S3GRAF v9.1 Release Notes

S3GRAF
Version 9.1
February 2016

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1. Introduction

S3GRAF v9.1 is the latest version of the Reservoir Engineering Visualisation software from Sciencesoft Ltd. S3GRAF provides functionality to quickly and efficiently visualise and analyse reservoir simulation data from a range of simulators. Line plots of well production data (for example) and views of the simulation grid can be created. With the 3D module three-dimensional displays of simulation grid data can be generated. The HPG module permits extremely fast loading of grid geometry and vector data, especially for large datasets.

The new features to be found in the latest version of S3GRAF are outlined as follows:

Workflow Manager

The Workflow Manager is a new way of using the power of S3GRAF for plotting, creating new quantities and performing analyses. Workflows capture a standard reservoir engineering task and allows it to be recreated quickly and easily from the Workflow Manager.

The Workflow Manager presents all the included workflows in an easily navigable list that can then be selected for application. The user can then set the relevant properties, based on the loaded data, to produce the analyses and information required.

Help Portal: http://support.sciencesoft.com/hc/en-us/articles/207518436

New User Functions

New functions have been made available for the User Functions feature of the Derived Quantities. These are:

- **CUMMAX** Cumulative Maximum
- **CUMMIN** Cumulative Minimum
- **DELTA** Difference across timestep

Create RFT Data Based on Solution Data Perforation Locations

Pseudo-RFT data can now be created from Solution and Grid data, based on the location of Completions contained in the Solution datasets. Previously this required a separate trajectory file and used actual MD values.

Help Portal: http://support.sciencesoft.com/hc/en-us/articles/205705245

New Statistic Calculations and Export Option

A set of calculations to produce the P90, P50 and P10 for a set of vectors has been made available for the Statistics tool. These quickly provide a quick representation of the statistical significance of a number of runs.

A new option for exporting calculated statistics vectors to the treeview has also been added to the Statistics tool.

Help Portal: http://support.sciencesoft.com/hc/en-us/articles/205019649

Layer Analysis GRF Commands
New GRF commands have been added to simplify the creation of a Layer Analysis. These new commands are executed with the use of an ALL keyword for layers and timesteps.

Improved Eclipse H5 File Support
Support has been improved for 2013 and 2014 versions of the Eclipse H5 file format for Summary data. This file allows Fetch on Demand to be used for Summary data.

VIP/Nexus ALIAS File Support Extended
The ALIAS file in VIP/Nexus allows wellnames longer than eight characters. The ALIAS/Alias xref file can now be applied to members within the map data for VDBs and for MAP files as well as for PLT files.

UTCHEM/UTCOMP Corner Point Grid Support
Support has been added for corner point grid formats in UTCHEM/UTCOMP.

UTCHEM Format Load Commands for GRF
The GRF language has now been extended to include the option to define the timestep format for Solution data. This allows the data to be organised by Time, Pore Volume or a combined Time & Pore Volume. There is also now an option to define the default x-axis for Summary data, this can be either Time or Pore Volume.

RFT Layer Lines
Formation depth lines can be added to RFT plots as an alternative to standard depth lines. Formations can be defined with a LYR file and loaded into S3GRAF. These allow quick identification of formations while examining well data with a RFT plot.

Help Portal: http://support.sciencesoft.com/hc/en-us/articles/207702626

Graph Search with Completions Indices
When using Graph Search, individual I, J and K values for the Completion data can be used to define the search. For instance, by defining a specific K, oil output from a defined formation can now be plotted (for all wells completed in that formation).

Help Portal: http://support.sciencesoft.com/hc/en-us/articles/205735105

Multi-Phase Injector Support
Support for the display of multi-phase injector wells has been added.

Alternative Ternary Colour Scheme

A new Ternary Plot colour scheme has been added to allow for differing conventions. This is a system setting and so can be changed permanently in S3GRAF.

The colour scheme for Ternary Plots can be toggled between:

Phase	Default Scheme	Alternate Scheme
Oil	Green	Red
Water	Blue	Blue
Gas	Red	Green

2. Workflow Manager

The Workflow Manager is a new way of using the power of S3GRAF for plotting, creating new quantities and performing analyses. Workflows capture a standard reservoir engineering task and allows it to be recreated quickly and easily from the Workflow Manager.

The Workflow Manager presents all the included workflows in a list that can then be selected for application. The user will then set the relevant properties, based on the loaded data, to produce the analyses and information required.

Workflows are based on modified GRF files, however the user does not need to understand the GRF script. Instead the user is presented with a description of the workflow's actions and a list of user-definable parameters, usually data dependant, which are then set before the workflow is executed.

2.1.Accessing the Workflows

Once any data set has been loaded into the Treeview, the *Workflow Manager* tool will be enabled. This can be accessed from the *Tools* menu, as seen in Figure 1, or from the *Derived Quantities* toolbar.

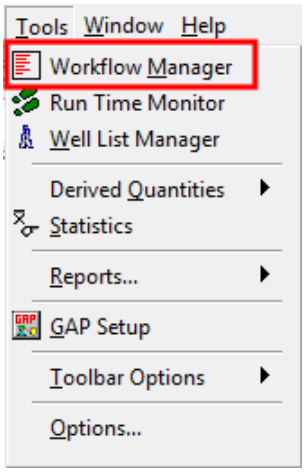

Figure 1 - Menu Access for Workflow Manager

Click on the **Workflow Manager** item and the *Workflow Manager* dialog will appear, as seen in Figure 2.

The presented workflows are dependent upon what data has been loaded into S3GRAF, i.e. if only Eclipse data sets are loaded then only the Eclipse specific Workflows are listed. This filtering can be changed by selection from the *Type* drop-down list, and can be refined further by specifying a filter using the *Filter* textbox and standard wildcards (*, ?, partial names, etc.).

The dialog will contain a list of valid Workflows that can then be applied to the loaded data. Double-clicking on a workflow or clicking the **Next** while a workflow is highlighted will then open a dialog for the chosen workflow where the necessary parameters can be set before execution.

