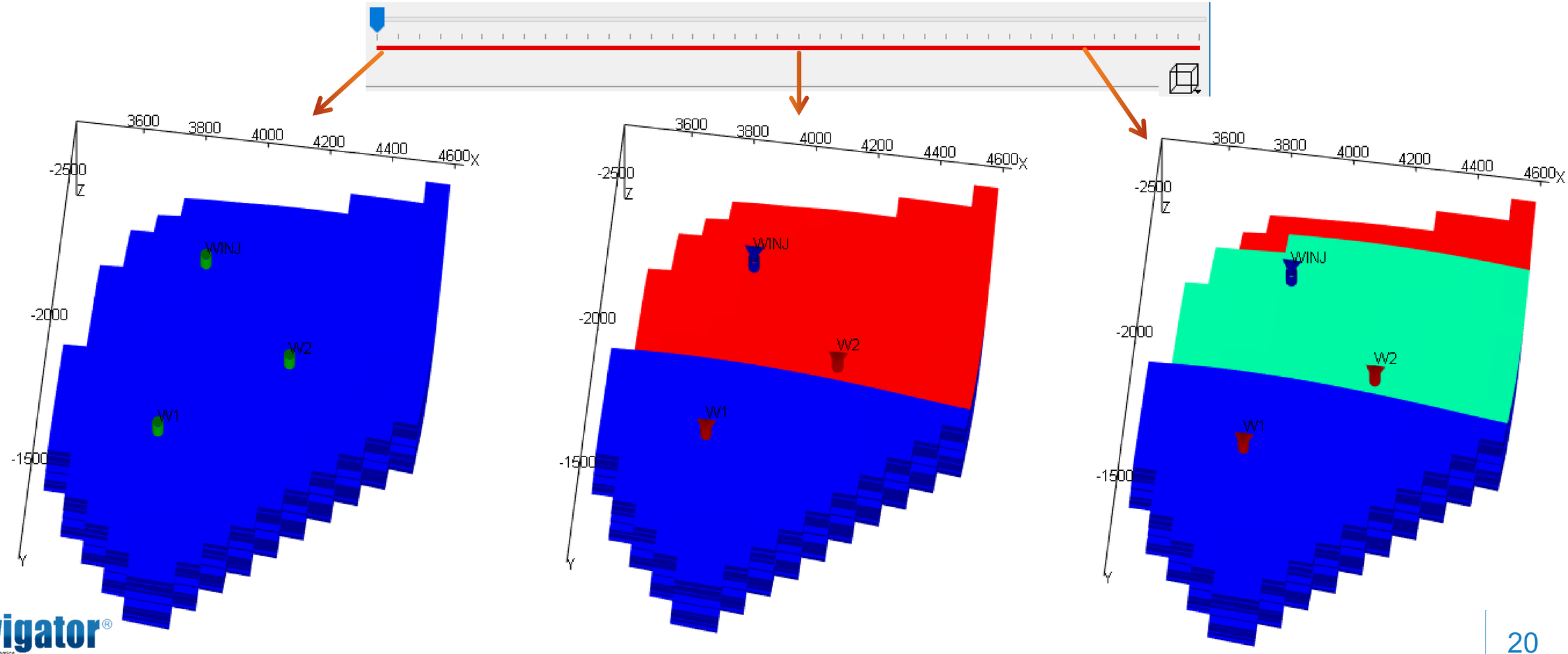
For models in IN format:

- The Python object CellSelectionFamily (a set of blocks) is now supported.
- The Python operations in the SCHEDULE section are now supported.



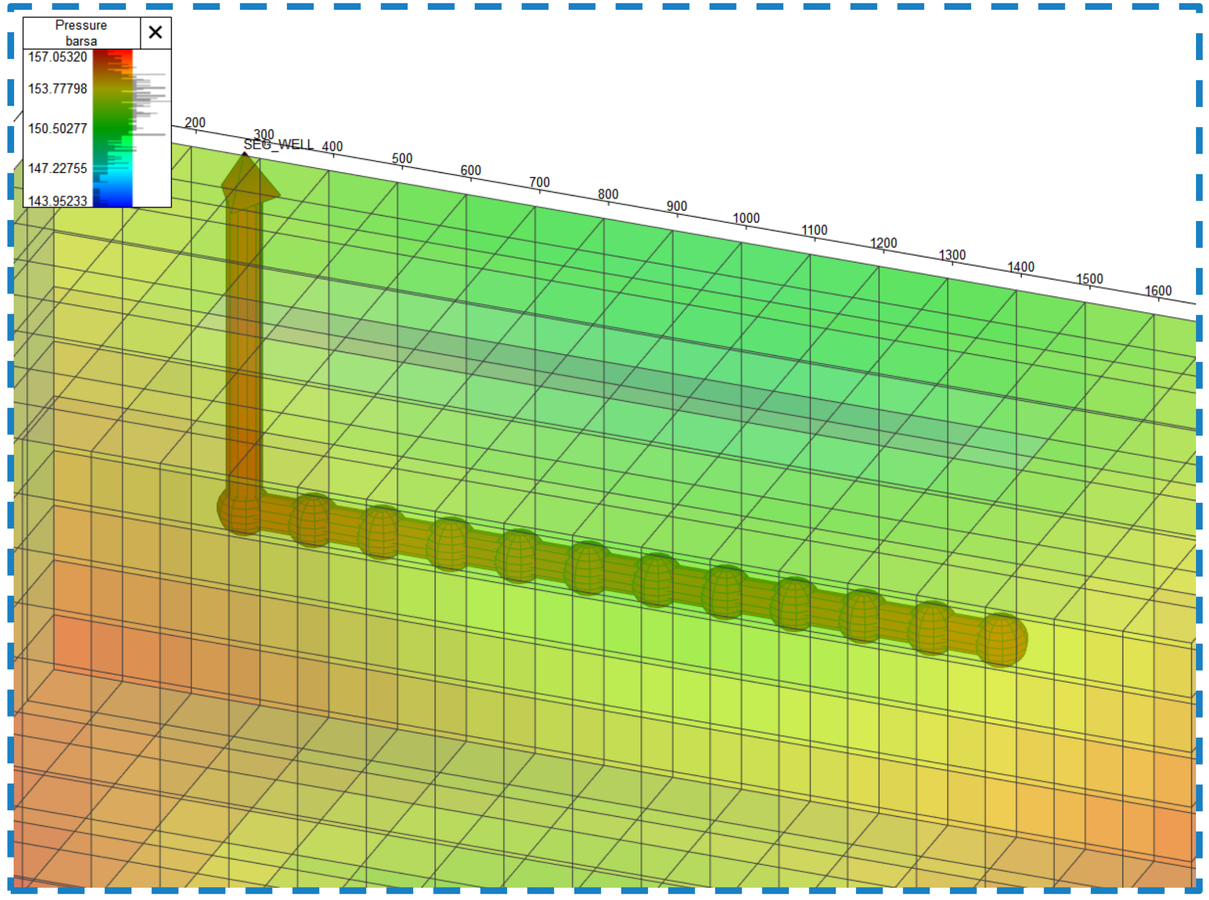
Permeability change in SCHEDULE

- **The change of permeability in the SCHEDULE section is now supported via the multipliers PERMMULT{X,Y,Z,XY,XZ,YZ,XYZ}.**

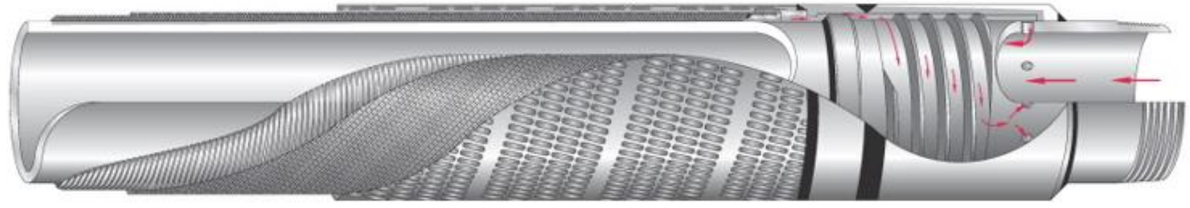


Labyrinth inflow control devices

- Labyrinth inflow control devices for multisegment wells are now supported (the WSEGLABY keyword)



An inflow control device (ICD) is a proven well completion technology designed to equalize the inflow along a wellbore



Connection factor calculation

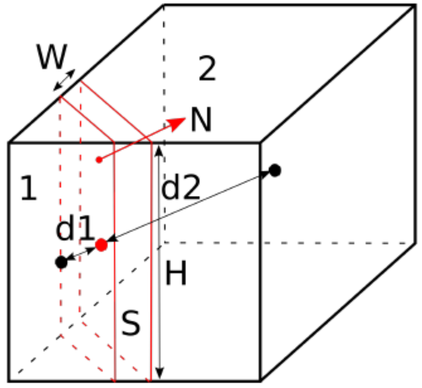
- The formula for calculation of connection factors for virtual perforations has changed: it now uses the harmonic average instead of the sum of the permeabilities on both sides of the fracture. The legacy logic is turned on by the FRACTURE_VIRTUAL_CF_LOGIC SUM option of the TNAVCTRL keyword.

The new formula
(FRACTURE_VIRTUAL_CF_LOGIC NEWTRAN)

$$T_{block \to frac} = PERM\_NFZ \cdot \frac{1}{\left(\frac{1}{T_1} + \frac{1}{T_2}\right)}$$

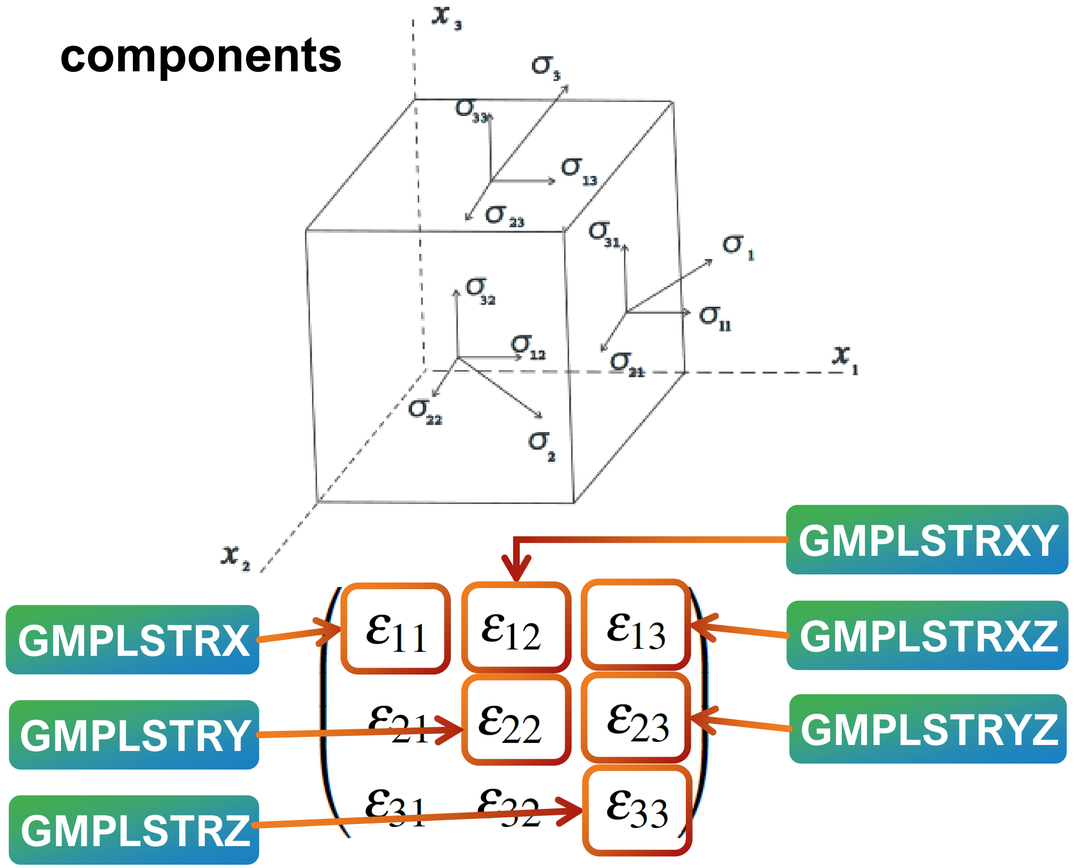
The old formula
(FRACTURE_VIRTUAL_CF_LOGIC SUM)

$$T_{block \to frac} = PERM\_NFZ \cdot S \cdot \left(\frac{1}{d_1} + \frac{1}{d_2}\right)$$



Geomechanical modeling

- **The linear isotropic plasticity model is now supported. The tensor of plastic deformations for such a model can be implemented as a function of the parameters of the dynamic model using the keywords GMPLSTRX, GMPLSTRY, GMPLSTRZ, GMPLSTRXY, GMPLSTRXZ, GMPLSTRYZ to define the tensor's components**



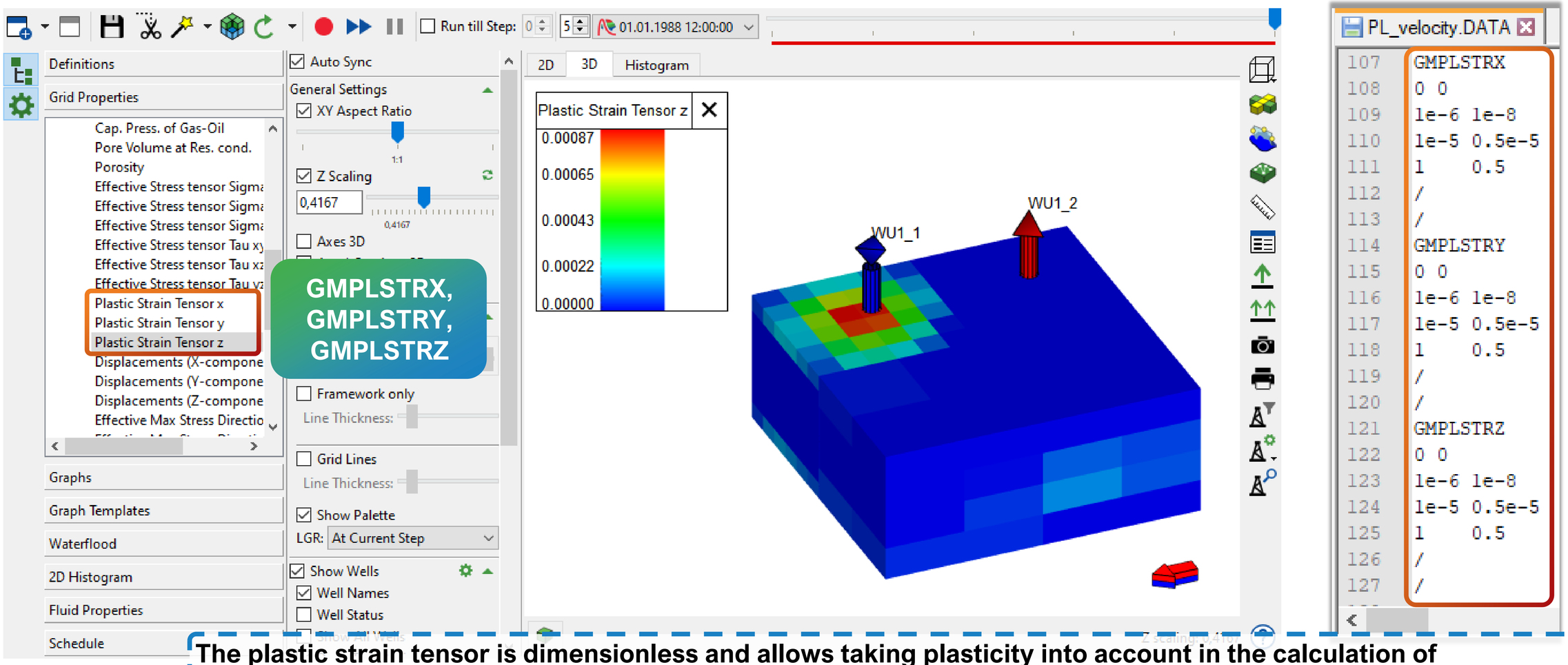
$$\varepsilon_{ij} = \varepsilon_{ij}^{p} + \varepsilon_{ij}^{e}$$

Hooke's law, in accordance with the initial conditions and the correction for plastic deformations, takes the following form:

$$\sigma_{ij} = \sigma_{ij}^{t=0} + 2\mu(\varepsilon_{ij} - \varepsilon_{ij}^{p}) + \lambda\,\delta_{ij}(\varepsilon_{kk} - \varepsilon_{kk}^{p}) - \alpha(p - p^{t=0})$$

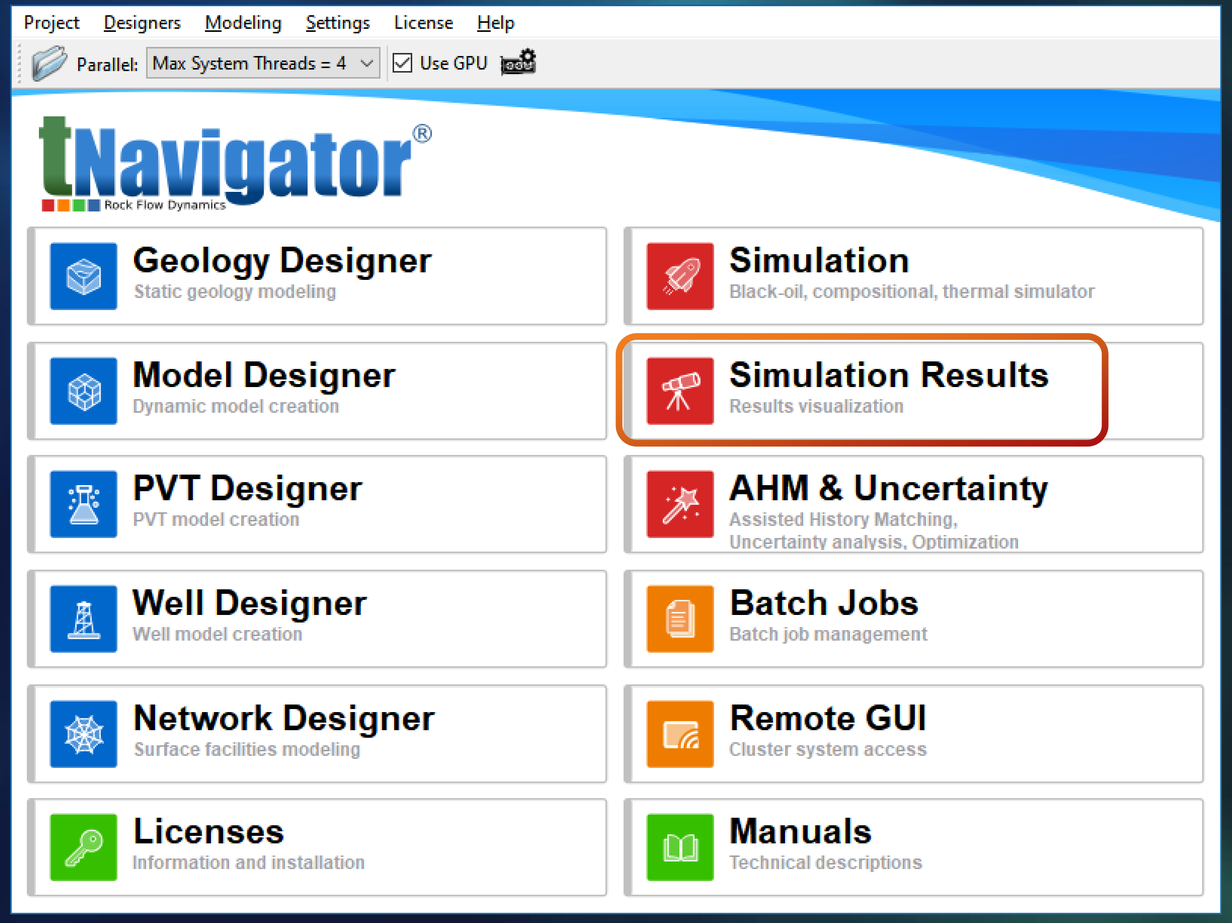
Visualization of the Plastic strain tensor

- **Plastic strain tensor components can now be visualized in 2D and 3D (2D or 3D → Grid Properties → Calculated → Plastic Strain Tensor)**



The plastic strain tensor is dimensionless and allows taking plasticity into account in the calculation of geomechanics. Thus, it becomes possible to calculate more correctly the change in porosity and the parameters associated with it.

Graphical Interface

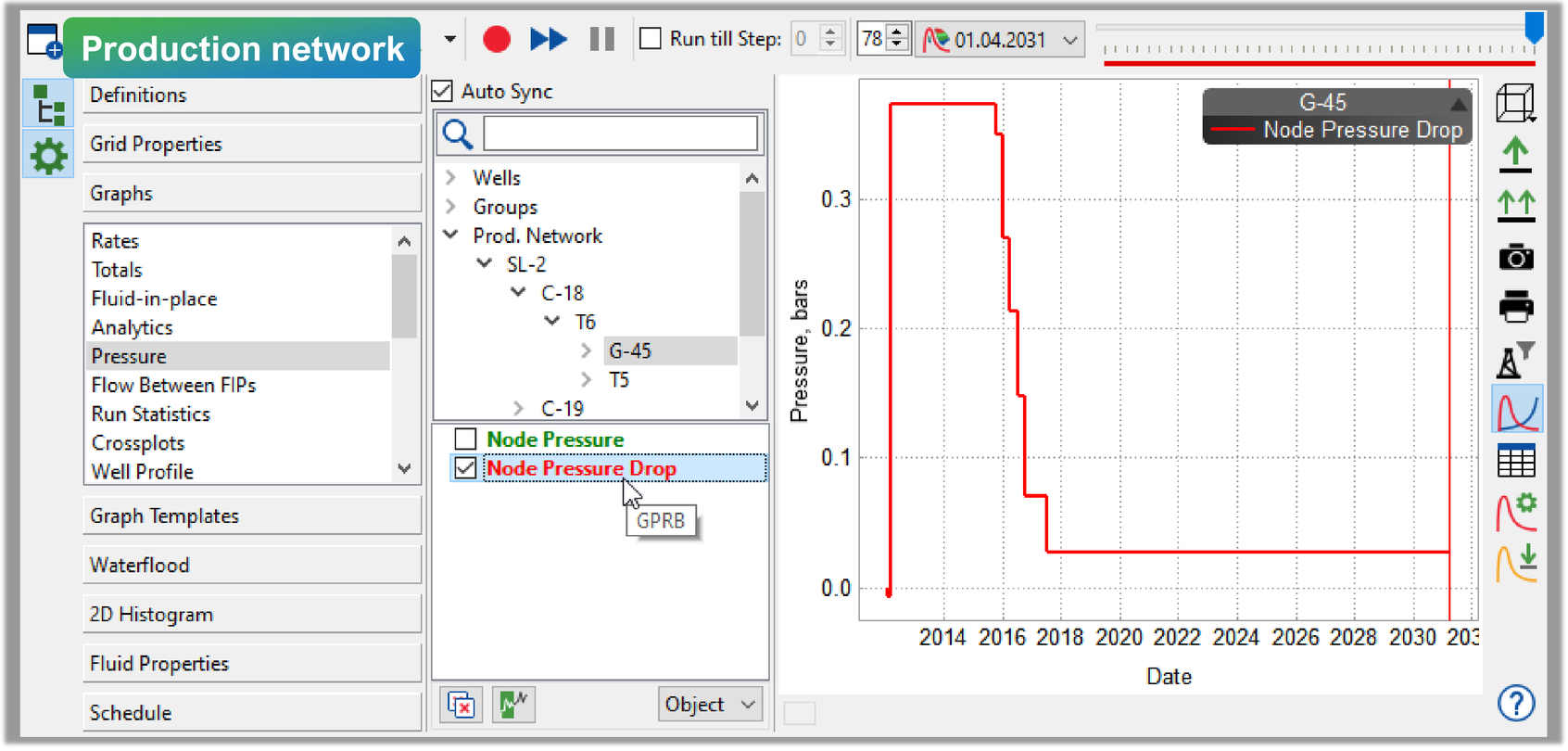


Graphs of pressure drops in network nodes

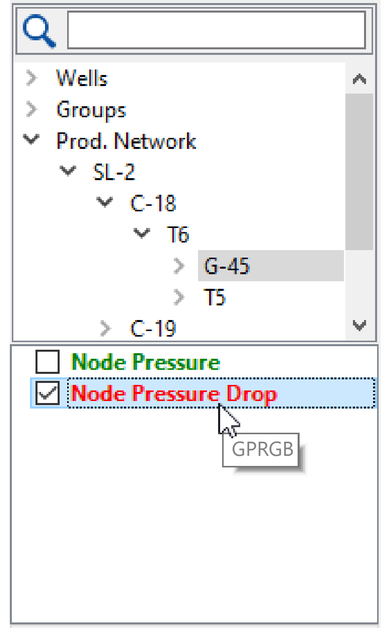
- **Graphs of pressure drops in network nodes are now supported (the NETWORK option):**
  - **the pressure drop in a production network node (GPRB);**
  - **the pressure drop in a gas injection network node (GPRBG);**
  - **the pressure drop in a water injection network node (GPRBW)**

  (Graphs → Node → Pressure → Node Pressure Drop)

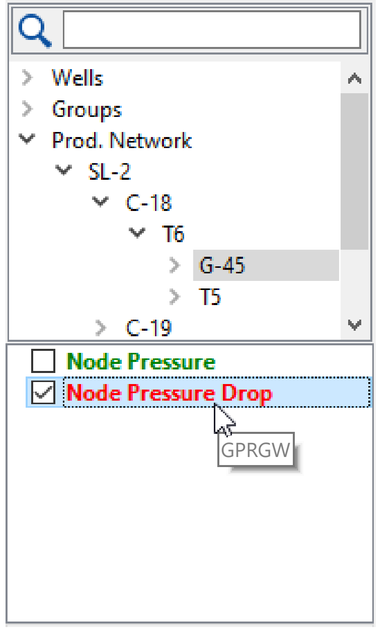
The network type is set via parameter 7 of the NODEPROP keyword



Gas injection network

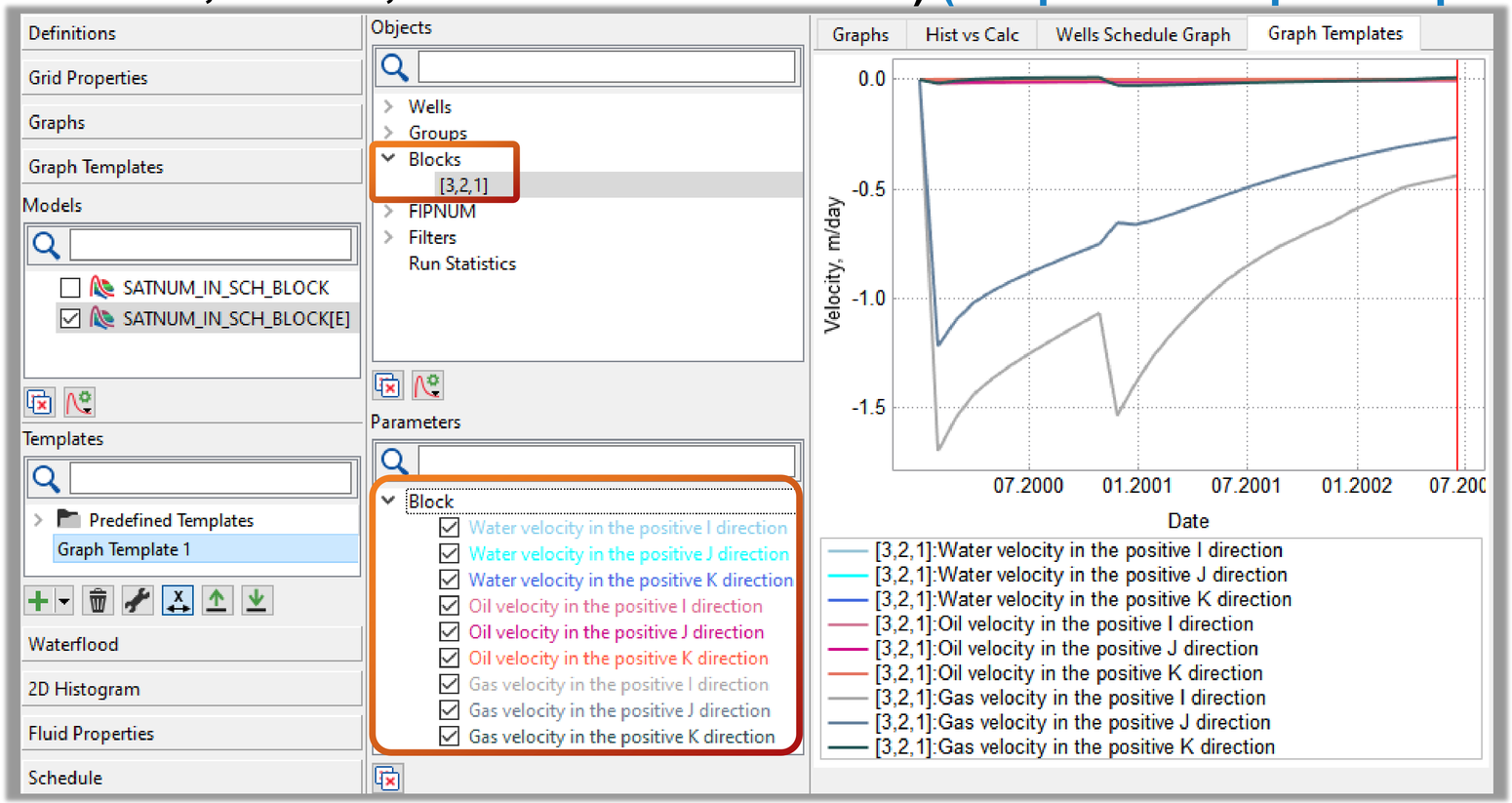


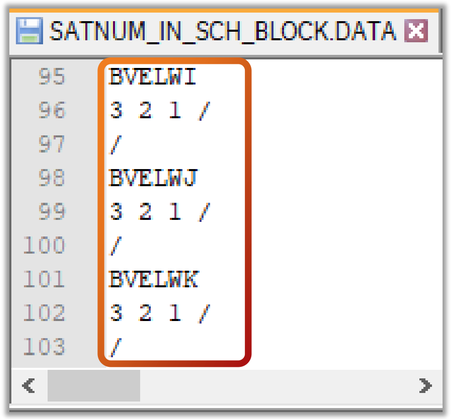
Water injection network



Displaying graphs by blocks in binary format

- **Graphs for blocks saved in UNRST/UNSMRY binary format can now be visualized (including the velocities of oil, gas and water). It is necessary to set the output to the restart files so that they contain the corresponding property (for velocity, the VELOCITY option of the RPTRST keyword should be used) and the I, J, K indices of the grid blocks using the B* mnemonics in the SUMMARY section (for velocities, the mnemonics BVELW, BVELO, BVELG should be used) (Graphs → Graph Templates → Blocks → Parameters)**





Graphs for oil recovery mechanisms

- **Oil production graphs for various recovery mechanisms are now available in black oil models (oil produced due rock compaction, water influx, etc.) (Graphs → Analytics → FIPNUM → Parameters)**

Total stock tank oil produced by:

$$PRC = -d(PV) * S_o * \frac{1}{B_o}$$ **Rock compaction**

$$PWI = PV * d(S_w) * \frac{1}{B_o}$$ **Water influx**

$$PGI = PV * d(S_g) * \frac{1}{B_o}$$ **Gas influx**

$$POE = PV * S_o * d(\frac{1}{B_o})$$ **Oil expansion**

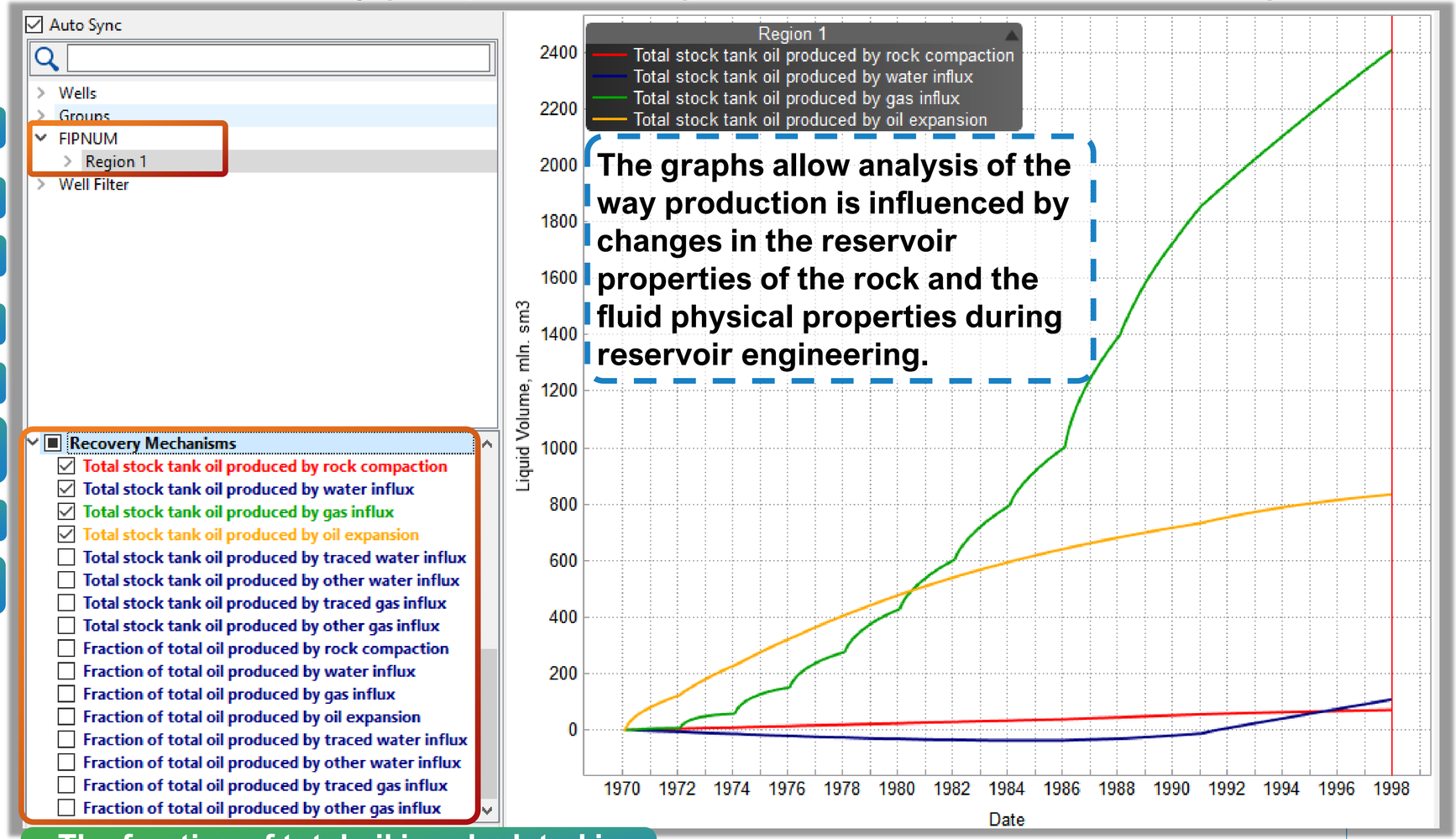
$$PTW = PV * F_{wt} * d(S_w) * \frac{1}{B_o}$$ **Traced water influx**

$$POW = PV * (1 - F_{wt}) * d(S_w) * \frac{1}{B_o}$$ **Other water influx**

$$PTG = PV * F_{gt} * d(S_g) * \frac{1}{B_o}$$ **Traced gas influx**

$$POG = PV * (1 - F_{gt}) * d(S_g) * \frac{1}{B_o}$$ **Other gas influx**

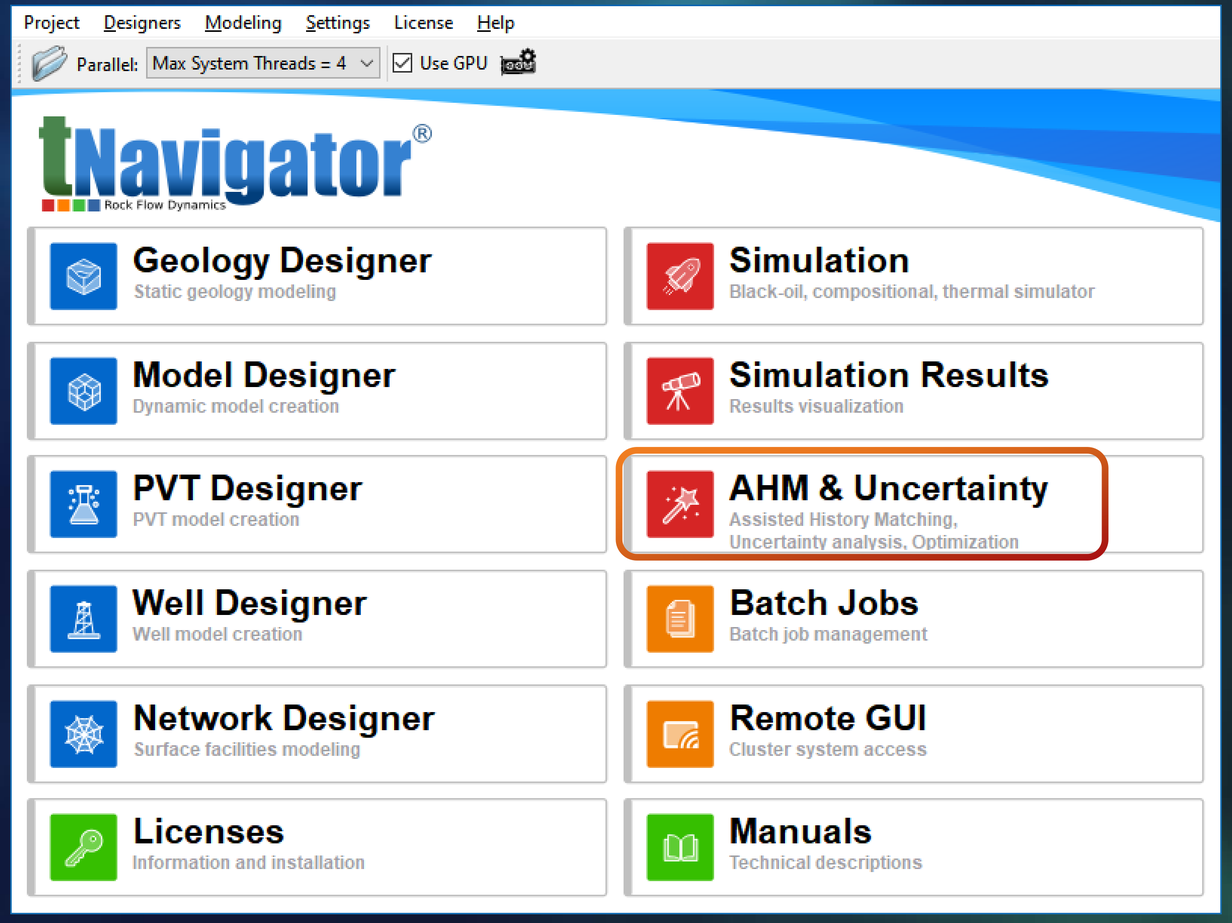
where:
PV is the pore volume;
S_o is the oil saturation;
S_g is the gas saturation;
S_w is the water saturation;
d(PV) is the change in pore volume in one timestep;
$d(S_g)$ is the change in gas saturation in one timestep;
$d(S_w)$ is the change in water saturation in one timestep ;
F_{wt} is the fraction of S_w, that is a water tracer;
F_{gt} is the fraction of S_g, that is a gas tracer;
B_o is the oil volume factor.



The graphs allow analysis of the way production is influenced by changes in the reservoir properties of the rock and the fluid physical properties during reservoir engineering.

The fraction of total oil is calculated in relation to total oil production

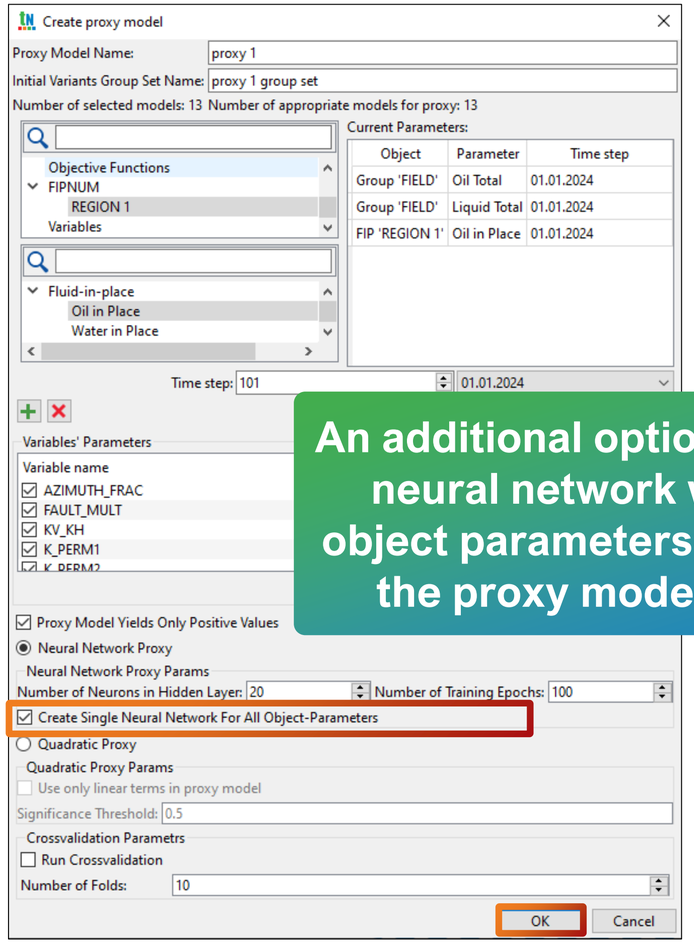
AHM and Uncertainty



Neural Network Proxy Model

- **A new mode to create a neural network for a large number of parameters has been implemented (Create Neural Network Proxy Model from Selected Variants → the tab Proxy Models → Create Single Neural Network For All Object-Parameters). In that case, a single neural network is built, which helps reduce the training time**

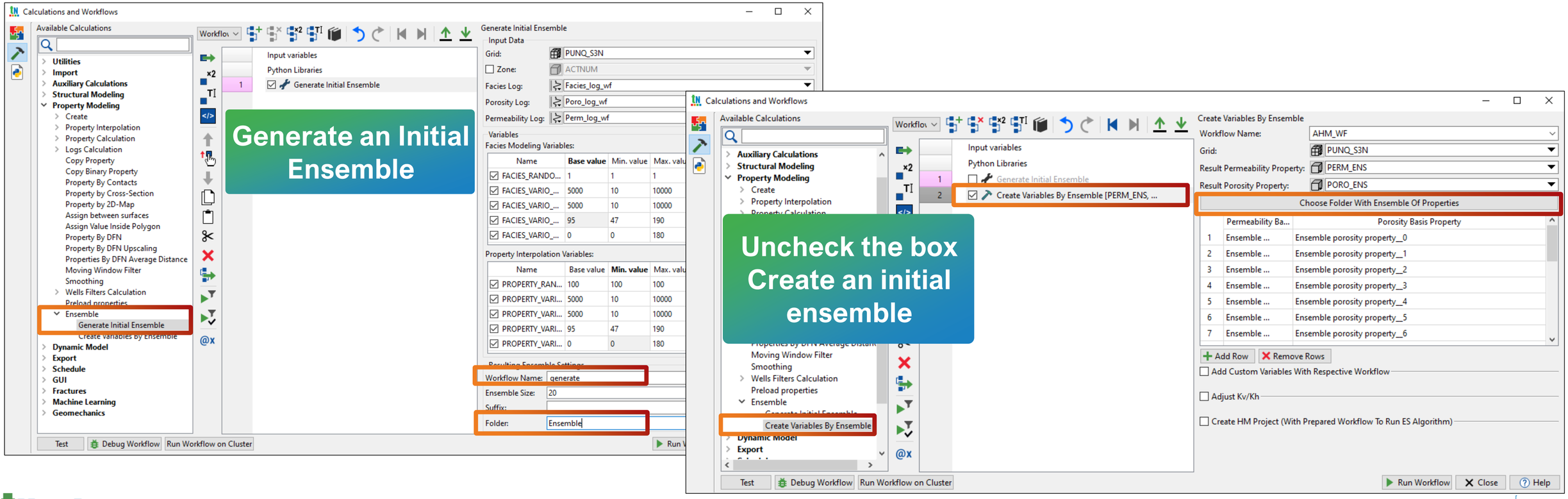
Previously, for each selected object parameter, its own neural network was created



An additional option to create a single neural network with output to all object parameters has been added to the proxy model creation dialog

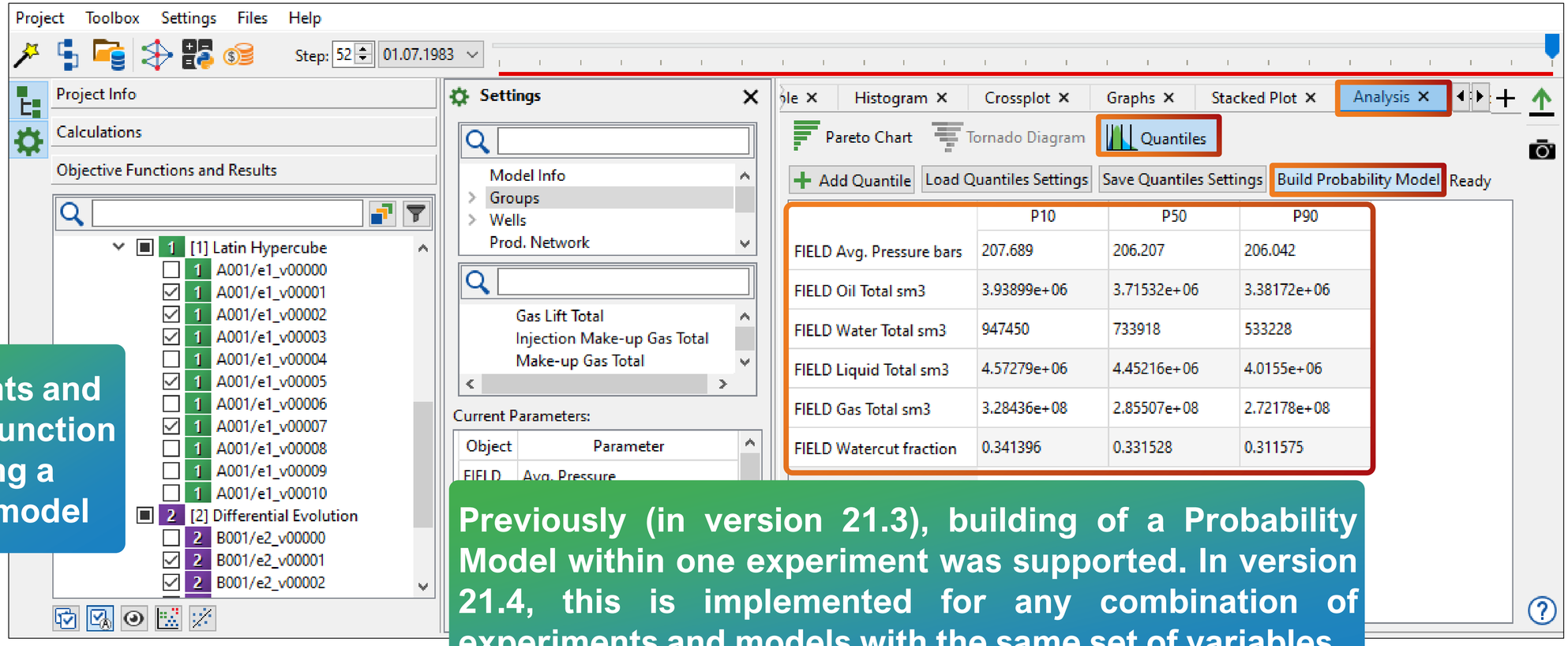
Setting custom variables for the Ensemble algorithm

- **Custom variables can now be added to the Ensemble algorithm. They are specified in a custom workflow (Workflows → Available Calculations → Property Modeling → Ensemble → Create Variables by Ensemble → Add Custom Variables With Respective Workflow)**



Building a Probability Model

- A probability model can now be built (the Build Probability Model button) in the Analysis tab on the basis of calculation results of some experiments if they are run in the same variable space. The variants and the objective function that will be used for building the probability model should be ticked in the Objective Functions and Results tree

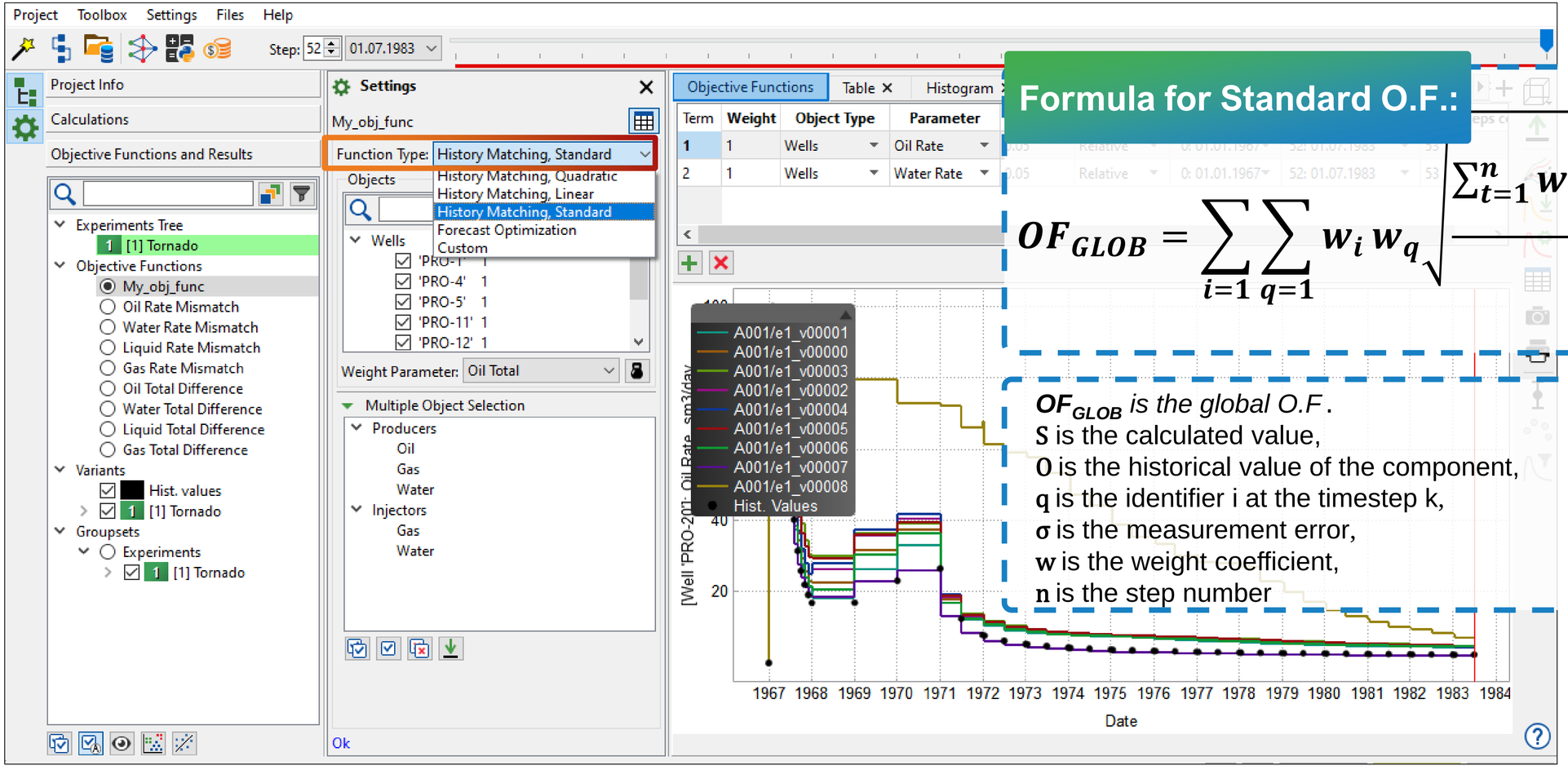


Select variants and an objective function for building a probability model

Previously (in version 21.3), building of a Probability Model within one experiment was supported. In version 21.4, this is implemented for any combination of experiments and models with the same set of variables

O.F. Standard

- A new type of objective function, Standard, has been added to help cut outliers on timesteps

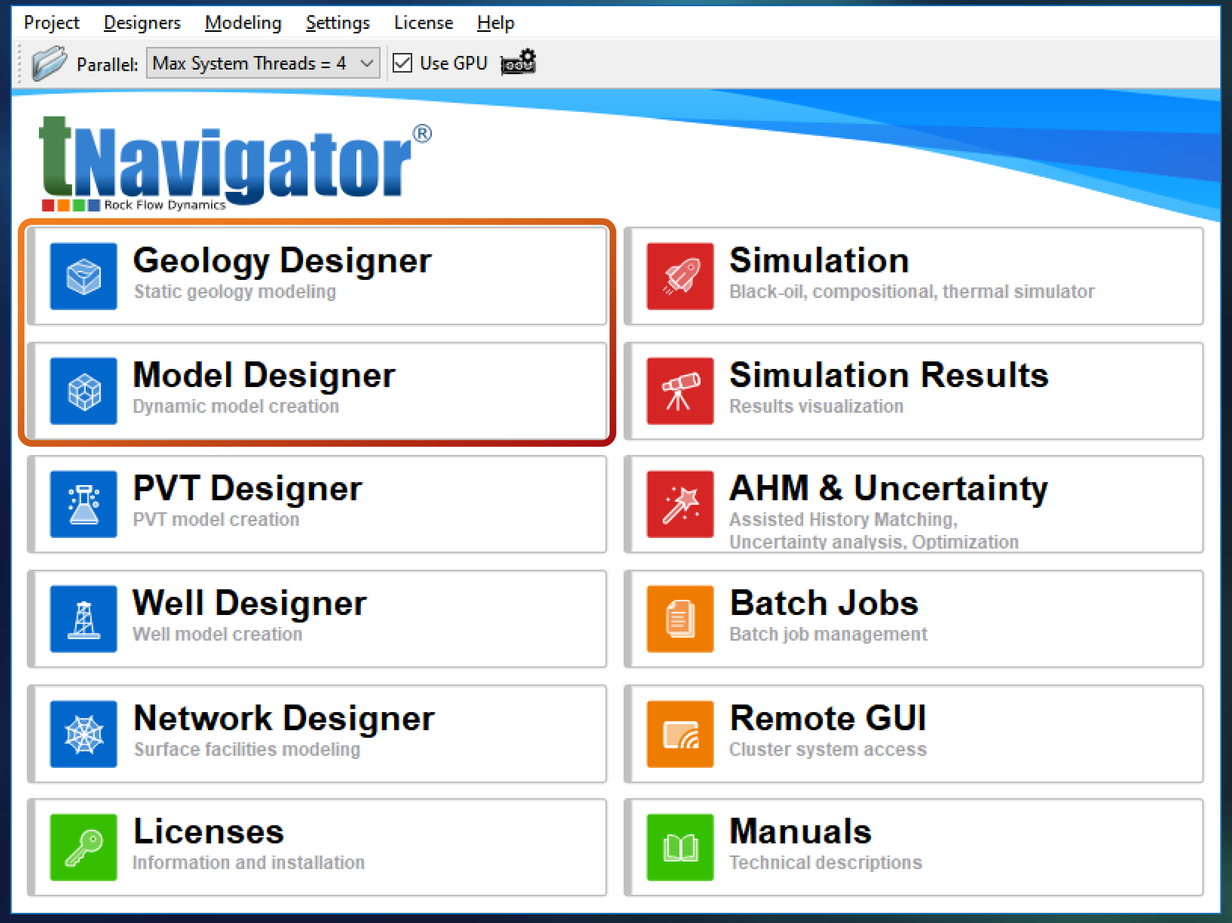


Formula for Standard O.F.:

$$OF_{GLOB} = \sum_{i=1} \sum_{q=1} w_i w_q \sqrt{\frac{\sum_{t=1}^{n} w_k \left(\frac{S_{q,i,k} - O_{q,i,k}}{\sigma_{q,i,k}} \right)^2}{\sum_{t=1}^{n} w_k}}$$

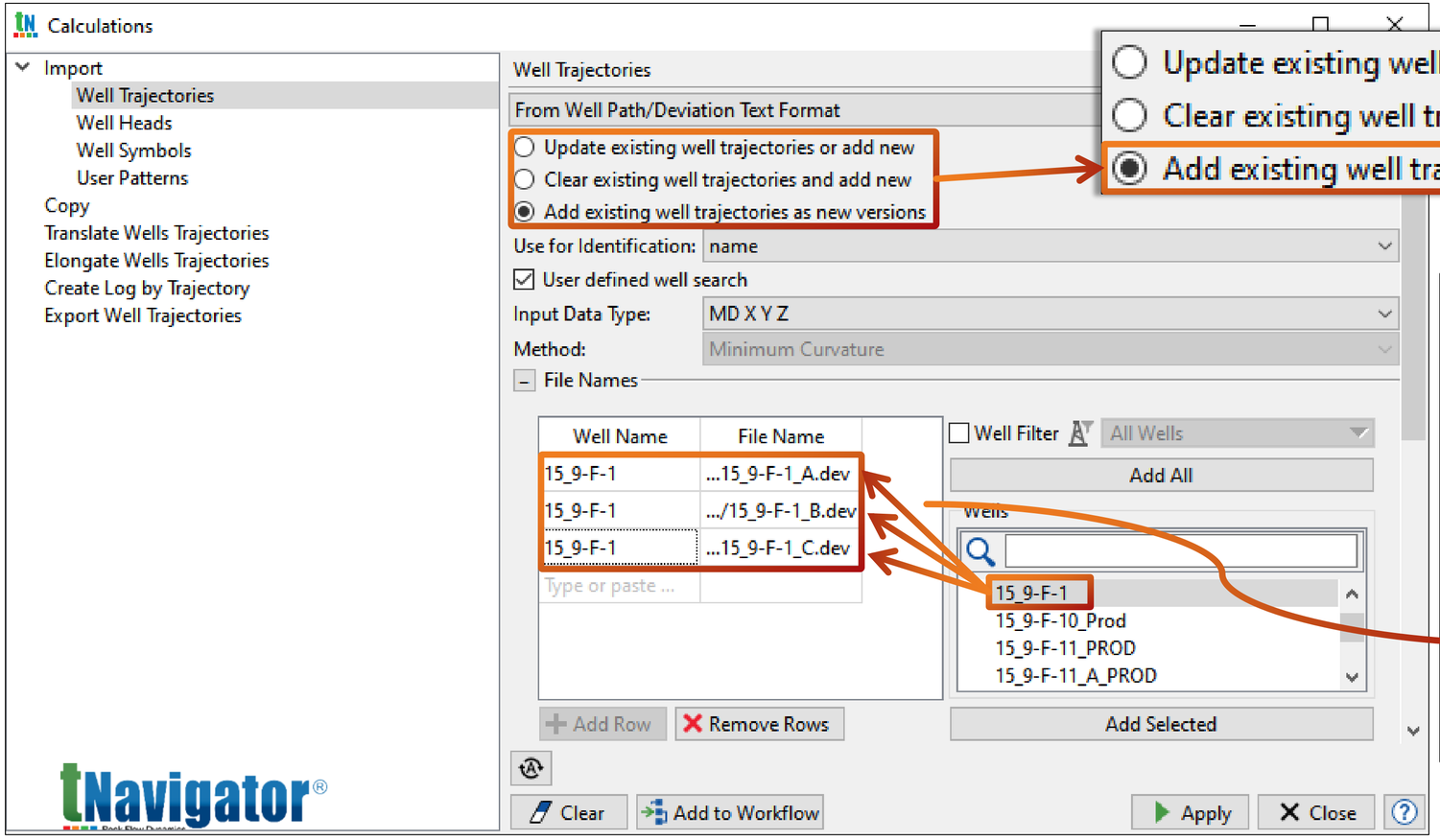
OF_{GLOB} *is the global O.F.*
S is the calculated value,
O is the historical value of the component,
q is the identifier i at the timestep k,
σ is the measurement error,
w is the weight coefficient,
n is the step number

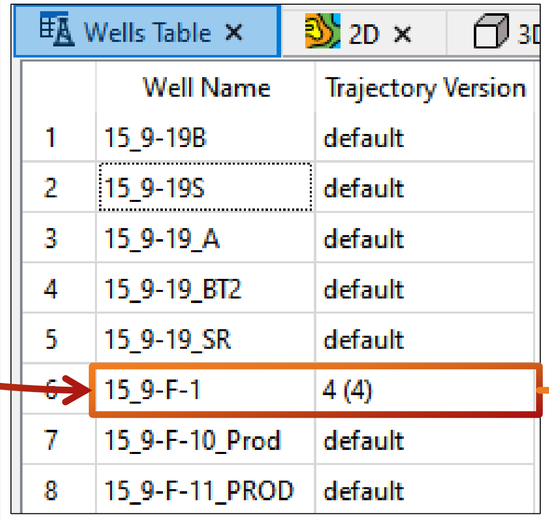
Geology Designer and Model Designer

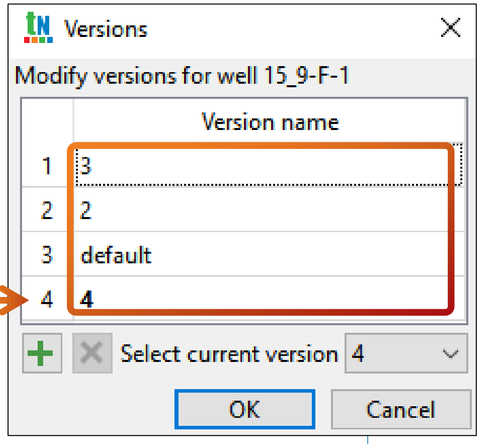


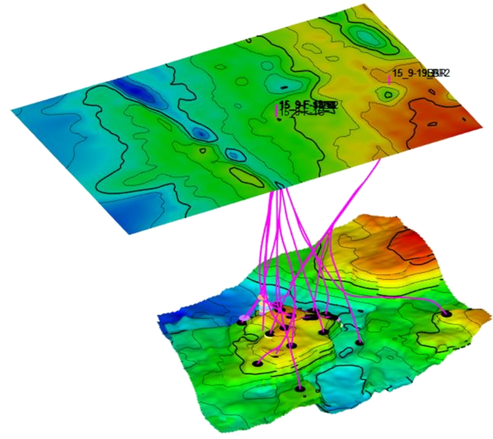
Manually assign a trajectory to a well

- It is now possible to manually assign the trajectory being imported to a well. If some wells have already been imported into the project, the user is able to choose one of the options: delete all the trajectories and import them again; update all trajectories; import the trajectory as one of the possible versions of the well trajectory (Import → Well Trajectories → User Defined Well Search)



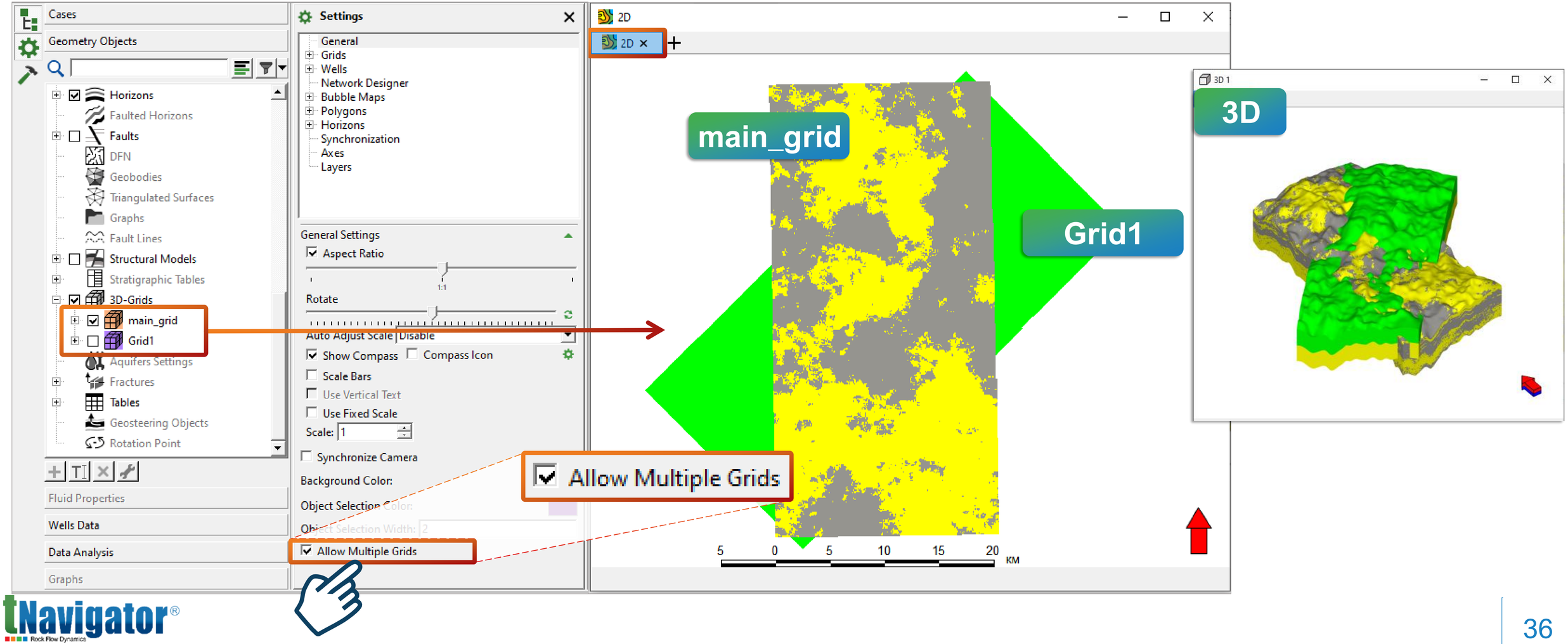






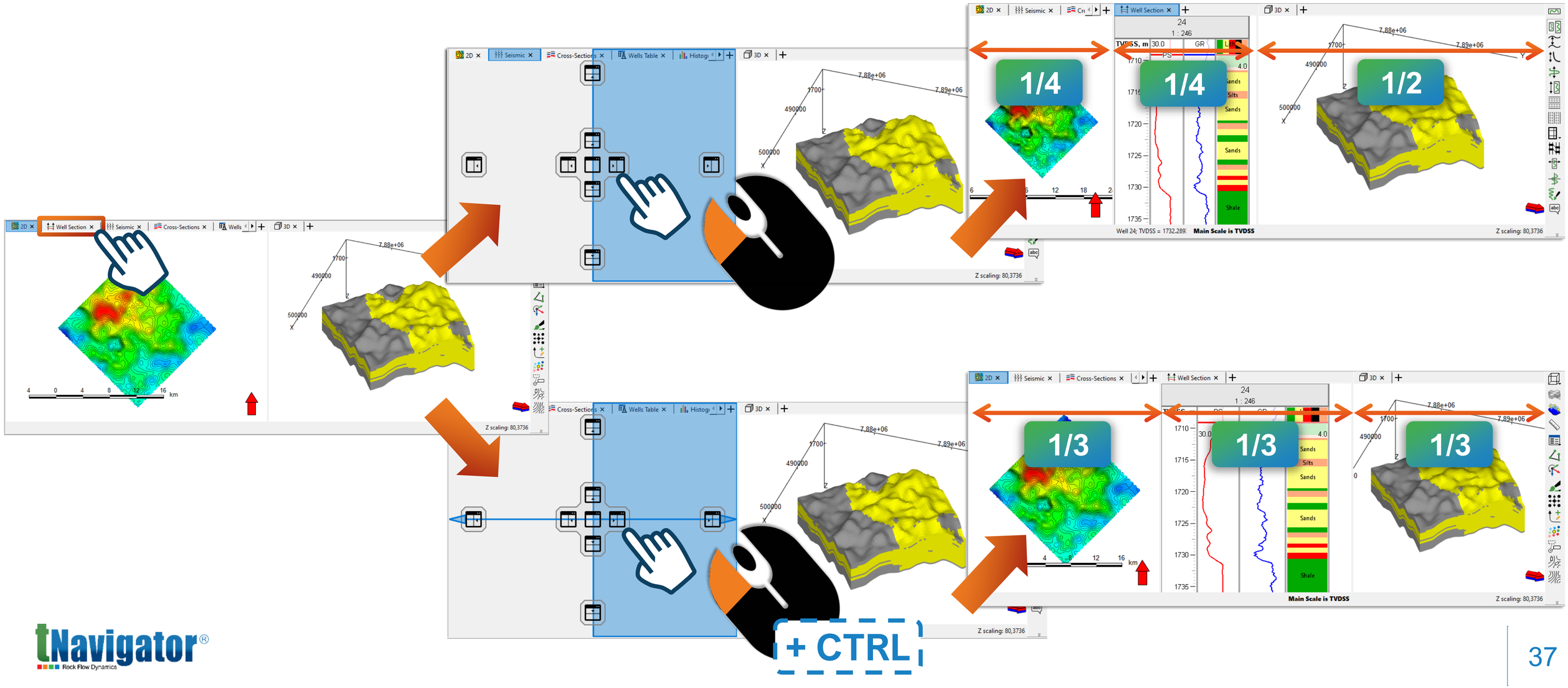
Multiple Grids in the 2D visualization tab

