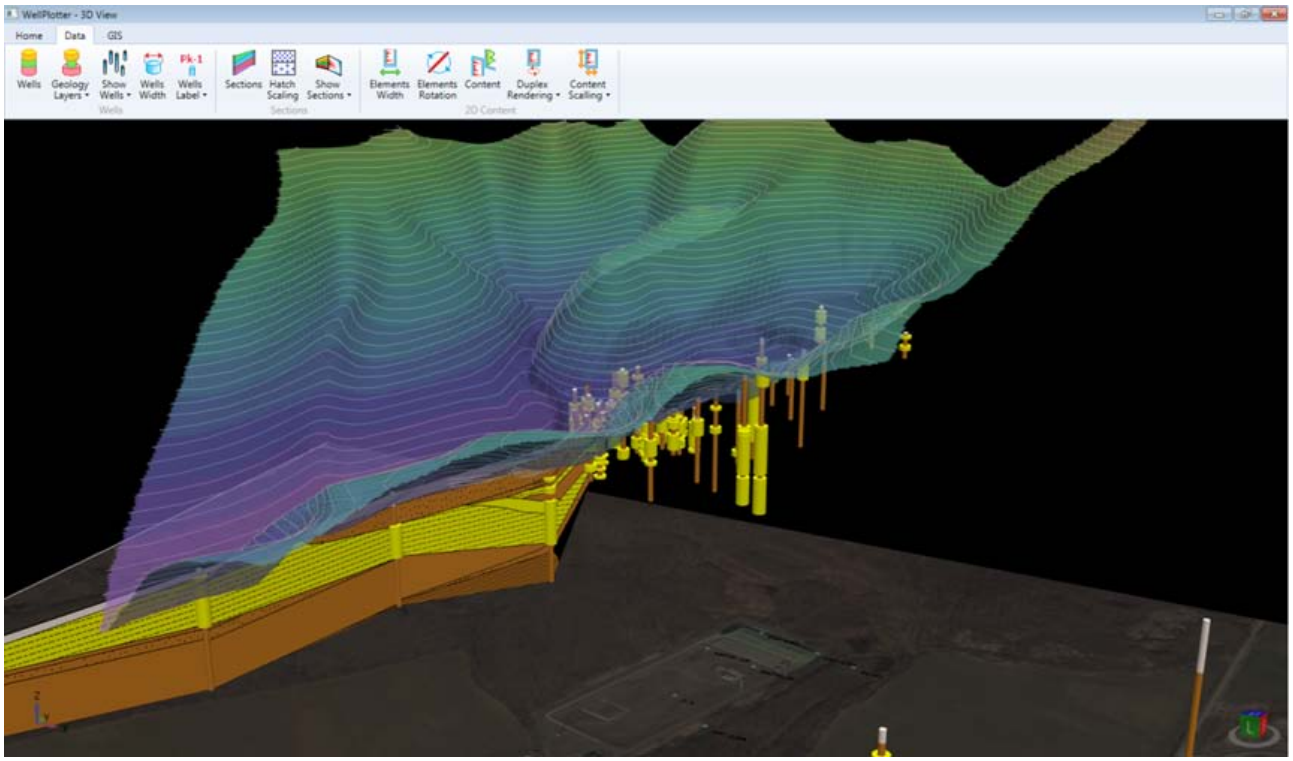
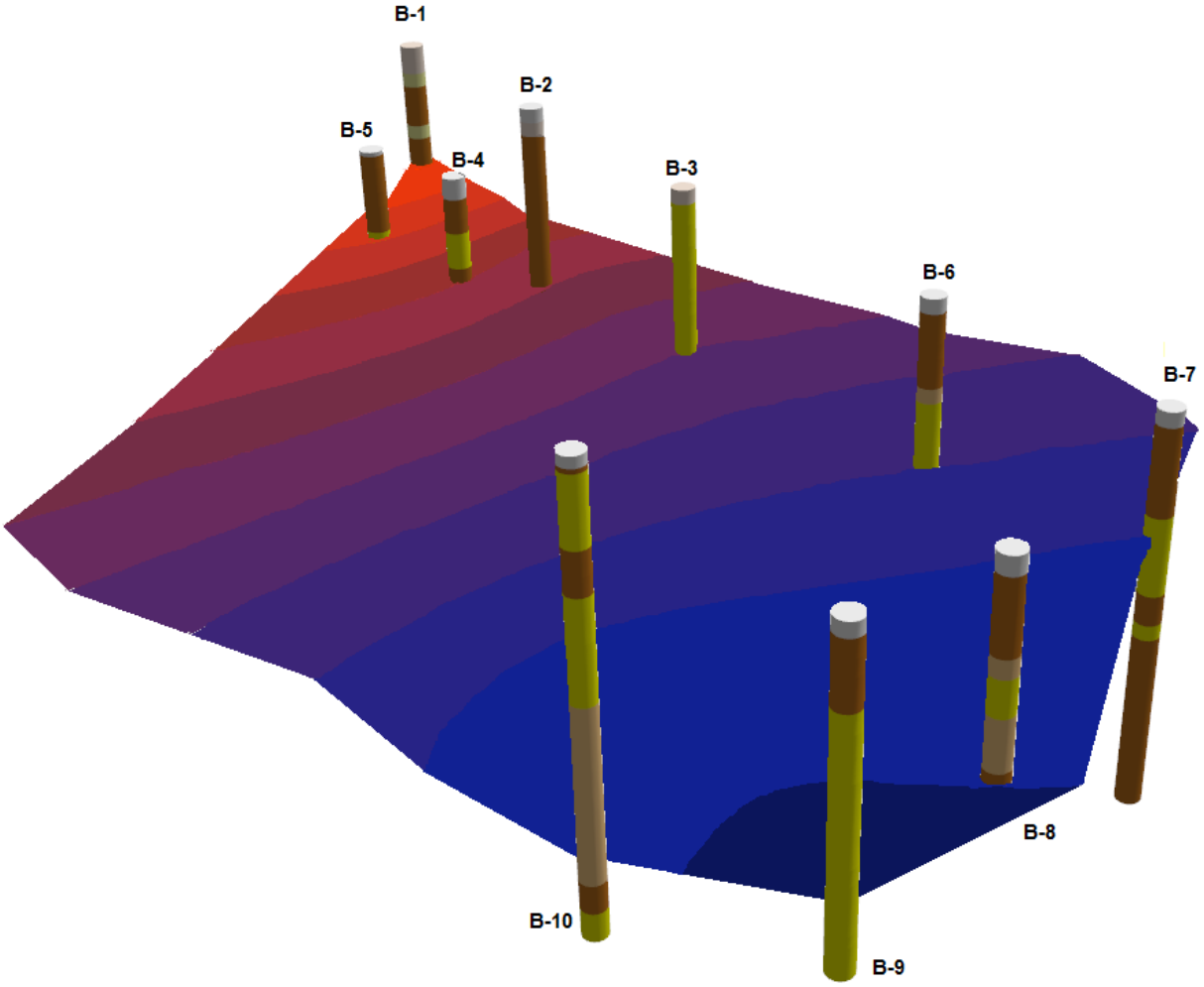
Well Plotter 1.0

User Manual for Well Plotter and Well Plotter 3D Software





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1 Introduction

This is a new tool from HydroOffice package for 1D, 2D and 3D visualization of geological, technical, numerical, structural and other types of data from geological and hydrogeological boreholes and wells.

Although other programs currently exist for these purposes, these all have specific options and constraints. It is imperative that you quickly and easily find a program which suits your needs, so I have put all the possibilities of our program in this manual, and in our video-tutorials. The beauty of our program is that you can try our **Demo Version** before you purchase the program. However, if visualization and reports of drilling exploration are your daily task, the demo program will most likely be insufficient for you, and you will need to buy the full program. All possibilities and limitations of this program are described in detail herein. You should find this program superior to similar marketed products, because I designed it for my personal needs in practical hydrogeology, and I have focused on complete functionality and easy use of this program.

The program is released in two editions; as Well Plotter and Well Plotter 3D. Their purpose and functionality are described in the next chapter, and the following sections describe all individual steps for working with the program. When you have read this manual and tried the program you will quickly become an experienced user. You will be able to comprehensively analyse and visualize data from exploration drilling in **1D**, **2D** and **3D** views. You will be able to create **very impressive professional graphical visualizations**, and this manual will help you to quickly master the program by referring to it when necessary.

2 Licensing

This **Well Plotter** program is a commercial tool, released in two Editions (Table 1). To use either of them, you must purchase a licence at HydroOffice.org. The basic version includes functionality for well data analysis and visualization in basic 1D. Well Log also allows you to view wells on the map. **Well Plotter 3D** has all the same features but has extra features to display data in both 2D Schemes and 3D Fence Diagrams. That edition is richer in functionality, but if you only need to create 1D Well Logs, the basic version is sufficient.

In addition, a **Demo Version** is distributed in HydroOffice package for you to test all functionality. This version is based on the 3D edition and includes the functionality of both programs. However, it has the limitation that while you can import your data from boreholes into the program and visualize them in 1D Well Log in 2D Scheme or in 3D View, it is not possible to export these visualizations or save your created project on disk.

Tab. 1: *Functionality description of individual software editions.*

Functionality	Well Plotter	Well Plotter 3D	Demo version
Input data import	Yes	Yes	Yes
Save project file	Yes	Yes	No
1D Well log	Yes	Yes	Yes
2D geological section	No	Yes	Yes
3D fence diagram	No	Yes	Yes
Visualization export	Yes	Yes	No

3 Installing

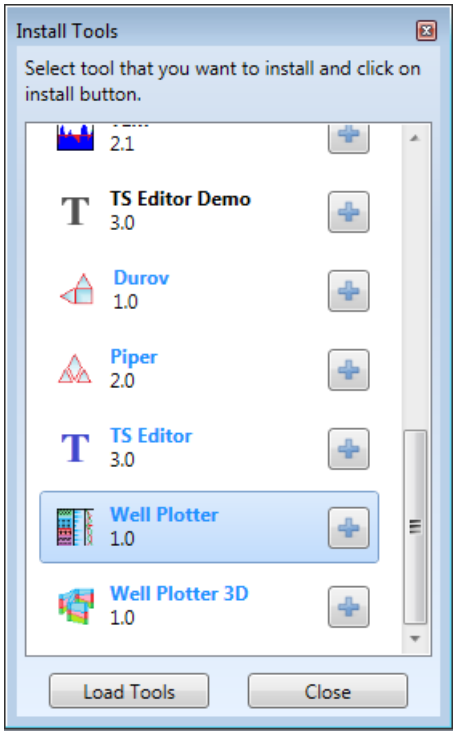


Fig. 1: *Well Plotter in the list of installable tools.*

Installing the program in all editions (Basic, 3D, Demo) is very simple and it works such as in other HydroOffice tools. These tools can be installed directly from the main window of HydroOffice software. If you have purchased a license, click in the main window on the **Install** button. After entering the user name and password, a list of installable tools will be displayed. Here can be shown these tools – **Well Plotter** / **Well Plotter 3D** or **Well Plotter 3D Demo**, in relation to license that you have purchased (Fig. 1). When you click on the button for installing, the program is downloaded from server, installed and appears in the list of available tools in the main window. Then, we can use this tool for work.

4 User Interface

The user interface of described program was designed in relation to simplicity and efficiency and consistency. Graphical user interface is shown in Figure **2**.

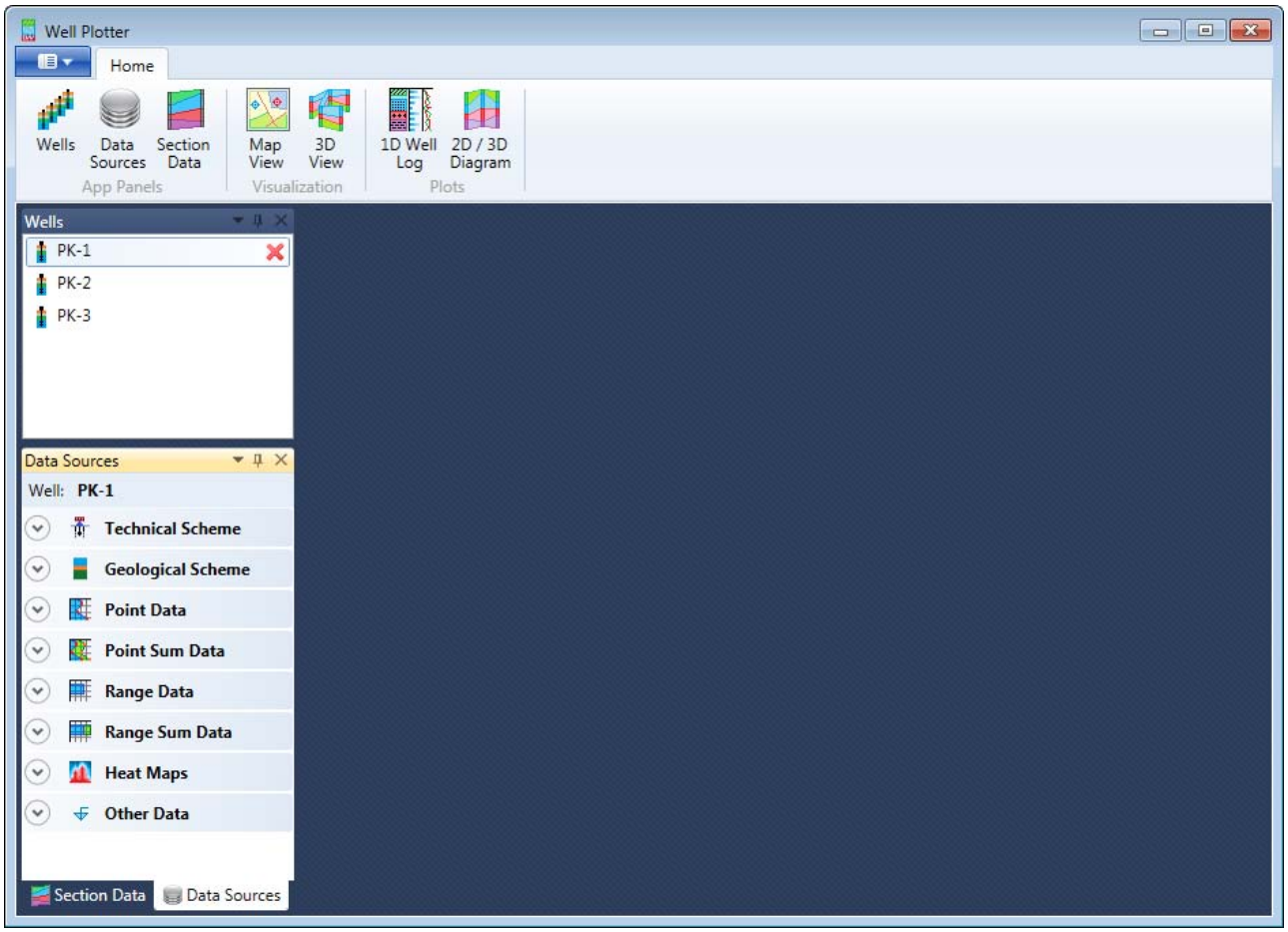


Fig. 2: *Graphical user interface of Well Plotter.*

This interface is divided into four parts; the ribbon toolbar, application panels, ribbon main menu button and the documents area. Under the application main menu button you find basic functions to show (1) the user manual, (2) managing project files and (3) export of visualizations. The main features of the program for working with data are shown in the ribbon toolbar called **Home** (Fig. **3**).

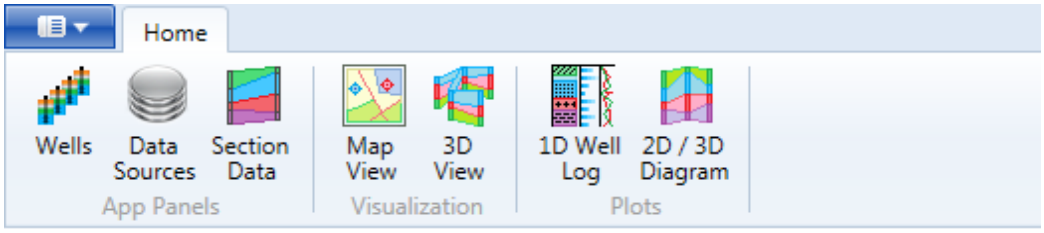


Fig. 3: *Home – the most important ribbon toolbar tab of the application.*

Your first command **"Wells"** activates a panel with a list of all wells in your current project (Fig. **4**).Although, you can create an unlimited number of wells in one project file, in practice I store a maximum of 56, because this program is not designed for long-term data archiving. But when you create the project file, you have immediate access to all wells with related data for rapid

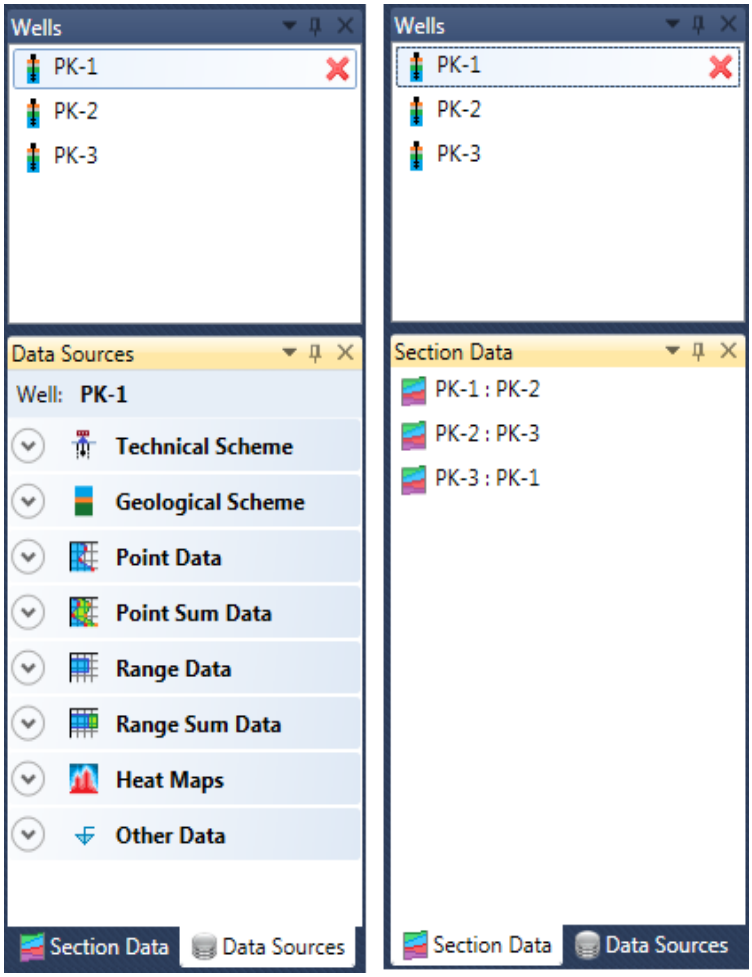


Fig. 4: *Application data panels (**Top** – Wells panel; **Bottom Left** – Data Sources panel; **Bottom Right** – Section Data panel).*

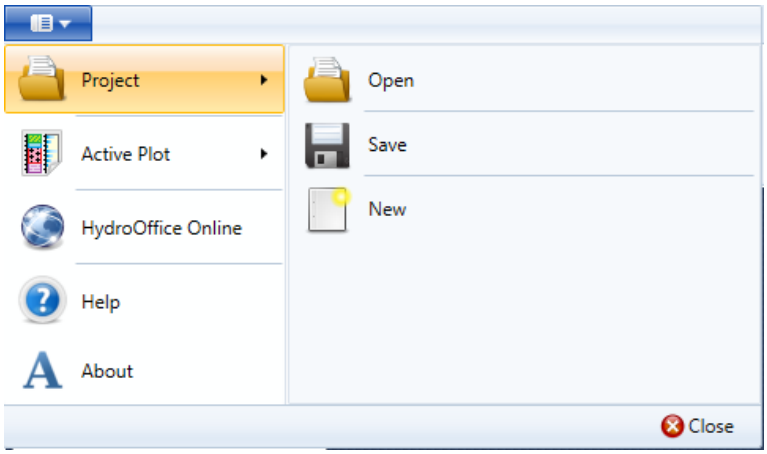


Fig. 5: *Features under Application Main Menu Button.*

visualization. Addition of wells into the project is discussed in chapter (**5.1**).

The remaining two commands (**Data Sources** and **Section Data**) display panels of imported well data, containing, for example, technical and geological schemes, numerical measurements, pictures and structural data. It also shows your prepared 2D Sections (Fig. **4**).

Other commands on the ribbon toolbar tab are used to visualize data. Although the basic program edition doesn't have visualization of spatial data in **3D View** and **2D/3D Diagrams**, the commands for **Map View** and **1D Well Log** are included in both editions.

Thus, the program has three data panels in the 3D Edition and 2 in the Basic. Where the **Wells** panel displays your wells, the **Data Sources** panel displays all imported and prepared data for individual wells in a structured manner and the **Section Data** panel, which is only available in the3D edition, compares stored 2D Sections of pairs of wells. The important **Application Main Menu Button** function is now explained (Fig. **5**).

Under this button you find **Open**, **Save** and **Create New Project** functions for **Export** and commands for loading the **HydroOffice Home Page** and **User Manual**. Also visible here is the **Documents Area**, where individual data documents and visualizations are displayed.

5 Well Plotter

The following section describes the basic functionality of the program in Basic and 3D editions. It highlights functions for adding wells, creating, editing and viewing well data, and their visualization in Map View and in 1D Well Log plot. The first subsection is devoted to managing wells in the program.

5.1 Panel Wells

The **Wells panel** manages all wells created in your current project. All functionality is contained in this panel, so it is not necessary to use any buttons from the ribbon toolbar. Just right-click inside the panel and all commands are displayed in the context menu (Fig. **6**).

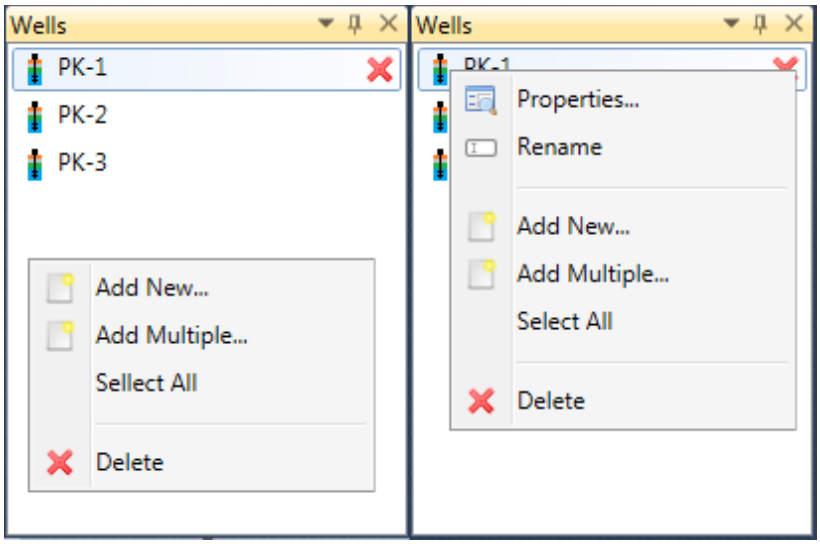


Fig. 6: *Functions in context menu for wells managing.*

Clicking in an empty panel area gives you the context menu shown in Figure **6 Left**. Here you **create a single well**, several wells with built-in wells editor or you **select all** wells and then **delete** them if that is what you want to do. When you click on an individual well record, extra commands are displayed in the **properties window** for **renaming** that well (Fig. **6 Right**).

When you click on the **Add New...** a form appears where you can define the basic parameters of your added well record (Fig. **7 Left**). It is mandatory that you supply at least the new well **name**. While adding well parameters is optional, it is advisable to enter as many values as possible. One of the most important is **well depth**; (defined as a positive number such as 100 metres), and because this value is frequently required for future visualizations, failure to specify it at this stage may lead to later incorrect visualizations.

If you are only working with the basic edition of the program, just enter **Latitude** / **Longitude coordinates** for display in the **Map View** window. But, when using the 3D edition, it is good to enter the well **altitude** and its **coordinates** in an arbitrary metric coordinate system. I use the Krovak S-JTSK coordinate system in my country, but you just have to keep your same units throughout the whole project. When you define the basic properties of your new well, just click the **Add New** button and it is added to your list. If you click on the **Properties** function in the panel context menu, you achieve the same result. In addition to this option, you can add multiple wells simultaneously Just click on **Add Multiple** and your new window supplies a list of all your new

wells (Fig. 8).

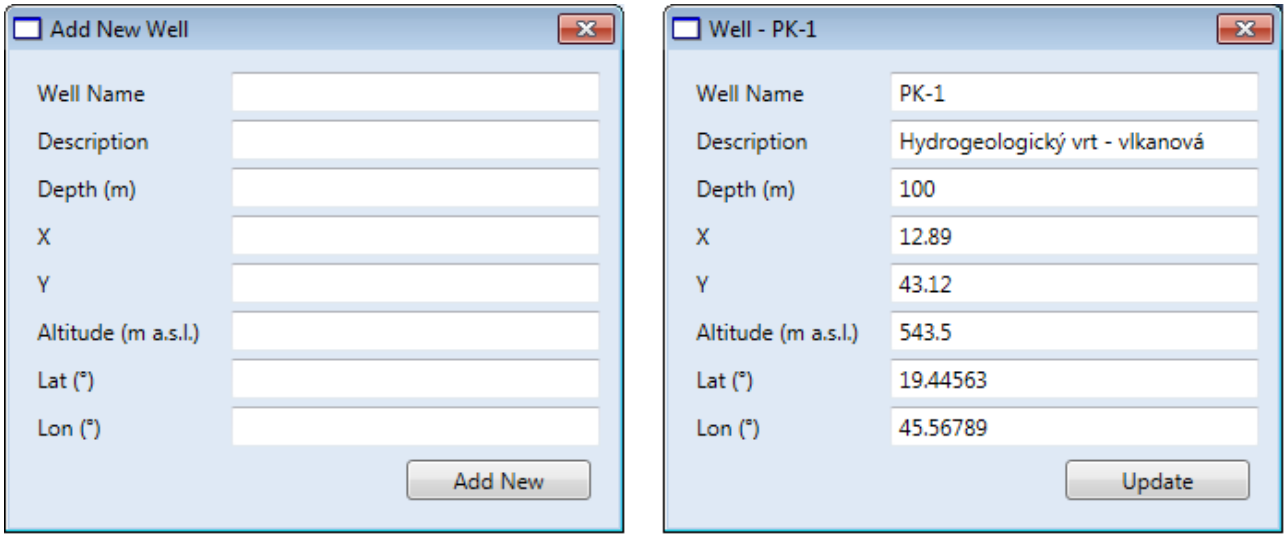


Fig. 7: ***Left*** *– adding a single new well;* ***Right*** *–editing properties of your selected well.*

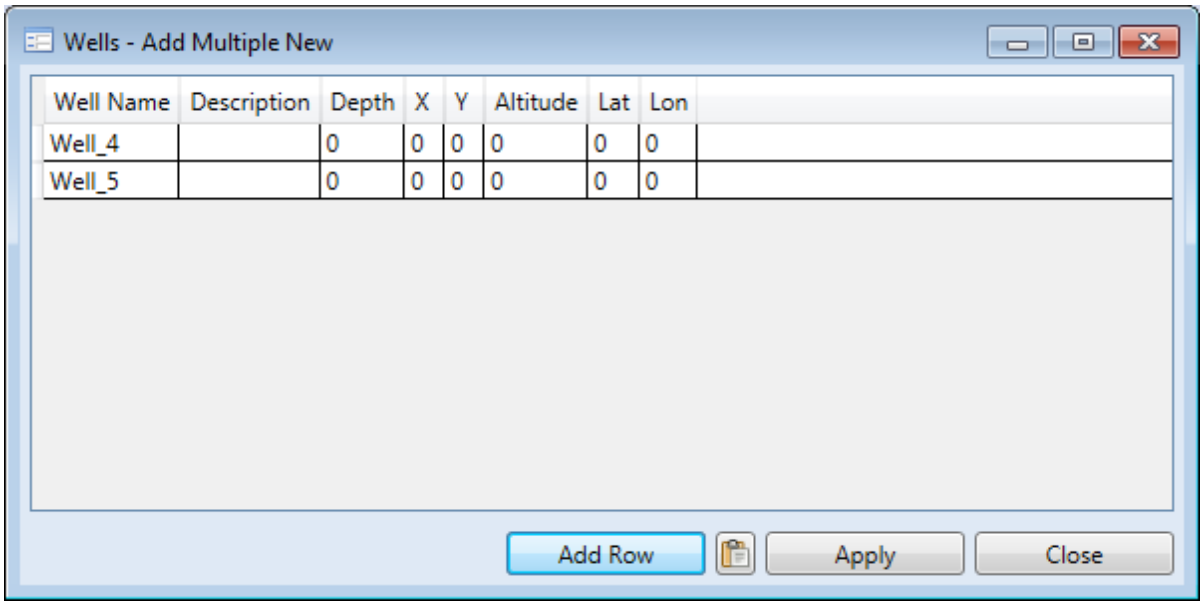
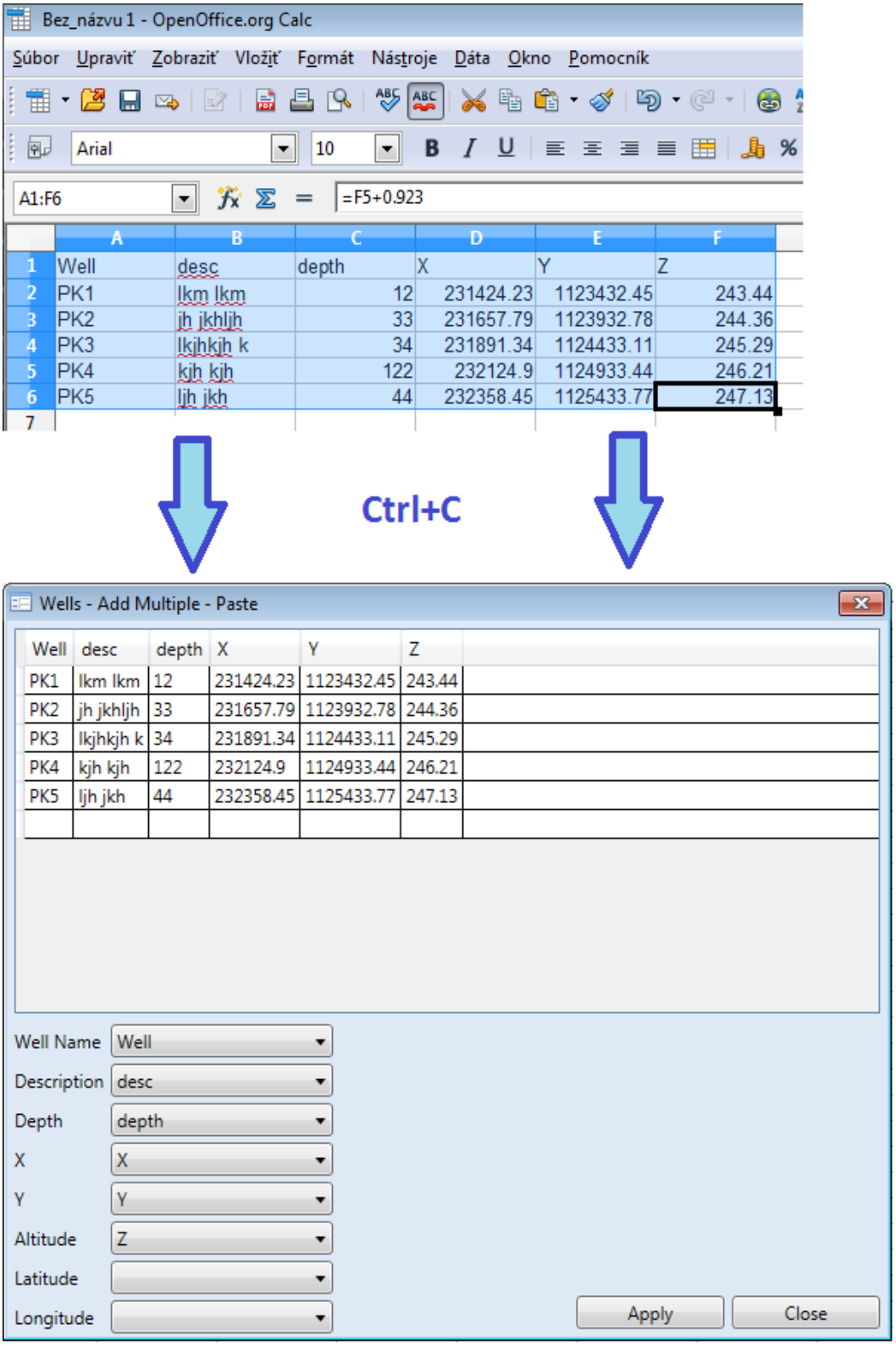


Fig. 8: *Window for adding several wells at once.*

Use the **Add Row** button to add the required number of records into your table and you can manually edit them. The **Apply** button places your added wells into the Wells panel. If you have prepared a list of wells in a spreadsheet editor such as Excel or Calc., you can import them directly into the program (Fig. 9).

Select these in the spreadsheet editor together **with your column headings** and press **Ctrl+C**. If you have copied them on your clipboard, just go back into the program and click on the **Paste** picture button. This creates a new table, which appears in another window and you can then synchronize these column names with your programmed ones using the combo boxes below the table. The program also synchronizes them automatically if the names are identical or similar enough. Simply click on the **Apply** button and your new data is added to the existing data in the main table. This procedure gives fast import of extra data from Excel.

The last function **Deletes** selected wells simultaneously, together with all the data and geological sections linked to them.



	A	B	C	D	E	F
1	Well	desc	depth	X	Y	Z
2	PK1	lkm lkm	12	231424.23	1123432.45	243.44
3	PK2	jh jkhljh	33	231657.79	1123932.78	244.36
4	PK3	lkjhkjh k	34	231891.34	1124433.11	245.29
5	PK4	kjh kjh	122	232124.9	1124933.44	246.21
6	PK5	ljh jkh	44	232358.45	1125433.77	247.13
7						

Well	desc	depth	X	Y	Z
PK1	lkm lkm	12	231424.23	1123432.45	243.44
PK2	jh jkhljh	33	231657.79	1123932.78	244.36
PK3	lkjhkjh k	34	231891.34	1124433.11	245.29
PK4	kjh kjh	122	232124.9	1124933.44	246.21
PK5	ljh jkh	44	232358.45	1125433.77	247.13

Fig. 9: *Fast data import into your program from spreadsheet editors using Copy–Paste.*

5.2 Data Source Panel

The **Data Sources** is the most important panel in the program, because here you can access all data for individual wells. This panel always displays imported data for each selected well and it is completely logically structured (Fig. **10**).