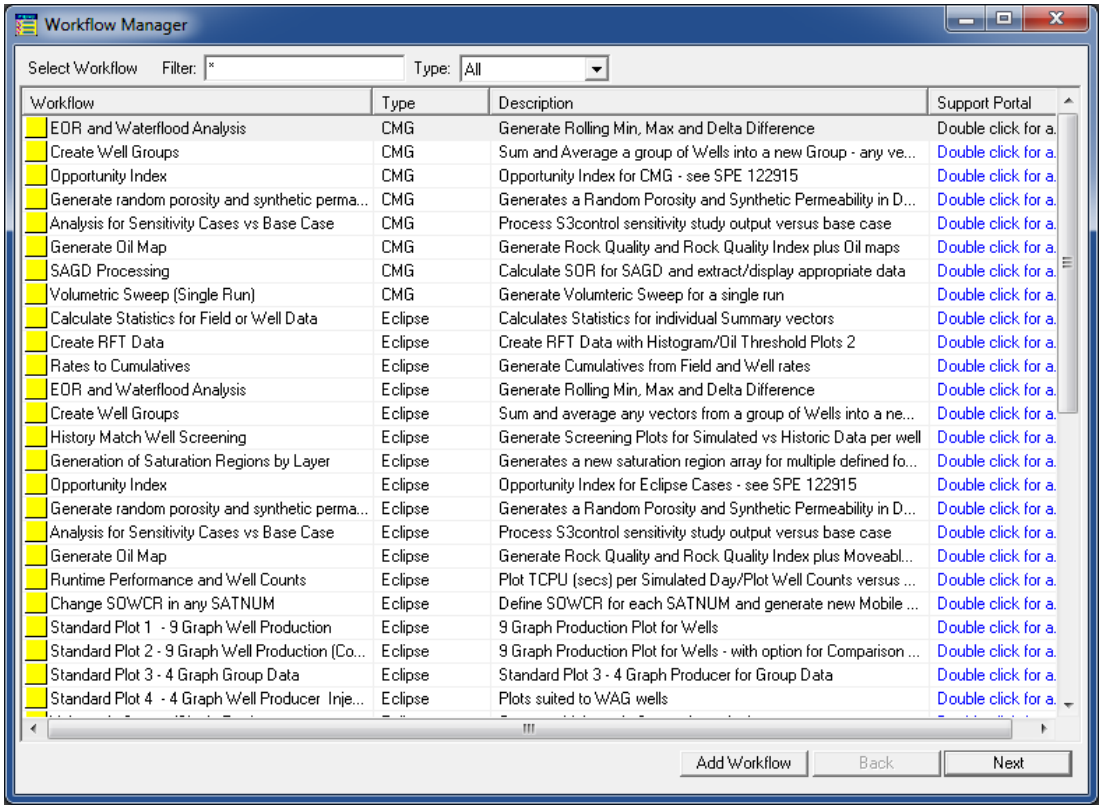

Figure 2 - Workflow Manager Dialog

2.2.Running a Workflow

The procedure for running a Workflow can be summarised as follows:

1. Load the data set upon which to perform the Workflow.
2. Open the *Workflow Manager*.
3. Select the Workflow to perform.
4. Set the required parameter values for the analysis.
5. Run the Workflow.
6. Examine the created plots and new items in the Treeview.

Workflow Selection

Once the *Workflow Manager* has been opened select a workflow from the list and click **Next**.

Each Workflow is accompanied by an article on the Sciencesoft Help Portal. This article will provide extra detail on the construction and use of the Workflow. Double-clicking on the last column will open the corresponding article in a browser. A registered Sciencesoft account is necessary to access the portal.

In this example the *Generate Oil Map* has been selected.

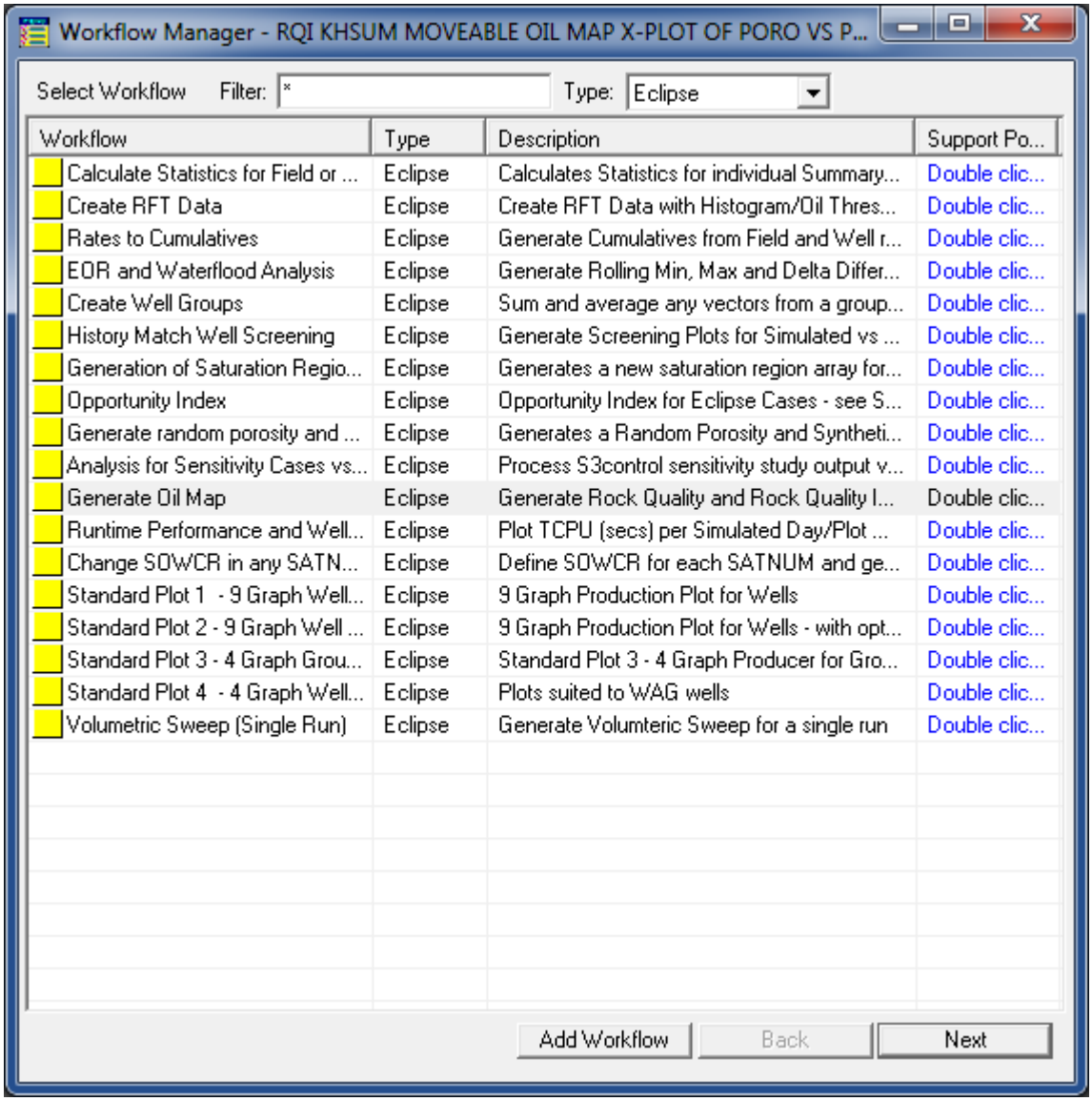

Figure 3 - Selecting a Workflow

Workflow Setup

The details for the chosen Workflow will then be presented, see Figure 4. This dialog will show more information on the Workflow including what data may be required, what calculations are performed and what the output will be.

This dialog details what information is required from the user and lists the parameters that need values to be set, such as well names or property values. Default values are presented but in most cases will be unsuitable for the chosen data set and are usually highly specific to the properties of the data set.

The data set origin will be automatically allocated from the first case in the *Origin* list.

If there are multiple data sets loaded, the origin can be selected from the *Select Origin* drop-down list, or typed in to the *Case name* parameter directly, as seen in Figure 5.