- **Multiple grids visualization in the 2D tab is now supported (2D tab → Settings → General → Allow Multiple Grids)**



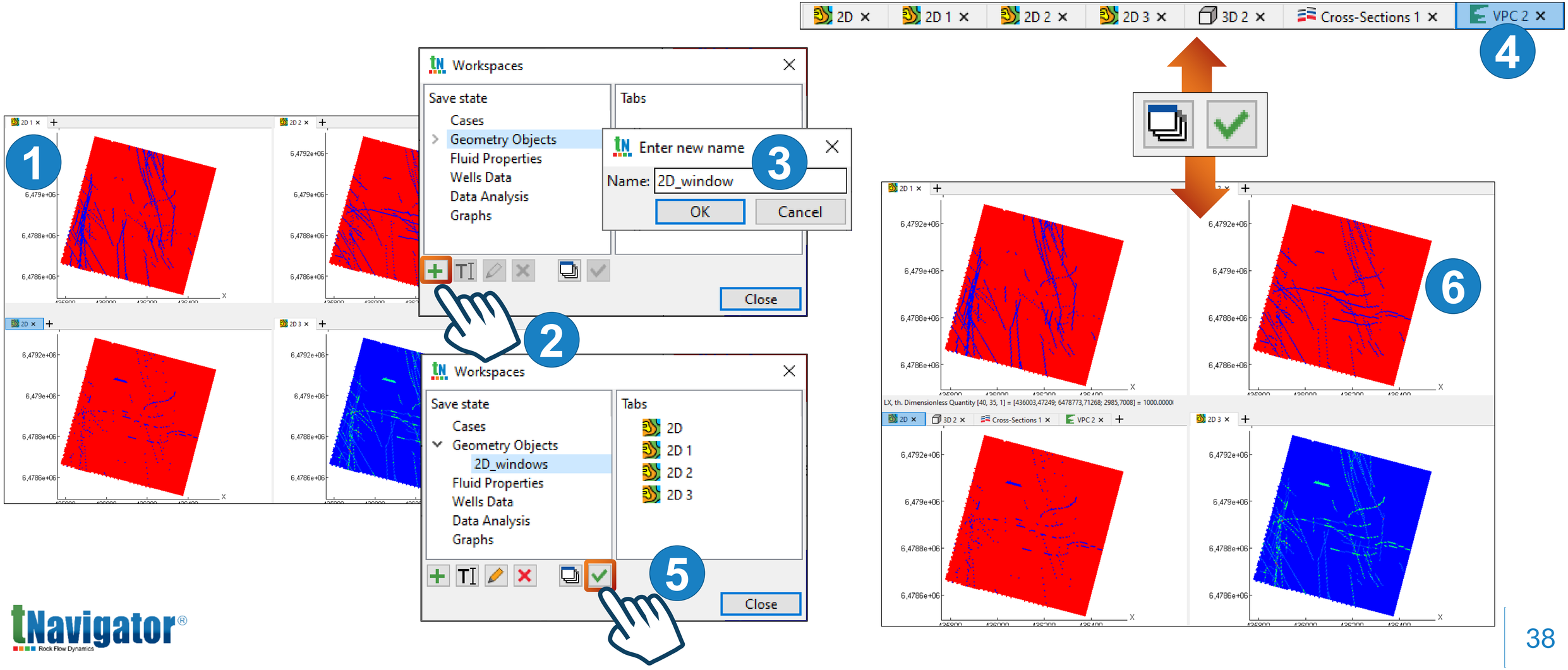
Controlling the position of visualization tabs

- It is now possible to enforce a uniform size upon the visualization tabs using the CTRL key



General: Workspaces

- **An option to save tab combinations in a project has been added: display all the necessary tabs in the project → View → Workspaces... → New State → Enter the name → Apply State**



Preview of data exchanging results

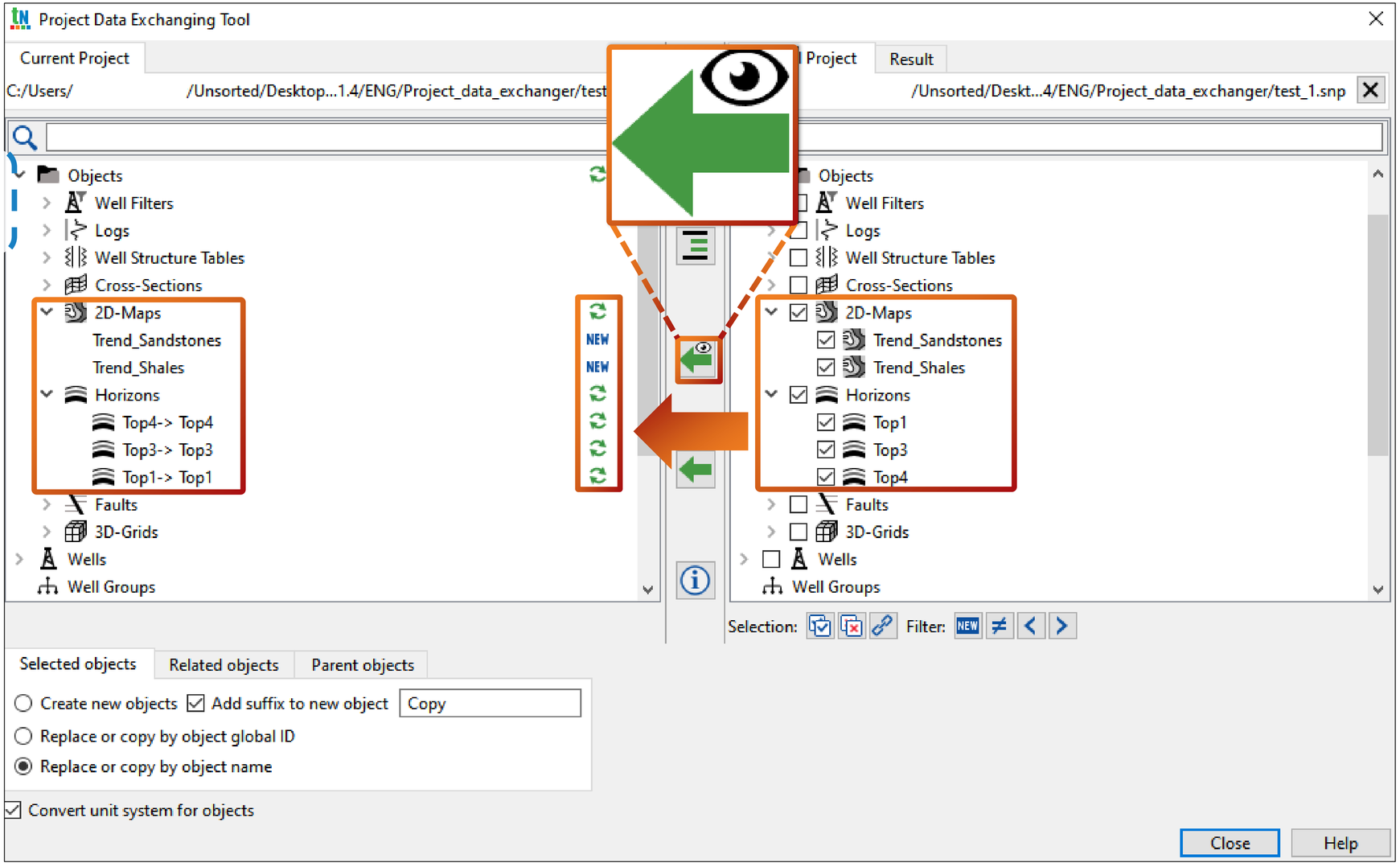
- After the objects for exchange have been selected, the user may activate the Preview option, which highlights the objects in the current project list of objects (Project → Project Data Exchanger → Preview)

An object is highlighted via the NEW icon if it has been added

If an object has been updated, it is highlighted with the icon

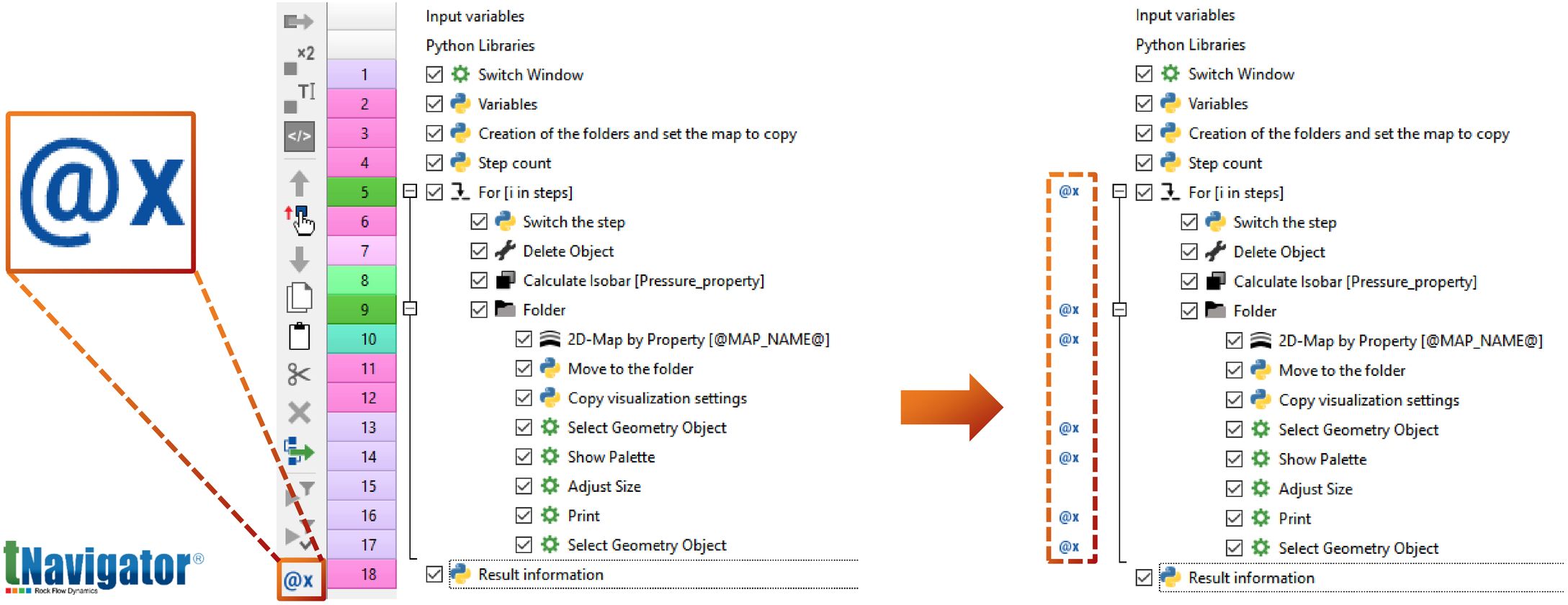
In the list of current project objects, the updated objects are displayed as two names in preview mode:

Top4-> Top4
Top3-> Top3
Top1-> Top1



Highlighting of workflow items with variables

- **Calculations containing local variables can now be highlighted in the workflow. The highlighting is implemented via the @x icon which symbolizes the variable (Calculations and Workflows → Show variables tooltip)**



Well Filters creation via Workflow

- **It is now possible to manage Well Filters in the workflow via Python functions. New functions allow creating and editing well filters (Custom Code → Well Filters → get_all_well_filters(), create_well_filter() etc.)**

For example, you can create a filter based on the presence of certain prefixes or postfixes in the well names

Well Filter
.add_tag (tag_class=<string>, tag=<string>)
.add_wells (wells=<optional<vector<wf_api_WELL_class>>>, wells_name=<optio
.add_wells_by_sufix (prefix=<optional<string>>, postfix
.clear_tags ()
.get_3d_bounds ()
.get_tags ()
.get_wells ()
.has_tag (tag_class=<string>, tag=<string>)
.is_empty ()
.name
.remove_tag (tag_class=<string>, tag=<string>)
.remove_wells (wells=<optional<vector<wf_api_WELL_c
create_well_filter (name=<string>, overwrite_existing=<
get_all_well_filters ()
get_all_well_filters_in_folder (folder=<string>)
get_well_filter_by_name (name=<string>)
well_filter_exists (name=<string>)

	Well Name
1	15_9-19B
2	15_9-19S
3	15_9-19_A
4	15_9-19_BT2
5	15_9-19_SR
6	15_9-F-1
7	15_9-F-10_Prod
8	15_9-F-11_PROD
9	15_9-F-11_A_PROD
10	15_9-F-11_B_PROD
11	15_9-F-11_T2_Production
12	15_9-F-12_prod
13	15_9-F-14_PROD

Custom code

Code editor

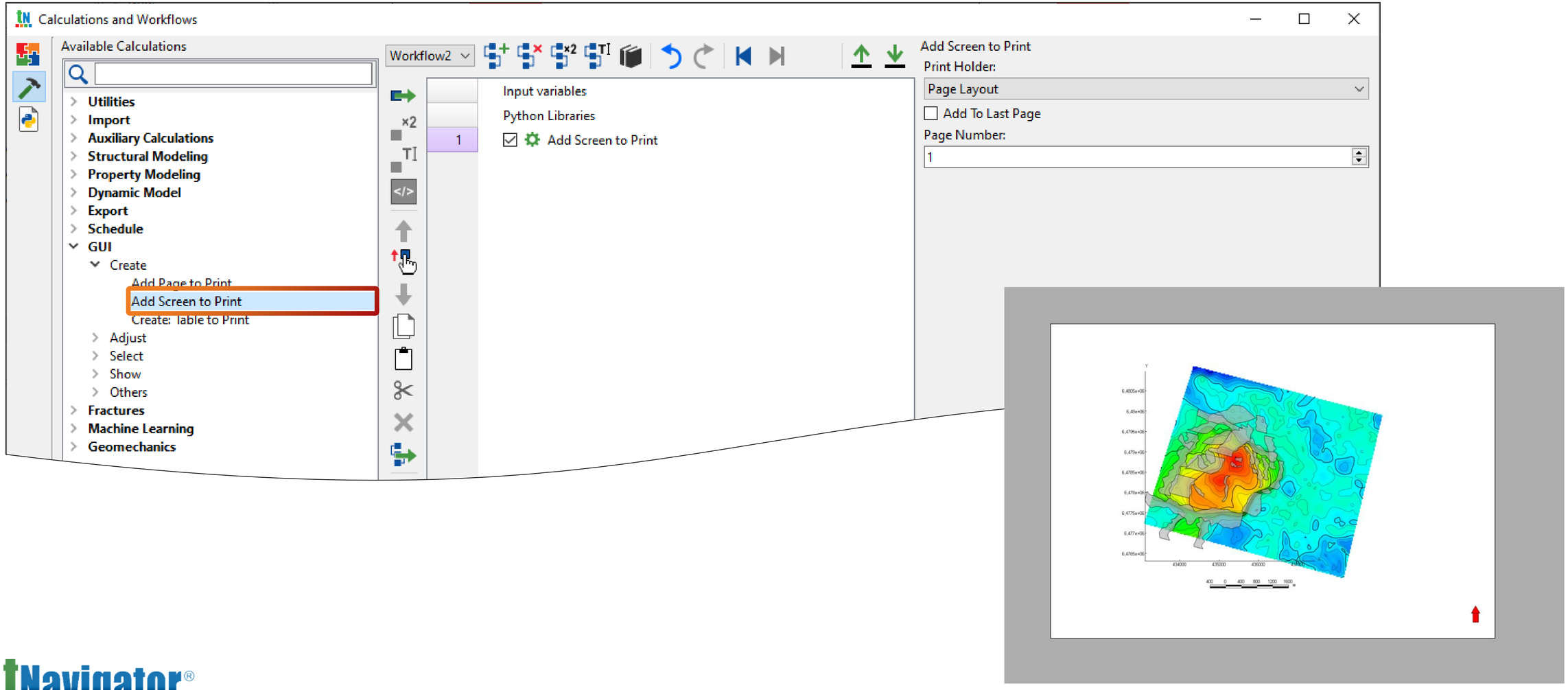
```
1  filter = create_well_filter (name='Production', overwrite_existing=True)
2
3  postfixes = ["PROD", "Prod", "Production", "prod"]
4
5  for i in postfixes:
6      filter.add_wells_by_sufix (postfix=i)
```

	Well Name
1	15_9-F-10_Prod
2	15_9-F-11_PROD
3	15_9-F-11_A_PROD
4	15_9-F-11_B_PROD
5	15_9-F-11_T2_Production
6	15_9-F-12_prod
7	15_9-F-14_PROD

tNavigator® Rock Flow Dynamics

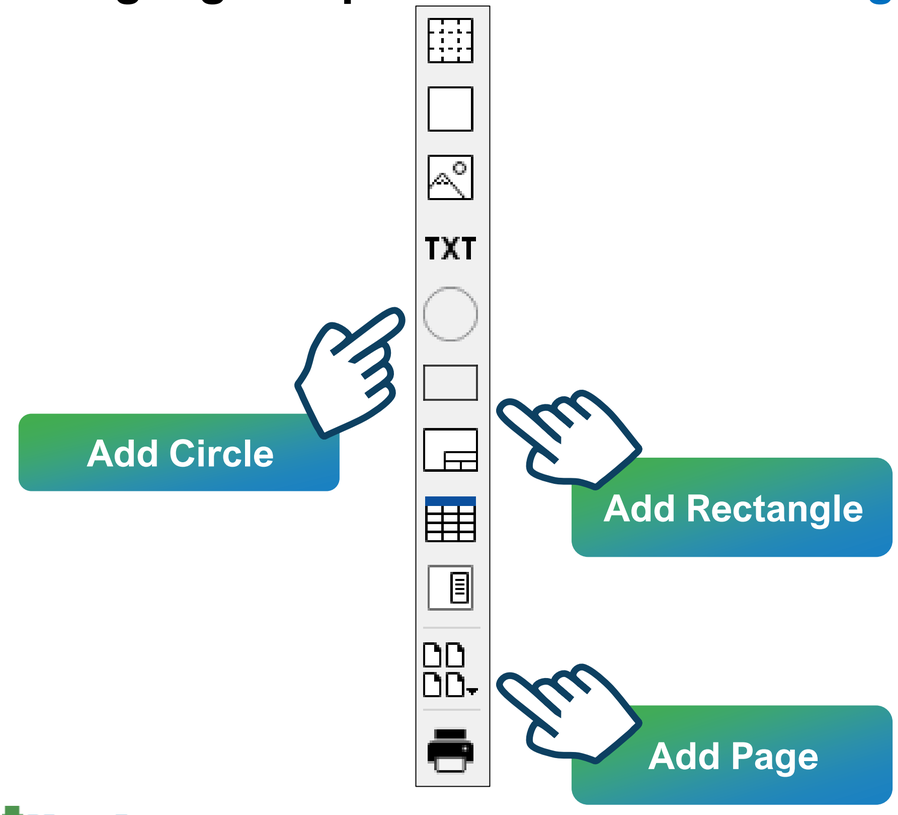
Page Layout: add a screenshot via Workflow

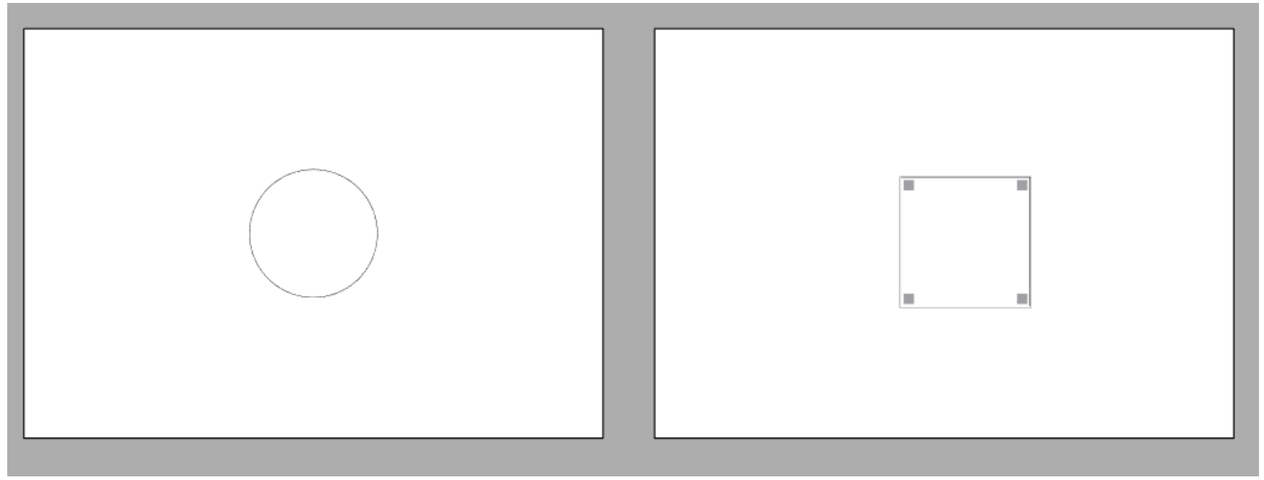
- **An option to add the screenshot of the current tab into the Page layout window via a workflow has been added: Calculations and Workflows → GUI → Create → Add Screen to Print**



Page Layout: Page, Circle, Rectangle

- It is now possible to create Page Layout with several pages: Page Layout → Pages Operations → Add Page
- It is now possible to draw circles and rectangles in the Page Layout window. These options can be used to highlight important information: Page Layout → Add Circle/Add Rectangle

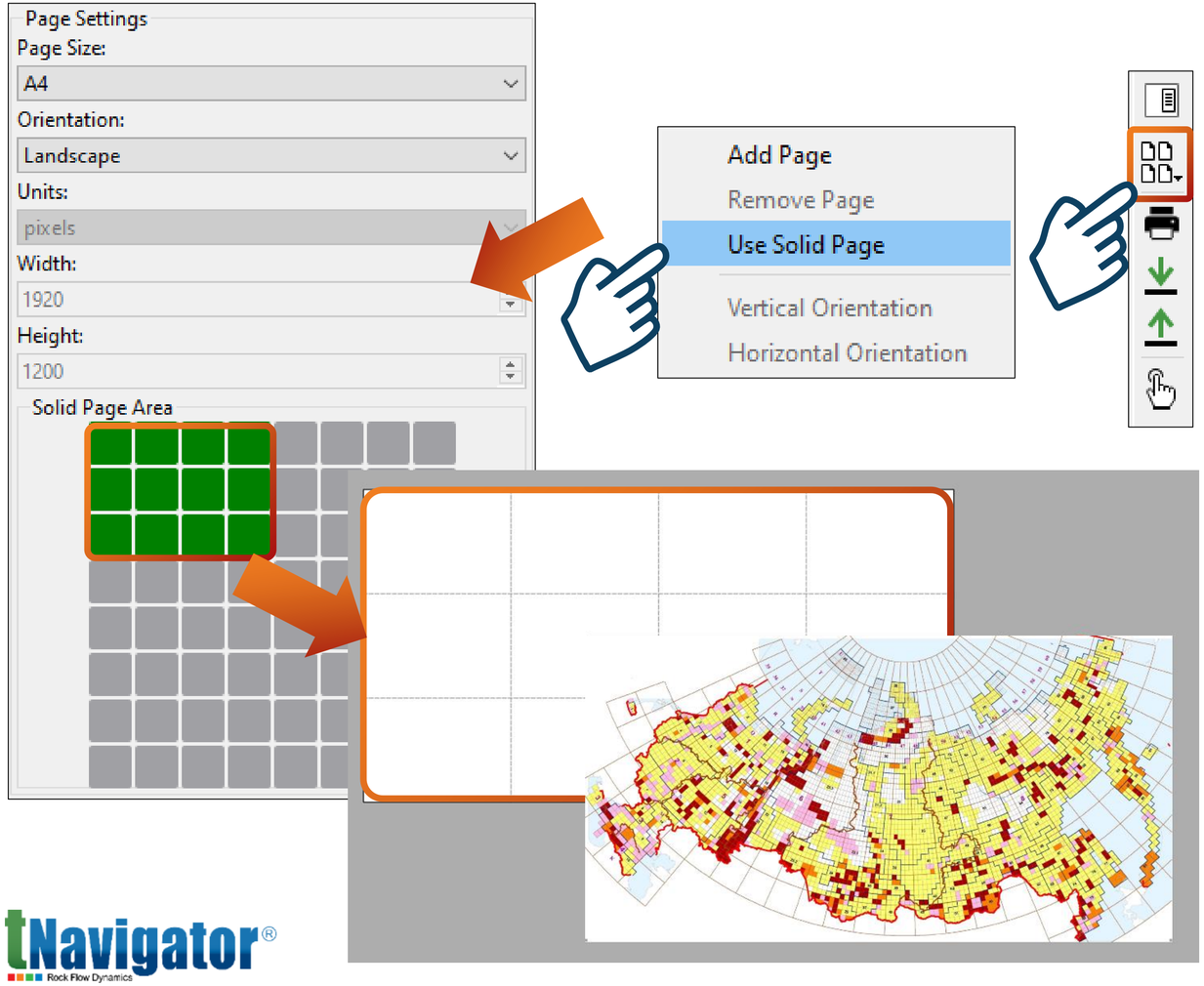


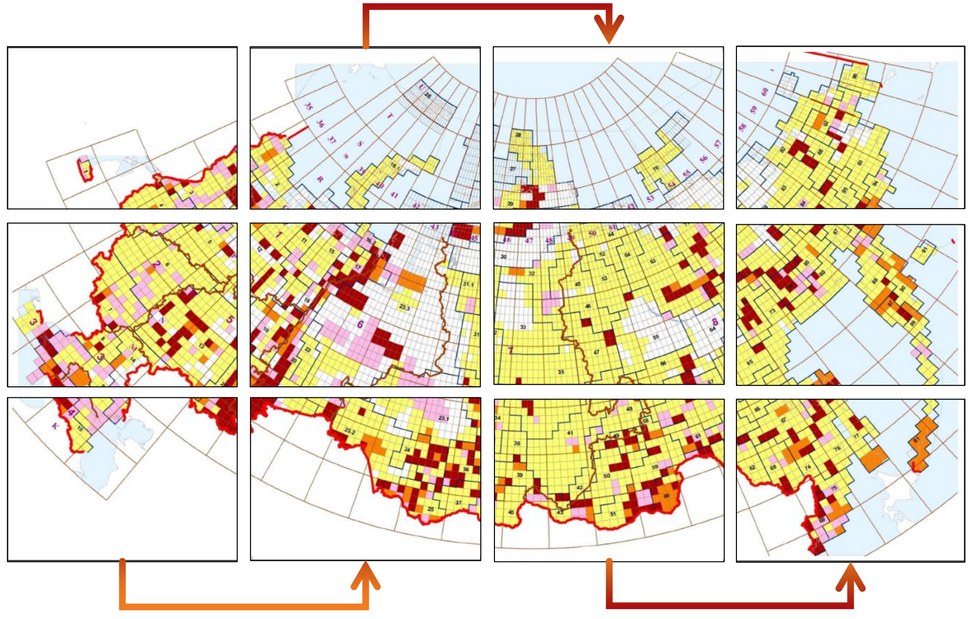


Page Layout: Multi-page print

- **An advantage of this feature is that maps of any format can be printed using a simple A4 printer:**

  Page Layout → Pages Operations → Use Solid Page → Settings → Solid Page Area





Updated Log Panel

tNavigator® Rock Flow Dynamics

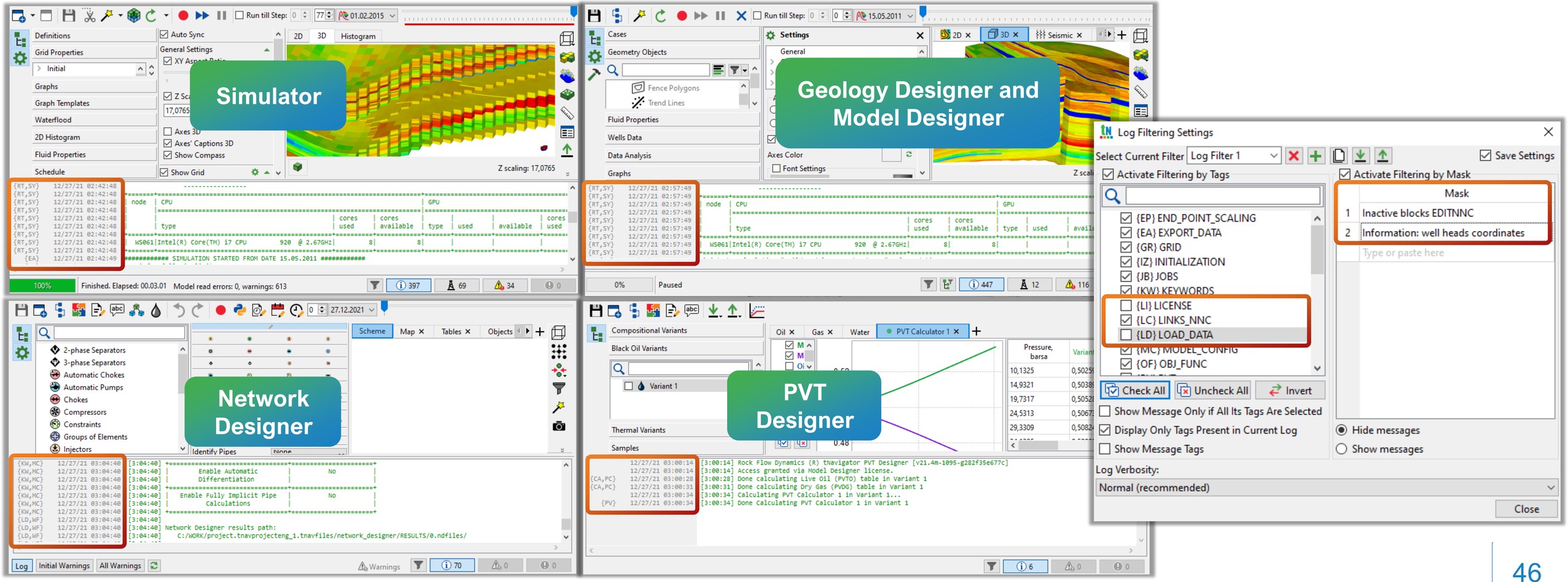
Contents

The following options are now supported:

- A common view of the log panel with an option to search and filter messages by tags or mask is now supported for all tNavigator modules: Simulator, Geology Designer, Model Designer, Network Designer, PVT Designer, etc.
- Message prefixes visualization (step, day, date, time);
- Displaying information about dates and well names in error messages;
- Clearing the log panel from all messages;
- Changing message colors;
- Output of log messages from several modules at the same time.

Common view of the log panel for tNavigator modules

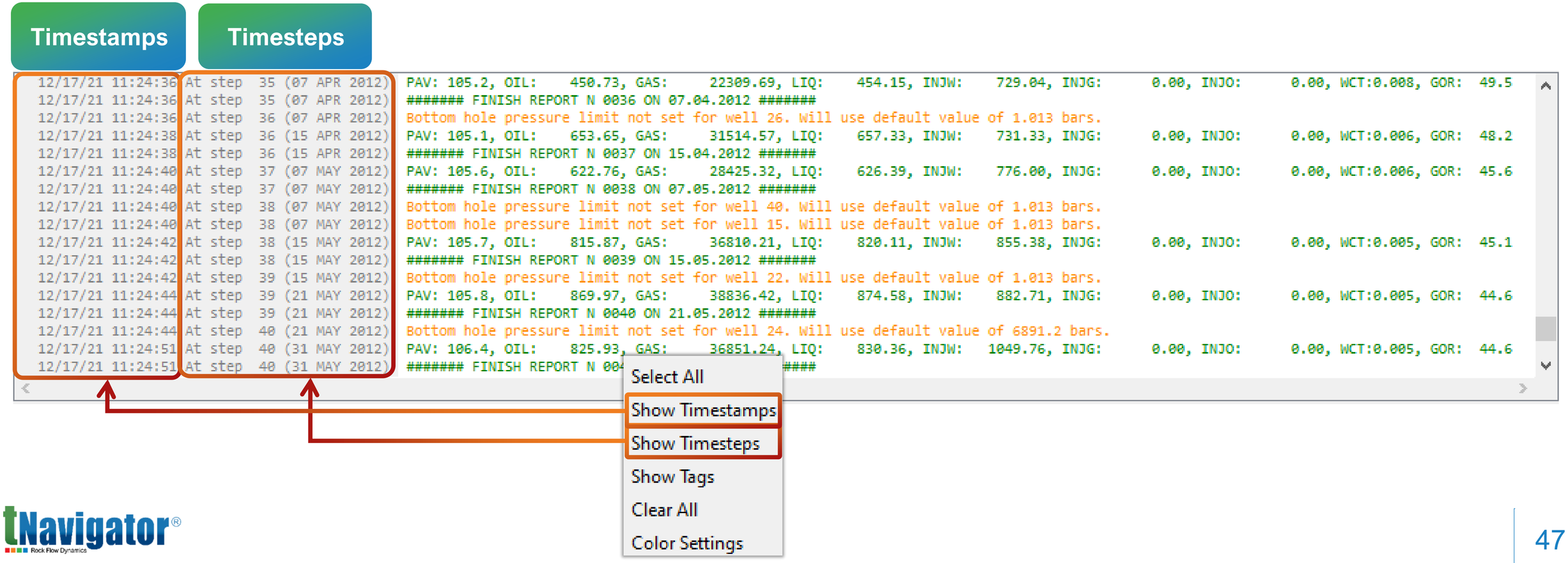
- **A common view of the log panel with an option to search and filter messages by tags or mask is now supported for all tNavigator modules: Simulator, Geology Designer, Model Designer, Network Designer, PVT Designer, etc.**



Message prefixes visualization in the log panel

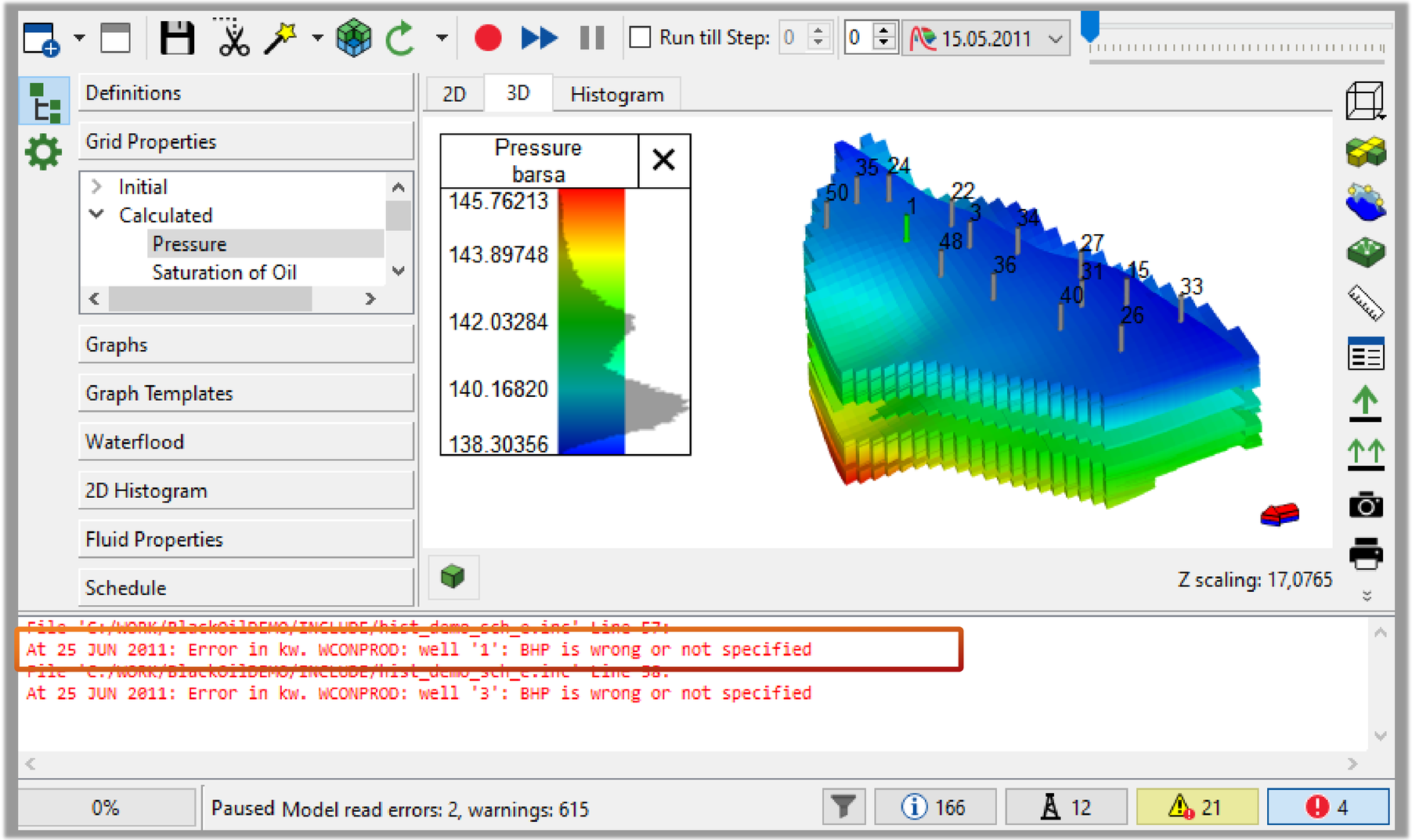
- **Blocks for message prefixes (step, day, date, time) are now visualized. The format settings of message prefixes can be changed using the REPORTFILE and REPORTSCREEN keywords**

  (Log panel → Right-click → Show Timestamps/Show timesteps)



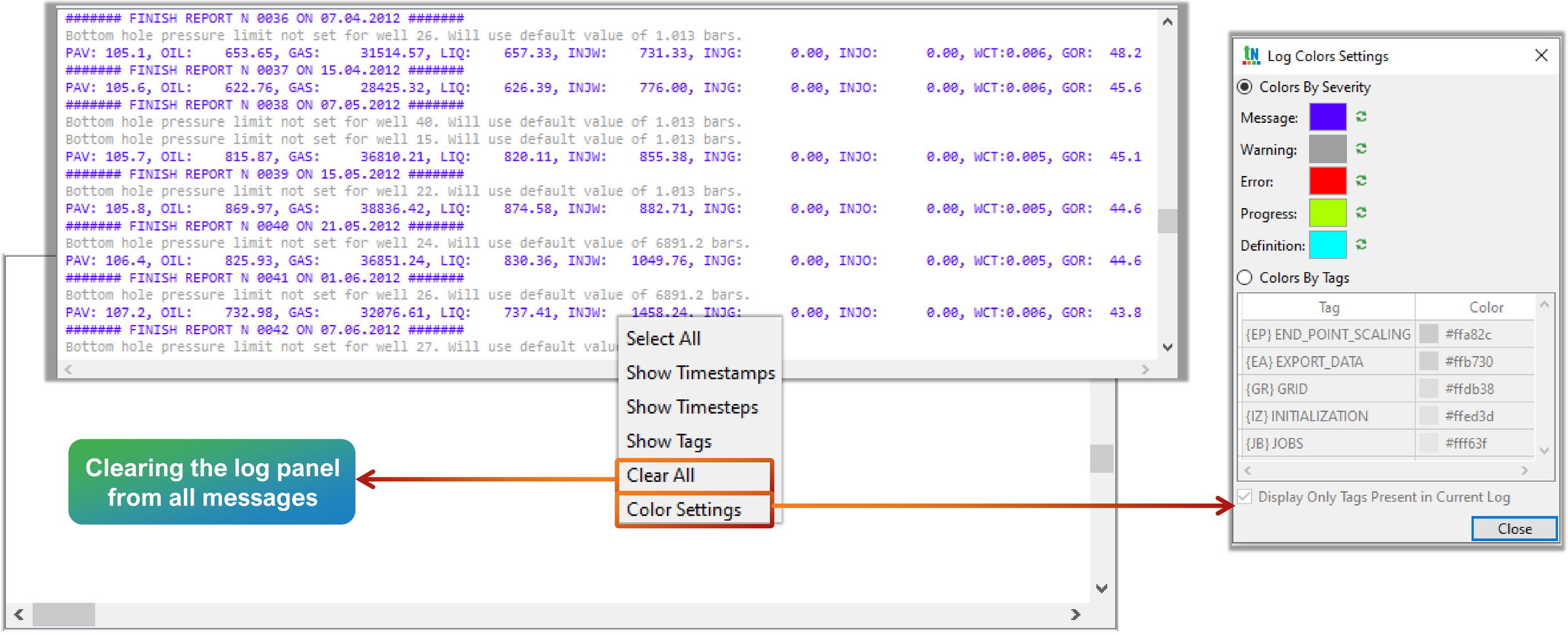
Error messages detailing

- **Information about dates and well names is now visualized in error messages for the keywords of the SCHEDULE section**



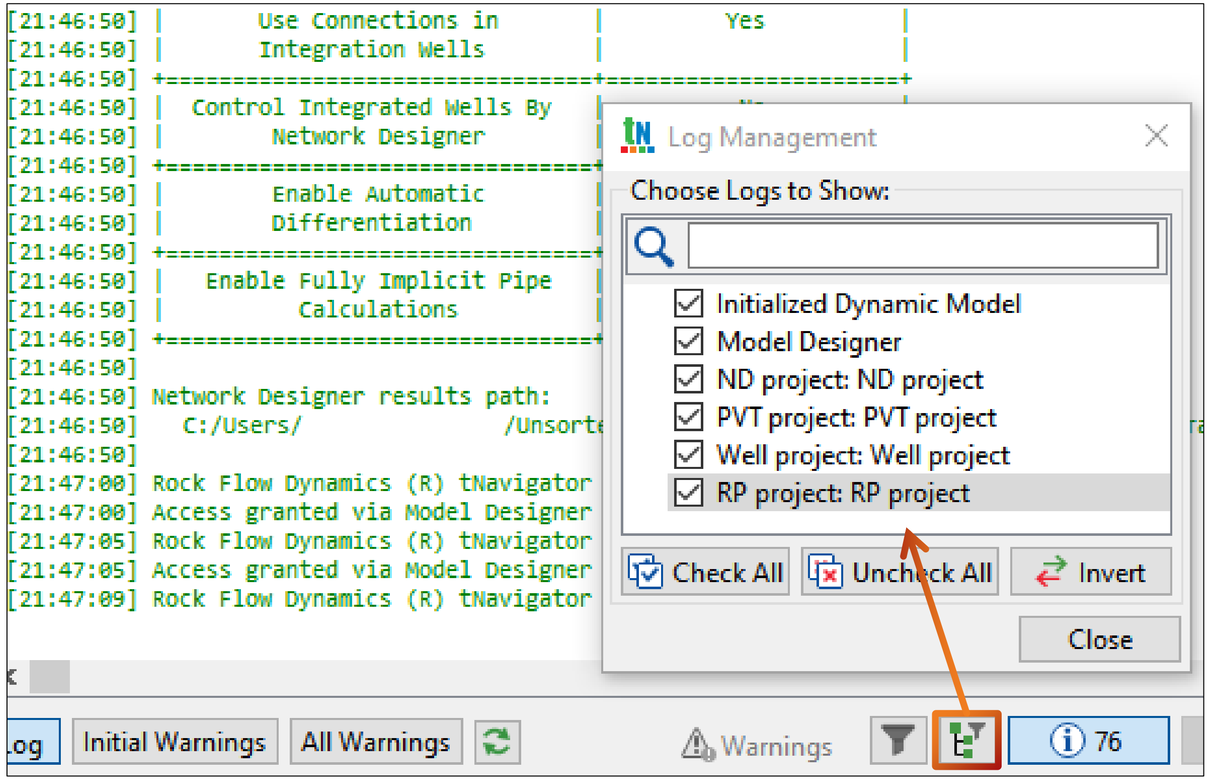
Change the color of messages and clear the log panel

- **All messages can now be cleaned off of the log panel (Log panel → Right-click → Clear All)**
- **The colors of messages (warnings, errors, etc.) in the log panel can now be edited (Log panel → Right-click → Color Settings)**

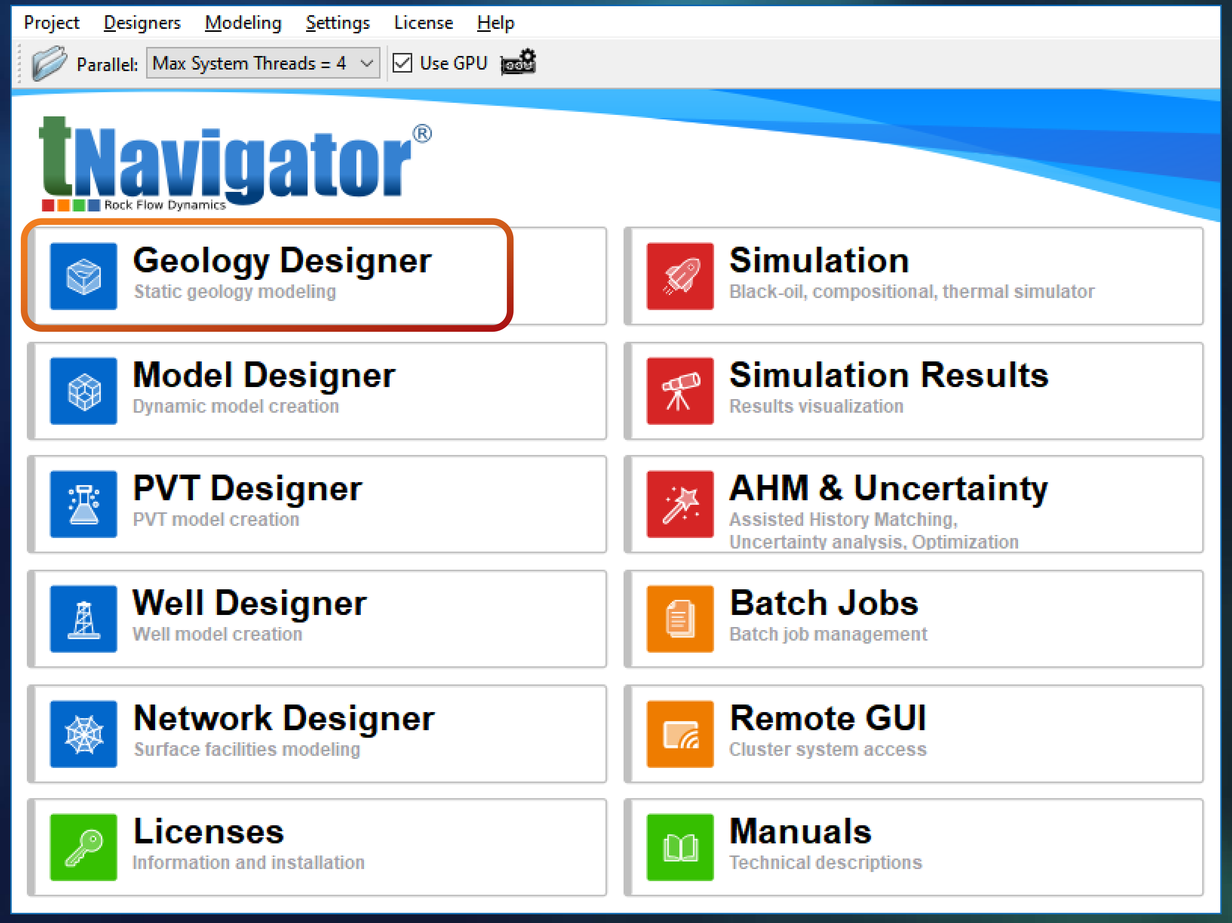


Log messages from several modules simultaneously

- It is now possible to output log messages from several modules simultaneously. The user can now select modules whose logs will be displayed in the log panel: Geology Designer, Model Designer, PVT Designer, Well Designer or Network Designer. This option is applicable to work with integrated models in Project Manager (Project Window → Log Management)

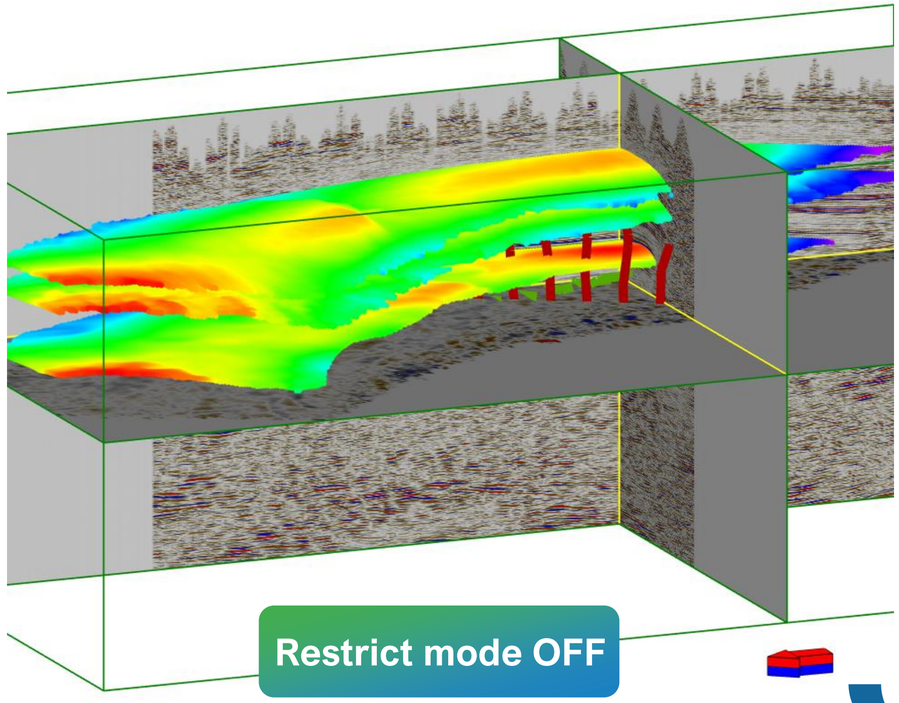


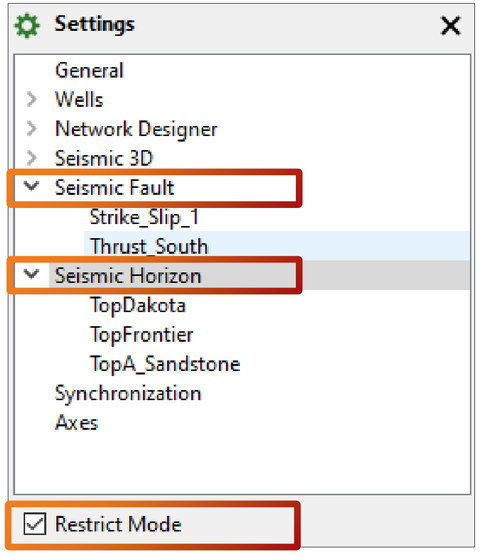
Geology Designer

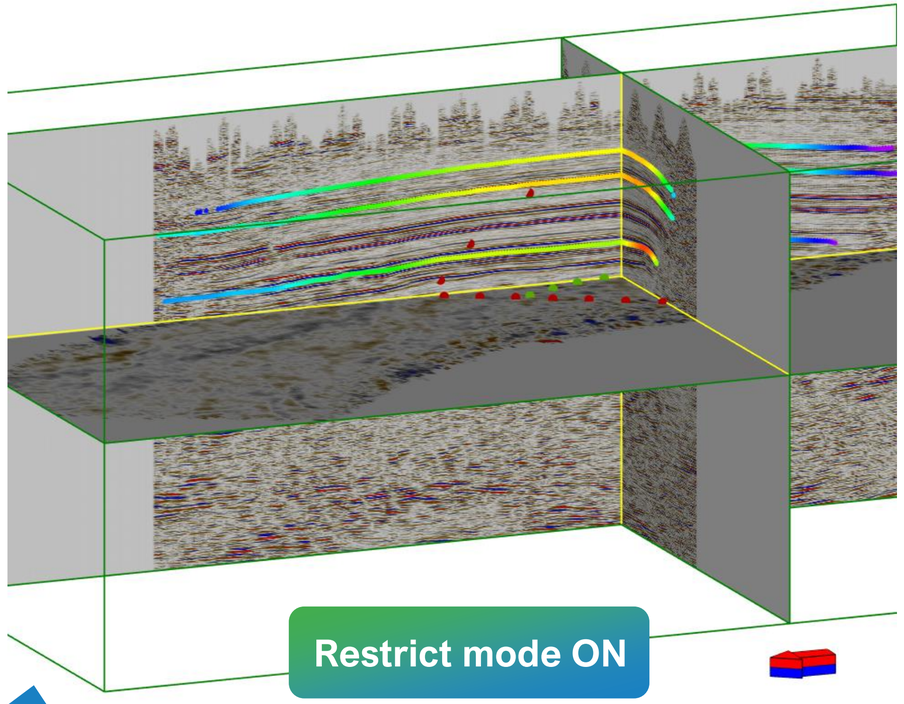


Restrict Mode for seismic horizons and faults

- **Restrict Mode has been added for visualization of seismic horizons and faults only at the intersections with the seismic data displayed in the 3D tab (3D tab → Settings → Seismic Fault and Horizon → Restrict Mode)**



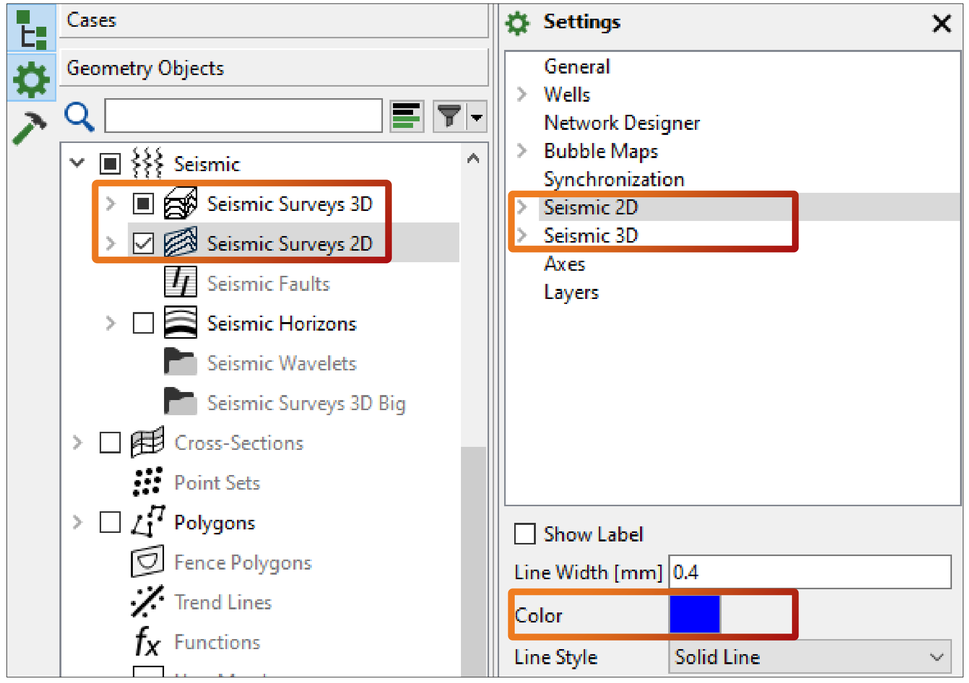


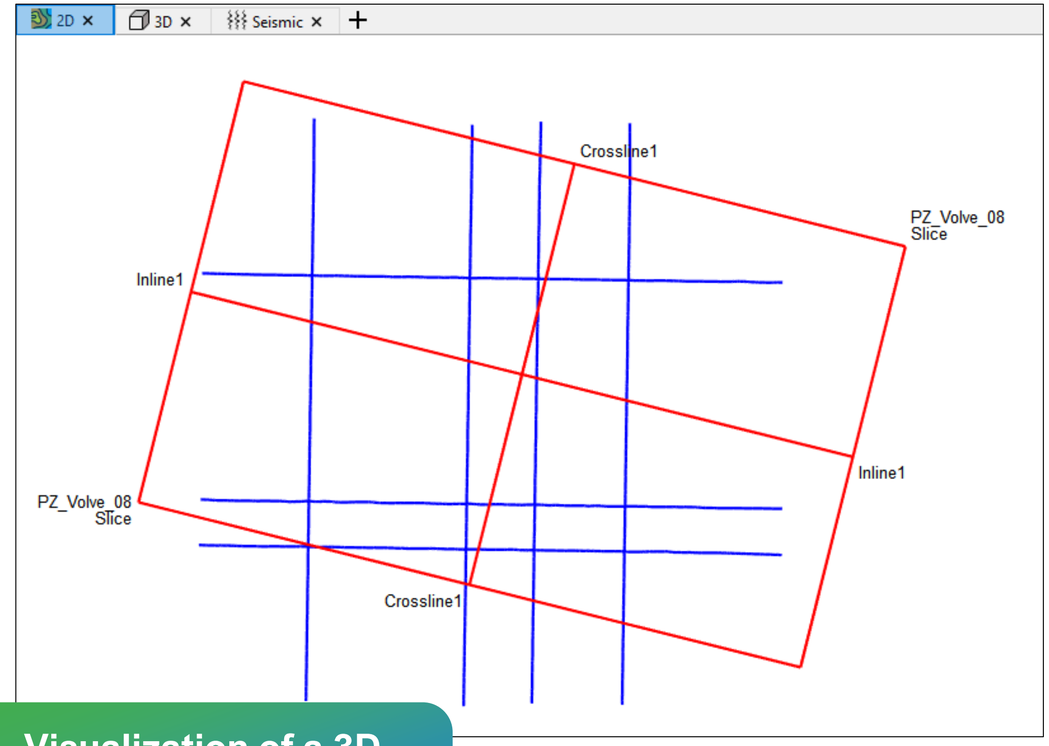


Color management of 2D and 3D surveys in the 2D tab

- **2D and 3D seismic surveys can now be simultaneously displayed in the 2D window in different colors**

  (2D tab → Settings → Seismic 2D/3D→ Color)



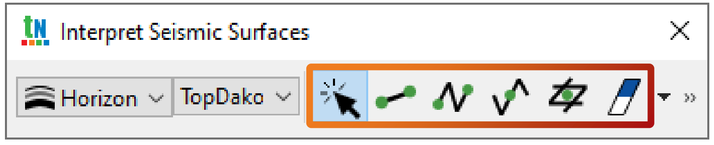


Visualization of a 3D survey and 2D seismic lines with different colors

Hotkeys for seismic data interpretation

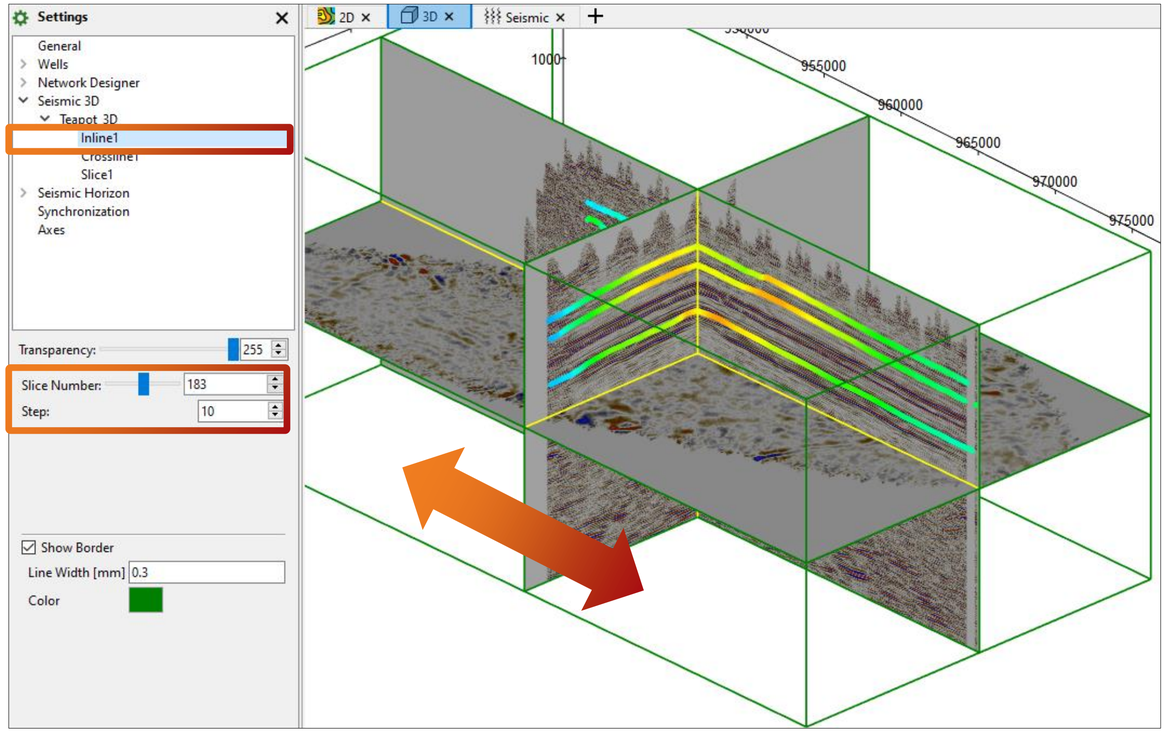
- **Hotkeys to work with seismic data have been added**
- **The following hotkeys can be used in the 3D tab:**

- **[M]** enables the Move Seismic Slice optio 
- **[I]** opens the Interpret Seismic Surfaces menu 
- **[1-6]** activates the corresponding tool of the menu



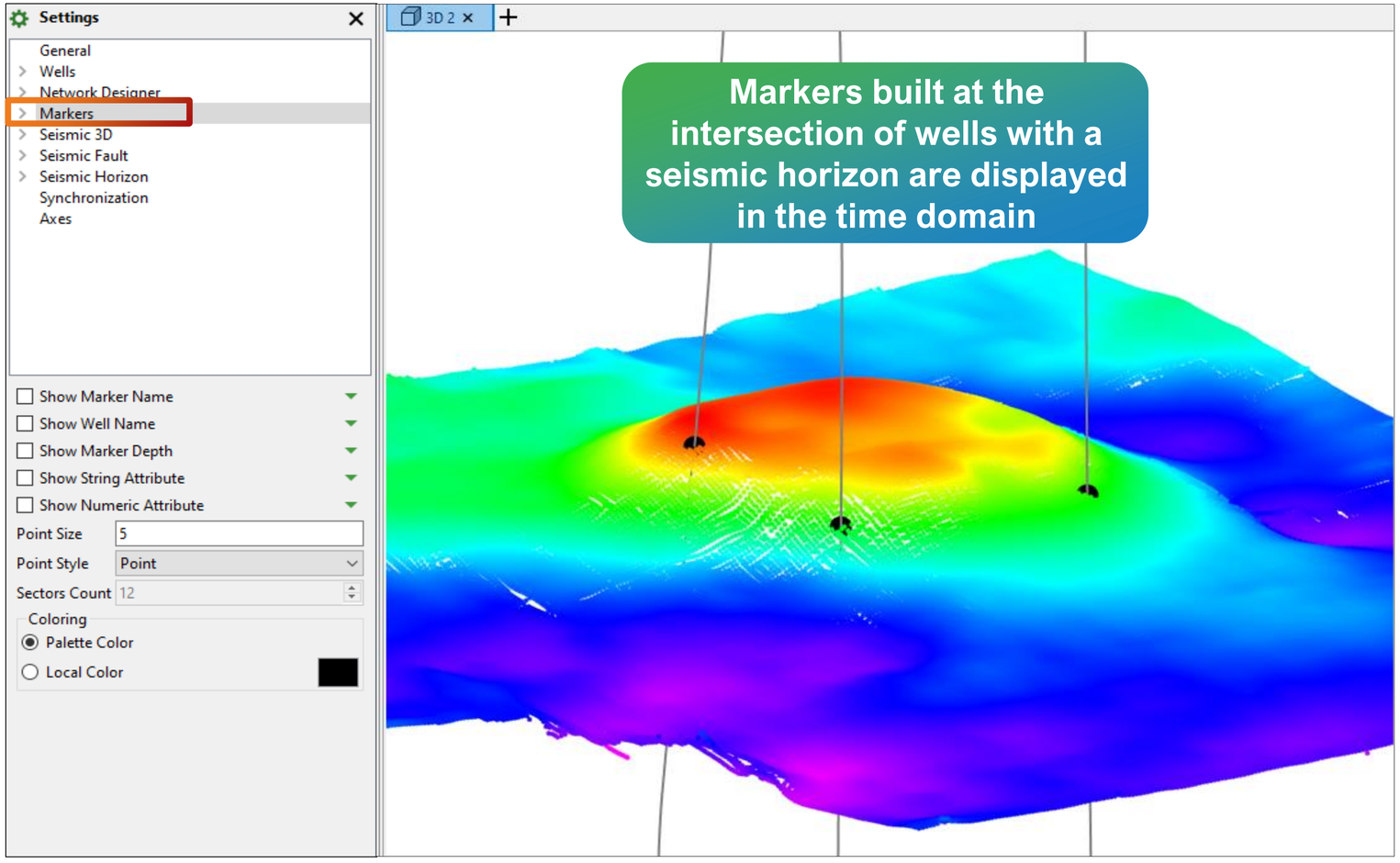
Hotkeys for seismic data interpretation

- Hotkeys to work with seismic data have been added
- The combination of the left/right arrow keys with Ctrl allows moving Inlines, Crosslines and Slices by a specified step in the Seismic tab, as well as in the 3D window for the direction selected in the Settings window