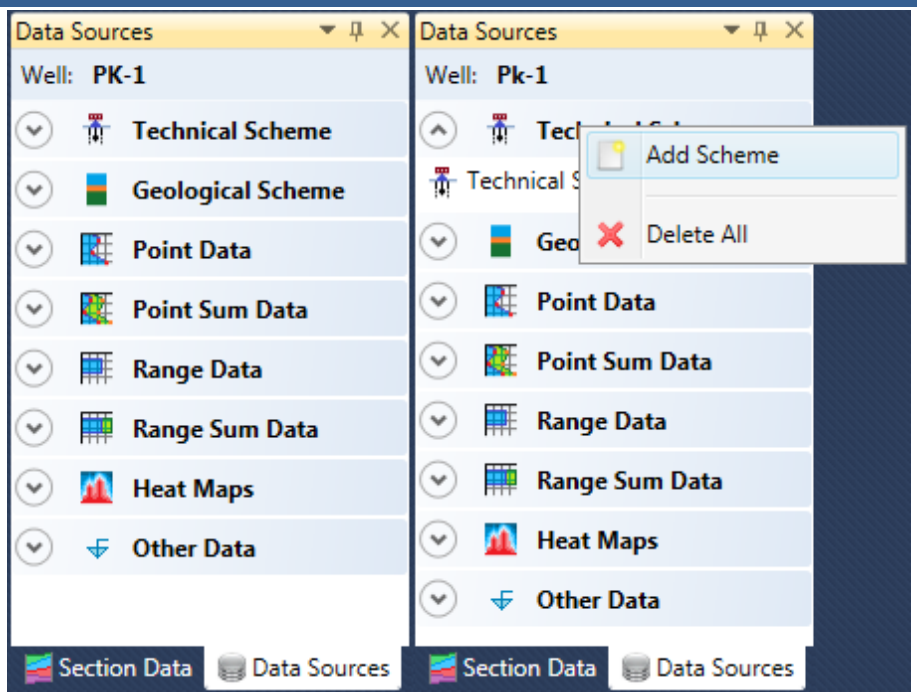


Fig. 10: *Data Source panel (**Left** – structured data view for selected well; **Right** – expanded list of technical schemes).*

After launching your program, this panel is empty. If you have already defined some wells in your program through the **Wells** panel, just double-click on your selected well and all related data is revealed. The current well is shown in the top part of this panel, with its data divided into the following sub-directories:

- technical schemes
- geological schemes
- points data
- points sum data
- range data
- heat maps
- all other data types

Variable parameters can be defined for each borehole based on well **geological** and **technical schemes**. Additional documents include **numerical data** of measurements and **heat maps**, while the **Other Data** group defines **textual**, **tectonic**, **time-dependent** and **image data**. Description and functionality of these data groups is contained in following sections.

All individual sub-lists can be expanded or collapsed by clicking on the circular button in the header, and these appear empty until parameters are added. To add new technical, geological scheme or numerical data, just right-click on the header of the data type and select **Add Item** in the context menu. The program first asks you to name your new entry, and this is added to your list as an empty document. The second command **Delete All** deletes all items in your list (Fig. **10 Right**).

The quantity of uploaded data in your selected group is unlimited, and it depends only on your requirements. If you want to edit the document, right-click on it and expand the context menu functions. Again, data management here does not require use of ribbon toolbar buttons. If you simply want to view the selected document, click the **Show** command in the context menu, or double-click on the selected item.

5.2.1 Technical Scheme

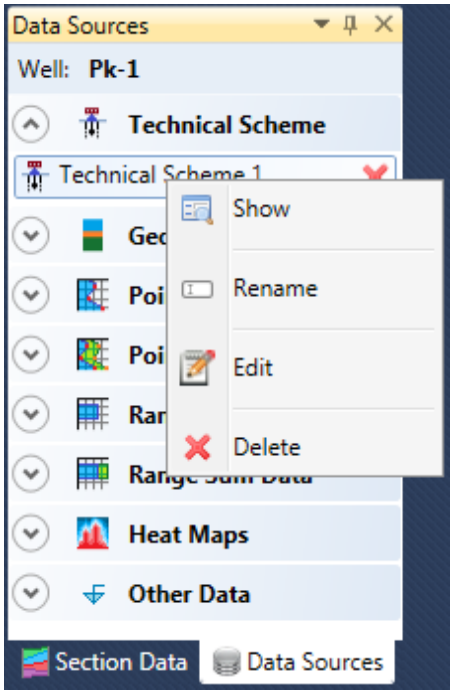


Fig. 11: Context menu commands for edit selected technical scheme.

In the technical schemes group you can prepare visualization of the technical construction of well. If you created an empty new document, just click it right mouse and select from context menu the **Edit** item (Fig. **11**).

After click on this item a form displays for the technical scheme definition. Use this form is very simple and intuitive. An example is shown in Figure **12**. In the left pane is displayed resulted technical scheme of well, which we generate by properties located in the right pane. The entire production of technical scheme is very fast. Using these properties user define visual rendering of scheme. For this purpose, may be freely combined functions that are described in following text.

At first you define segments of the borehole in the top table. These segments are defined by their beginning and end in depth, by diameter, and filling. Each segment is defined basically as a simple rectangle. For create new well segments use the **Add** button and by **Delete** button you can delete these segments at once. If you click on the **Add** button, a form will be displayed, in which we define a new segment (Fig. **13**).

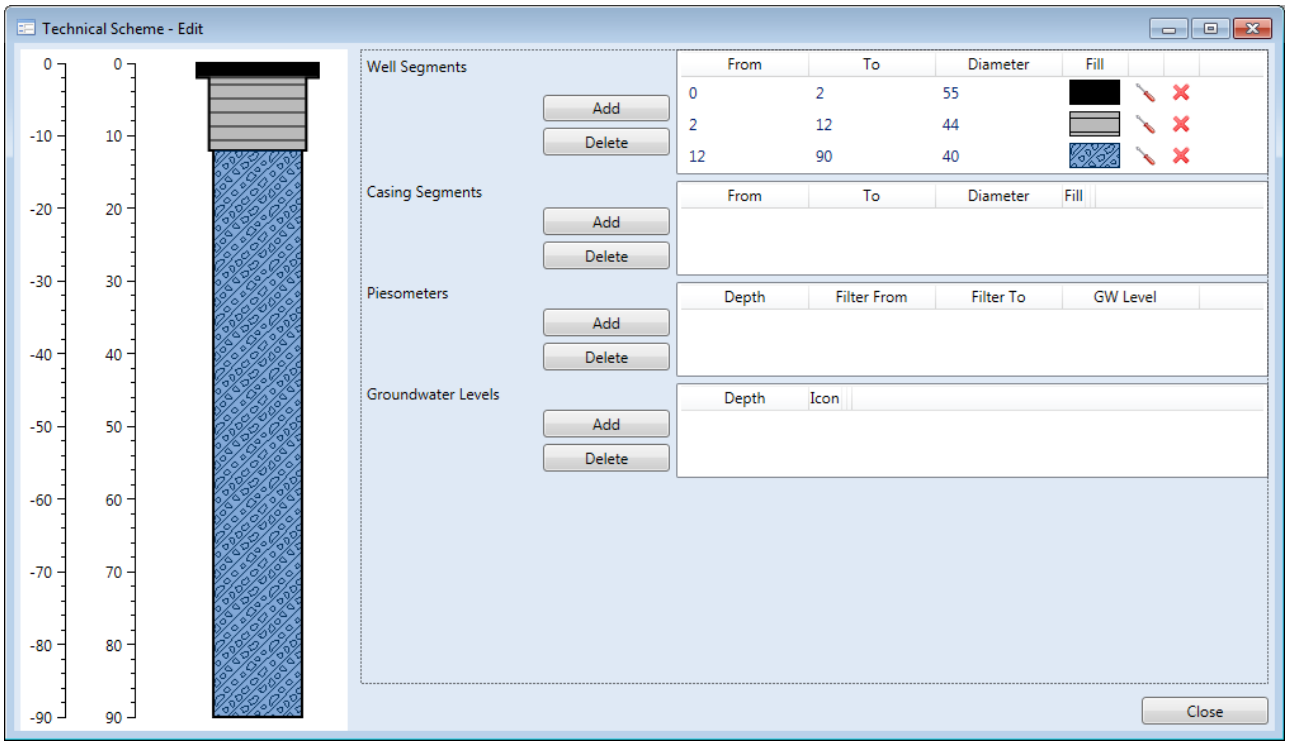


Fig. 12: The technical scheme editor.

In this dialogue, you define the start and end depth at which the segment will occur and its diameter. Then you need to edit the fill property. For its definition, click on the lower rectangle and the fill editor will display (Fig. **14**).

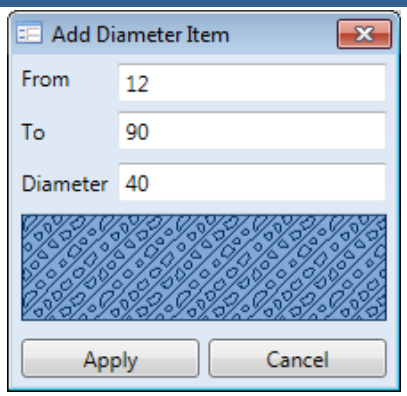


Fig. 13: *Help dialogue for definition of well segment.*

This editor we use not only for technical schemes, but also for defining textures and colours of layers in geological schemes. This editor contains more than 500 build-in textures, so the user can select from a relatively high number. In the left pane, select a texture or you can import into program your own. In detail is this process defined in **Annex 1**. Then by using two colours canvas user defines the foreground and background colour of selected texture. By the up-down control can user set-up rotation of texture. If it is defined, click on the **Apply** button and defined texture is applied to a new segment of the borehole. On previous Figure **12**, you can see an example of three borehole segments use with defined depths, diameters and textures.

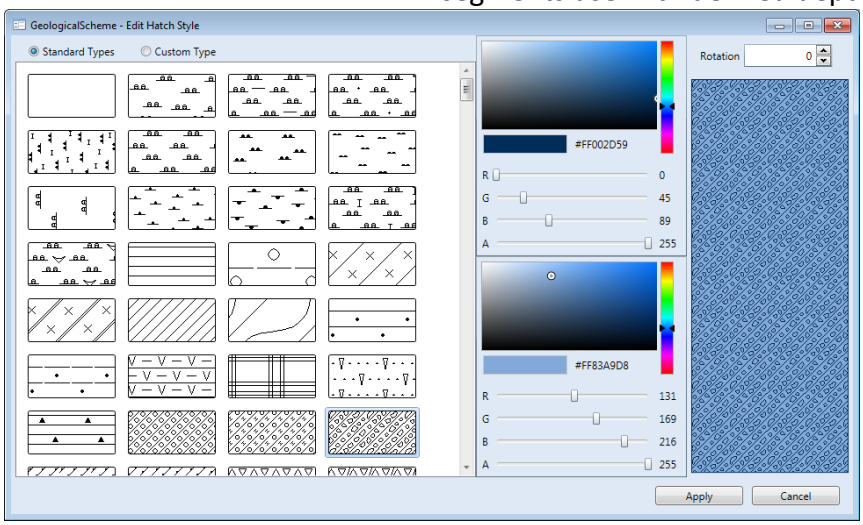


Fig. 14: *Texture editor for filling technical and geological schemes.*

The next step is to define segments of the **well casing**. These segments are drawn on the previous group of segments. The principle is identical to the previous case. Combining these two types of segments you can display very variable types of technical schemes. In addition to the technical part, it is possible to render the geological layers around the well. For the definition of geological data, however, we prefer to use separate – specialized data documents (chapter **5.2.2**).

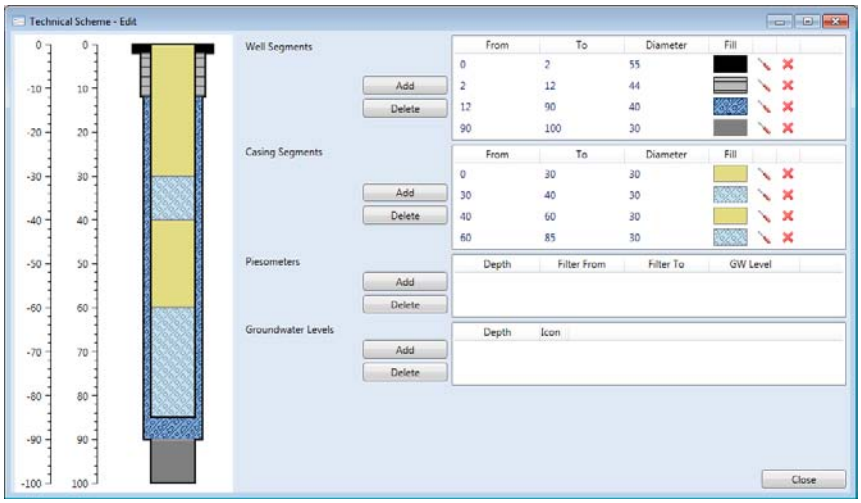


Fig. 15: *Well casing definition in technical scheme.*

These options do not stop the rendering possibilities of technical schemes. As a hydrogeologist, I often work with wells that include multiple piesometers. These can be defined and edited in the third table. To add a new piesometer, click on the **Add** button. Help form displays as shown in Figure **16**.

Inside this form, you define for each piesometer its depth and the position of filter segment. The filter section is then displayed as a segment with horizontal hatching. Finally, if you want, you can define the depth of ground water level in the piesometer. This is inside the piesometer displayed as a blue triangle. For each well, we can define unlimited number of piesometers. If there are multiple, they probably will not be fully visible. This problem, however, occurs only in preview mode in this form and in the resulting visualization you can adjust the overall width of the technical scheme so all piesometer s will be sufficiently visible. The picture **17**

shows an example of well with two piesometers.

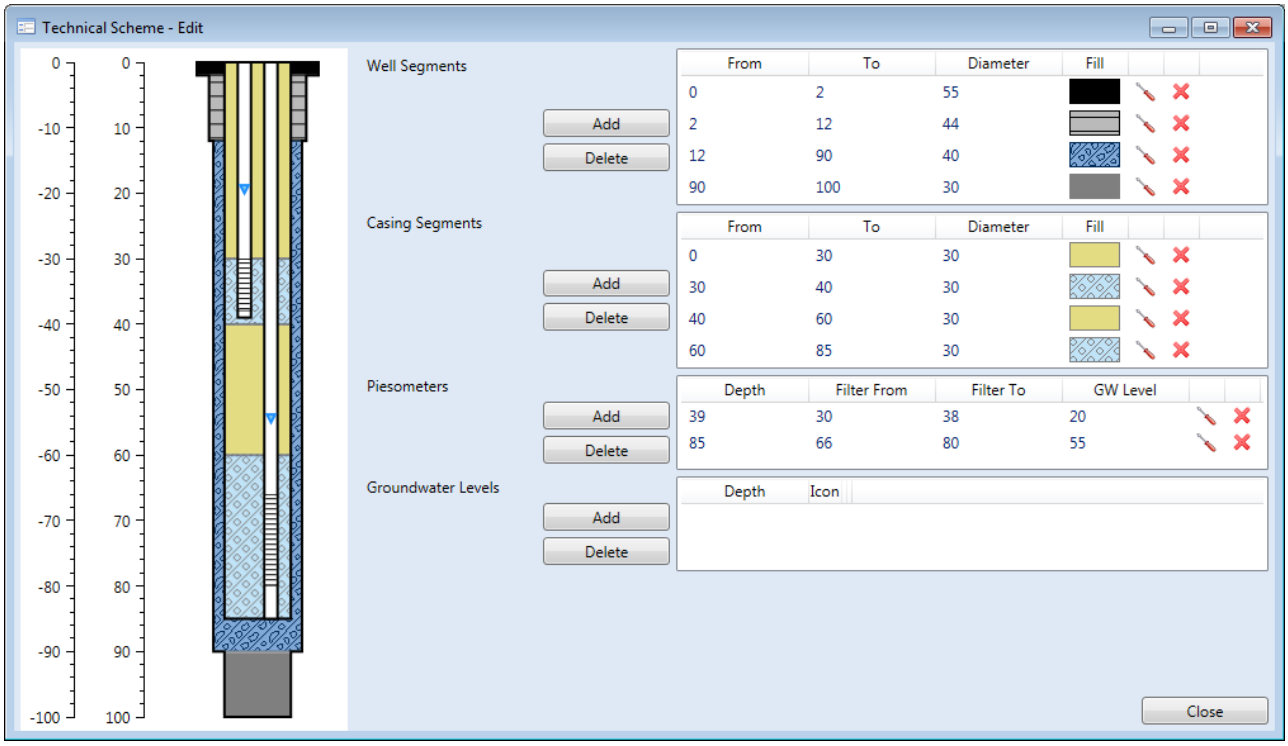


Fig. 17: *An example of technical scheme with two defined piesometers.*

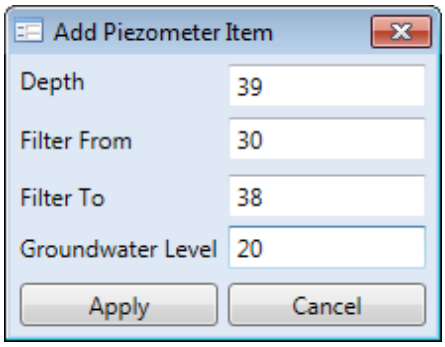


Fig. 16: *Form for piesometer definition*

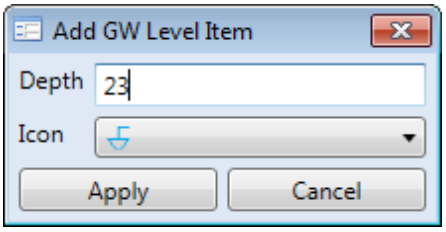


Fig. 18: *Form for groundwater level definition.*

Finally, in the last table, you can define several groundwater levels. These levels are defined as in previous cases, using help form, which is shown in Figure **18**. In this form we define the depth of groundwater levels and by combo box you choose a mark that will define the level. By this way, you can for example display an encountered and also steady groundwater level. The individual technical parameters can be optionally used, adjusted, combined and plotted in extremely variable technical diagrams. Examples of created technical schemes are in Figure **19**.

The defined schema is automatically stored in your document, and if you are satisfied with your prepared technical scheme, just clicks the **Close** button in the lower right corner of the window. When you want to quickly display a selected technical scheme, double-click on it in the list and the document area is displayed in a separate window (Fig. **20**).

Your prepared schemes can be visualized with other data in the 1D Well Log or in other types of visualizations. Complex multiple technical schemes for each well can be presented parallel to each other in the resultant plot. The following sub-section covers importing and defining geological schemes.

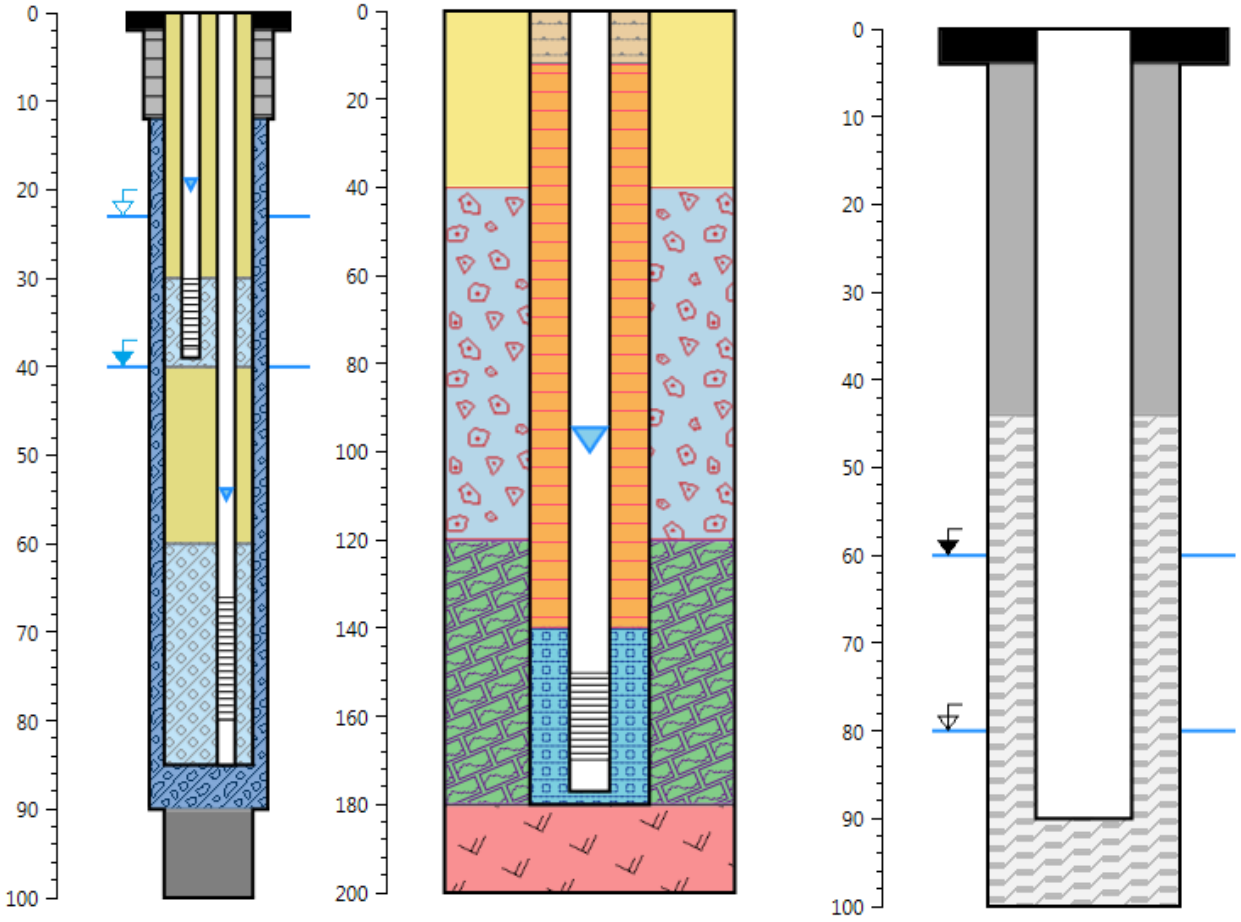


Fig. 19: *Examples of well technical schemes.*

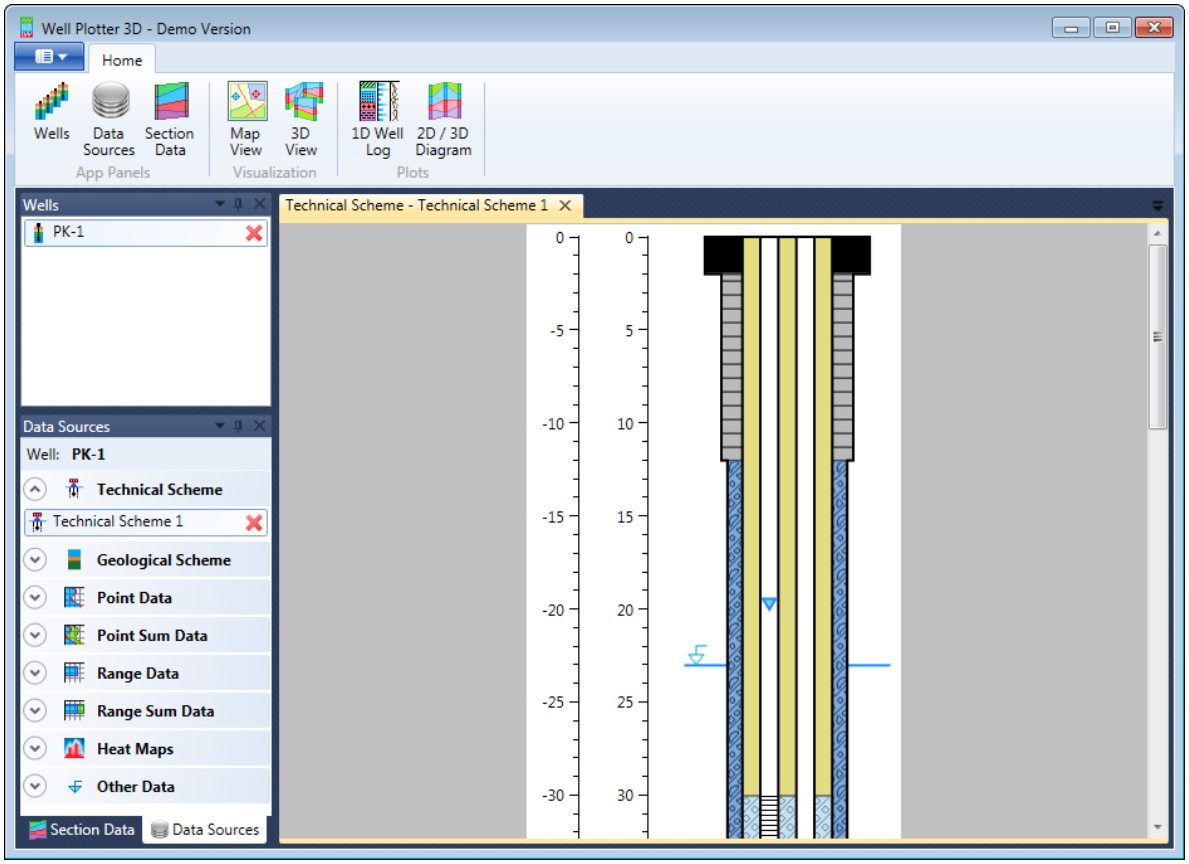


Fig. 20: *An example of document view with a prepared technical scheme.*

5.2.2 Geological Scheme

Geological structure arising from drilling exploration constitutes the most important data for analysis and visualization. The second section of the **Data Sources** panel handles this data (Fig. **21**). To add a new geological section, simply right-click in the header area of the geological section context menu and select **Add Scheme**.

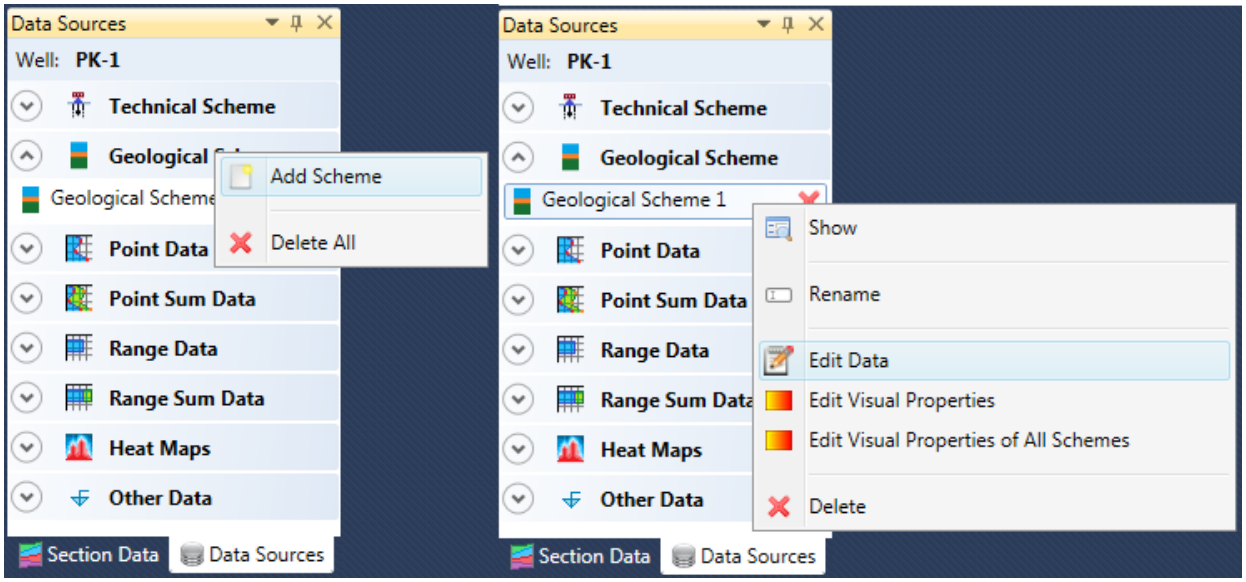


Fig. 21: *Left – addition of a new geological scheme via context menu; Right – commands for working with stored geological schemes.*

Similar to working with technical schemes, multiple interpreted and uninterpreted geological schemes can be added for each well. Here, you add a new empty document and edit it in two stages. You first define your individual geological layers with their description, geological index and depth of occurrence. To achieve this, right-click on the selected geological scheme and select **Edit Data** from the context menu (Fig. **21 Right**). . In the second step, you define a visual representation of the geological strata on the resultant form by inserting individual profile items (Fig. **22**).

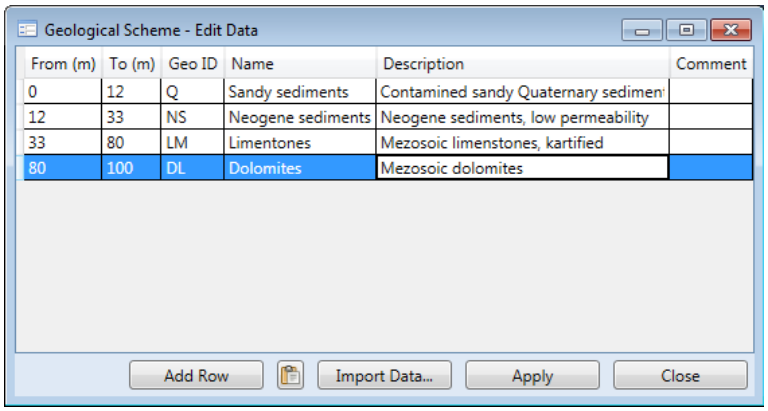


Fig. 22: *Layer editor of geological profiles.*

You use the **Add Row** button to get sufficient rows in the table for the number of layers in your profile. Then these items can be manually edited directly in the table. In addition to manual editing, you can use two additional functions for profiling.

If your data is stored in a spreadsheet in a similar format, you can use **Copy–Paste**. An example is shown in Figure **23**. Select the data table with column names in the external program and press **Ctrl+C**. Then switch to the geological scheme editor window and press the **Paste** picture. The program automatically reads the copied clipboard data, parses it and displays in table (Fig. **23**).Next, synchronize your original and externally derived column headings in this new window using the combo boxes below the table. Then click "**Apply**", so that the help-window closes, and all external data is imported into your

main table.

In addition, you can just read the data using the **Import Data** button which allows you to import data from a **CSV file**. This is used by default in the HydroOffice software package. Unlike classical CSV files, however, the programs in this package use a tab space as column separator. You can create this type of document structure in Excel by saving the file as "*Tab Delimited Text File*". When you select this, a form identical to the one in Figure **23** opens for you to add data and to synchronize the column headings in your current file.

You must properly define the range of occurrence where the layer is located and also define the **GeoID** and **Name** parameters. The **GeoID** parameter is very important in this program, because this column can include a string index or a number that identifies your type of sedimentary rock. Here, I use the standardized geology indexes in my country, where each rock type keeps the same index. If you have substitution of sand and clay layers in your geological profile, then you place your own indexes in Table 2, and these are always repeated thereafter. The input of these indices is very important because you will constantly refer to them in your future work.

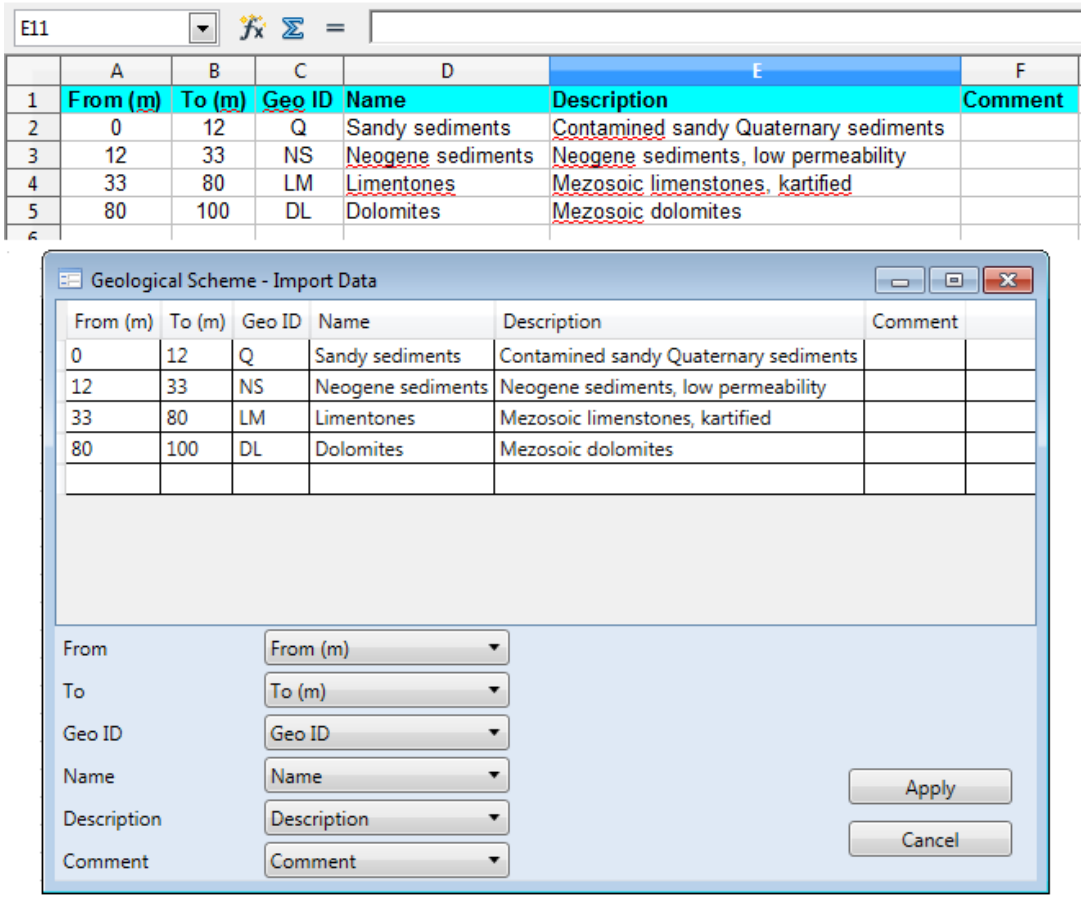


Fig. 23: *Data import using Copy–Paste.*

The **Name** parameter is used to describe strata in your visualizations. The other columns are optional and these can be used in visualizations if you want to view particular phenomena. When you have defined all data in your table, press the **Apply** button and close the window. When you display your prepared document, you see that the colour and texture is the same for all items. This is predefined by the program (Fig. **24**). To change this setting, right-click on the selected geological scheme document and select the **Edit Visual Properties** function from the context menu (Fig. **21 Right**).

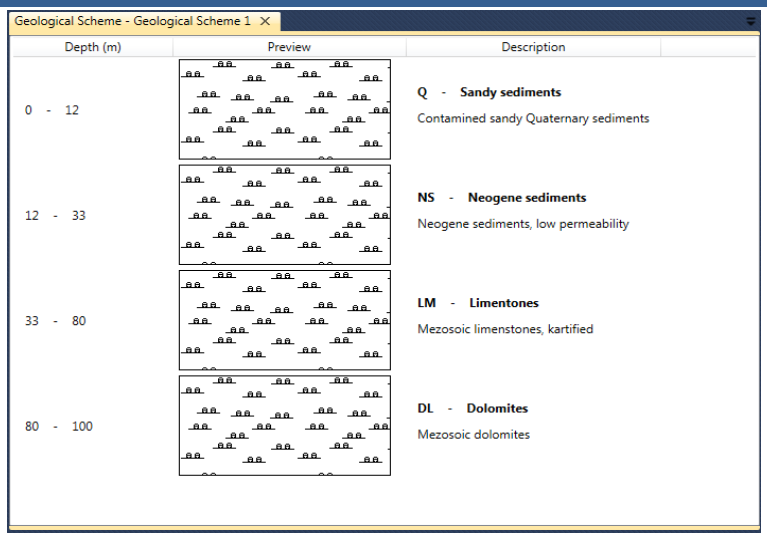


Fig. 24: *Display of the geological scheme document, after definition of textual and depth data.*

The dialog in Figure **25 Left** contains the unique **GeoID**'s in your document. If your geological profile has substitution of multiple sand and clay layers, this table will contain only those two records.