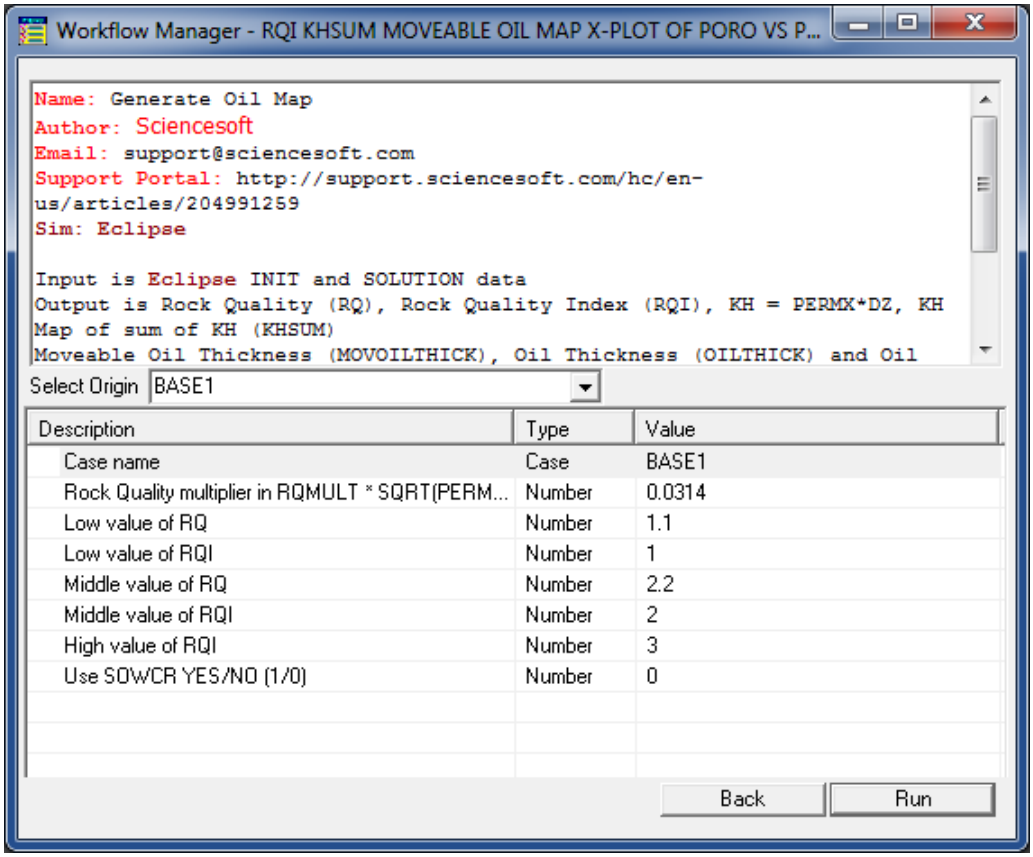

Figure 4 – Workflow Launch Dialog

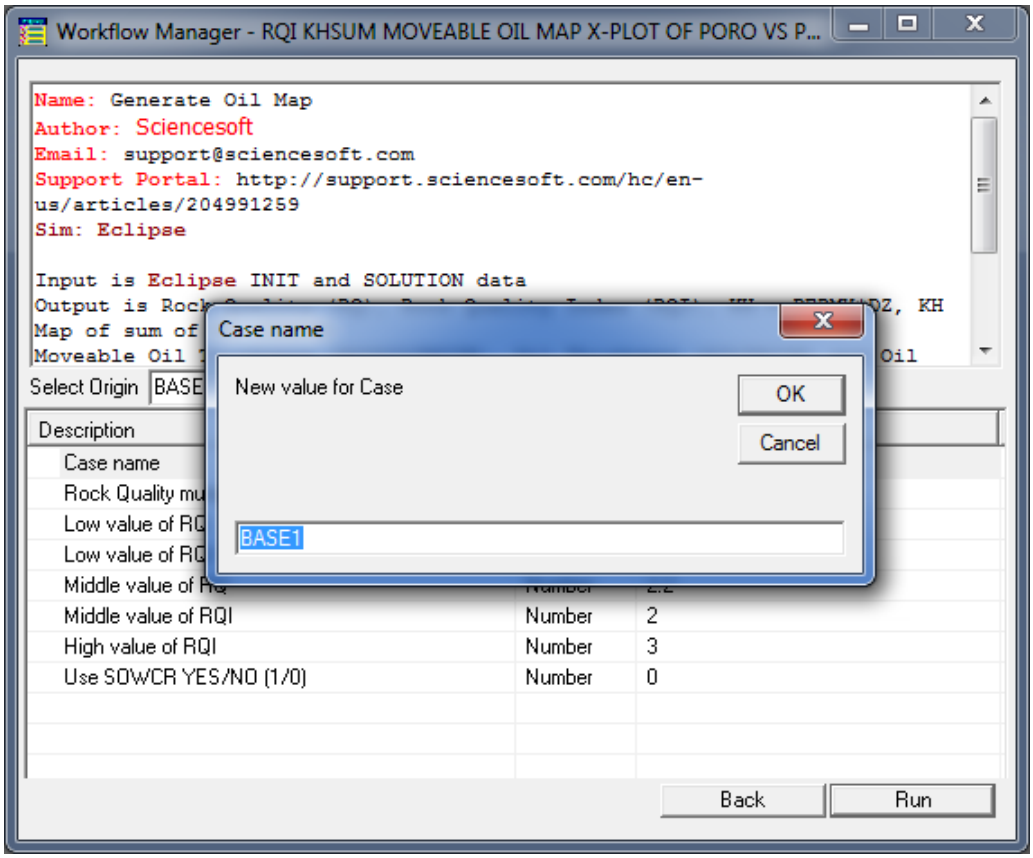

Figure 5 - Setting a Workflow Case Name

Parameter Definitions

A Workflow may depend upon a number of values to be set by the user, such as values for Rock Quality (*RQ*) in the example. These are presented in a list below the description of the Workflow. All of the items should be changed to suit the selected data before running the Workflow.

Double-clicking on any of the rows produces a dialog to change the item value, see Figure 6.

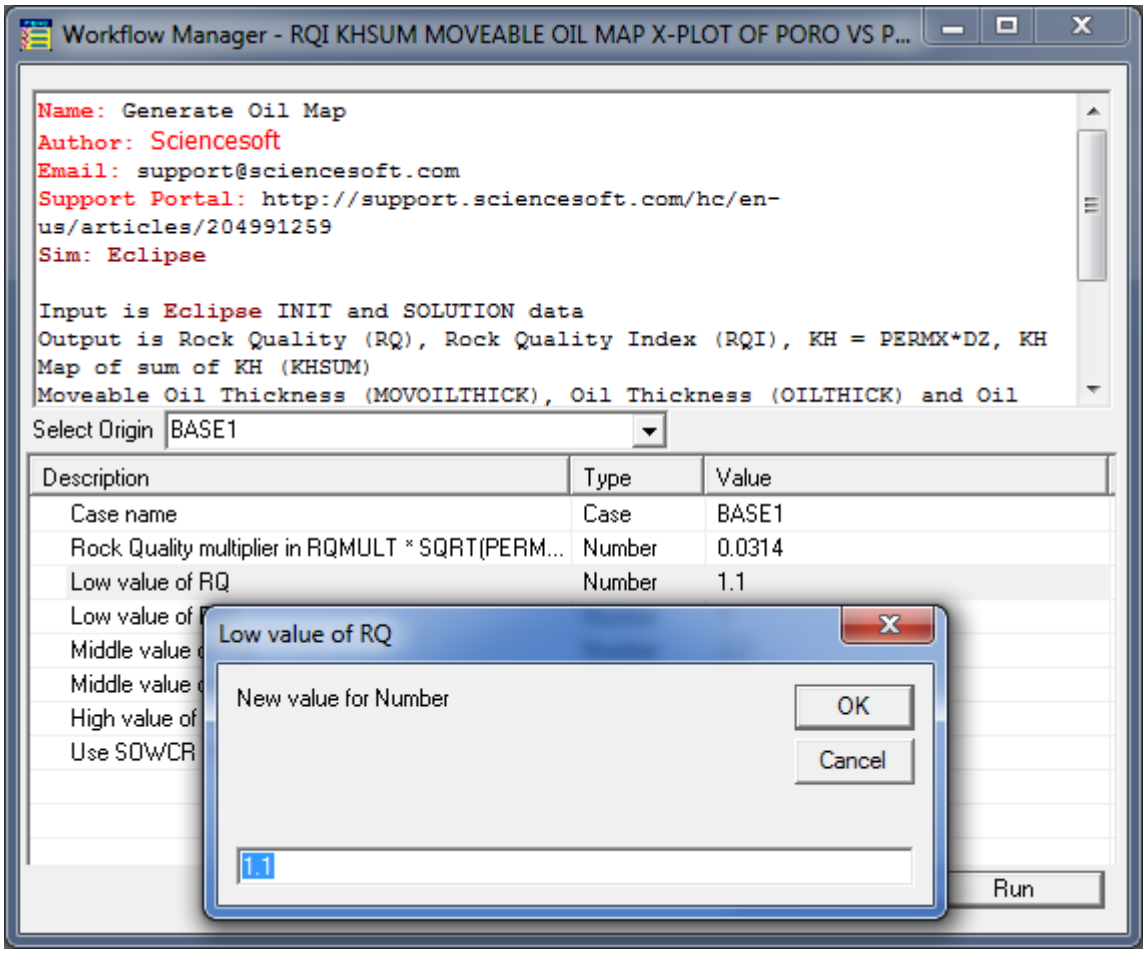

Figure 6 - Setting a Workflow Parameter

Running the Workflow

Once satisfied with the values, click the **Run** button. Behind the scenes the system will create a temporary GRF to apply the workflow procedure and automatically load it into S3GRAF. If the Workflow completes successfully, the normal GRF message will be displayed, see Figure 7.