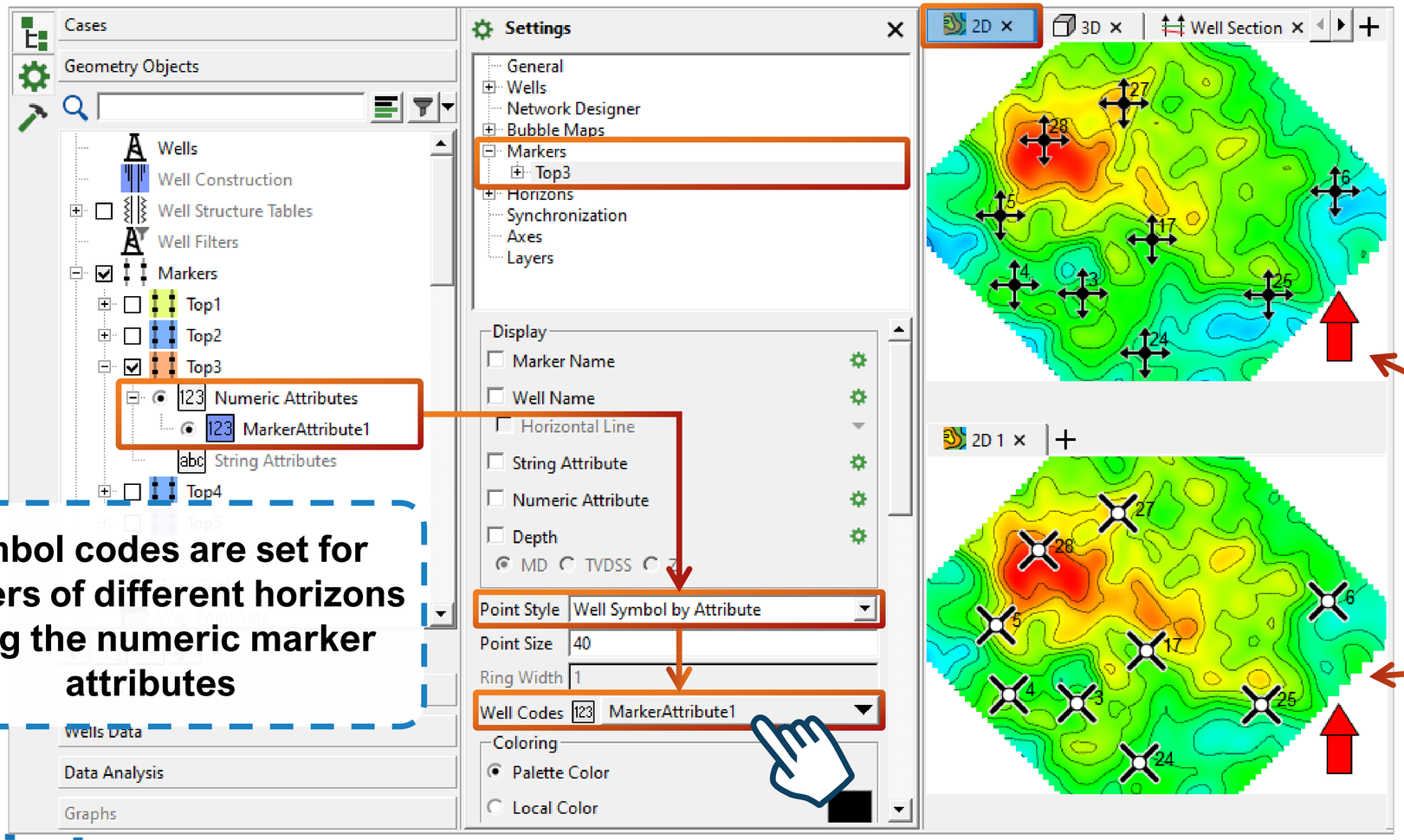
Markers creation by seismic horizon

- **A calculation to create markers at the intersection of well trajectories with seismic horizons has been added (Markers → Calculations → Build Marker by Seismic Horizon)**



Well symbols control for markers in the 2D tab

- **Well symbols can be set for markers using the numeric marker attributes, for example unique well symbols for different horizons in the 2D tab**

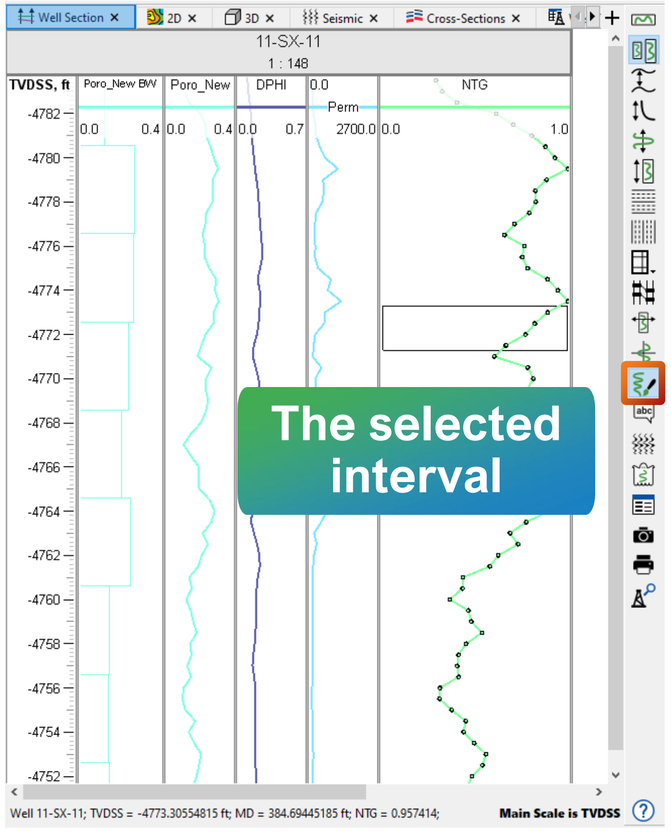


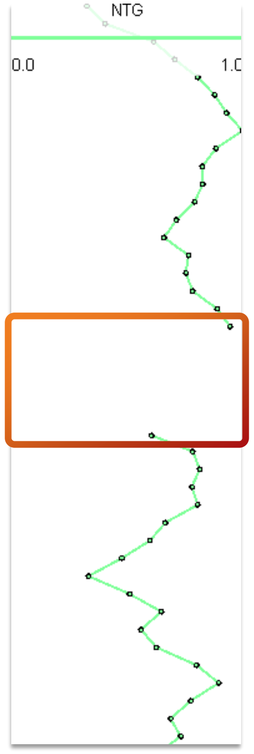
Symbol codes are set for markers of different horizons using the numeric marker attributes

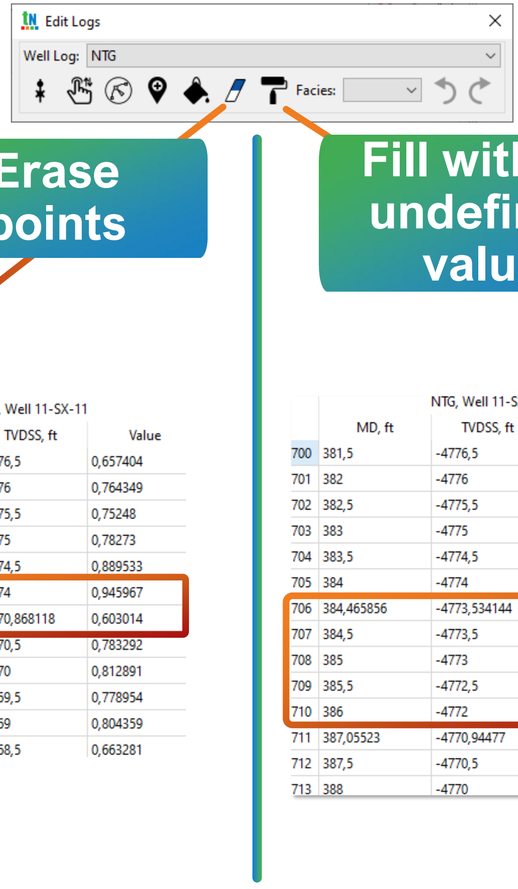
Interactive eraser for well logs

- **Manually delete a part of a well log curve in the Well Section tab**
- **Delete points or fill them with an undefined value**

Well Section → Right toolbar → Edit Well Logs → Erase Points





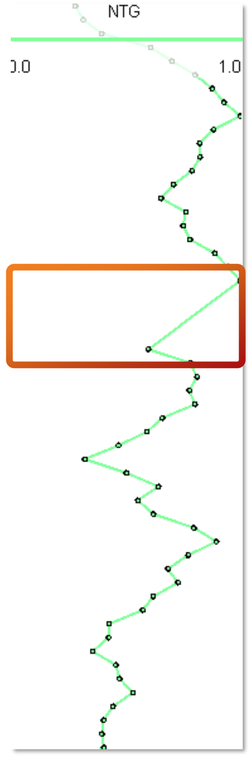


NTG, Well 11-SX-11

	MD, ft	TVDSS, ft	Value
700	381,5	-4776,5	0,657404
701	382	-4776	0,764349
702	382,5	-4775,5	0,75248
703	383	-4775	0,78273
704	383,5	-4774,5	0,889533
705	384	-4774	0,945967
706	387,131882	-4770,868118	0,603014
707	387,5	-4770,5	0,783292
708	388	-4770	0,812891
709	388,5	-4769,5	0,778954
710	389	-4769	0,804359
711	389,5	-4768,5	0,663281

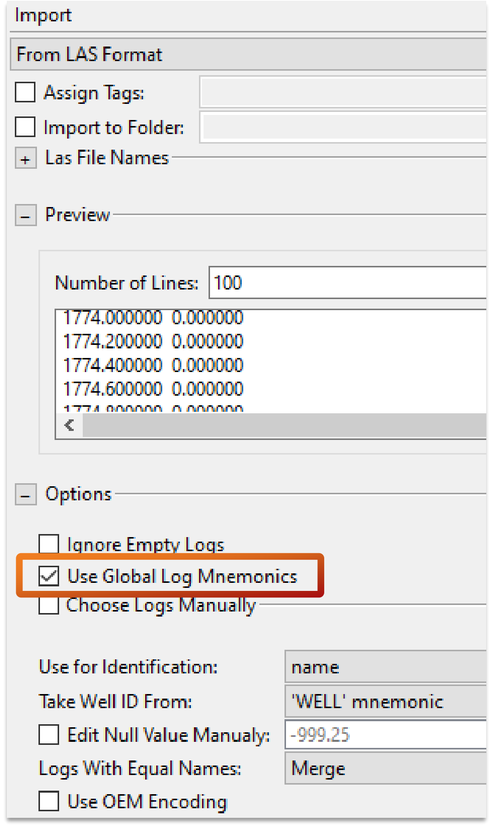
NTG, Well 11-SX-11

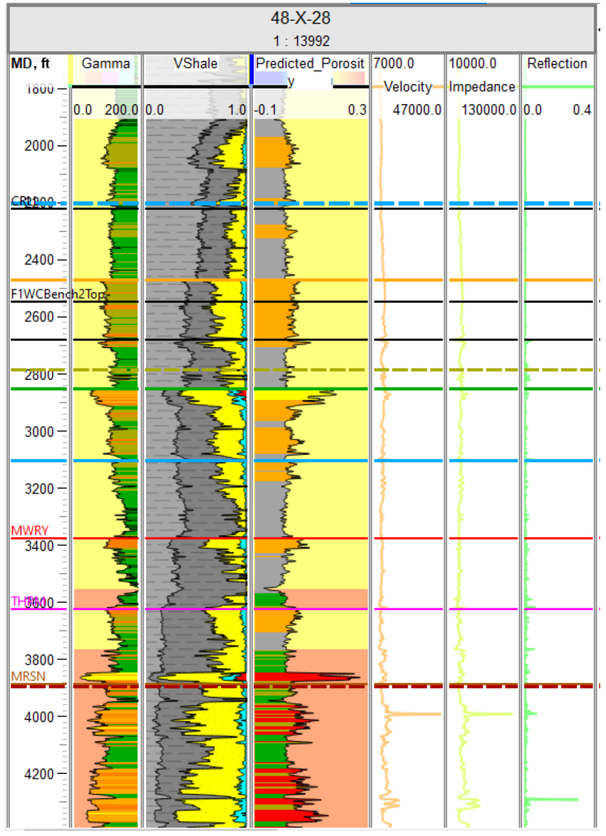
	MD, ft	TVDSS, ft	Value
700	381,5	-4776,5	0,657404
701	382	-4776	0,764349
702	382,5	-4775,5	0,75248
703	383	-4775	0,78273
704	383,5	-4774,5	0,889533
705	384	-4774	0,945967
706	384,465856	-4773,534144	
707	384,5	-4773,5	
708	385	-4773	
709	385,5	-4772,5	
710	386	-4772	
711	387,05523	-4770,94477	0,603014
712	387,5	-4770,5	0,783292
713	388	-4770	0,812891



Well logs mnemonics during their import

- Set a custom name for each imported well log, different from the name indicated in the file.
- May be useful when you routinely need to rename loaded well logs (e.g., Gamma Ray to GR, GAMM or GK) (Logs → Calculations → Import → Use Global Log Mnemonics)

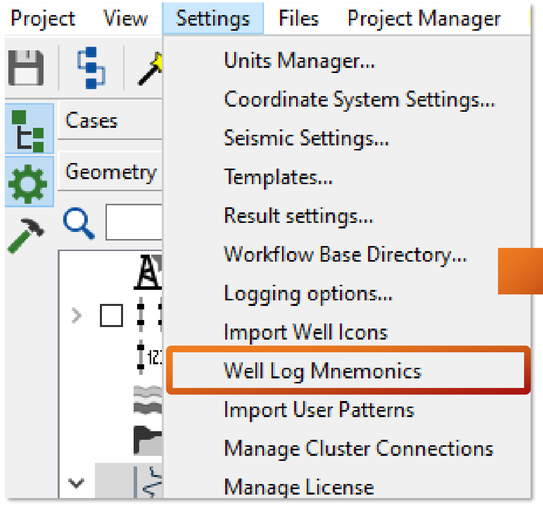


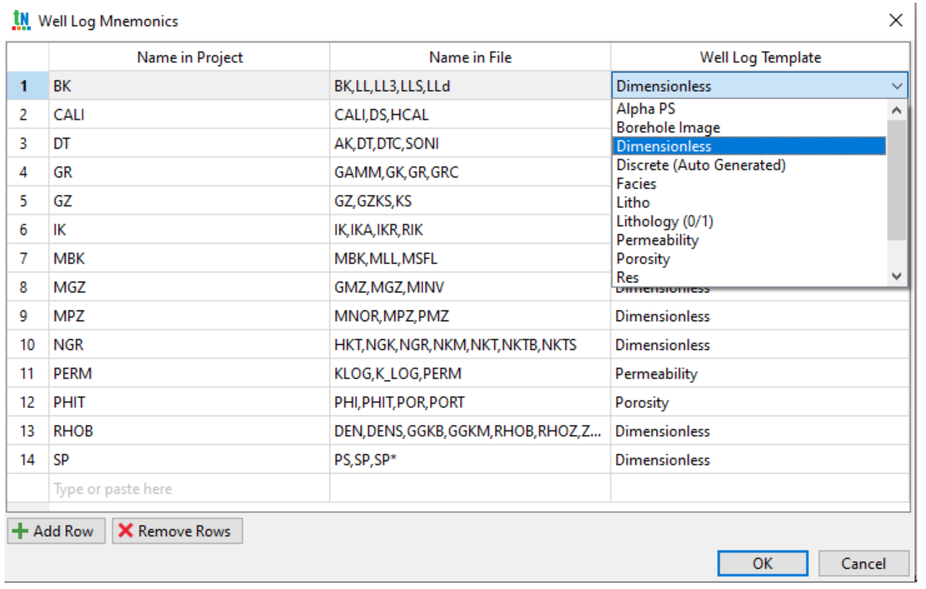


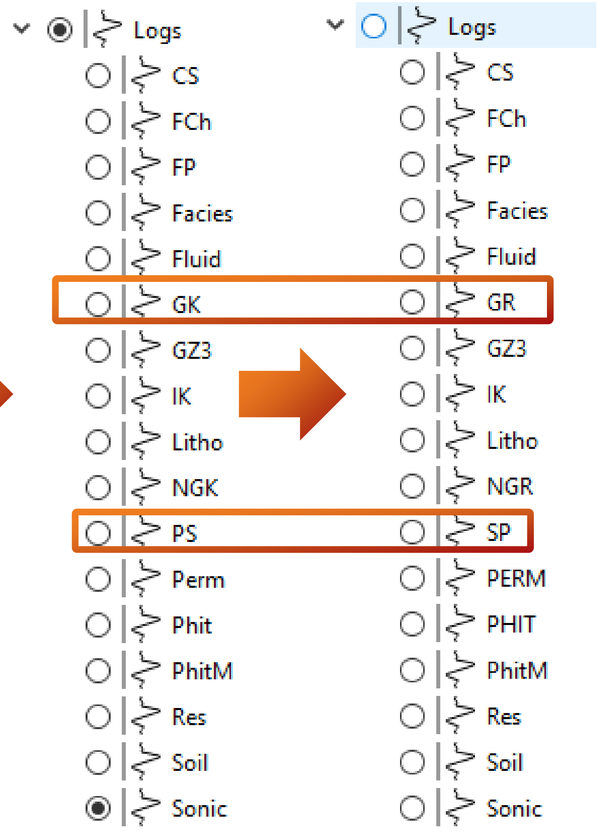
Well logs mnemonics during their import

- **A dictionary of log names (mnemonics) can be predefined and applied to all imported logs**

  (Settings → Well Log Mnemonics)







Set custom names or use the existing mnemonic dictionary

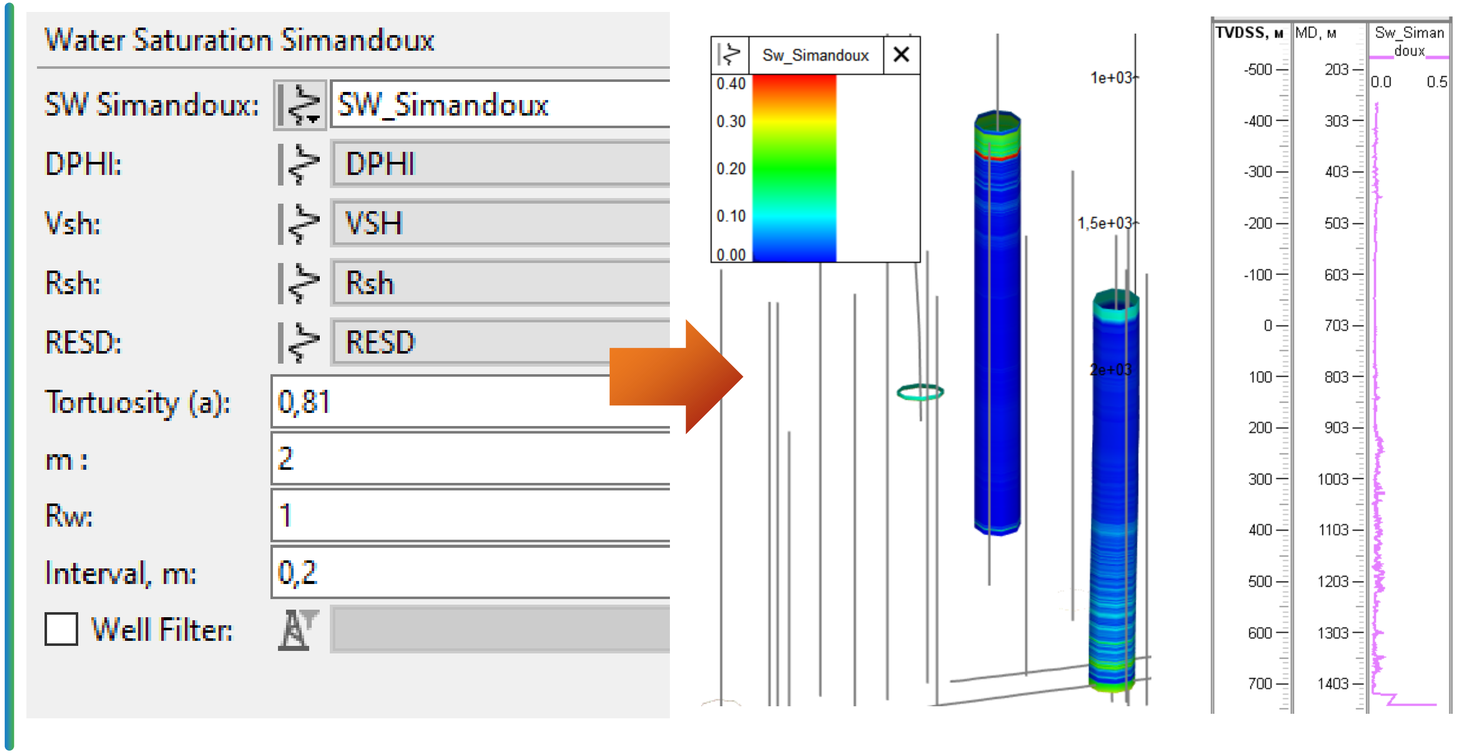
Water saturation logs based on the Simandoux equation

- **Water saturation logs based on the Simandoux equation**

  (Logs → Calculations → Water Saturation Simandoux)

$$SW_{Simandoux} = \frac{a.Rw}{2.\Phi^m} * \left(\sqrt{\left(\frac{Vsh}{Rsh}\right)^2 + \frac{4\phi^m}{a.Rw.Rt}} - \frac{Vsh}{Rsh}\right)$$

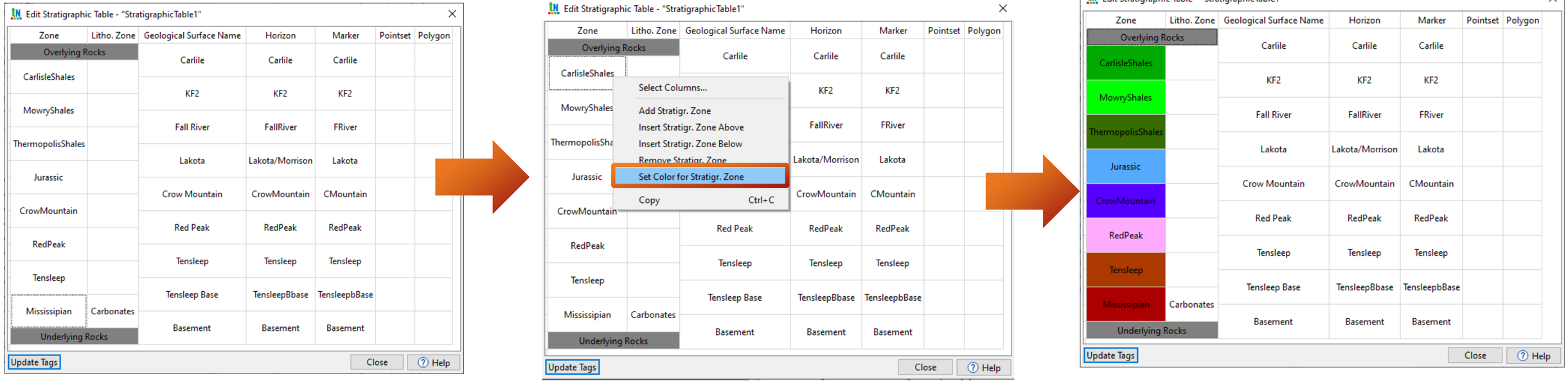
a: a constant based on lithology
m: a constant based on lithology
phi: the DPHI log is used
Vsh: the shale volume log is used
Rt: the formation resistivity
Rw: the formation water resistivity (a constant obtained via local well measurement)
Rsh: the resistivity of shale in the formation (taken from the formation resistivity at the highest Vsh value in each well)



Color filling by a Stratigraphic table

- **Visualization of color filling between markers for all wells in the well section tab is now available. To display the color filling, a Stratigraphic Table with the required markers must be created beforehand**

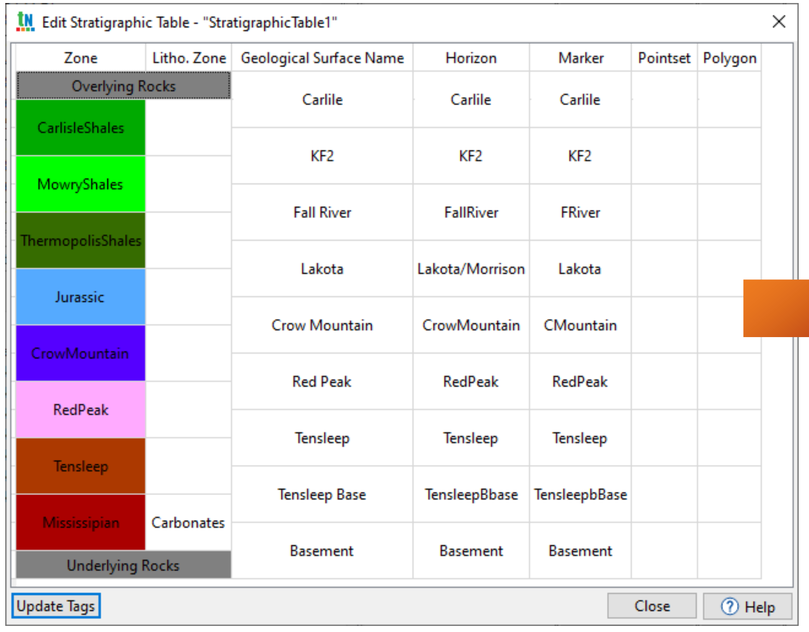
  Stratigraphic Table → Create → Edit Stratigraphic Table → the Well Section tab → check the created table in the object tree.

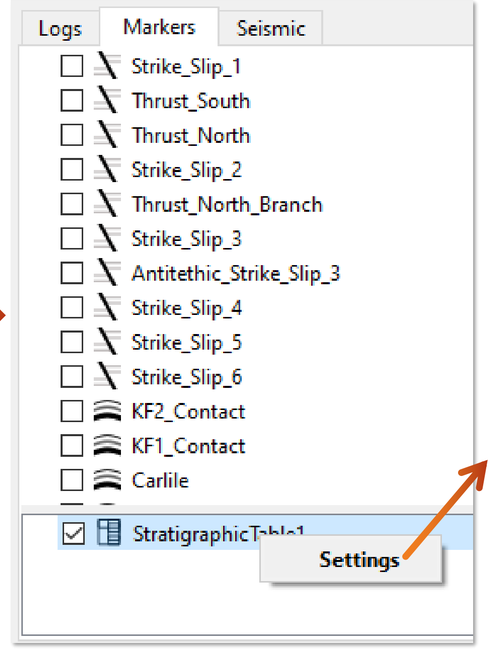


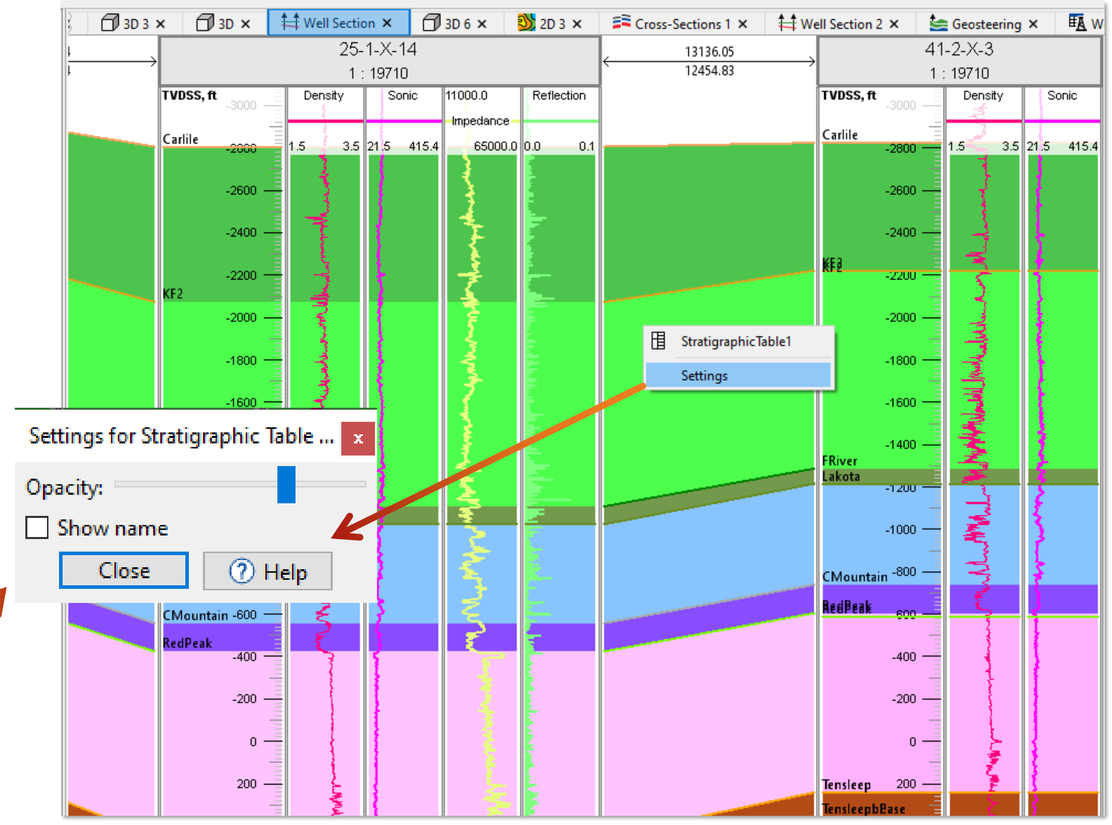
Color filling by a Stratigraphic table

- **Visualization of color filling between markers for all wells in the well section tab is now available. To display the color filling, a Stratigraphic Table with the required markers must be created beforehand**

  Stratigraphic Table → Create → Edit Stratigraphic Table → the Well Section tab → check the created table in the object tree.

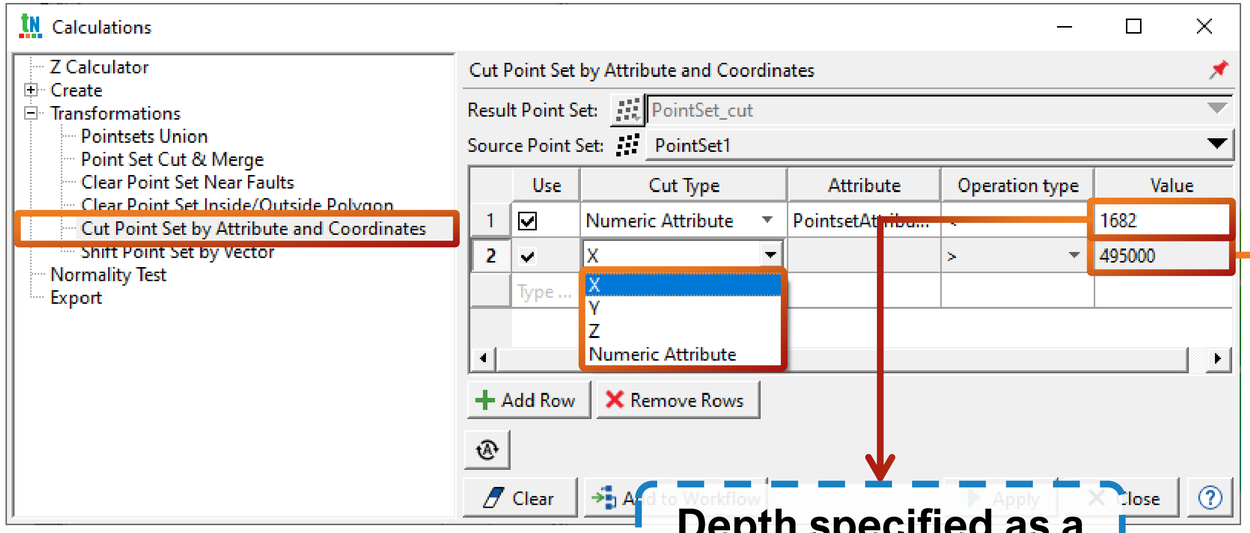






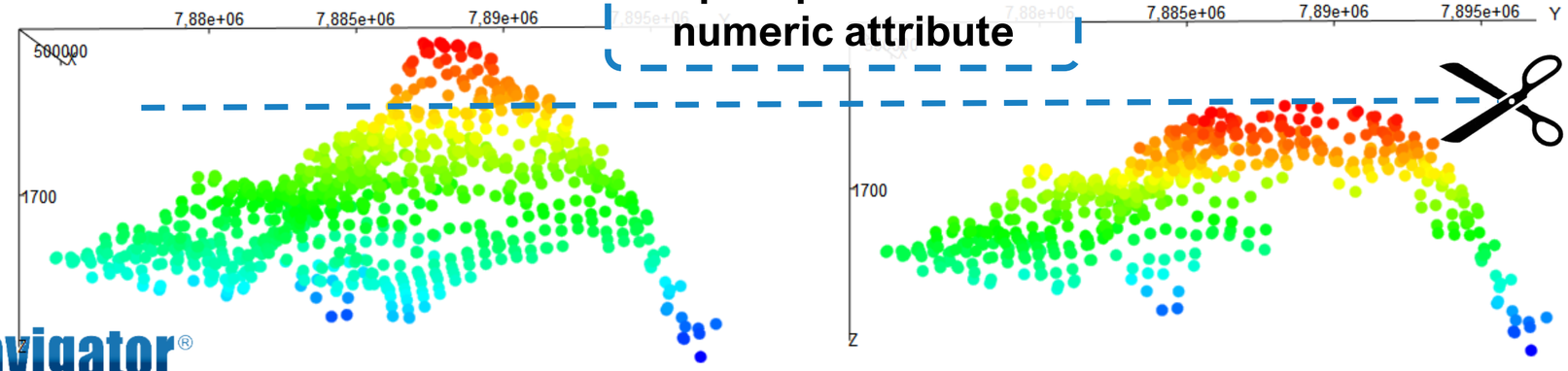
Point Set filtering

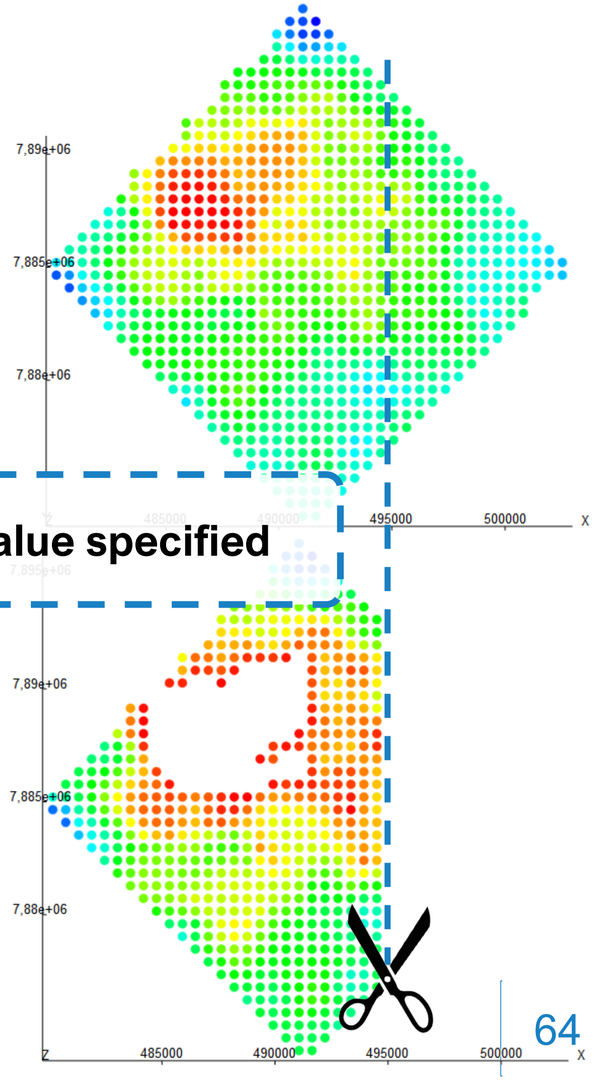
- **A calculation titled Cut Point Set by Attribute and Coordinates has been added. It allows filtering points by coordinates and/or by numeric attributes (Point Sets → Calculations → Transformations → Cut Point Set by Attribute and Coordinates)**



Depth specified as a numeric attribute

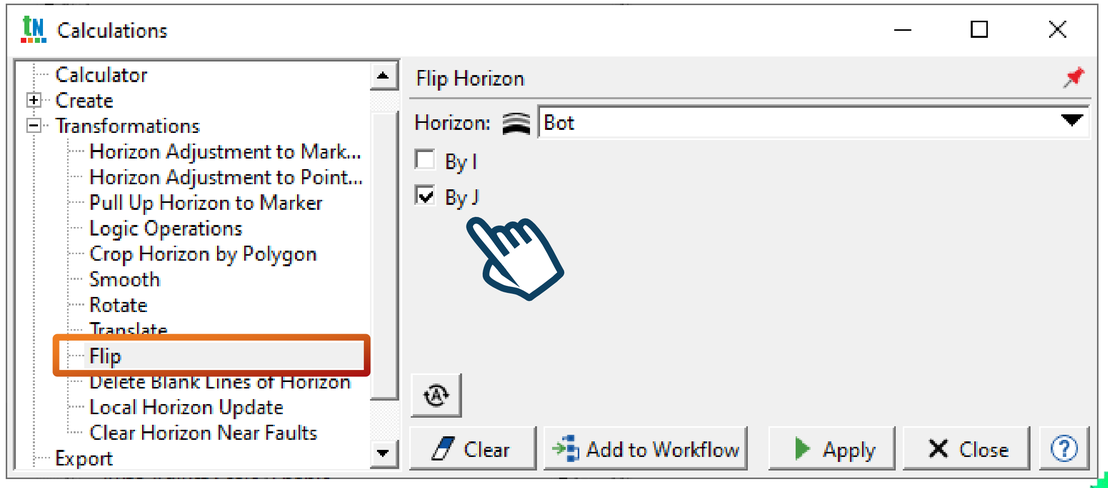
X value specified

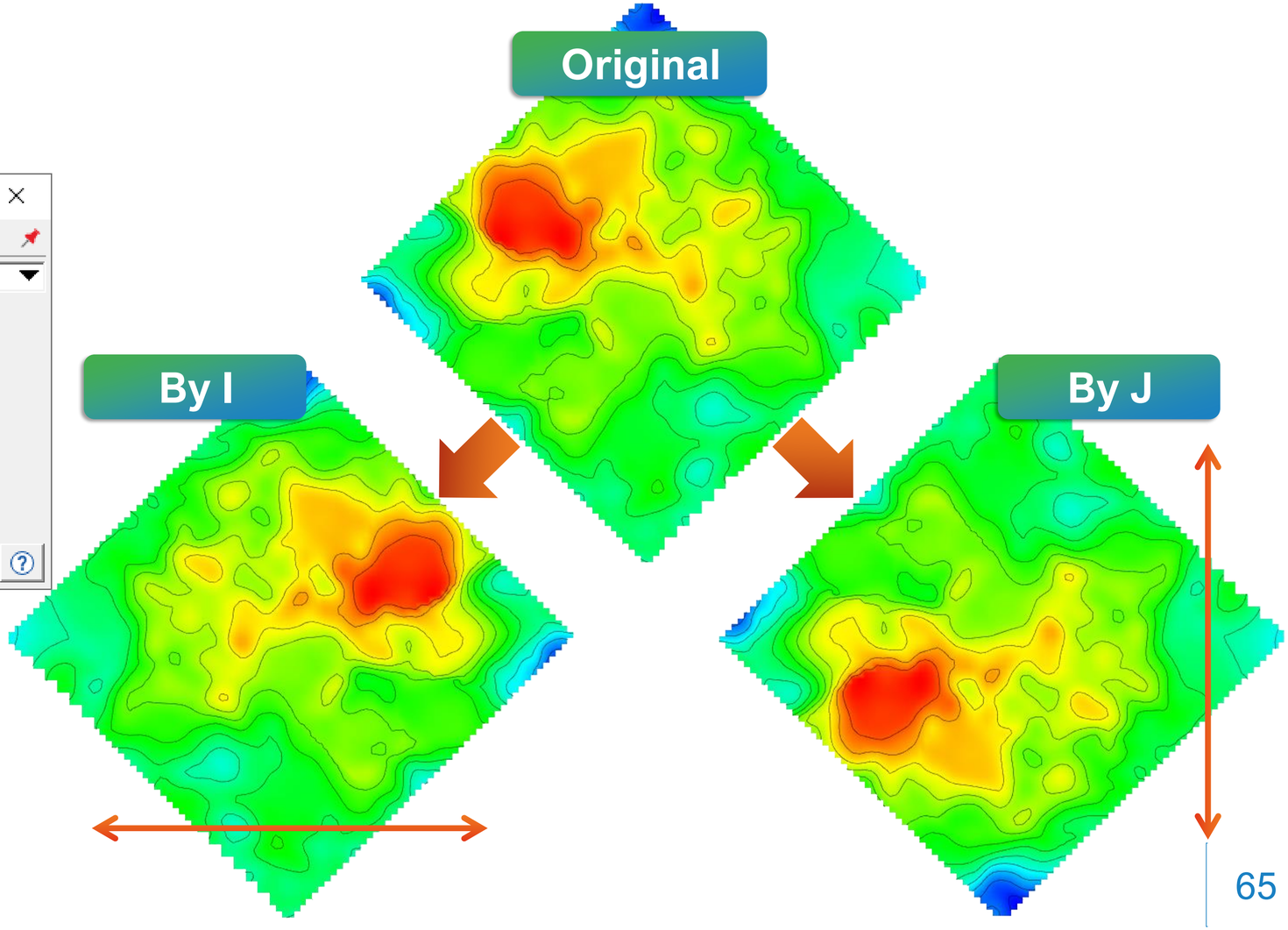




Flip 2D-Maps and Horizons calculation

- **For Horizons and 2D-Maps, a new calculation has been added: Flip. Horizons and 2D-Maps can be flipped along the I and/or J directions (Horizons/2D-Maps → Calculations → Transformations → Flip)**

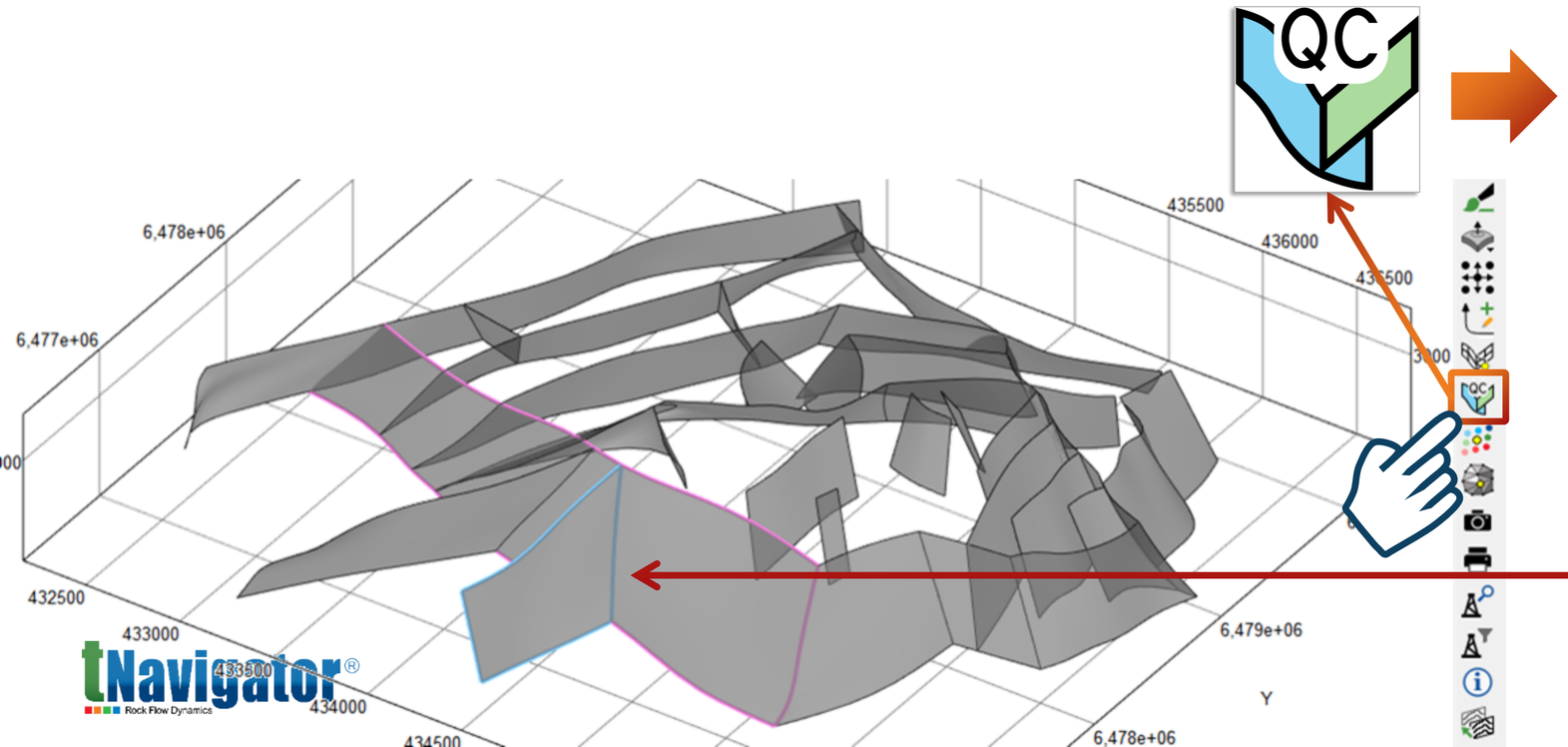




Fault QC: an interactive tool

- An interactive tool for quality control of fault creation has been added: Fault QC. It offers an interactive window, which shows the faults displayed in the visualization window at the moment and having possible errors in geometry

  (the 3D tab → Right toolbar)



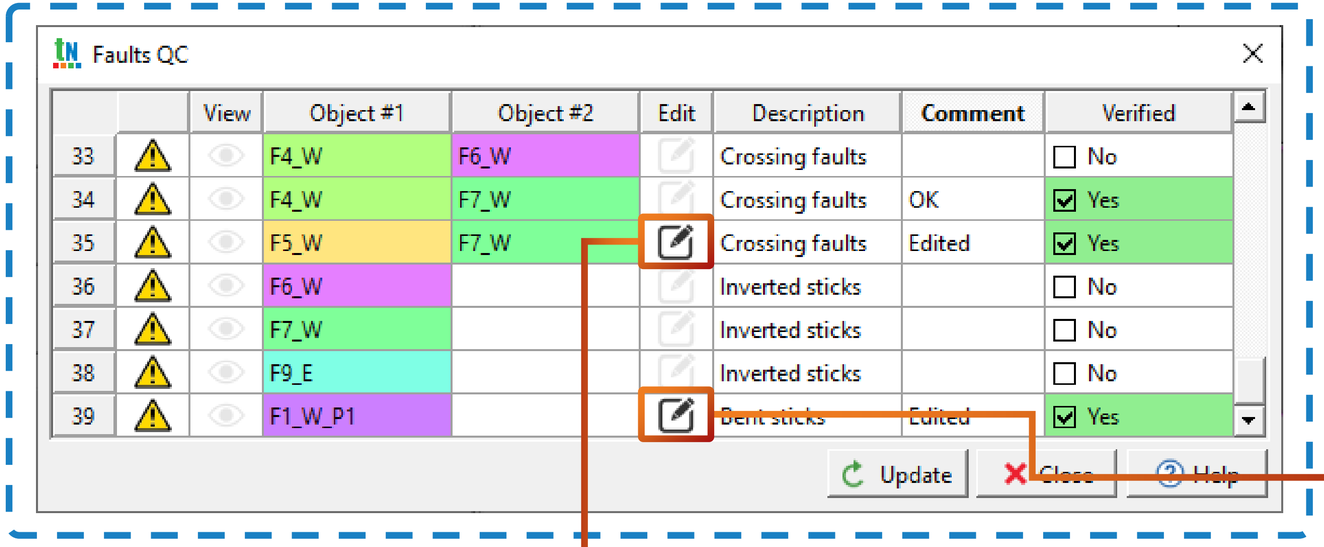
Faults QC

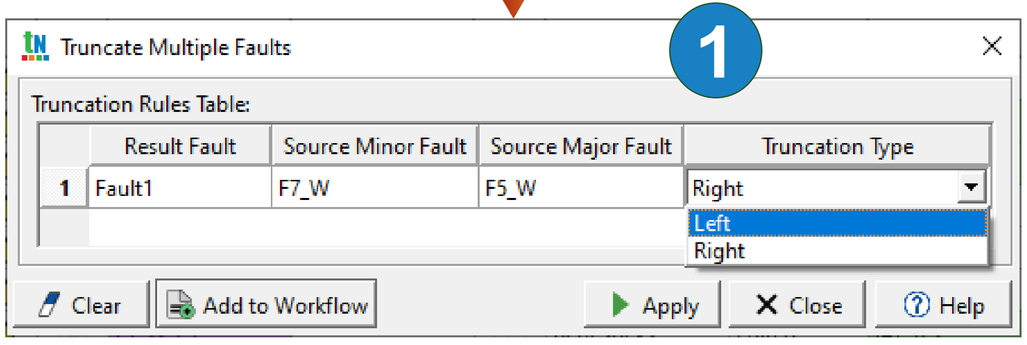
		View	Object #1	Object #2	Edit	Description	Comment	Verified
6	⚠		F1_N	F2_E		Crossing faults		No
7	⚠		F1_N	F2_N1		Crossing faults		No
8	⚠		F1_N	F2_W		Crossing faults		No
9	⚠		F1_N	F3_E		Crossing faults		No
10	⚠		F1_N	F3_W_N		Crossing faults		No
11	⚠		F1_N	F4_E		Crossing faults		No
12	⚠		F1_N	F4_W		Crossing faults		No
13	⚠		F1_N	F5_E		Crossing faults	OK	Yes
14	⚠		F1_N	F5_W		Crossing faults	OK	Yes
15	⚠		F1_S	F1_W_P1		Crossing faults	Edited	Yes
16	⚠	👁	F1_S	F2_S		Crossing faults	Edited	Yes
17	⚠		F1_S	F3_S		Crossing faults		No
18	⚠		F1_S	F3_W_S		Crossing faults		No
19	⚠		F1_S	F4_W		Crossing faults		No
20	⚠		F1_S	F5_W		Crossing faults	OK	Yes
21	⚠		F1_Sal_N	F1_Sal_S		Crossing faults		No
22	⚠		F1_Sal_N	F1_W_P2S		Crossing faults	Edited	Yes
23	⚠		F1_Sal_N	F2_W		Crossing faults		No
24	⚠		F1_Sal_S	F1_W_P2S		Crossing faults		No
25	⚠		F1_Sal_S	F2_W		Crossing faults		No
26	⚠		F1_W_P1	F1_W_P2S		Crossing faults	OK	Yes
27	⚠		F1_W_P1	F9_E		Crossing faults	Edited	Yes
28	⚠		F1_W_P2N	F1_W_P2S		Crossing faults	OK	Yes
29	⚠		F2_Em_C	F3_E		Crossing faults	OK	Yes
30	⚠		F2_N1	F2_N2		Crossing faults	Edited	Yes
31	⚠		F3_W_N	F3_W_S		Crossing faults		No
32	⚠		F3_W_S	F6_W		Crossing faults		No
33	⚠		F4_W	F6_W		Crossing faults		No
34	⚠		F4_W	F7_W		Crossing faults		No
35	⚠		F5_W	F7_W		Crossing faults		No
36	⚠		F6_W			Inverted sticks		No
37	⚠		F7_W			Inverted sticks		No
38	⚠		F9_E			Inverted sticks		No
39	⚠		F1_W_P1			Bent sticks		No

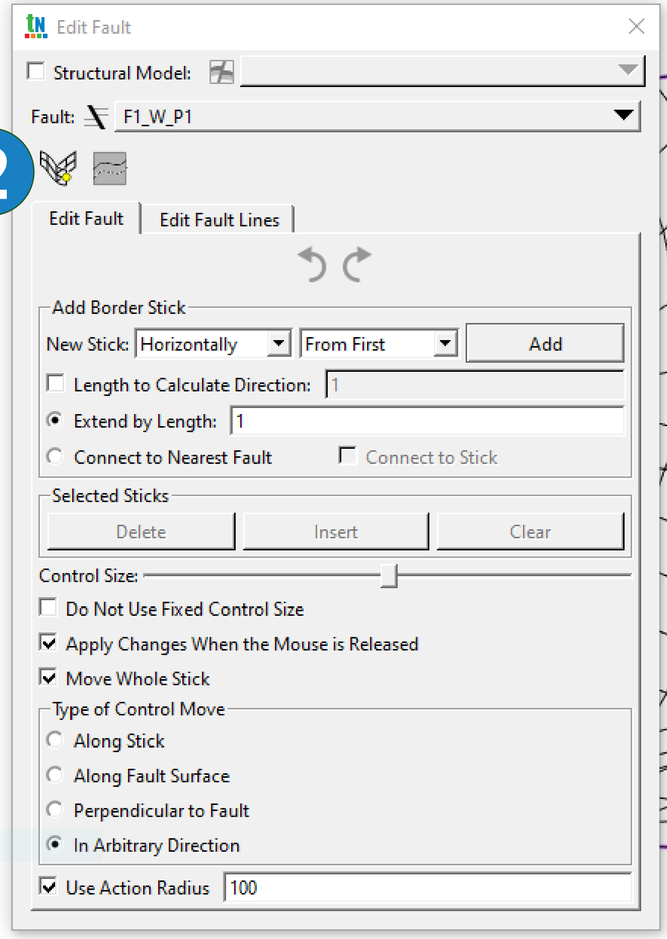
Update | Close | Help

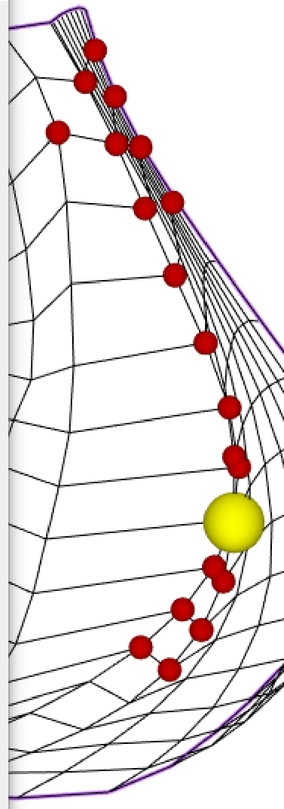
Fault QC: an interactive tool

- **Depending on the indicated problem, the user is prompted to open the interactive faults editing tool or the truncation rules table. After verification, the Verified mark is set**



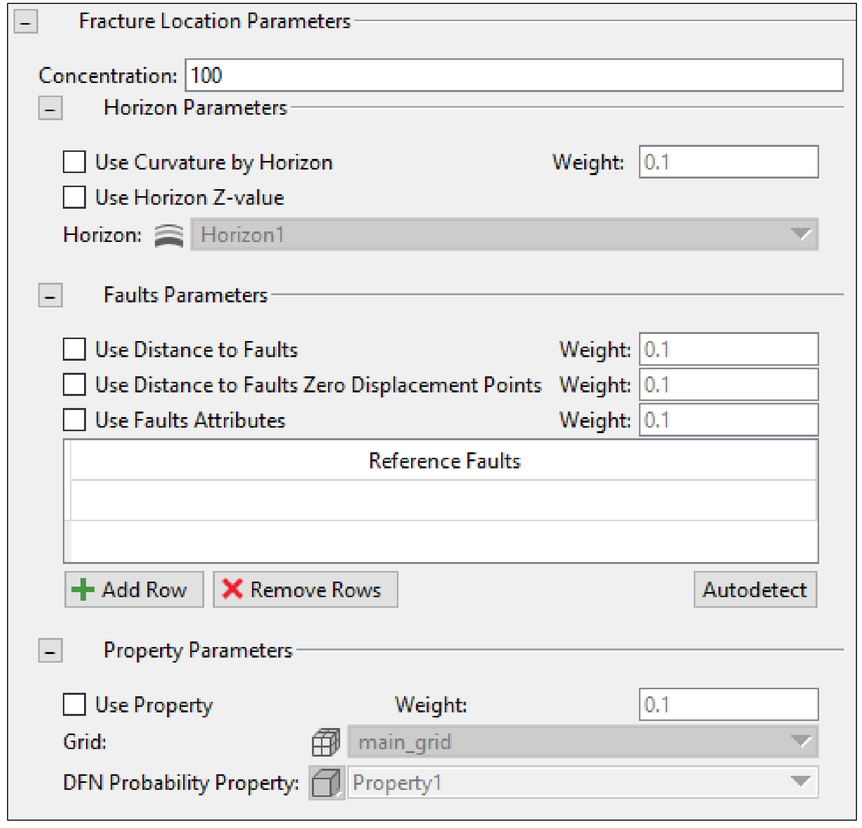


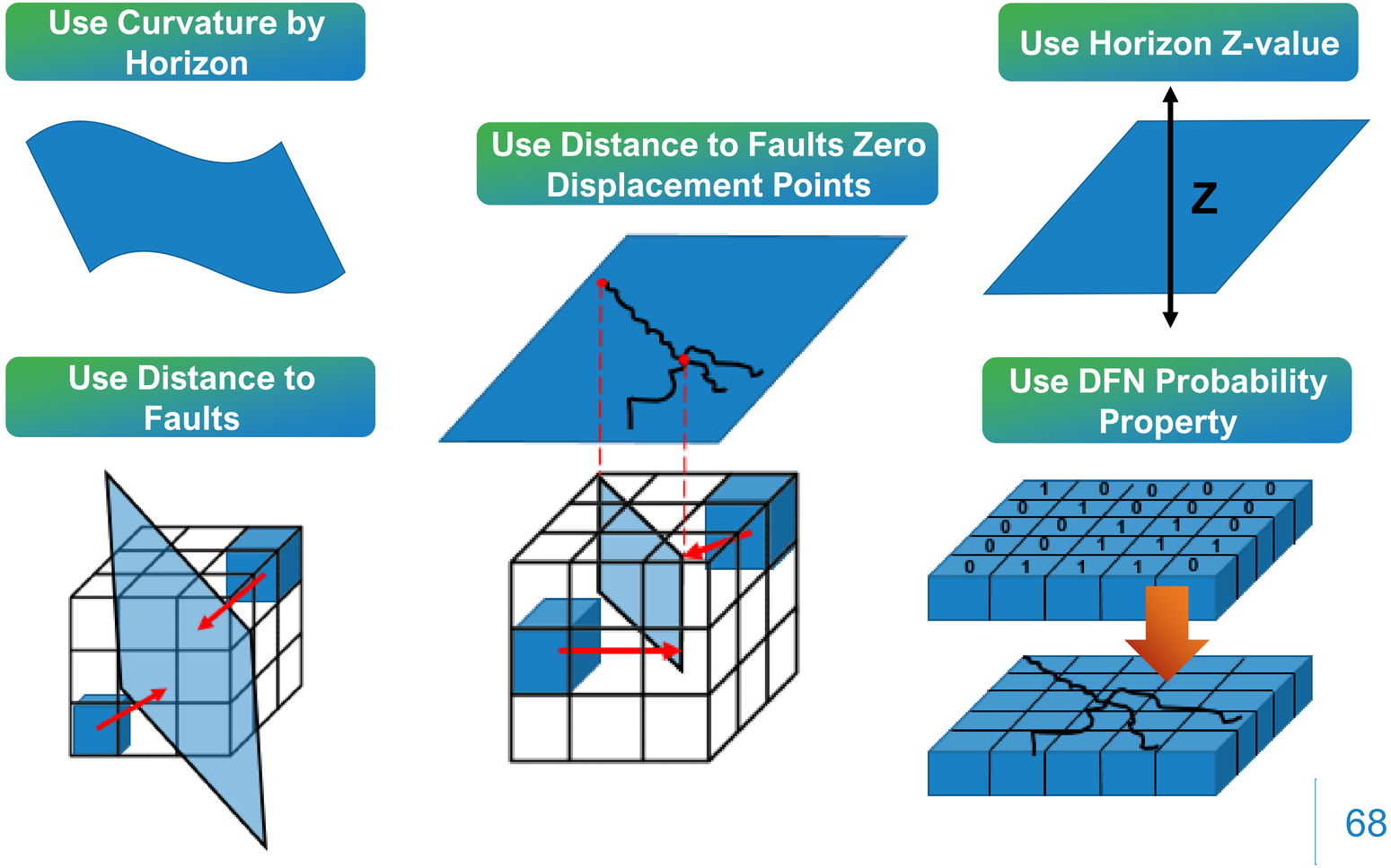




DFN: Create DFN new options

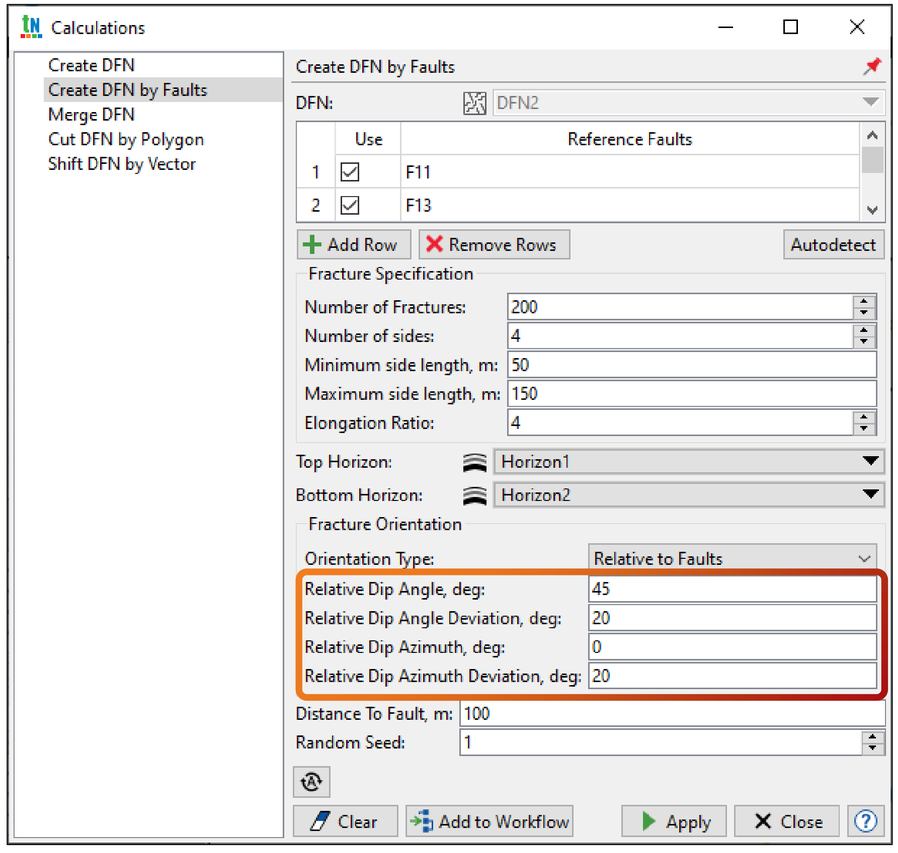
- The Create DFN calculation has been significantly redesigned. The user can now fully control the fractures that influence the distribution and concentration of fractures within the horizon: Geometry Objects → DFN → Create DFN

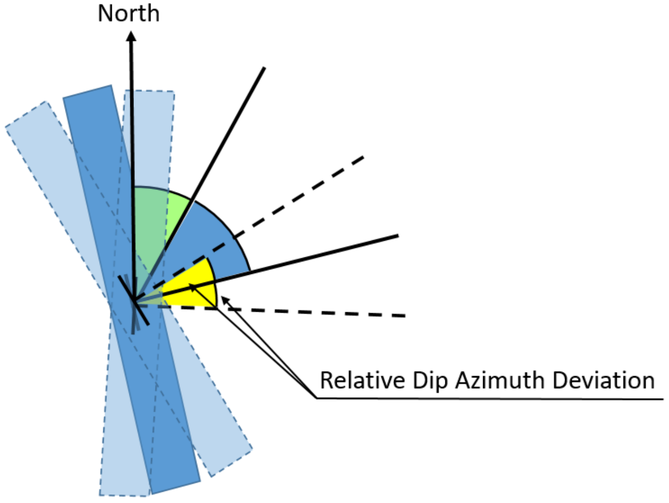


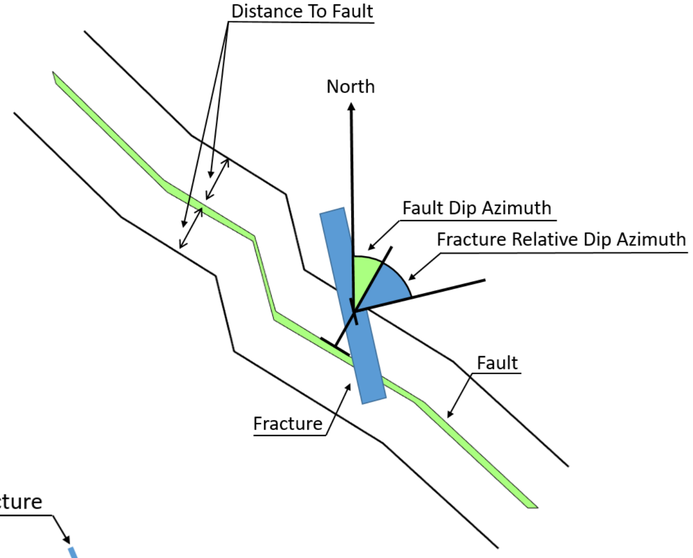


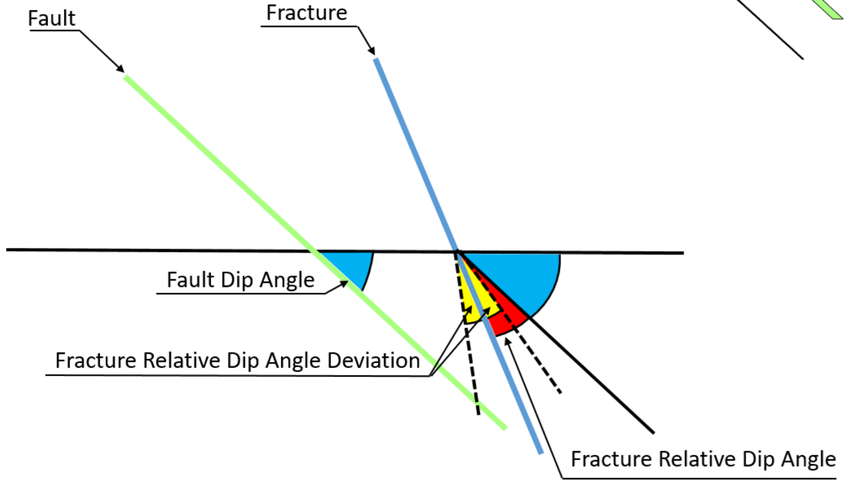
DFN: Create DFN by Faults new options

- **In the Create DFN by Faults calculation, additional settings of fracture position control have been added, namely: relative dip azimuth and relative dip azimuth deviation: Geometry Objects → DFN → Create DFN by Faults**