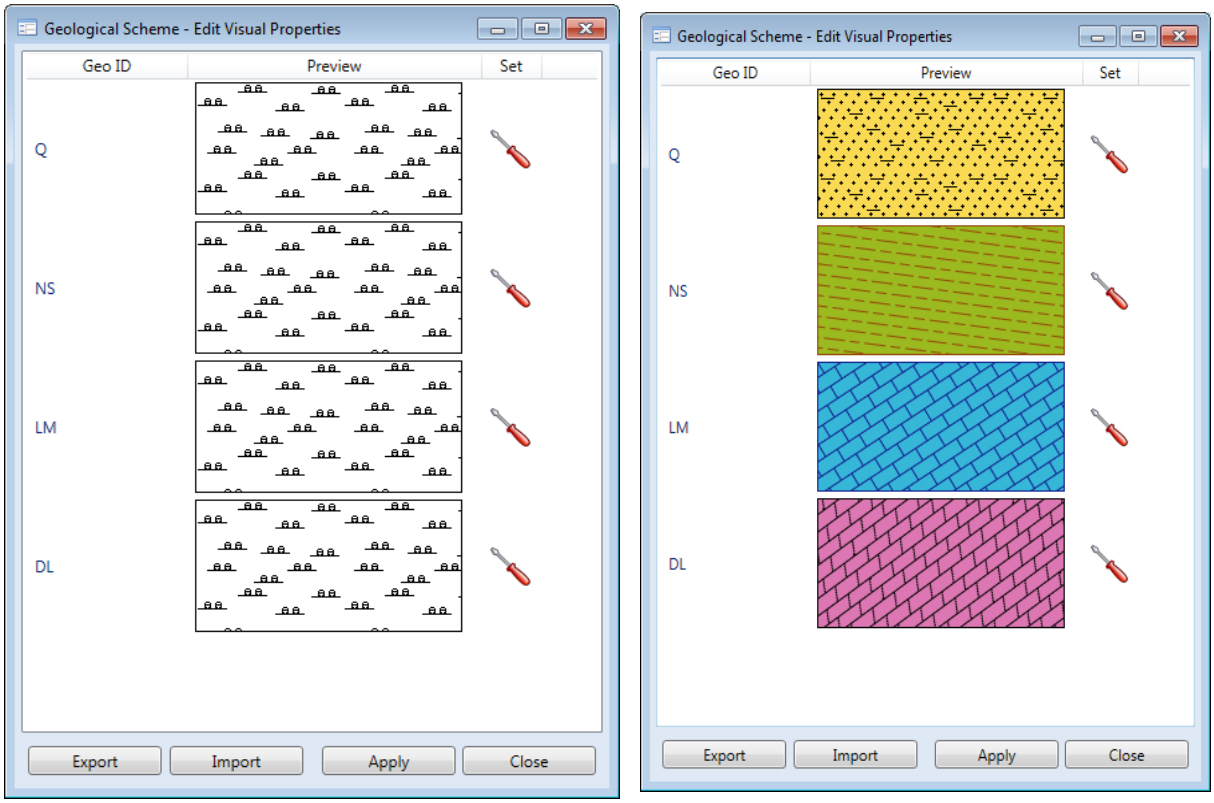


Fig. 25: *Editor of visual properties for geological profile (**Left** – before set-up; **Right** – after set-up).*

A **preview of geological texture** is given when your **GeoID** parameter is set in the table row. This can be changed by clicking on the **Screwdriver** image, so that the Figure **14** texture editor dialog appears. You can change the texture, foreground and background colour and the rotation of your selected texture using this dialog's options. After clicking the **Apply** button your changes appear in the table. When you have defined visual settings for all your records, the table of geological indices appears as in Figure **25 Right**. These settings are transferred to the geological scheme by clicking the **Apply** button, and subsequent images of your geological scheme document appear as in Figure **25**.

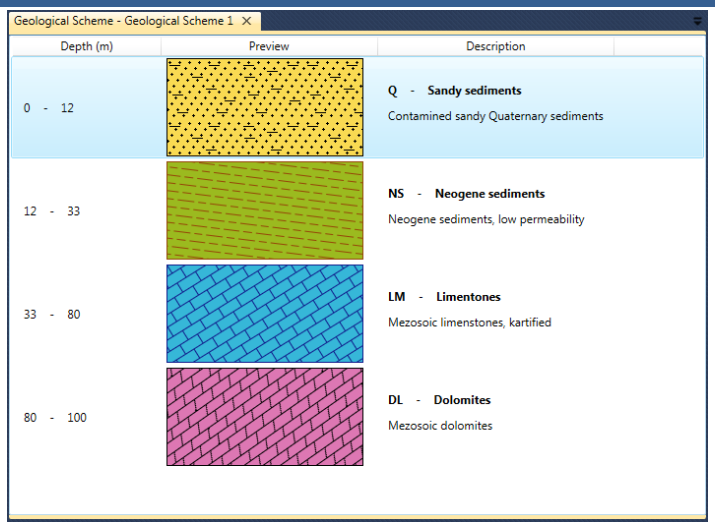


Fig. 25: *An example of document with defined visual geological layer properties.*

```
<?xml version="1.0" encoding="utf-8"?>
<ArrayOfGeoSettings xmlns:xsi="http://www.
  <GeoSettings>
    <GeoID>Q</GeoID>
    <HatchStyle>Se_PI_8.png</HatchStyle>
    <ForeColor>#FF000000</ForeColor>
    <BackColor>#FFF9DA52</BackColor>
    <HatchRotation>0</HatchRotation>
  </GeoSettings>
  <GeoSettings>
    <GeoID>NS</GeoID>
    <HatchStyle>Li__B_7.png</HatchStyle>
    <ForeColor>#FF964709</ForeColor>
    <BackColor>#FF9BBA1F</BackColor>
    <HatchRotation>7</HatchRotation>
  </GeoSettings>
  <GeoSettings>
    <GeoID>LM</GeoID>
    <HatchStyle>Te_23.png</HatchStyle>
    <ForeColor>#FF121C8C</ForeColor>
    <BackColor>#FF36B7D8</BackColor>
    <HatchRotation>-32</HatchRotation>
  </GeoSettings>
  <GeoSettings>
    <GeoID>DL</GeoID>
    <HatchStyle>Te_2.png</HatchStyle>
    <ForeColor>#FF000000</ForeColor>
    <BackColor>#FFDD77B3</BackColor>
    <HatchRotation>-35</HatchRotation>
  </GeoSettings>
</ArrayOfGeoSettings>
```

Fig. 26: *An example of exported settings for individual geological indexes.*

The described Figure **25** dialog also contains **Import** and **Export** buttons (Fig. **25**). Their function is important if you frequently use the same visual settings for the same geological indexes. You can then export these settings from this program and reuse them in other projects. The settings are stored in a separate **XML** document where you can edit their structure and content outside the program. For example, you can change colours, or add new geological index records (Fig. **26**).

This prepared file can then be reused to set up the visual properties of geological schemes from other wells. In my work, I prepare this type of file, to define the visual settings for a variety of geological indexes. This feature significantly saves time because you can reload these settings into your programs with the **Import** button.

The greatest improvement in this program is that you can simultaneously set all visual properties for multiple geological schemes in your project. Just click the Data Source panel in the context menu to **Edit Visual Properties of All Schemes** (Fig. **21 Right**). When you click on this item, the exact form in Figure **25** appears, showing all unique geological indices in your project. You can then individually set or edit their properties from an external XML file. The alternative dialog from Figure **27** is obtained when you click on the **Apply** button. This allows you to choose all geological schemes you want to set-up from the provided list; and the program automatically sets up your visual properties in all selected documents.

If you subsequently see a geological section document where bulk editing was used, you will notice that the predefined texture of items has been changed. The majority of functions described in previous text is also available in the displayed document window when you right-click in the table area (Fig. **28**). You can also copy your table data onto the clipboard.

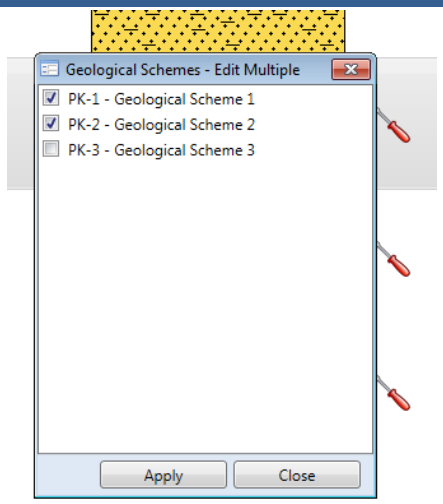


Fig. 27: *Selection of wells with their geological schemes, where you can immediately apply visual properties.*

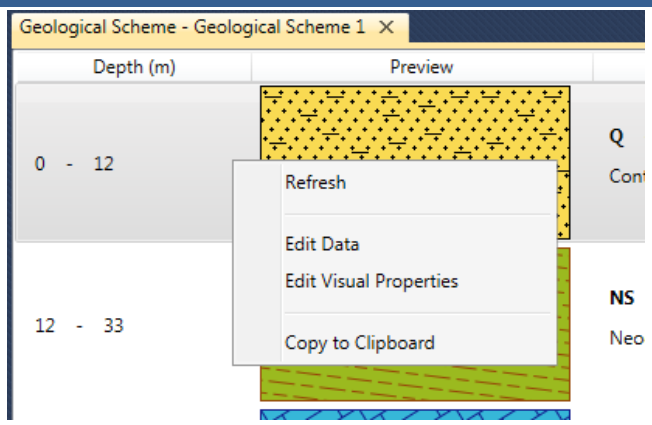


Fig. 28: *Functions shown in the context menu, when you display the geological scheme.*

5.2.3 Point Data

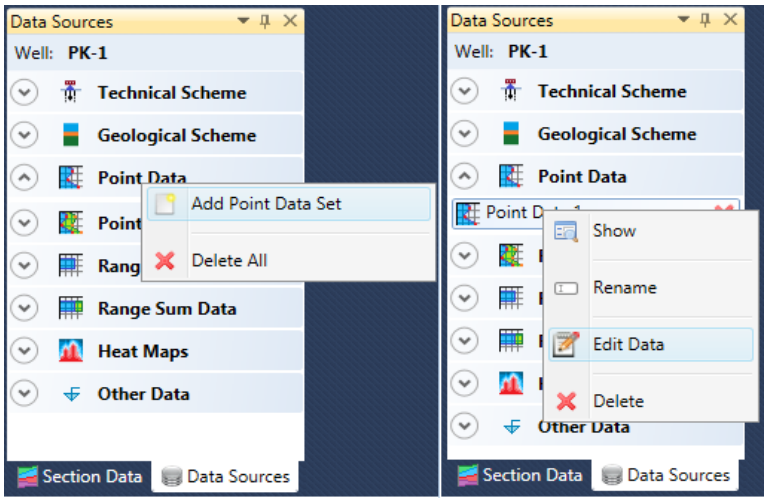


Fig. 29: *Point Data editing in Data Sources panel using the context menu functions.*

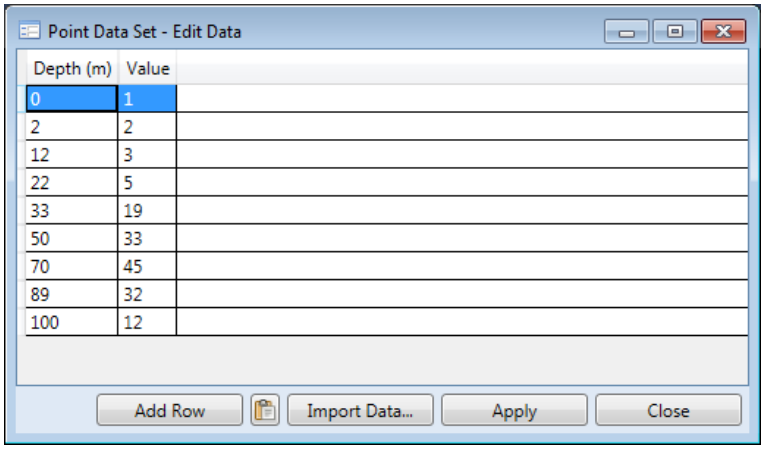


Fig. 30: *The form for point data edits.*

This sub-chapter explains the import and view options of numerical point data. This gives a set of point measurements of selected variables with your own values for defined depths. These include depths, for example, for groundwater temperatures, pressures and sediment clay content.

The **Data Sources** panel sublist defines this data (Fig. **29**). As in previous cases, you add a new document to the list by right-clicking on the header – **Point Data**, and then you select **Add Point Data Set** from the context menu. After your addition, you can work with this document by right-clicking again to obtain a pop-up menu. If you want to edit data, for example, just click on the **Edit Data** function (Fig. **29 Right**).

This function a new form displays, where you can edit point data (Fig. **30**). Here, you can add numeric values at defined depths **manually**, using **Copy-Paste**, or you can import data from a **CSV file** with tab separated values.

When your data is prepared in the table, click the **Apply** button and close this form. Future display of your document appears as in Figure **31**. This again only presents a quick preview. Final

visualizations are explained throughout the text for the individual program applications. Explanations are described later.

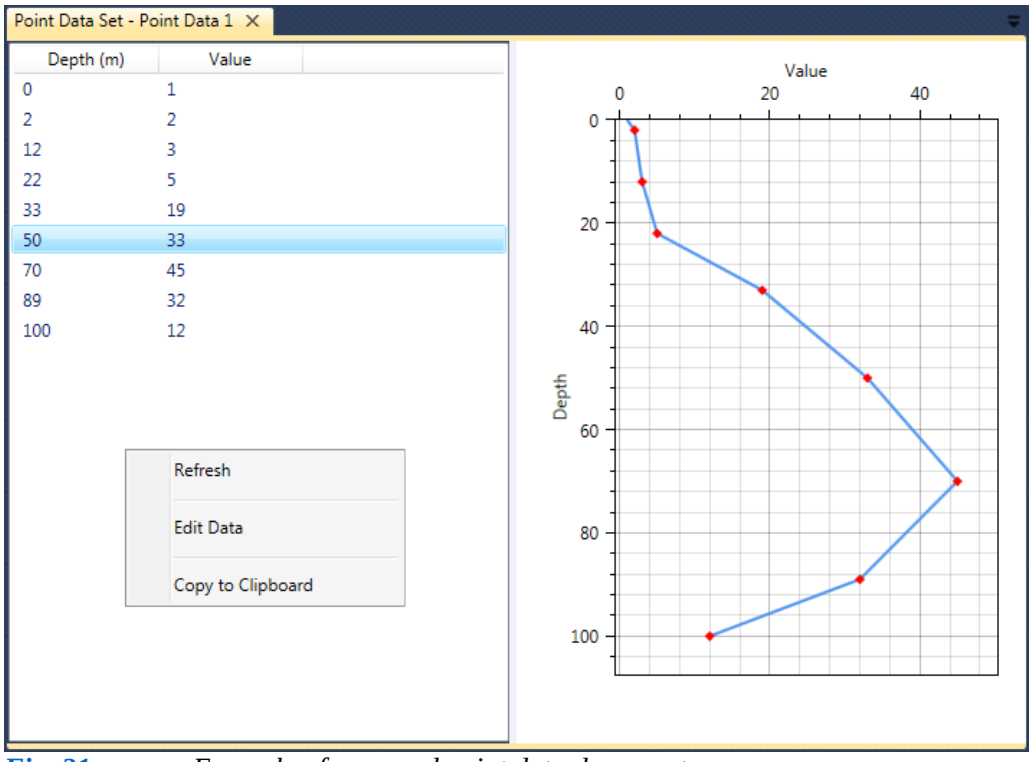


Fig. 31: Example of prepared point data document.

5.2.4 Point Sum Data

You also need point summary data. These are different so that you can display multiple numerical values at defined depths. They include your clay concentrations, sediment sand and dust contents, and dissolved groundwater solids. Adding a new document or working with your current document is exactly as described for previous operations (Fig. 32).

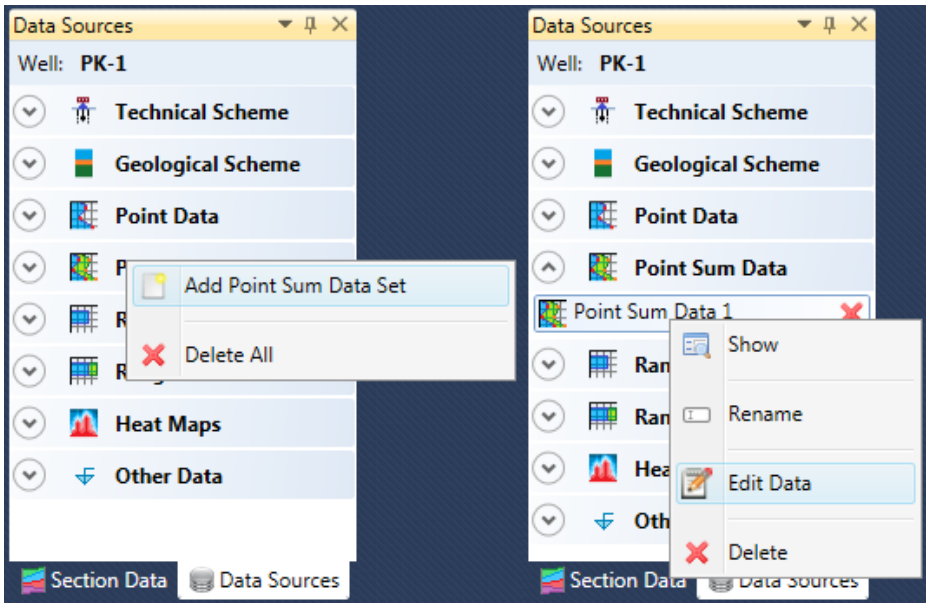


*Fig. 32: **Left** – adding a new document; **Right** – commands for edit and view of selected document*

When you click **Edit Data** in the pop-up menu, the blank form in Figure **33** is revealed. But you cannot add your data by typing manually here, so you incorporate it by **Copy–Paste** or import it from a tab-separated **CSV file**.

An example of a prepared CSV document is shown in Figure **34**. This lets you add defined depth values for Ca, Mg and Na + K groundwater concentrations.

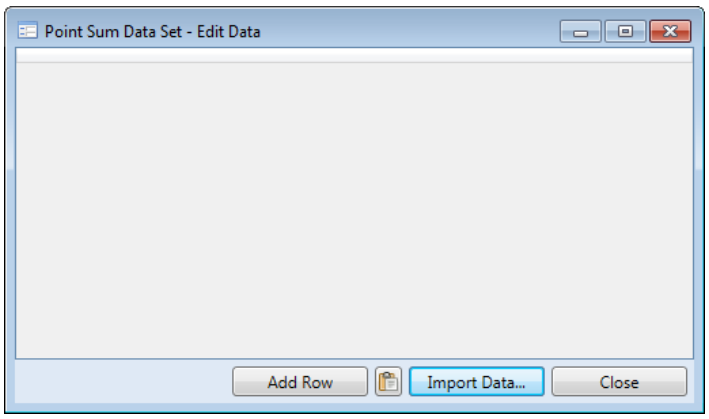


Fig. 33: *An empty window for data processing.*

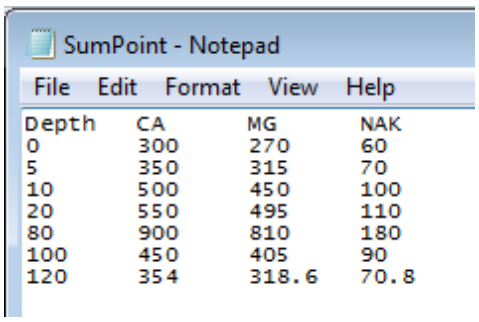


Fig. 34: *Example of prepared CSV file.*

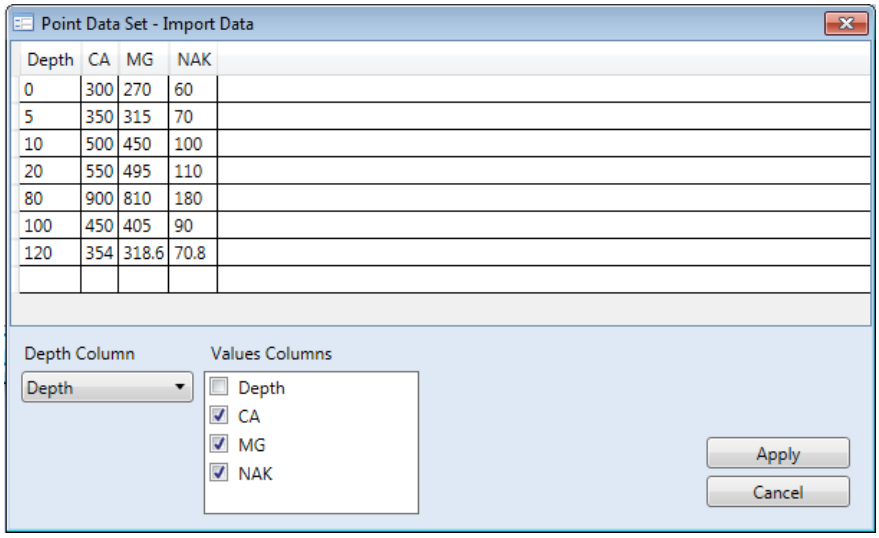


Fig. 35: *Synchronization and definition of input data from external CSV file.*

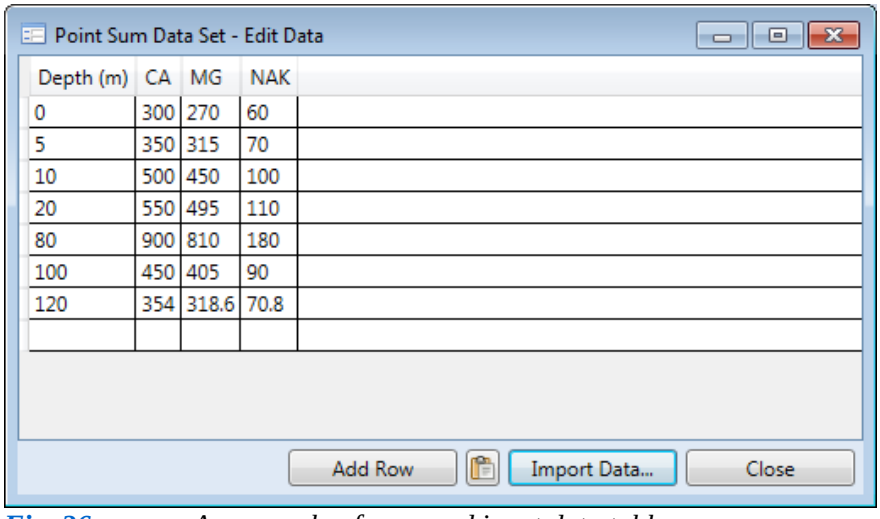


Fig. 36: *An example of prepared input data table.*

When your data is imported into the program by either of the functions described above, the Figure **35** form is displayed. This prepared new data table is taken from an input file. Firstly, you define the column for stored depth measurement values using the combo box below the table, and then you select the columns you want to import into the program from the checked list-box and press the **Apply** button.

These settings allow new structural data to be added into your table. You can also add new rows to the table and manually edit them before closing this window.

Your prepared document with input data will look like Figure **37**; with your data displayed as a vertically stacked area series. The final visualization of all data is described later.

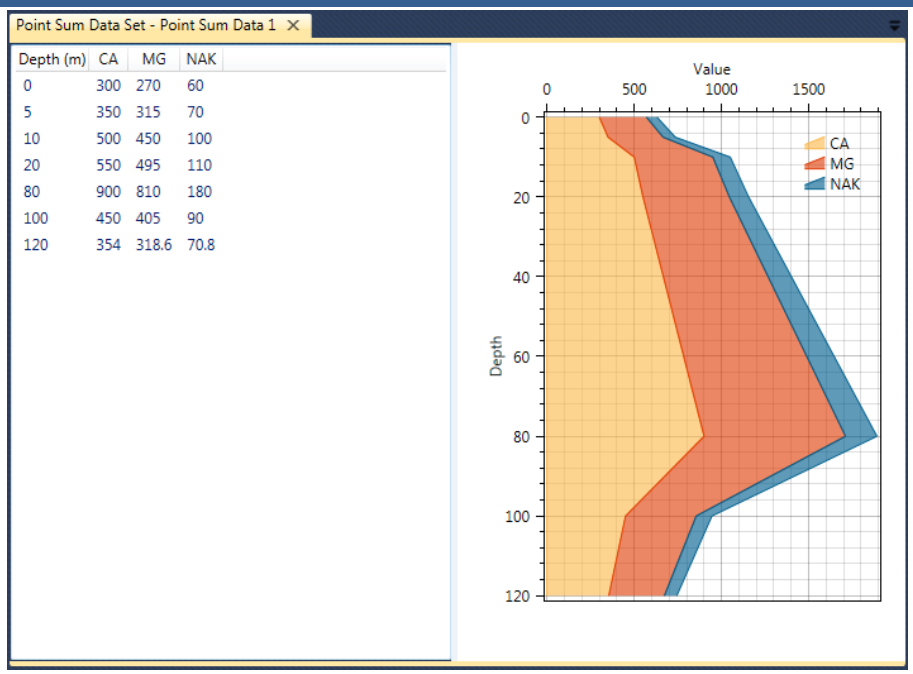


Fig. 37: *Example of prepared data document.*

5.2.5 Range Data

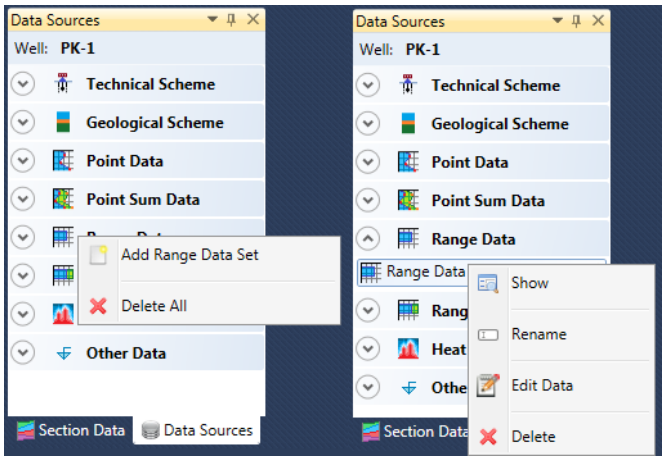


Fig. 38: *Commands from the context menu for displaying and editing range data sets.*

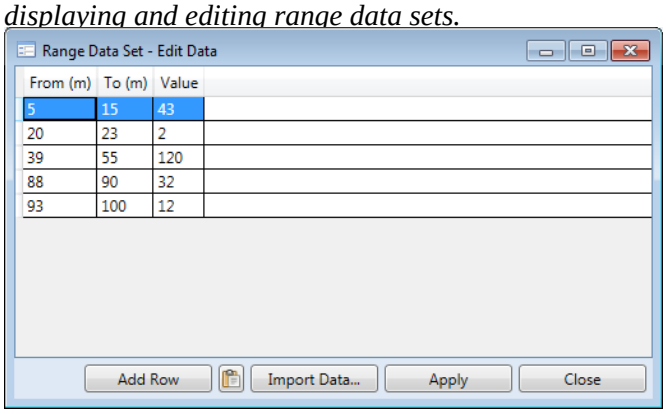


Fig. 39: *Form for editing range data type.*

If your numerical data is defined for a **depth range** rather than at a point in depth or your values are measured at regular depth intervals, you use the appropriate group from the **Data Sources** panel in Figure **38**. Documents here are added exactly as in previous cases, and if you want to view or edit your document, you choose the appropriate function from the context menu (Fig. **38**).

Clicking on the **Edit Data** function displays the data editing form in Figure **39**. The table has three columns. The first two define the depth range for measured values and the third column stores your numerical values.

Depth ranges can be defined as segments of equal or variable size. As usual, you can add data to the table by typing your values **manually,** or by **Copy–Paste**, or importing them from tab separated **CSV file**.

When your data is entered, click **Apply** and close the form. Your prepared data document will resemble the example in Figure **40**. Measured inflows of groundwater into the well related to depth can be illustrated, and all types of numerical range data can be imported into your document.

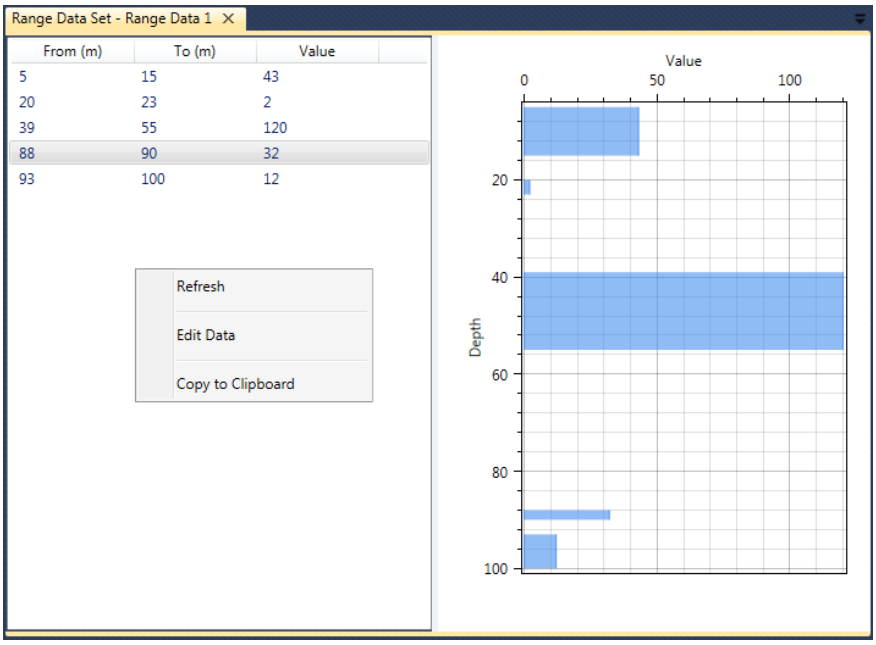


Fig. 40: *Example of document preview with range type of numerical data.*

5.2.6 Range Sum Data

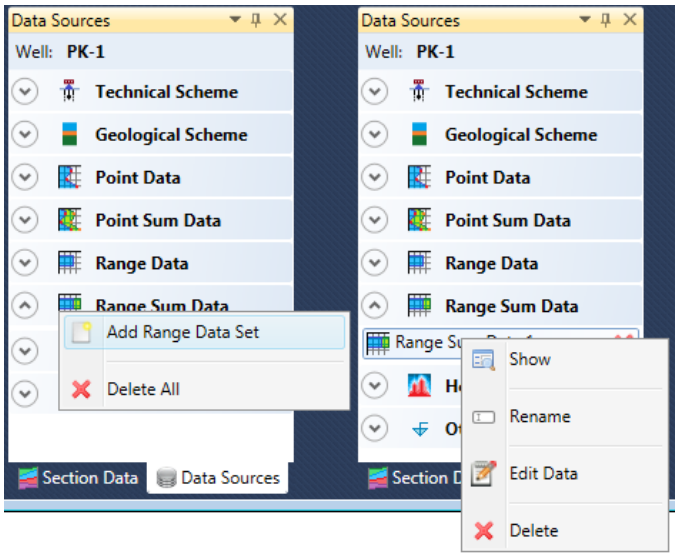


Fig. 41: *Functions from context menu for edit Range Sum Data.*

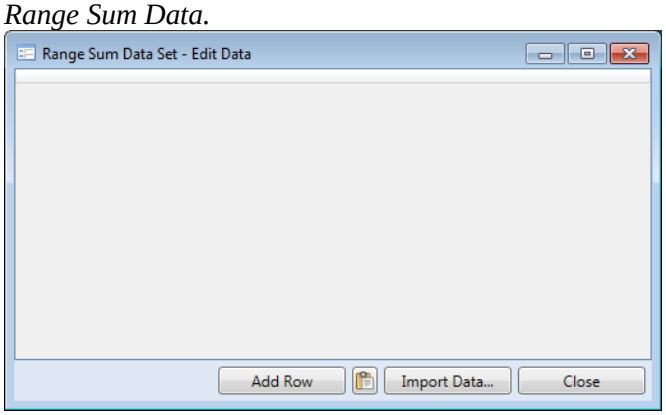


Fig. 42: *Edit window for data in the Range Sum Data group.*

When recording depth measurements, if you have **several numerical parameters** within a **defined range**, you can use **Range Sum Data** to define your depth intervals. The basic condition for this is that the same defined ranges are used in all imported parameters. This is useful when you want to record values of combined dissolved solids in groundwater; and here you can add and edit new documents from the **Data Sources** context menu (Fig. **41**).

After creating your new blank document, the import data form will appear as in Figure **42**, and your entered data can be edited using the **Edit Data** function. The Table structure and definition is undefined exactly as in the **Point Sum Data** function. This depends entirely on your input data, so **Copy-Paste** your own input table from your spreadsheet or **CSV file**.

An example prepared CSV document for import is shown in Figure **43**. The first two columns define the depth ranges of your measured values and the following columns list your measured values. The number of columns available for measured numerical values is unlimited; dependent only on your

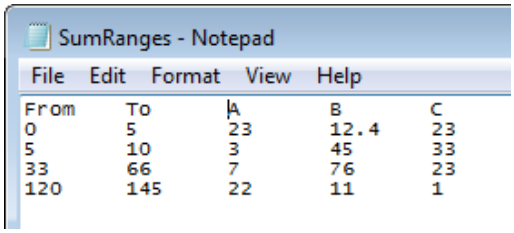


Fig. 43: *Example of prepared data document in CSV format.*

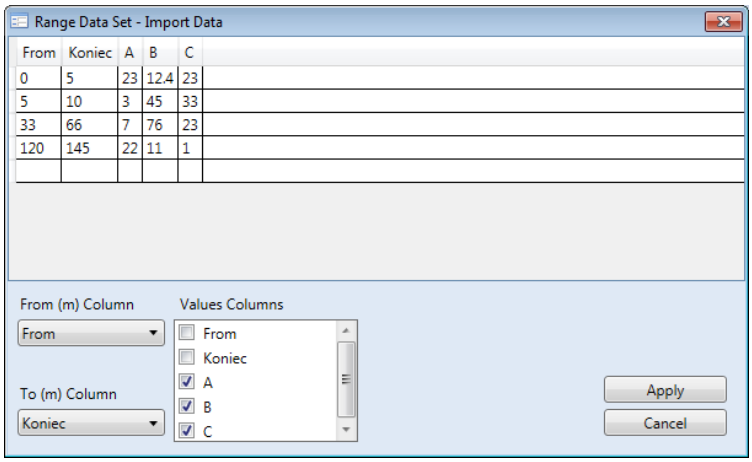


Fig. 44: *Help form for Range Sum Data import.*

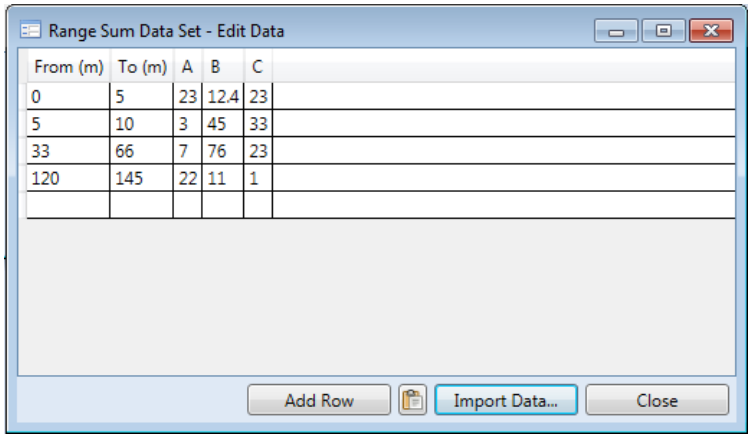


Fig. 45: *Prepared data set of Range Sum Data.*

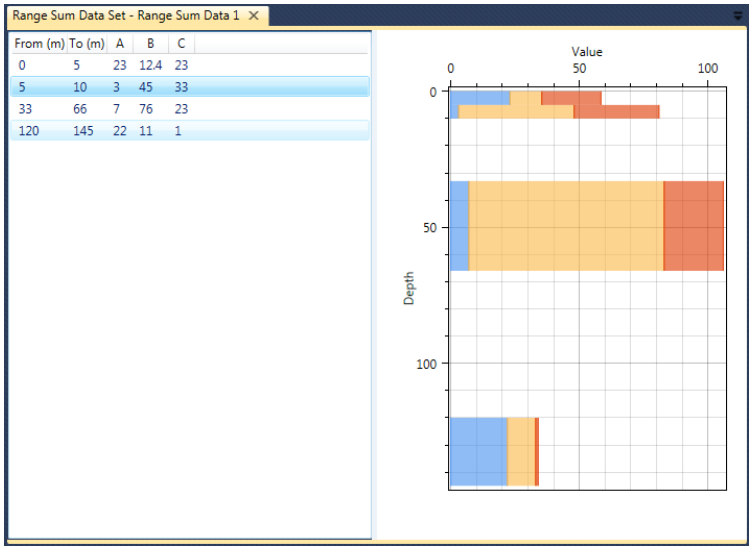


Fig. 46: *Document example containing Range Sum Data.*

own requirements.

The Figure **44** help-form appears when you import data into program, with parsed values in individual columns. The combo boxes below the table define the columns for your initial and final depths, and then you use the check-list box to select the value columns you want import from the external file. Here, you can import all columns or only the selected ones you need.