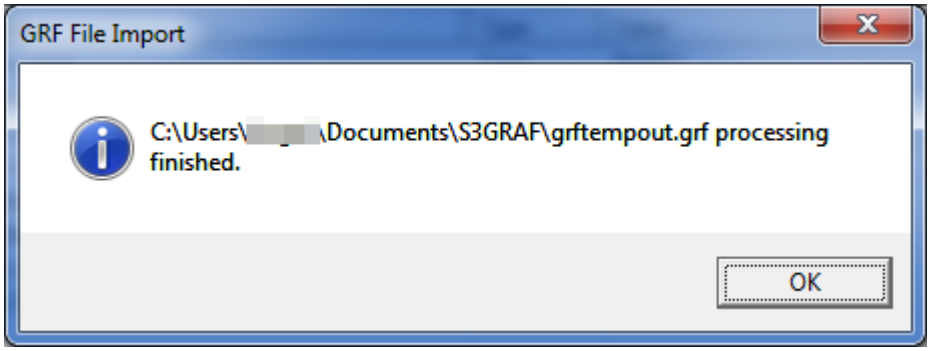

Figure 7 - Successful Workflow Application Message

Any new data sets will appear in the Treeview and any plots or grids will be added to the Graph List (and displayed if the *Display Graphs immediately after import* is on).

If there is an error a warning message, see Figure 8, will appear inviting the user to investigate the GRF reader report file. This can then be used to debug any issues recreating the Workflow.

Figure 8 - Unsuccessful Workflow Application Message

2.3.Importing a New Workflow

New workflows may be supplied through Sciencesoft's support desk and these can be imported into S3GRAF. To do this open the *Workflow Manager* and click on the **Add Workflow** button at the bottom of the dialog. A file open dialog will be presented so select the file to be added and click **OK** in the usual manner.

Alternatively the Workflow file can be dragged-and-dropped onto the *Workflow Manager* dialog to add it to the list.

If it is a valid Workflow file it will be added to the system and a message confirming the addition presented, see Figure 9, clicking **OK** and it will be added to the list for use.

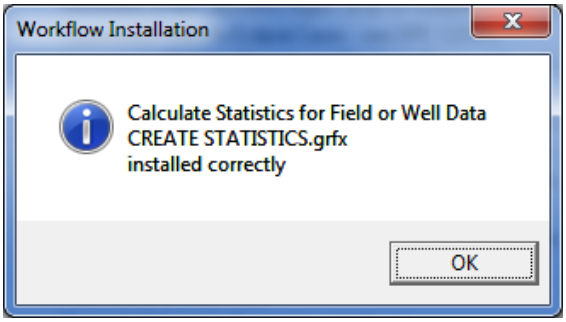

Figure 9 - Workflow Addition Confirmation Message

2.4.Notes on Workflows

A range of common Workflows have been provided as part of the S3GRAF installation and have been created by the Sciencesoft support team. Other Workflows will be added in future and as part of our support system. If a customer requires a new workflow, this can be provided on demand. Please email support@sciencesoft.com.

2.5.Help Centre linkage

Further details on individual Workflows can be found on the Sciencesoft Help Portal. Each Workflow presented in the *Workflow Manager* list has a direct link to the Portal for an article describing, in detail, the workflow performed.

A registered Sciencesoft account is necessary to access the Portal.

3. New Analysis Features

3.1.New User Functions

There are three new mathematical functions that can be used within the User Function tool. This is launched from *User Function* item in the *Derived Quantities* sub-menu of the *Tools* menu or the corresponding toolbar button.

These functions are summarised as follows:

CUMMAX - Cumulative Maximum

This function calculates the cumulative maximum of each element of a map vector (grid cell) through time, i.e. for element *n* of the given vector, the cumulative maximum is the maximum value of n occurring 1 through *t* (where *t* is the current timestep).

This is invoked in the User Function as:

```
Y=CUMMAX(A)
```

Where `Y` is the output vector and `A` is the grid Solution property. For example, if `A` was PRESSURE from the 5th timestep the output `Y` would be the maximum PRESSURE for each cell over the 1st to 5th timestep period but not including anything beyond the 5th timestep.

CUMMIN - Cumulative Minimum

This function calculates the cumulative minimum of each element of a map vector (grid cell) through time, i.e. for element *n* of the given vector, the cumulative minimum is the minimum value of *n* occurring 1 through *t* (where *t* is the current timestep).

This is invoked in the User Function as:

```
Y=CUMMIN(A)
```

Where `Y` is the output vector and `A` is the grid Solution property. For example, if `A` was PRESSURE from the 5th timestep the output `Y` would be the minimum PRESSURE for each cell over the 1st to 5th timestep period but not including anything beyond the 5th timestep.

DELTA - Difference across timestep

This function calculates the difference for each map vector element between the current timestep (*t*) and the previous timestep (*t*-1), i.e. show the value changes for the current step.

This is invoked in the User Function as:

```
Y=DELTA(A)
```

Where `Y` is the output vector and `A` is the grid Solution property. For example, if `A` was PRESSURE from the 5th timestep the output `Y` would be the PRESSURE change for each cell

between the 5th and the 4th timesteps. If A is the first timestep then the output Y is set to zero for all cells.

3.2.Create RFT Data Based in Solution Data Perforation Locations

The *Standard Function* feature includes the *Create RFT Data* function that produces RFT data based on a wellbore path as defined by a trajectory file. When this is unavailable the path of the well can instead be approximated from the completion/perforation locations contained in the Solution data sets and pseudo-RFT data created.

The *Standard Function* feature is accessed from the *Standard Function* item in the *Tools -> Derived Quantities* menu or the corresponding toolbar button. The *Create RFT Data* option can then be selected from the drop-down function selection of the dialog shown in Figure 10.