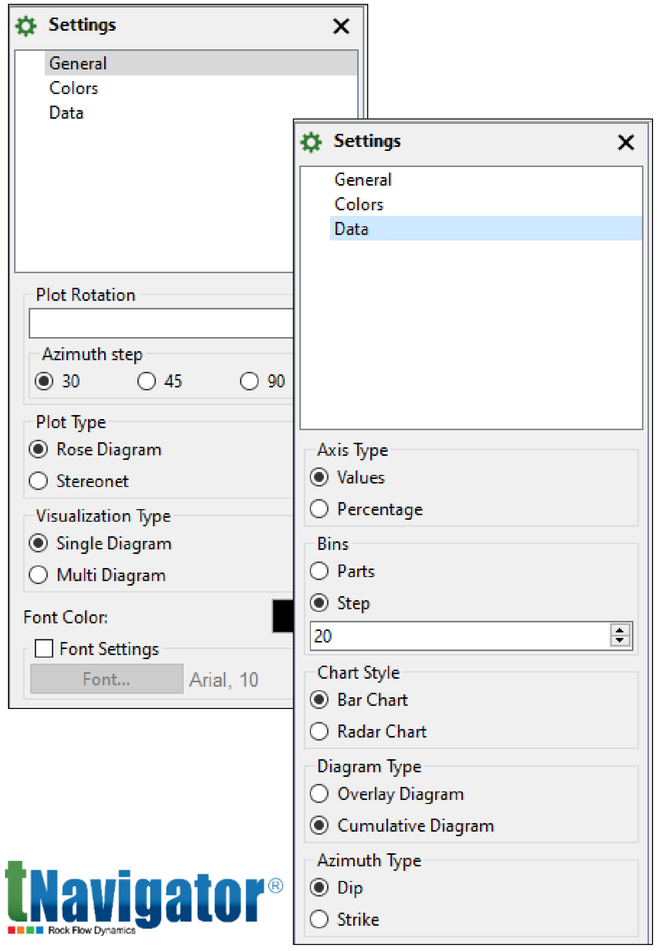


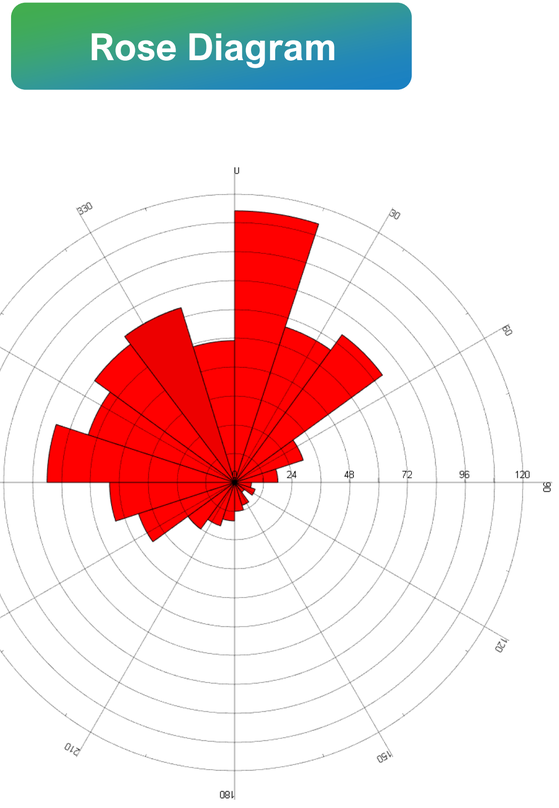


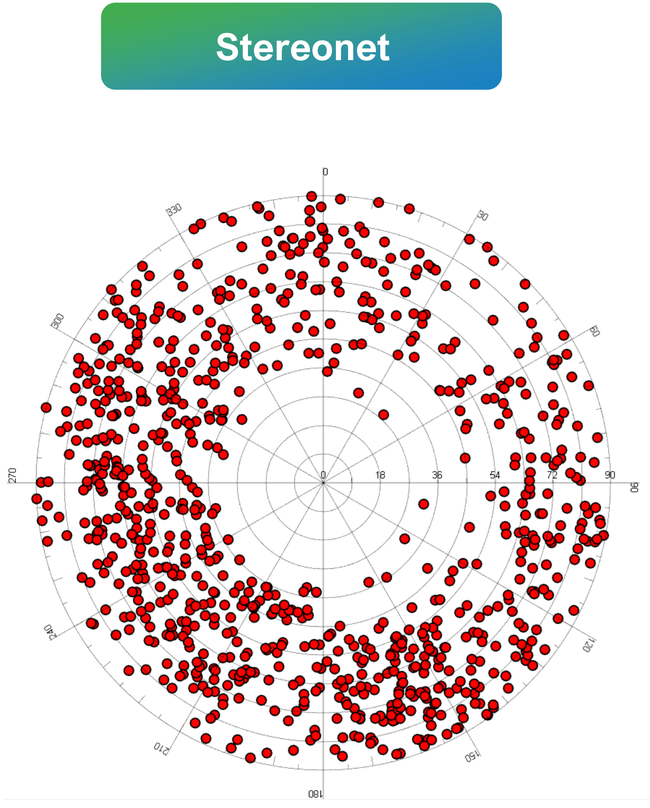


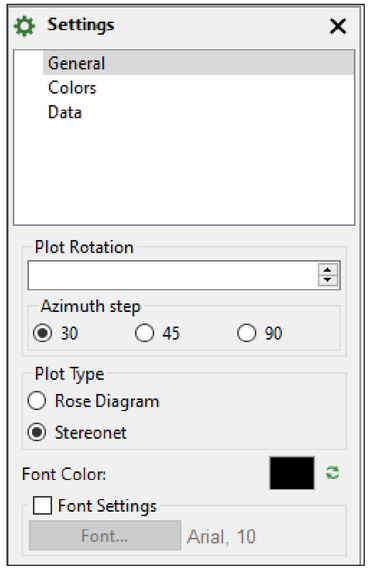
DFN: Stereonet and Rose Diagram

- **In the list of available windows and tabs, a new object has been introduced: Stereonet/Rose Diagram. A Rose diagram displays objects that have an azimuth, while Stereonet describes 3D objects which are characterized not only by an azimuth (direction), but also by a slope.**



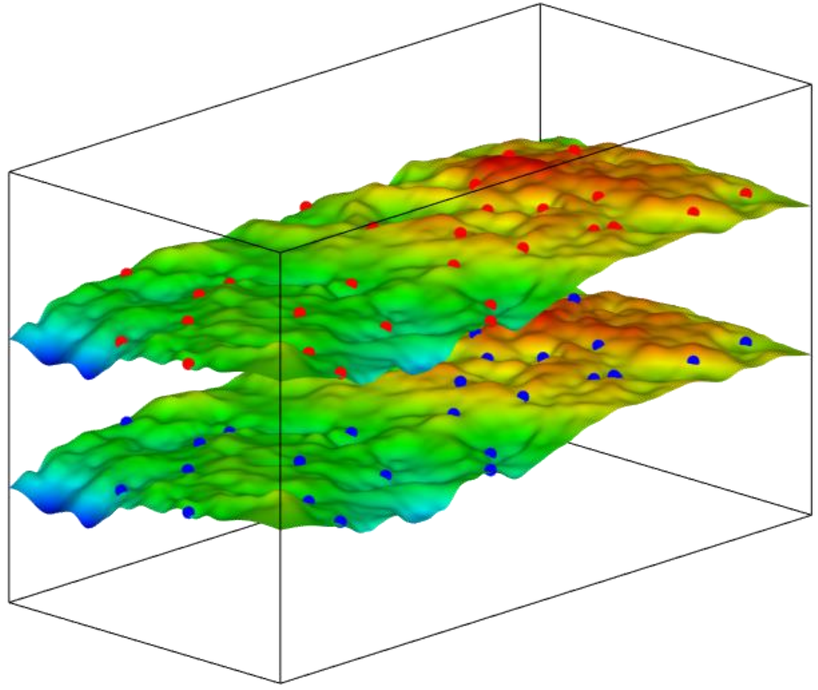


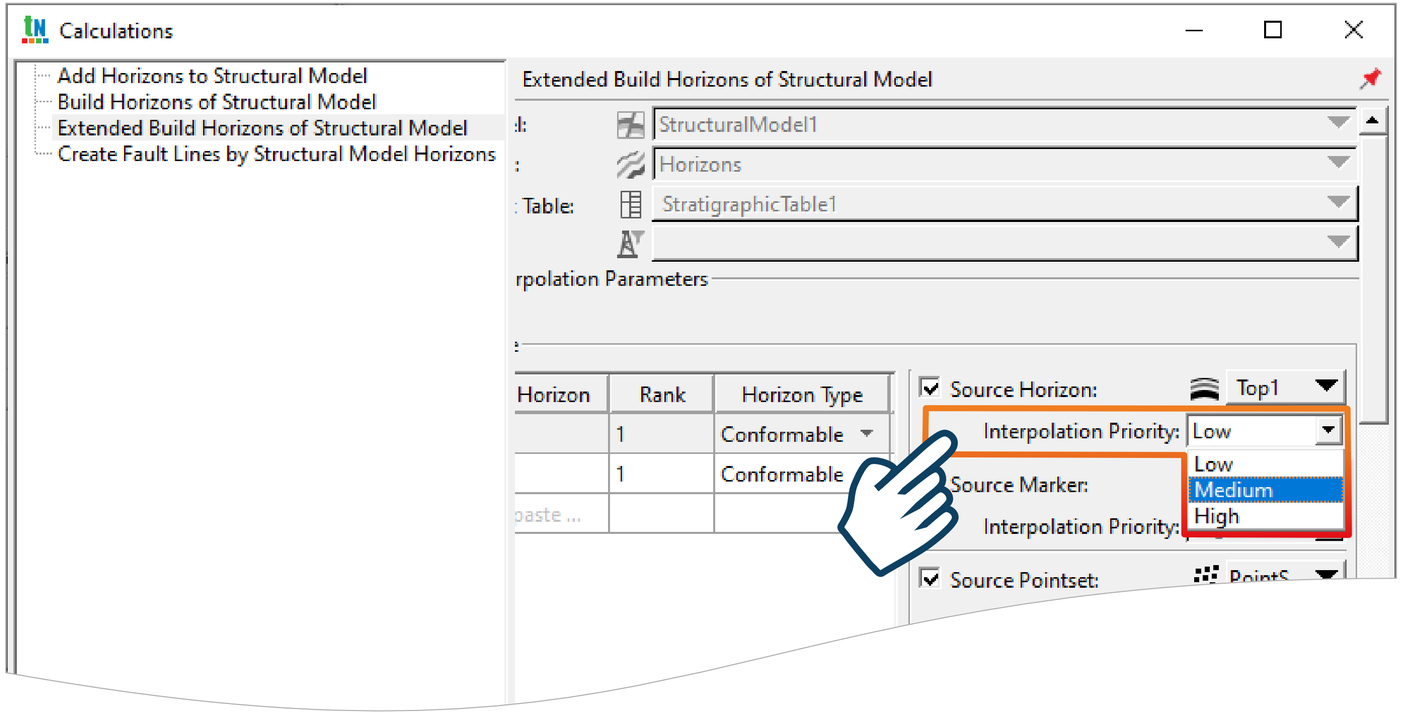




Controlling the priority of input data when creating Structural Model horizons

- **In the Extended Build Horizons of Structural Model calculation, an option to set the input data priority to control the degree of their influence on the result has been added. This allows some input data a greater degree of influence on the resulting horizon (Structural Models → Horizons → Extended Build Horizons of Structural Model → Interpolation Priority)**

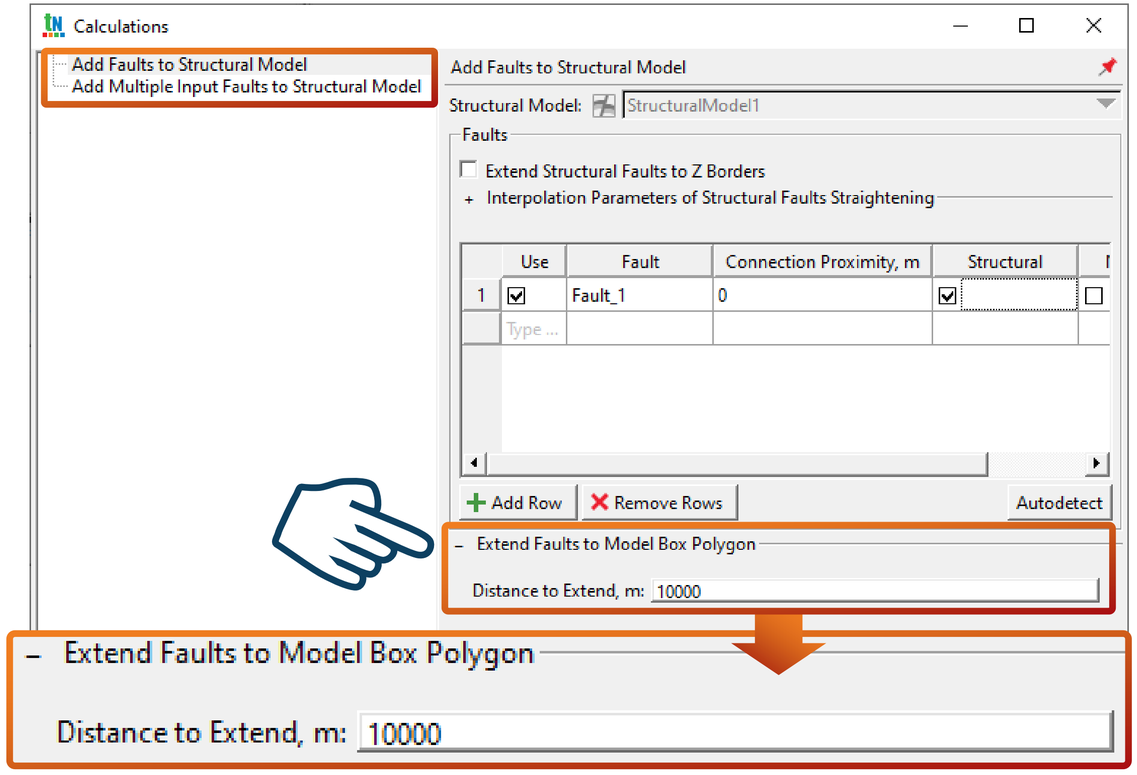


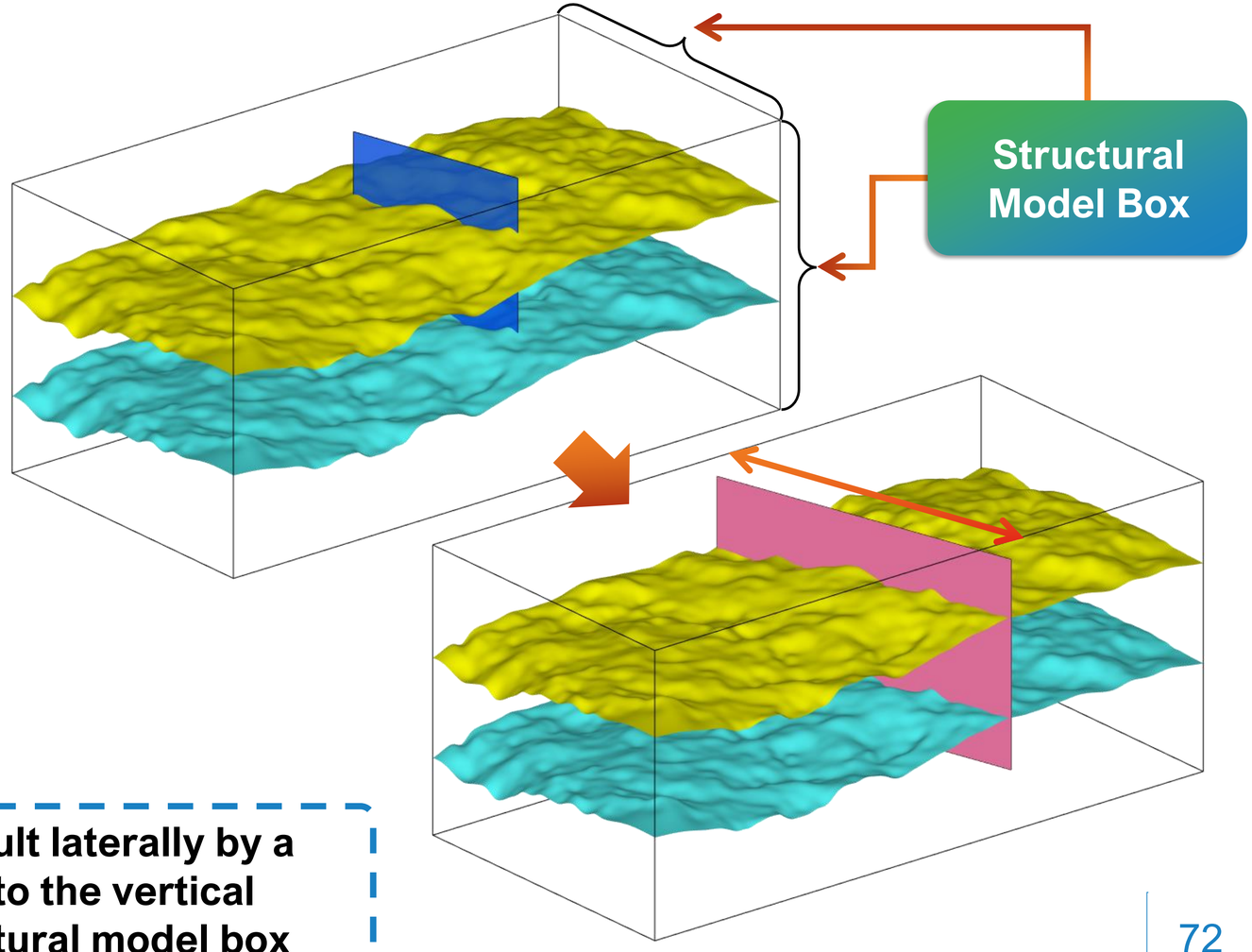


Fault Extension in a Structural Model

- **In the calculations Add faults to the structural model and Add Multiple Input Faults to the Structural Model, an option titled Extend Faults to Model Box Polygon has been added.**

  (Structural Models → Faults → Calculations)

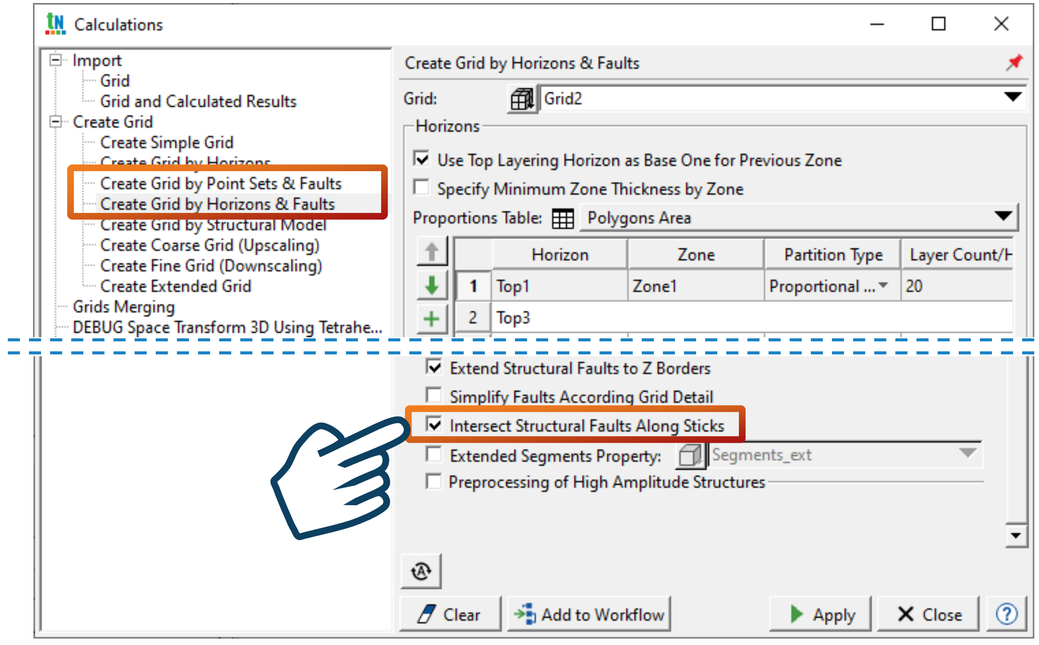


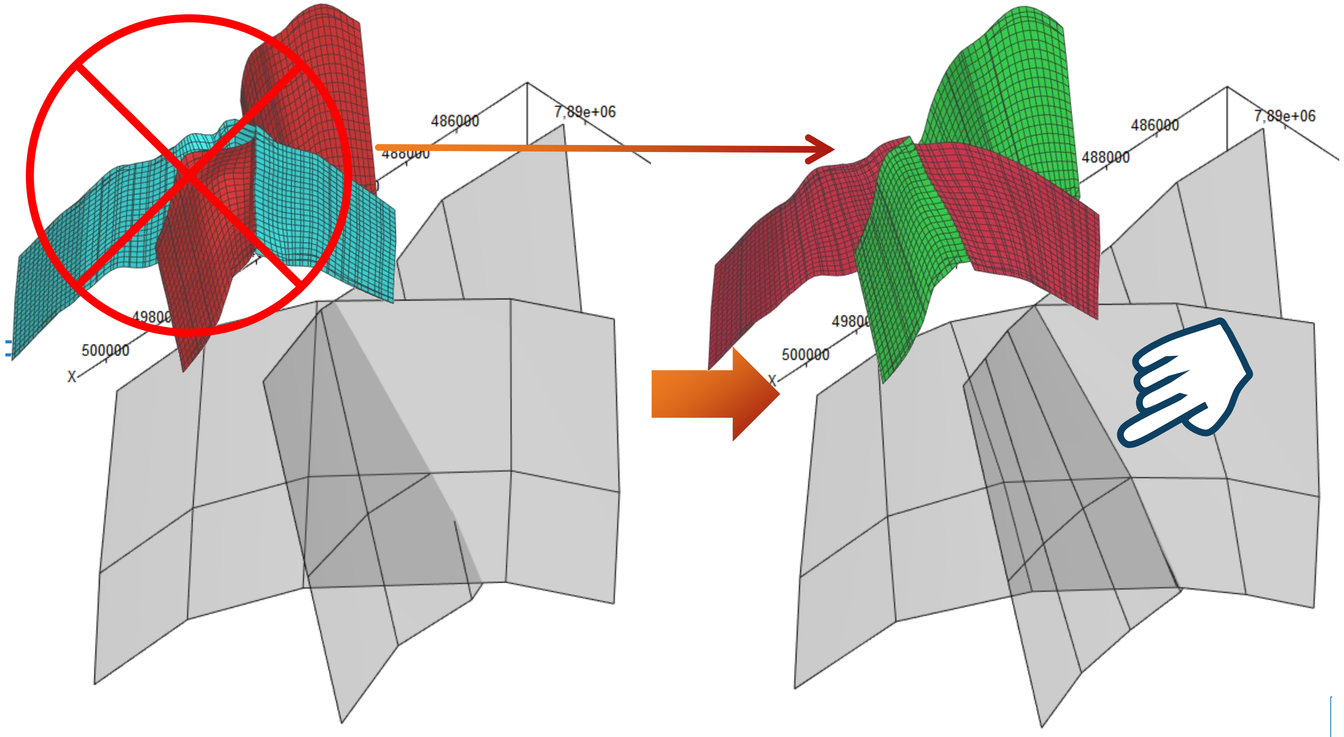


Allows extending the fault laterally by a specified distance or to the vertical boundaries of the structural model box

Coordination of a structural faults intersection

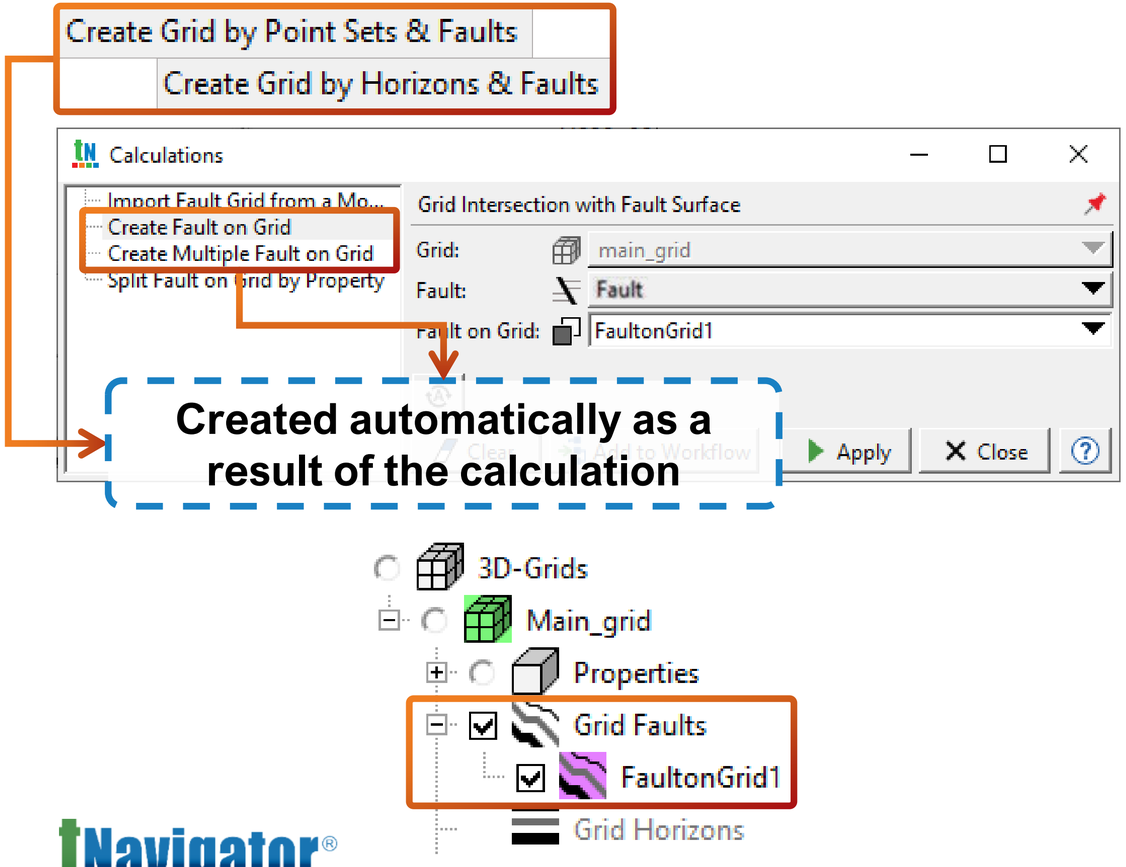
- **In the calculations Create Grid by Point Sets and Faults and Create Grid by Horizons and Faults, an option titled Intersect Structural Faults Along Sticks has been added. During the calculation, this option alters the intersecting structural faults so that they intersect via a common stick (3D-Grids → Calculations → Create Grid by Point Sets and Faults/Create Grid by Horizons and Faults → Advanced Settings)**

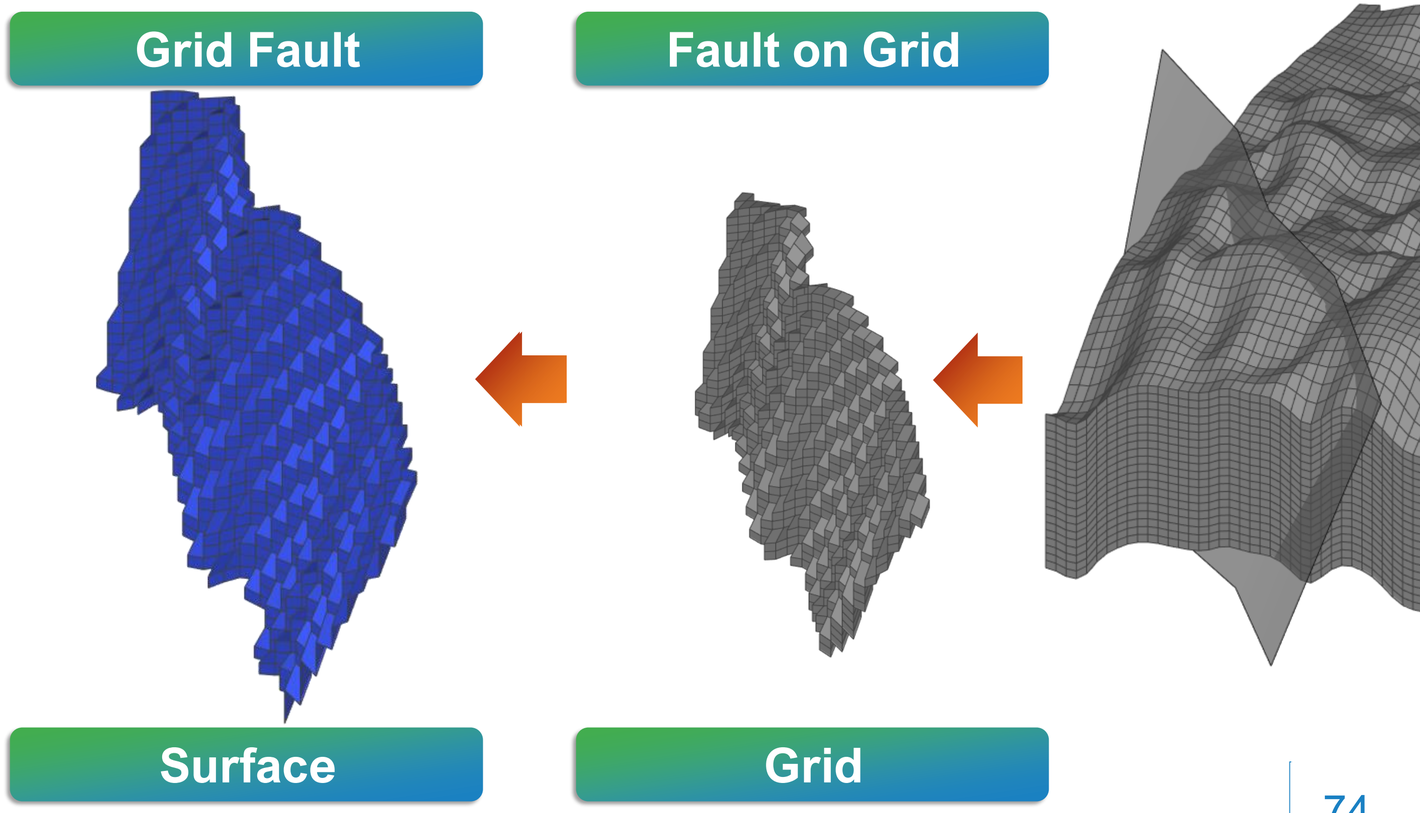




New Object: Grid Fault

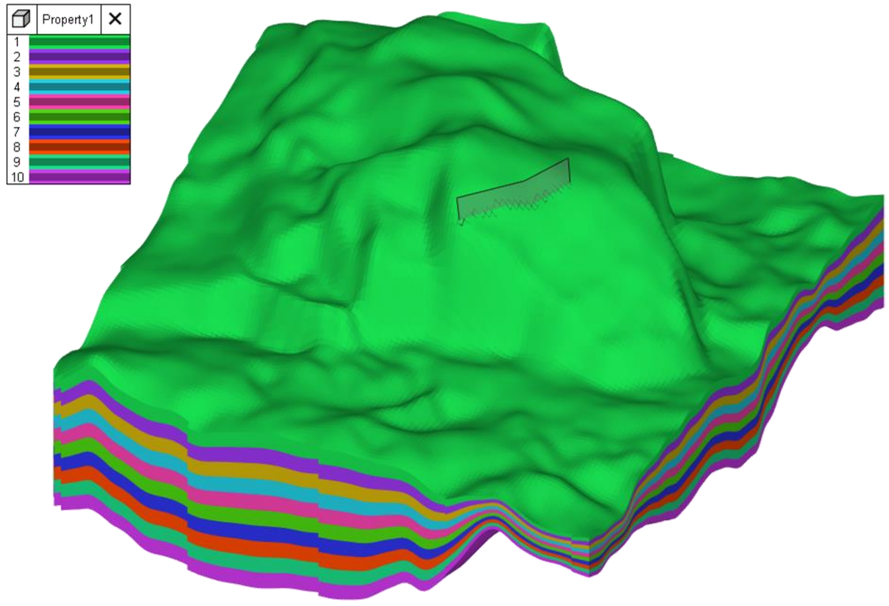
- **A new type of object has been added: Grid Faults. It represents a surface and is necessary to understand how the fault is embedded in the 3D model. It allows quality control of the created fault model and visual comparison with the original faults (Geometry Objects → 3D-Grids → Grid Faults)**

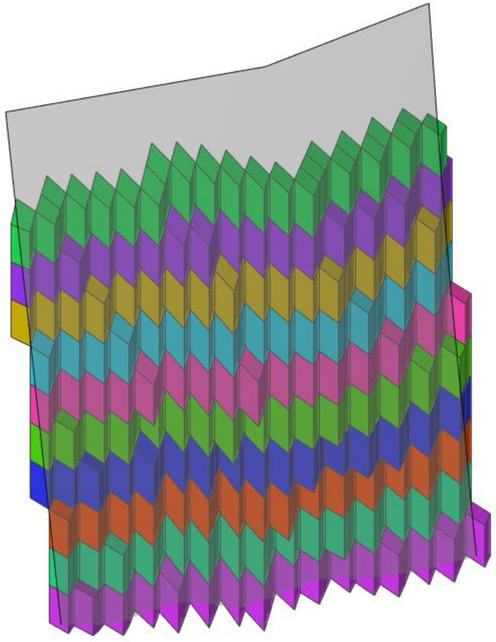


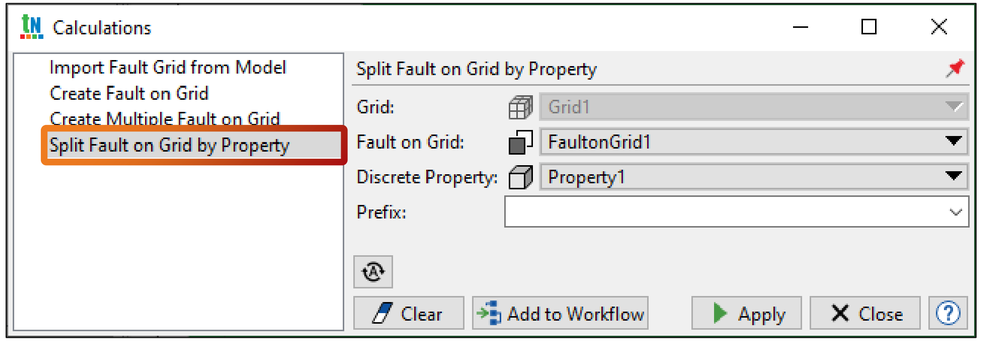


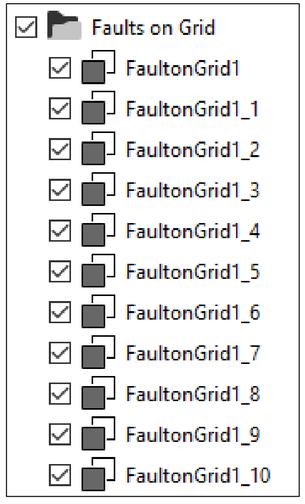
Faults on Grid: Split by Property

- An option to split a Faults on Grid object into segments with the help of a discrete property has been added. Each new segment of the initial object is the intersection of the fault surface with the grid cells within the limits of the appropriate discrete zone (Geometry Objects → Properties → Faults on Grid → Split Fault on Grid by Property)





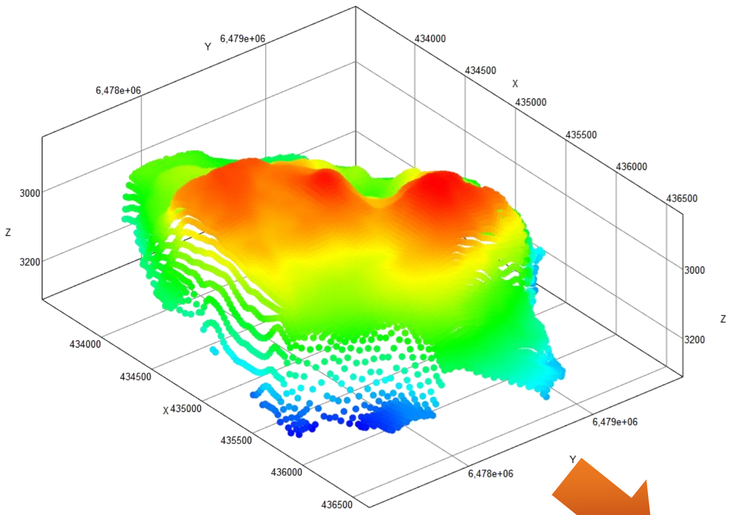


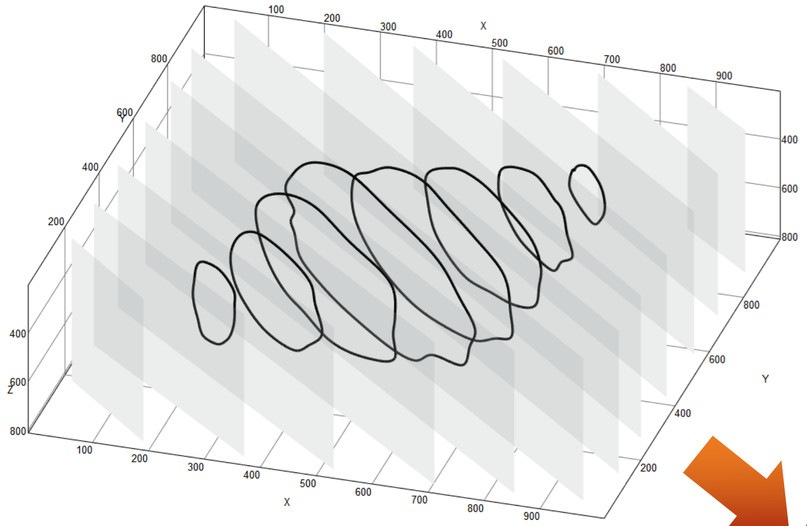


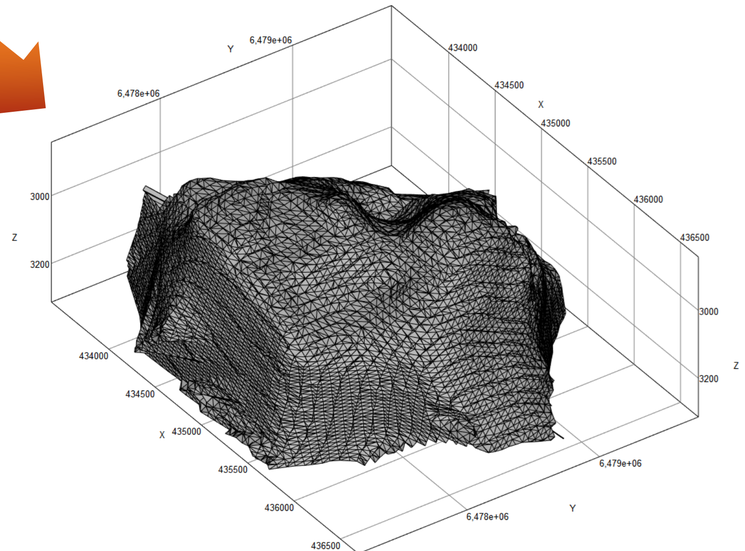
Geobody creation based on point sets or polygons

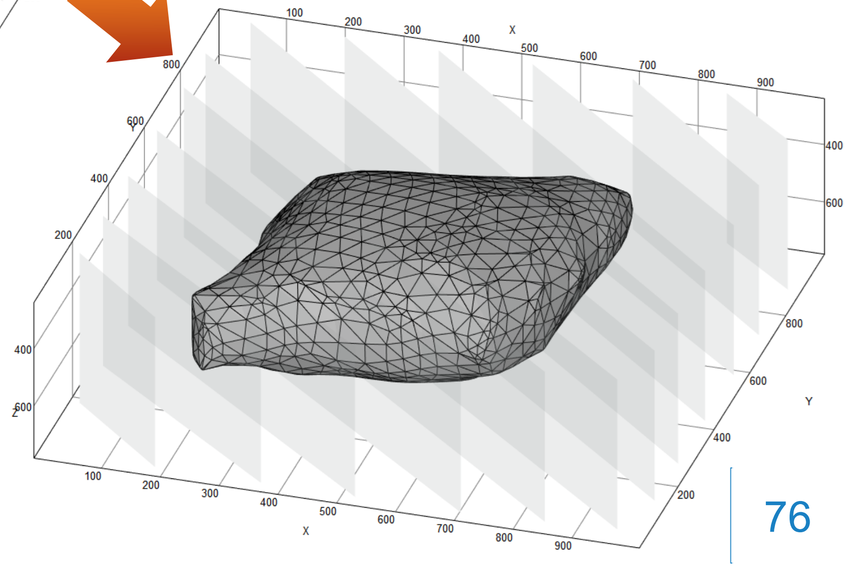
- **An option for automatic creation of geobodies based on point sets or fence polygons has been added**

  (Calculations → Create → Create Geobody by Point Set/Fence Polygons)





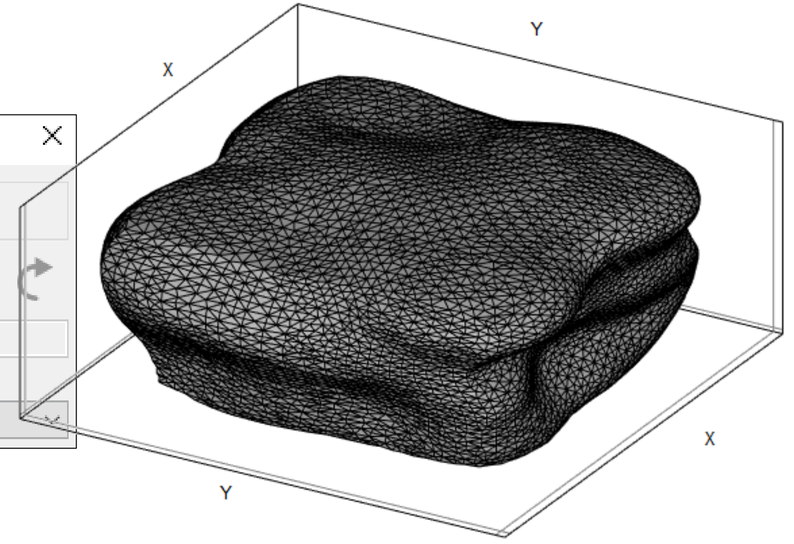


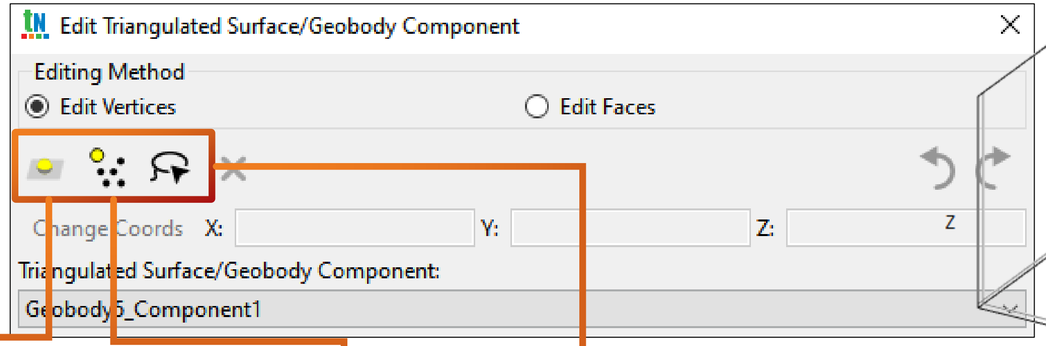


Geobody surface editing

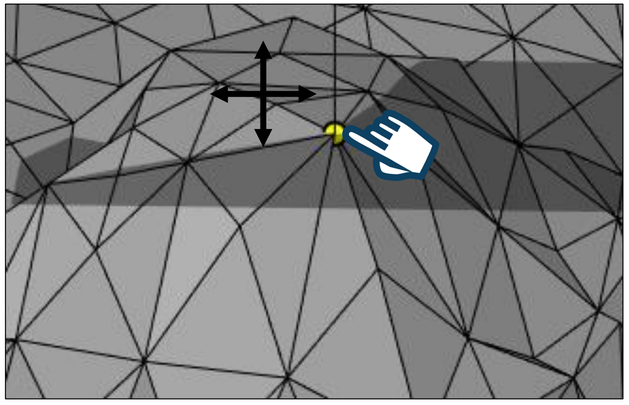
- **A new tool for interactive editing of geobodies' triangulated surfaces in 3D has been added (3D → Edit Triangulated Surface)**

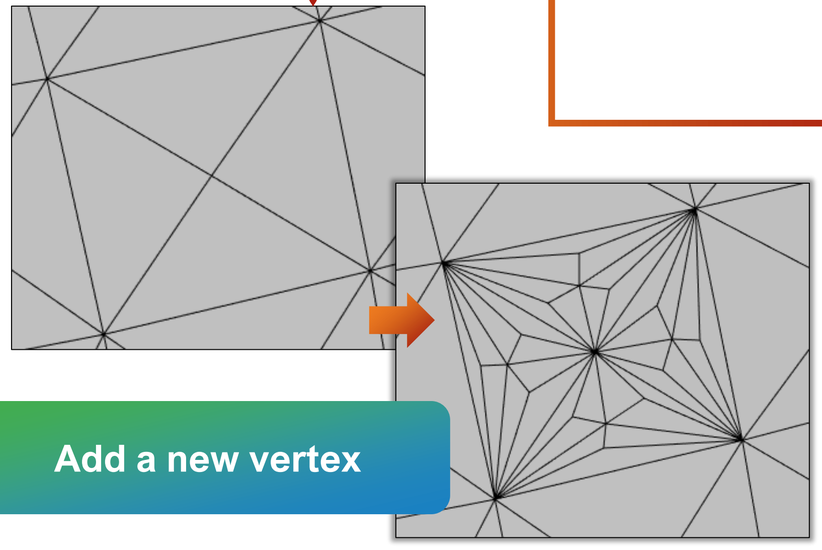
The editing is performed via selection of one or more vertices of the surface and their further dragging



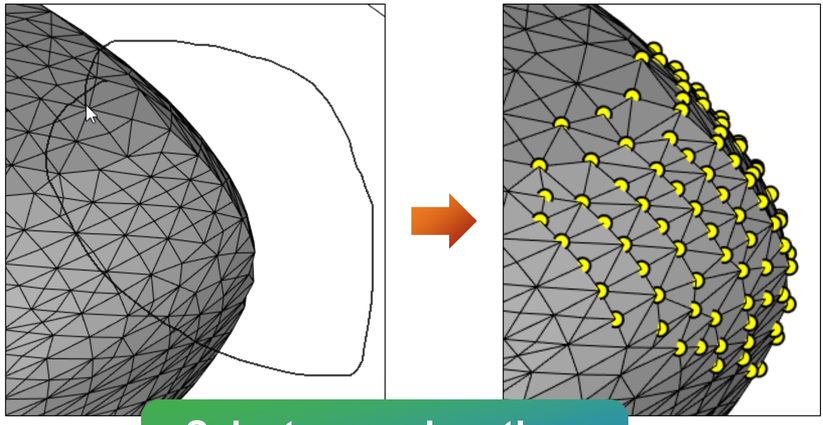


Moving a vertex in space. It is possible to set a radius of action





Add a new vertex

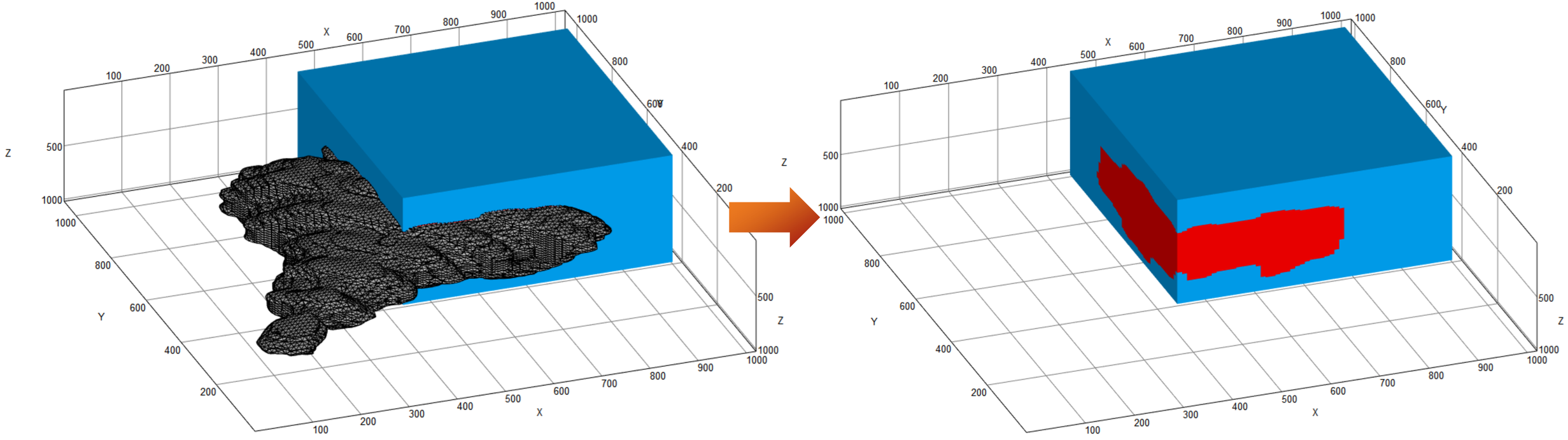


Select several vertices and delete them

Create properties by geobodies

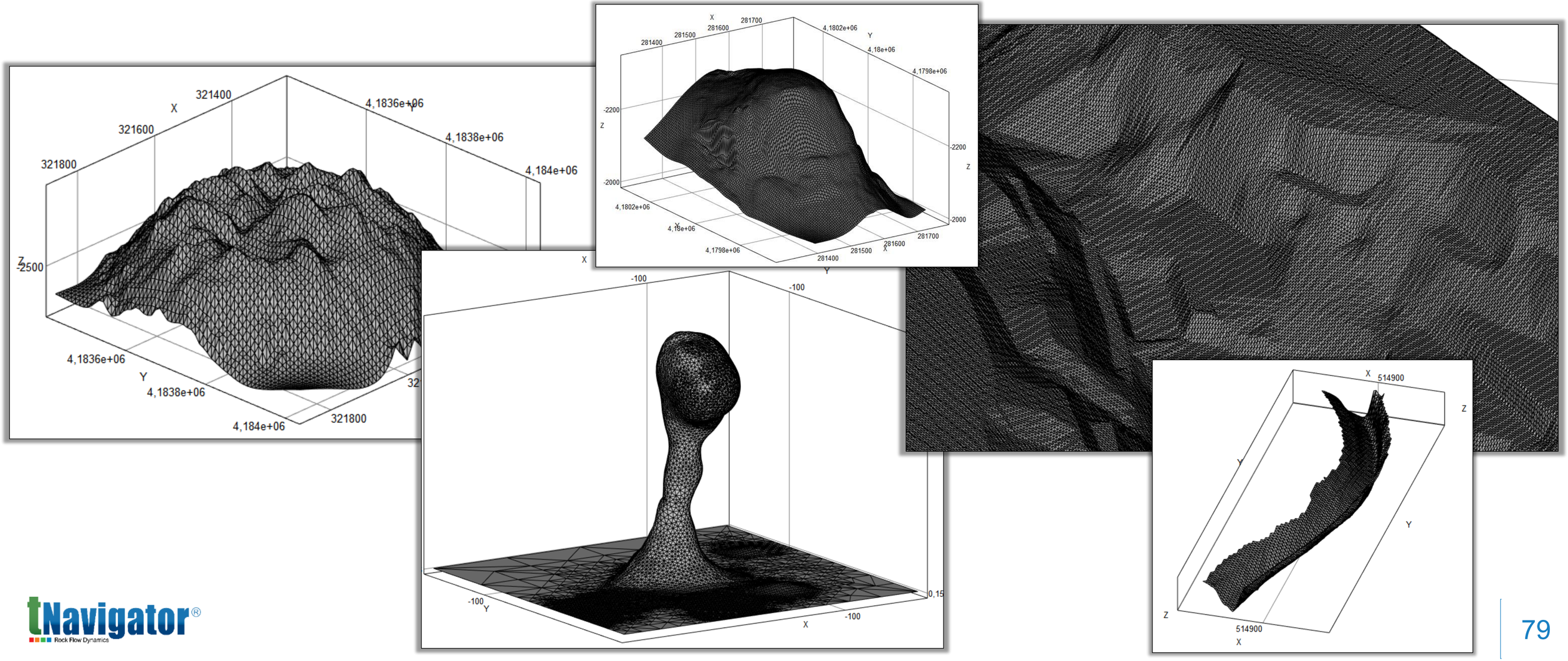
- **An option to create properties by geobodies has been added. In this calculation, there are two types of settings available for the user: either each cell of the property will reflect this cell's volume fraction located within the modeled geobody, or each cell located within the geobody will be assigned one user-defined value, and the cells outside will be assigned another value**

  (3D-Grids → Properties → Calculations → Create → Create Build Property by Geobody)



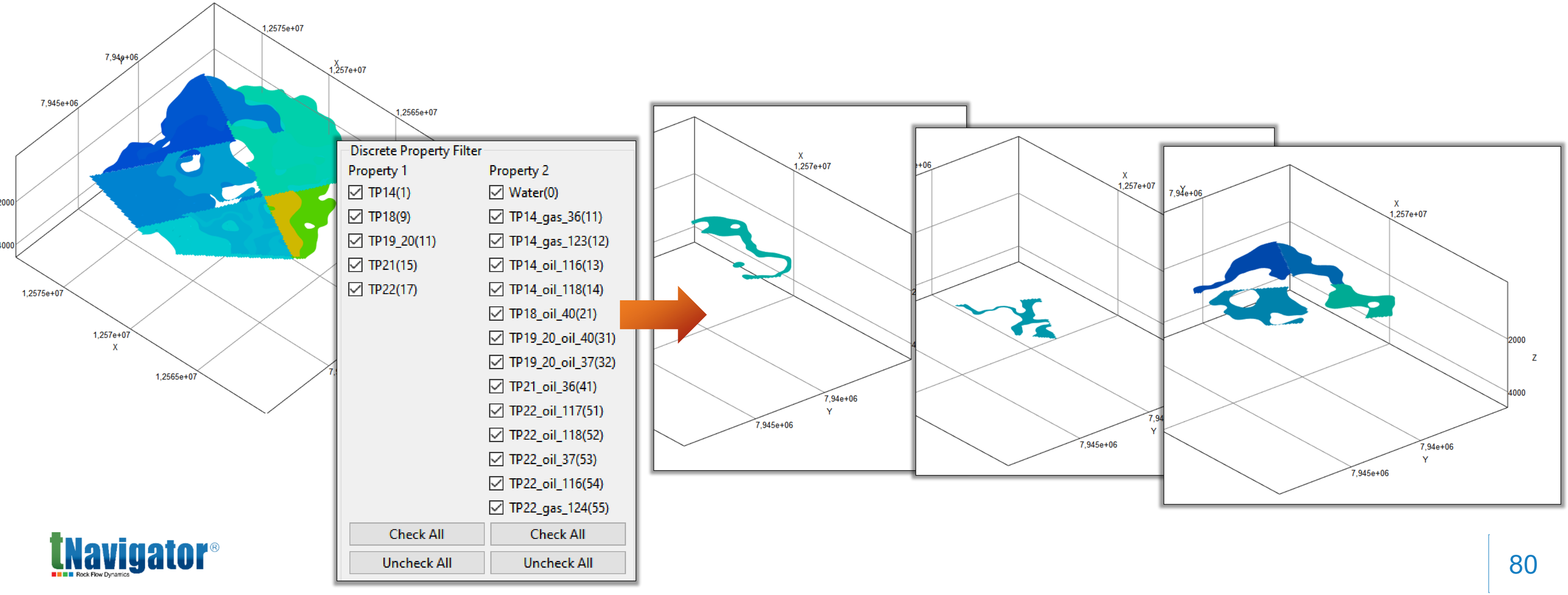
Import/export of triangulated surfaces and geobodies

- An option for the import/export of triangulated surfaces and geobodies in .tsurf, .ply, .dxf formats has been added (Geobodies/Triangulated surfaces → Calculations → Import/Export)



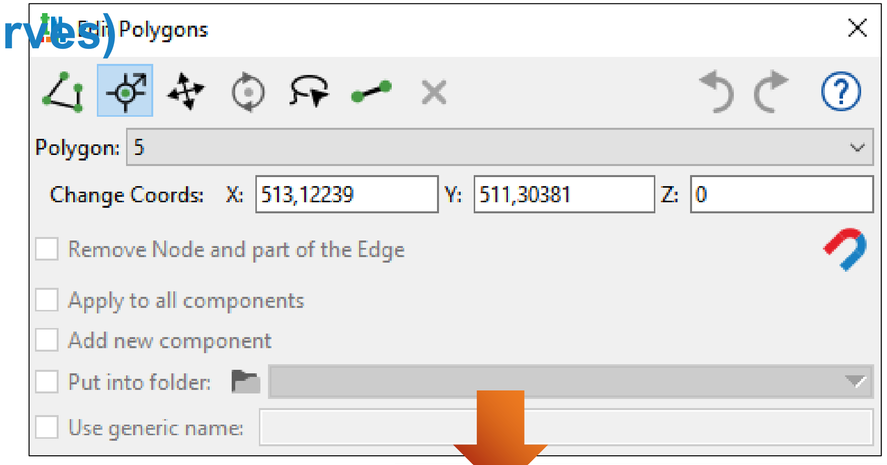
Contacts filtering based on discrete properties

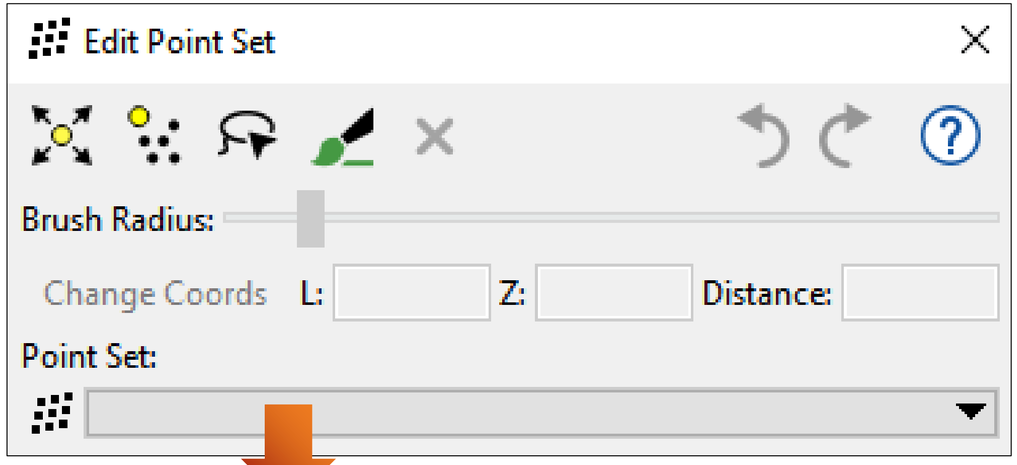
- **An option for contacts filtering based on discrete properties (Zones/Regions) has been added, which allows visualization of the contact for every single layer or deposit (Settings → Contacts → Discrete Property Filter)**

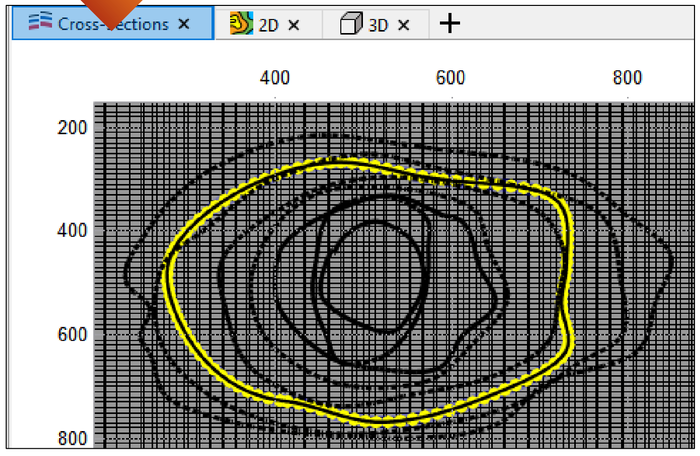


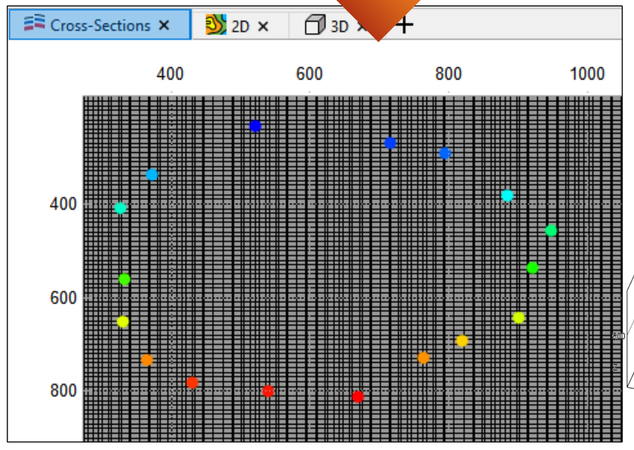
Point set and polygon creation on a Cross-Section

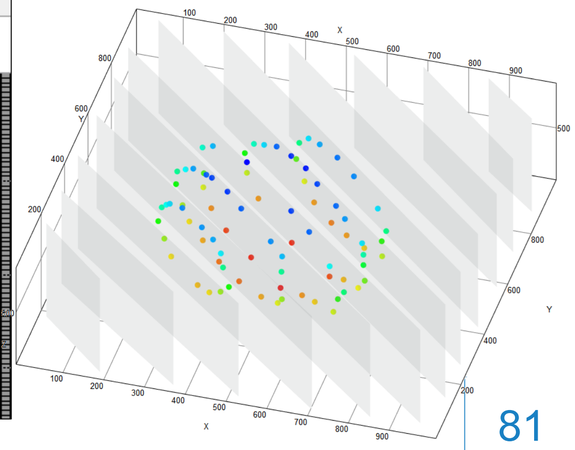
- **Tools for point set and polygon creation and editing have been implemented for the Cross-Section tab. These tools are important for raster cross-sections digitizing, seismic data, manual corrections during conceptual modeling or geological cross-section design (Cross-Sections → Edit Point Sets/Edit curves)**











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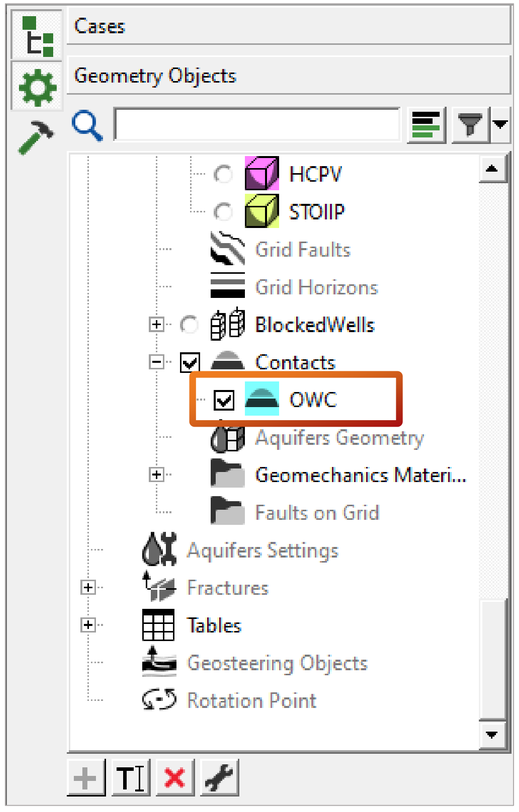
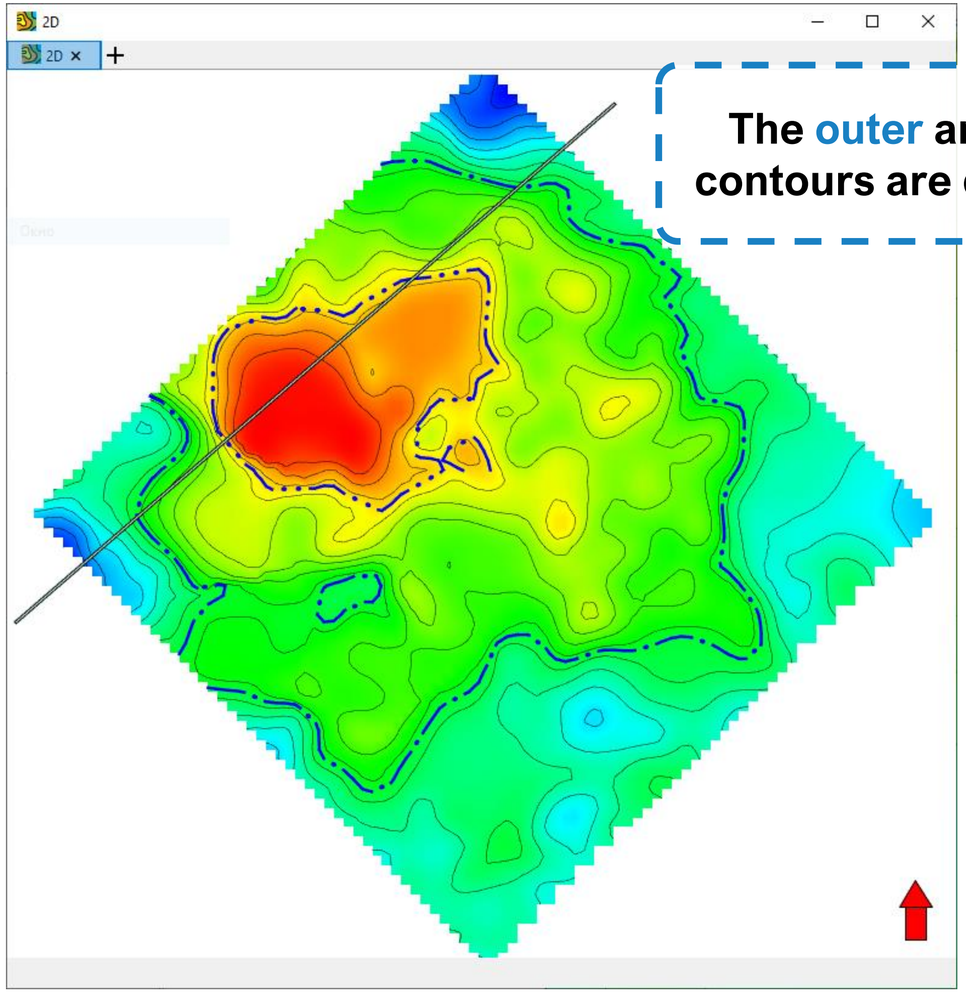
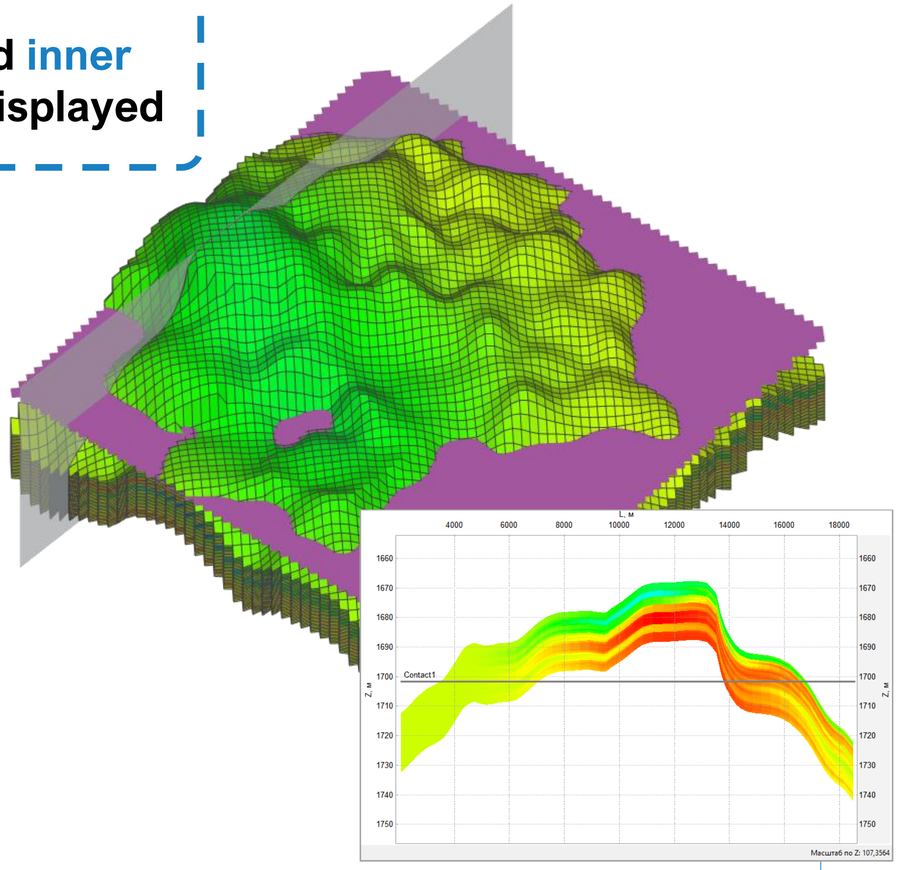
Contact visualization in the 2D tab