Press the **Apply** button, and your structured data set is imported into the main table as in Figure **45**. You can then edit it manually and add new rows with the **Add Row** button.

Figure **46** illustrates a document with your prepared data in a stacked bar-series, with variable column width for well depth.

5.2.7 Heat Maps

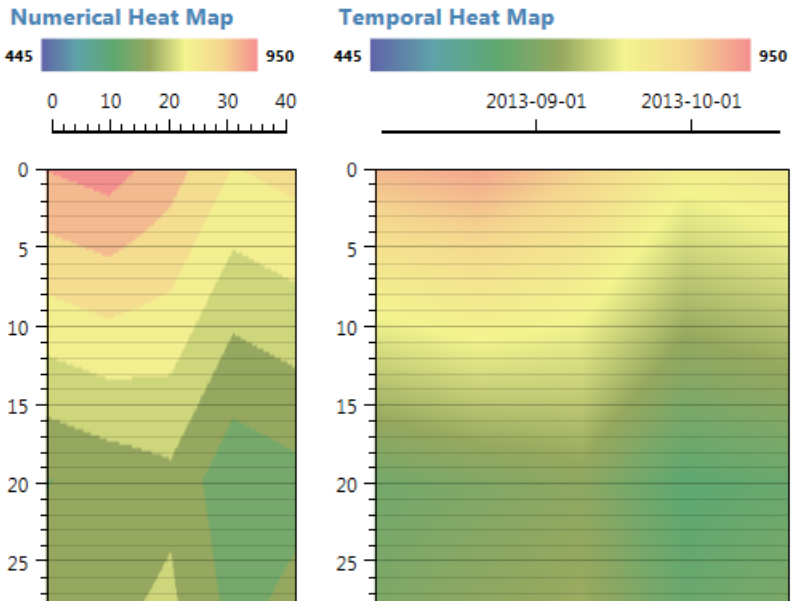


Fig. 47: *Heat maps examples (**Left** – numerical heat map; **Right** – temporal heat map).*

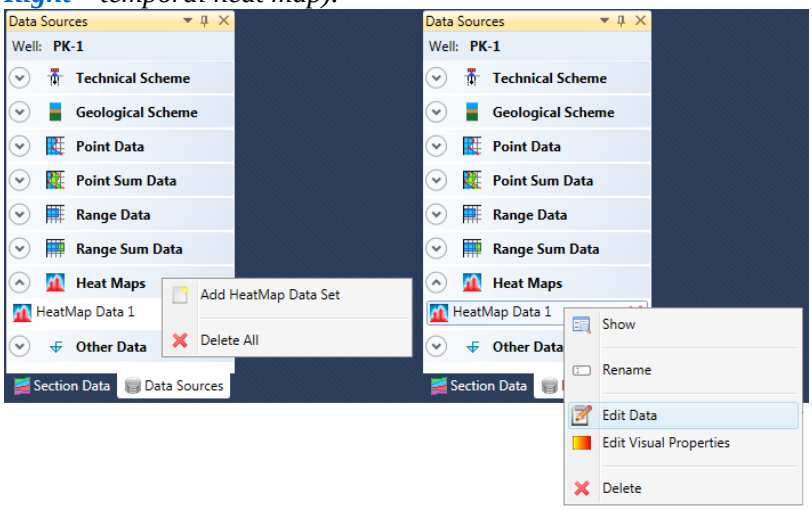


Fig. 48: *Context menu commands for work with heat maps.*

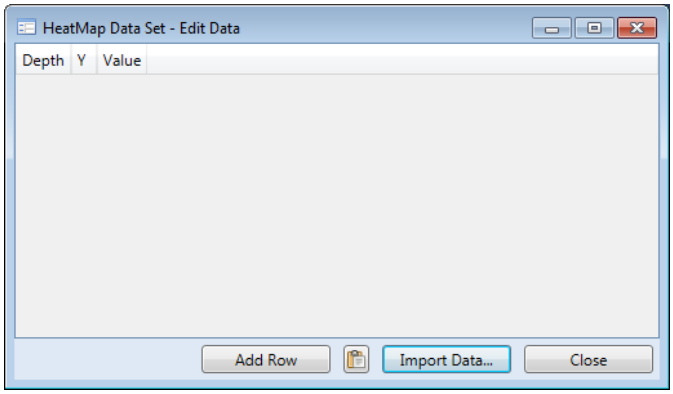


Fig. 49: *Form for heat map input data definition.*

Another important data type you use is **multivariate numerical data**. This can contain numerical measurements for well depth and time, or geophysical measurements of depth and distance from the well. Examples are shown in Figure **47**. There is a **numerical heat map** on the left side and a **temporal heat map** on the right. The difference in these two heat maps is in units on the horizontal X-axis.

You can use the functions in Figure **48** context menu to create your heat maps.

After adding your new empty heat map, you can fill and edit it using the **Edit Data** context menu functions. The form in Figure **49** allows you to enter depth measurements as a positive number in the **Depth** column, while column **Y** defines times or additional numerical values. The time must be entered in **numerical** format, not in date form, so that means that your initial time is **zero**. Other values are then defined in numerical days, months, years or other time based periods as the difference between your zero and end times. Numerical measurements are then placed in the last column, as depicted in ***Fig. 50.***

A prepared document example is in Figure **50**. It has measurements from depth 0 to 200 metres in periods of 0 to 40 days. Definition of the actual date values for horizontal axis (Fig. **47 Right**) is in another place.

This prepared file can be imported into the program by **Copy-Paste**, by **typing manually** or by **import from a CSV file** with tab separated values. Your resultant window will be similar to Figure **51**.

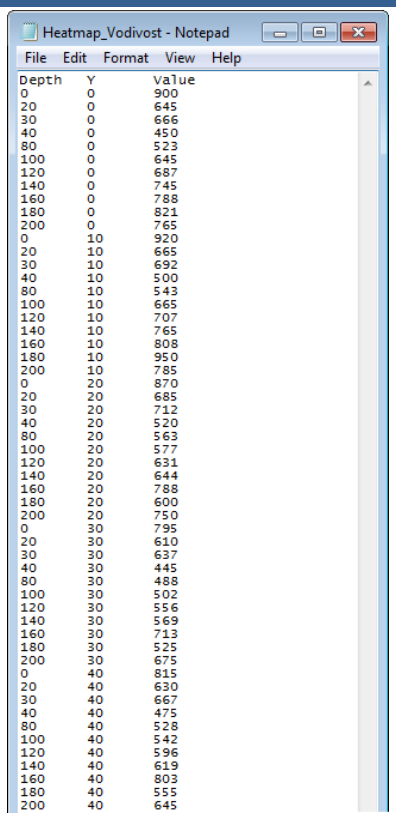


Fig. 50: *Example of data file in heat map production.*

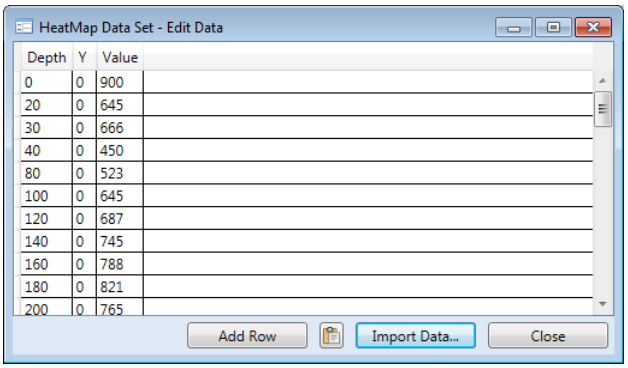


Fig. 51: *The input data window for heat map definition.*

When your input data is entered, close this window. To create your heat map, right-click on the document and select the **Edit Visual Properties** function from the context menu shown in Fig. **48 Right**, and the window in Figure **52** is now ready for you.

The top area of this window is initially empty to display your heat map; and you create this using the properties and settings in the bottom part of the window. You must define the following parameters to view your map. The **delta Depth** and **delta Y** parameters are used to set resolution of your map. Both of these have the predefined value of 1, so you can accurately define the required map in both horizontal and vertical directions. The lower these values are, the higher the resolution you will have in your final visualization. The highest resolution is achieved when you set-up your values manually, by decreasing them until your desired resolution is obtained. This resolution also depends on the measurement density. It is not possible to make this adjustment automatically, so an example with different resolution settings is shown in Figure **53**.

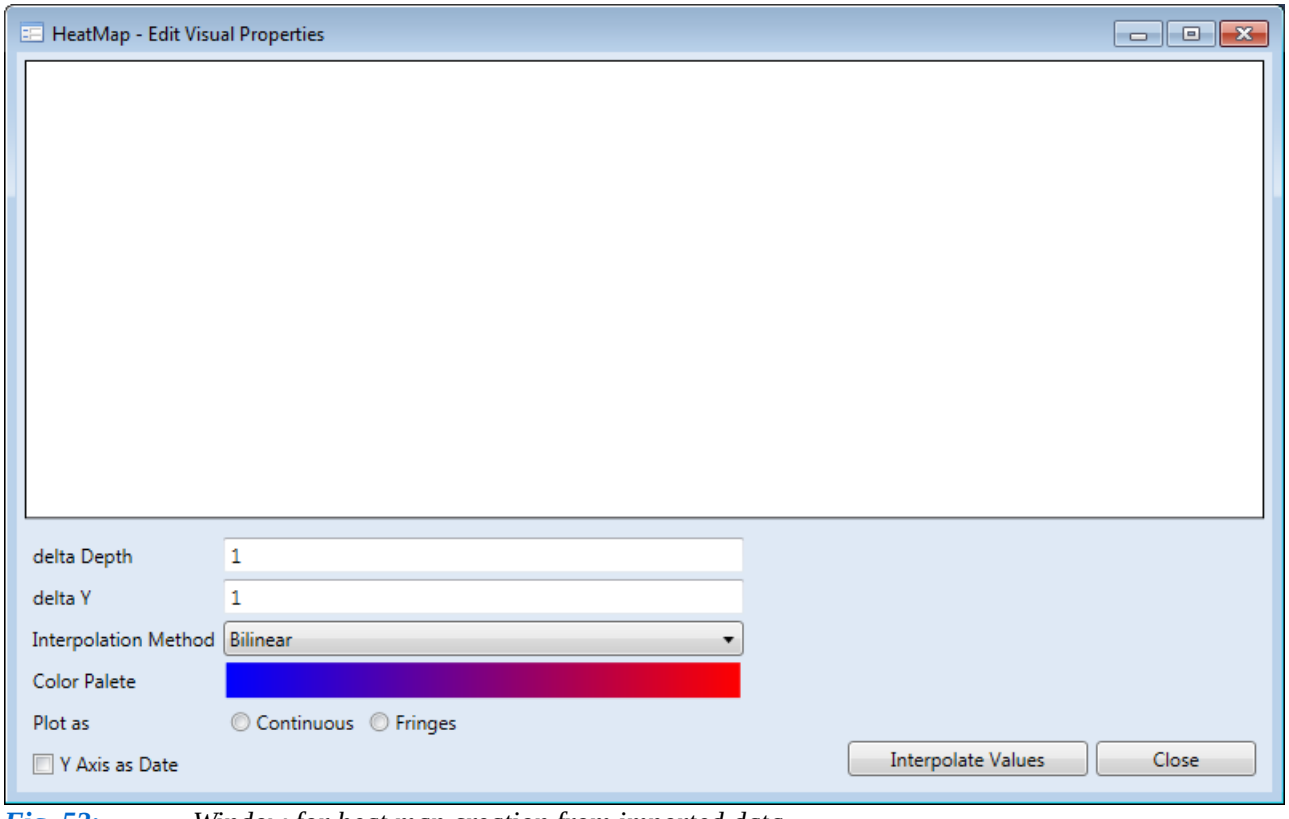


Fig. 52: *Window for heat map creation from imported data.*

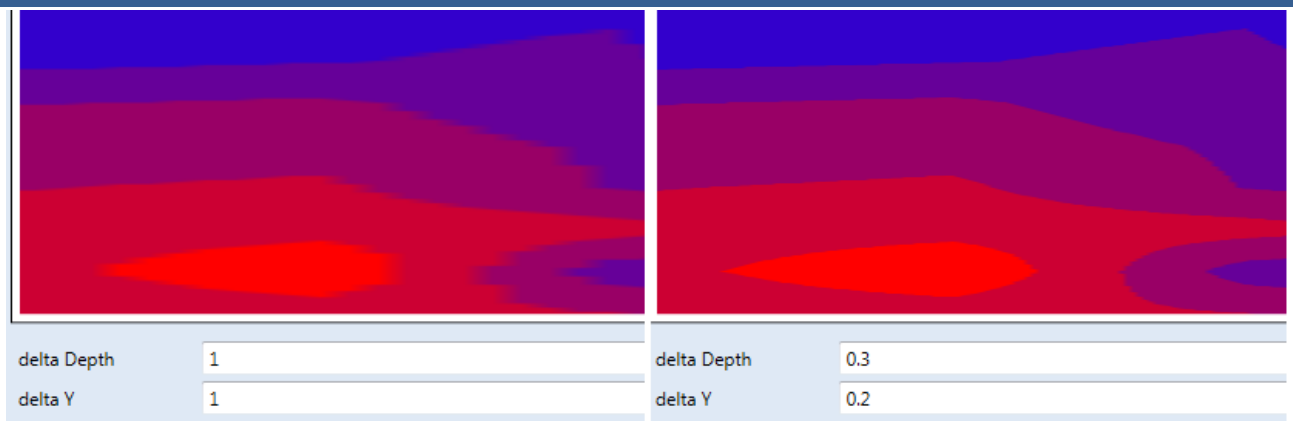


Fig. 53: *Two examples of heat map resolution settings (**Left** – predefined resolution; **Right** – modified resolution).*

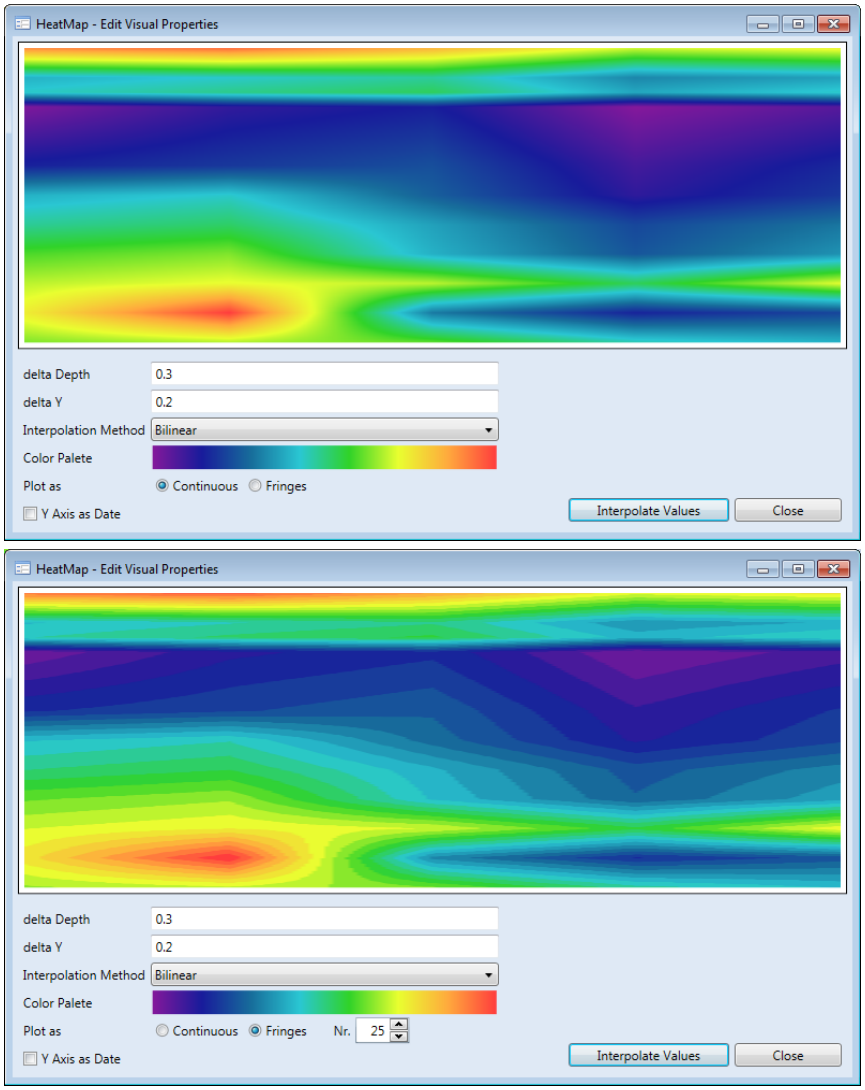


Fig. 54: *Colour palette modes for heat map (**Top** – palette with continuous colour gradient; **Bottom** – a palette with sharp colours edges).*

The next line offers the choice of heat map **interpolation methods**, but since this current program version contains only the bi-linear interpolation method, you do not have to change this parameter.

The following line lets you define the **colour palette** used for your result. In ***Fig. 53*** this result was obtained using only red and blue, but Figure **54** shows a palette created from eight colours. The number and order of colours is unlimited, so you can create highly variable **colour palette combinations**. The program initially offers you the red and blue combination, but you change this by simply clicking on the palette preview and selecting your colours from the dialog box.

The final visual setting is the **mode** of display from your defined colour palette (Fig. **54**). You choose if you want to display colours as a continuous gradient for your value ranges (Fig. **54 Top**), or if you want sharp colour boundaries between them (Fig. **54 Bottom**). For this second option, you set the number of colours you want in your heat map. In my Figure **54** examples, I used 25 passages and the resultant heat maps consist of 25 colours.

If you wish to prepare a temporal heat map, now you define the resulting horizontal time axis (Fig. **47 Right**). If your numerical values in column Y represent time steps, you can change

these values to date format values by clicking on the **Y-Axis as Date** check-box (Fig. **55**). The additional two fields define your initial and final measurement dates, and these will be displayed on the horizontal time axis in your final visualization.

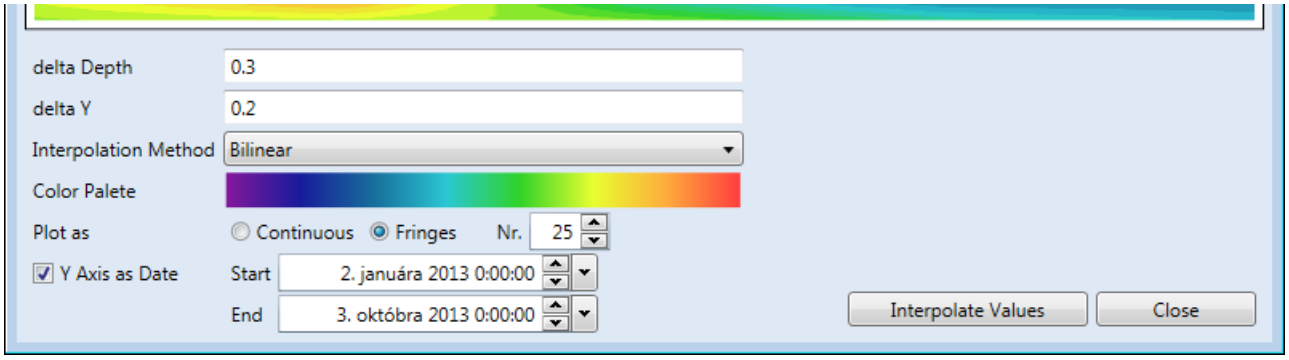


Fig. 55: *Setting temporal axis for the final heat map.*

After applying the described settings, you can create your resultant heat map by pressing the **Interpolate Values** button. If you are satisfied with the result, just close the window and your prepared heat map is completed for future visualization. To achieve this, click the **Show** command in the context menu, and you see your document with all imported data illustrated as a simple heat map preview (Fig. **56**). Although the preview does not contain the horizontal axis, it is included in the final visualization.

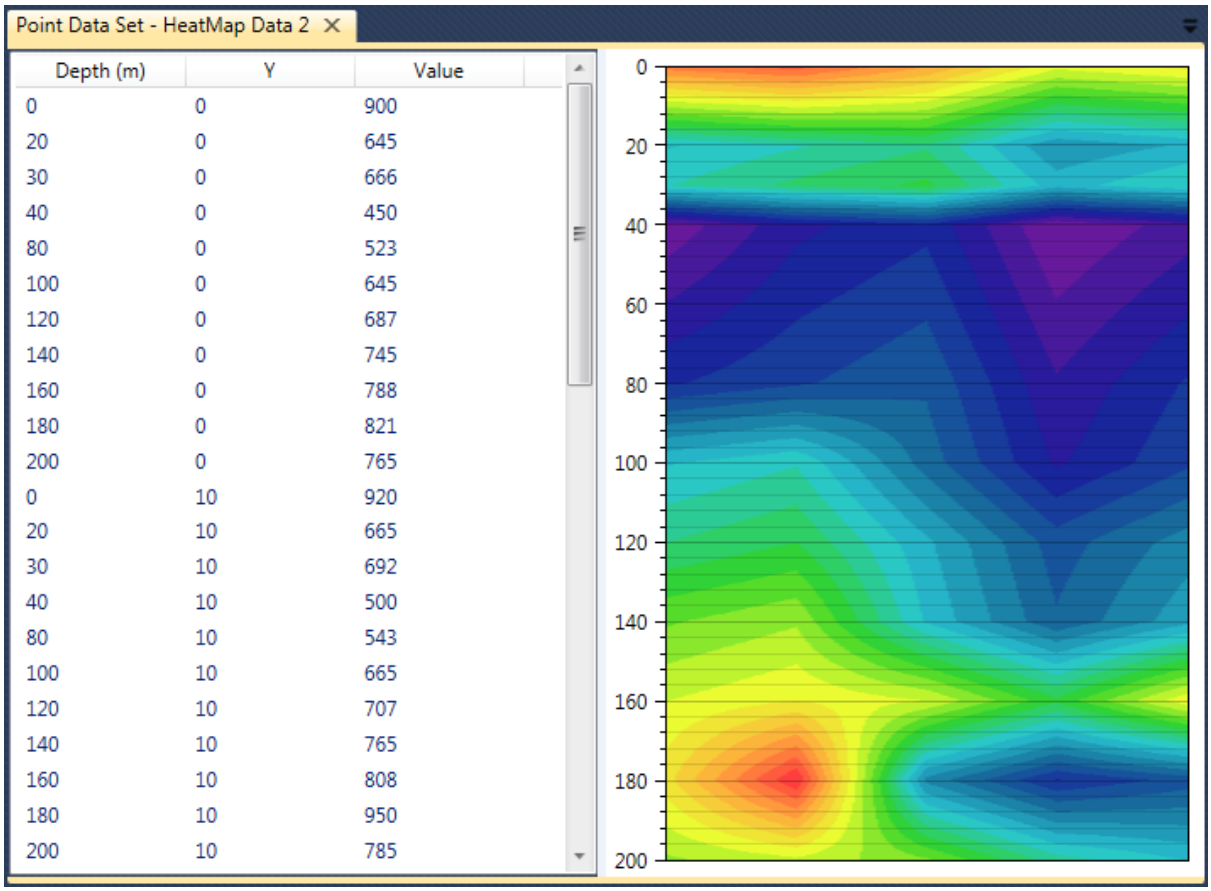


Fig. 56: *Example of created heat map with input data.*

In addition to the described 2D heat maps, you can create a **1D Heat Map**. Its preparation and display is described in **Annex 2**. Sub-chapter 5.2.8 now explains the preparation and display of additional specific data you frequently require for well visualization and interpretation.

5.2.8 Other Data

The **Other Data** group contains functions for working with additional borehole and well data. As usual, these functions are controlled by the context menu (Fig. **57**). An advantage here is that you can add and edit multiple data types. These include **textual** descriptions, **images**, **tectonic** data and numerical values for **time series** related to defined depths and depth ranges.

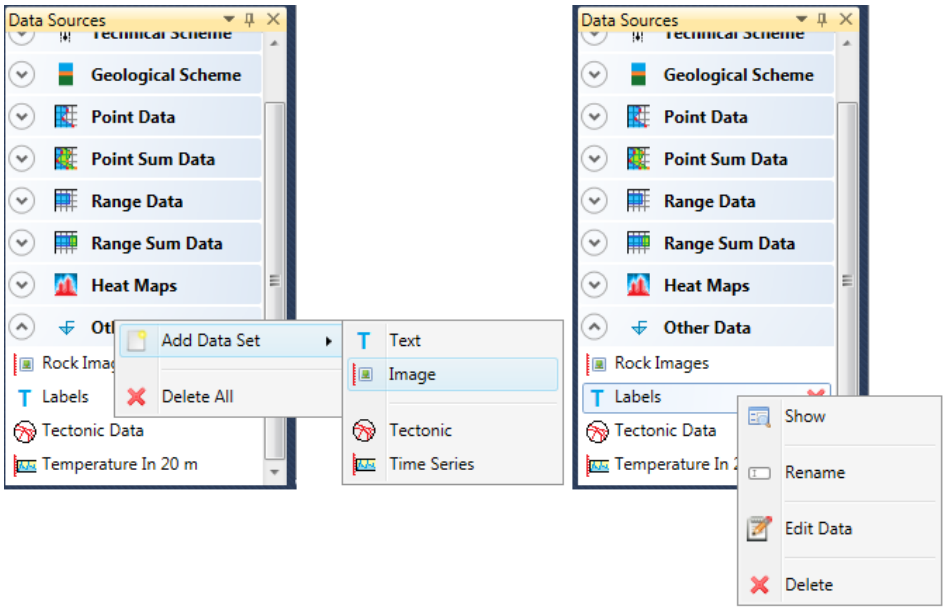


Fig. 57: *Functions from the context menu for adding and editing data documents in the "Other Data" group.*

If you want to add a new data document, right-click on this group header and select the type of data document that you want to add from the **Add Data Set** contextual menu.

Following your document addition, you work with it as usual with functions from the context menu (Fig. **57 Right**). The various types of data documents are distinguished by icons in this menu list.

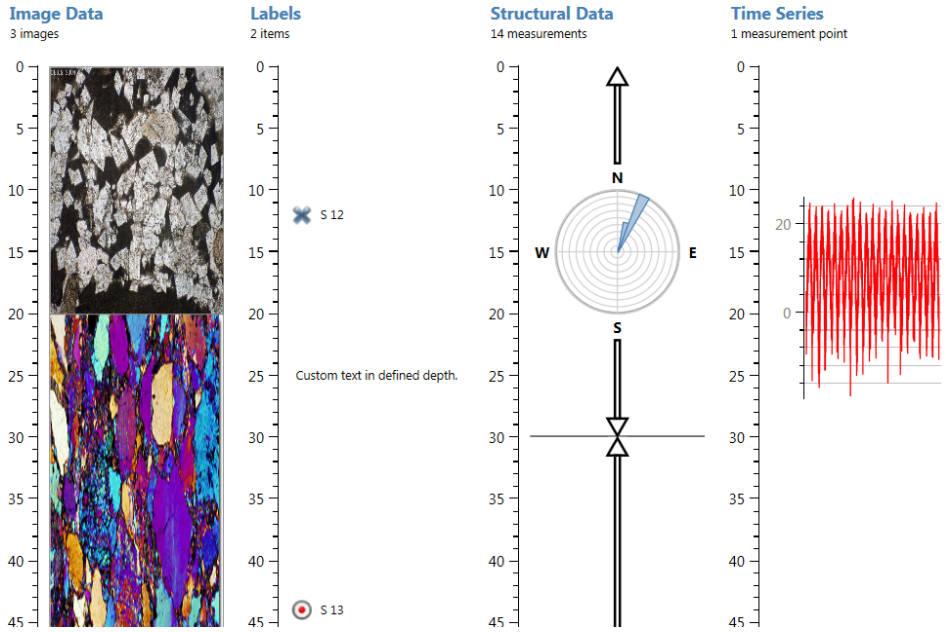


Fig. 58: *Examples of data types that can be prepared in the described group.*

Examples of data prepared for this group of documents are in Figure **58**; and the following sub-sections explain the step by step procedures to obtain documents with these results.

5.2.8.1 Textual data

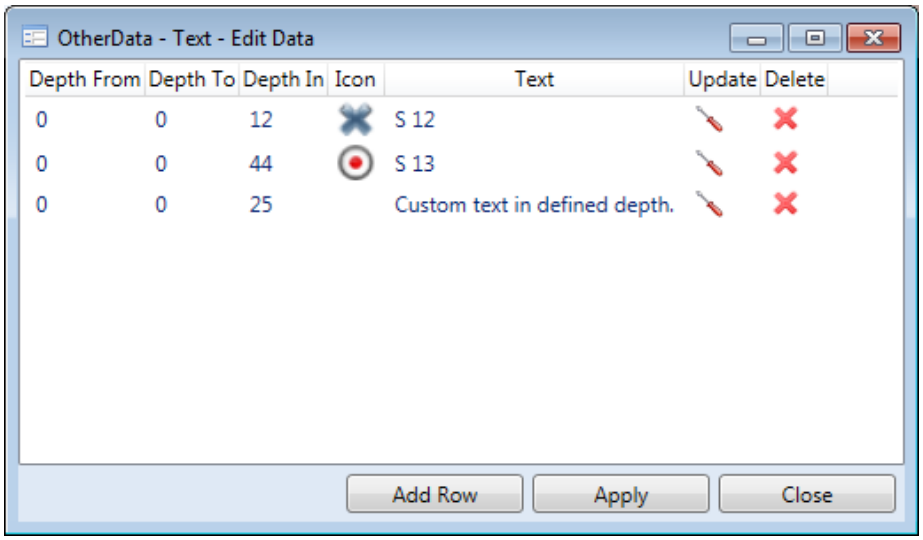


Fig. 59: Form for adding and editing textual items.

Textual data is described first. Here, you can add labels for defined depths and depth ranges. Click on the **Edit Data** function in the context menu and the Figure **59** help-dialog appears. You can now add or edit text you want displayed in your well's vertical profile.

Unlike previous data types, these cannot be imported from an external file because of the character of these objects. Therefore, you click the **Add Row** button and obtain the form in Figure **60 Left**.

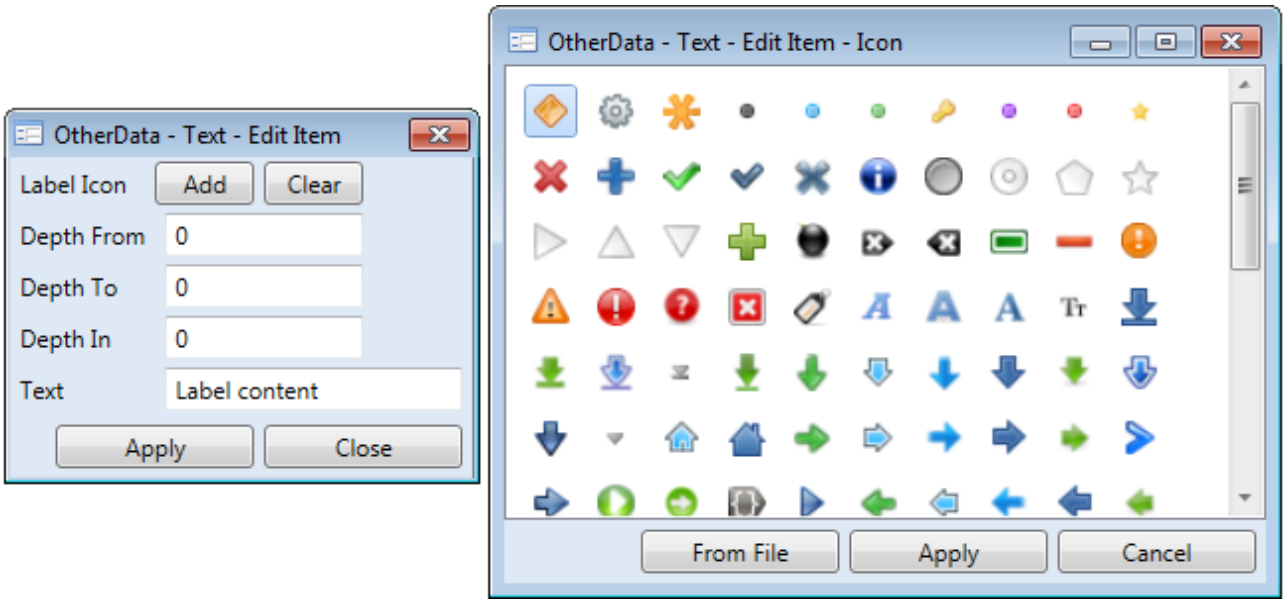


Fig. 60: Help dialogues for text definition.

Here, you can combine parameters for each entry to create four types of text labels (Fig. **61**). First, set the **Label Icon** property. If you need an icon in front of your text, click the **Add** button and select your icon from the 142 choices in Figure **60 Right**. To use your own custom icon from disk, you must load the icon into the program using the **From File** button. Click the **Apply** button after choosing your icon and the window will close. If you want to delete this icon later, just click on the **Clear** button (Fig. **60 Left**).

The following three lines; **Depth From**, **Depth To** and **Depth In**, are used to define the depth interval at which you want your label displayed. You can set your edited label at a defined depth or to a selected depth interval. If you choose depth interval, write a zero value in the **Depth In** line. Conversely, if you want to use only the **Depth In** property, the remaining **Depth From** and **Depth To** properties must remain zero. Finally, set the property **Text** containing the text string you want to appear in your visualization. This text information can be used, for example, as a sample indicator

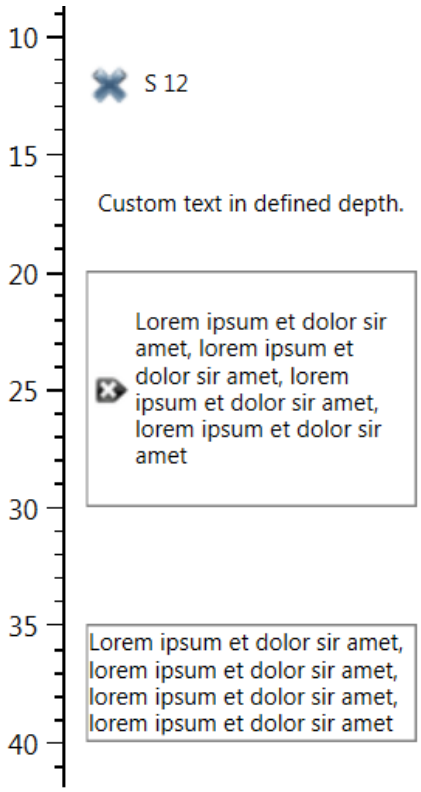


Fig. 61: *Examples of text label definitions.*

or to describe technical scheme segments. When you set-up this item, simply click on the **Apply** button and your item is added to the table in the main editing window.

Examples of text label types you can create in this program are shown in Figure **61**. The top two items were defined by the **Depth In** parameter; to the exact depth. The first label contains an icon and the second does not. If you use the **Depth In** parameter, the label will be displayed at the exact depth and it will consist of a single line. If your text is too long, it will not be shown in full. The bottom two Figure **61** examples illustrate labels defined in depth range. The first example has a label icon and the second has not.

When you have finished editing your text labels, simply click on the **Apply** button and close the window. A preview of your document is similar to Figure **62**. In this way, you can add unlimited structured text into each document, and their complex visualizations are described later. The following subsection explains preparing, editing and viewing your depth and depth range files.