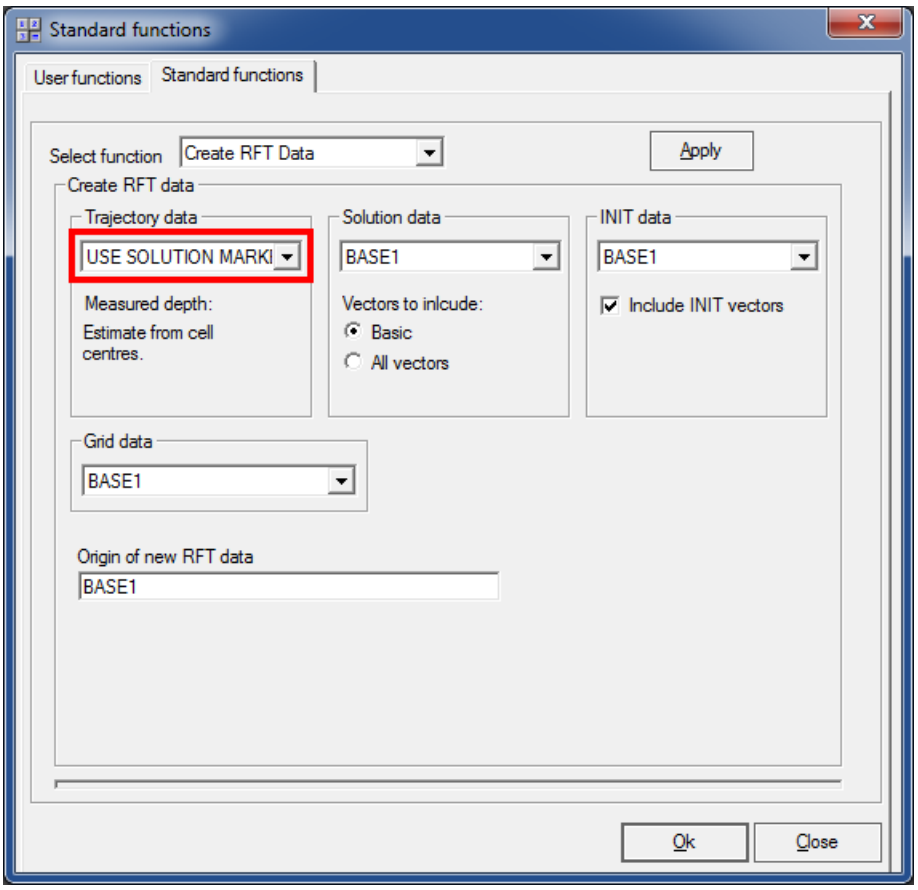

Figure 10 - Standard Function Dialog for Create RFT Data

To perform the calculation based on the Solution select *USE SOLUTION MARKERS* from the Trajectory drop-down, circled in red in Figure 10.

Calculation Methodology

This option will take the cell values for the Solution and INIT vectors at the location of the well completions/perforations and export them to a new RFT data set in the treeview.

Due to the limitations of the data available only an estimate of the Measured Depth (MD) is made. This is based on a calculation of the direct distance between the cell centres for each successive completion/perforation cell location. The depth of the first completion/perforation is used to set the initial MD then the calculated distance between the first and second completion/perforation is added to this to define the MD of the second completion/perforation. This is repeated for each successive completion/perforation.

3.3.New Statistics Calculations and Export Option

Calculations to produce the P90, P50 and P10 for a set of vectors have been made available for the *Statistics* tool. These can quickly provide a representation of the statistical significance of a number of runs. The option to export the calculations from the *Statistics* tool has also been made available to allow the new data to be further analysed.

The *Statistics* dialog is accessed from the *Tools* menu by clicking on the *Statistics* item. The new calculations can be selected from the drop-down list, circled in red in Figure 11.

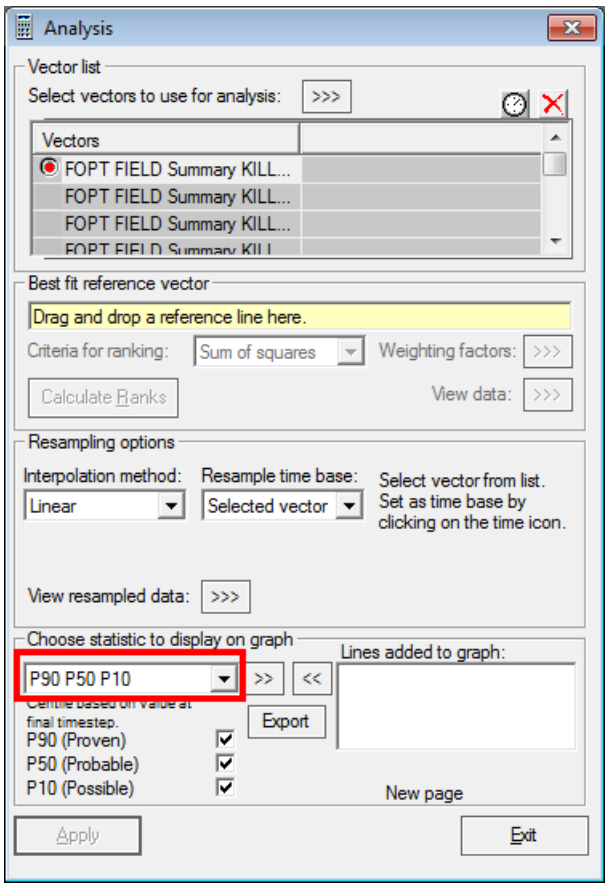

Figure 11 - Statistics Dialog

P90, P50 and P10

Added to the list of statistics to display on the graph is *P90 P50 P10*. These calculations produce the P90 (proven), P50 (probable) and P10 (possible) as a probability analysis for the chosen data vectors as a measurement of distribution between them.

In practice this will take the vector list defined in the *Statistics* dialog and extract the values for each vector at the final timestep of the reference time base. These values are ordered to produce a percentile ranking and the closest matches for the P90, P50 and P10 found. The P90 is defined as the proven result (with an estimated 90% chance of final vector values exceeding this), P50 is the probable result (analogous to the median) and P10 is known as the possible result (estimated 10% exceeding this).

This method is intended for analysing oil production totals from multiple runs to generate the most common definition of P90, P50 and P10. However, the technique can be applied to any list of vectors.

Each calculation can be applied individually by selecting the relevant checkboxes.

Export Option

Any of the calculations that can be performed from the *Statistics* dialog can now be exported to the Treeview where they can be examined further. When the relevant settings are chosen for the statistical calculation the user can click on the *Export* button on the *Statistics* dialog to output the data to the Treeview where it will be listed as a new data set and suitably named.

3.4.Layer Analysis GRF Commands

There are now GRF commands to simplify the reproduction of Layer Analysis from GRF. For *Layer Sum*, *Layer Average* and *Layer Sample* commands the layer range that the analysis operates over can be simplified from `OVER <top_layer> TO <bottom_layer>` to `OVER ALL` when including all the layers.

Further, when performing a Layer Analysis over all timesteps, instead of repeating the GRF command for each timestep individually a single GRF command can be used by specifying `STEP ALL` rather than `STEP 1`, etc.

This shorthand is invoked as necessary when creating a GRF after performing a Layer Analysis by hand.

4. New File/Loading Support

4.1.Improved H5 File Support

Support has been improved for 2013 and 2014 versions of the Eclipse H5 file format for Summary data. This file allows Fetch on Demand, as part of the HPG module, to be used for Summary data. This enables faster loading and smaller memory footprints.

4.2.VIP/Nexus Alias File Support Extended

The ALIAS file in VIP/Nexus simulations allow class member names longer than eight characters. The ALIAS files are used as a lookup to match the defaulted member name with the defined long name.

For VDBs the *ALIAS.bin* file details the lookup and these are used for both the loaded Plot data and the wells shown on grid displays. All references to the member names in S3GRAF will be replaced with the long names. Their use is controlled from the load dialog by checking the *Use long well names (Nexus)* as seen circled in red in Figure 12.