- **In the 2D visualization tab, you can now display contacts as contours. The option helps to prepare reporting materials (the 2D Tab)**





The outer and inner contours are displayed



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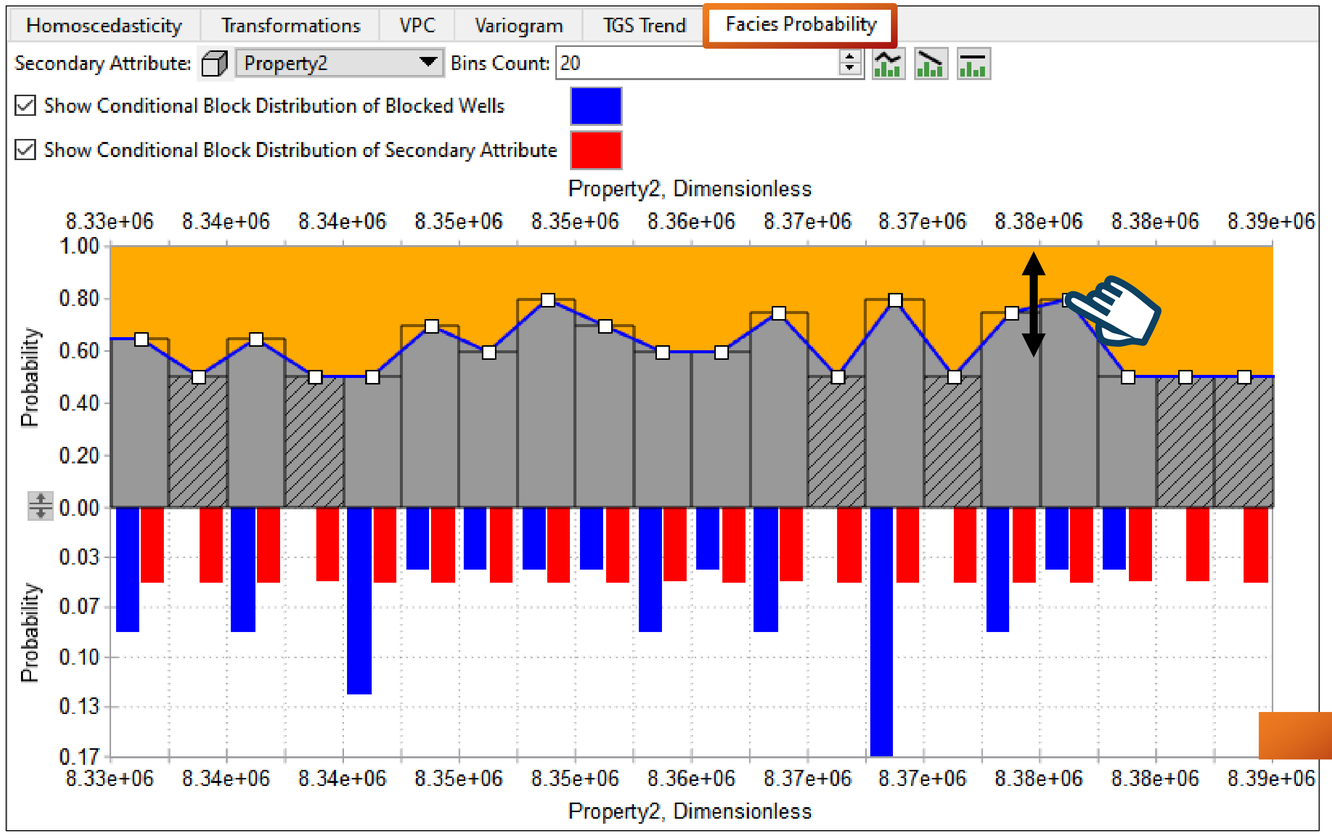
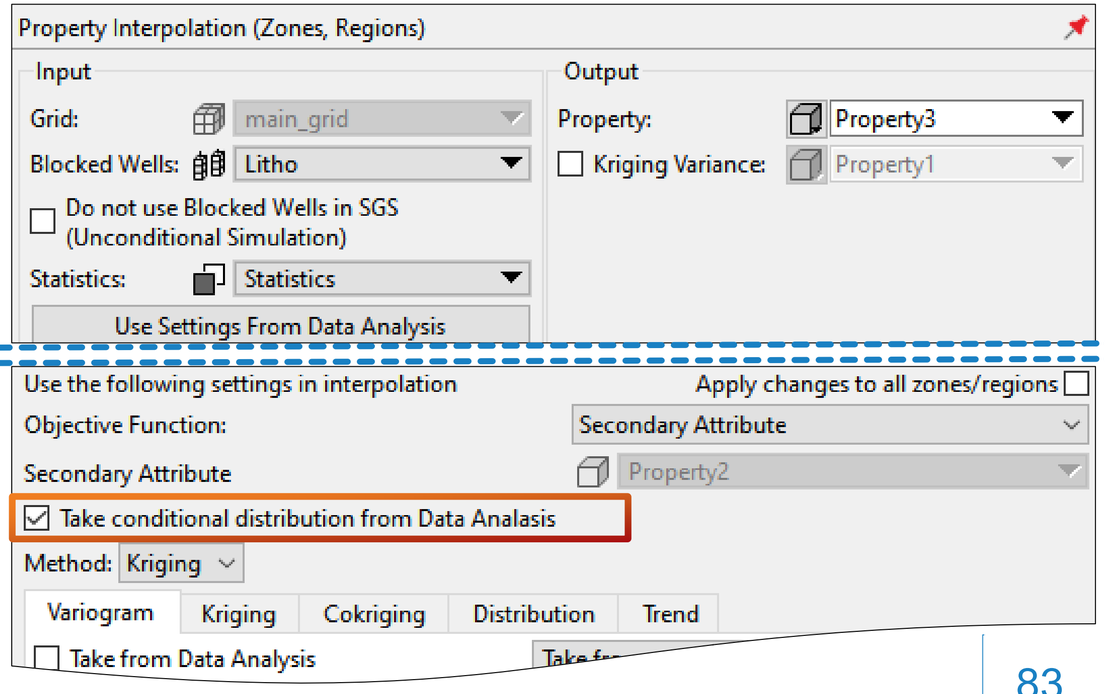
Facies Probability in Data Analysis

- **A new tab titled Facies Probability is now available in Data Analysis, allowing analysis and, if necessary, editing of the dependence between a discrete property (facies) and a continuous one (for instance, a seismic attribute)**



Later, this distribution may be used for discrete property interpolation



Geosteering

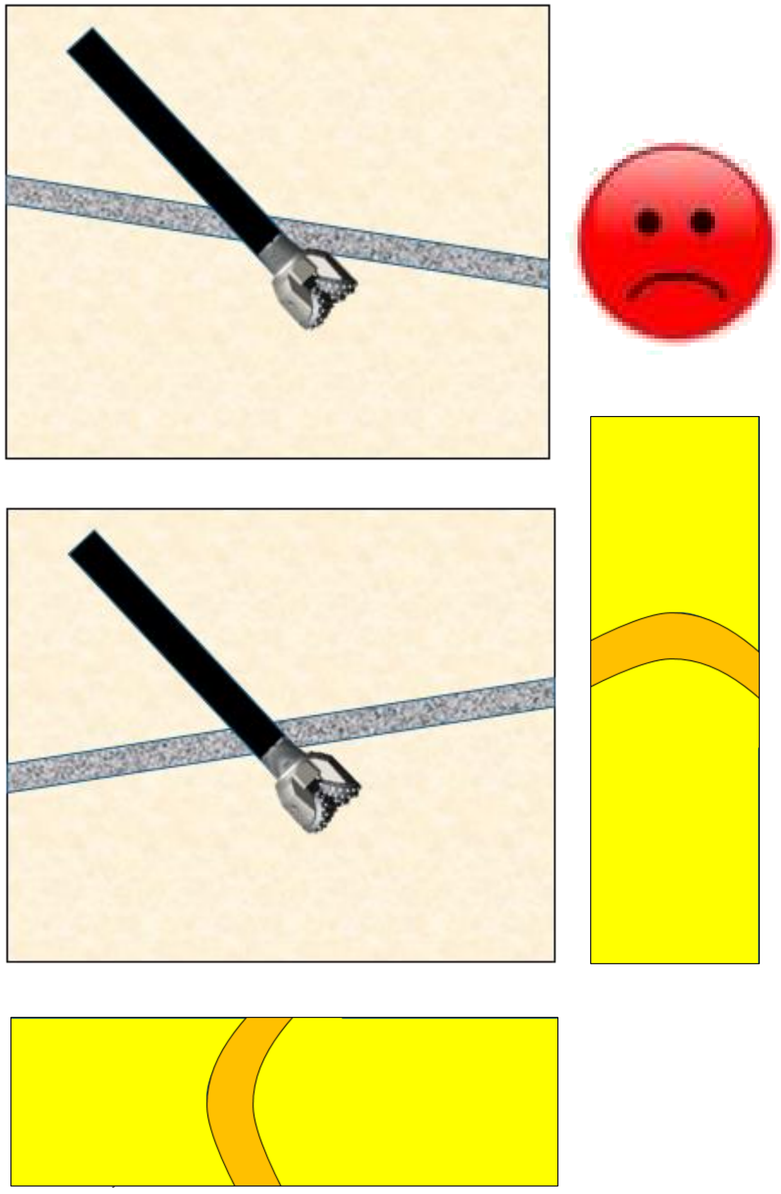
tNavigator® Rock Flow Dynamics

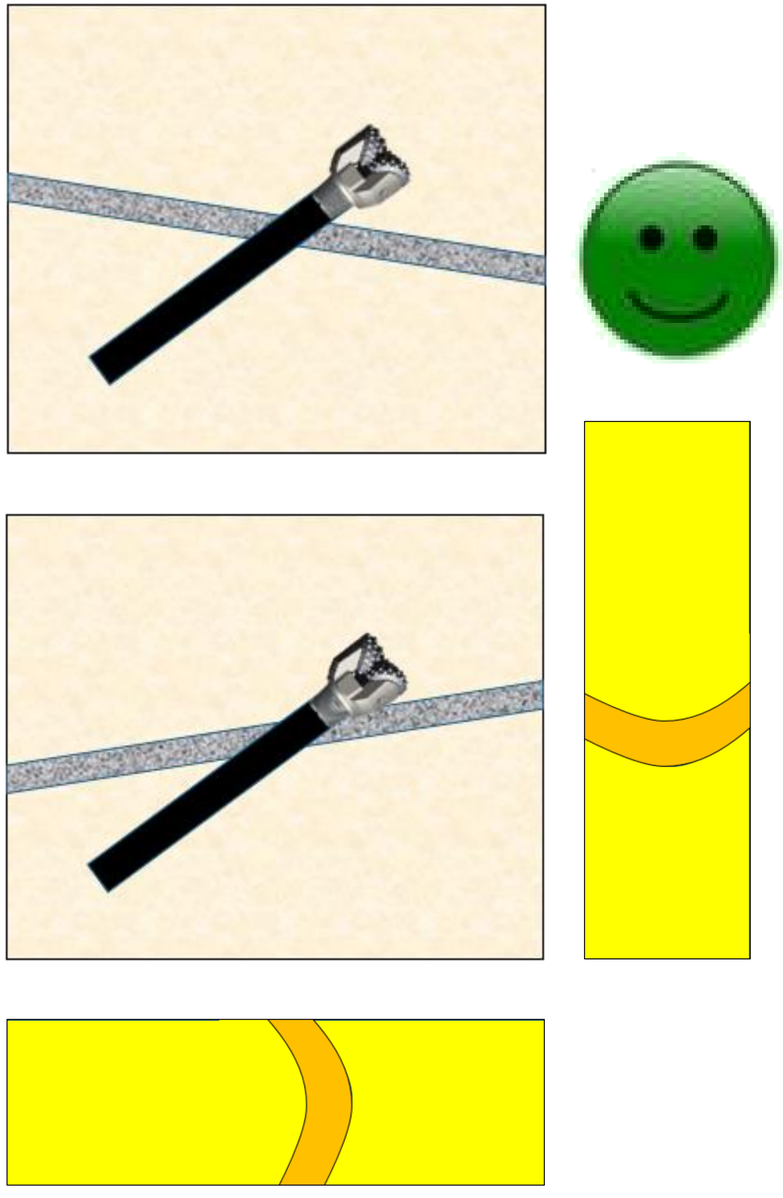
Contents

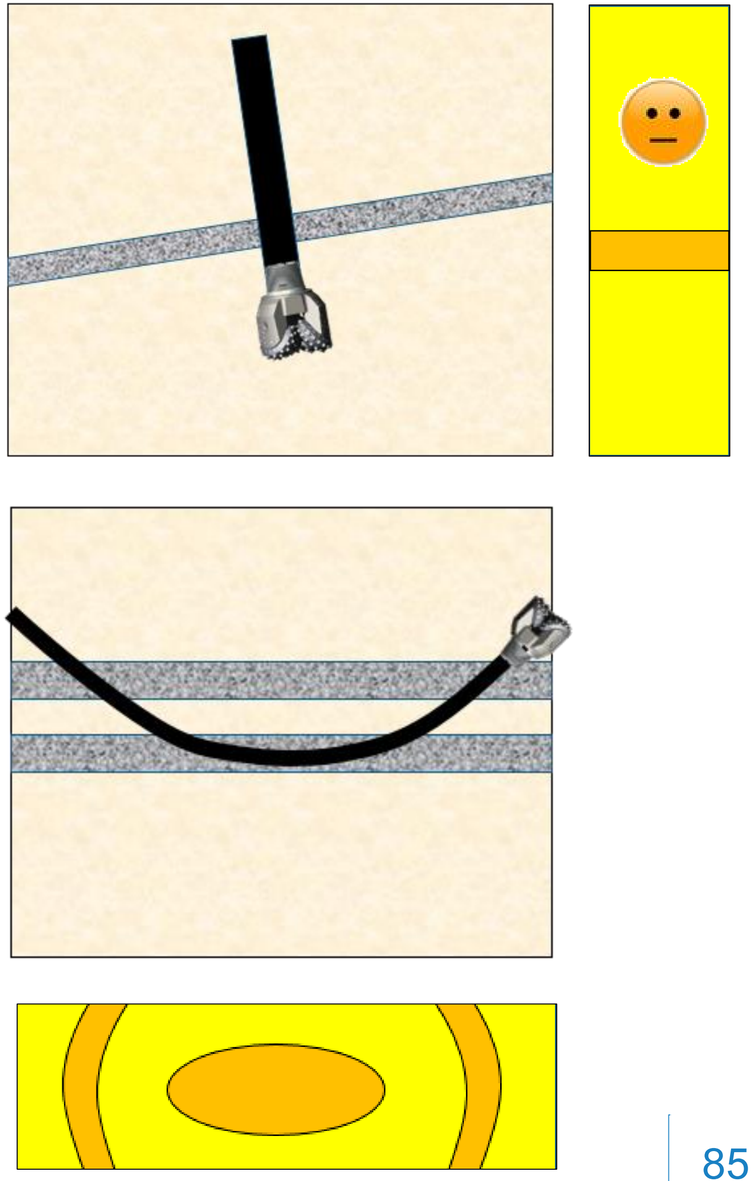
The following options have been added:

- Azimuthal images interpretation during well navigation.
- Automatic calculation of the gap between the drilling bit and the receiver where no geophysical data are present (no logs values).
- Setting a custom location for well names in the Cross-Section panel in the Geosteering tab
- Generation of synthetic images for the drilled well based on the reference well data.

Geosteering: Images interpretation

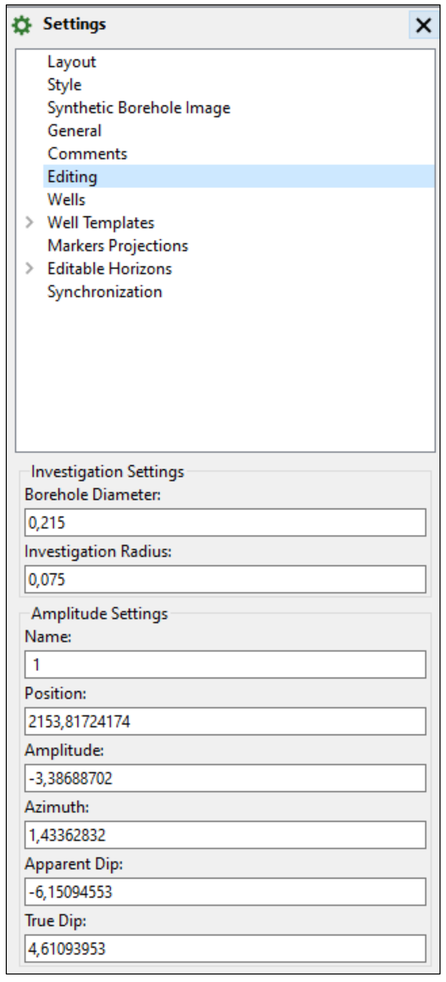


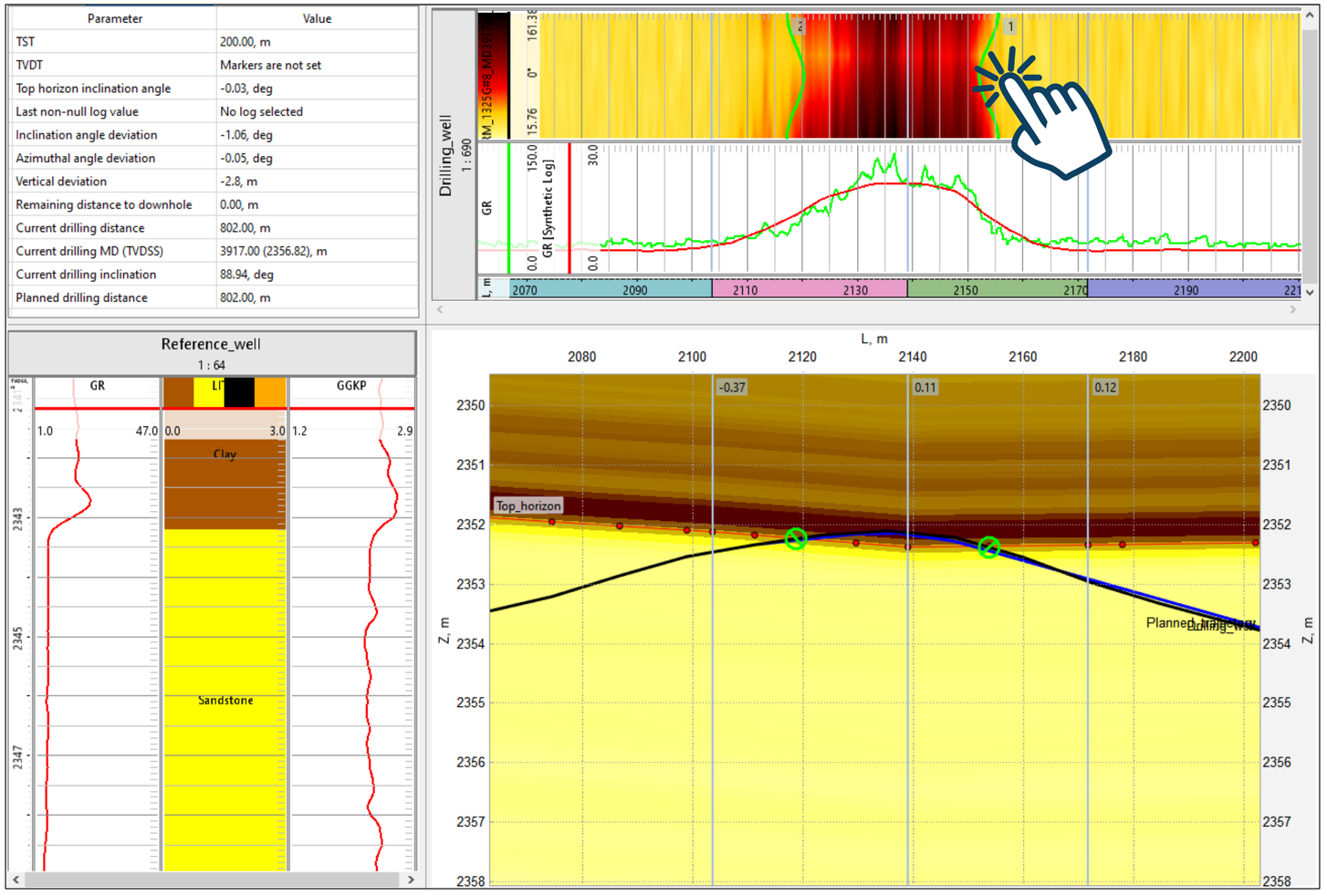


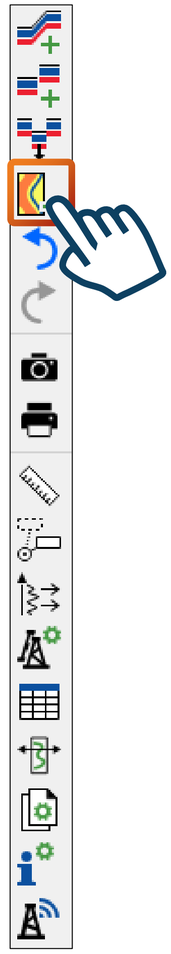


Geosteering: Images interpretation

- **An option for azimuthal images interpretation during well navigation has been added (Geosteering → display the required image → Right Toolbar → click the Add Image Interpretation button)**

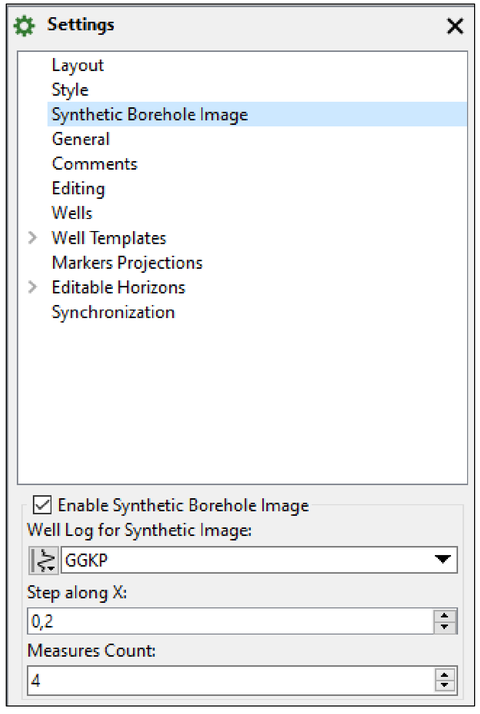


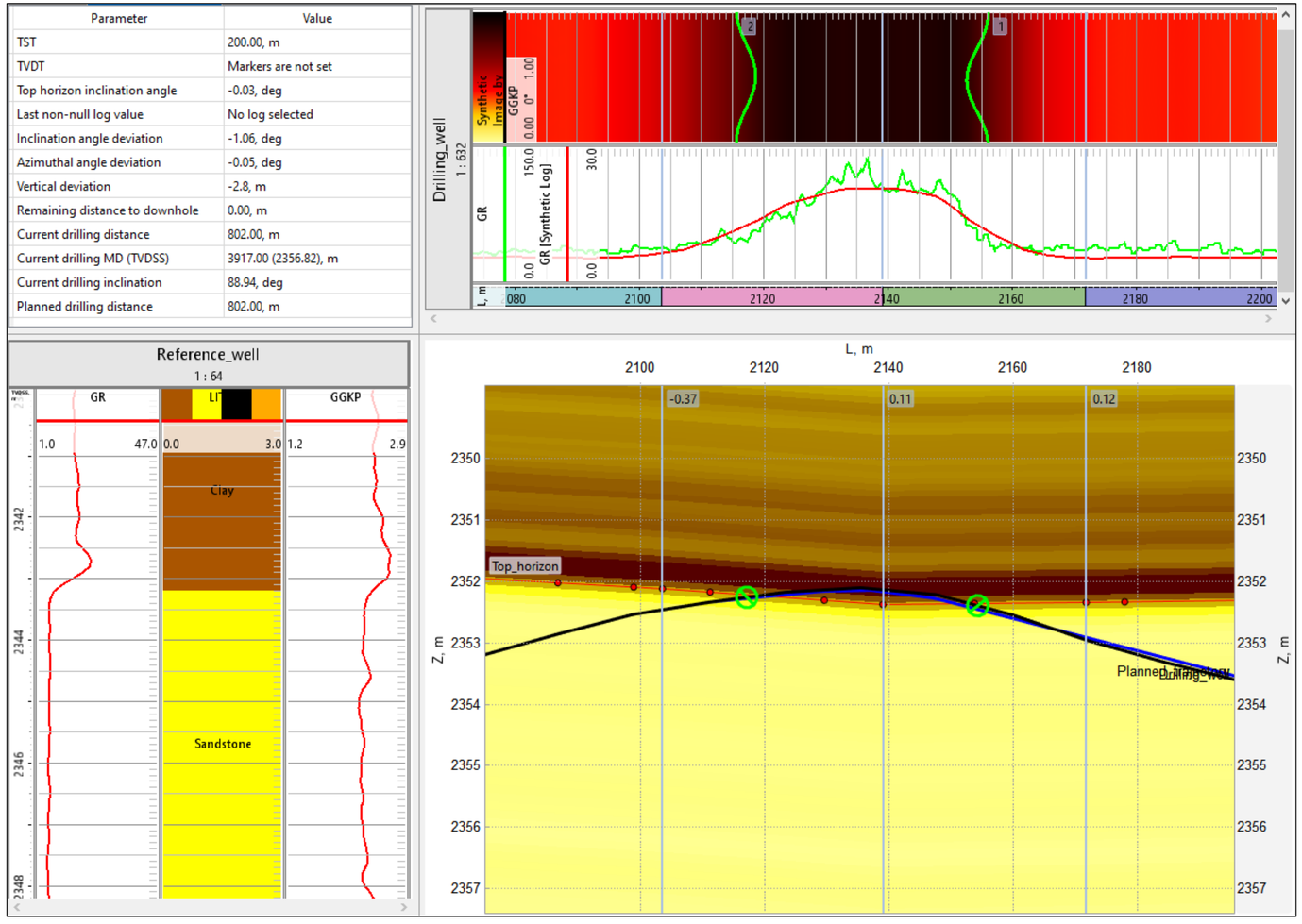




Geosteering: Synthetic images creation

- **An option to generate synthetic images for the drilled well based on the reference well data has been added (Settings → Synthetic Borehole Image → Enable Synthetic Borehole Image → Well Log for Synthetic Image)**



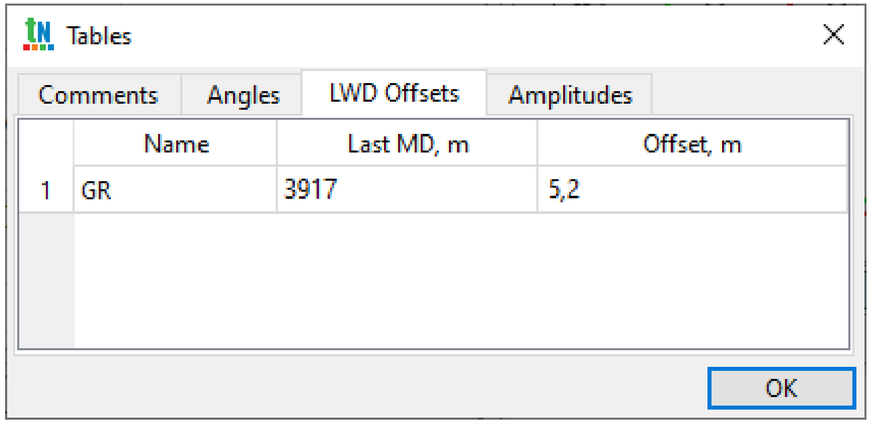


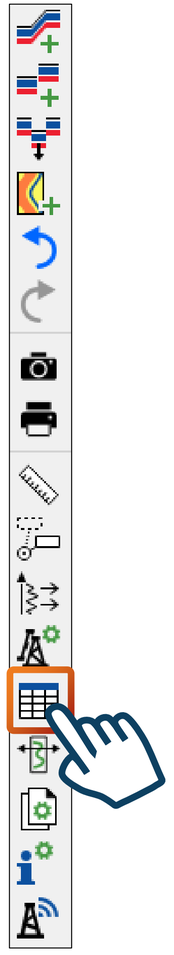
Geosteering: Offset intervals calculation

- **An option for automatic calculation of the distance between the drilling bit and the receiver has been added (Geosteering → Right Toolbar → Open Tables → LWD Offsets)**

```
#=============================================================
~Version information
VERS.   2.0 :
WRAP.   NO :

#=============================================================
~Well
STRT .M  3058.900000 :
STOP .M  3917.500000 :
STEP .M  0 :
NULL .   -999.250000  :
COMP.      : COMPANY
WELL.    Drilling_well : WELL
FLD.       : FIELD
LOC.       : LOCATION
SRVC.      : SERVICE COMPANY
DATE.      : DATE
PROV.      : PROVINCE
UWI.       : UNIQUE WELL ID
API.       : API NUMBER

#=============================================================
~Curve
DEPT .M                  : DEPTH
Rt  .    : Rt
GR  .    : GR
#=============================================================

3911.300000     -999.250000      36.010000
3911.400000     -999.250000      35.380000
3911.500000     -999.250000      35.380000
3911.600000     -999.250000      35.380000
3911.700000     -999.250000      35.380000
3911.800000     -999.250000      35.380000
3911.900000     -999.250000    -999.250000
3912.000000     -999.250000    -999.250000
3912.100000     -999.250000    -999.250000
3912.200000     -999.250000    -999.250000

3917.300000     -999.250000    -999.250000
3917.400000     -999.250000    -999.250000
3917.500000     -999.250000    -999.250000
```

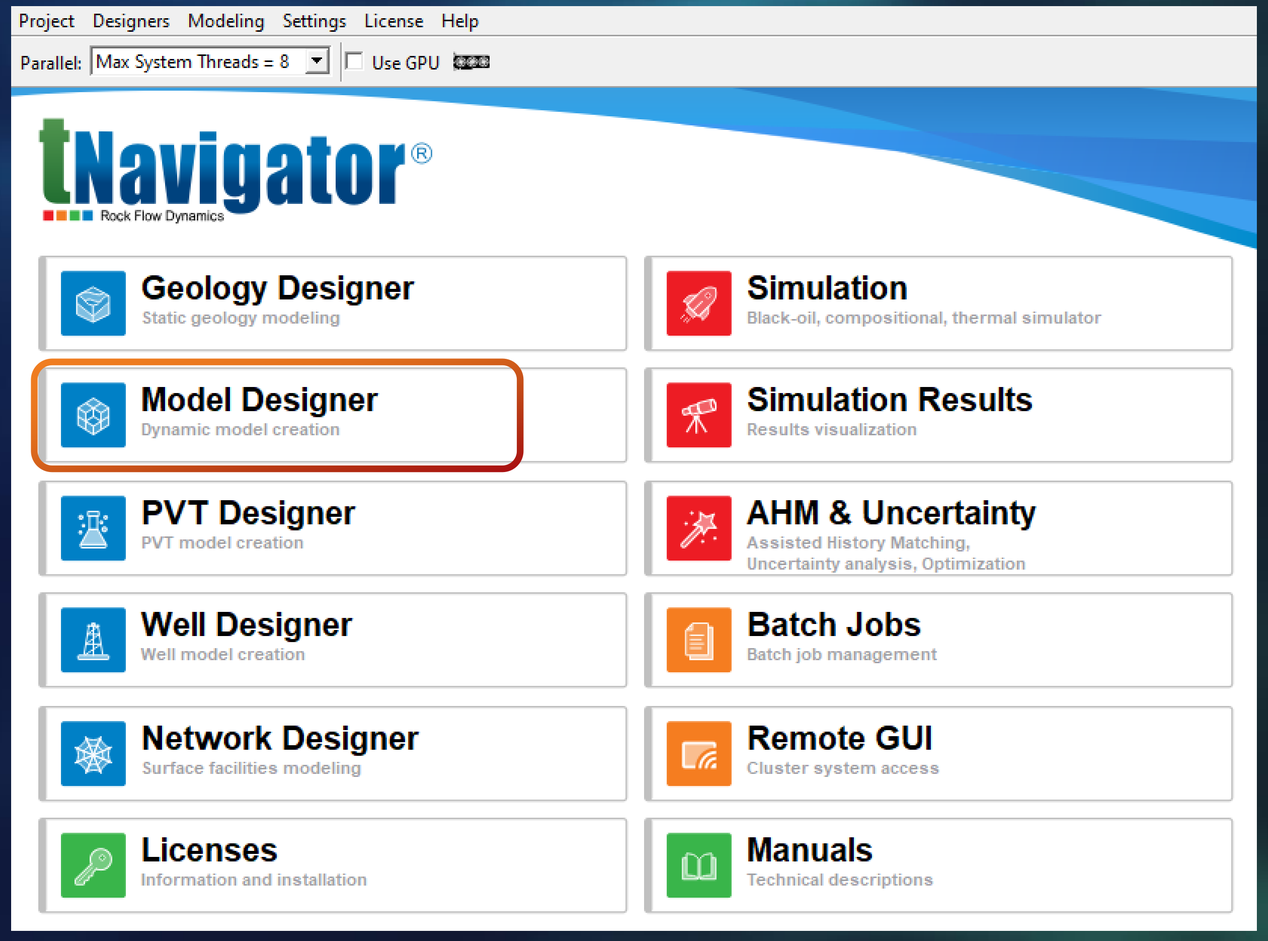
Parameter	Value
TST	200.00, m
TVDT	Markers are not set
Top horizon inclination angle	-0.03, deg
Last non-null log value	No log selected
Inclination angle deviation	-1.06, deg
Azimuthal angle deviation	-0.05, deg
Vertical deviation	-2.8, m
Remaining distance to downhole	0.00, m
Current drilling distance	802.00, m
Current drilling MD (TVDSS)	3917.00 (2356.82), m
Current drilling inclination	88.94, deg
Planned drilling distance	802.00, m





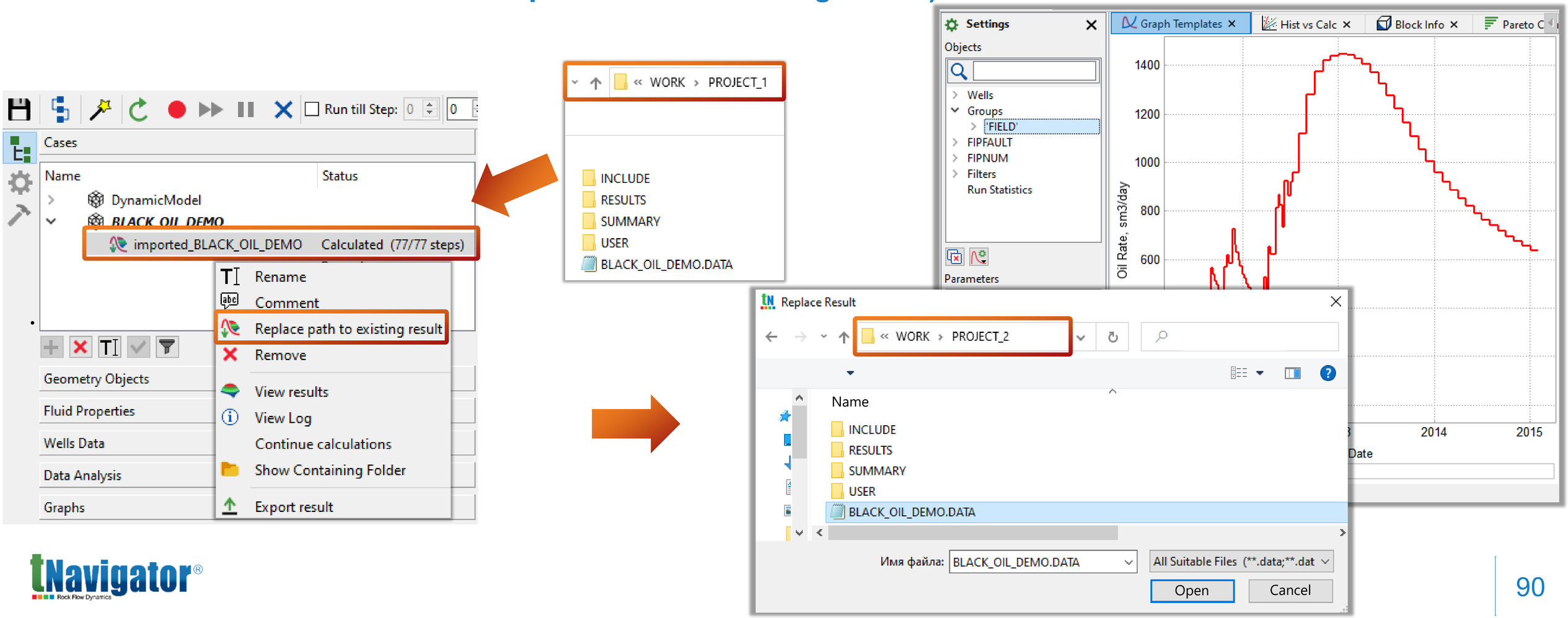
Offset = Current drilling MD – MD of the last non-null log value = 3917.0 – 3911.8 = 5.2m

Model Designer



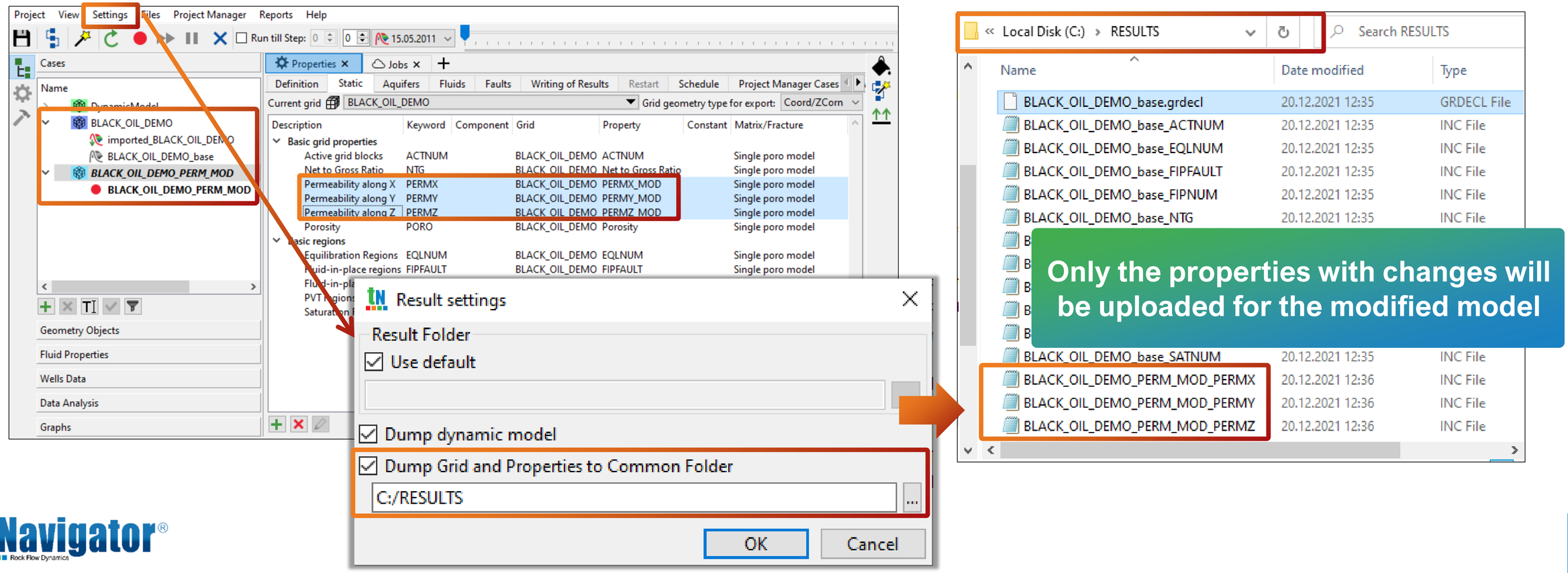
Change the path to loaded calculation results

- It is now possible to change the path to loaded calculation results. It allows using calculation results of other users (including for restarts) after copying the project to another folder (Cases → DynamicModel name → RMB on the result → Replace Path to Existing Result)



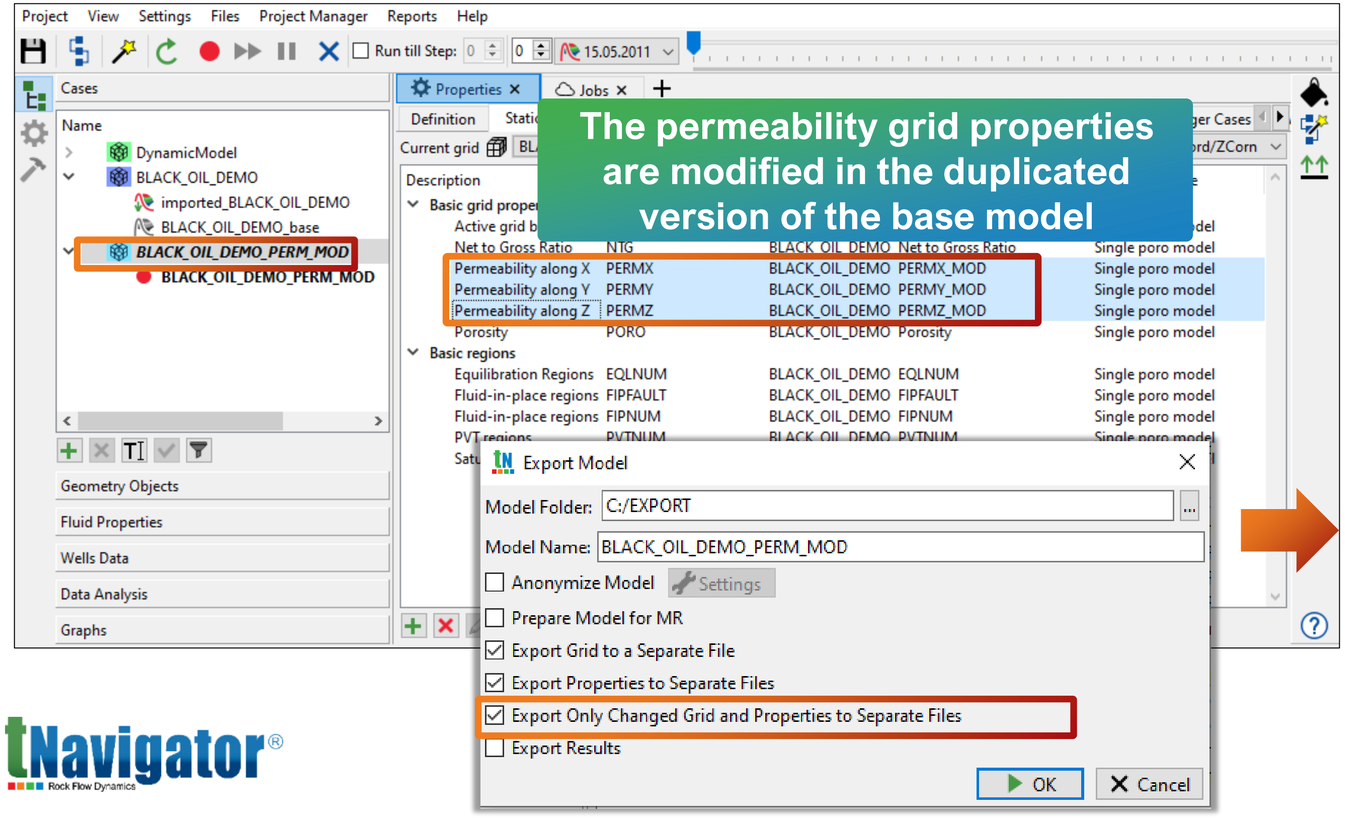
Optimizing the output size of several models with the same grids during initialization

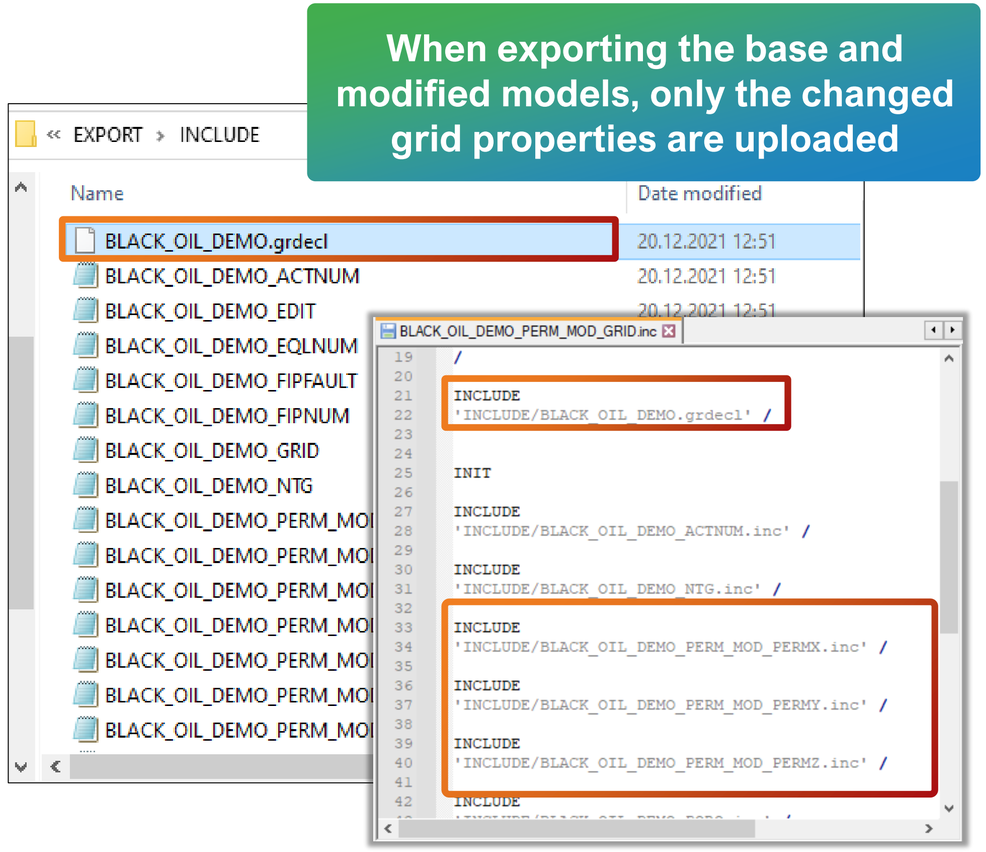
- **The grid properties and data of models can now be uploaded to a specified folder (in this case, the properties without changes will not be uploaded) (Settings → Result Settings → Dump Grid and Properties to Common Folder)**



Optimizing the output size of several models with the same grids during export

- **It is now possible to optimize the size of the output of included files for different cases of simulation models that have one base model (Cases → RMB on DynamicModel name → Export Model → Export Only Changed Grid and Properties to Separate Files)**



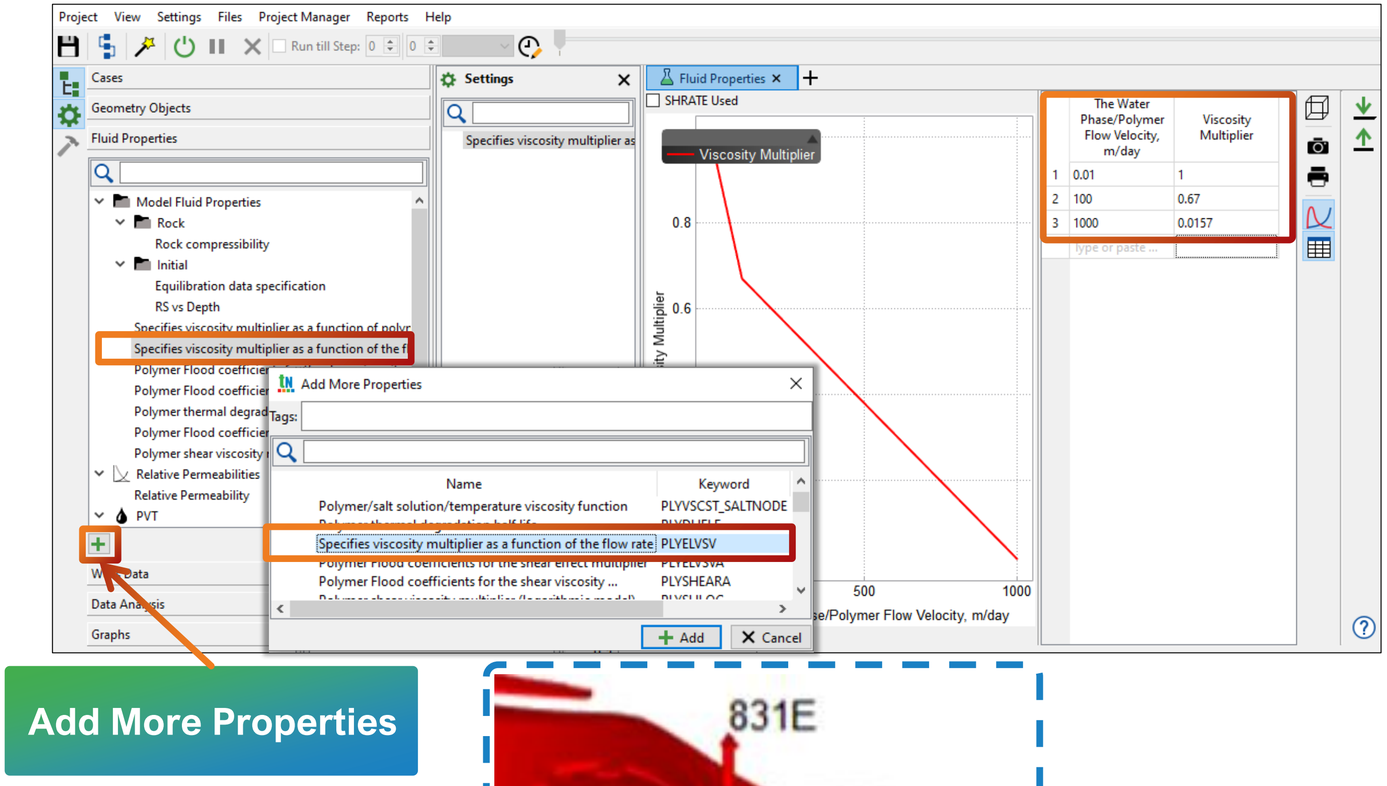


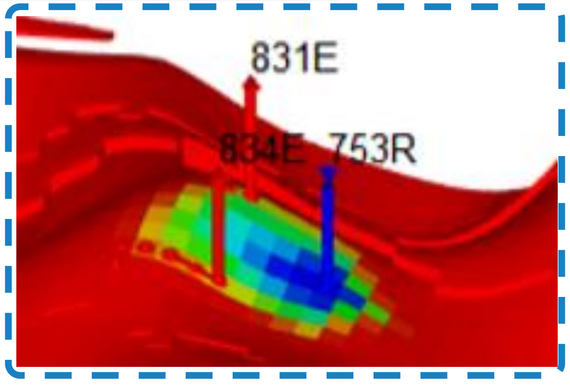
Polymer injection

- **The following fluid properties associated with the analytical model of polymer injection are now supported**

  (Fluid Properties → EOR; Cases → Static)

- **PLYELVSC** is for the elongational viscosity multiplier as a function of the polymer concentration in a table
- **PLYELVSV** is for the elongational viscosity multiplier as a function of the stream velocity
- **PLYELVMAXA, PLYELVSVA** are for the elongational viscosity multiplier in analytical form
- **PLYDHFLF** is for the temperature-dependent polymer half-life period
- **PLYSHEARA** is for the shear viscosity multiplier
- **PLYKRRF**: rock permeability for the purposes of polymer calculation is now supported
- **PLYSHLOG** is for the logarithmic law of the dependence of the viscosity multiplier on the flow velocity



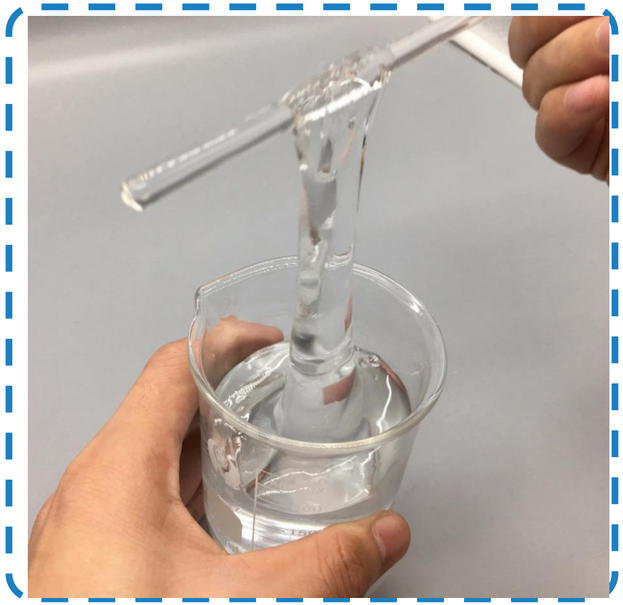


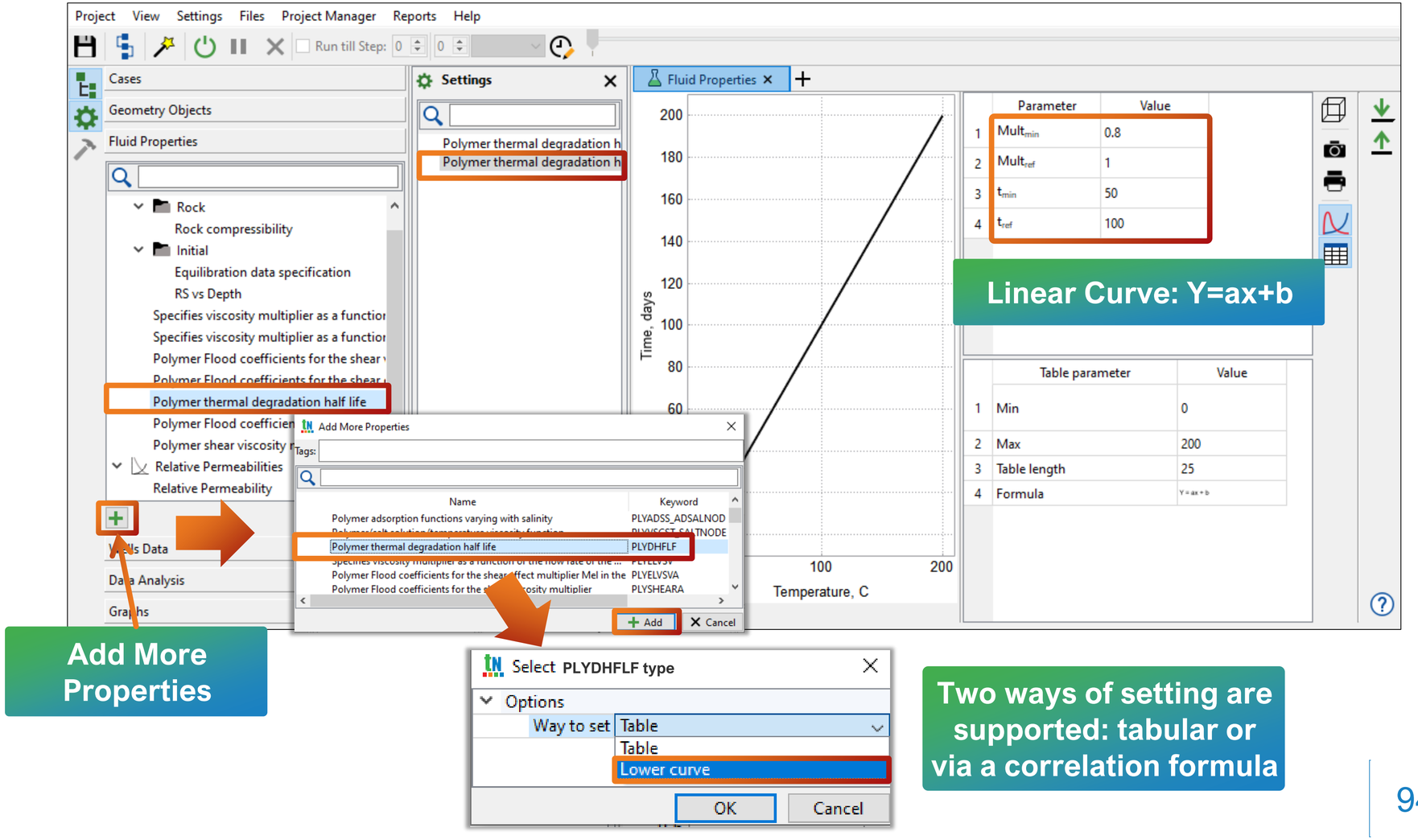
Correlations for polymer properties

- **It is now possible to set polymer half-life period (PLYDHFLF) versus temperature as a correlation**

  (Fluid Properties → EOR)

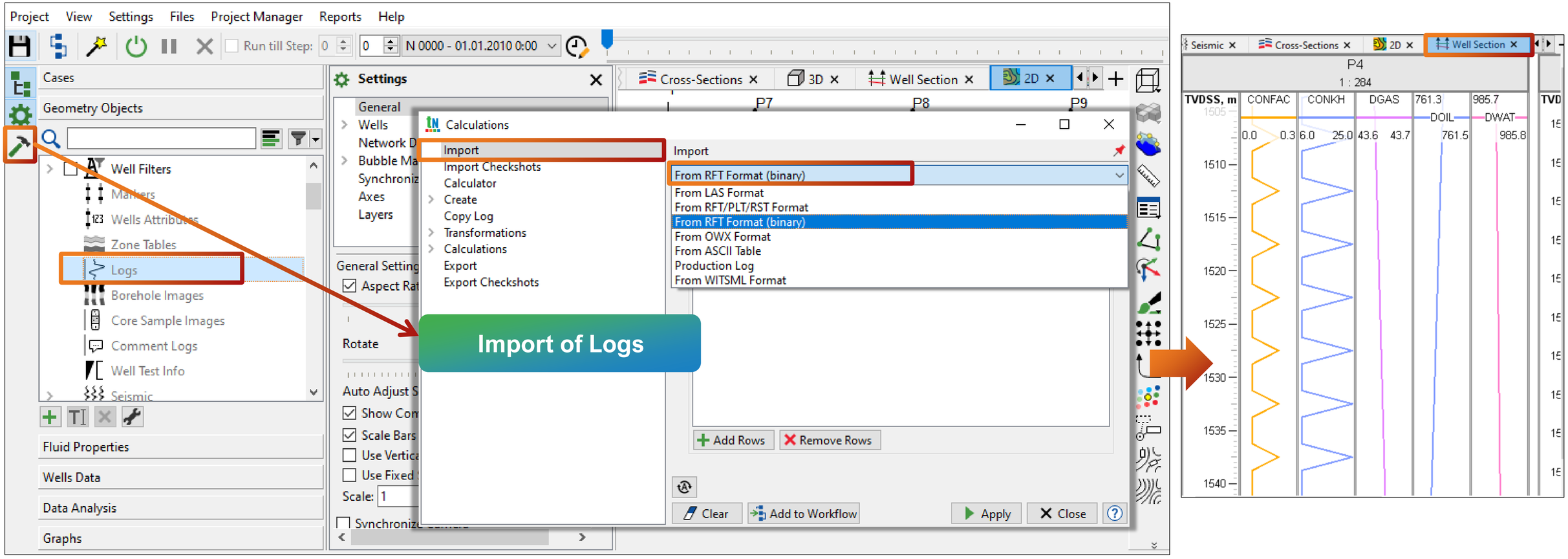
PLYDHFLF is for the temperature-dependent polymer half-life period





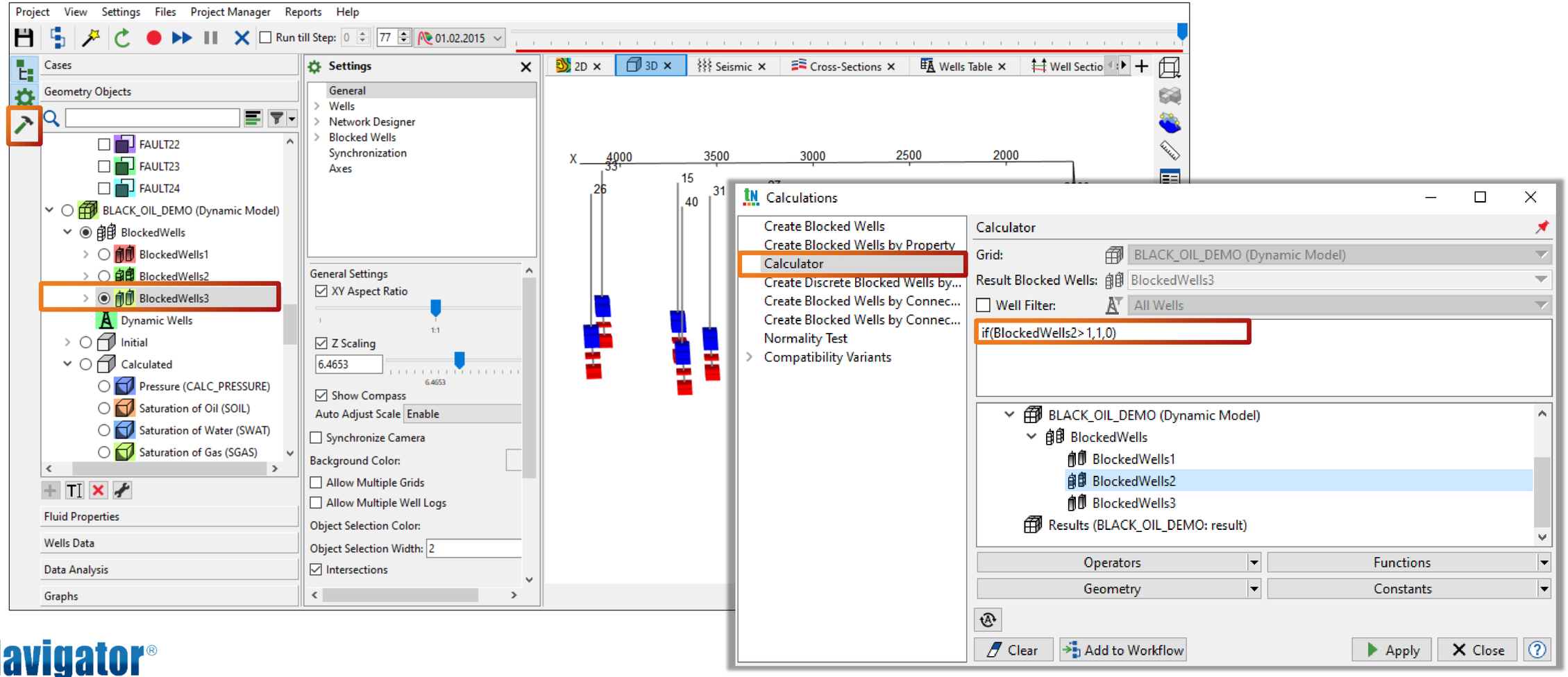
Logs in RFT binary format

- **Import of Logs in RFT binary format is now supported (Geometry Objects → Logs → Import → From RFT Format (binary))**



BlockedWells calculator

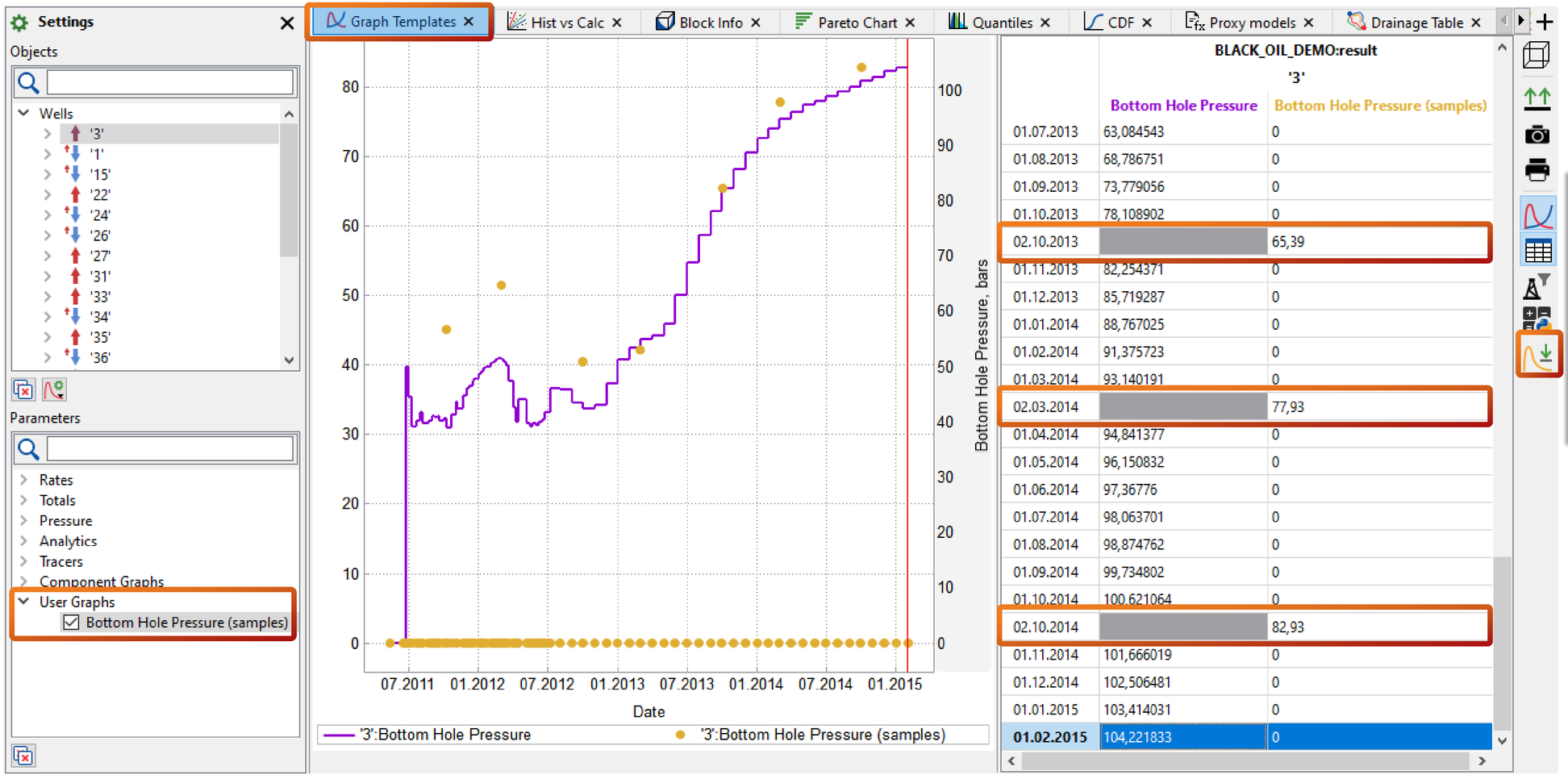
- **It is now possible to work with dynamic model data using arithmetic operations in the BlockedWells calculator (Geometry Objects → BlockedWells → Calculations → Calculator)**