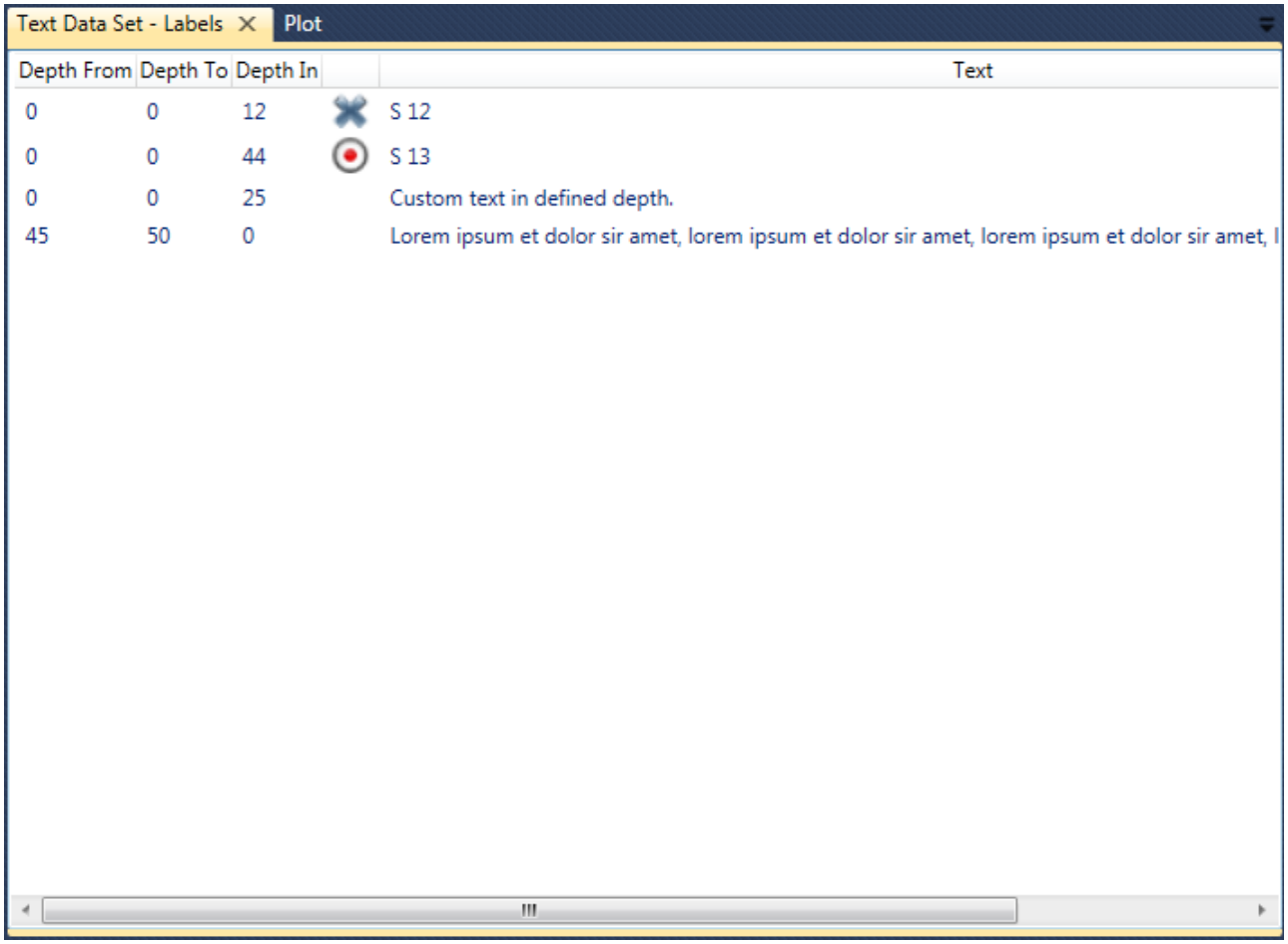


Fig. 62: *Example of document with prepared text labels.*

5.2.8.2 Images data

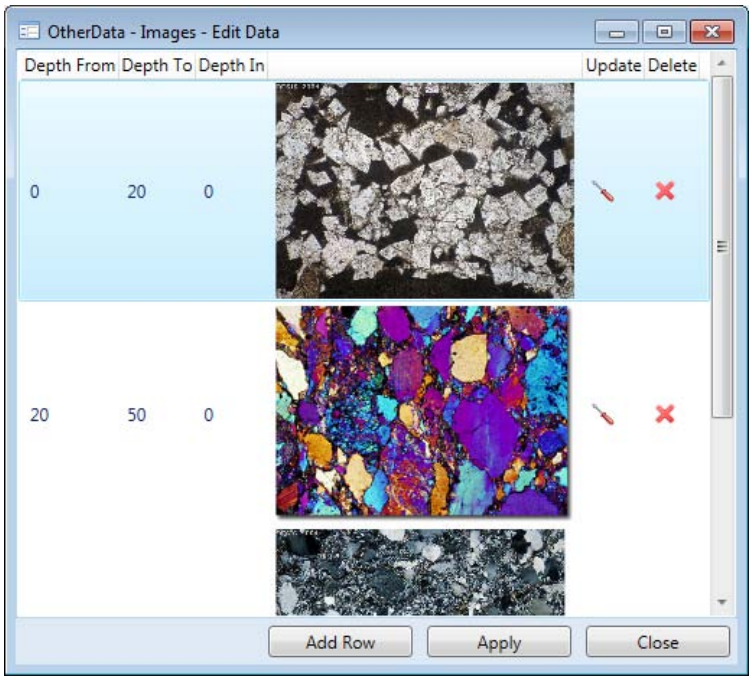


Fig. 63: Window for editing images in data documents.

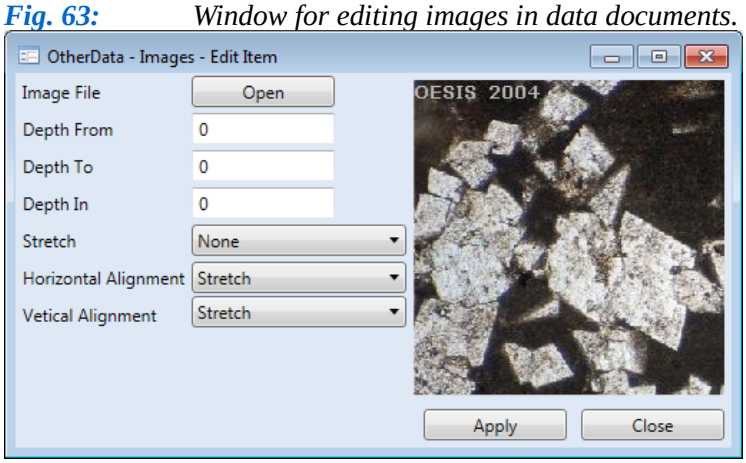


Fig. 64: Window for editing and adding new image items into the document.

Images of well vertical profiles can be displayed in this document type. If you want to edit your image data document, right-click in the **Data Sources** panel and select the **Edit Data** command from the context menu. The window in Figure **63** then appears.

As usual, individual images can be added into your list with the **Add Row** button. Editing a selected row in your table involves clicking on the screwdriver icon at the end of the row. Care in editing is required here, because if you click on the last icon, the selected row will be deleted from your table. (This, however, could also be your editing intention).

When you click on the icon for editing the row or you press the **Add Row** button, you have the window in Figure **64**, where you can edit individual records. You press the **Open** button to import a picture from a computer disk, and your selected file is loaded into the right area of the window. After saving your project into the file, you need the images in the same location because the program only stores information on where the image is located on the disk. If you change this location, it is impossible to reload it into the program later. The remaining three text boxes define where the vertical profile of the well's depth or depth range interval is displayed. These settings work exactly as the text labels described in the previous chapter.

Fig. 65: Examples of Stretch property states.

The last three combo boxes define your image display in defined depth intervals. The **Stretch** parameter sets the display method. You can set this in three states – **None**, **Fill** or **Uniform**. Examples of these settings are shown in Figure **65**. When you set it to **None**, the image

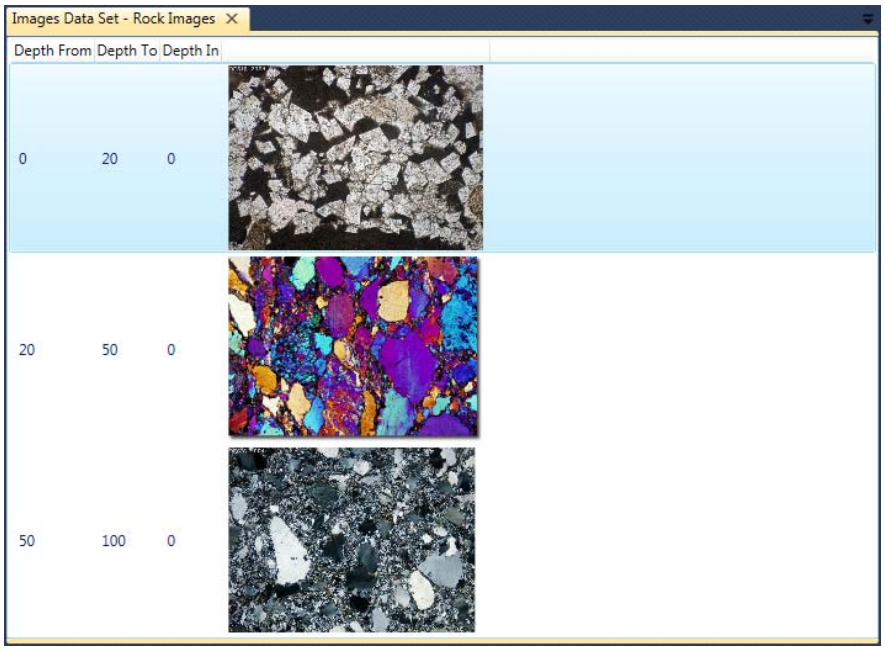


Fig. 66: Example of image data document preview.

is shown in actual size, so if it is greater than available space, you will see only the part of it trimmed to the current block size. If you set it to **Fill**, the image will cover all the available space, and if this space is insufficient, the image will be deformed. The **Uniform** choice expands your image within the maximum available space without deformation.

The last two combo boxes allow you to adjust the **horizontal** and **vertical alignment** of the image. These can be aligned to one side or centred to the middle of the space. These settings are explained in chapter **5.4.4.6** for 1D Well Log rendering. Finally, Figure **66** gives an example of your document preview.

5.2.8.3 Tectonic data

Tectonic and structural data can also be displayed in Well Plotter. This is prepared and edited in the document shown in Fig. **67**.

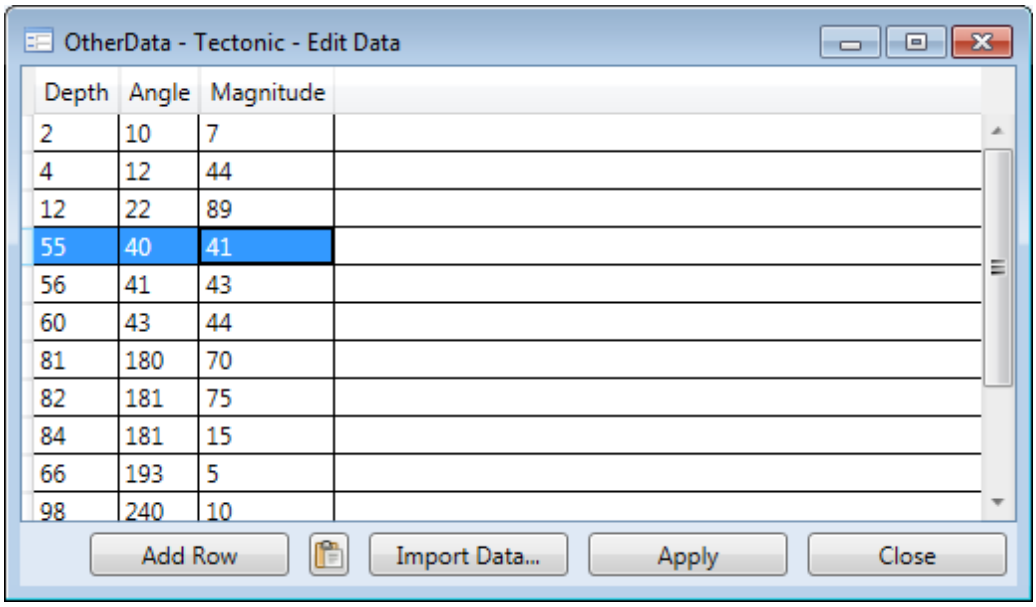


Fig. 67: Window for preparating and editing tectonic and structural data.

The Figure **67** structural data is determined by depth, angle and magnitude. For each structural measurement you must define the vertical profile depth as shown in Figure **68**.

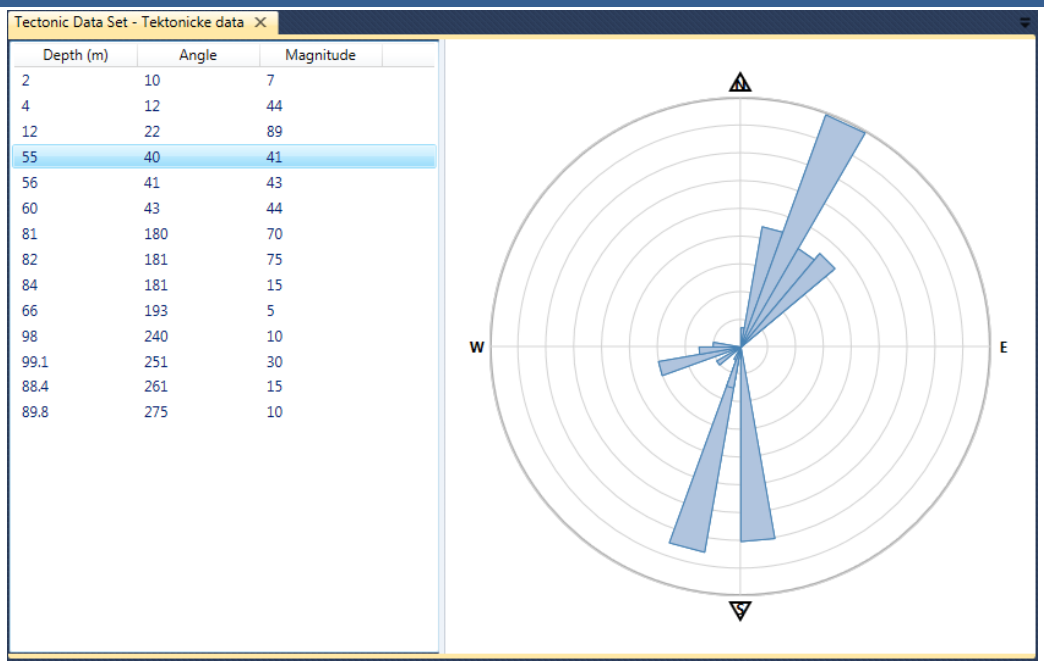


Fig. 68: *Example of document preview of tectonic and structural data.*

5.2.8.4 Time Series data

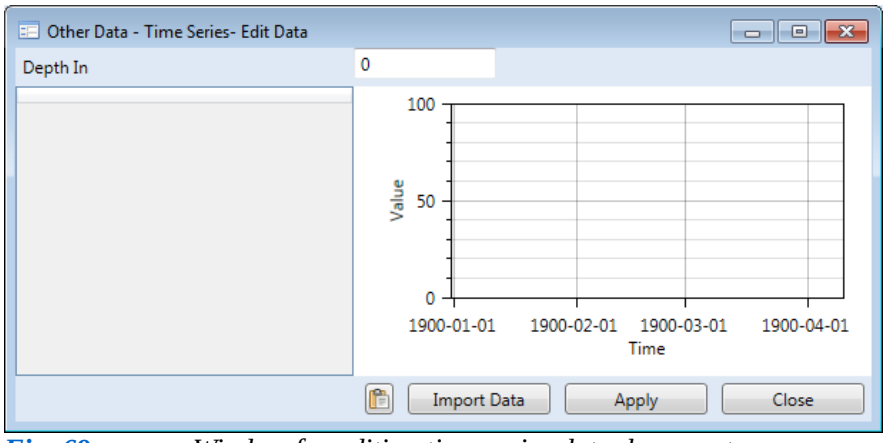


Fig. 69: *Window for editing time series data document.*

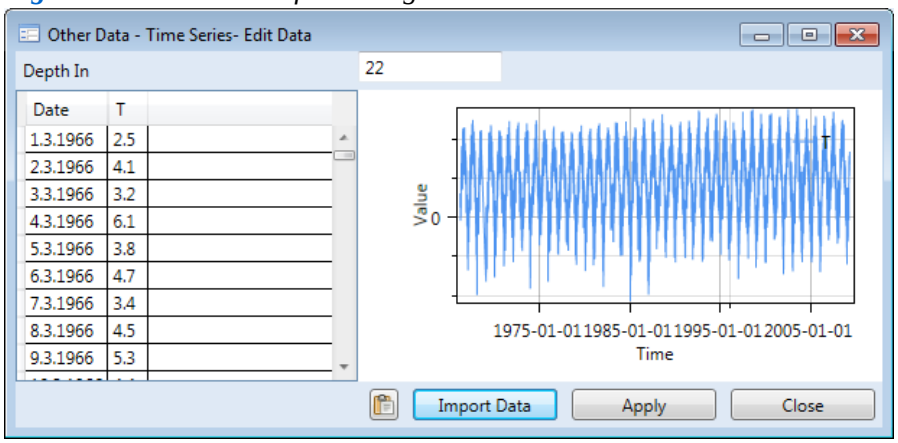


Fig. 70: *Example of prepared time series data document.*

Your next step is to set the time series data. If you want to enter numerical logger measurements over time, this can be displayed, in your well profile. The new document will contain the time series data, and you can add all types of previous data to this one. You can then edit this new document with **Edit Data** in the context menu. Figure **68** empty table and graph has been prepared for you.

Using the **Import Data** and **Apply** buttons you can import time series from external sources into this window via **Copy–Paste** or an external **CSV file**. Your document can contain more than one parameter, for example, continuous temperature and water electrical conductivity. After importing the time series, you must define the observed depth of your values in the text box above the graph; as in Figure **70**. In this example, I imported continuous measurements at 22 metres depth.

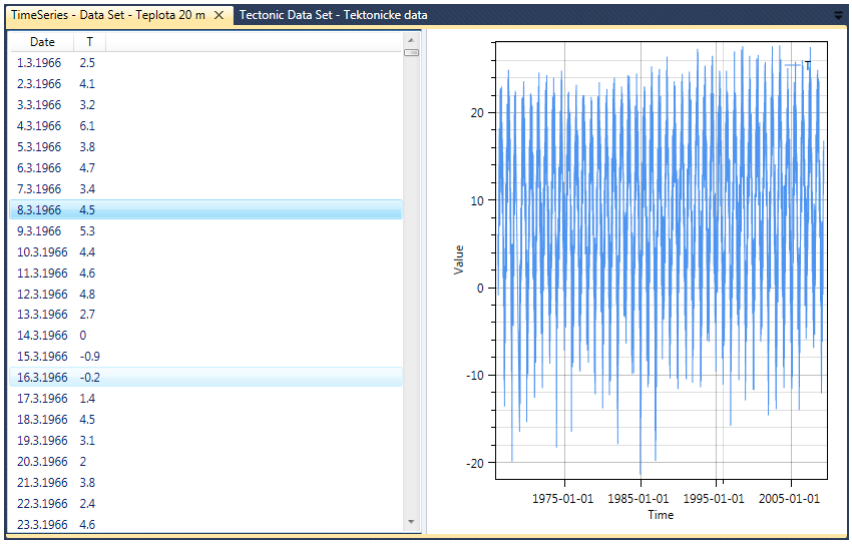


Fig. 71: *Example of time series document preview.*

Now click on the **Apply** button and close the window. A preview of your document is in Figure **71**. This has a table of imported continuous measurements of your selected parameters and their simple linear graph.

5.3 Map View

The previous subsections gave step by step descriptions of the data types you can use in the Well Plotter program. This chapter describes your data visualization options, and explains well displays on the base map available in all program editions. Press the **Map View** button on the Home ribbon tab to display visualizations. Each well you have created in your work must have defined **Latitude** and **Longitude coordinates**. When you click on **Map View**, the new document window in Figure **72 appears**. This shows a world map with a cluster of points indicating the position of your individual wells.

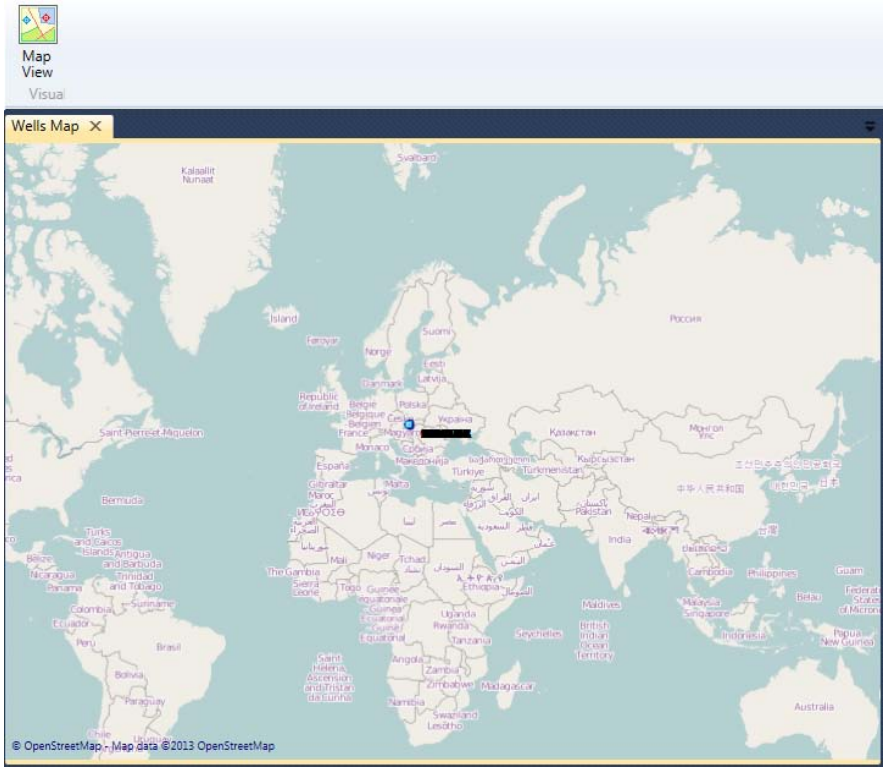


Fig. 72: *The Map View feature in the Well Plotter program.*

This map does not initially allow zooming, but if you want to work dynamically with this map, right-click on the map and select **Map Provider** from the context menu (Fig. **73**).

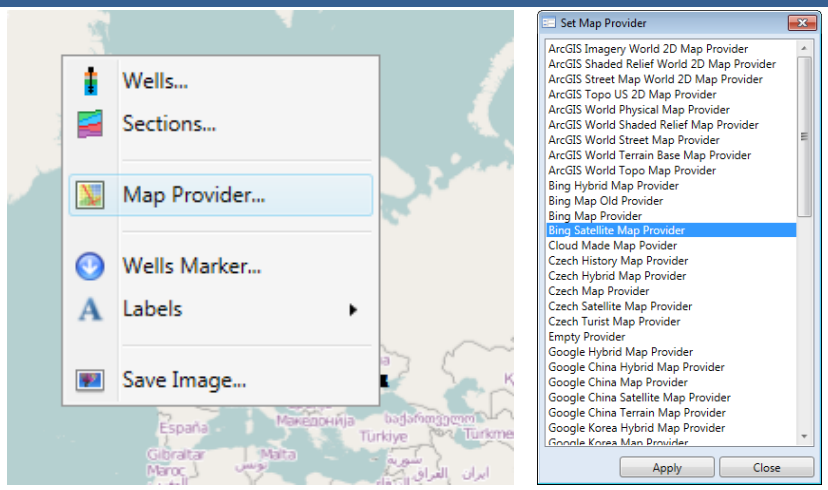


Fig. 73: ***Left*** *- Functions from the context menu for working with Map View;* ***Right*** *- Map Provider selection.*

In this window, you have a wide choice of online **Map Providers** for the underlying map. However, some providers only allow the **use of their maps under various licences** and not for commercial purposes. Therefore, before choosing your selected provider, check the actual licence terms for map usage on the internet. The best licence terms has **OpenStreetMap** provider. When you have chosen your provider, press **Apply** and you can use the map's zooming and panning features. **Map View** has a built-in function, so that when you load the map once from the internet in a selected scale, this is automatically stored on computer disk and you can always view it offline. A zoomed map example of displayed wells and geological sections is shown in Figure **74**.

Fig. 74: *Example of map view in actual practice.*

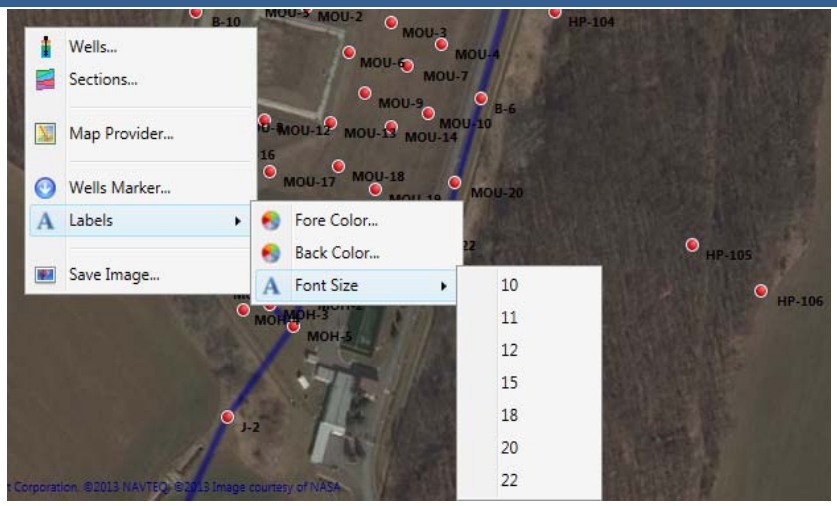


Fig. 75: *Functions for adjusting wells labels.*

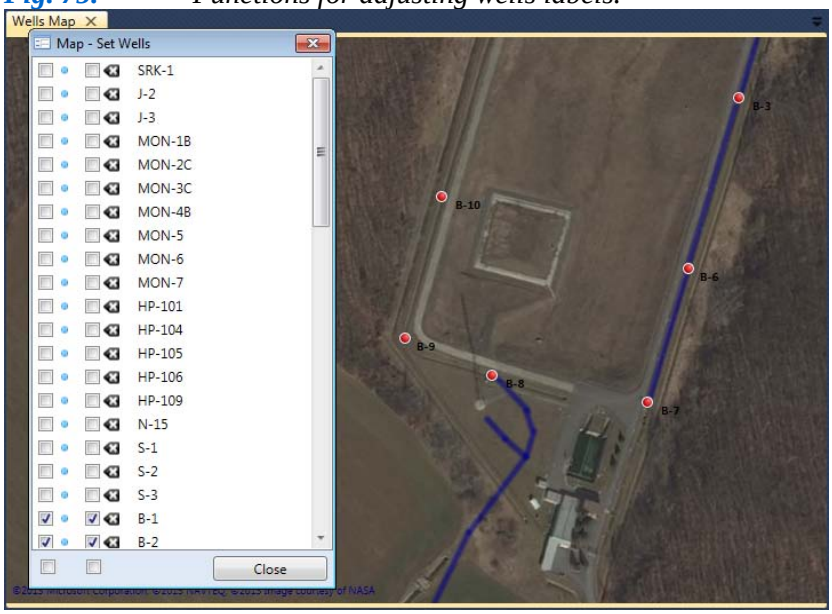


Fig. 76: *Display settings of wells.*

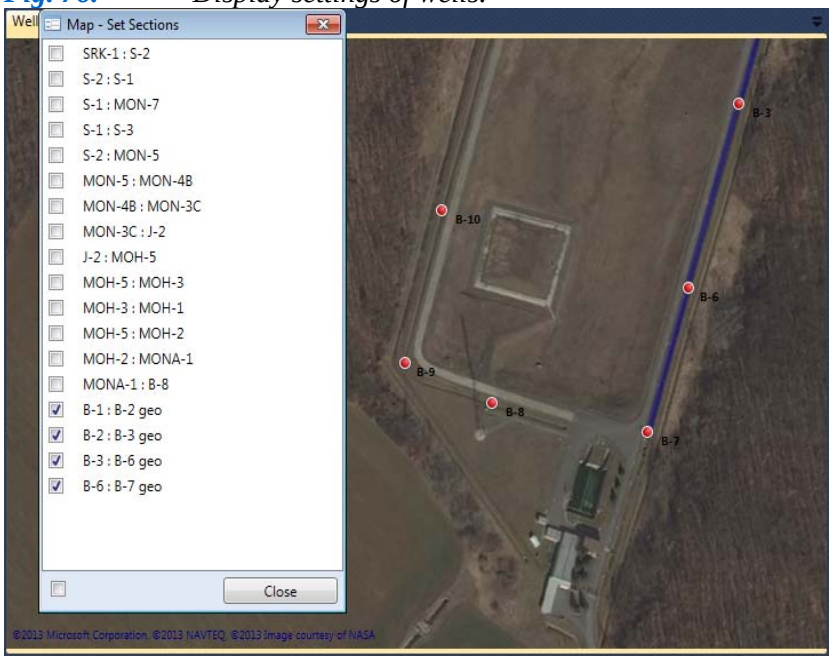


Fig. 77: *Display settings of geological sections.*

Map View can edit wells and geological sections display settings. All features are accessible from the context menu displayed when you right-click in the map (Fig. **75**). For example, you can set wells markers by clicking on **Wells Marker** and a separate window is displayed with your list of 142 icons in Figure **60 Right**. Choose one of these or use an external image from a disk as your marker. Here, you can also set your well-label visual properties, such as background colour, text colour and font size. The last command in the context menu is **Save Image**, and this exports your well map to a file on disk.

The context menu also contains **Wells** and **Sections** functions where, you can set the visibility of individual wells and geological sections (Figs. **76** and **77**). Click on **Wells**, and you have Figure **76**. In this window you can set well visibility on your map; with one line available for each well. The check boxes in the first column set whether the well is visible on the map or not and the second check box sets if you want your well-label displayed. The following two check boxes simultaneously set-up whether you want to show or hide all wells and their labels.

The **Well Plotter 3D edition** sets the display of **geological sections** in the map window in thick blue lines. Clicking on **Sections** in the context menu gives you the Figure **77** window, where you can select sections you want to see or hide. Here, you can use the check box below the list to simultaneously set the same value for all geological sections.

Here, you have all **Map View** options for well and geological section description. This is a quick and easy way to visualize wells in 2D on the map. Figure **78** shows some map providers

Fig. 78: *Examples of various map providers in use.*

5.4 1D Well Log

Previous sections have described how to add wells to your project, define their properties and assign your various data types. This chapter focuses on data visualization; describing the options and settings in **1D Well Log**. This visualization has columns parallel to each different type of data display depending on well depth. These 1D Logs can be created in both editions of the Well Plotter program. The rendered visualizations here are designed as hardware accelerated vector graphics, so you can plot large visualizations and these can be dynamically zoomed and panned. It is first necessary to create a plot paper, so click the **1D Well Log** ribbon button (Fig. **79**) to display the form in Figure **79 Right**. Here, you can set your basic visualization properties in this dialogue. These include its size, background and border colour and also header and footer visibility. You then define the maximum depth of each well's vertical profile. You can always change these settings later if you wish.

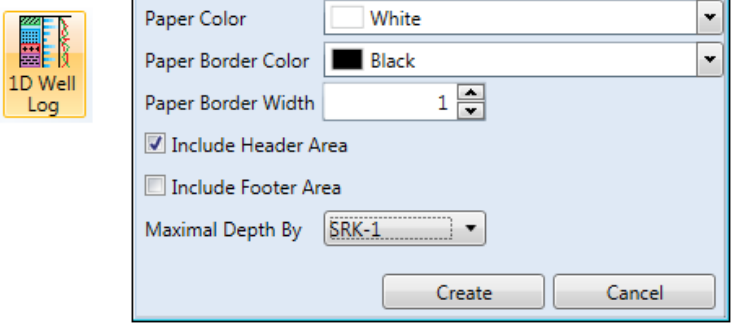


Fig. 79: *Basic settings of 1D Well Log plot.*

First, set your **paper size** by predefined traditional formats or by manual size definition in centimetres, and set the **paper**

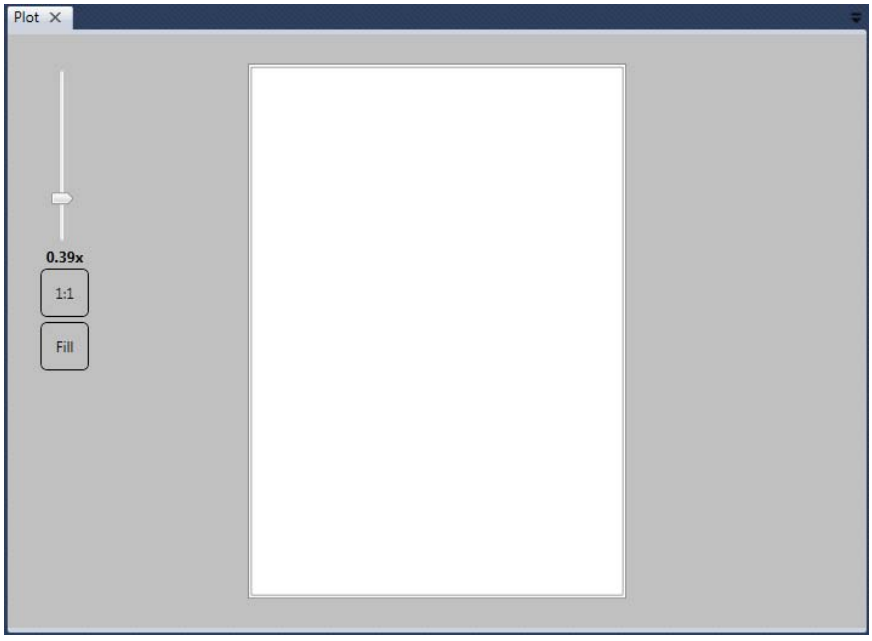


Fig. 80: *Empty plot paper prepared for 1D Well Log.*

orientation to Landscape or Portrait.

Resolution visualization is set from the combo box. You can leave the predefined value or you can change it to enlarge or reduce paper size. The actual resolution depends only on your system and monitor. You can then set the **background colour**, **border line colour** and the **thickness** and **visibility** of your **header** and **footer area**.

The **maximum depth** of your well can be changed manually from the initial vertical profile depth plotted in external documents. Set all your parameters and press **Create**. Your initial window will be closed and the new document window will display with your inserted paper-size (Fig. **80**). The Ribbon Toolbar also changes as in Figure **81**, but all functions illustrated there are only active when you view your document.

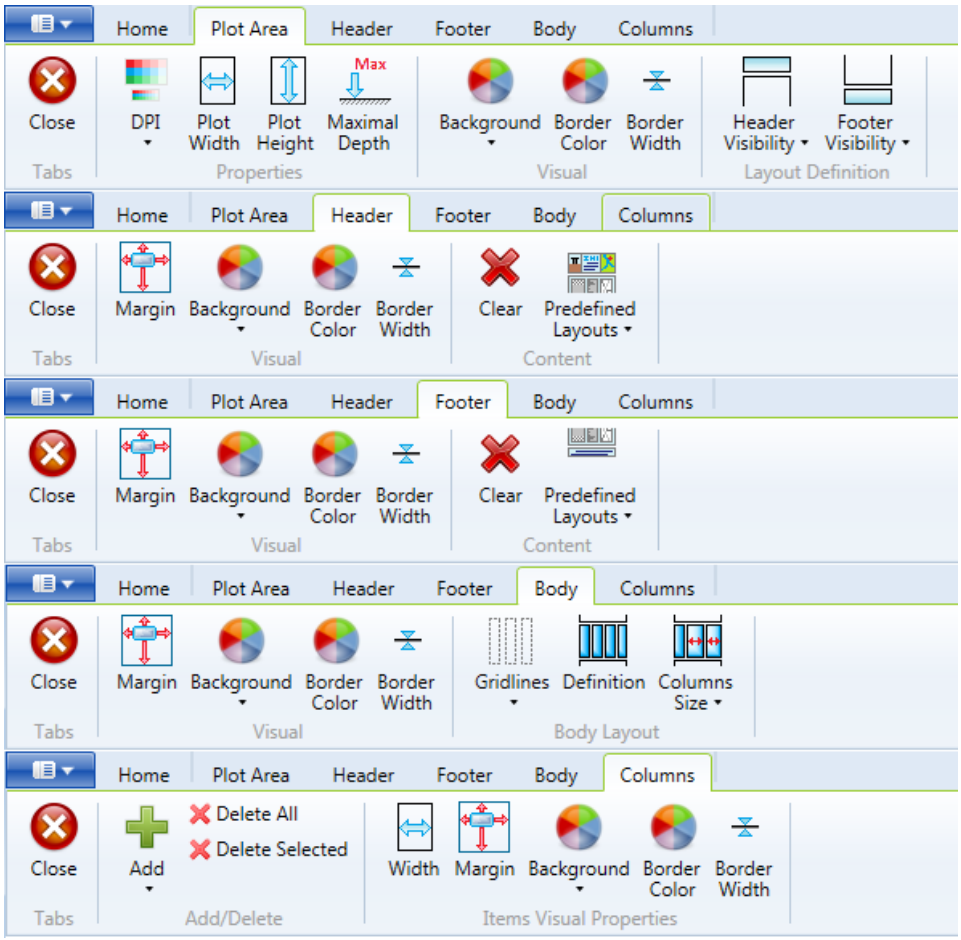


Fig. 81: *Commands in the context ribbon toolbar tabs for work with 1D Well Log.*

5.4.1 Plot Area

The Figure 82 toolbar features the **Plot Area** ribbon tab. This is used to set basic visualization properties. Each function in this tab has identical character to the properties in the previously described help window for 1D Well Log formation. The **Close** button at the beginning of each contextual ribbon tab hides the ribbon context tabs, but these automatically reappear when you view your document.