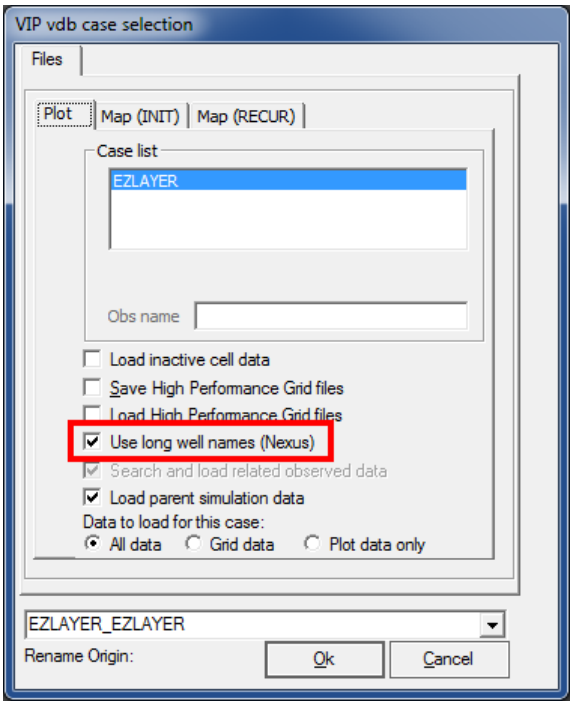

Figure 12 - VDB load dialog

For MAP and PLT files the *Alias_names.xref* file is used to lookup the long member names for the various data classes. These are also used for the loaded Plot data and the well names when displaying a grid. Their use is also controlled from the load dialog by checking the *Use long well names from xref file* as shown circled in red in Figure 13.

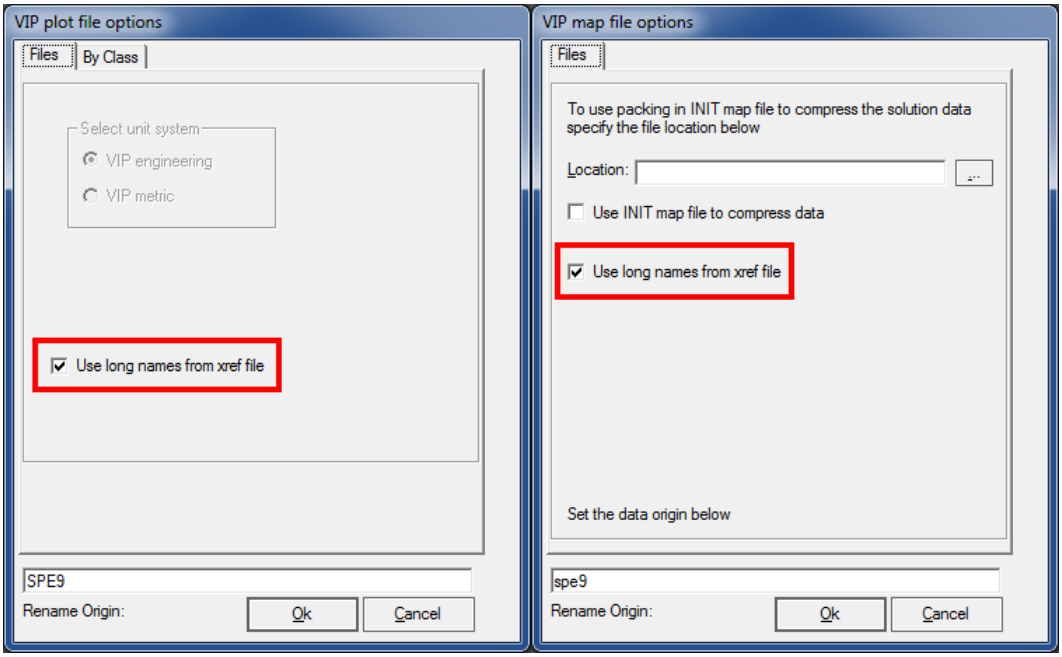

Figure 13 - Load dialogs for MAP and PLT files

For example, in the *ALIAS_names_xref* file the WELLS might be names as:

```
WELLS

SHORT       LONG
-----       ----
WEL00001    WELL1_PRODUCER
WEL00002    WELL2_INJECTOR
…
```

So associated map data will use WELL1_PRODUCER, etc., to label the wells on the grid display and to name the well as such in the Treeview and line plots.

4.3.UTCHEM/UTCOMP Corner Point Grid Support

Support has been added for corner point grid formats in UTCHEM/UTCOMP. This is handled automatically and should be transparent to the user.

4.4.UTCHEM Format Load Command for GRF

The GRF language has now been extended to include the option to define the timestep format for Solution data. This allows the data to be organised by Time, Pore Volume or a combined Time & Pore Volume. There is also now an option to define the default x-axis for Summary data, this can be either Time or Pore Volume.

For Solution data the organisation of the data can be in Time, Pore Volume or Time and Pore Volume. The GRF load command to load the solution data is:

```
LOAD UTCHEM FORMAT <format> SOLUTION <filename>
```

Where the `<format>` entry is either:

Keyword	Solution timestep definition
PV	Defined by injected Pore Volume
TIME	Defined by Time
TIMEPV	Defined by Time and injected Pore Volume

Table 1 - UTCHEM Load Format Commands for Solution Data

For Summary data the default x-axis vector can be Time or Pore Volume and the FORMAT keyword is used

```
LOAD UTCHEM FORMAT <format> SUMMARY <filename>
```

Where the `<format>` entry is either:

Keyword	Default Summary X-Axis
PV	Defined as injected Pore Volume (PV)
TIME	Defined by Time (TIME)

Table 2 - UTCHEM Load Format Commands for Summary Data

The default option for Solution data is to use Time and for Summary data it is Pore Volume.

5. New Line Plot Features

5.1.RFT Layer Lines

Formation depth lines can be added to RFT plots as an alternative to standard depth lines. Formations can be defined with a LYR file and loaded into S3GRAF. These allow quick identification of formations while examining well data with a RFT plot.

LYR files contain data required to produce RFT formations lines. They consist of a list of formation names and the layer range that constitutes a formation. These definitions are then used for formation layer lines as representations of the approximate depth boundaries between formations in RFT plots.

LYR files can be loaded in the normal manner, either dragged-and-dropped onto S3GRAF or through *File -> Open*. Once loaded an LYR file will appear in the Treeview under an origin defined by the file name and in a folder labelled "LYR". It is intended that a LYR file should have the same filename as the accompanying RFT file.

LYR File Example

The LYR file consists of a list of formation names with their upper and lower layer indices. It can be created by Eclipse or by hand in a text editor.

The below *.LYR* file example shows four sand formations stretching over grid layers (z-direction). Each formation is defined with a name, bracketed with single quotes, and an upper and lower layer index, separated by a dash (-).

```
'SAND_1' 1 - 3
'SAND_2' 4 - 5
'SAND_3' 6 - 8
'SAND_4' 9 - 11
```

e.g. SAND_1 - Stretches over layer k=1 to layer k=3.

RFT Plots and Layers

Once a RFT plot has been produced the RFT layers can be added with the *Show RFT Layers* toggle button, seen in Figure 14. When a LYR file has been loaded within the current Origin.

Figure 14 - RFT Layers Button

Whereas standard depth lines represent the cell centred depths at each completion, formation layer lines from the LYR file represent the approximate depth boundaries between specified groups of layers. This is estimated by comparing the layer indices of the formations to perforation indices and their corresponding depths for the displayed RFT line.

The Figure 15 shows the Pressure down a well as it traverses formations SAND_1 to SAND_3.