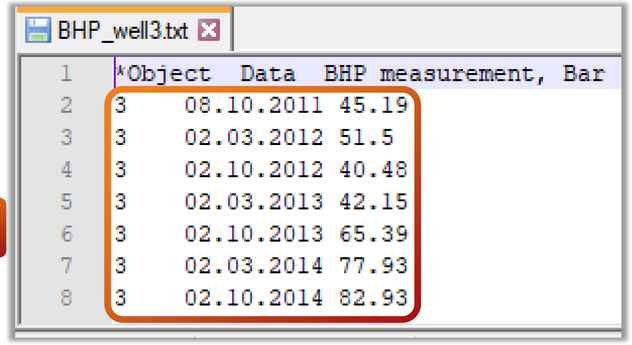


Load graphs with arbitrary dates

- **It is now possible to load graphs with arbitrary dates (which may differ from those set in the model)**

  (Graphs → Graphs Templates → Load Graphs)

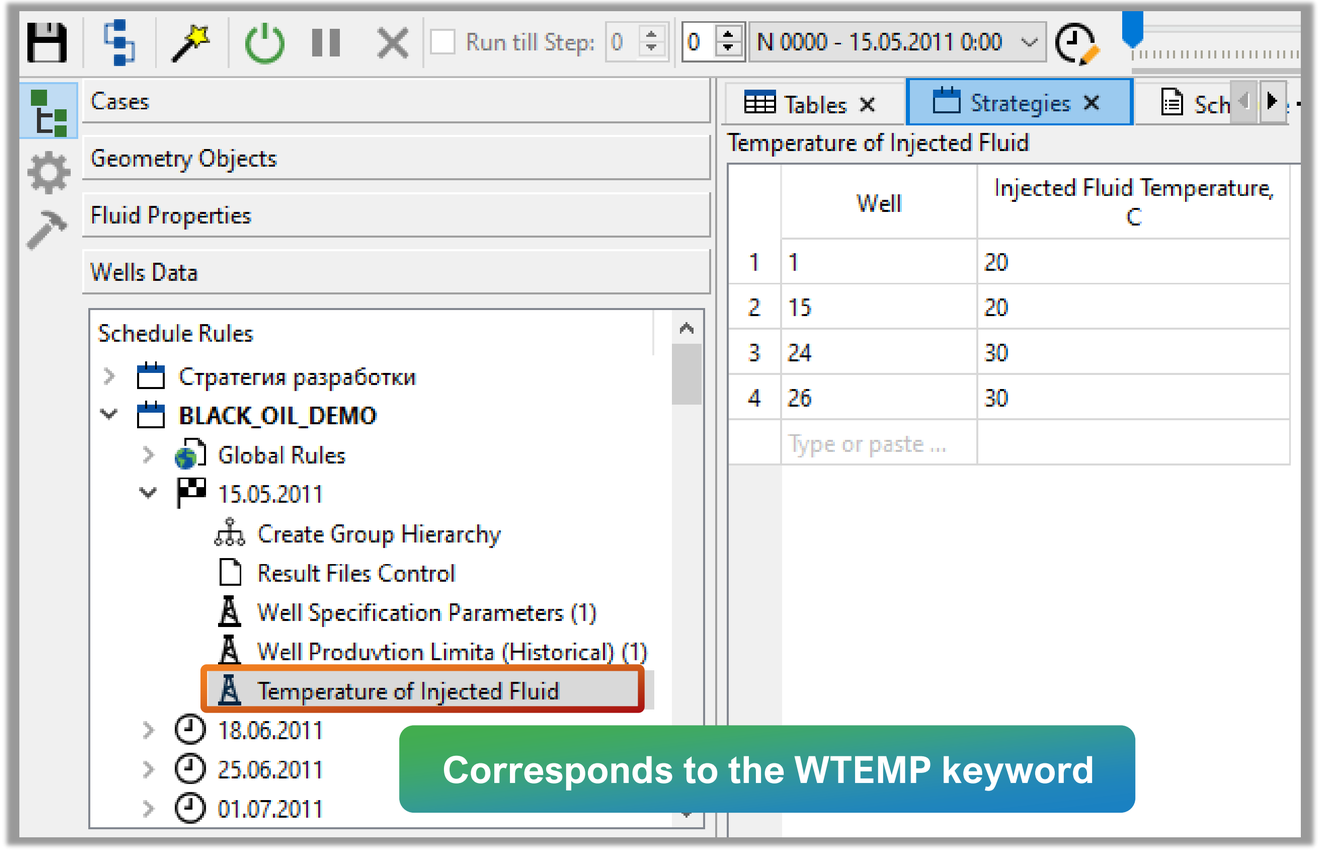


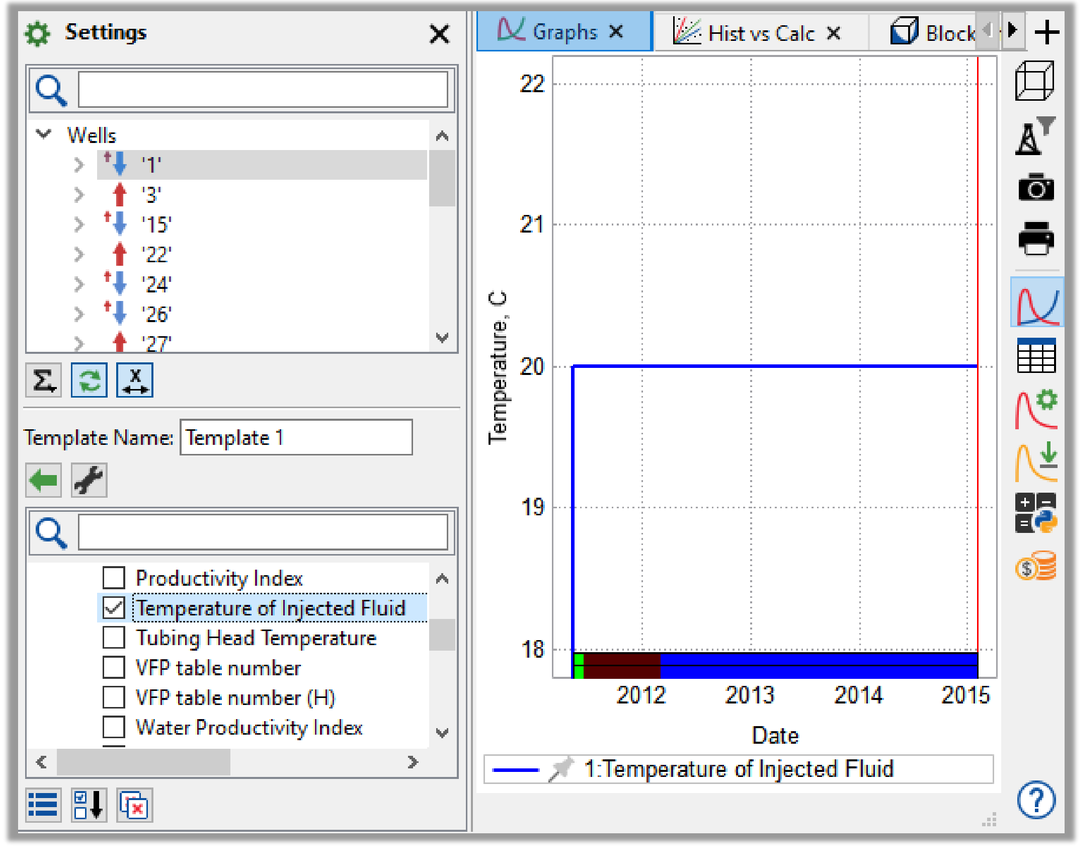


The rule Temperature of Injected Fluid

- **A rule to set the temperature of injected fluid is now supported (corresponds to the WTEMP keyword)**

  (Strategies → Thermal Properties → Temperature of Injected Fluid)



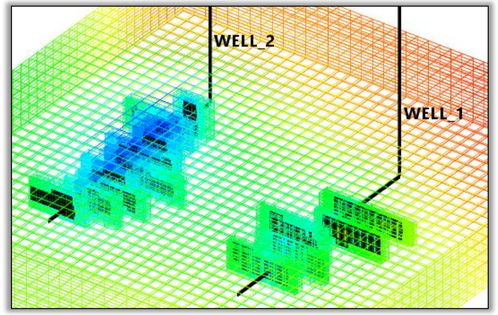


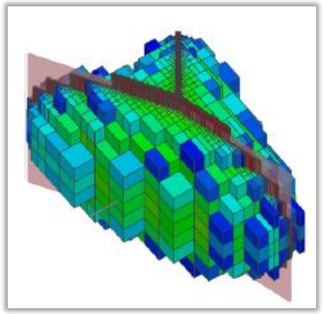
Fracture Simulator

tNavigator® Rock Flow Dynamics

Contents

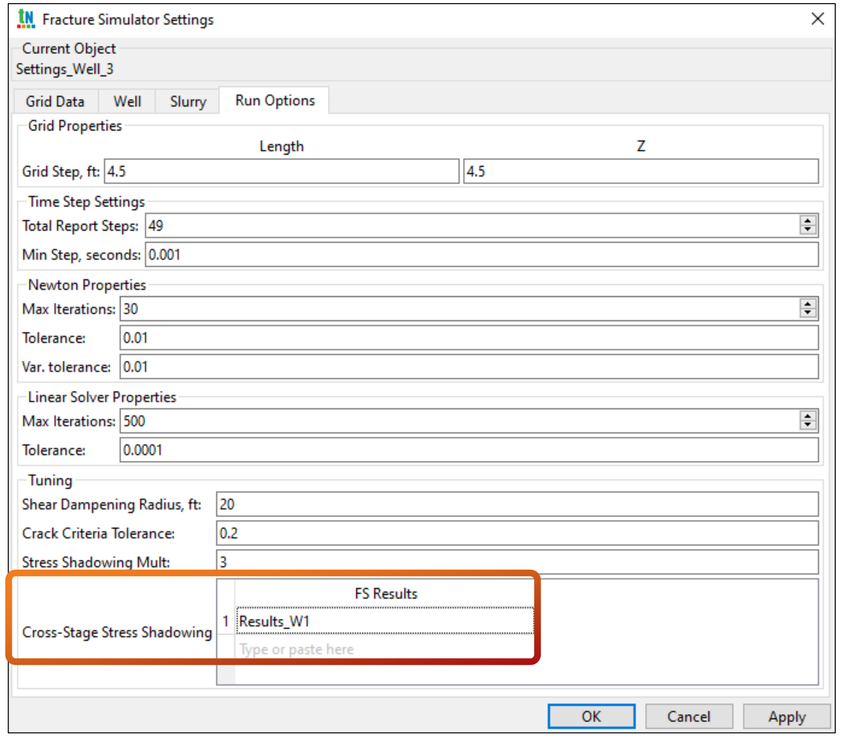
- It is now possible to take into account the mutual influence of fractures implemented at different wells to model the fracture stage at the current well
- Automatic use of calculated properties in the simulation model for the calculation of fracturing stages is now supported



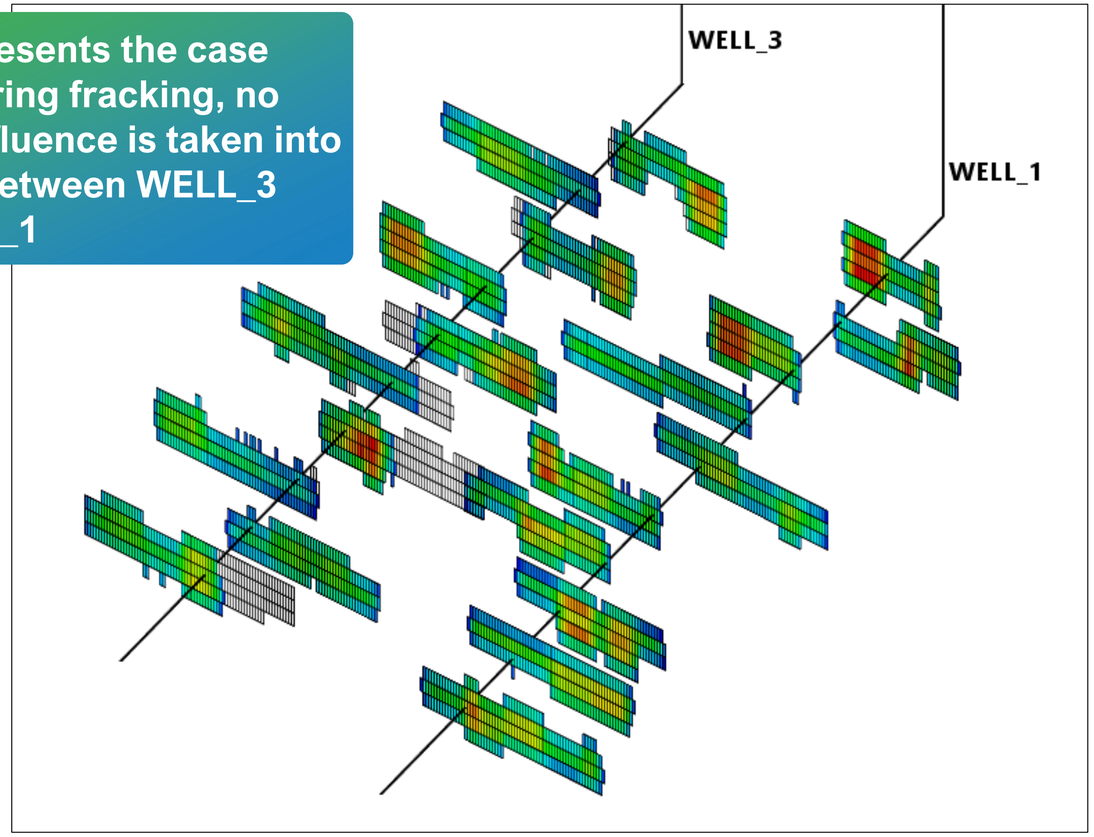


Stress Shadowing between Wells

- It is now possible to take into account the mutual influence of fractures implemented at different wells to model the fracture stage at the current well. To do this, in Fracture Simulator Settings the user should specify the calculated fracturing stages that will be taken into account, as well as the start of the injection

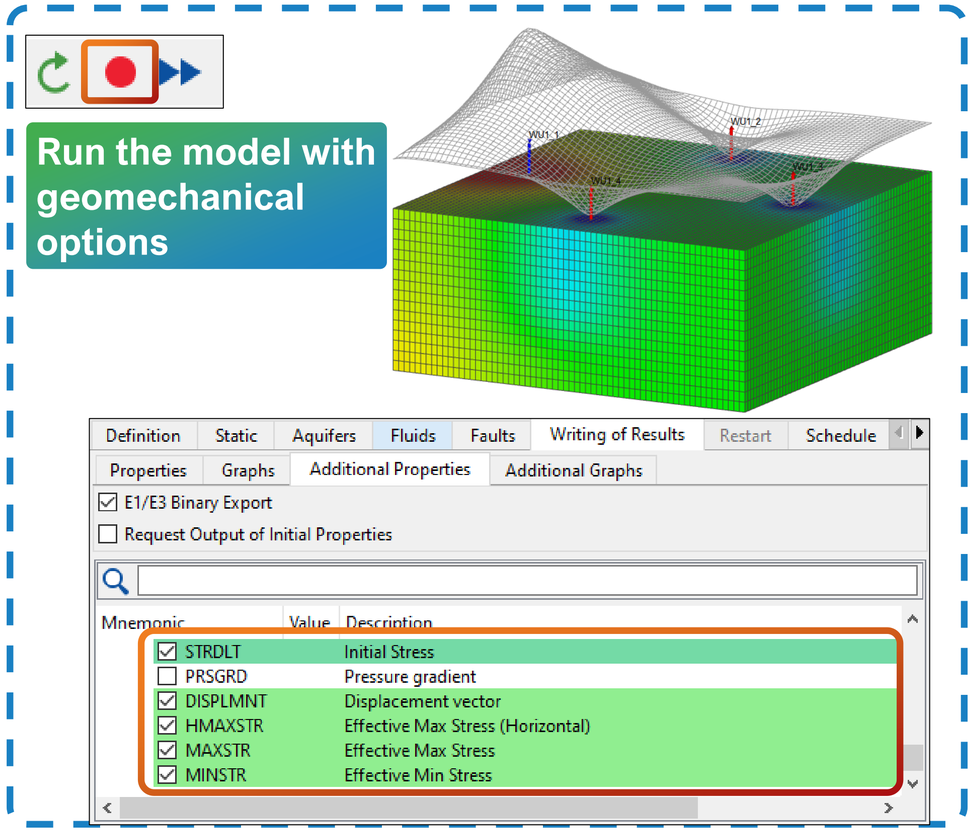


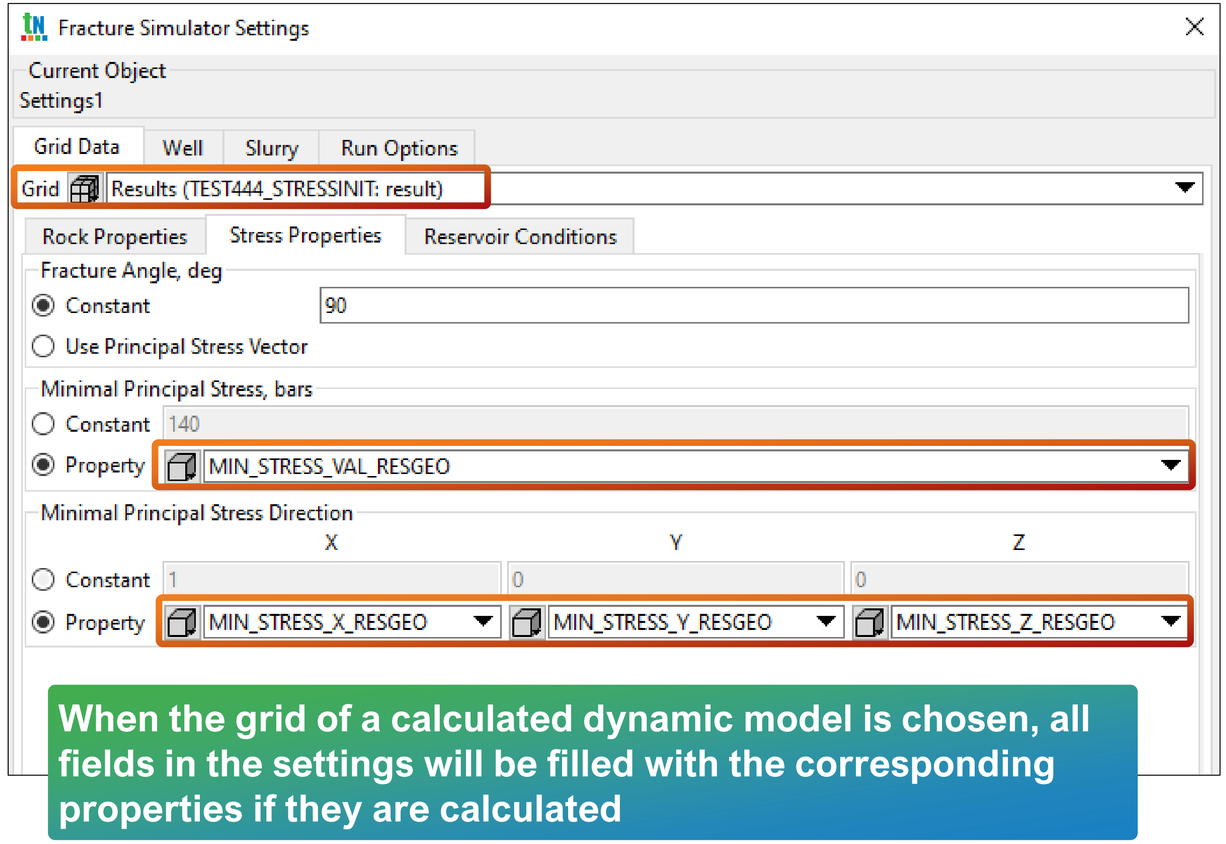
Gray represents the case where during fracking, no mutual influence is taken into account between WELL_3 and WELL_1



Use Calculated Props from the Dynamic Model

- **Automatic use of calculated properties in the simulation model for the calculation of fracturing stages is now supported. Grid properties for the stage will be automatically set from the dynamic model calculated for the reporting date which is closest to the stage creation date**

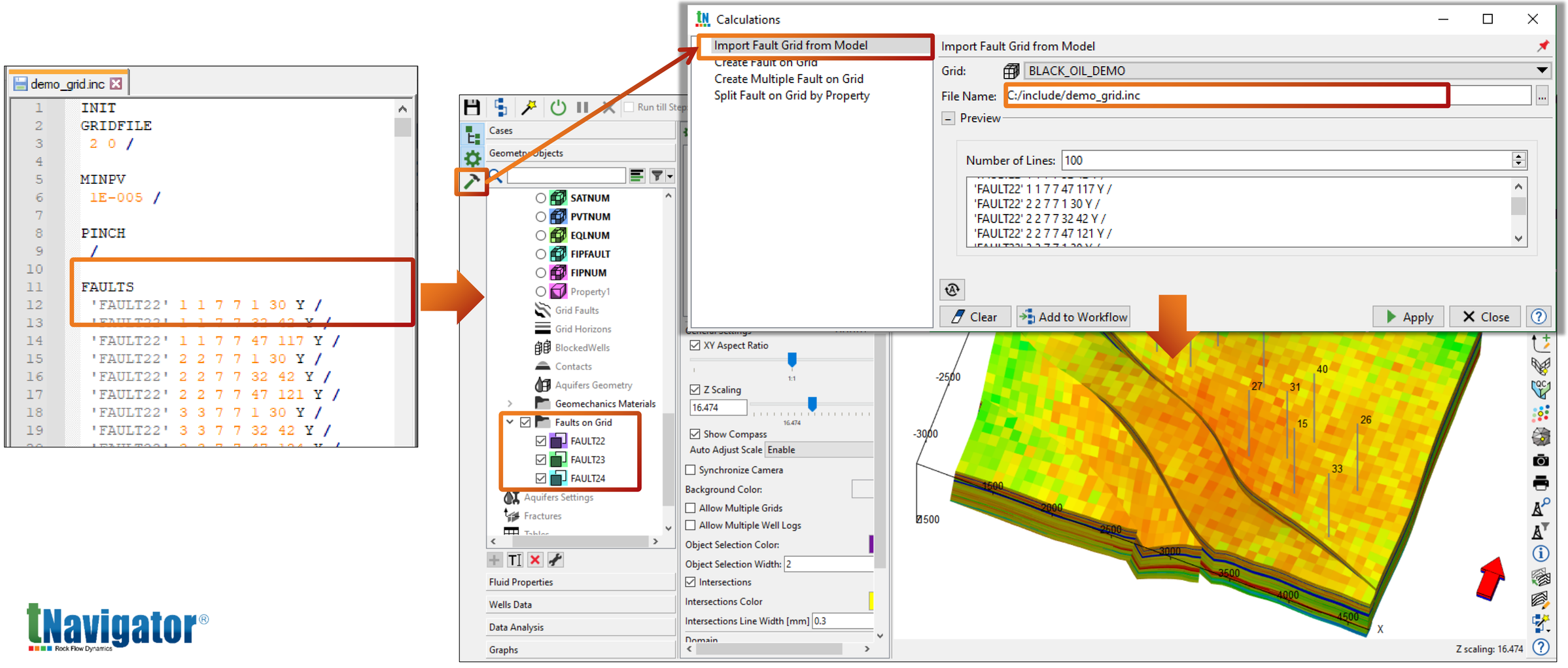




When the grid of a calculated dynamic model is chosen, all fields in the settings will be filled with the corresponding properties if they are calculated

Import Fault data from an external file

- It is now possible to import fault data from a model or an external file. In this case, the fault data must be specified using the **FAULTS** keyword **(3D-Grids → Faults on Grid → Import Fault Grid from a Model)**

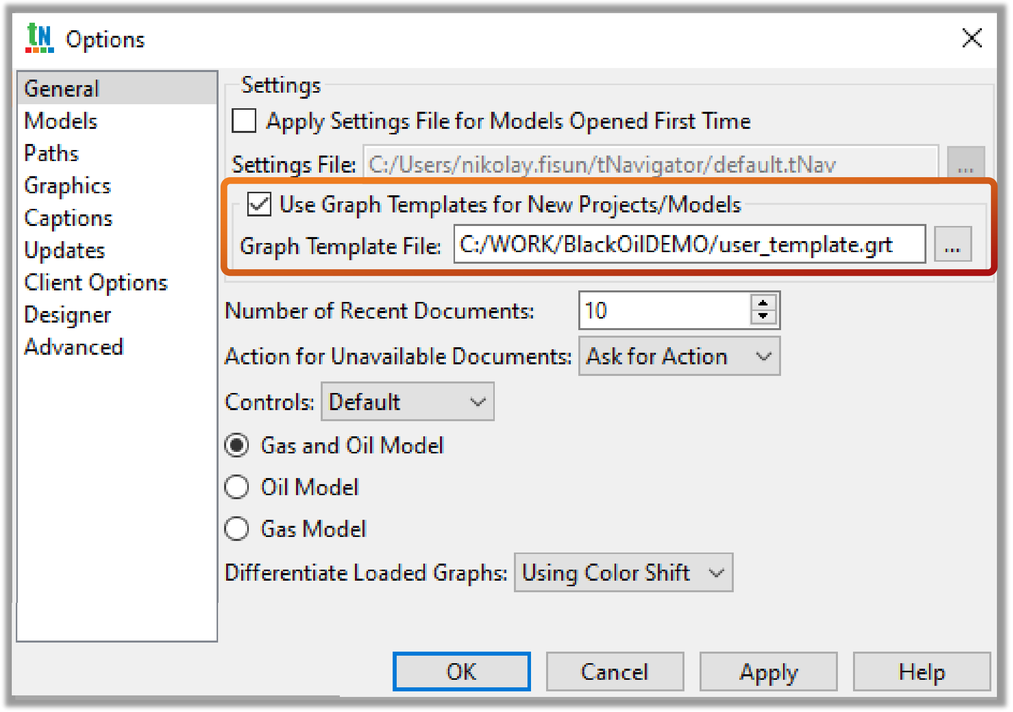


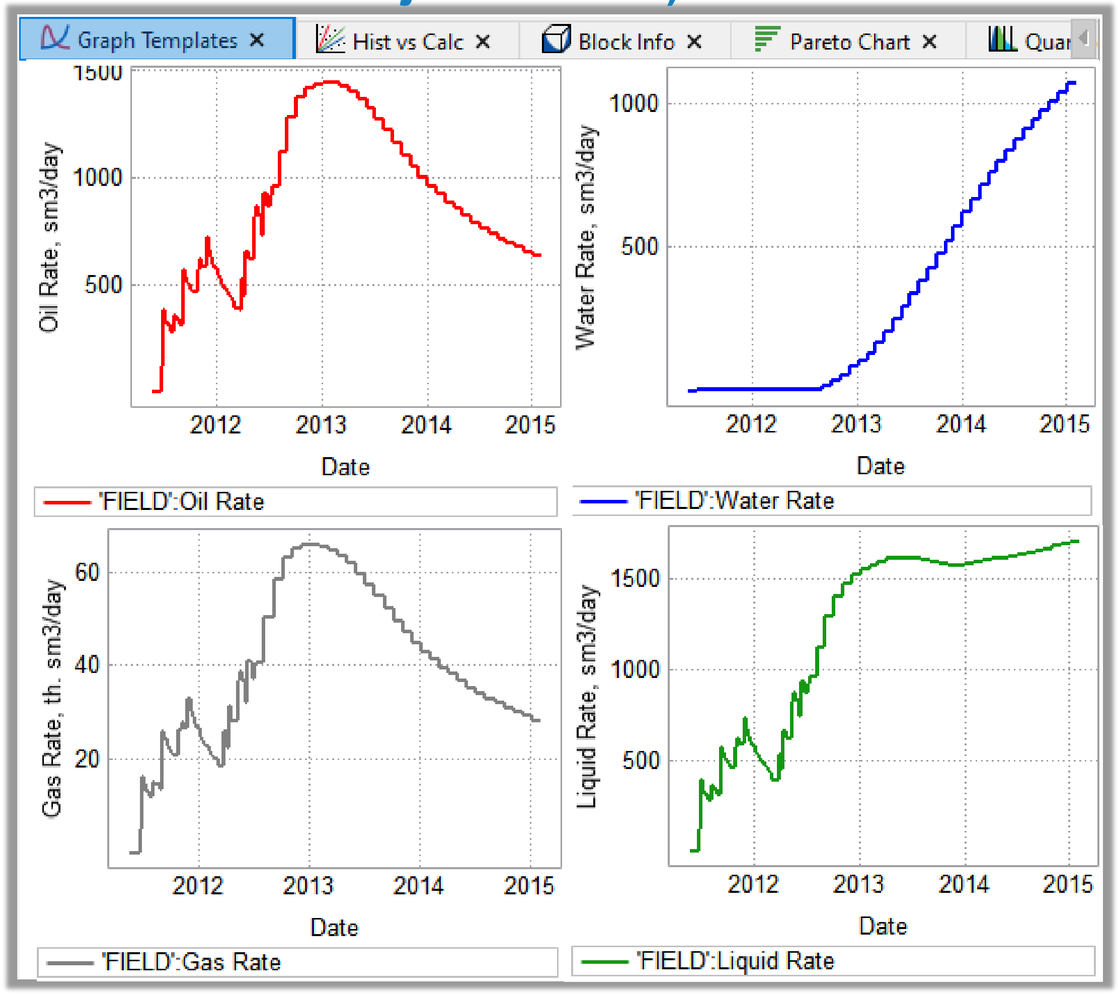
Automatic graph template loading

- **It is now possible to load graph templates automatically for new projects.**

  It allows use of pre-prepared graph templates to analyze field development parameters

  (Settings → Options → General → Use Graph Templates for New Project/Models)





RP Designer

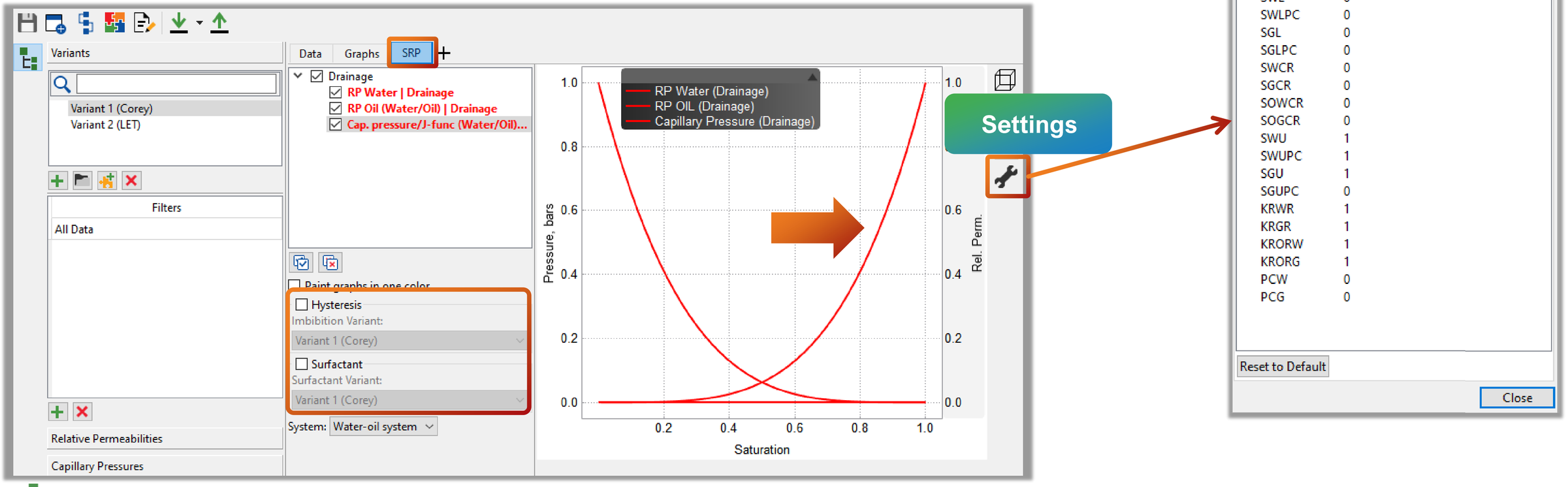
tNavigator® Rock Flow Dynamics

Contents

- The SRP tab has been added (scaled relative permeabilities)
- The hysteresis effect can now be calculated
- RP curves can now be visually edited by changing endpoints
- Multiple graphs' colors can be edited at once

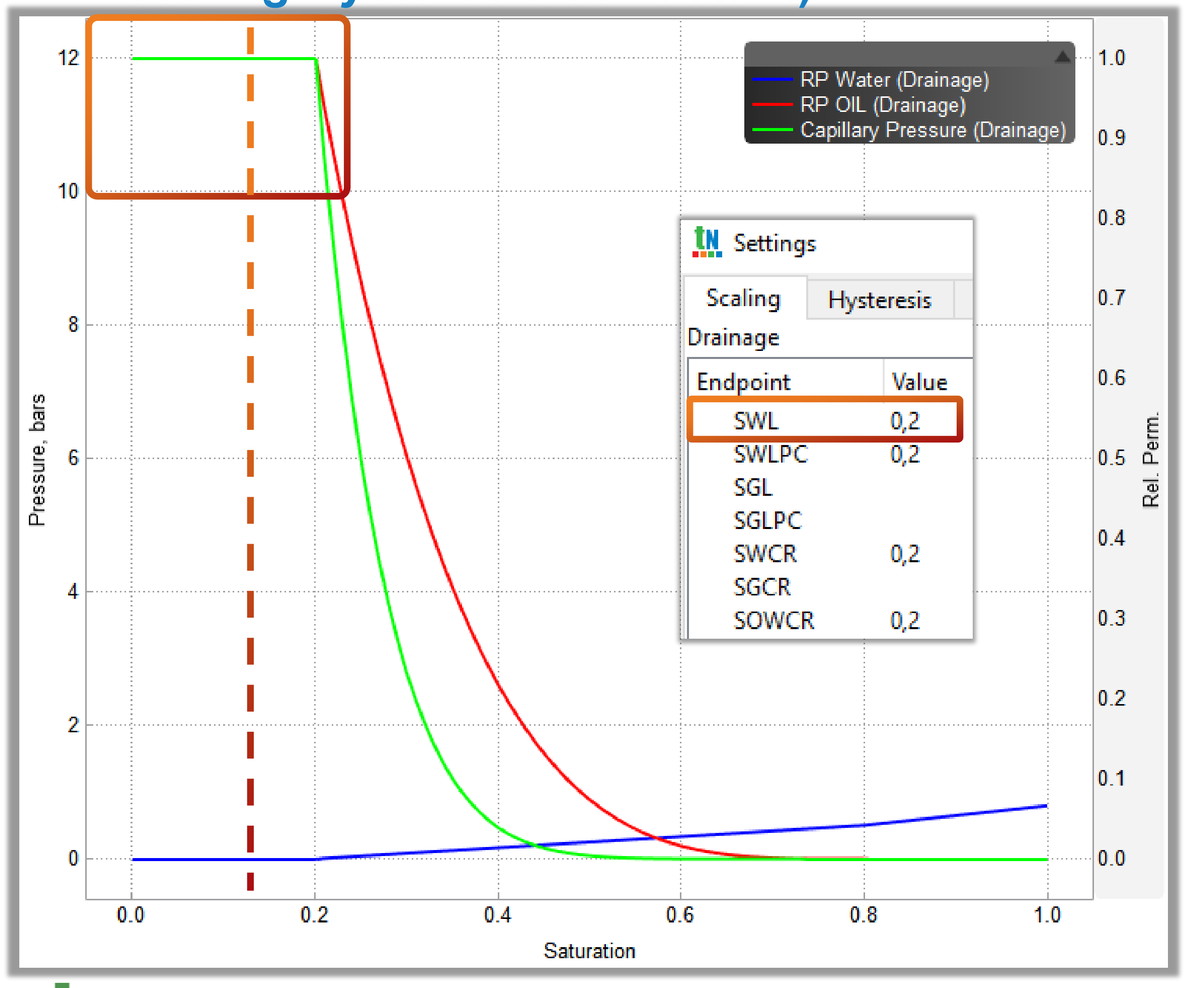
RP Designer: SRP tab (scaled relative permeabilities)

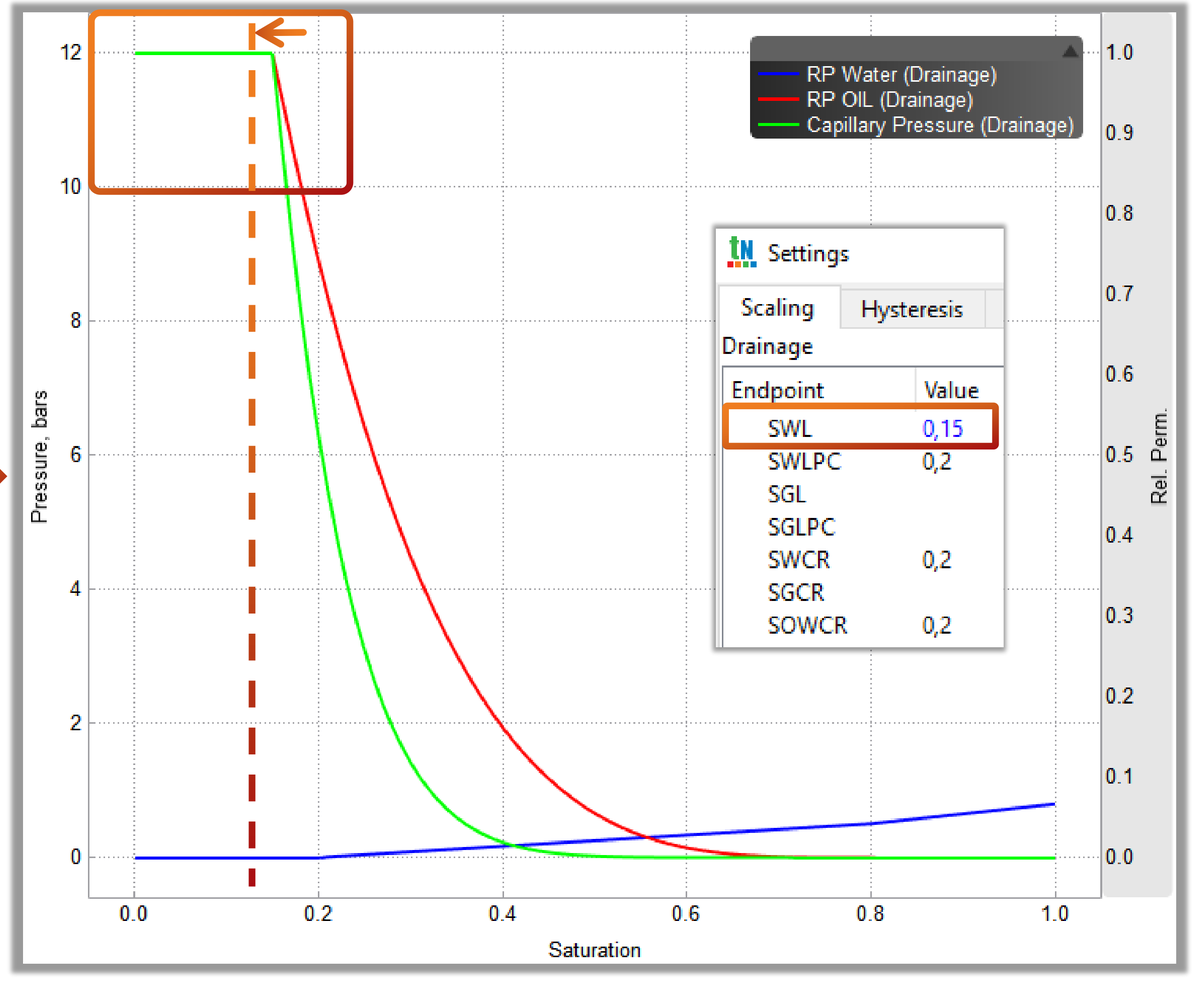
- **The SRP tab provides the following possibilities:**
  - **to visualize RP curves while changing endpoints;**
  - **to calculate the effect of hysteresis;**
  - **to calculate RP curves in the presence of surfactants**



RP Designer: change RP endpoints

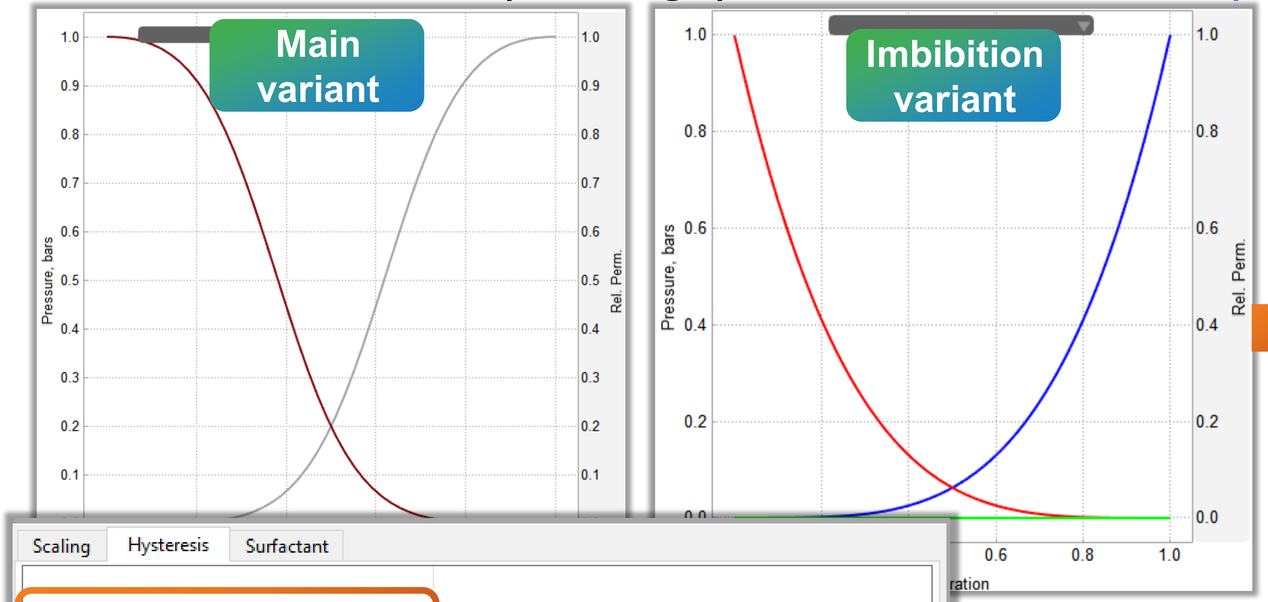
- **It is now possible to visualize RP curves while changing endpoints (Variants → SRP → Settings → Scaling/Hysteresis/Surfactant)**

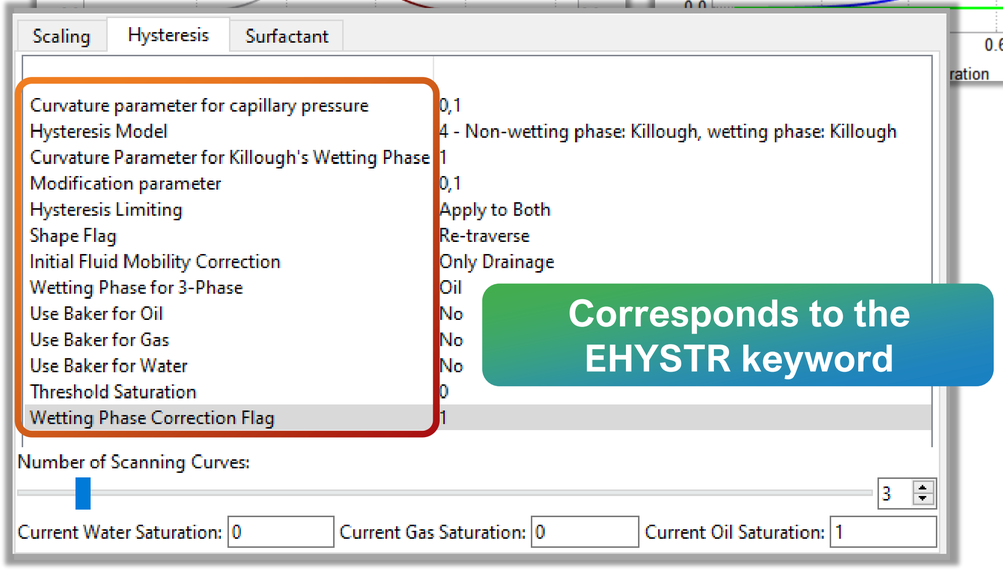


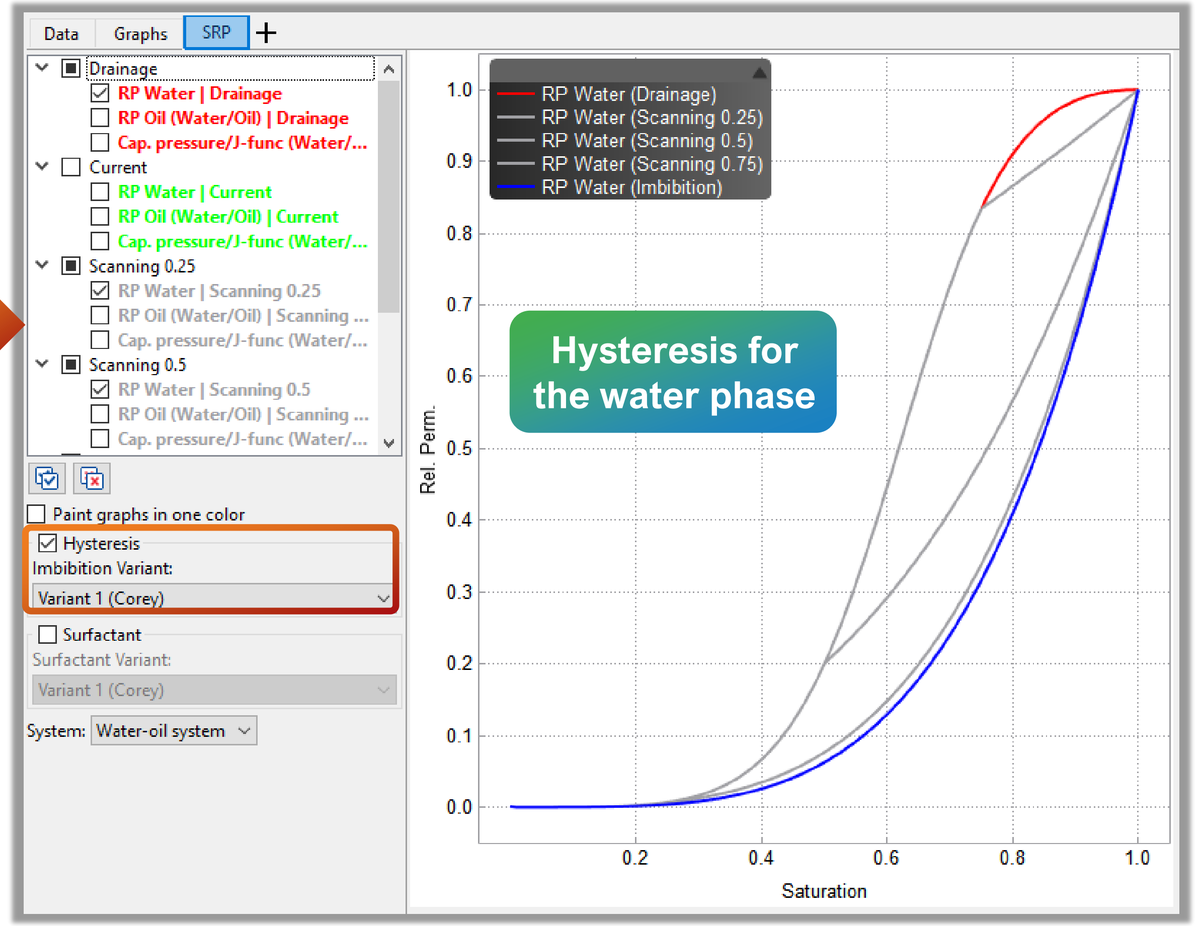


RP Designer: the Hysteresis option

- The new SRP tab allows the calculation of the hysteresis effect. It is now possible to select a variant for the main curve (drainage), the imbibition curve (Variants → SRP → Hysteresis)

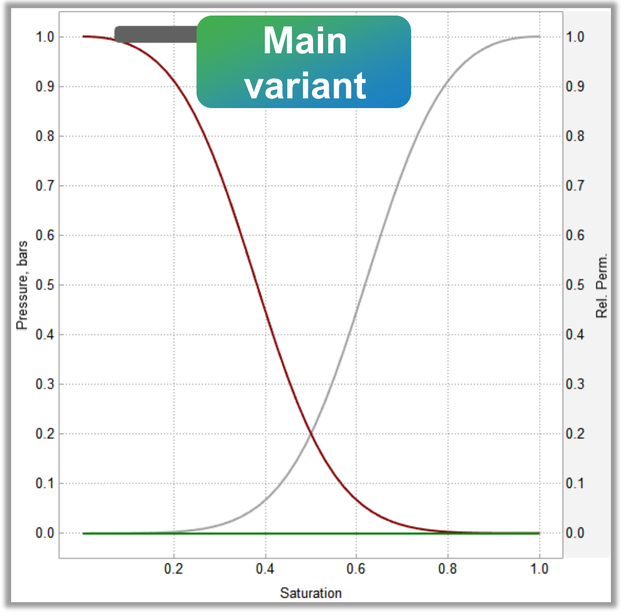


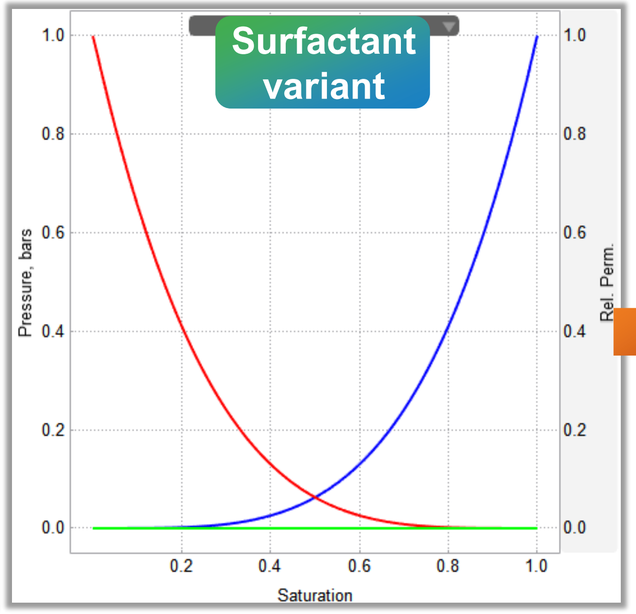


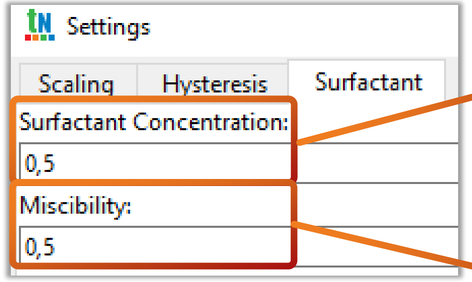


RP Designer: the Surfactant option

- **The new SRP tab allows the calculation of RP curves in the presence of surfactants. It is now possible to select a variant for the RP curve in the presence of surfactants (Variants → SRP → Surfactant)**

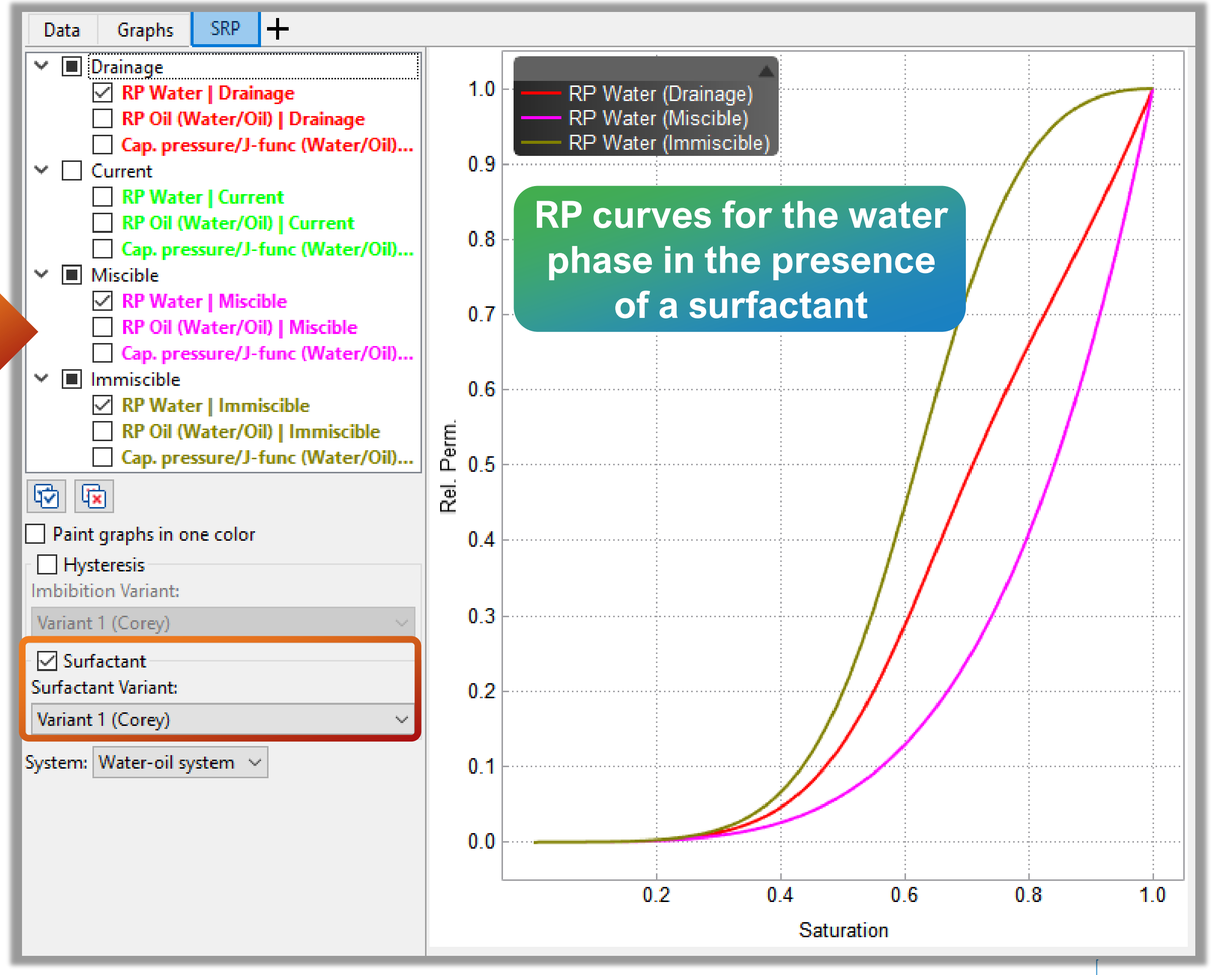






Corresponds to parameter 2 of the EHYSTR keyword

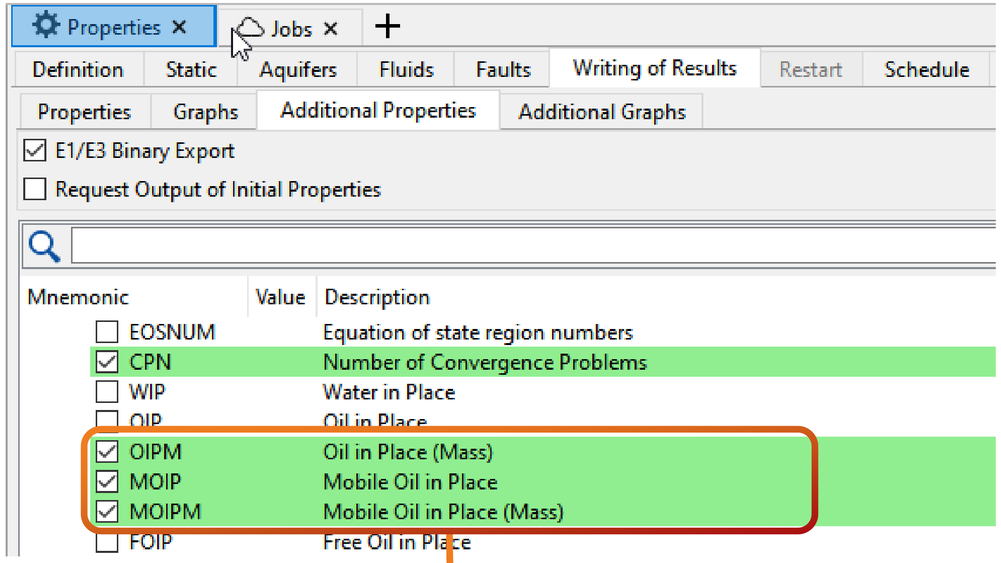
Corresponds to parameter 2 of the SURFCAPD keyword

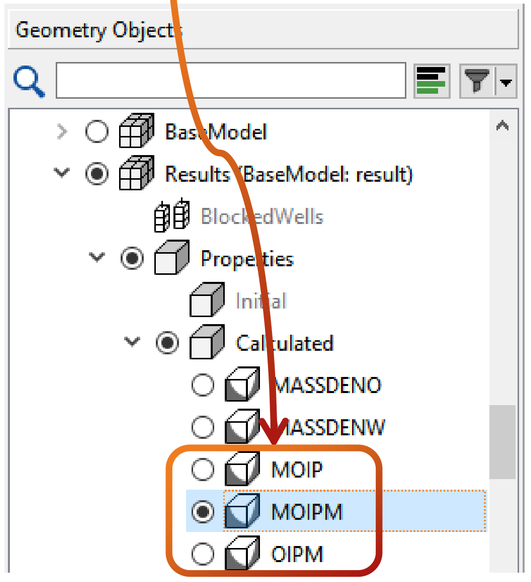


Data input/output

New grid properties are available

(Cases → Properties → Writing of Results → Additional Properties):



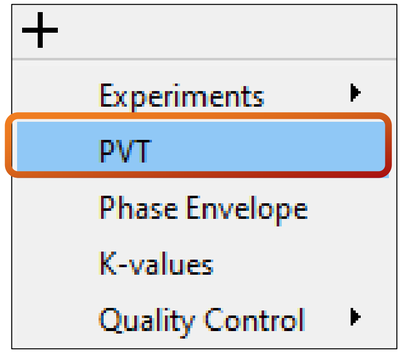


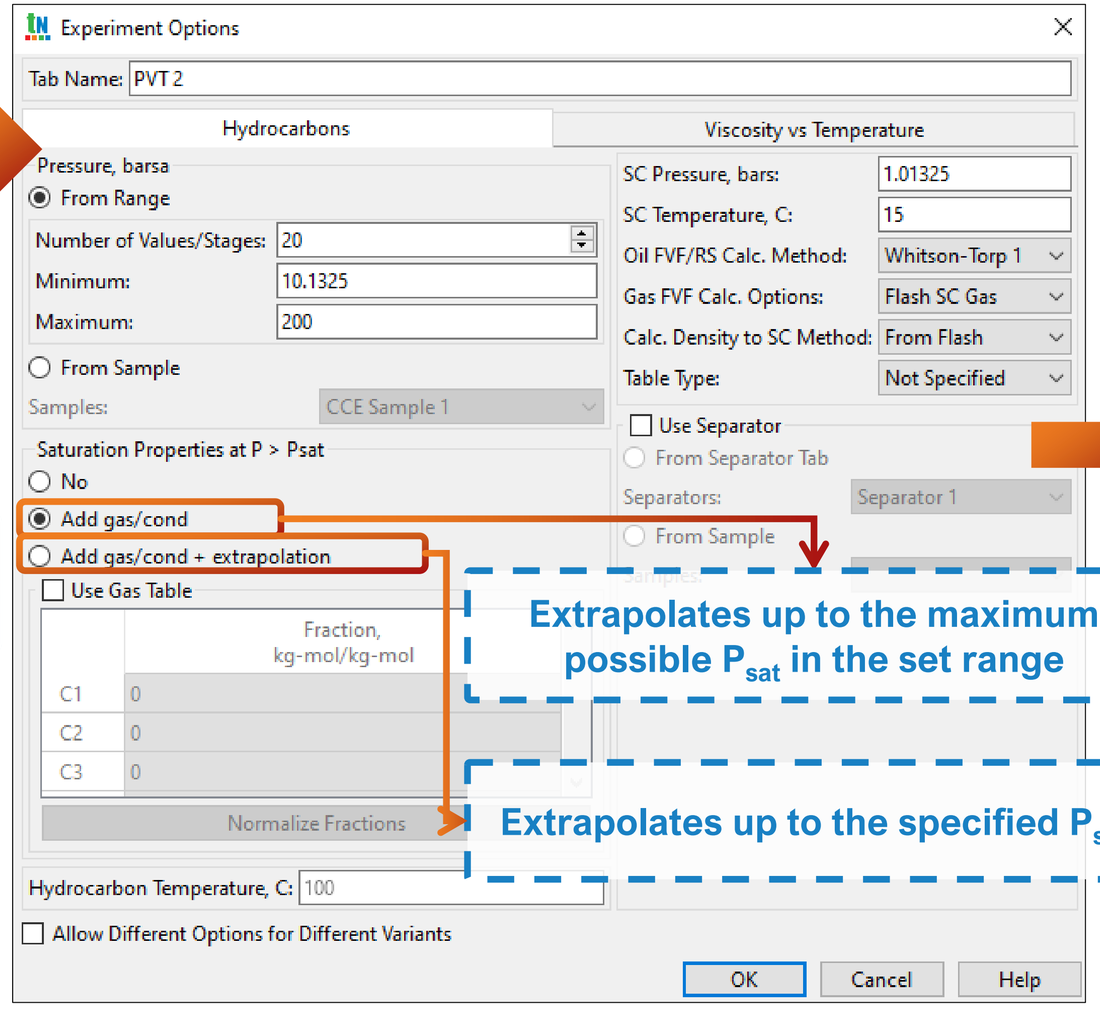
- **Mass densities of water, oil, and gas in a black oil model (MASSDENO/W/G)**
- **Oil-in-place mass (OIPM), mobile oil-in-place (MOIP), mobile oil-in-place mass (MOIPM)**
- **Molar densities of components (MLSC, MWAT)**
- **K-values (KVALUES)**
- **Number of convergence problems in each block (CPN)**
- **... etc.**

PVT Designer

PVT: extrapolating a saturated branch

- **When creating a black oil variant based on a compositional one, a saturated branch can be extrapolated above the specified saturation pressure in the case of gas injection into the reservoir**

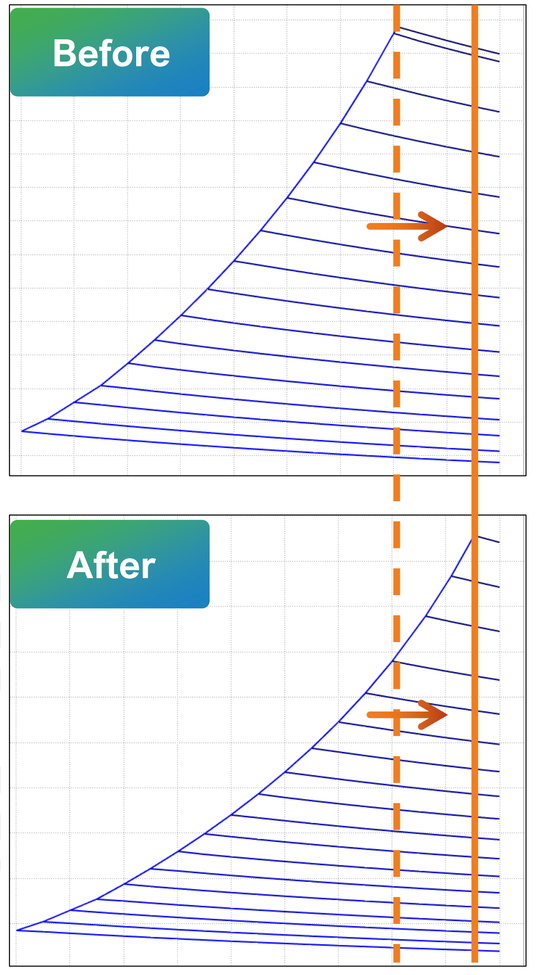




If necessary, the composition of the gas/condensate being added can be specified

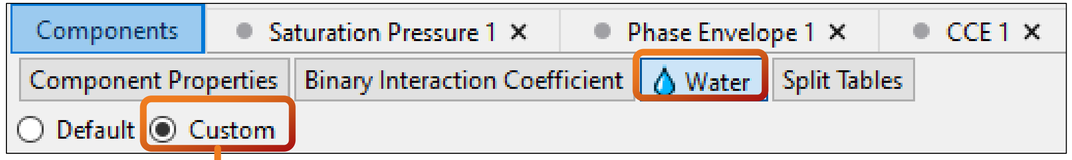
Extrapolates up to the maximum possible P_{sat} in the set range

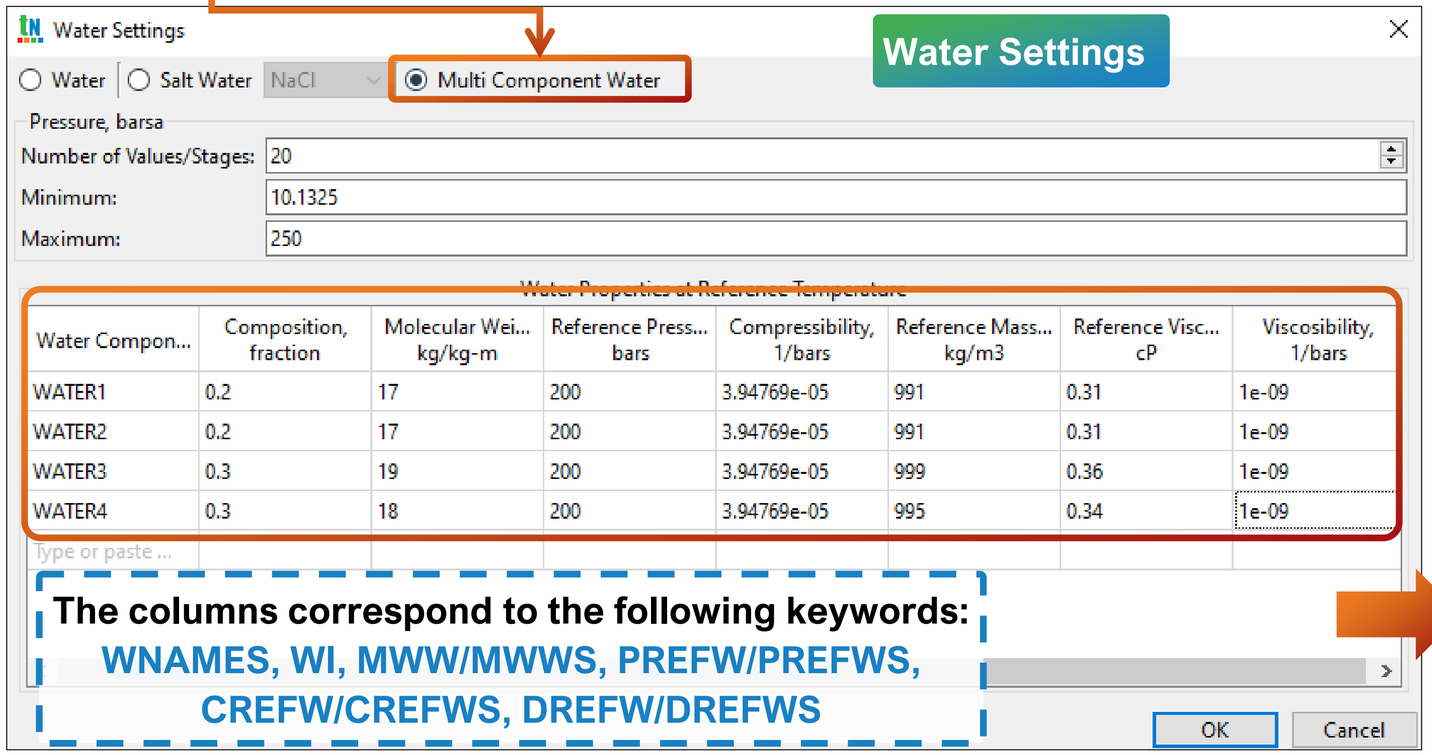
Extrapolates up to the specified P_{sat}