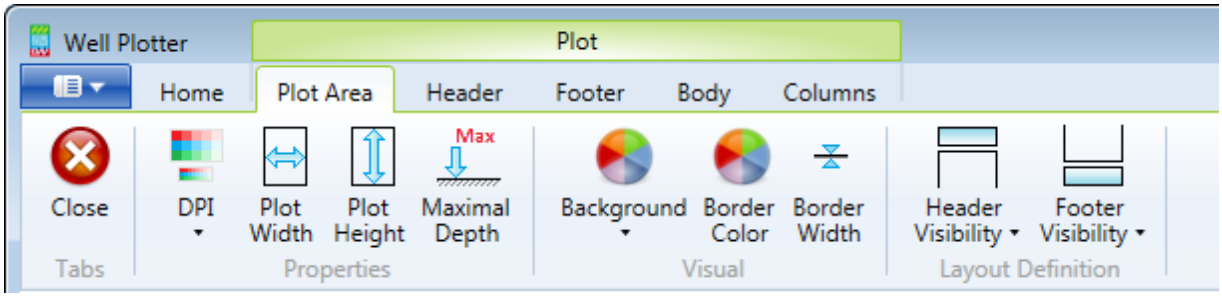


Fig. 82: *Plot Area ribbon tab with commands for basic plot-paper set-up.*

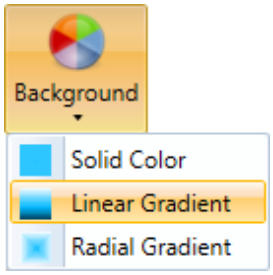


Fig. 83: *Functions for background colour display.*

Functions in (**Fig. 82**) **Properties** group are used to define visualization size and plot-diagram maximum depth. The **Visual** features allow you to set your basic plot-paper visual parameters. These define background colour and paper border colour and thickness. You can then choose your background colour from Figure **83**.

The program enables to set your background as **solid colour**, or with two-coloured **linear gradient** or **radial gradient**. When you click on **Linear Gradient**, Figure **84** window opens.

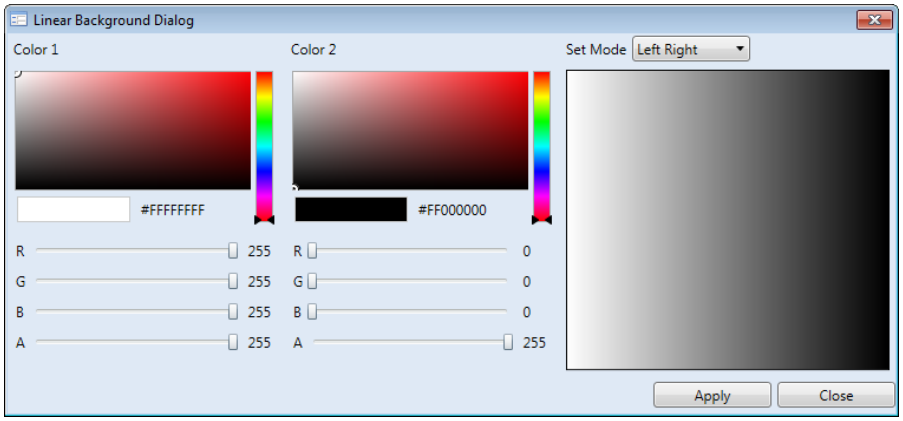


Fig. 84: *Help window for dual coloured linear gradient.*

Examples of other available background colour settings are shown in Figure **85**. Using these functions it is possible to define highly variable backgrounds.

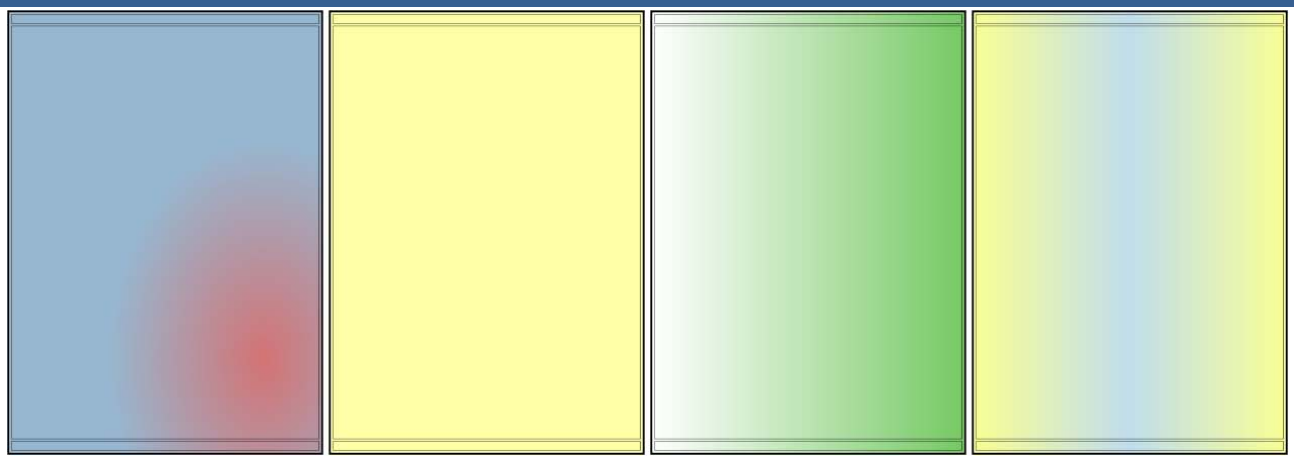


Fig. 85: *Examples of plot background colour compositions.*

The last two buttons in Figure 82 **Layout Definition** group show or hide your **Header** and **Footer Areas**; now described in Section **5.4.2**.

5.4.2 Plot Header / Footer

Creation and modification of **Header** and **Footer Areas** in the 1D Well Log is prepared for the insertion of additional information. This includes a location map of your borehole, basic drilling parameters or corporate logo. Although both header and footer areas are described, the only difference is their position in the resulting plot; with header at the top and footer at the bottom. The ribbon toolbar tabs for their modification are shown in Figure **86**.

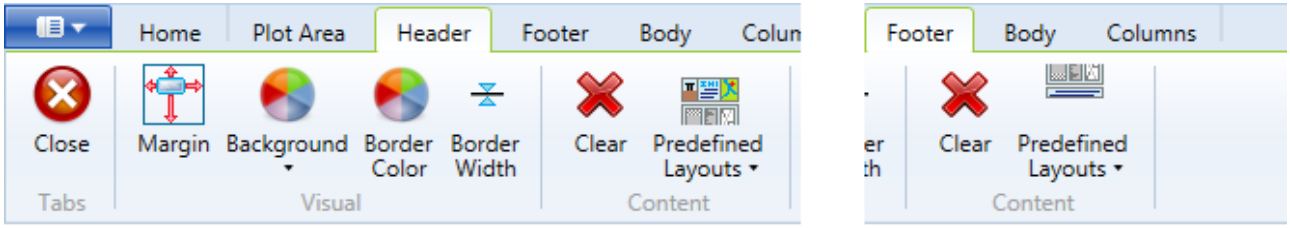


Fig. 86: *Ribbon toolbar tabs for header and footer modification.*

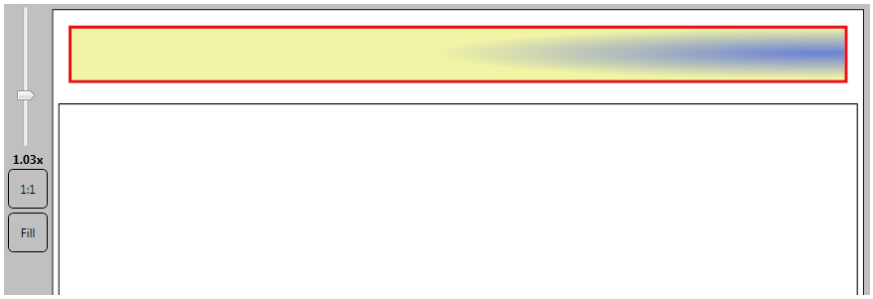


Fig. 87: *Example of header area modifications.*

The functionality of these ribbon tabs is identical. Here, you can set all the basic parameters in the previous chapter, including **offsetting** objects **from the edge** of the plot, the **background colour** and the **width** and **colour** of your **border lines**. An example is shown in Figure **87**. The **Content** group in both tabs contains two functions. Using the **Clear** button you can delete the current content of the described areas, and clicking on **Predefined Layouts** gives you a ribbon gallery with predefined headers and footers (Figs. **88** and **89**). Figure **88 Right** shows that this command only creates a basic template structure, so you then define your content manually.

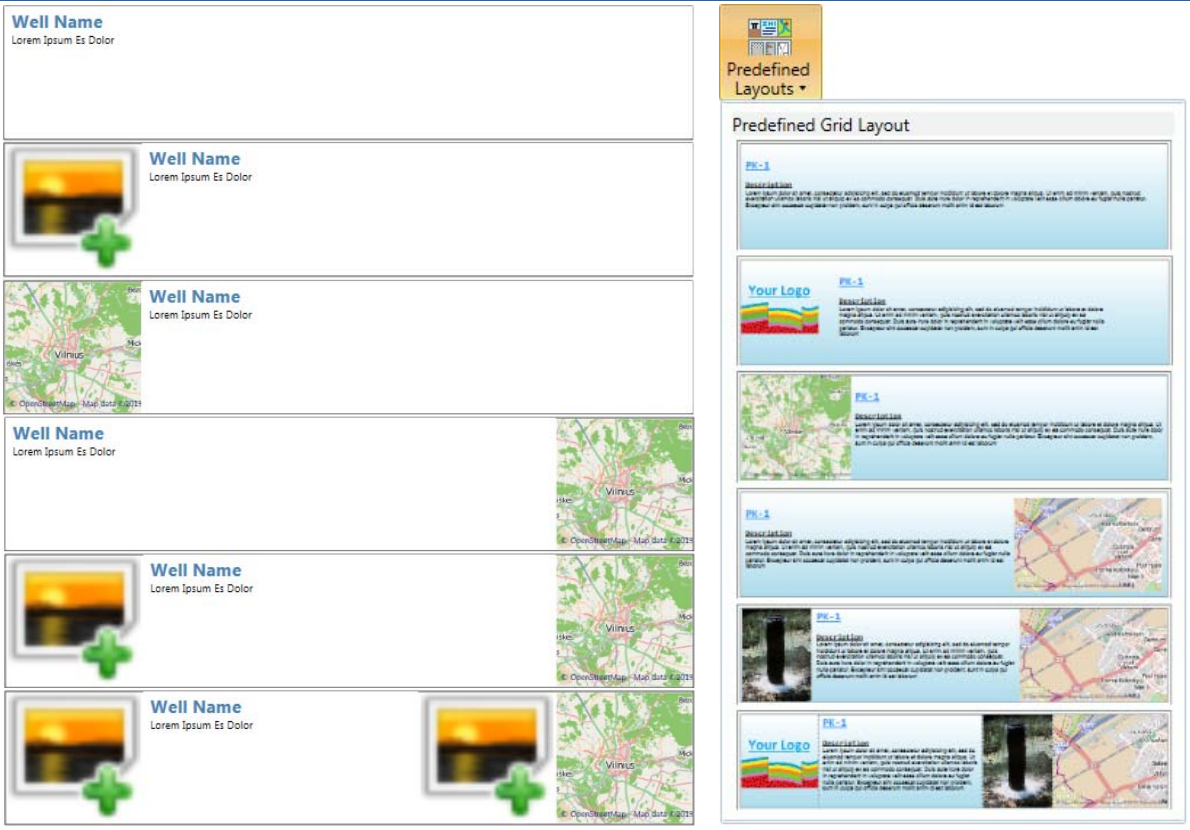


Fig. 88: ***Left*** *– selection from predefined headers;* ***Right*** *– examples of header templates created using this feature.*

Fig. 89: *Selection from predefined footer layout templates.*

A header example prepared in this way is shown in Figure **90**. You can create dynamic headers and footers. Because this ribbon toolbar has few predetermined features, here you insert your own content and edit it to suit your purposes. The following text describes options for direct work in the header area.

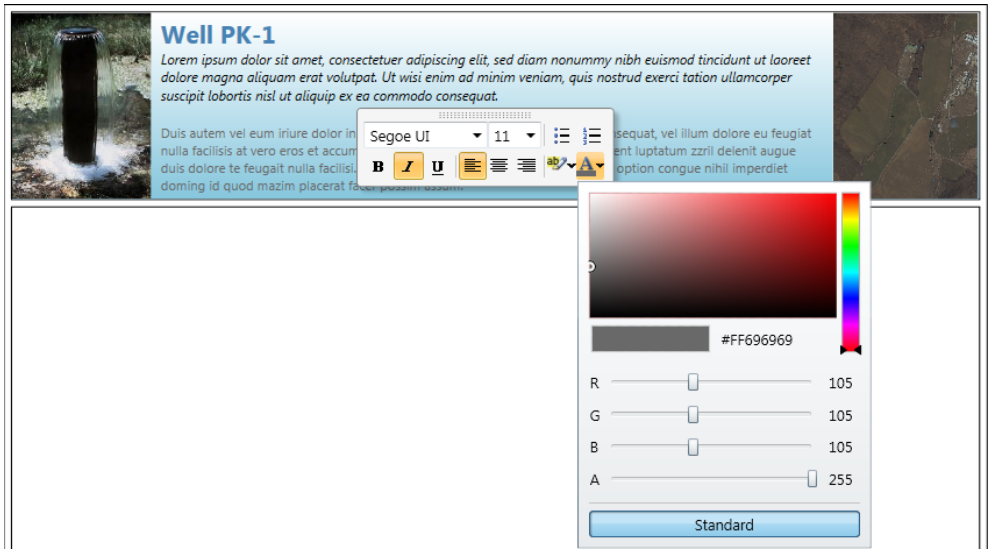


Fig. 90: *Example of edited header area.*

You have almost unlimited editing options for your headers and footers. When you want to edit your header area, right-click on it and a pop-up menu appears with the basic functions (Fig. **91**). **Height** defines the height of header and footer areas, and selection of the **Mode** sub-menu defines the essential character of these areas. Here you have a choice of **Rich Text Box** or **Grid Layout**.

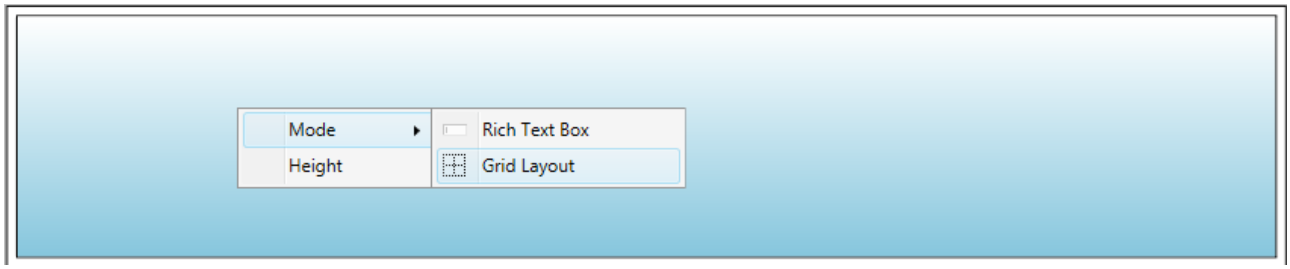
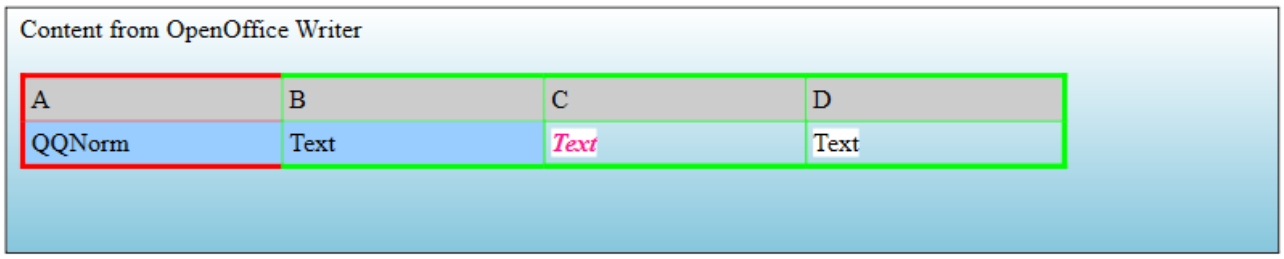


Fig. 91: *Basic properties of header and footer areas.*

When you define the header area using the **Rich Text Box**, it behaves as pure text box control (Fig. **92**). This text box is easy to understand and edit. Click on your text and the Fig. **90** pop-up toolbox offers basic editing functions; but not functions for complex structures and adjustments. These can be performed from a table created in external programs such as MS Word or OpenOffice Writer. Then, you just paste this content into your text field using **CTRL+V**. An example of this content is shown in Figure **92**, where the external table was created with different cell and text format, and the content is copied directly into the header area. Although you may occasionally experience problems with transmission of very complex text, this program has good compatibility with OpenOffice programs.


Content from OpenOffice Writer

A	B	C	D
QQNorm	Text	*Text*	Text

Fig. 92: *Header area defined as classic Rich Text Box.*

Using the **Grid Layout** for header and footer area definition offers greater scope than using the **Rich Text Box**, because the context menu includes the new functions illustrated in Fig. **93**.

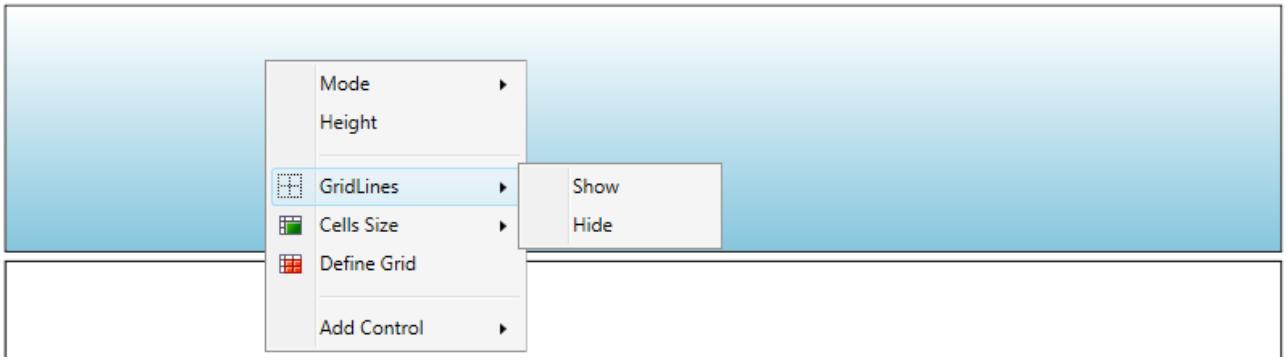


Fig. 93: *Functions in context menu for Grid Layout.*

This menu includes the possibility of **Mode** selection and setting up the area **Height**. It also contains functions for working with, and adding content, into a **grid** layout. Here, the **grid lines** give structure to your grid cells (Fig. **94**). The entire area first defines a single cell. Just click on the **Define Grid** command to display the Figure **94** form which allows you set your **number** of **columns** and **rows**. After setting these features, click **Apply**.

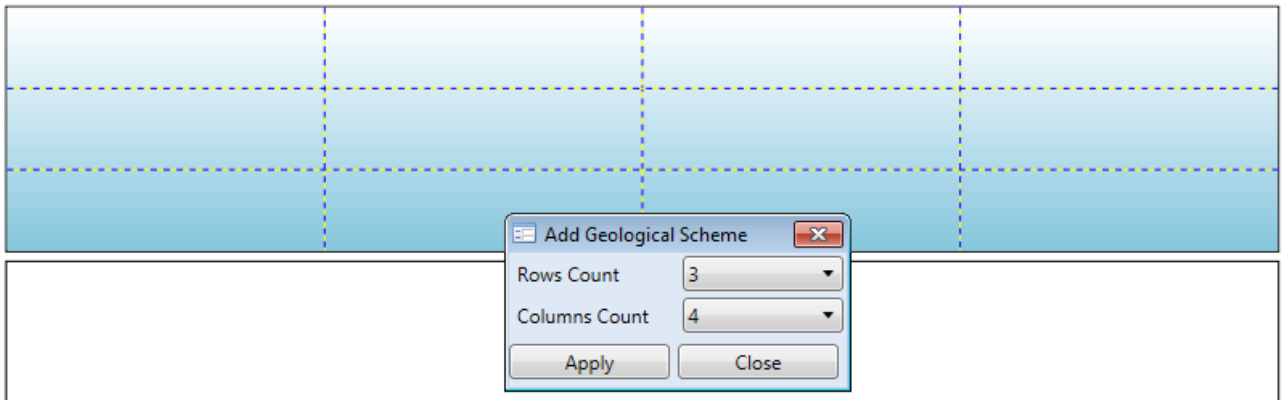


Fig. 94: *Dialog for grid cell definition.*

The **Cells Size** menu defines **uniform sized** cells or cell size **defined by the content**. It is best to start with **Uniform** size so that the customized content expands to fill the entire cell. You can then change it to your text and numerical content requirements using **defined by the content**. .

When the number of grid rows and columns are defined, you can add the content into the header. Individual objects can be added by pressing **Add Control** in the context menu (Fig. **95**).

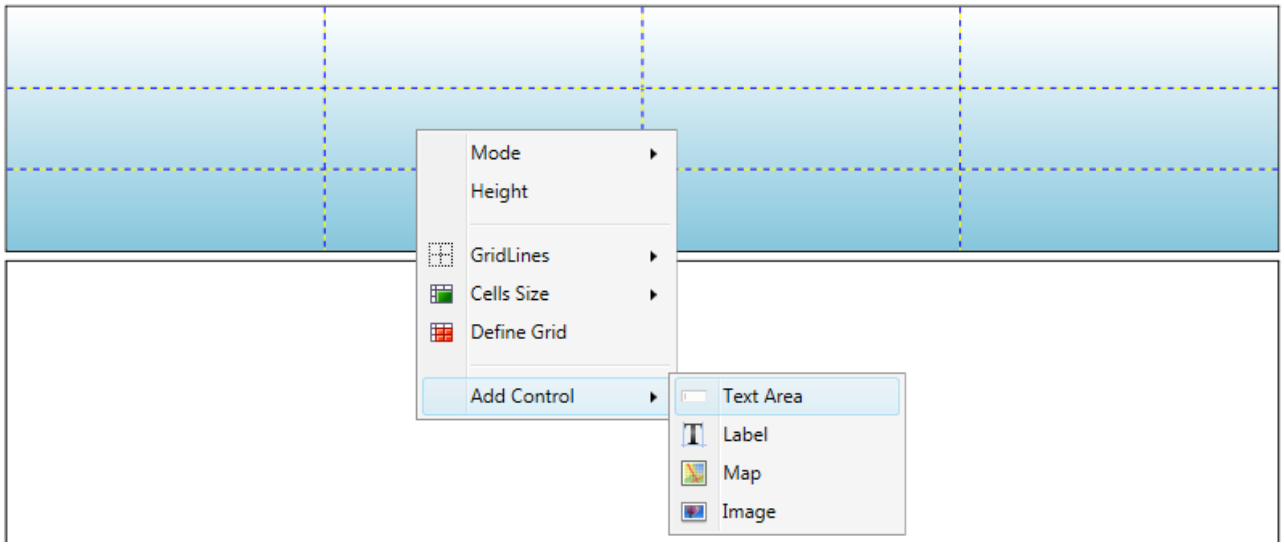


Fig. 95: *Object selection for insertion in the grid.*

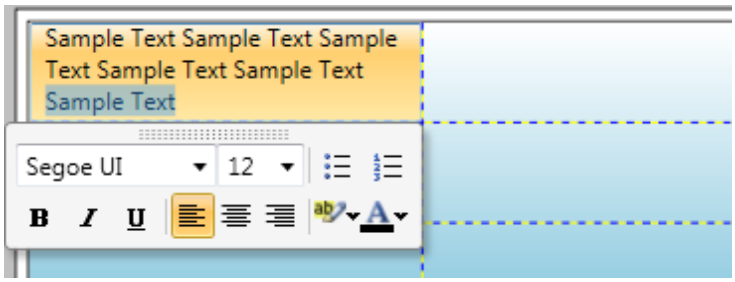


Fig. 96: *Text Area editing after insertion into the grid cell.*

All objects placed in the grid appear in the top left cell. Figure **96** example shows insertion of **Text Area**. Now, you can immediately edit its contents. Functionality is the same as in **Rich Text Box** where you can import and paste the content created in external text editors.

Figure **97** shows how the layout changes when you change the **Cells Size** parameter from **Uniform** to **By Content**. You change the cell size for your embedded objects utilizing the **Size** command. To change your grid insertion from its initial top-left cell position, click on **Row / Column** (Fig. **98**). Then use the combo box dialog to set your new grid position, and this will be automatically shown by pressing **Apply**.

If you need the object spread over several cells use the **Row / Column Span** function from the context menu, and set the span property in the rows or columns direction. Figure **100** example illustrates the span property set on three columns and two rows.

You can insert the following four types of objects in your grid; (1) **Image**, (2) a single-line

Label, (3) **Text Area** and also (4) the **Map**. Their **size** and **position** set in the header area grid is shown in Figure **101**. You can then hide the grid-lines and edit the content of individual objects. To display the grid context menu you must to click on an empty area outside the embedded objects.

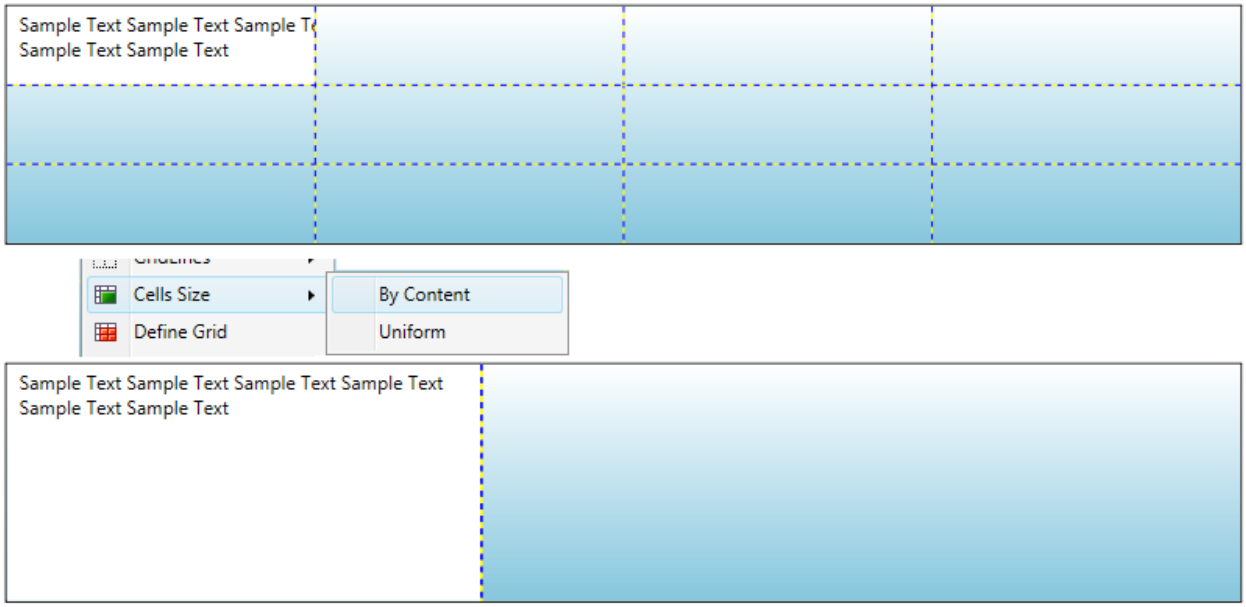


Fig. 97: *Setting the size of grid cells (**Top** – uniform size; **Bottom** – size defined by embedded objects).*

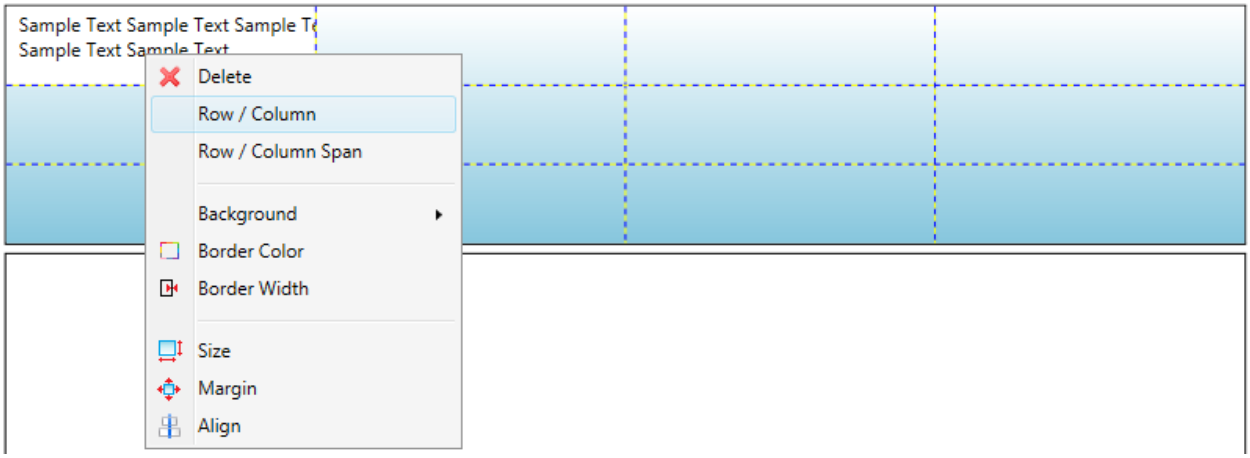


Fig. 98: *Context menu commands for Text Area object.*

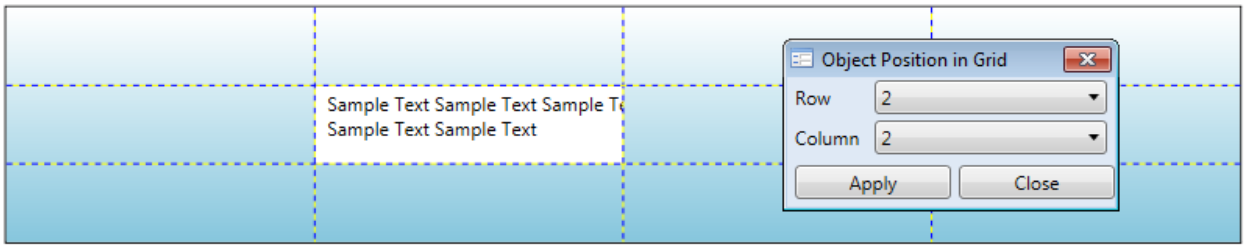


Fig. 99: *Object position within the grid using the row / column position property.*

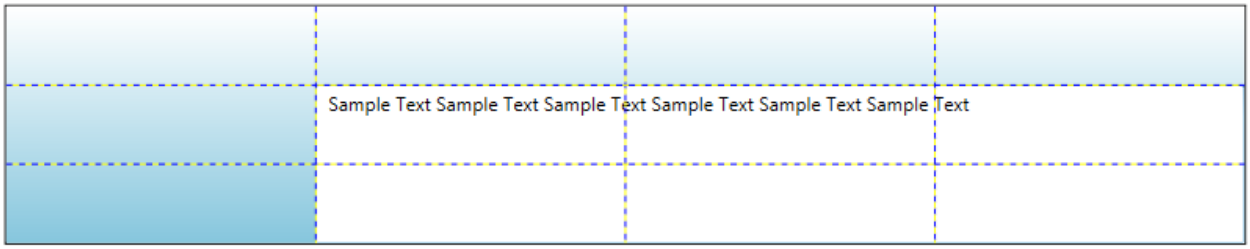


Fig. 100: *Setting the Row and Column Span properties for objects in the grid.*

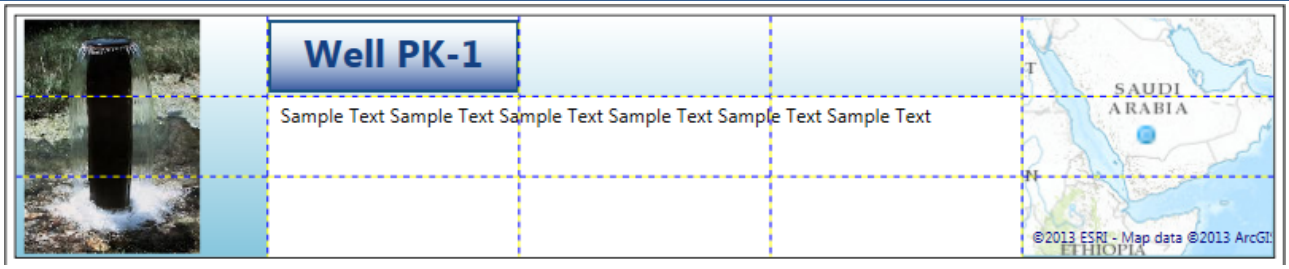


Fig. 101: *Example of size and position properties of multiple objects within the grid.*

If you have never previously worked with grid layout technology, it can initially be difficult to set your object to the desired shape and position. Practice ensures you create visually impressive header and footer areas.

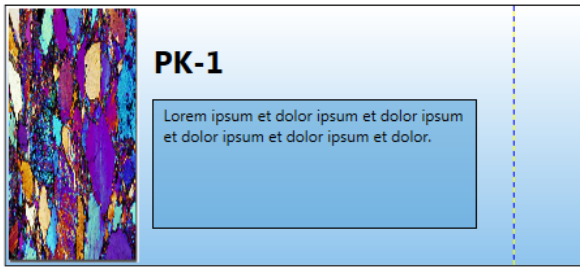


Fig. 102: *Example of object composition in a one grid cell using the Size, Margin and Alignment properties of individual objects.*

In addition to described methods, the grid can also be composed using a different method. You begin using the grid layout with **only one cell**, and gradually place all objects and their position by **Size**, **Margin** and **Alignment** combinations from the context menu. Figure **102** illustrates your result.

Even when your grid-lines are hidden, you can start editing individual objects as shown in the context menus in Fig. **103**. Most functions are identical for all objects, and these can later be deleted from your grid by clicking **Delete**. The **Position** in the grid is controlled by two additional functions. Identical functions for all objects are at the bottom of the context menu, and these set the object's **background colour**, the **colour** and **width** of the **border lines** and the object's **size**, **margin** and **alignment**. The central context menu area contains functions which differ from one type of object to another.