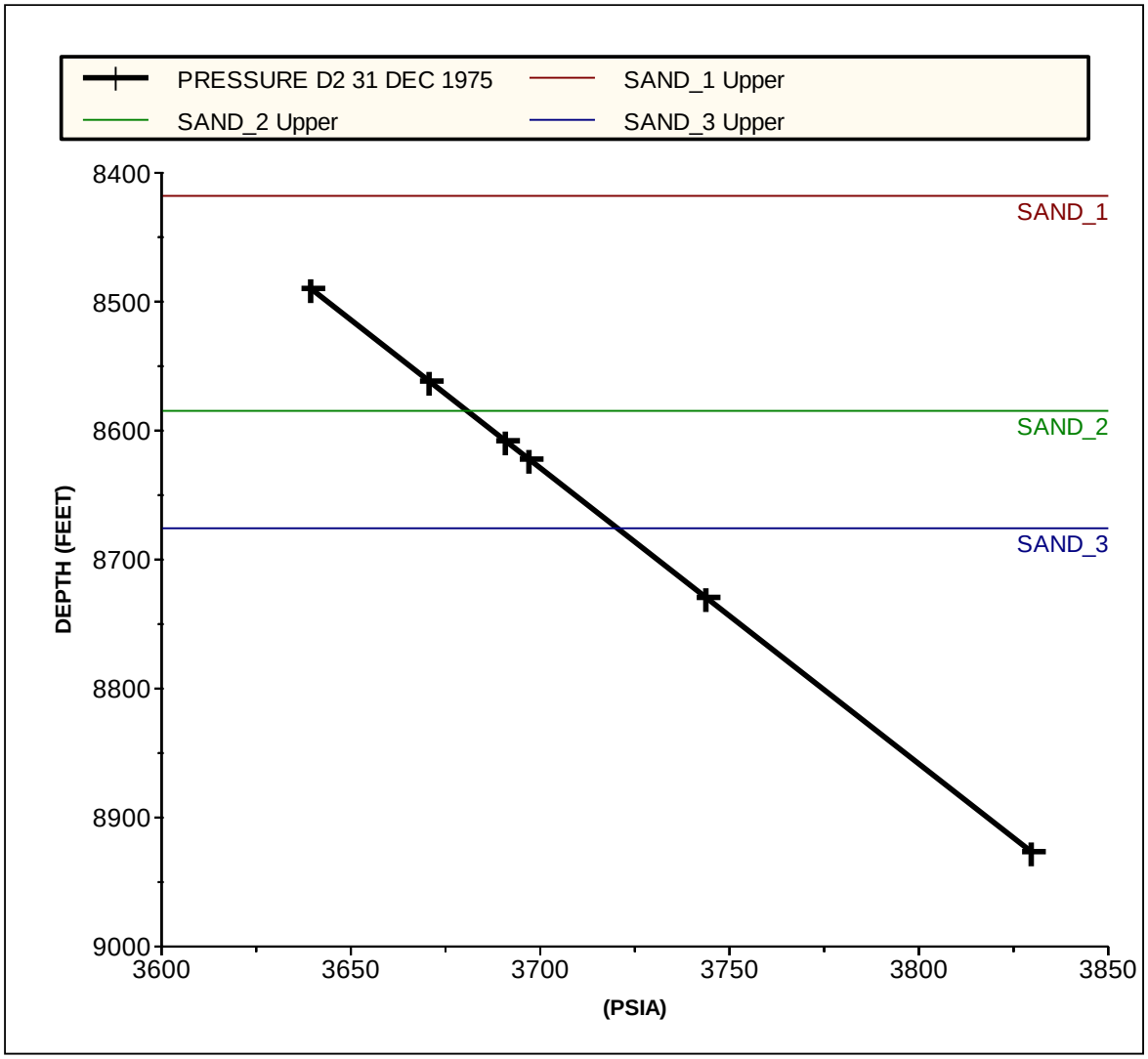

Figure 15 - Example Display of RFT Layers

5.2.Graph Search with Completion Indices

When using Graph Search, individual I, J and K values for the Completion data can be used to define the search. For instance, by specifying different K, oil output from a defined formation can now be plotted (for all wells completed in that formation).

In S3GRAF it is possible to create a graph containing multiple lines quickly using the *Graph Search* facility. This feature will search for all lines matching a pre-set criteria and then place the lines onto either an existing or a new graph. S3GRAF can now process an Index field in the *Graph Search* to allow for searching on a grid layer (or in the I- or J-direction).

The *Graph Search* facility can be found under the *Graph* menu. When it is selected the dialog shown in Figure 16 will appear.

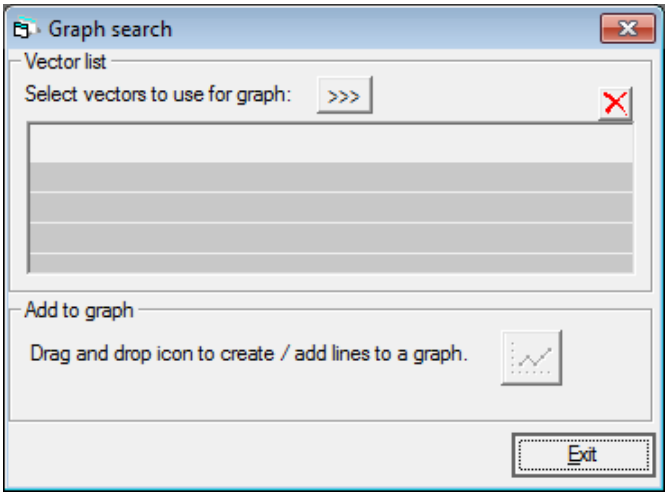

Figure 16 - Graph Search Functionality

Clicking on the ">>>" button at the top of the dialog will allow the selection of the vectors to add to the graph. Dropping a data vector that includes an index or cell location and performing a *Search and Add* will populate the vector list with the corresponding vector properties, including any index or cell indices. An example is shown in Figure 17.

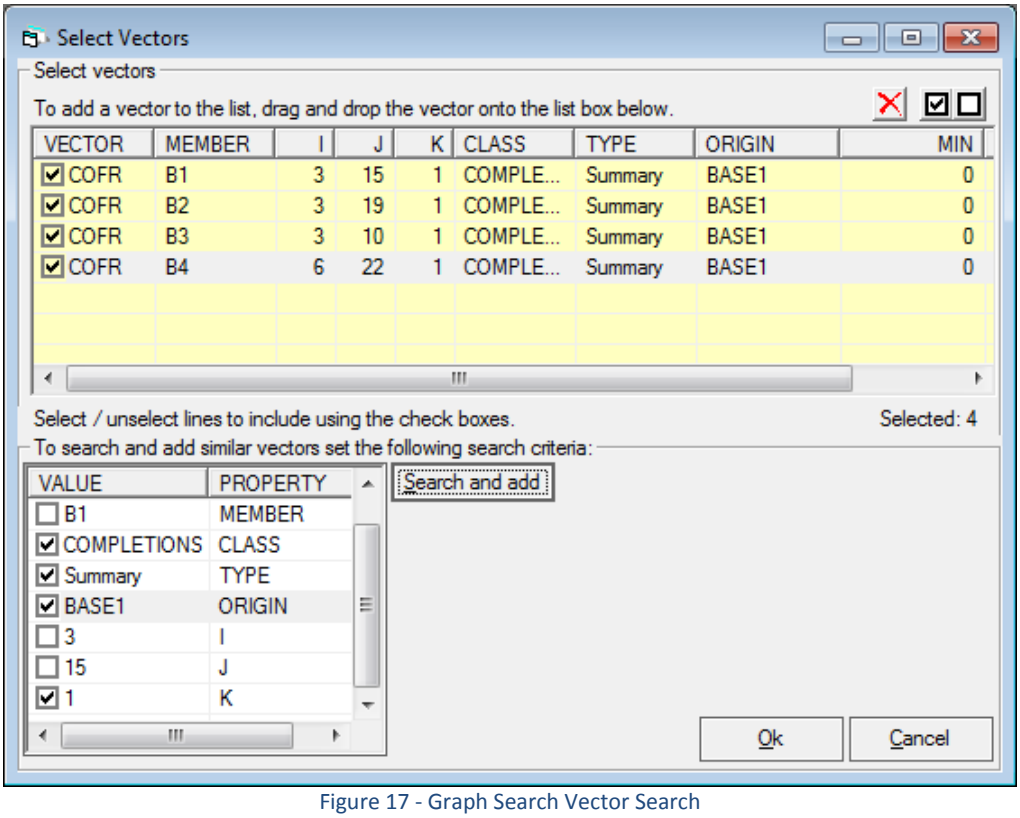

Figure 17 - Graph Search Vector Search

Each property of the vector (*Member*, *Class*, *Type*, *I*, *J*, *K*) can be used in a Graph Search. Ticking a box sets the search to match on that property.