Compositional: multiple water components

- **Multiple water components and their properties can now be set in compositional variants**

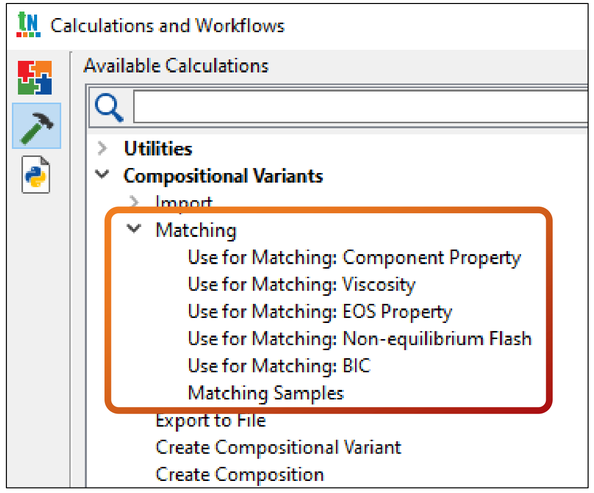


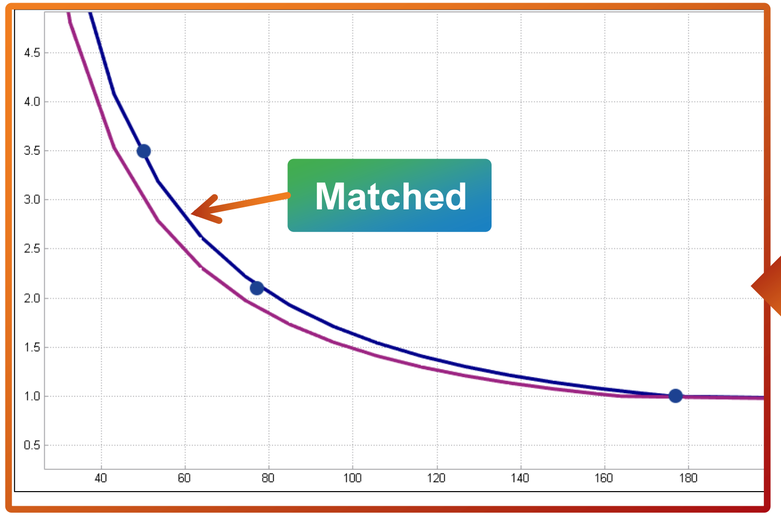


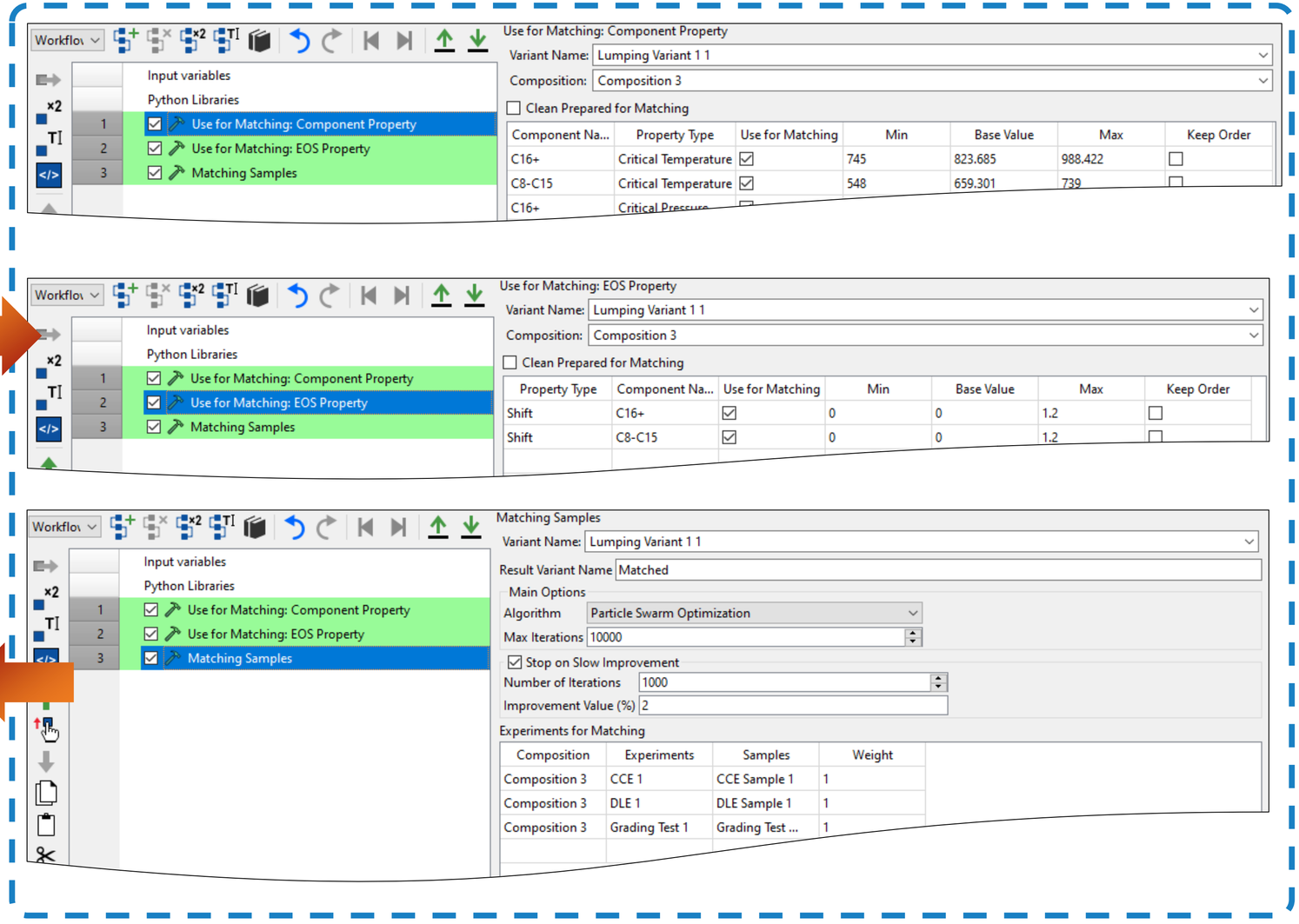

```
CREFW
-- water compressibility for each of water components
 0.00003947693066864051 4 0.00003947693066864051 0.0000
DREFW
-- water densities at a reference pressure
 991
 991
 999
 995 /
PREFW
-- reference pressures for water components
 200 200 200 200 /
VREFW
-- viscosity(nw)  viscosibility(nw)
   0.31            0.31                0.36 0.34
   1e-9            1e-9                1e-9 1e-9 /
```

Workflow: matching to samples

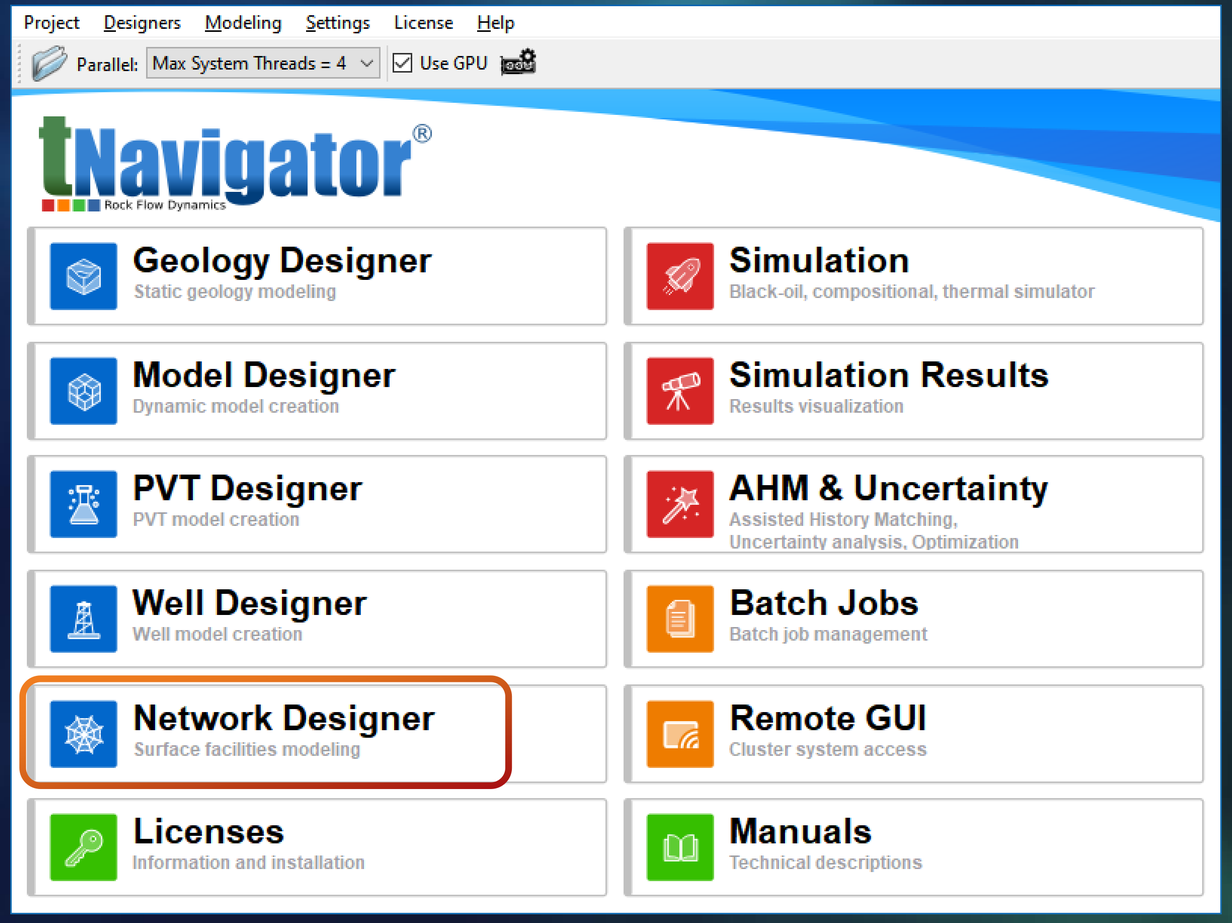
- **Compositional and black oil variants can now be matched to samples**





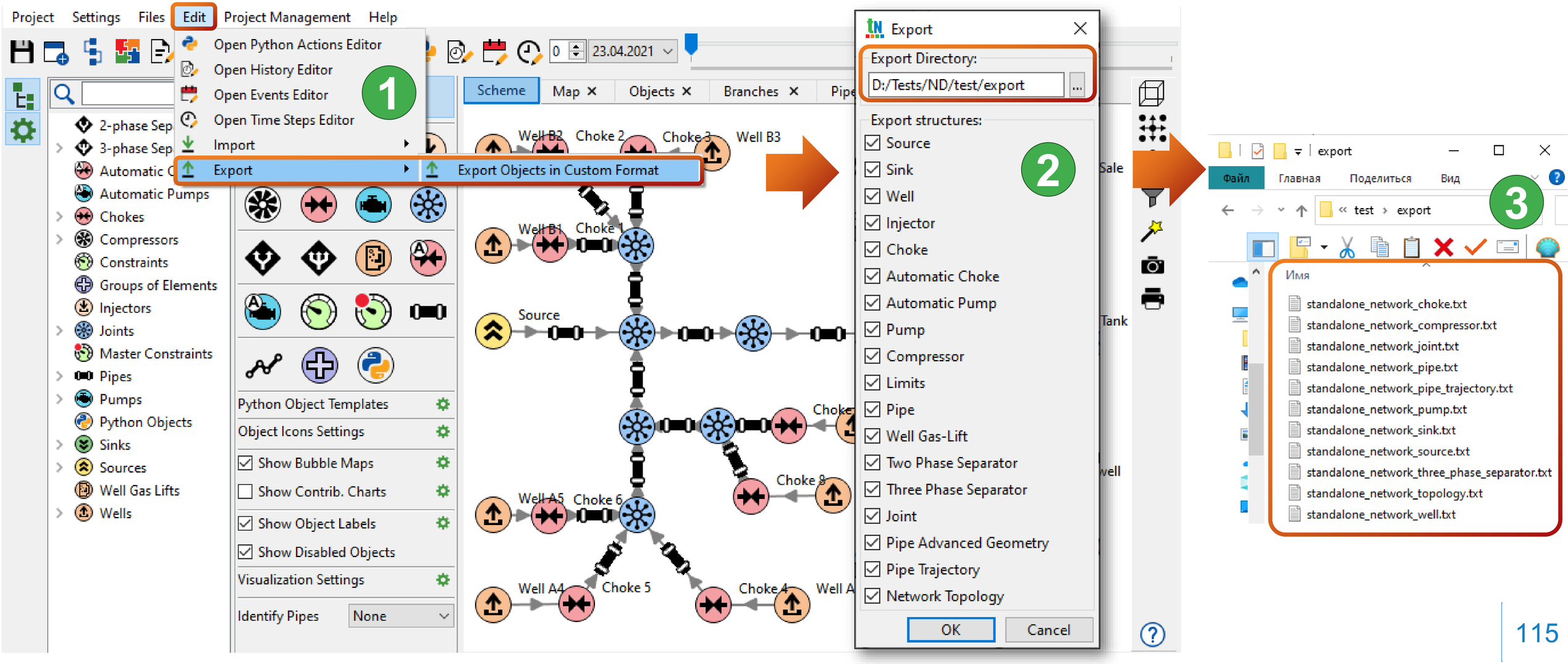


Network Designer



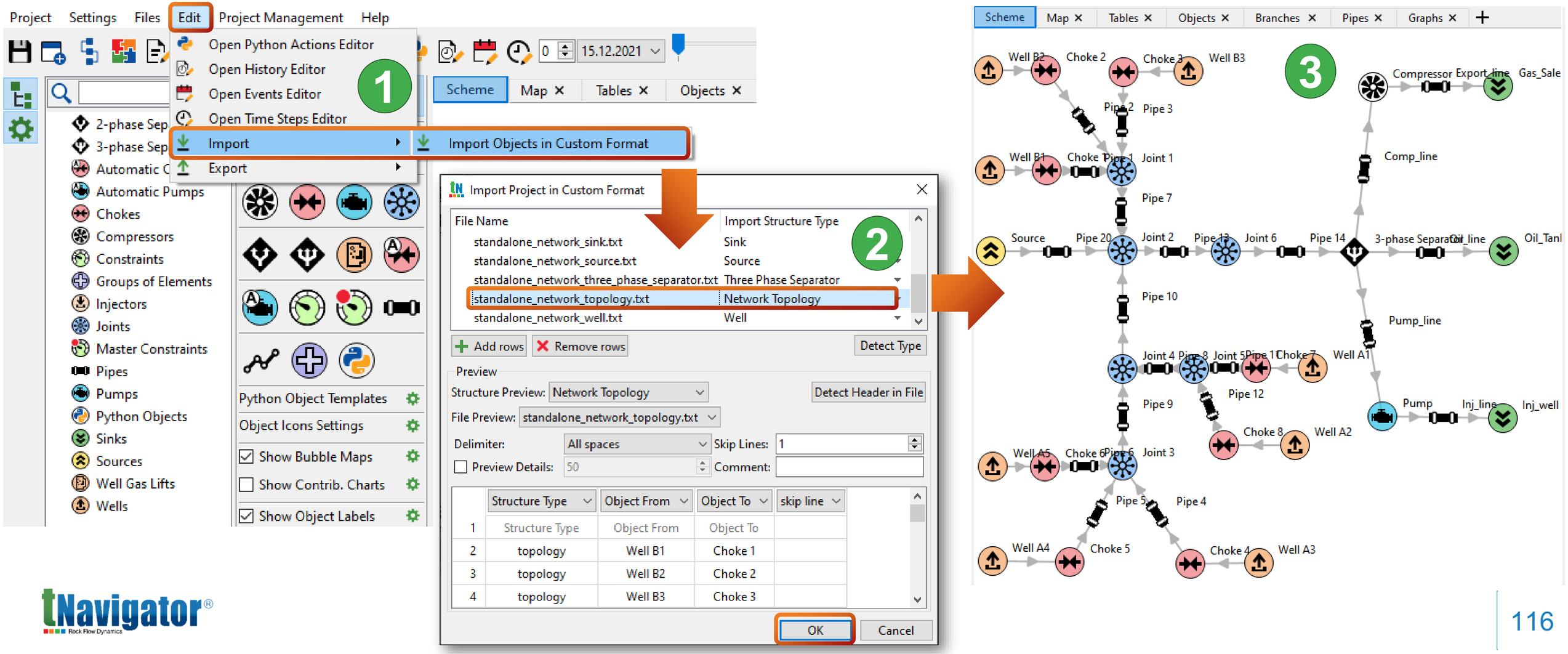
Export objects in a custom format

- It is now possible to export data for network objects in tabular form in a user-specified format (the top menu Edit → Export → Import/Export Objects in Custom Format)



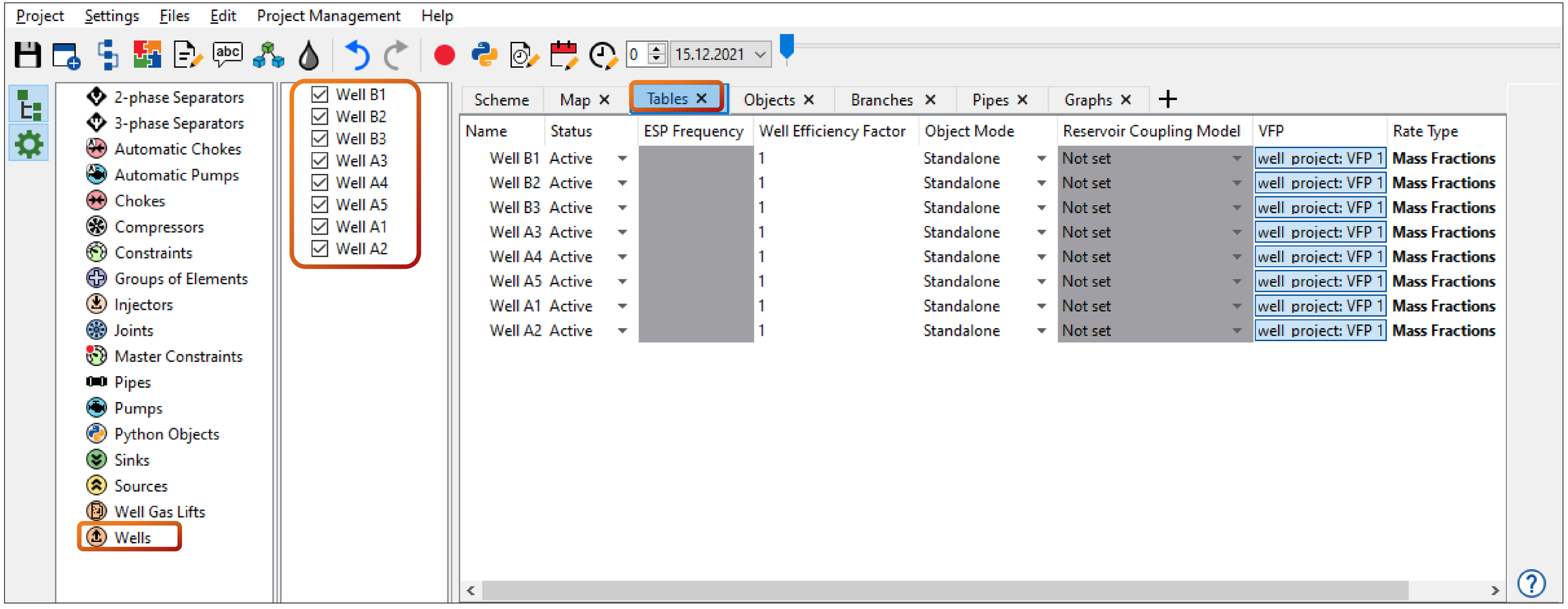
Import objects in a custom format

- It is now possible to import data for network objects in tabular form in a user-specified format (the top menu Edit → Import → Import Objects in Custom Format)



View the parameters of imported objects

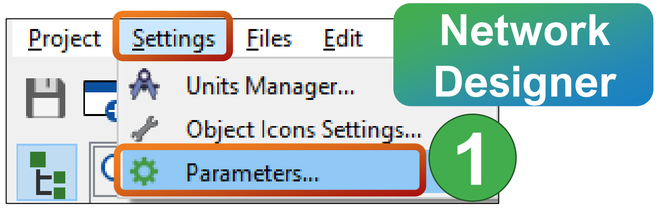
- In the Tables tab, it is now possible to see the parameters of the network objects and the network topology imported from a file in tabular form.

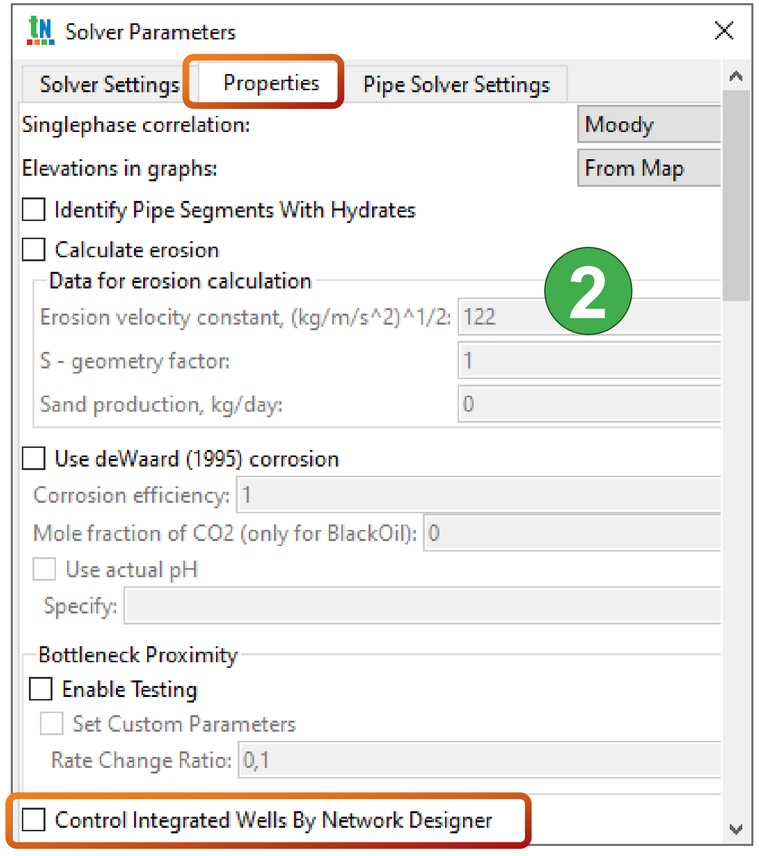


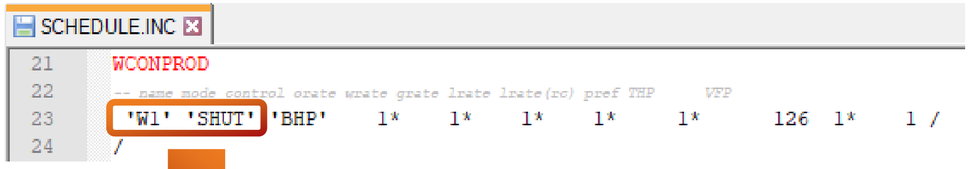
Well control by Network Designer

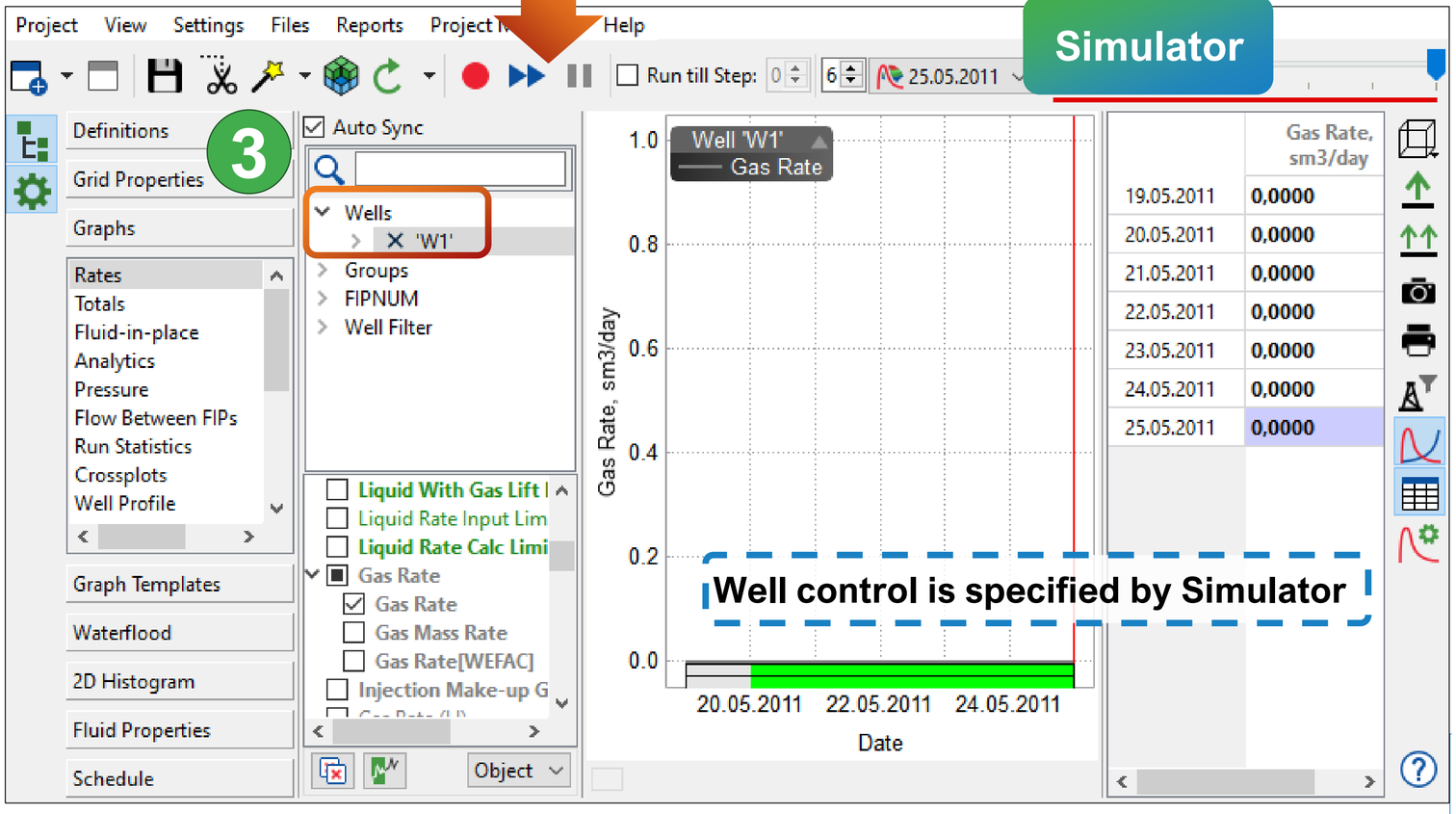
- **For integrated models, Network Designer has top priority in terms of controlling a well**

  (Settings → Parameters → Properties → Control Integrated Wells By Network Designer)



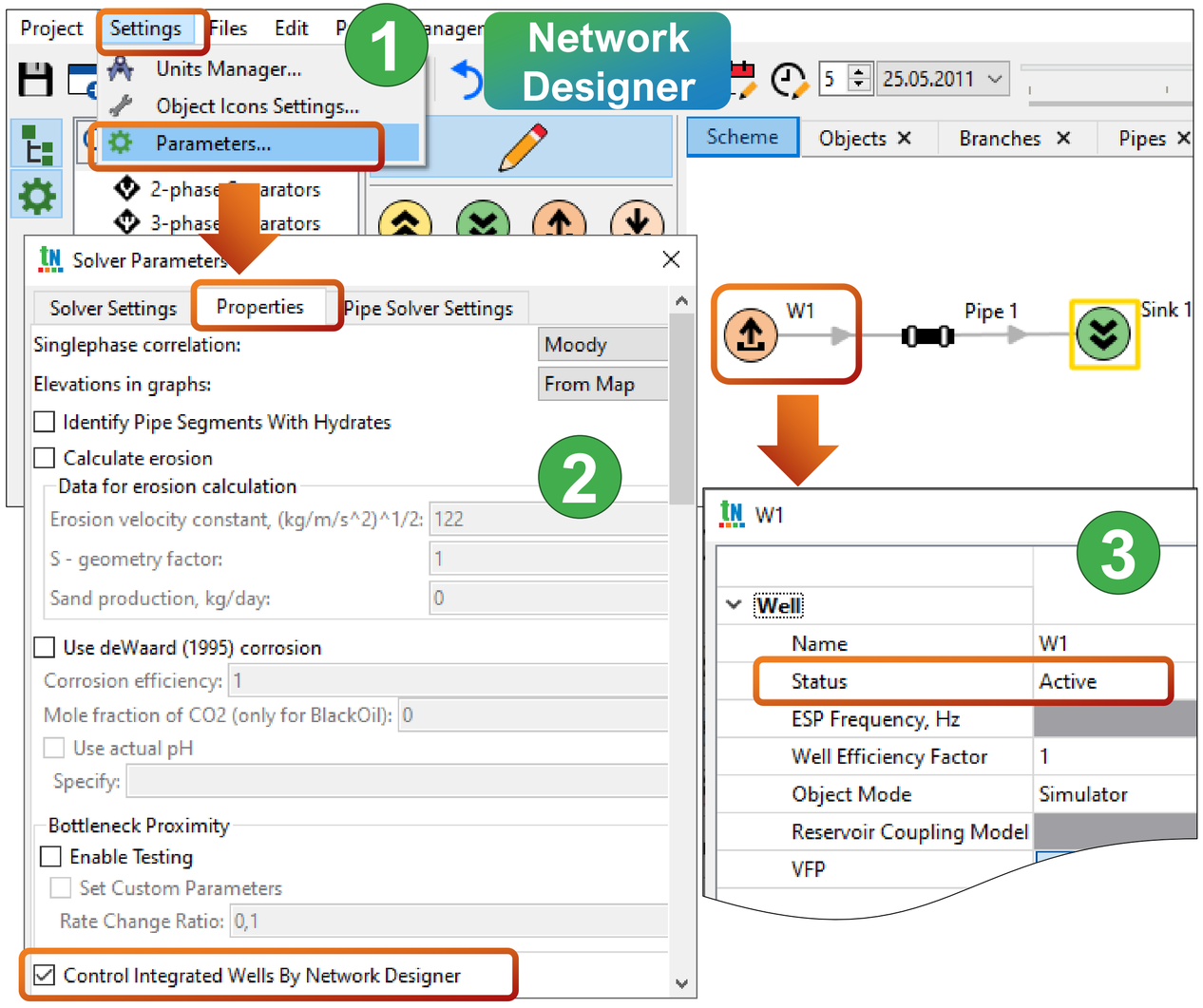


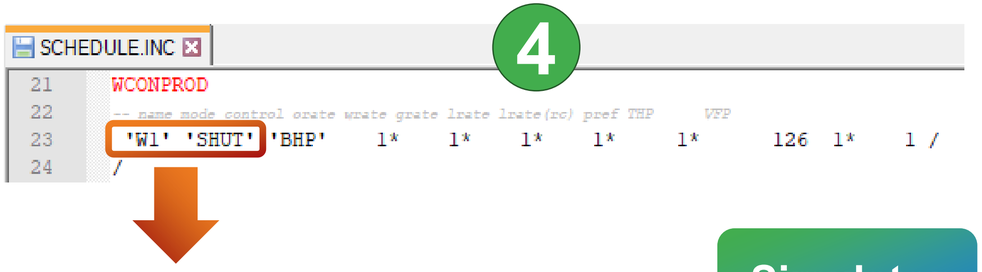


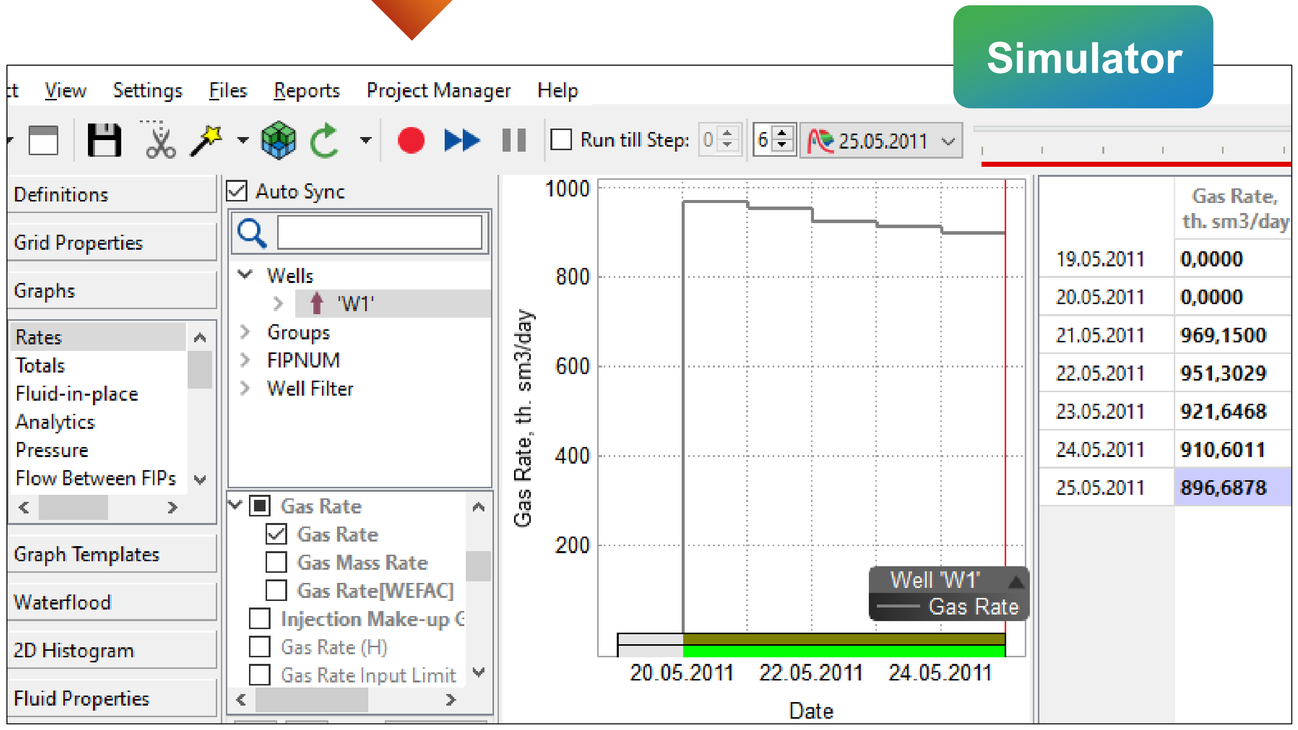


Well control by Network Designer

- Network Designer has top priority in terms of controlling a well
- Activation of a well is equivalent to specification of the WCONPROD keyword along with THP control



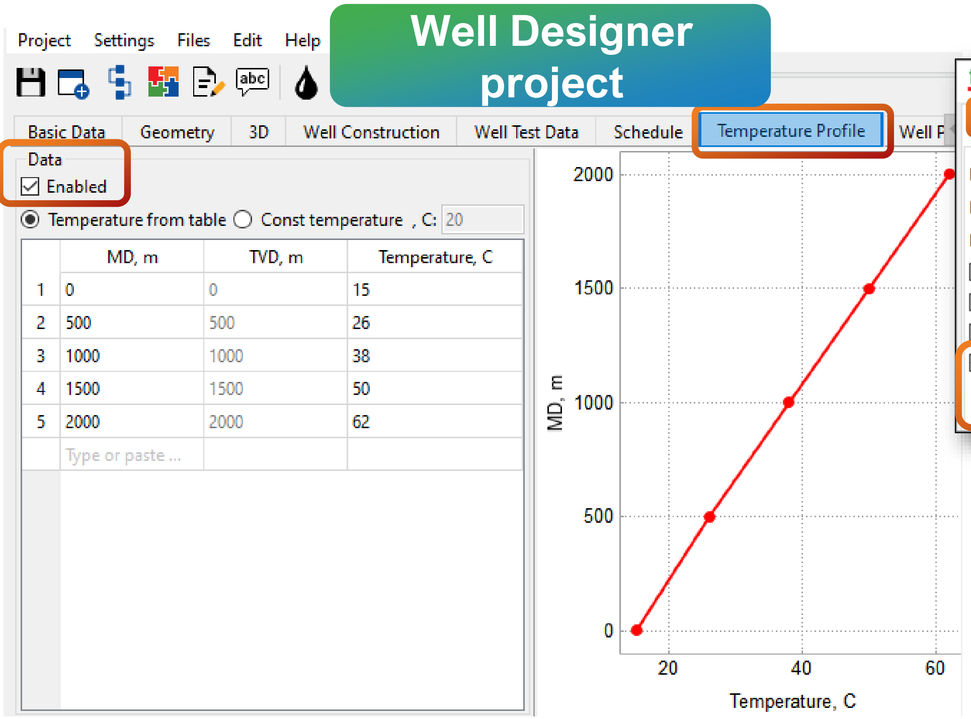


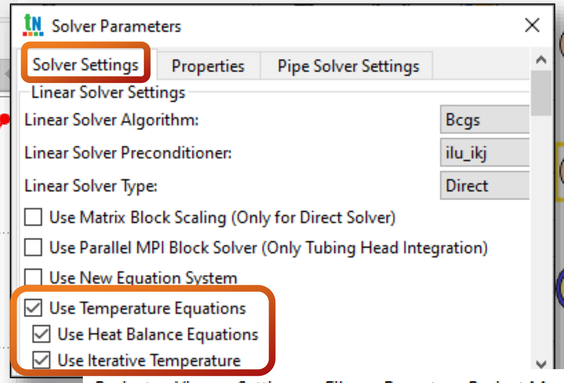


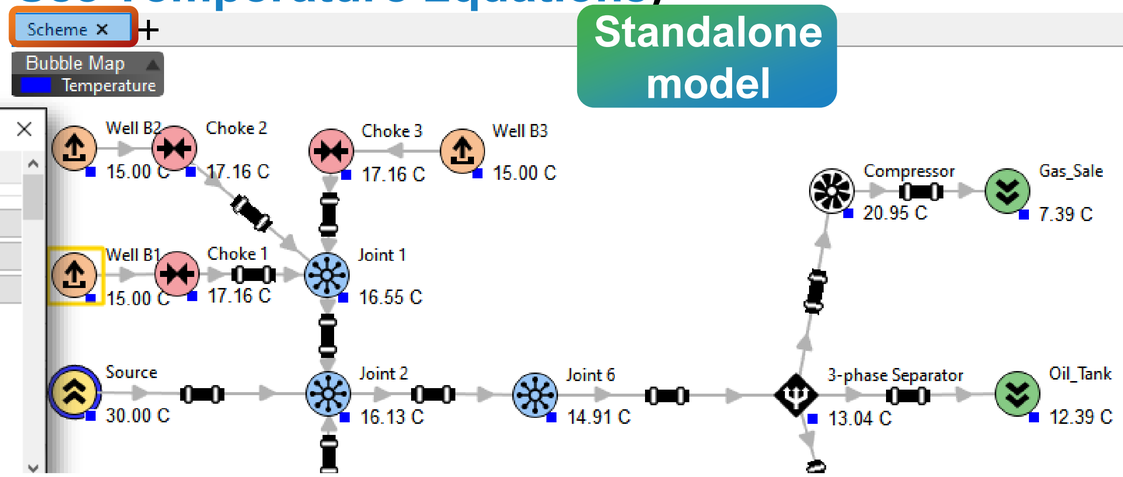
Well control is specified by Simulator

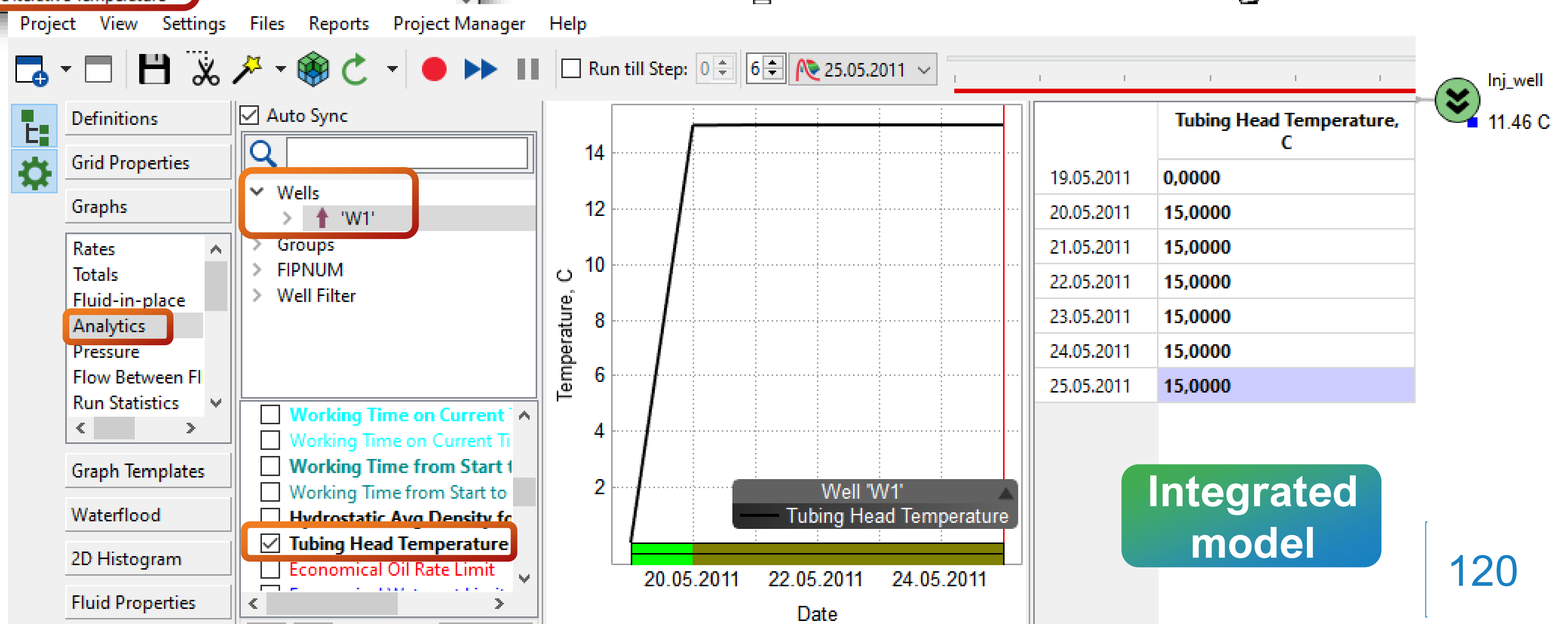
Temperature profile in a well

- **For Standalone and integrated models, the temperature profile in a well is taken into account in calculations (Settings → Parameters → Solver Settings → Use Temperature Equations)**



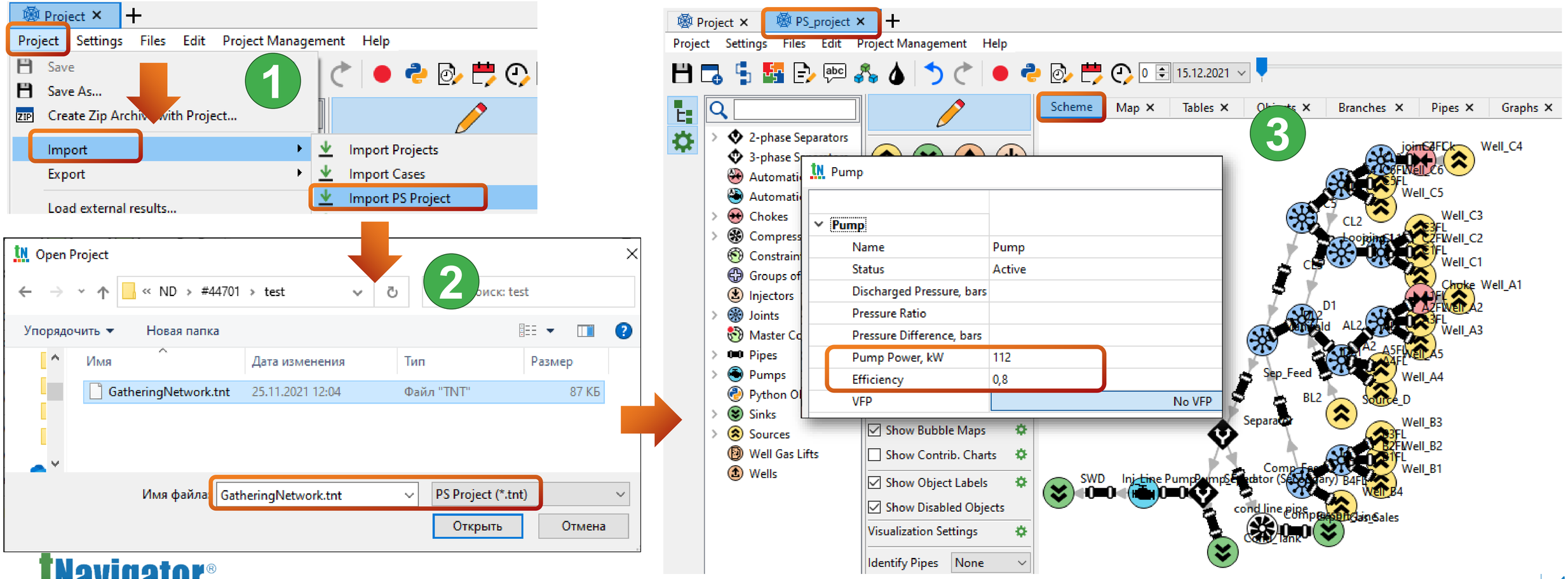






Import PS project

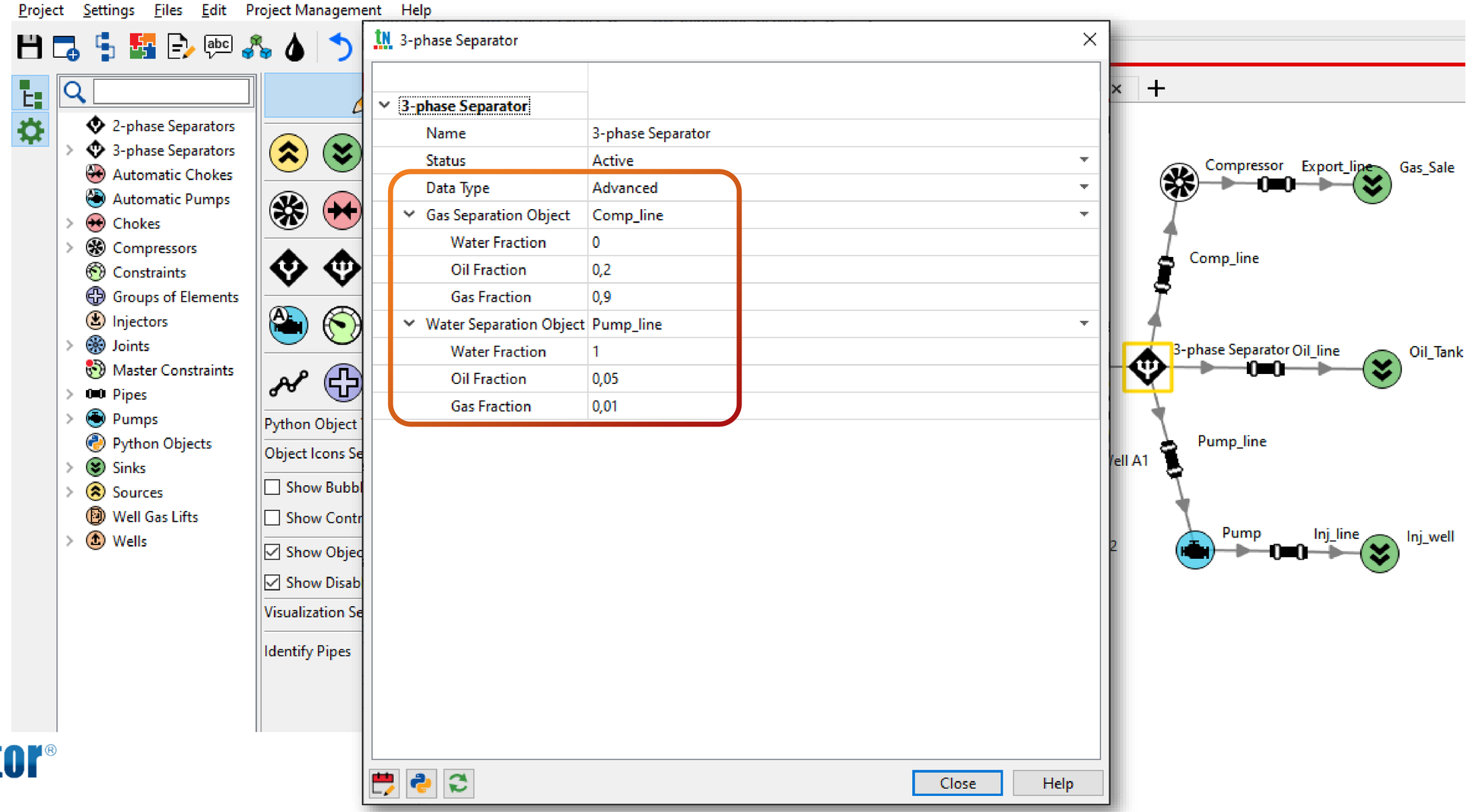
- The top menu Project → Import → Import PS Project
- The network topology will be imported to the Scheme tab along with the object parameters coinciding with the parameters in Network Designer, and the fluid model used in the PS project will be detected



Separator

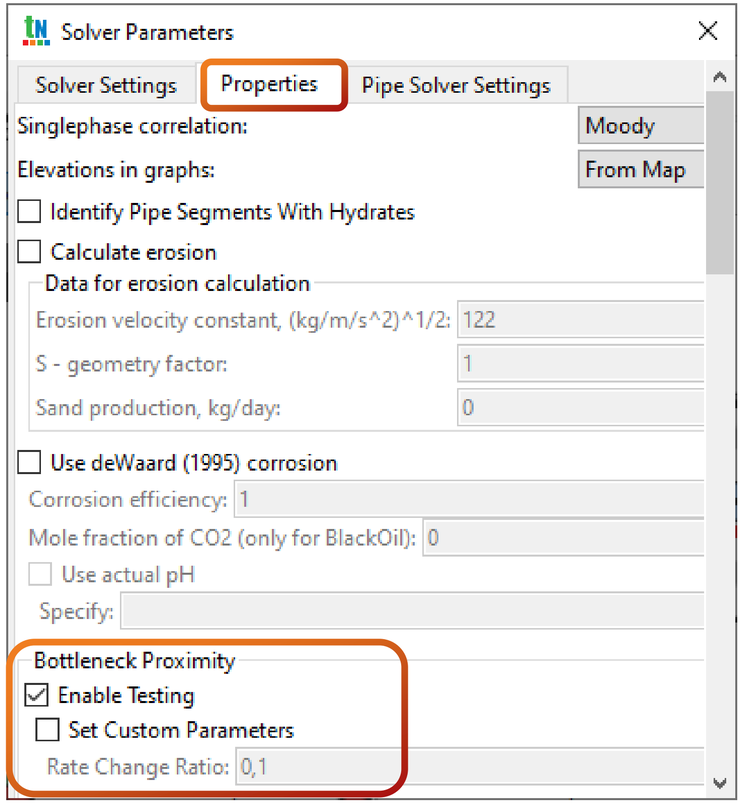
- **It is now possible to specify phases' fractions directed into the separation object(s)**

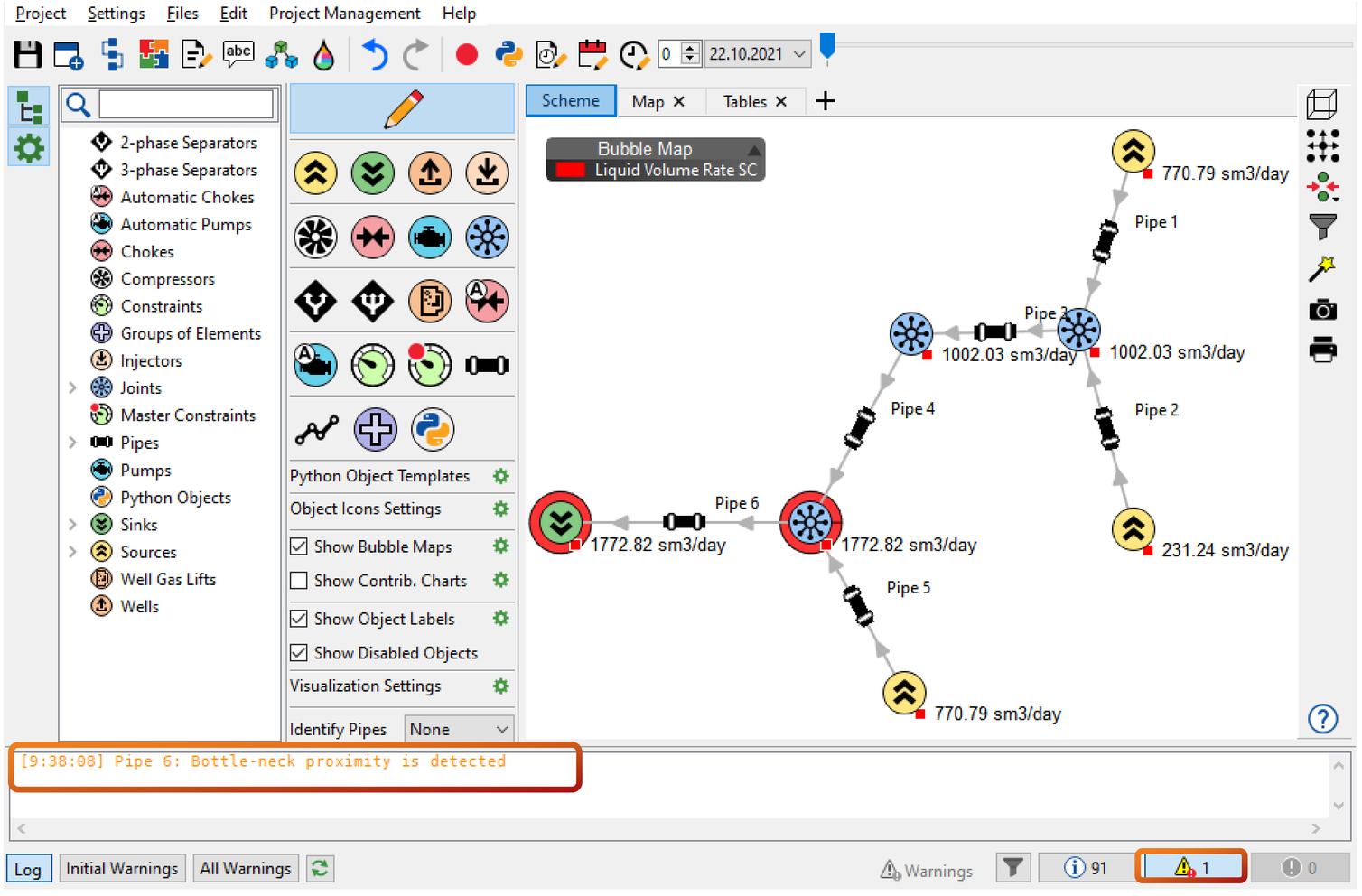
  (RMB on the object → Edit → Data Type → Advanced



Bottleneck analysis

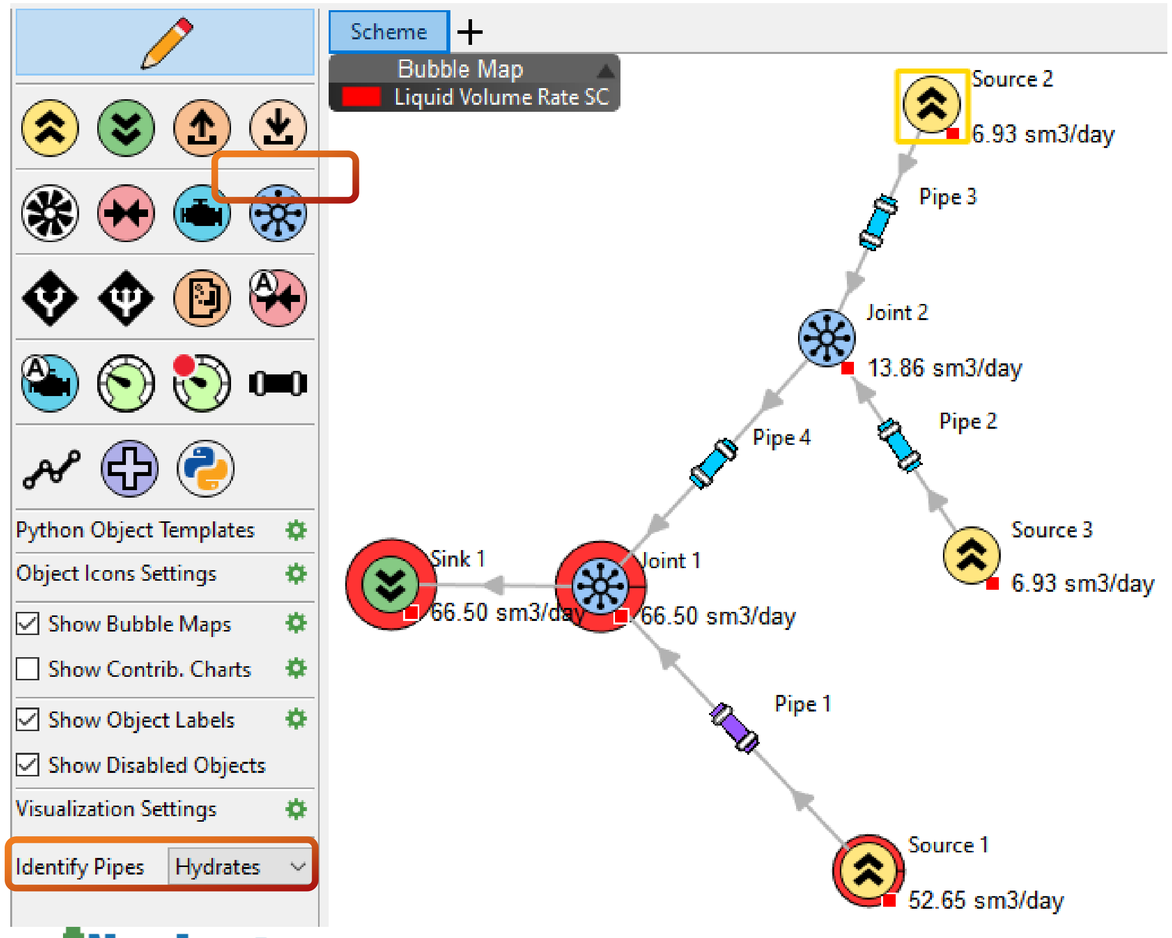
- It is now possible to analyze a pipe capacity compared to its current state. If the rate through a pipe at the current conditions is close to its capacity limit, a warning appears in the project log in the Log panel (Settings → Parameters → Properties → Enable Testing)

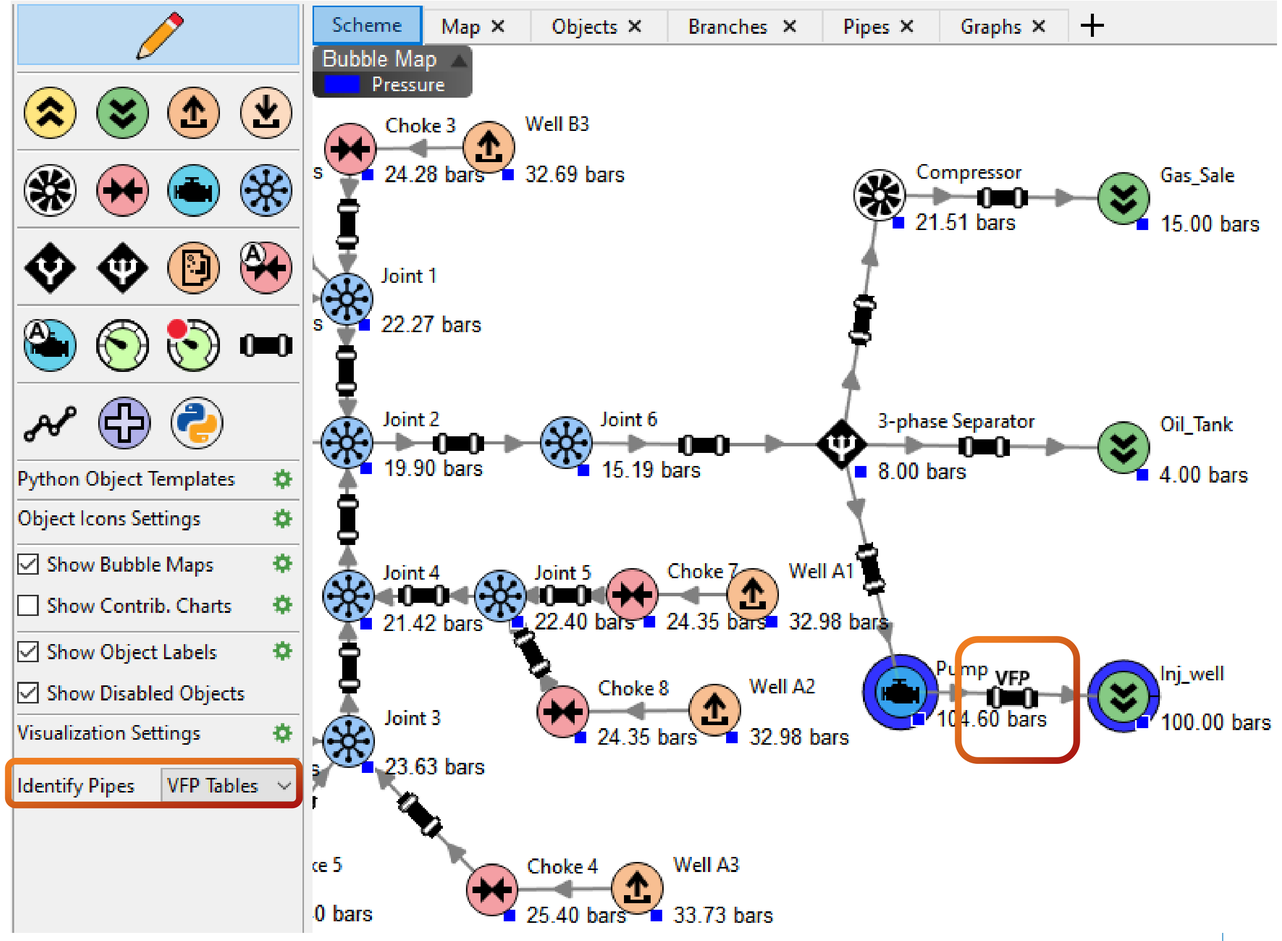




Pipe visualization variants in the Scheme tab

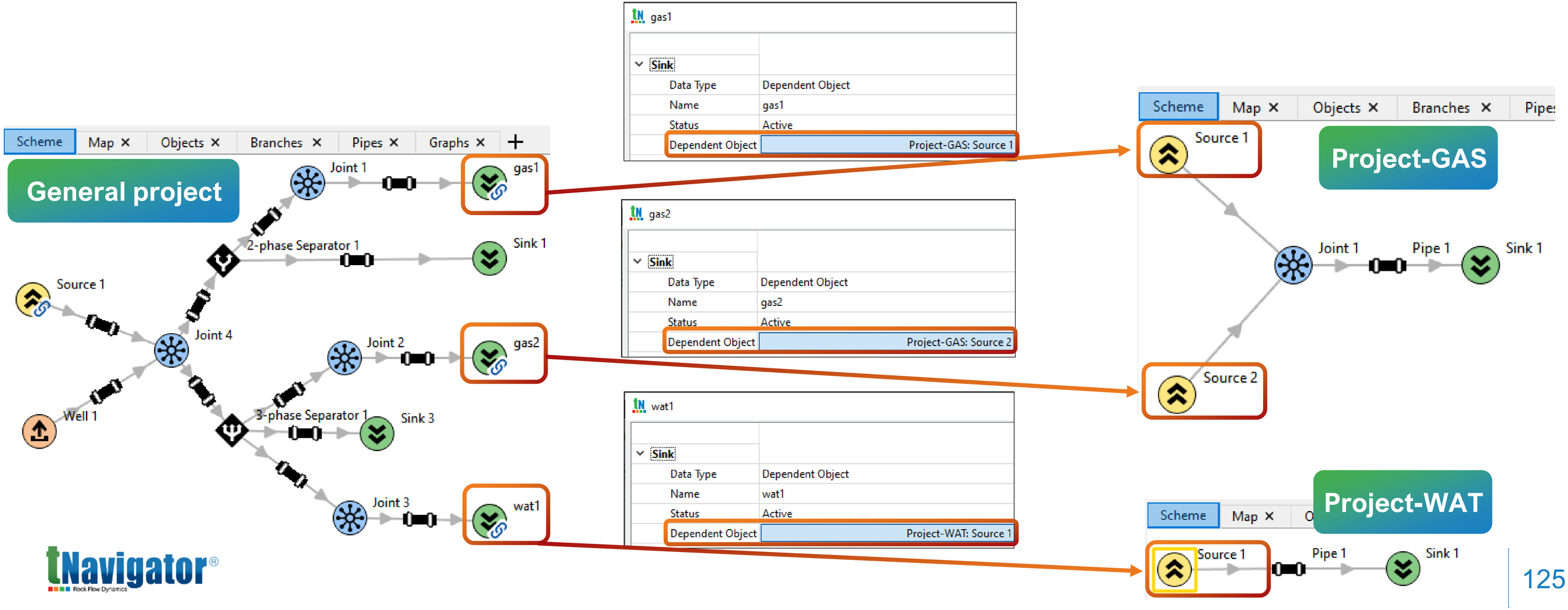
- The possible options include a standard icon, an icon visualizing hydrates formation in a pipe and an icon with the VFP symbol, which indicates that a VFP project is in place for the pipe