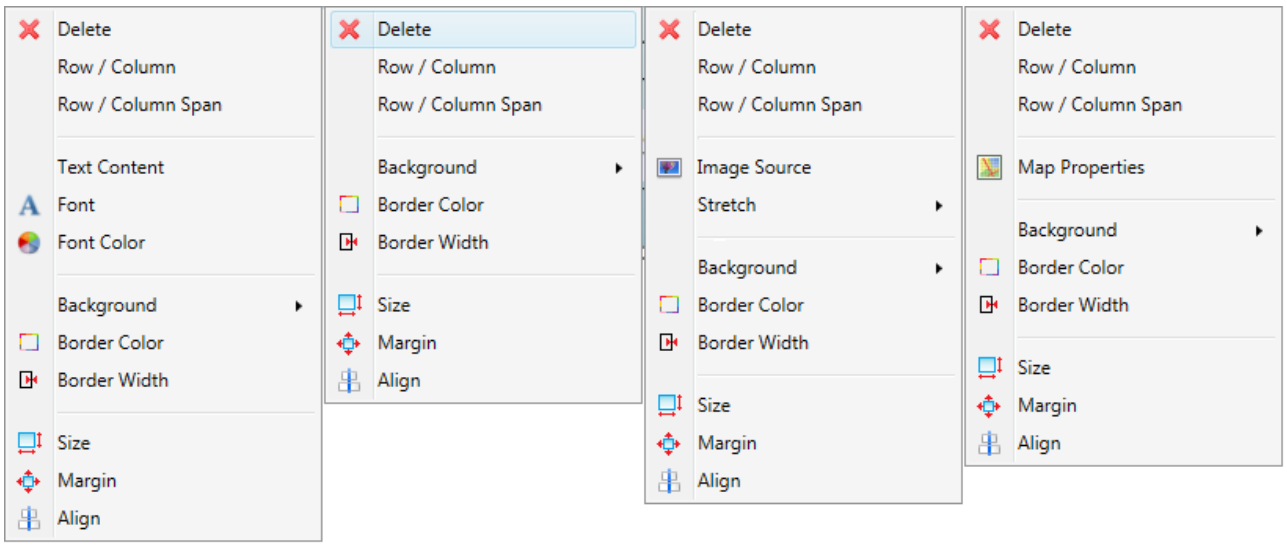


Fig. 103: *Commands from context menus for individual types of objects – Label, Text Area, Image and Map.*

The **Label** column allows you to set text content, font and colour, but no specific functions are set in the **Text Area** column. The **Image** column lets you alter the **Image Source,** and the final **Stretch** commands import the image into your plot and stretch its properties' configuration.

Finally the **Map Properties** command adjusts your map display in the form in Figure **104**. Here, you set your map provider and simple well marker displays; but this property offers less settings than the **Map View** visualization previously described. The **Main Well** and **Others Well**

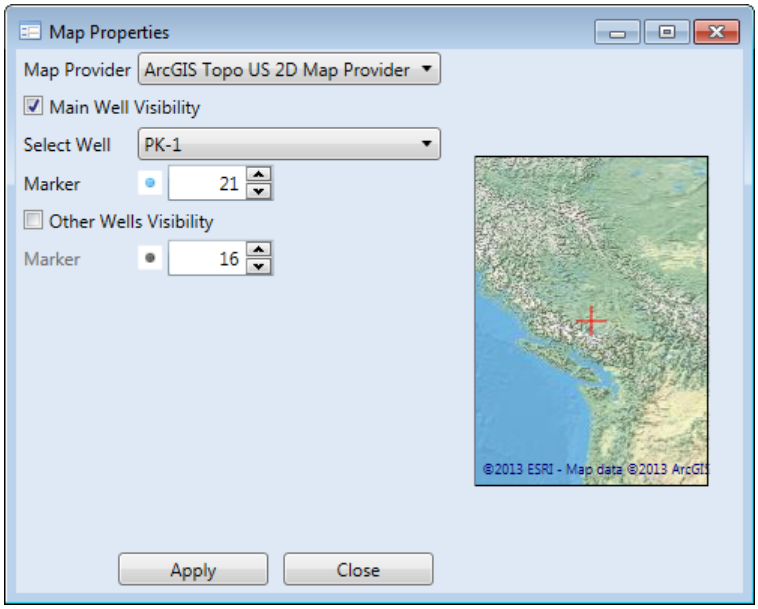


Fig. 104: *Map properties dialog.*

parameters set well displays in the map and you can visually distinguished the actual well you are working on from others in your project. Mouse scrolling and panning within the map adjusts the position and scale of your map display. When all your required settings are completed, you press **Apply** and the resultant map is in the header area. If you need a map not provided in this program, just create an image file and import it into your header area.

Figure **105** shows how the resulting header looks after editing. Here, the **Image** object shows the photo of your well, the Map display of the well position and Text Area with the created and copied table from an external text editor such as OpenOffice Writer. The footer area is defined in exactly the same way with the same features and settings. The following text lets you set-up the **Plot Body** area.

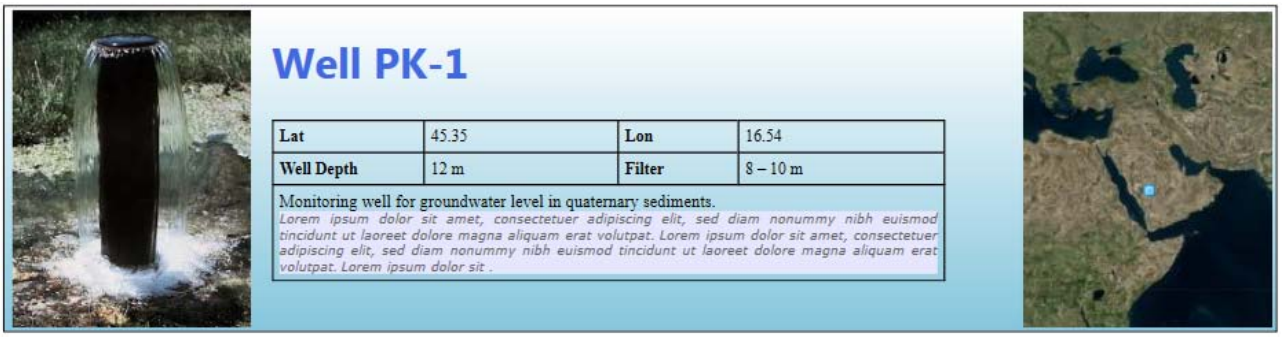


Fig. 105: *Example of resultant header area.*

5.4.3 Plot Body

The **Plot Body** fills the area between header and footer, and the **Body** functions in the ribbon toolbar tab set up your content in this area (Fig. **106**).

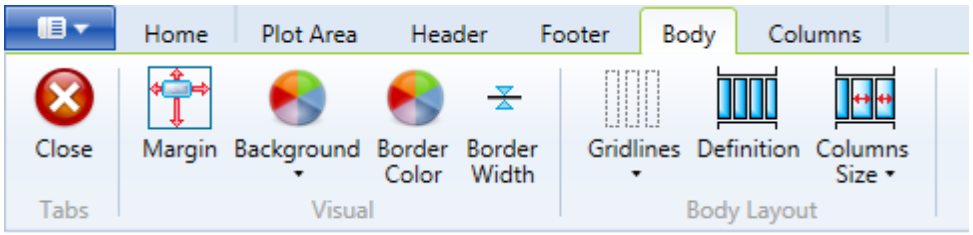


Fig. 106: *Commands in the ribbon toolbar tab for placing content in the Plot Body area.*

Functions in the **Visual** group modify your visual settings in the plot body area (Fig. **107**). The functions in this group set your background area, the **Body** area position between the plot edges and your border lines' colour and thickness. These commands function exactly as in the previous ribbon tab example.

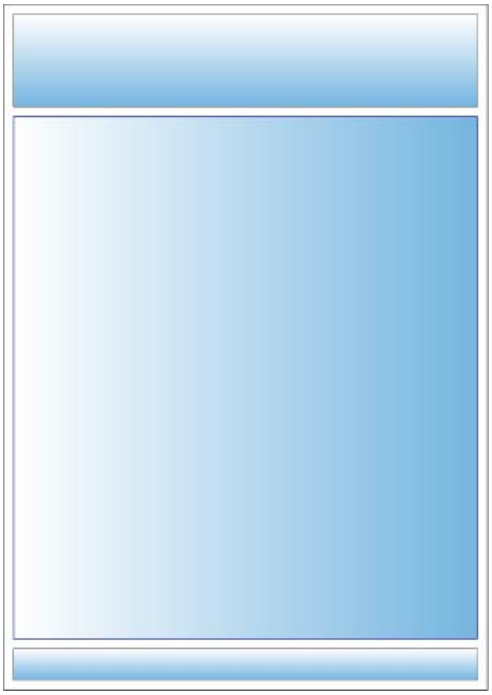


Fig. 107: Display of plot segments for header, body and footer.

The added **BodyLayout functions** in Fig. **108** set the structure of your 1D Well Log. You first define the **number of columns** you need in the body area to display your well data. Then the **Grid Lines** button displays or hides lines separating your individual columns. The **Plot Body** area contains three columns created by default. If you want to increase or decrease this number, just click on the **Definition** button.

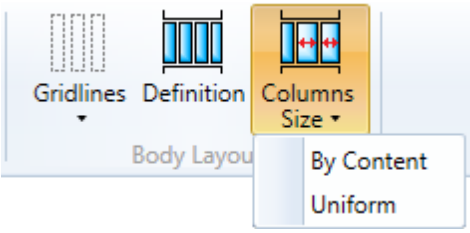


Fig. 108: Commands in the Body Layout group.

Figure **109** dialog displays your defined number of columns. The maximum number available is **20**. Click the **Apply** button, and the number of columns you have chosen is displayed. Finally, you can define the width of your columns. If you want equal width columns leave the predefined **Uniform** command. Use **By Content** when the column width is defined by the size of your embedded well data. Using the default **Uniform** command makes it easier to correctly use the other features. The following **Plot Columns** chapter explains how to insert and modify data in your plot body columns, and how to hide the help grid-lines for future visualization.

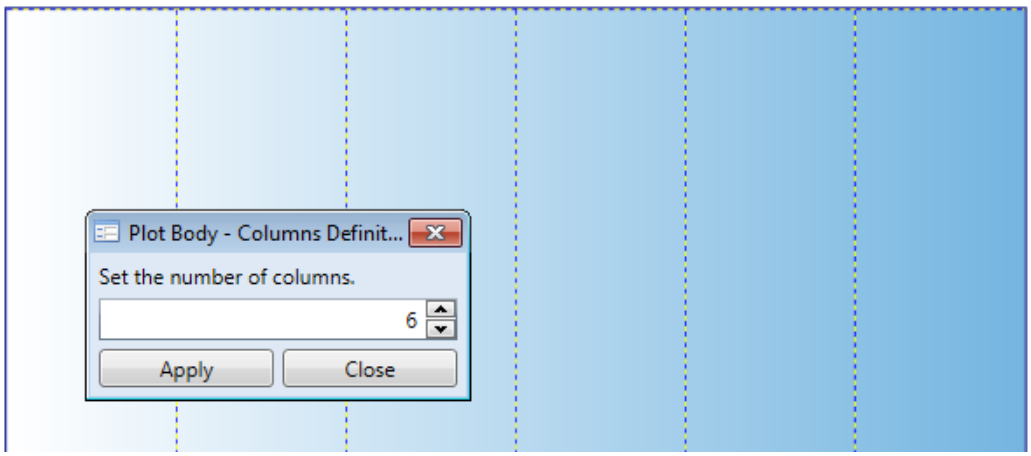


Fig. 109: Dialog for definition of column number.

5.4.4 Plot Columns

Using the **Columns** ribbon tab in Figure **110** is most important, because it enables you to add required data into the plot. This data can include geological and technical schemes or numerical data. The following text describes the step by step procedure for adding, editing and deleting all data in your prepared columns.

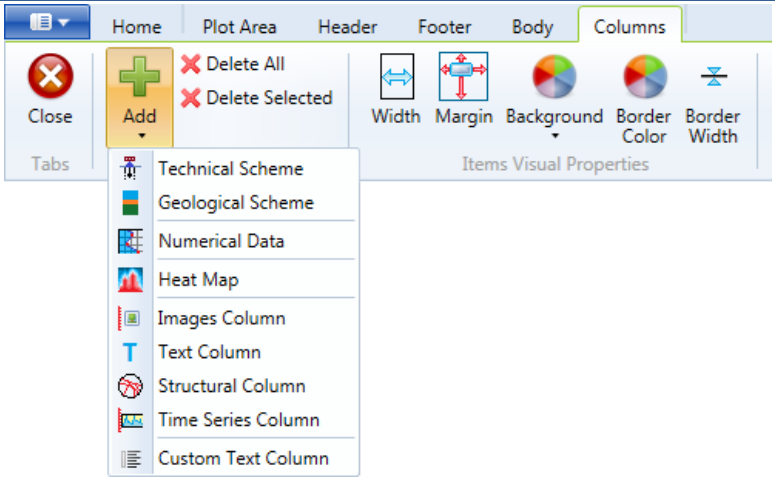


Fig. 110: *Ribbon tab Columns with functions for adding and editing displayed data in individual columns in the Plot Body area.*

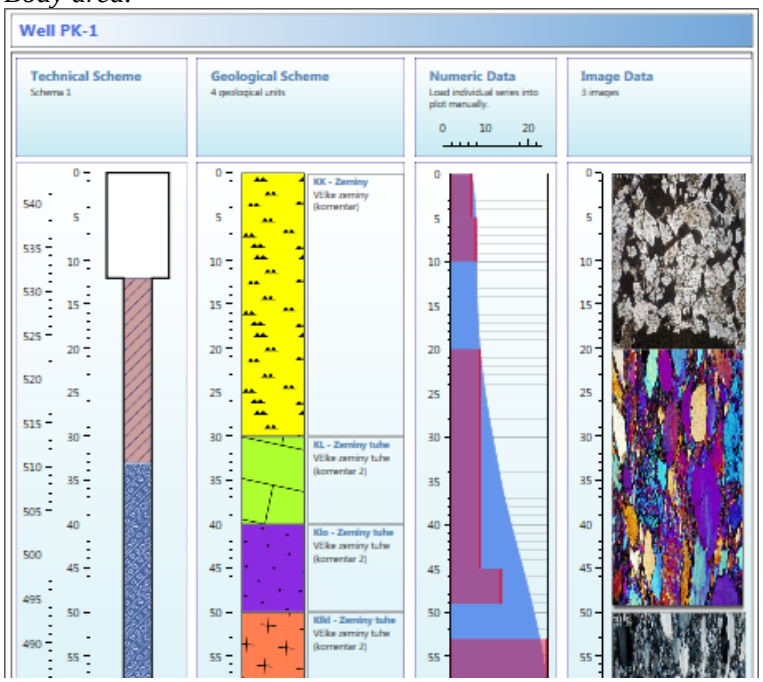


Fig. 111: *Example of plot after adding your-defined data.*

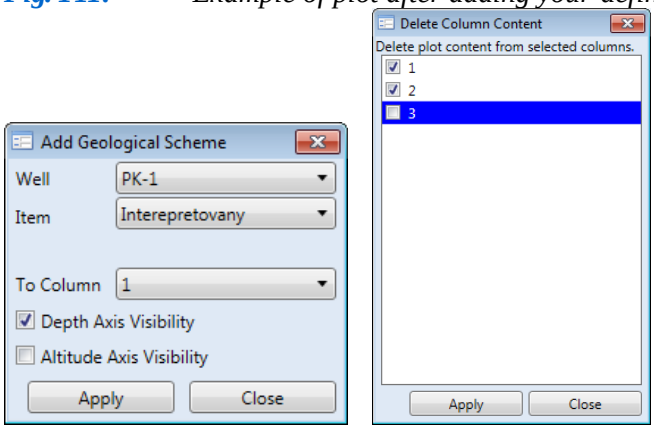


Fig. 112: ***Left*** *- Form to add selected data into the plot;* ***Right*** *- Form for deleting data from plot according to column number.*

The first button to use is **Add**. This places your chosen data in the plot. For example, you can add technical or geological schemes, numerical data, heat maps or other specific data types. This creates a plot similar to Figure **111**.

Clicking on the menu **Add** button allows you to choose the type of data you want to display. A help window appears similar to the one in Figure **112 Left**. In this example, a geological scheme was chosen. The help windows are similar for all data types and differences between them are described in the following sup-chapters. In this window you select your well and the related data you want to show. Then choose the column where you want to insert it and set the type of vertical axis you want. This axis is defined by the depth from the surface or by altitude values. Here, you have the choice to display both axes, either axis or none. Clicking **Apply** displays your selected column data. The plot first shows only the vertical axis without the data, so right-click in this area, then press **Refresh** in the context menu and your data becomes fully visible.

Two buttons in this ribbon group are used to clear data from your plot. The **Delete All** command deletes all data, and **Delete Selected** deletes only what you select for deletion. This help form is shown in Figure **112 Right**.

This help form lets you select columns for data deletion. These columns can be chosen by check-boxes and when you click **Apply**, the content in those selected columns is deleted.

Figure **113** gives an example of placing geological content into a column and clicking **Refresh** to display a geological scheme. Two items are created in the column. The first is the header which describes the data type and the second displays the actual data content in your document. These two parts are linked. If you move

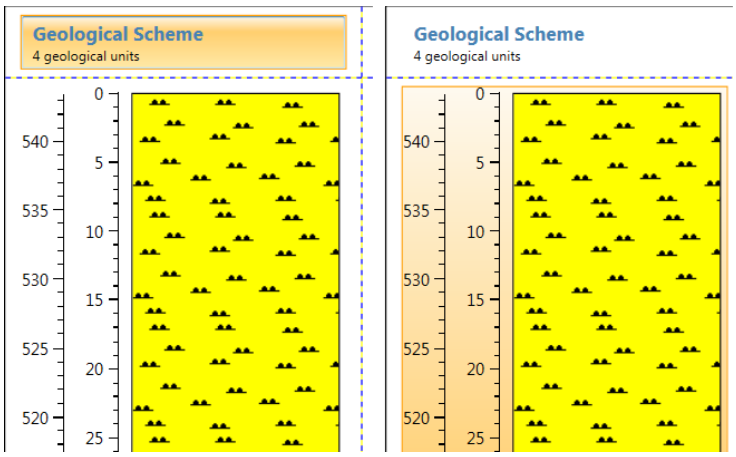


Fig. 113: Example of active areas highlighted when you move the mouse over them.

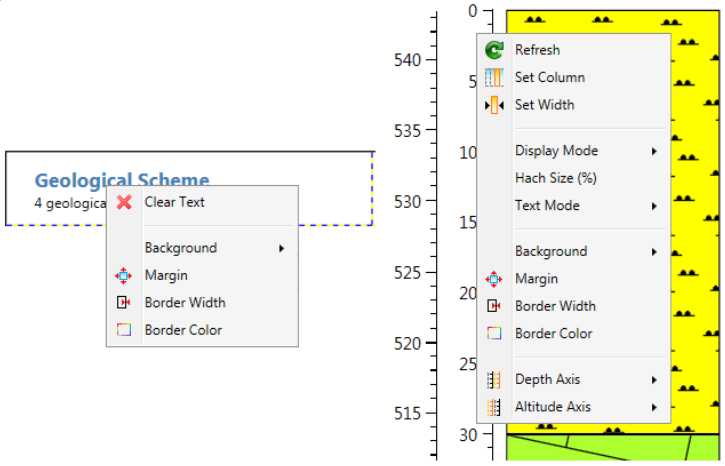


Fig. 114: Functions from context menus for object modification.

the mouse over them, they are highlighted by changing the background colour. The ribbon tool bar contains few features, but many others are hidden in the **context menu** in Figure **114** described next.

Figure **114** highlights modification options for both header and column content using the **context menu**. Here, you can **individually modify header** and your displayed **data content**. When you click on any object, Figure **114** context menu is displayed. The header has only minor editing options because it already automatically displays data type and notes in relation to this data type. This is editable, and you can also change the background colour, the margin properties and border line colour and thickness. The most important part of the header is the text area where you can type custom content.

Work in this text area is exactly the same as always, where you can directly edit content in the plot or you can paste content from external text editors. Alternatively, click on any text item and a pop-up panel appears with functions for text formatting.

The modification options in ***Fig. 114*** should suffice for your most complex work. These functions are accessed by right-clicking in the desired area, and they are identical for all types of displayed data. Additional specific options are described in the following subsections.

The first three functions exemplify their use for all data types (Fig. **115 Left**).

(1) The **Refresh** function is used to render the visual content. If you change the plot height, the data that are already displayed is not automatically redrawn; only the vertical axis is redrawn. This setting was chosen for economy of computational performance. For example, if you plotted a geological scheme and you subsequently want to increase the plot size, you must redraw the object by clicking on the **Refresh** command.

(2) The **Set Column** function moves data from one column to another. When you click on it, the Figure **115 Right** help form defines the new column you want your data moved to. The program does not automatically check whether data already exists in the column you want your selected data moved to, so you must know in advance if your new intended column is already empty.

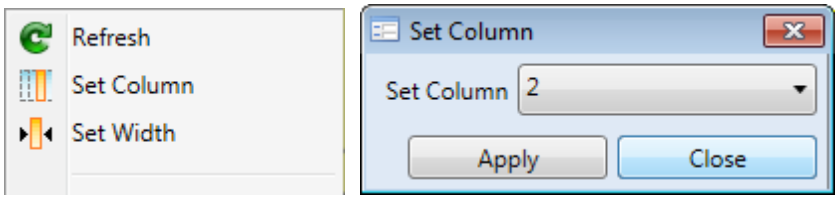


*Fig. 115: **Left** – selection from basic functions in the context menu; **Right** – form for column position set-up.*

(3) The **Set Width** function defines the width of the object in your column. If you **type a negative value** in the input box, the object will be automatically expanded to fill the available free space.

Specific functions for each displayed data type are always placed in the middle of the context menus, and similar functions are located at the bottom (Fig. **116** and **117**). Features shown in Figure **116** are used to adjust visual characteristics, but these same features are also contained in the ribbon tab (Fig. **116 Right**). The only difference between them is when you use the **context menu** functions these are applied **only to the selected object** and when you use the **ribbon tab**, they are simultaneously **applied to all objects** in the plot body area. Using these functions, you can change the background, the margin properties and the colours and thickness of your border-lines.

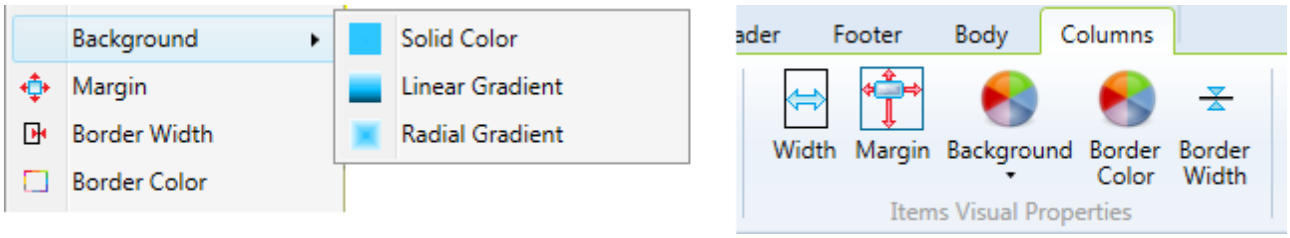


Fig. 116: *Features for adjustment of visual properties of objects in columns (**Left** – functions from the context menu for individual objects; **Right** – functions for simultaneous adjustments of all objects in the plot body area).*

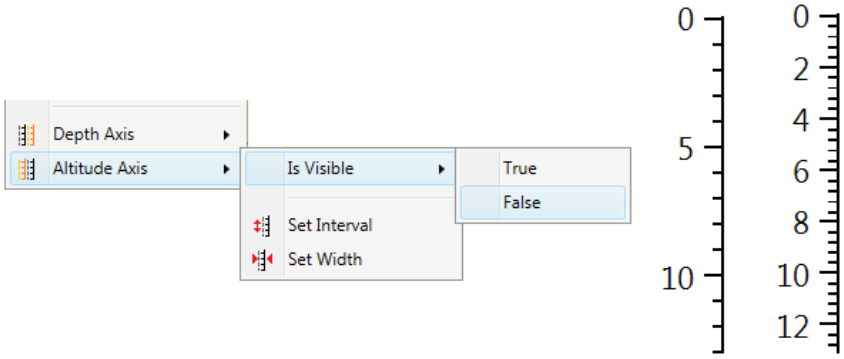


Fig. 117: ***Left** – Commands in the context menu for definition and adjustment of vertical axes; **Right** – example of Axis Interval change.*

The two remaining **Depth Axis** and **Altitude Axis** items in the context menu change your vertical axes properties. These include their visibility, width and the intervals at which the labels are displayed on the axes. (Fig. **117**)

You are now able to display data in your plot body columns, to move them within columns and to change basic parameters such as background colour and vertical axes. You can also delete unnecessary content. The following sub-sections modify the display of individual data types and explain the function of specific plot objects.

5.4.4.1 Technical Scheme

Your options for displaying technical schemes are explained first. You can view your created technical scheme in a data document by clicking on **Add – Technical Scheme** in the ribbon tab. This displays your selected document in a plot body-area column, and clicking **Refresh** in the context menu shows your selected technical scheme (Fig. **118 Left**). Your scheme also contains a header which can be adjusted to suit your requirements. Since this technical scheme has only a few editing options, you can right-click in the display area to obtain a context menu for increased editing.

Most editing features have already been described in the previous chapter; so this sub-section concentrates on additional features. One new feature is **Well Margin** (Fig. **118 Middle**). This sets the horizontal offset of the well from both sides. It does not change the size of the displayed object, but resizes the offset of the well from the vertical axis and from the right side of your object. Figure **188** provides an example of this offset reduction.

The remaining commands in the context menu are identical to those described in the previous chapter. Examples include adjusting background colour, setting vertical axis visibility and changing columns and content in the plot body-area.

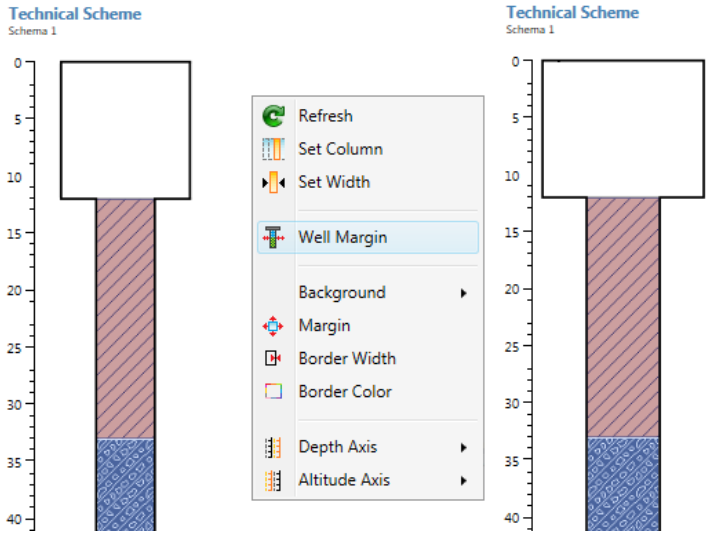


Fig. 118: ***Left*** *– technical scheme in plot;* ***Middle*** *– context menu with commands for scheme adjustment;* ***Right*** *– example of Well Margin parameter modification.*

5.4.4.2 Geological Scheme

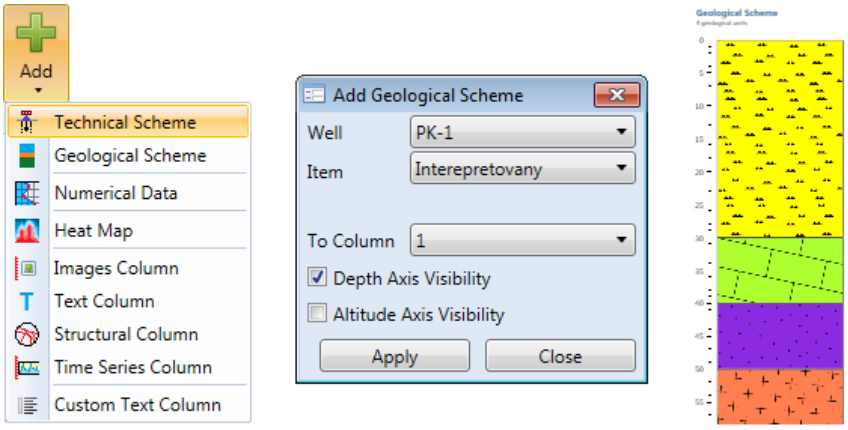


Fig. 119: ***Left*** *- adding a geological scheme to the plot,* ***Middle*** *- form for selection of the geological scheme document,* ***Right*** *- basic view of geological scheme after adding it and clicking*

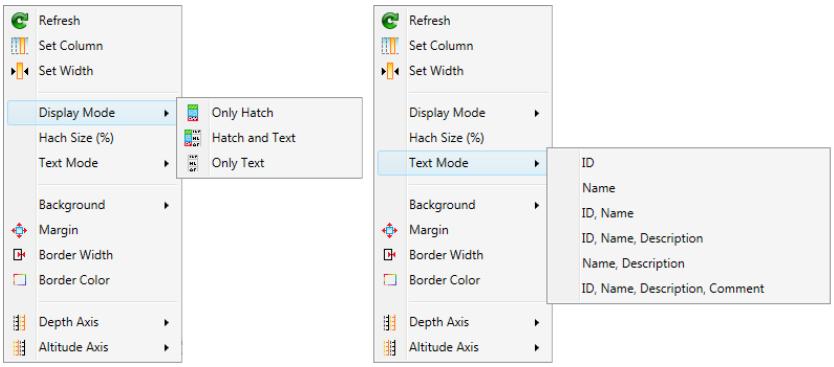


Fig. 120: *Features from the context menu for geological scheme content.*

Multiple geological schemes can be simultaneously added to your plot using **Add – Geological Scheme** in the ribbon toolbar (Fig. **119 Left**). Clicking on this brings down the help form in the middle of Figure **119**.

You use the two combo boxes in this form to select your well and its related geological scheme. Then, set the column you want to show it in and choose your vertical axis. When you click **Apply**, your selected geological scheme is in the plot, but not visible. To visualize it, click **Refresh** and your scheme comes up as in figure **119 Right**. Geological hatch patterns occupy the entire content space and information about the number of your displayed layers is in the header column. The context menu for your scheme has the three extra adjustable features of **Display Mode**, **Hatch Size %** and **Text Mode** (Fig. **120**).

These three functions significantly modify the appearance of your geological scheme. Figure **121** gives an example of the **Display Mode** parameter. This modifies the way data is

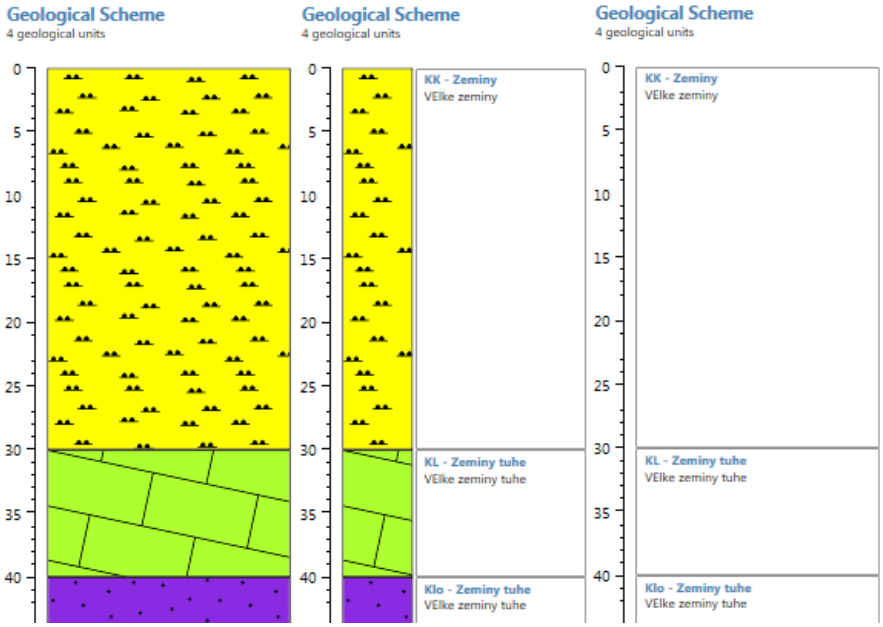


Fig. 121: Example of various states using Display Mode.

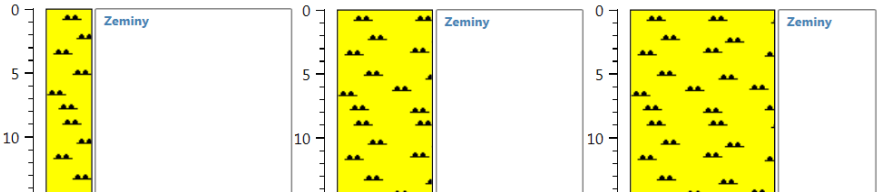


Fig. 122: Example of Hatch Size (%) parameter changing.

displayed in your geological section. This can be viewed only in visual hatch pattern, by a combination of hatch patterns and text content or else by referring to the explanatory text description.

By setting the **Display Mode** parameter to **Hatch and Text** in Figure **121 Middle**, you can change the width of the hatch pattern according to your needs. This adjustment is finalised by clicking on **Hatch Size (%)**, which defines the hatch pattern width in percentage values. Figure **122** gives the example of 20, 40 and 60 % widths.

The **Text Mode** function adjusts your displayed text. This function changes the geological index and the name and description of the geological layer imported from your source data file, as described in Chapter **5.2.2**. You add your comments or a combination of any prepared data in the text area, and all this new information is displayed in your geological scheme document. Examples of these **Text Mode** property changes are given in Figure **123**.

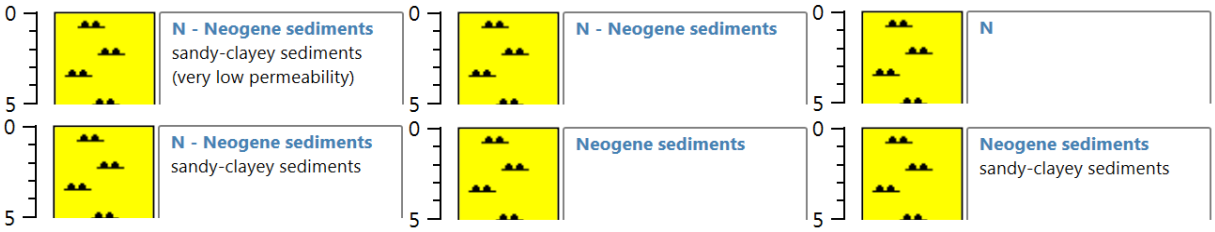


Fig. 123: Examples of Text Mode changes.

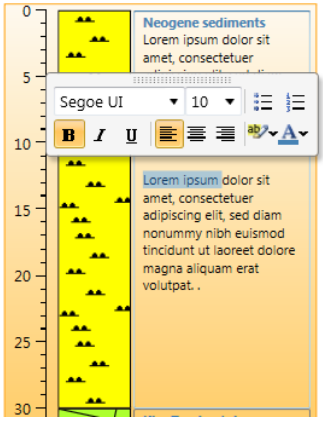


Fig. 124: Direct editing of text inside the geological scheme.

In addition to these changes using functions from the context menu, you also have the opportunity to edit your geological scheme directly in the plot. Typographical error correction and information addition can be edited before visualization export. Similarly, if you want to change the textual format, just select the part you want changed and the context panel displays functions for font, size and colour editing (Fig. **124**). However, here you must remember that if your changes alter the size of the entire plot, it will be necessary to redraw your geological scheme by clicking **Refresh**. This function reloads the data from the underlying data document. Customised data is not stored in the background data document, so lost material here must be replaced. Therefore, if you want to make any interventions directly in the plot, make these modifications at the end, before exporting the plot from the

program. In some cases it may happen that a textual area for your geological scheme is not large enough or your text caption is not fully visible, **Annex 3** explains how to overcome these problems.

5.4.4.3 Numerical Data

This chapter describes your options for simultaneously displaying all numeric data types in your plot. These all use the same rendering method and can be combined in one column.

First, click on **Add – Numerical Data** in the ribbon toolbar, and help form Figure **125** comes up. This form is slightly different from previous ones. Here you do not choose data you want rendered, instead you select only the column where you want your object inserted and select whether your horizontal axis should be linear or logarithmic. These are illustrated in figure **126**.