In the example above, *Member* (i.e. Well) is unchecked and can take any value - not just well *B1*. This means all wells will be included in the search. The search is for *Completions Summary*

data from *BASE1* (all checked). *I* and *J* can take any value (unchecked). What must match is that the Completions are in layer 1 (*K*=1 is checked).

After pressing *Search and add* the Graph Search finds four wells (*B1*,*B2*,*B3*,*B4*) completed in layer *K*=1, with *I*,*J* values of (*3*,*15*) (*3*,*19*) (*3*,*10*) (*6*,*22*).

Clicking **OK** will return to the *Graph Search* dialog, now filled with the list of selected vectors, shown in Figure 18.

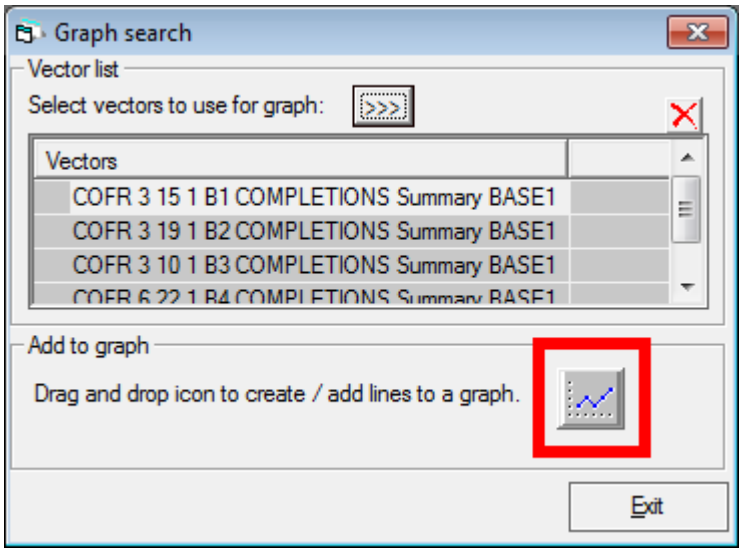

Figure 18 - Filled Graph Search Dialog

Dragging and dropping the icon highlighted in red onto the Display Area will produce a plot containing all the selected vectors.

6. New Grid Features

6.1.Multi-Phase Injector Support

Support for the display of Oil injector and Multi-Phase injector wells has been added. These will be interpreted from the loaded data and he appropriate symbols used. Examples for the new symbols for Multi-Phase injectors are shown in Figure 19 and Figure 20.

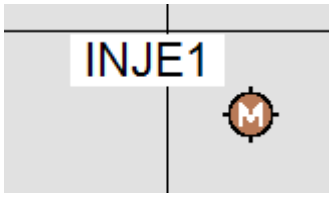

Figure 19 - Multi-Phase Injector 2D

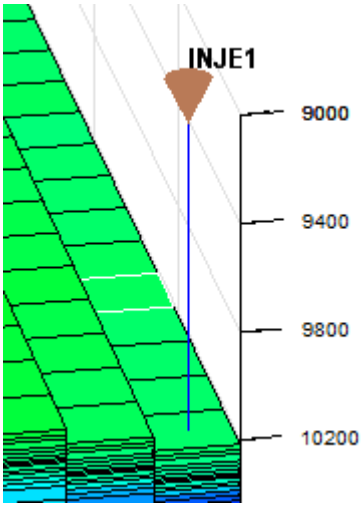

Figure 20 - Multi-Phase Injector 3D

Examples of the new symbols for Oil injectors are shown in Figure 21 and Figure 22.

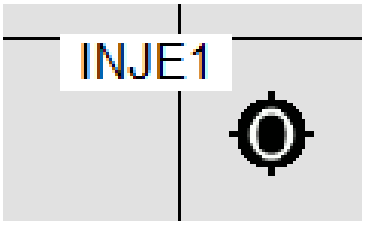

Figure 21 - Oil Injector 2D

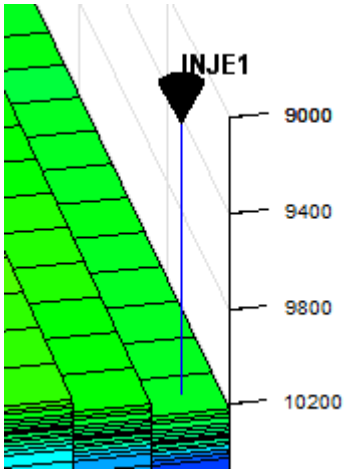

Figure 22 - Oil Injector 3D

6.2.Alternative Ternary Colour Scheme

A new Ternary Plot colour scheme has been added to allow for differing conventions. This is a system setting and so can be changed permanently in S3GRAF. The colour scheme for Ternary Plots can be toggled between the *Default* and *Alternate* scheme as defined in Table 3.

Phase	Default Scheme	Alternate Scheme
Oil	Green	Red
Water	Blue	Blue
Gas	Red	Green

Table 3 - Ternary Colour Schemes

The global option can be set from the *S3GRAF Options* dialog, which is accessed by clicking on the *Tools* menu and selecting *Options…* and finally clicking on the *Grid* tab. This will present the options as seen in Figure 23, the option is set from *Default* to *Alternative* by checking the *Alternative Ternary Colours* checkbox, seen circled in red.

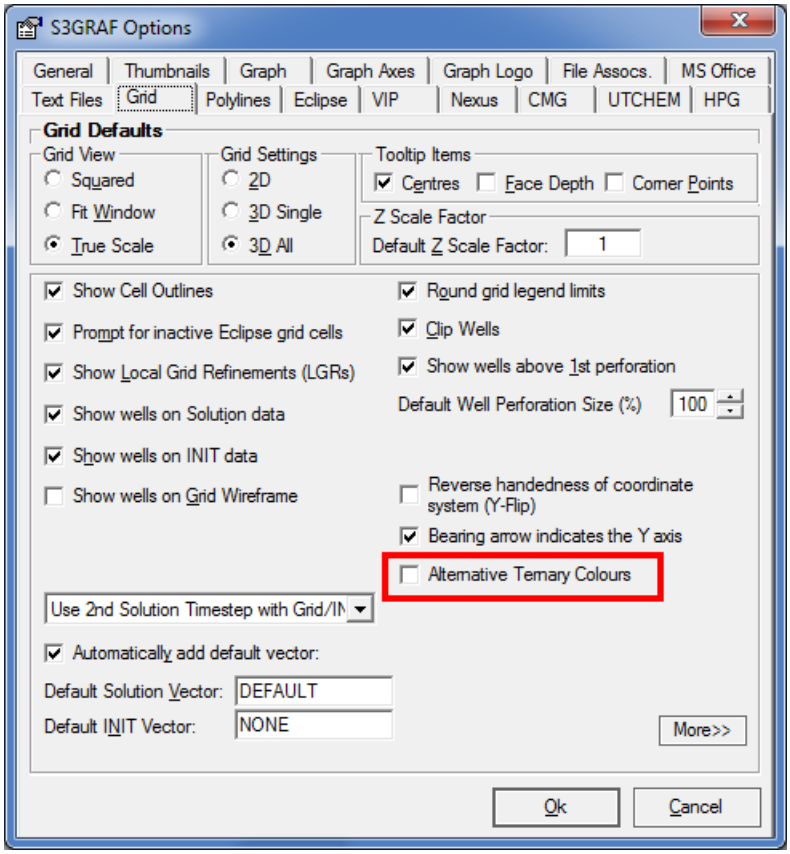

Figure 23 - S3GRAF Options dialog, Grid Settings