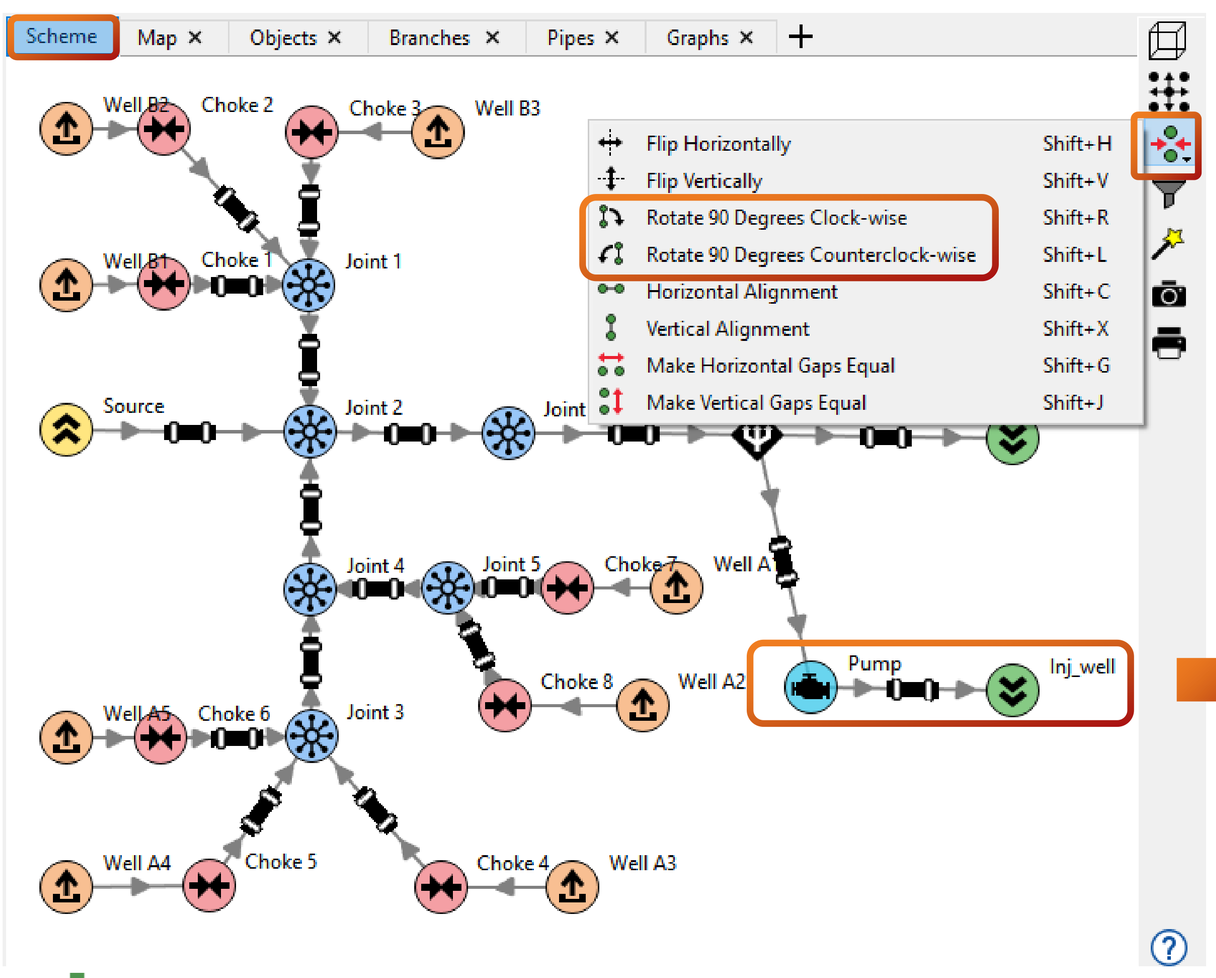
Coupling several Standalone models

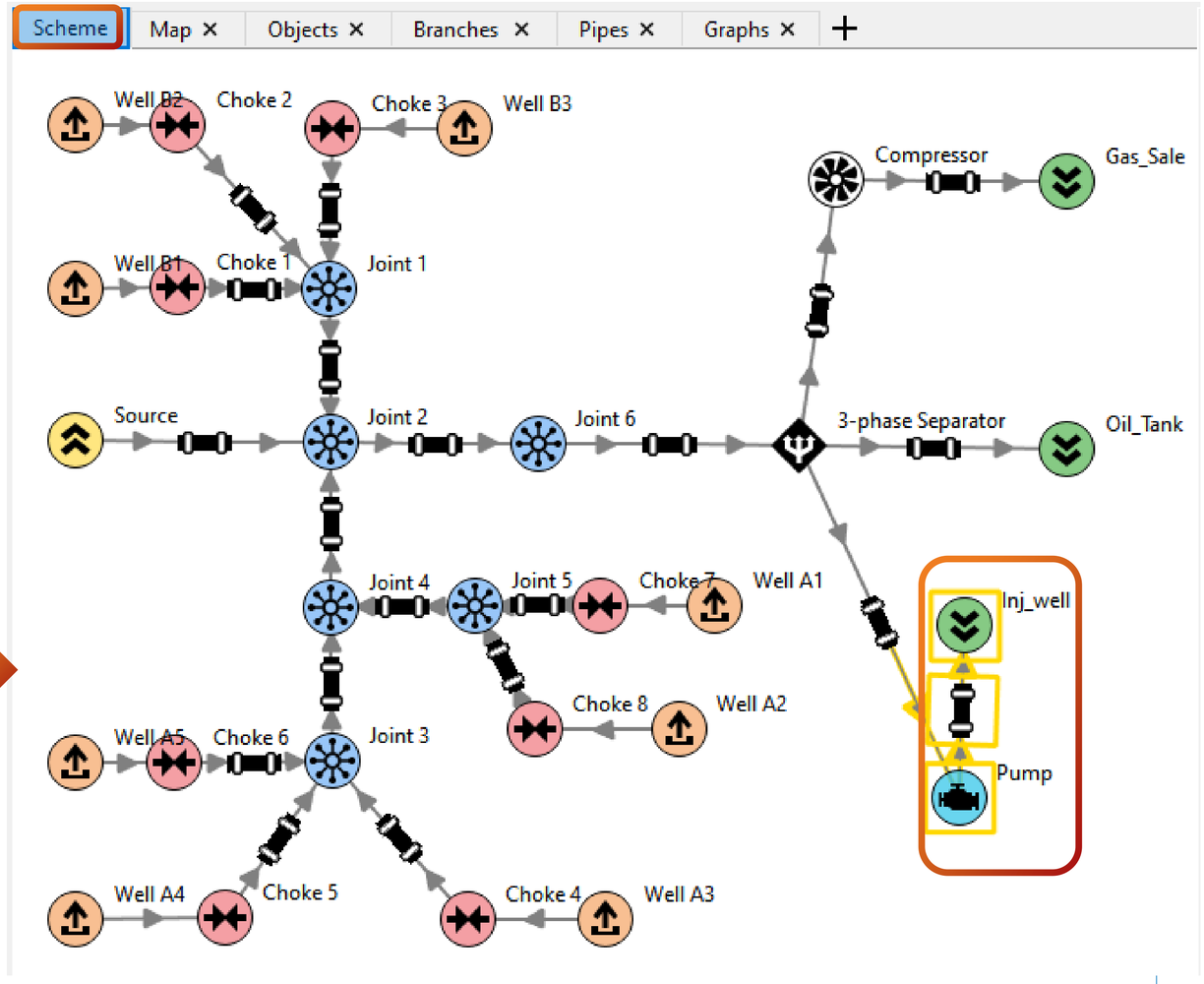
- **Each network should be active and have the same data steps. The coupling is carried out via Sources and Sinks (RMB on the object → Edit → Data Type → Dependent Object and in the Dependent Object field specify the name of an object in the coupled project of the surface network)**



Rotation of network objects in the Scheme tab

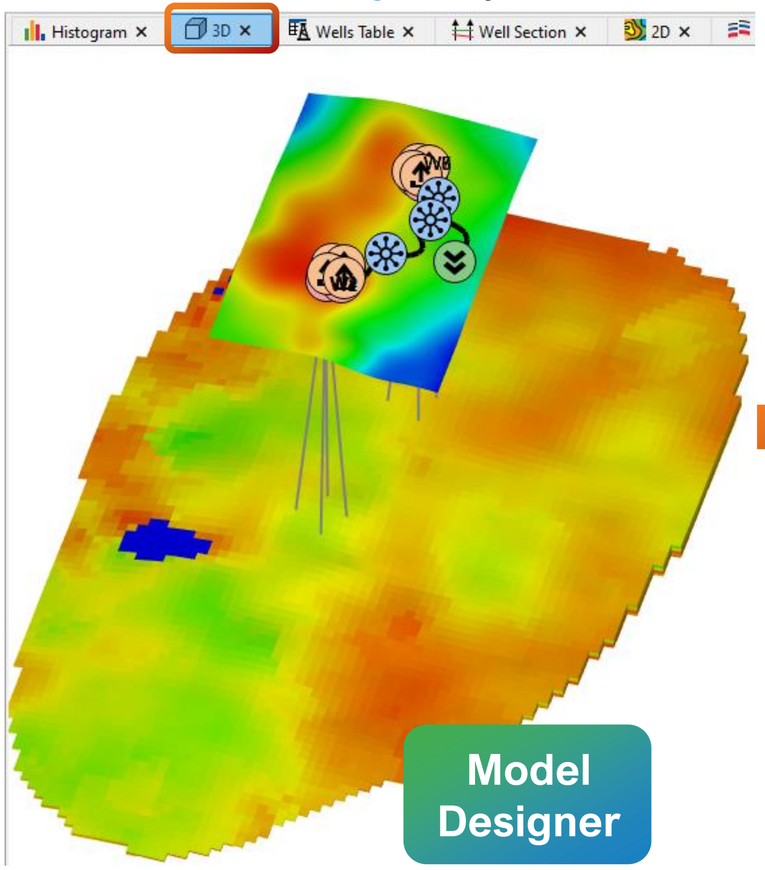
- **The button in the right panel → Alignment of Selected Objects → Rotate 90 Degrees Clock-wise and Rotate 90 Degrees Counterclock-wise**

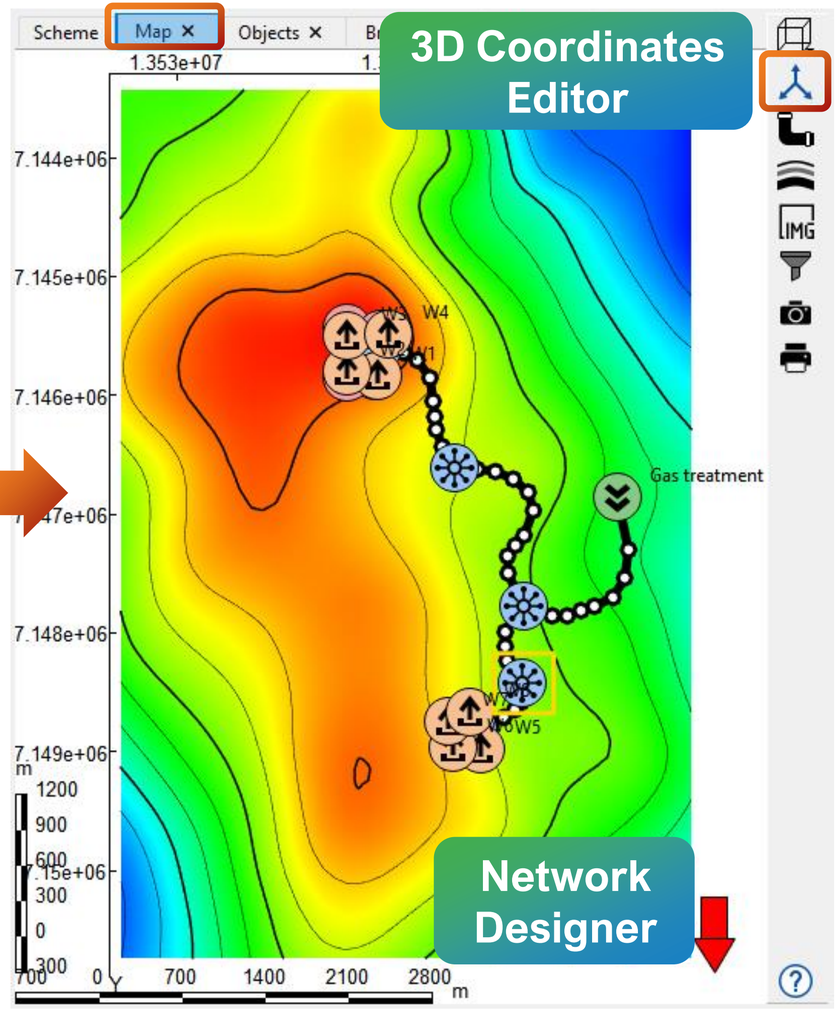


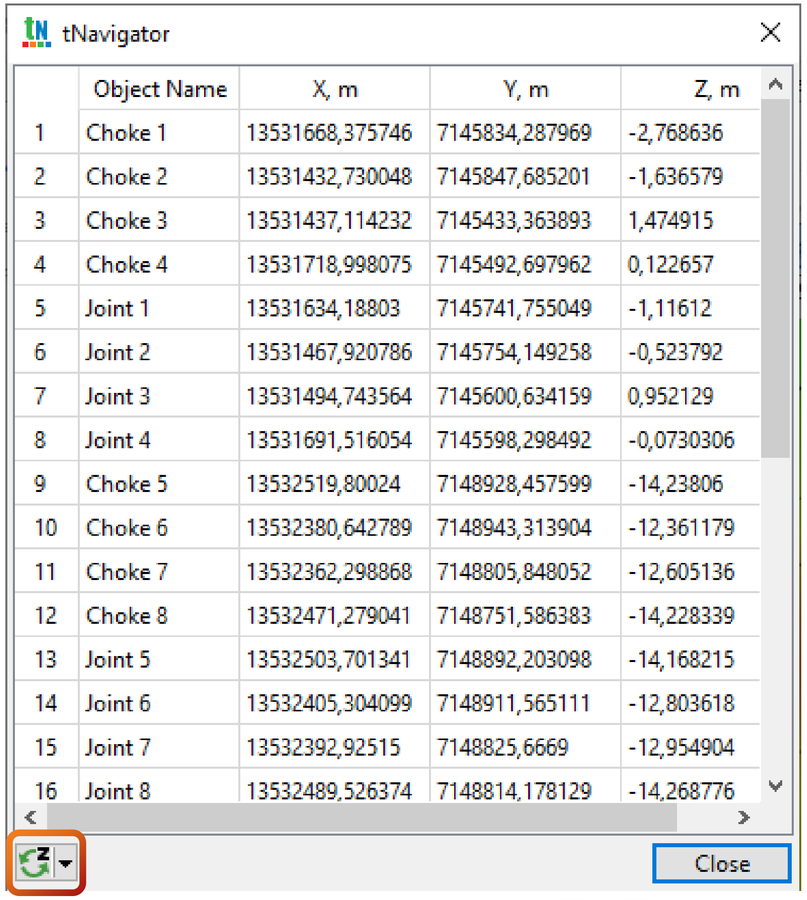


Synchronization of the Z coordinates with the map

- In the Map tab, it is now possible to synchronize the Z coordinates of network objects with the surface map (the right-panel button 3D Coordinates Editor → Synchronize Z Coordinates With Horizon Only Visible Objects)







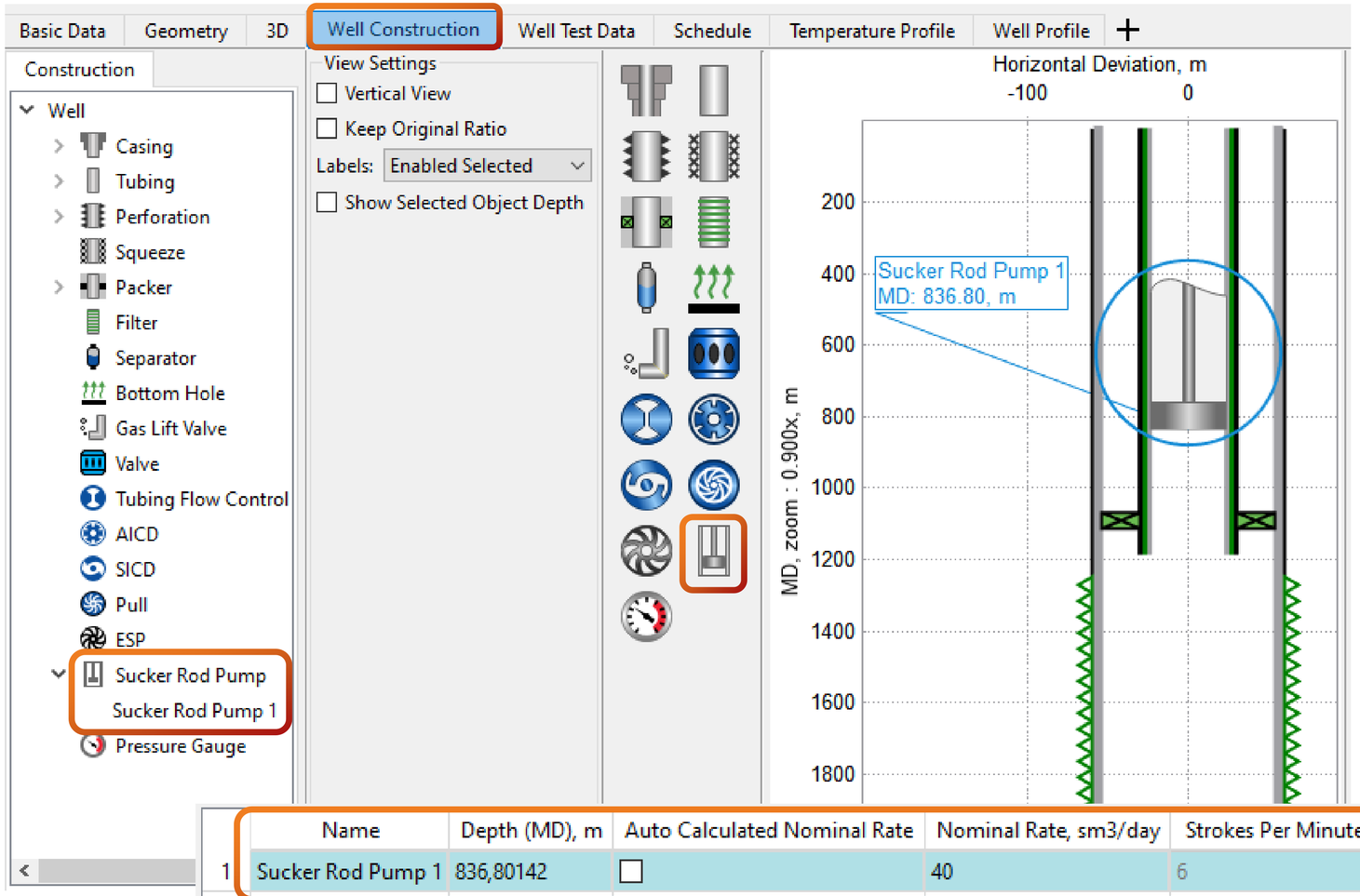
Synchronize Z Coordinates With Horizon Only Visible Objects

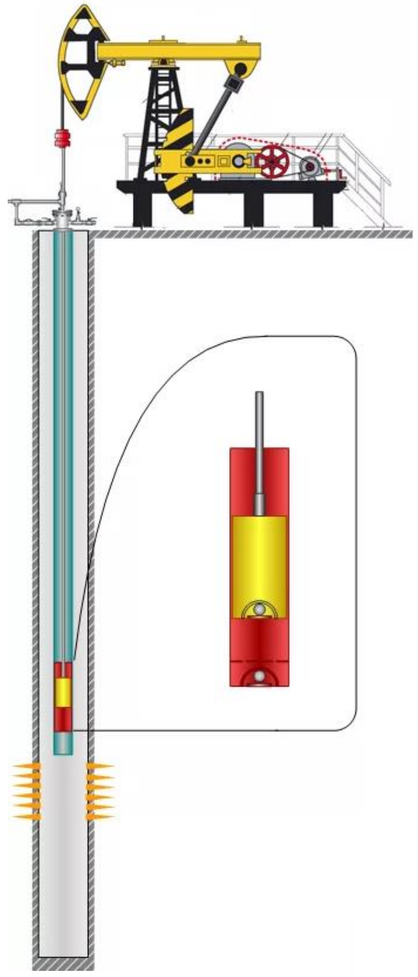
tNavigator® Rock Flow Dynamics

Well Designer

Sucker Rod Pump

- A new object—Sucker Rod Pump—has been added



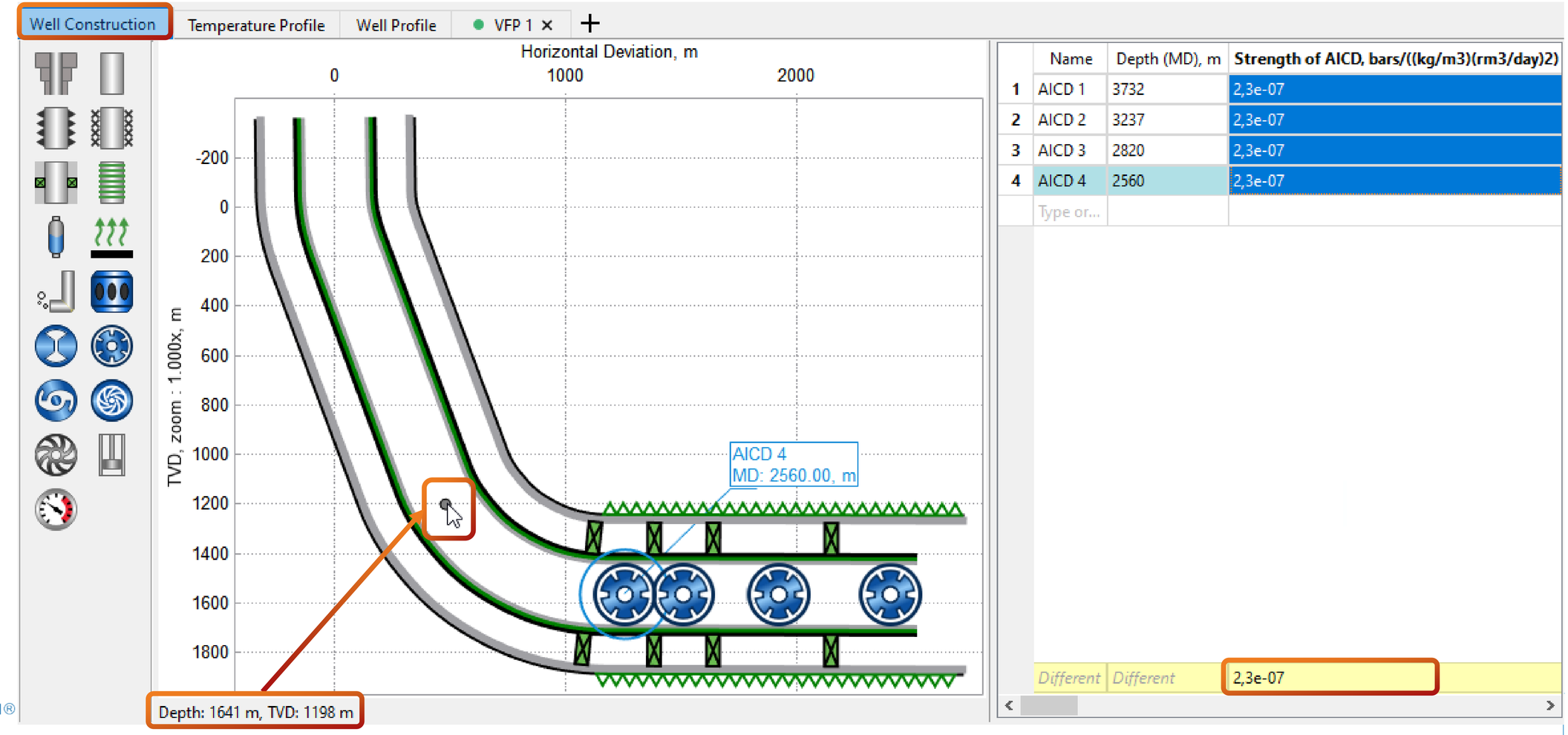


	Name	Depth (MD), m	Auto Calculated Nominal Rate	Nominal Rate, sm3/day	Strokes Per Minute	Stroke Length, m	Plunger Diameter, m	Slippage Factor	Diameter, m	Status
1	Sucker Rod Pump 1	836,80142	☐	40	6	3	0,075	0,02	0,04445	Active
	Type or paste here									

Parameters of Sucker Rod Pump

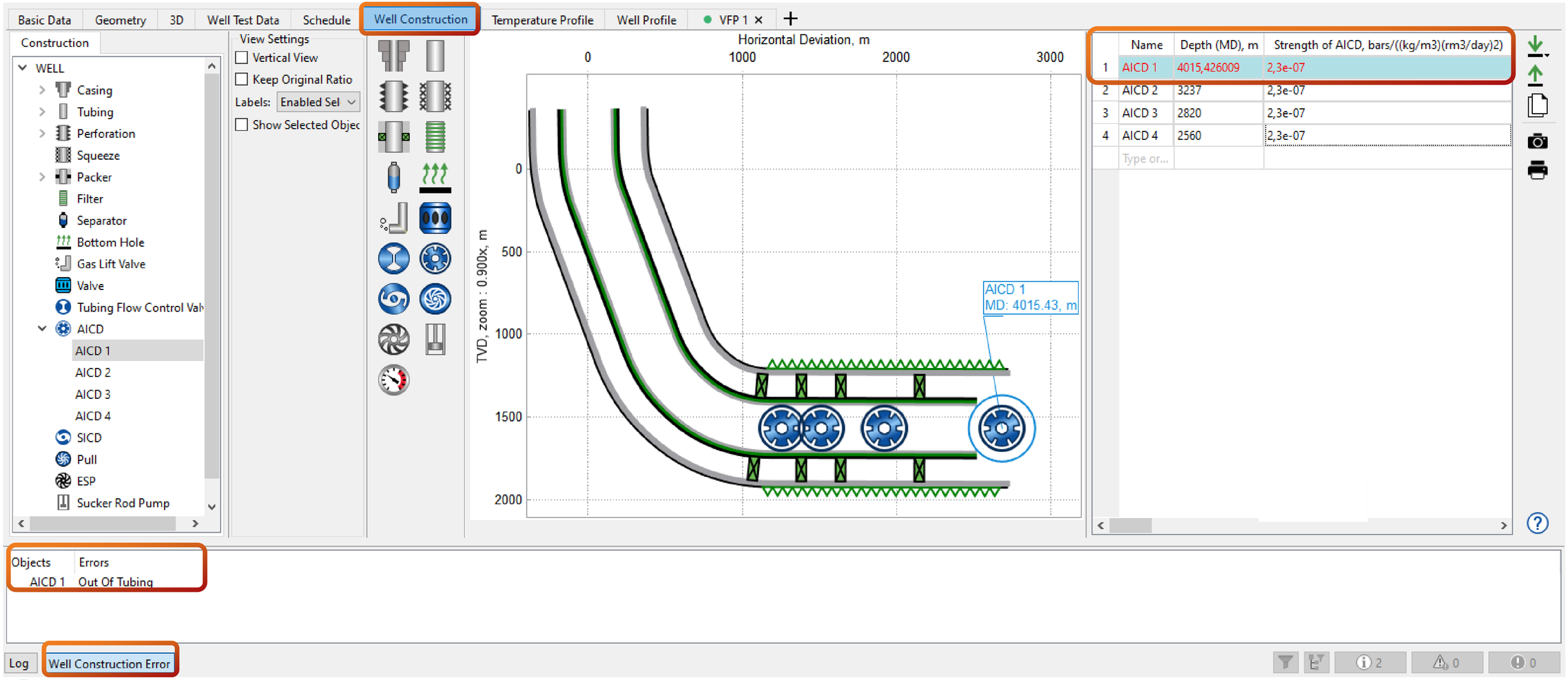
Multiediting

- In the Well Construction tab, it is possible to multiedit parameter values of well construction elements
- The depth may now be visualized both in measured depth (MD) and in true vertical depth (TVD)



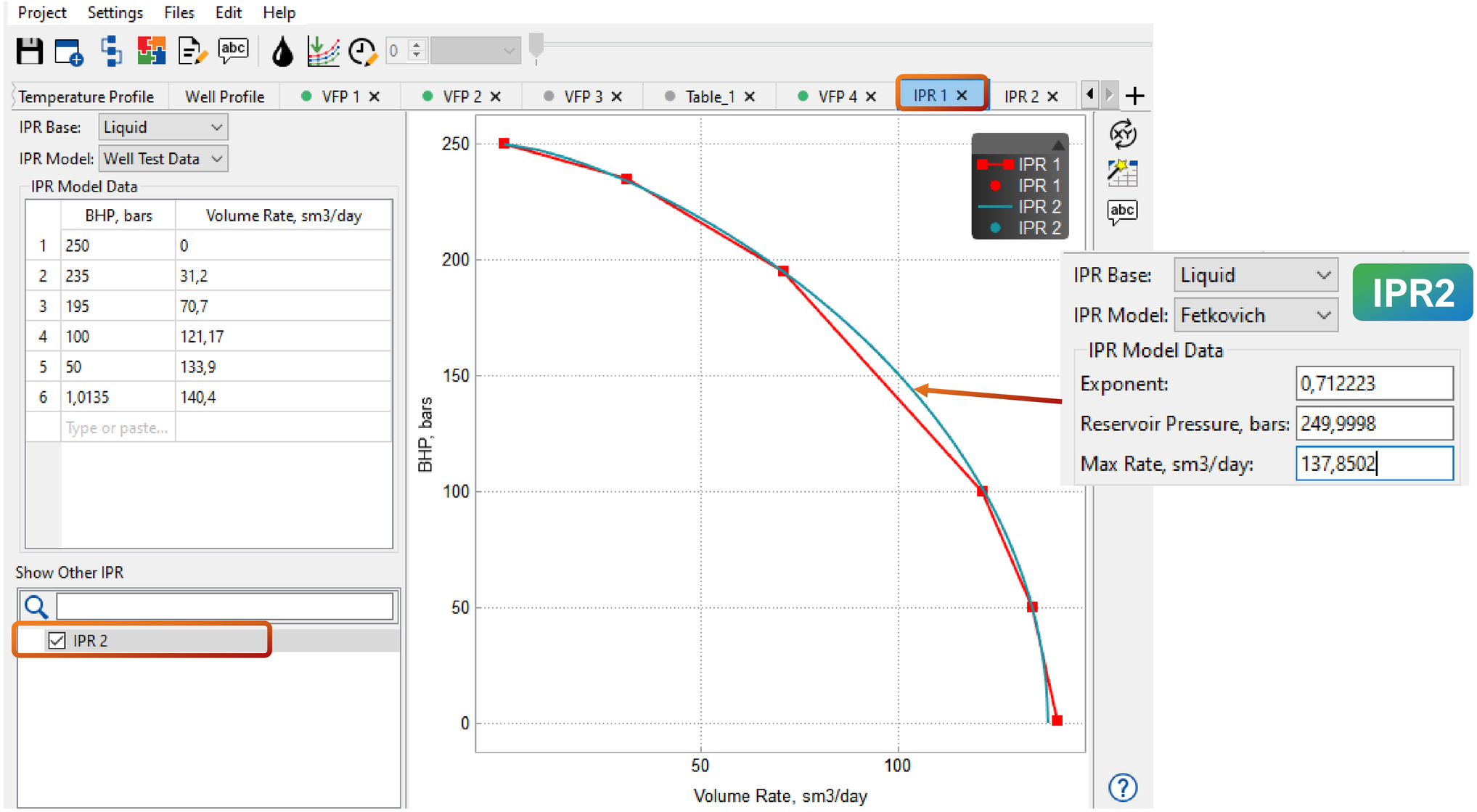
Well construction errors

- **The well project log in the Log panel can now be used to control errors occurring when creating a well construction**



IPR curves

- It is now possible to visualize several selected IPR curves in the IPR tab

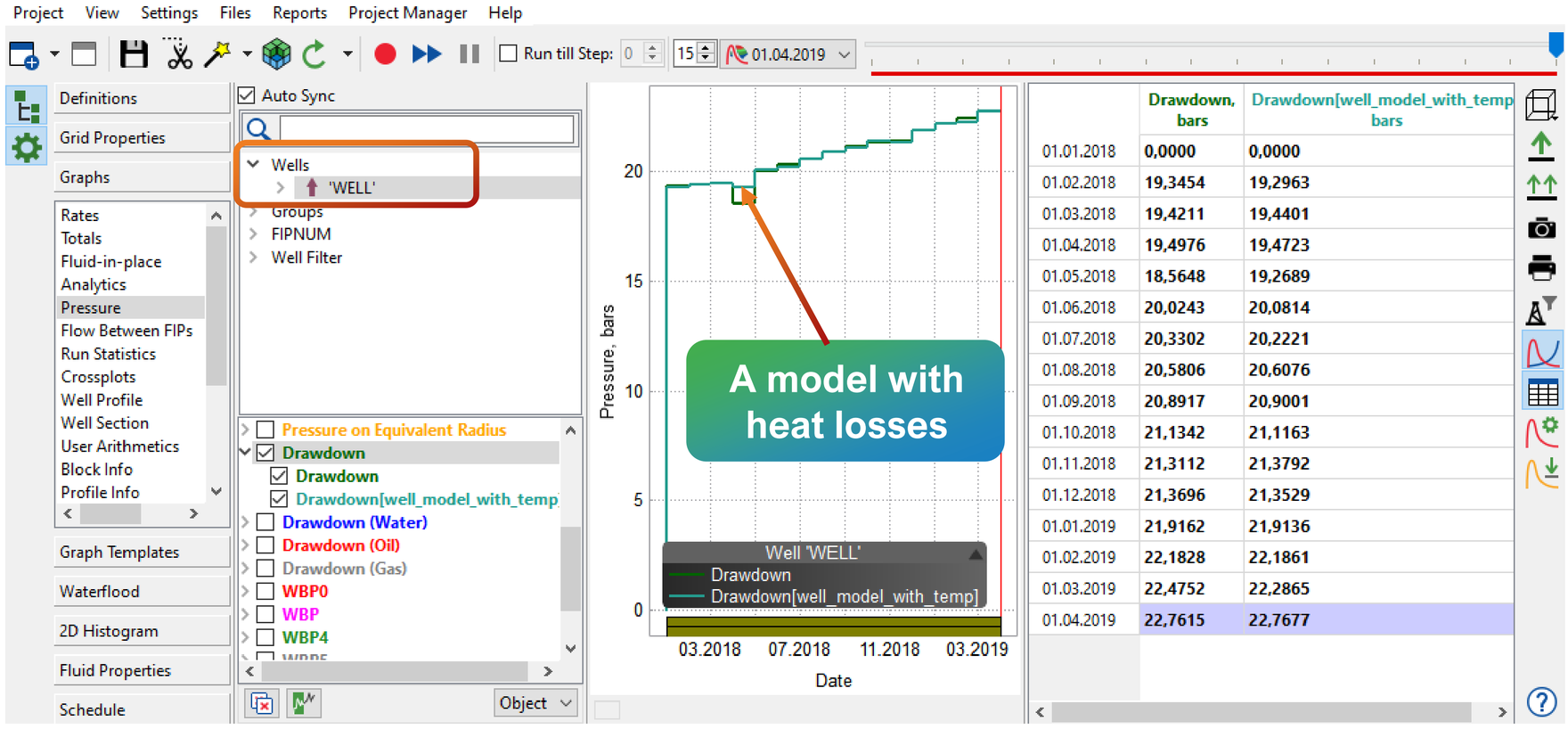


Heat losses along a wellbore

- The environment temperature (the TEMPERATURE parameter of the WELLDATA keyword) and the coefficient for the heat exchange between the wellbore and the environment (the CONDTUBE parameter of the WELLDATA keyword) are taken into account

model_sch_with_temp.inc

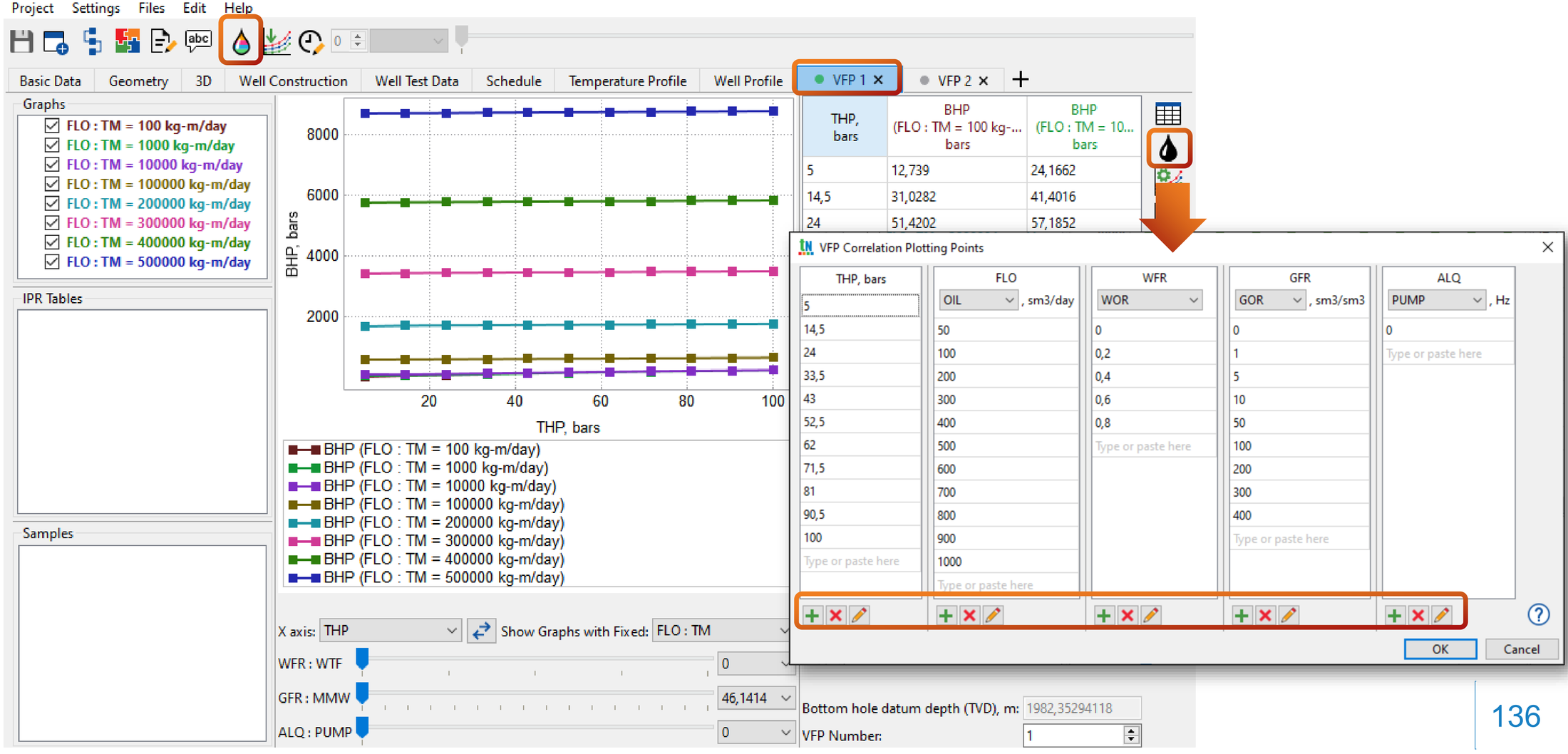
```
WCONPROD
-- wname  status  control  orate  wrate  grate  lrate  lrate(rc)  BHP  THP
 'WELL' OPEN THP 2* 1* 3* 10 /
/

WELLDATA
-- name  branch mdu mdl  md/tvd  parameter    value
   'WELL' 0      200  400     MD      TEMPERATURE  12 /
   'WELL' 0      400  1000    MD      TEMPERATURE  40 /
   'WELL' 0      1000 1500    MD      TEMPERATURE  60 /
   'WELL' 0      1500 2000    MD      TEMPERATURE  80 /

   'WELL' 0      200  400     MD      CONDTUBE  4 /
   'WELL' 0      400  1000    MD      CONDTUBE  9 /
   'WELL' 0      1000 1500    MD      CONDTUBE  16 /
   'WELL' 0      1500 2000    MD      CONDTUBE  22 /
/

DATES
01 FEB 2018 /
/
```



	Drawdown, bars	Drawdown[well_model_with_temp bars
01.01.2018	0,0000	0,0000
01.02.2018	19,3454	19,2963
01.03.2018	19,4211	19,4401
01.04.2018	19,4976	19,4723
01.05.2018	18,5648	19,2689
01.06.2018	20,0243	20,0814
01.07.2018	20,3302	20,2221
01.08.2018	20,5806	20,6076
01.09.2018	20,8917	20,9001
01.10.2018	21,1342	21,1163
01.11.2018	21,3112	21,3792
01.12.2018	21,3696	21,3529
01.01.2019	21,9162	21,9136
01.02.2019	22,1828	22,1861
01.03.2019	22,4752	22,2865
01.04.2019	22,7615	22,7677

VFPPROD points for Black Oil

- It is now possible to edit the points of parameters of a black oil model in the VFP Correlation Plotting Points table, which are used in calculation of VFP curves based on the compositional model



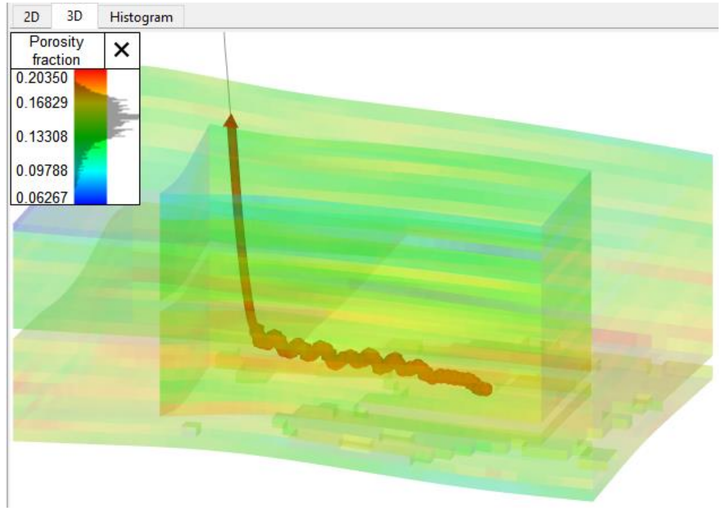
Modeling the corrosion of well material

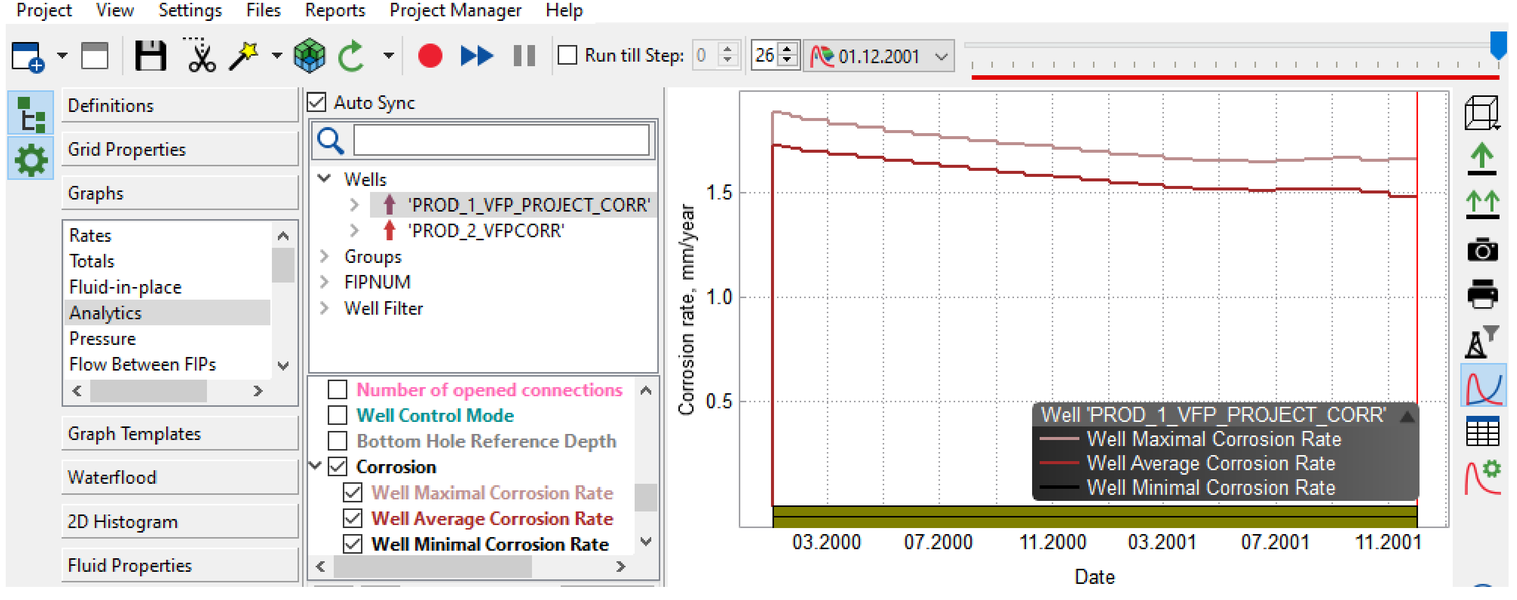
- The corrosion of well material may now be modeled using the deWaard (1995) model with the help of the **WELCORER** keyword

Corrosion of tubing

R_V_1_2_welcorer.DATA

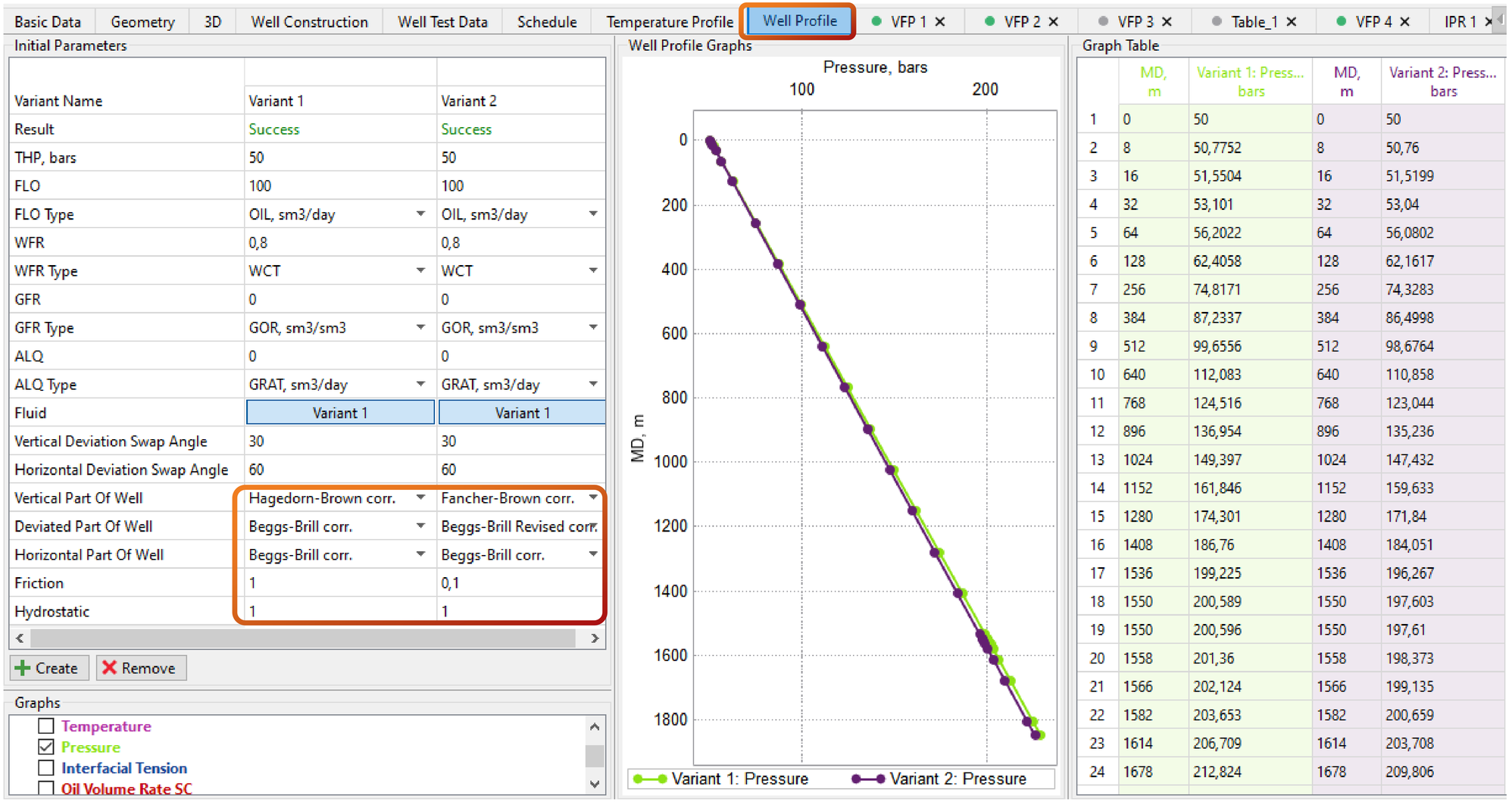
```
331  WELCORER
332  PROD_1_vfp_project_corr /
333  CORROSION_EFFICIENCY 0.57 /
334  MOLE_FRACTION_CO2 0.08 /
335  ACTUAL_PH 5.5 /
336  /
```



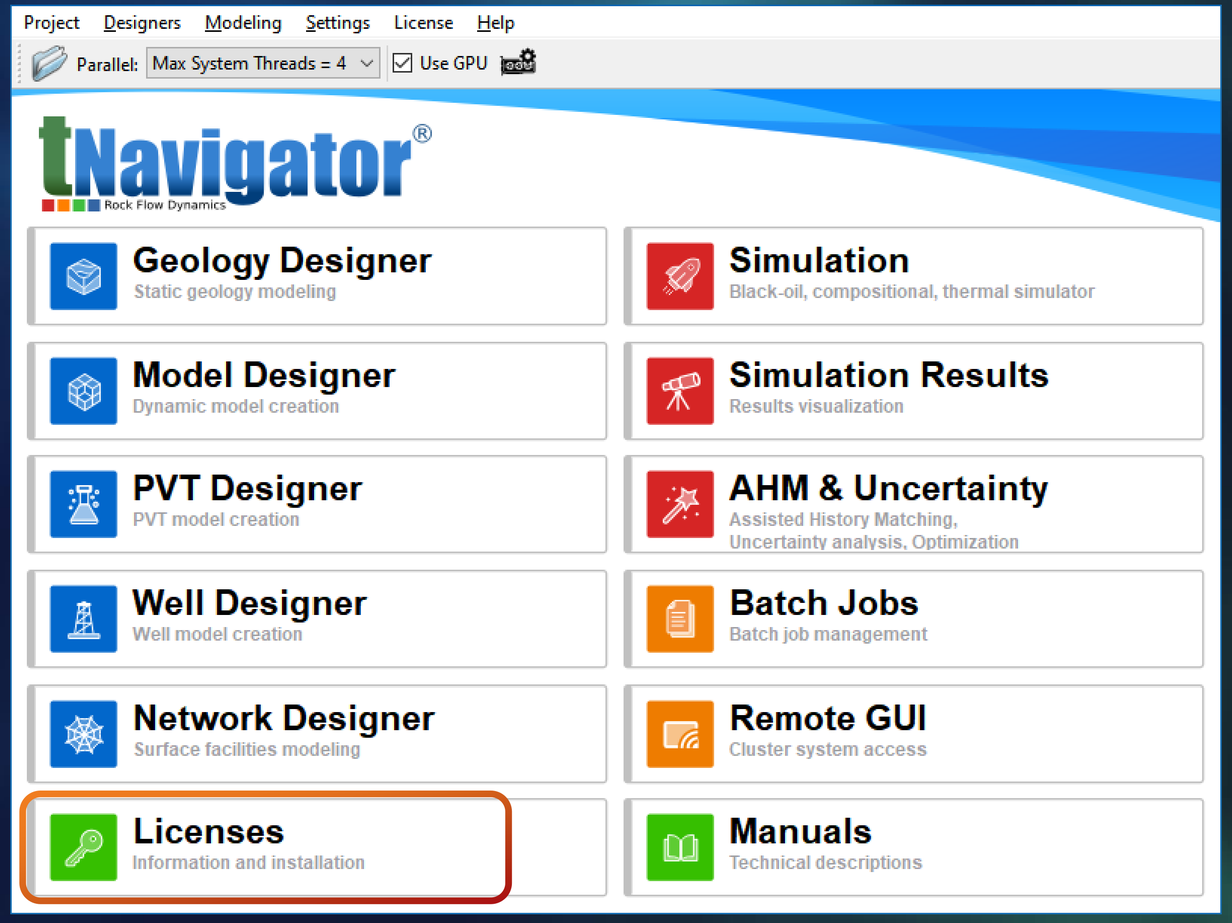


Well Profile tab

- It is now possible to show several parameters (pressure, temperature, etc.) simultaneously for different combinations of rates, tubing head pressures (THP), GFR, WFR, ALQ and correlation types



Licensing and License Server



Licensing and License Server

- **License use statistics aggregated by users, groups, queues, and license types may be visualized in the tNavigator graphical interface.**

License Server Report localhost:8057[group:1]

Group	GUI	black oil	compositional	geology designer	history matching	model designer	network designer
1	258	0	0	168	0	168	168
1	27418	1	0	38286	1229	38286	0
1	5440	4183	4130	10	0	234	10
1	542	71	0	92	0	387	0
1	456	0	0	0	0	455	455
1	2855	0	0	2855	0	0	0
1	8333	420	0	7986	0	8350	7986
1	10019	768	5	5617	10	6761	1903
1	4569	16	14	1351	0	1351	0
1	83	77	0	0	0	0	0
1	1553	0	0	1459	0	1459	0
1	3038	4758	0	263	1875	263	0
1	32342	2905	2526	0	0	0	0
1	15164	0	0	13589	0	543	0

Total: GUI 112070 min, black oil 13199 min, compositional 6675 min, geology designer 71676 min, history matching 3114 min, model designer 58257 min, network designer 10522 min

Save Selected to File | Close

- **A summary table on the use of licenses has been added to the calculation log.**

THERM11_FIX.log

```
23113 | Licenses info                                                                |                    |
23114 +==============================================================================+====================+
23115 | Maximal number of Black Oil licenses                                         |                  1 |
23116 | Total Black Oil licenses utilization time                                    |           00.00.23 |
23117 | Maximal number of Compositional licenses                                     |                  1 |
23118 | Total Compositional licenses utilization time                                |           00.00.23 |
23119 | Maximal number of Thermal licenses                                           |                  1 |
23120 | Total Thermal licenses utilization time                                      |           00.00.23 |
23121 +==============================================================================+====================+
```

tNavigator® Rock Flow Dynamics

Documentation & Localization

Built-in documentation

- A section with the list of supported keywords in IN format is available as a part of User Manual.

17. Keywords for format IN

The keywords of format IN correspond to certain keywords of tN/E1/E3 formats according to the following tables. Note that the keywords related to initial data arrays are listed separately in the second table.

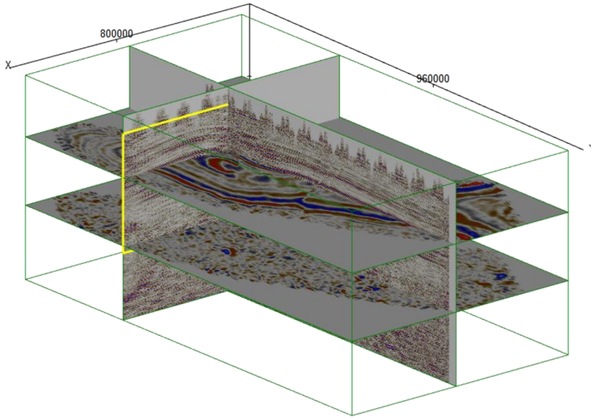
IN keywords

IN keyword	Corresponding tN/E1/E3 keyword(s)
BINARYINTERACTIONCOEF	BIC (see 13.16.46)
BOXPROPERTYEDIT	ARITHMETIC (see 13.3.2)
BRINECOMPONENTCOMPRESSIBILITIES	BDENSITY (see 13.7.7), BRINE (see 13.1.61), PVTW (see 13.5.9), PVTWSALT (see 13.7.8)
BRINECOMPONENTPROPERTIES	BRINE (see 13.1.61), ECLMC (see 13.1.63), SALTVD (see 13.18.54)
BRINECONCENTRATIONDEPTHTABLE	BRINE (see 13.1.61), SALTVD (see 13.18.54)
BRINEFLUIDMODEL	BRINE (see 13.1.61), SALTVD (see 13.18.54)
CAPPRESSURE	SGFN (see 13.6.14), SWFN (see 13.6.13)
CAPPRESSUREHYSTERESIS	EHYSTR (see 13.6.92)
CARLSONRELPERMHYSTERESIS	EHYSTR (see 13.6.92), SATOPTS (see 13.1.76)
CARTERTRACY	AQUANCON (see 13.19.11), AQUCT (see 13.19.9), AQUDIMS (see 13.19.1)
CARTERTRACYINFLUENCEFUNCTIONTABLE	AQUDIMS (see 13.19.1), AQUTAB (see 13.19.10)
CELLACTIVITY	MINPV (see 13.2.31), PINCH (see 13.2.63)
CELLDOUBLEPROPERTY	SOLUTION (see 13.18.1)

New training tutorials (1)

A tutorial for Geology Designer:

- **GD4.7. How To Work With SEGY Headers**

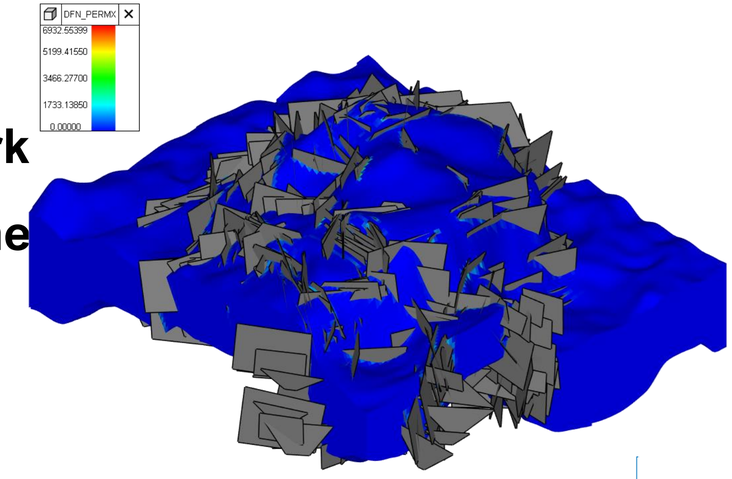


This tutorial provides a workflow for import of seismic 3D data in the case where

the text header contains no information concerning the inlines and crosslines positions in the SEG-Y file.

A tutorial for Geology Designer and Model Designer:

- **COMMON1.9. How To Create Dual Porosity Models via DFN**

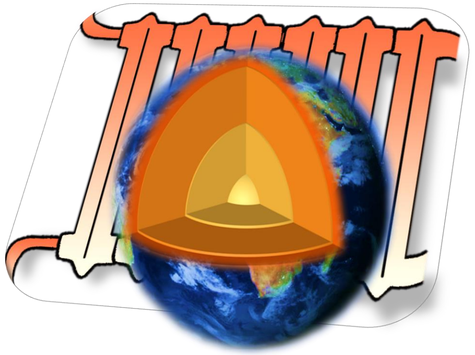


This tutorial covers the basic workflow for creating discrete fracture network (DFN) and dual porosity (DP) models in Geology Designer and Model Designe

The input data are loaded, the geological and (later) dynamic models are built, then the calculations are run and the results are analyzed.

New training tutorials (2)

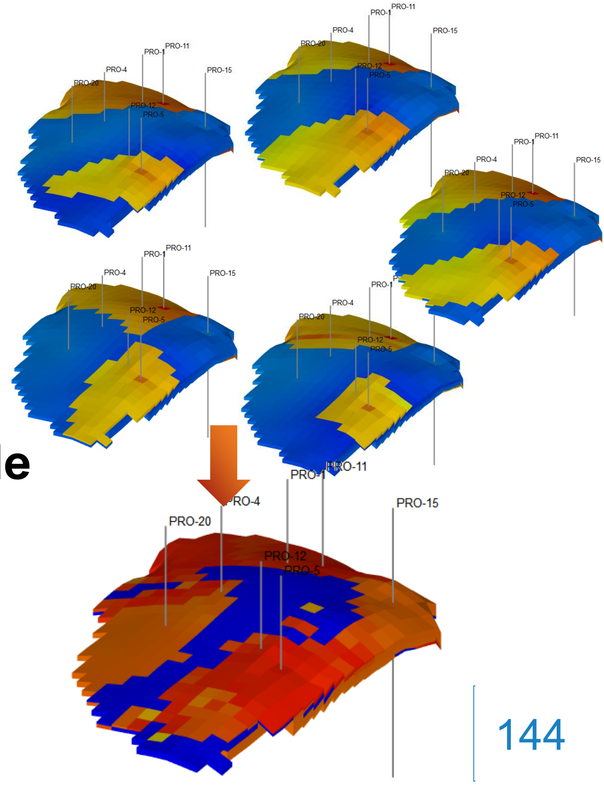
A tutorial for Model Designer:



- **MD3.3. How To Create Geothermal Model**

This tutorial explores the creation of a geothermal black oil model with temperature extension using a simple grid with a five-point well placement system as an example. The tutorial also includes the .data file of the resulting geothermal model.

A tutorial for Model Designer and AHM:



- **MDAHM1.5. How To Use Ensemble Smoother Method**

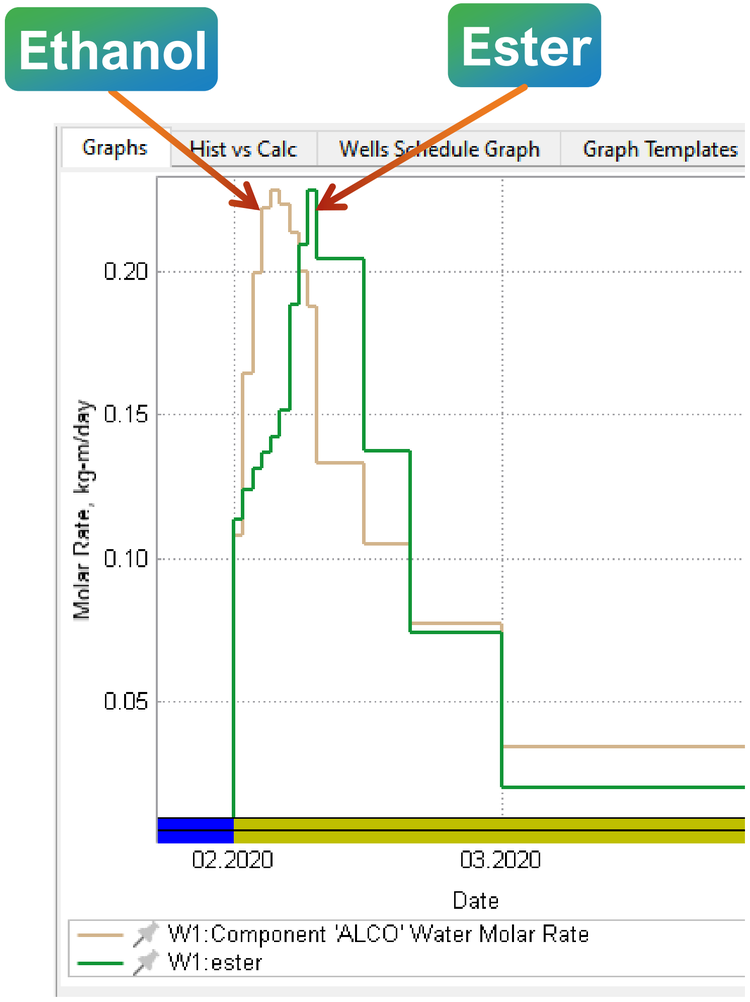
In this tutorial, we show the approach to running the ensemble smoothing method. The initial data are loaded into Model Designer, the necessary variables and workflow are created, an initial ensemble of variants is generated, and the ensemble smoothing method with the defined objective function is started.

New training tutorials (3)

A tutorial for Simulator:

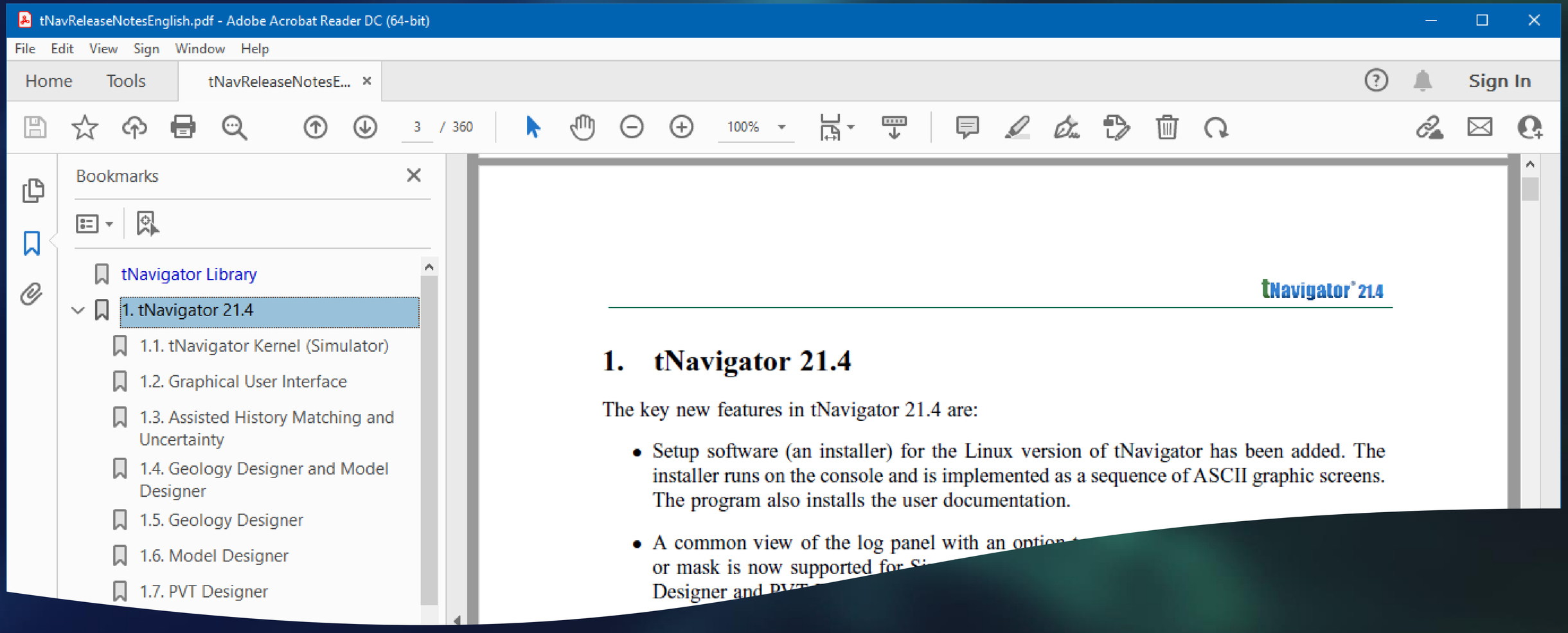
- **SIM6.10. How To Model Single Well Chemical Tracer Test**

  This tutorial explores a compositional model with chemical reactions. The ester is modeled as two components, one in the oil phase and the other in the water phase. The distribution of ether between phases is modeled using chemical reactions. The ester dissolved in water reacts with water to form ethanol and acetic acid.



Thank you for your attention!

The complete list of new features is available in the Release Notes



Rock Flow Dynamics

Would you like to test tNavigator?

Get a demo

rfdsales@rfdyn.com

Already using tNavigator and have questions?

Contact technical support

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