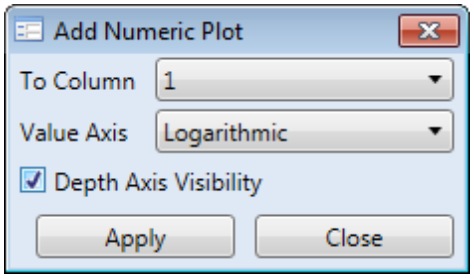


Fig. 125: *Form for adding numerical data to your plot.*

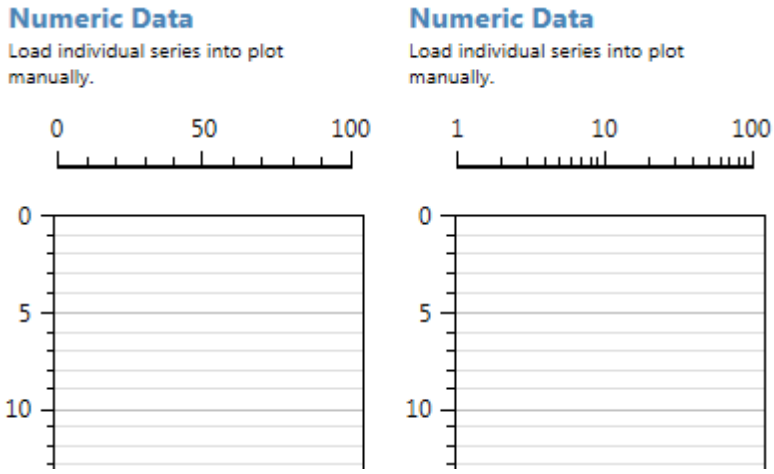


Fig. 126: *Display examples of horizontal axis (**Left** – linear type; **Right** – logarithmic type).*

The logarithmic scale can be used only if the data does not include a zero or negative value. Click **Apply** on the blank graph display and add your data by right-clicking on the displayed object. Using the **Add** item, select the type of data you want to see. These types have the same division as in the **Data Sources** panel previously described. According to their type, you can choose the type of series that you want to use. For point data, for example, you can choose **Line/Point Series** or **Area Series** in ***Figure 127***

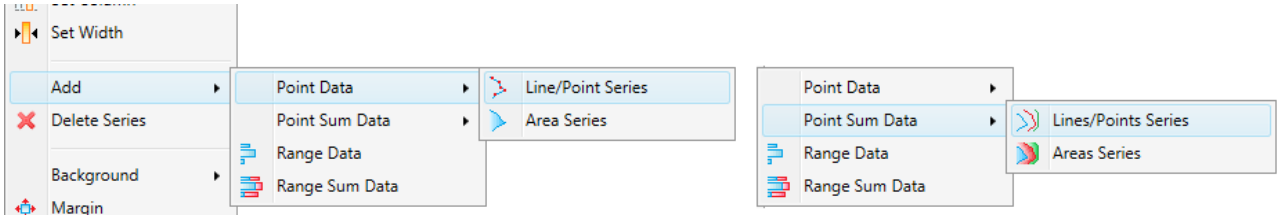


Fig. 127: *Context menu functions for adding data to a graph.*

Clicking on the selected item displays Figure **128** help form. The dialogue corresponding to your chosen series type is now displayed. Select the numerical data you want to show from the first two combo boxes and use the following settings to define your series display. Here you can define the background colour, your border lines' type and thickness, and smoothing of the lines connecting your points.

Press **Apply** and a new data series for your settings is added to the graph. Various types of numerical data from several wells can be displayed in one object. Examples of the different series types that can be displayed in your graph are shown in Figure **129**.

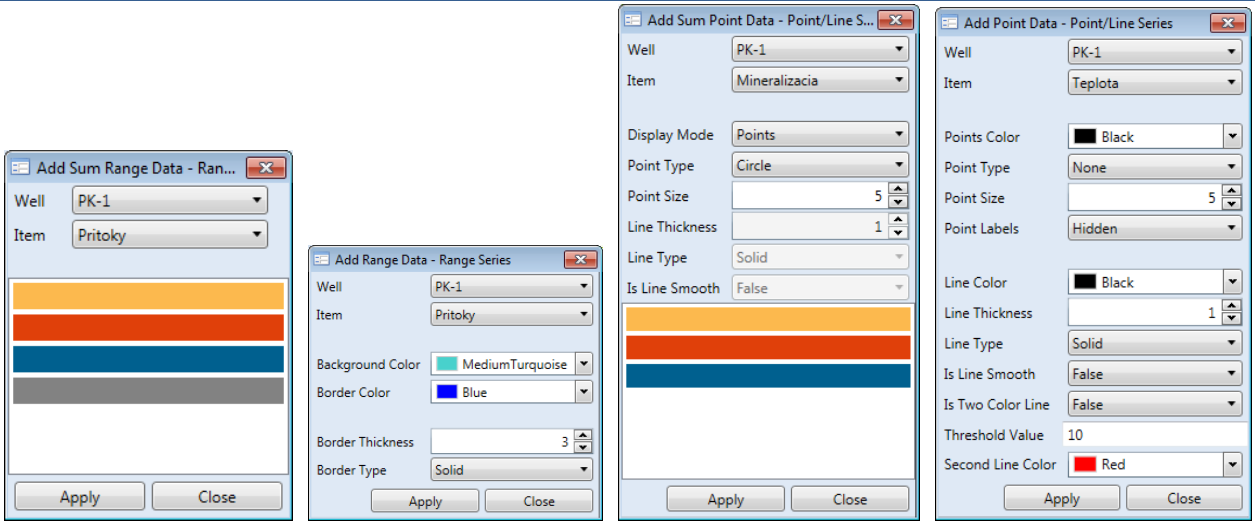


Fig. 128: *Help forms for data series set-up in your graph.*

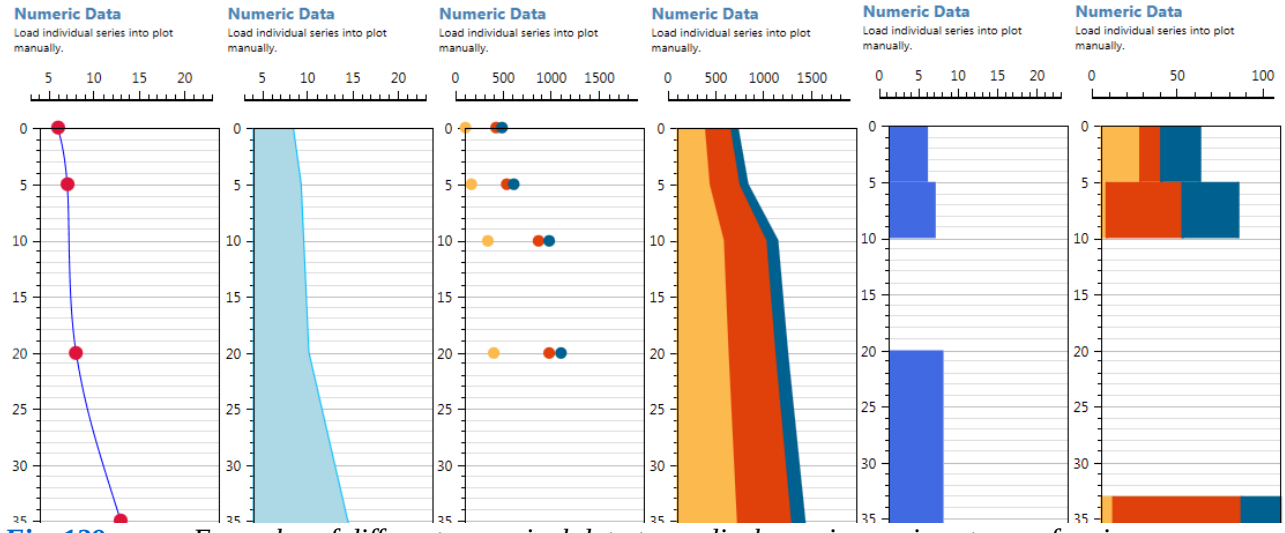


Fig. 129: *Examples of different numerical data types display, using various types of series.*

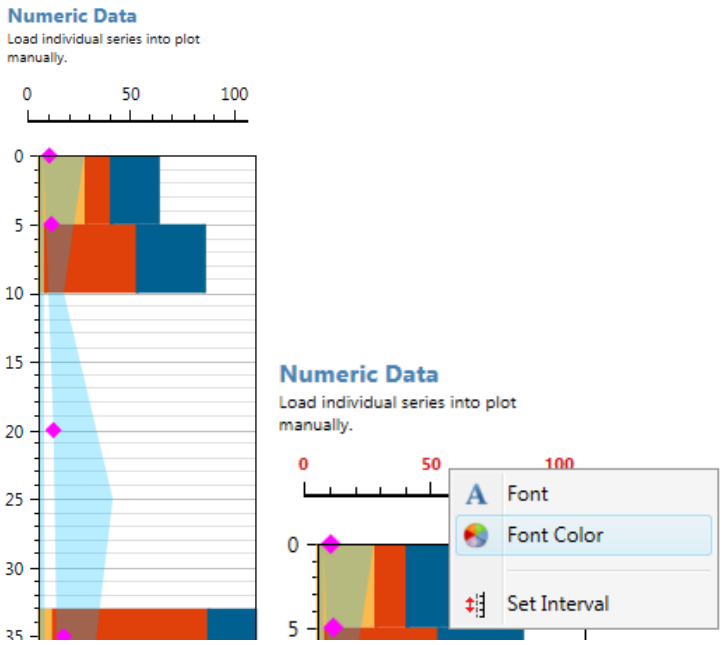


Fig. 130: ***Left*** *– example of numerical data display in a graph using a combination of several series types;* ***Right*** *– contextual menu with functions for the horizontal axis in the column header area.*

Figure **129** show that you can display data in your graph in variable forms and with a variety of visual settings. Your variable series **can be combined** to create any chart you want. The example in Figure **130** provides a graph with three series types; (1) stacked columns of variable height, (2) a partly transparent area series and (3) a point series.

If you want to delete a displayed series in your graph, just click **Delete Series** in the context menu. In addition to the context menu for the graph object, you can also use the **pop-up menu** associated with the **horizontal axis** in the column header. With this menu, you can set the label intervals on your axis and also their

font and colour (Fig. **130 Right**).

5.4.4.4 Heat Maps

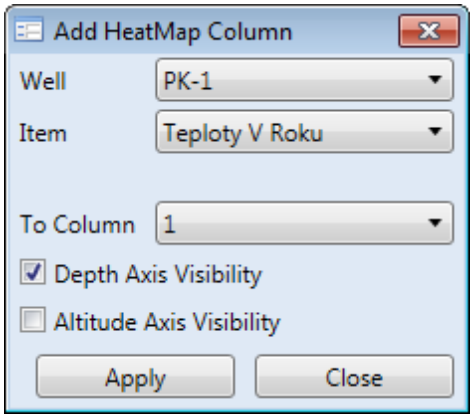


Fig. 131: *Dialogue for heat map addition.*

Heat Maps provide your most impressive visualizations. These display numerical data, related to dimensions such as time intervals or distances from the well. **Heat Map** display in a plot is easier than its preparation. Clicking on the **Add – Heat Map** ribbon menu button gives Figure **131** help form. Select the document with your prepared heat map and set the column where you want it displayed. Finally, you set your vertical axis type.

Now click **Apply,** and your heat map is added to your selected plot column. You can then click **Refresh** for your heat map display, as in Figure **132**. Here, there are two types of displayed heat maps. Figure **132 Left** shows a heat map with value changes in your well related to another numerical value and Figure **132 Right** gives value changes in your well over time.

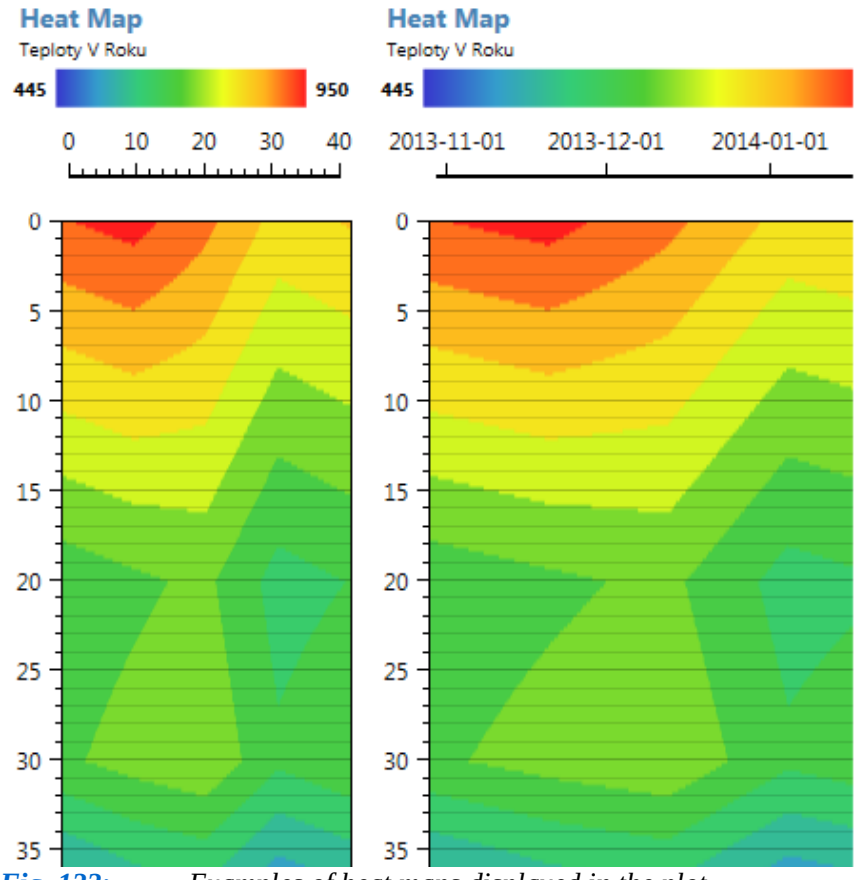


Fig. 132: *Examples of heat maps displayed in the plot.*

There are no specific functions in the context menu for this object. All the functions are general, as described in Chapter **5.4.5**.

5.4.4.5 Textual Data

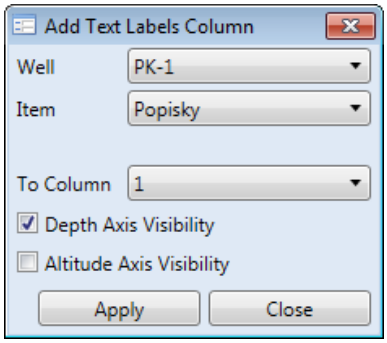


Fig. 133: *Form for adding text labels into the plot.*

Your **text labels** can also be displayed in the plot. These can be added pressing the **Add - Text Column** in the ribbon toolbar which brings up Figure **133** help dialog.

In this dialogue, you select the data document you want to display. The **Apply** button defines your object in the plot, and clicking **Refresh** renders visualisation of this selected data document. Figure **134** provides an example of two label views. The first is for a depth of 30 metres in a single-line label. The second label is for the depth range of 33 to 55 metres and here the label can have multiple lines. The image icons discussed earlier in the preparation of data documents were also assigned to individual labels in Figure **134**.

Your object displayed in the plot has only the three individual specific functions illustrated in Figure **134 Right**. The **Mode** parameter defines how your labels can be edited inside the plot. You must remember that if you edit your labels inside the plot, your editing is not stored in the source data document, so if you then click on the **Refresh** button, only the original data will be reloaded and your edits will be lost. Figure **135** gives an example of label editing.

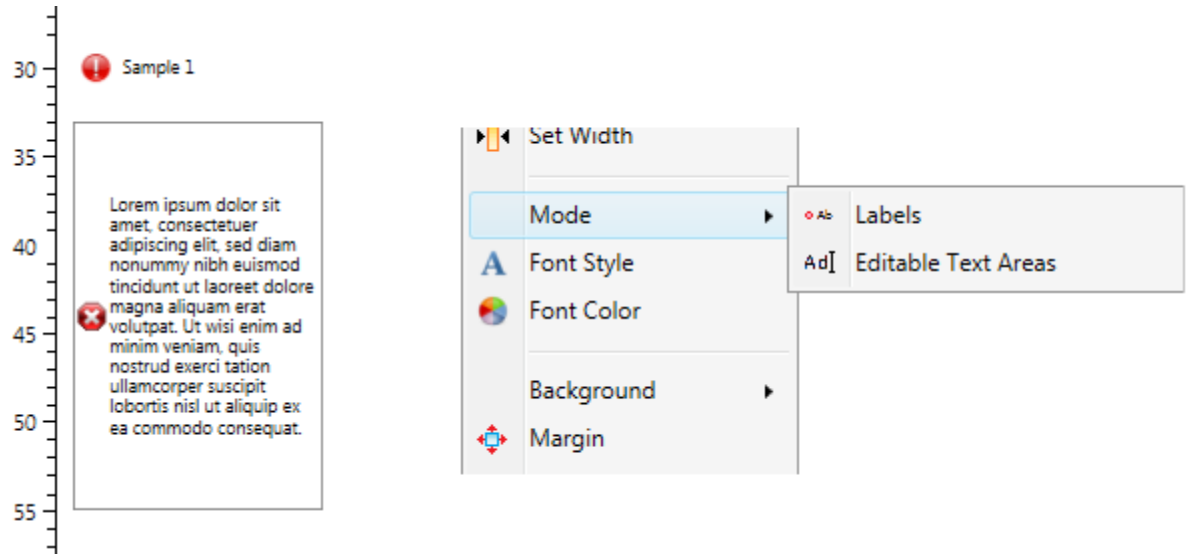


Fig. 134: ***Left*** *– example of text labels in your plot column;* ***Right*** *– specific functions in the labels context menu.*

In addition, you can use features in the context menu to set label font style and font colour. Using these, you can provide additional information related to your defined depth; such as sampling depths.

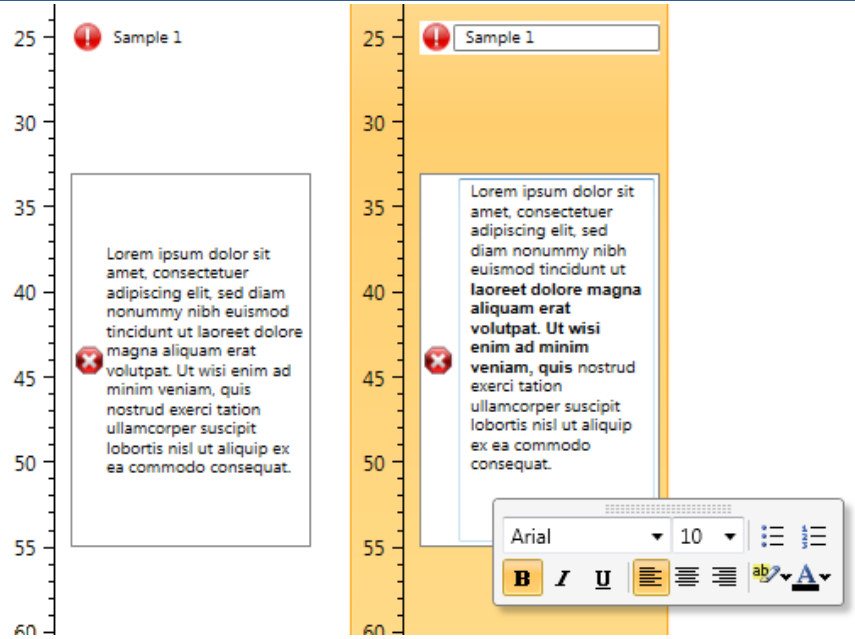


Fig. 135: *Editing option for text labels in your plot.*

5.4.4.6 Images

Images are the next data type that can be rendered in your plot. You add these to the plot using the **Add** button in the ribbon toolbar. Then click **Refresh** in the context menu and your images are visible in the column. There are two specialized, functions in the context menu for this type of visualization; namely **Use Unified Properties** and **Properties** (Fig. **136**).

The first is **Use Unified Properties** which sets the same parameters for all images, thus overriding the possibility of individual parameter control in your data document. The second **Properties** item in the context menu sets these unified properties (Fig. **136 Right**). Clicking on **Apply** simultaneously adjusts these properties for all images. Examples of different variations of these settings are shown in Figure **137** where, the **Stretch**, **Horizontal Alignment** and **Vertical Alignment** parameters were edited.

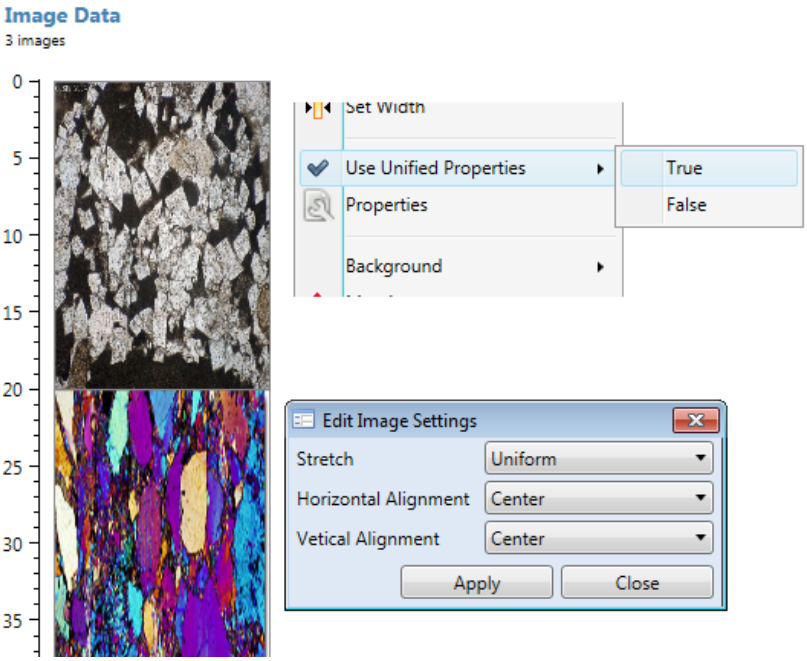


Fig. 136: ***Left*** *– image data object in the plot column;* ***Top Right*** *– functions from the context menu to customize the display of images in the profile;* ***Bottom Right*** *– form to set your unified image properties.*

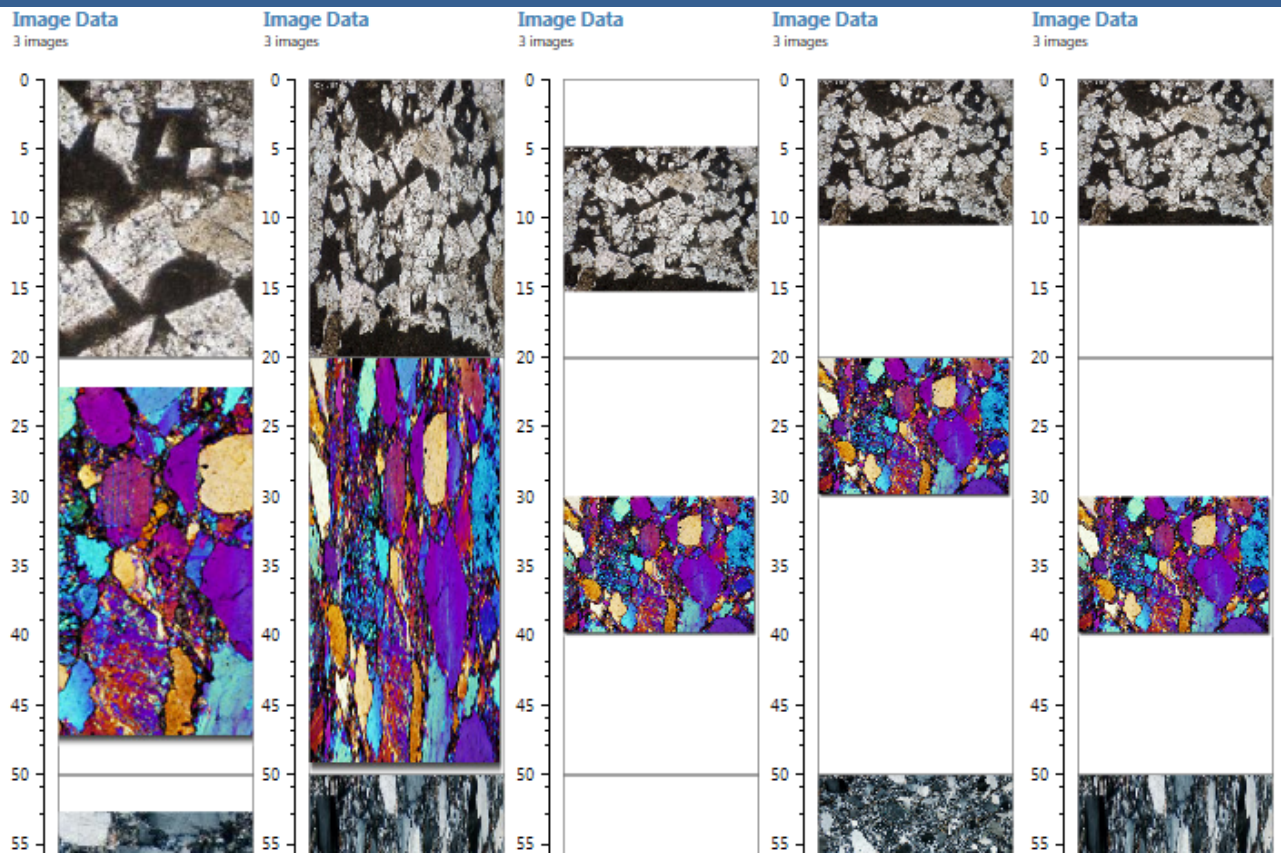


Fig. 137: *Examples of Stretch, Horizontal and Vertical Alignment parameter variations for profile images.*

5.4.4.7 Tectonic Data

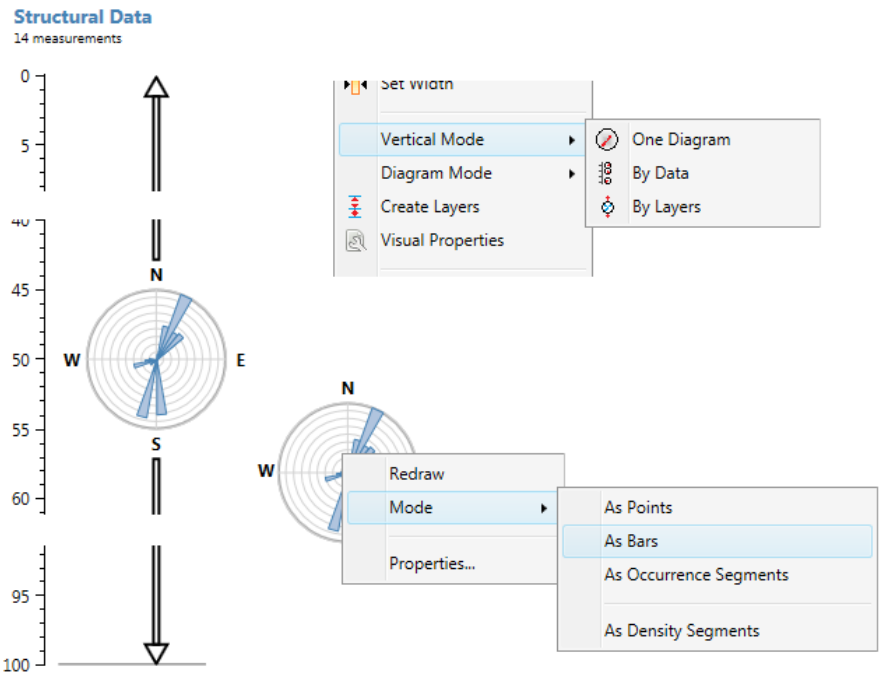


Fig. 138: ***Left*** *– example of structural data visualisation in your well's vertical profile;* ***Right Top*** *– commands for visualisation adjustment;* ***Right Bottom*** *– functions for adjustment of your selected single tectonogram*

Your **tectonic and structural data** can also be displayed in the plot. This data is defined in the document by three parameters; **depth**, **magnitude** and **azimuth**. Display your tectonic data in the plot, click **Refresh** in the context menu and visualization appears as in Figure **138 Left**. This visualization consists of a single **rose diagram** with data and arrows indicating your displayed depth range. A single diagram displays all data for the whole well.

Right-clicking on your object displays editing functions. In addition to

standard features, this menu has all the new features which are specially designed for this object (Fig. **138 Top Right**). In addition, right-clicking on the selected diagram brings up your editing options (Fig. **138 Bottom Right**).

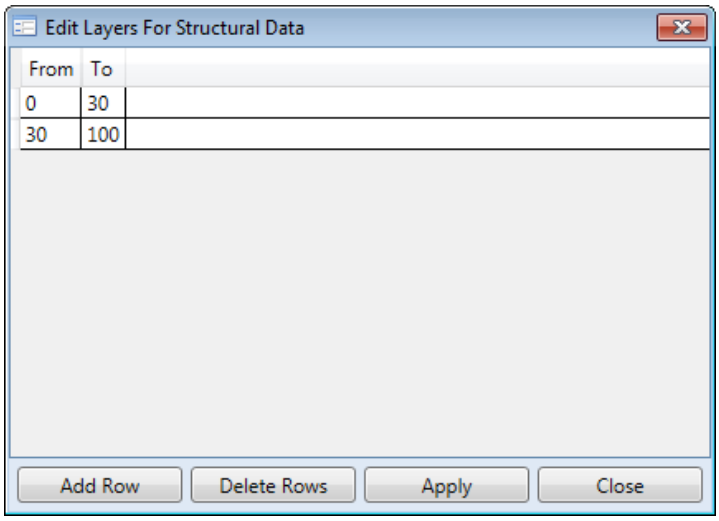


Fig. 139: *Form for layers definition where all measurements will be merged into one diagram.*

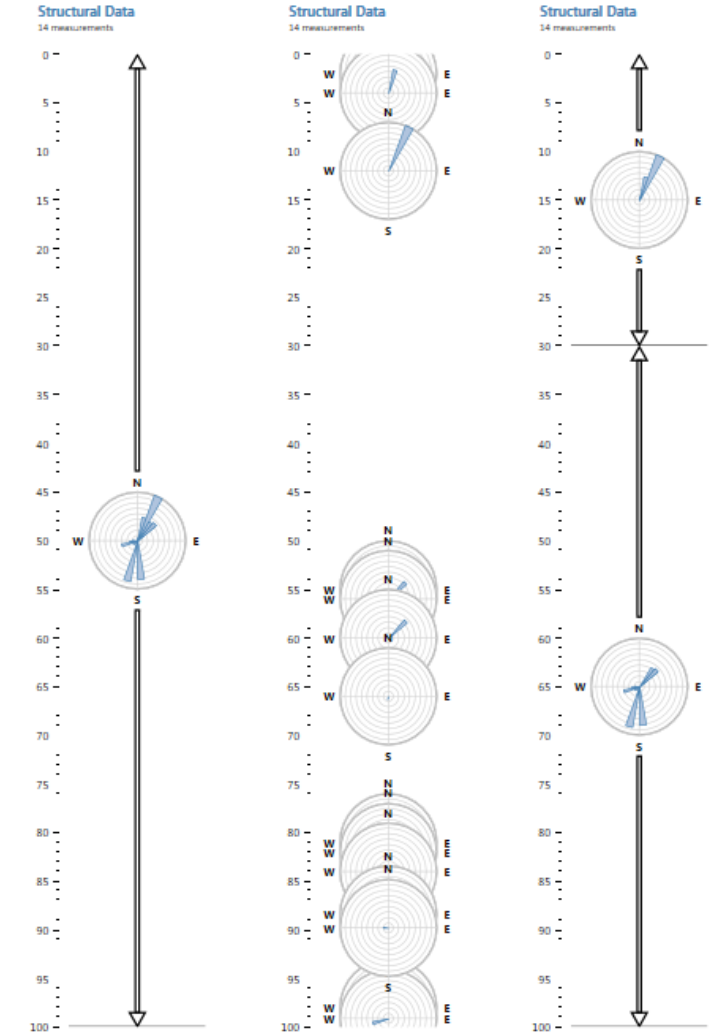


Fig. 140: *Examples of Vertical Mode parameter choices (**Left** – One diagram; **Middle** – By Data; **Right** – By Layers).*

display are illustrated in Figure **141**.

The first function in the context menu for your entire plot object is **Vertical Mode** which can show tectonic data in three ways. If you have a small set of data, use the **One Diagram** property and all data is displayed in a single diagram. If you have larger sets of measurements, use the **By Data** property. Multiple vertical diagrams are then displayed for individual depth measurements. This setting is good if you want to display a limited amount of data related to depth, but if you have a lot of data concentrated in a relatively short depth range, the individual diagrams will overlap.

Therefore, for very large datasets it is best to use the third property - **By Layers**. Here, measurements are merged in your diagrams according to your defined number of layers. An example of this setting's benefits is that you can display summary diagrams according to changes in geological properties. However, when you use this setting, you must define your depth ranges using the **Create Layers** help form in Figure **139**. This form defines your depth intervals, so that once again all measurements fit in one diagram. Figure **139** defines two layers; at 0 to 30 metres and 30 to 100 metres. Click **Apply**, and two diagrams are rendered in your plot showing data from the two depth levels. Examples of your three choices are displayed in Figure **140**.

Another feature in the context menu is the **Mode** property which defines the type of diagram used. This setting is applied for all diagrams in the profile. However, if you want to set this property individually for each diagram, just right-click on it and use the pop-up menu (Fig. **138 Bottom Right**). Examples of the four choices for your diagram

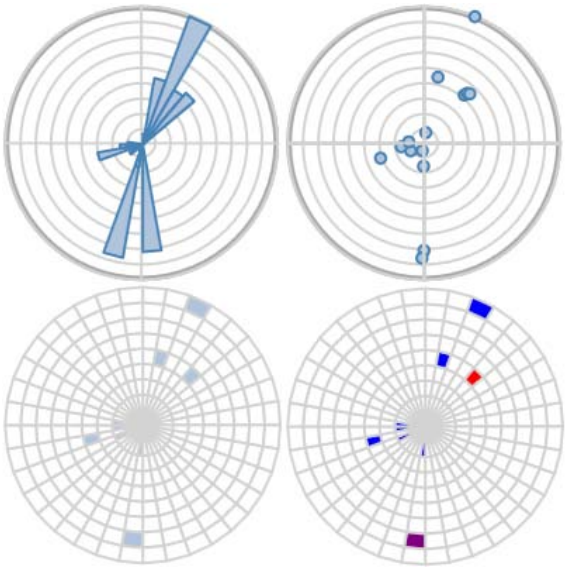


Fig. 141: *Modes of tectonogram display in the plot (**Top Left** – as Bars; **Top Right** – as Points; **Bottom Left**– as Occurrence Segments; **Bottom Right** – as Density Segments).*

The program's predefined method of viewing data is by **Bars**. This is useful if you have a small amount of data, but for a greater amount of data you can use the **as Points** setting. This mode displays individual measurements as points, so here a number of similar measurement values are more easily recognized. Similarly, the **as Occurrence Segments** option highlights segments with 10° step azimuth and magnitude marks when your data falls into these ranges. Your fourth choice is **as Density Segments**. This setting is similar to the previous one, except that the segment colour is defined by the number of measurements falling in that segment. Here, segments with a small number of measurements are highlighted in blue and multiple measurement segments are in red.

Finally when you click on the **Properties** item, you receive the form in Figure **142**. This defines your diagram's visual parameters, and can be used for individual diagrams or for all diagrams concurrently. Again, you must remember that if you change only one individual diagram and click **Refresh** in the context menu all editing changes you have made to its visual settings will be cancelled. The combined parameters are shown in Figure **142 Right**. Here, set the **Vertical Mode** parameter to **By Data** and your measurements are rendered at a defined depth from the surface. Since the diagrams in your profile overlap, their visual characteristics are modified so that all measurements become visible. The colour of multiple diagram objects is set to transparent. These described features give you highly variable visualizations of tectonic and structural measurements. The next section describes adding the time series of your measured numerical values into the vertical well profile.

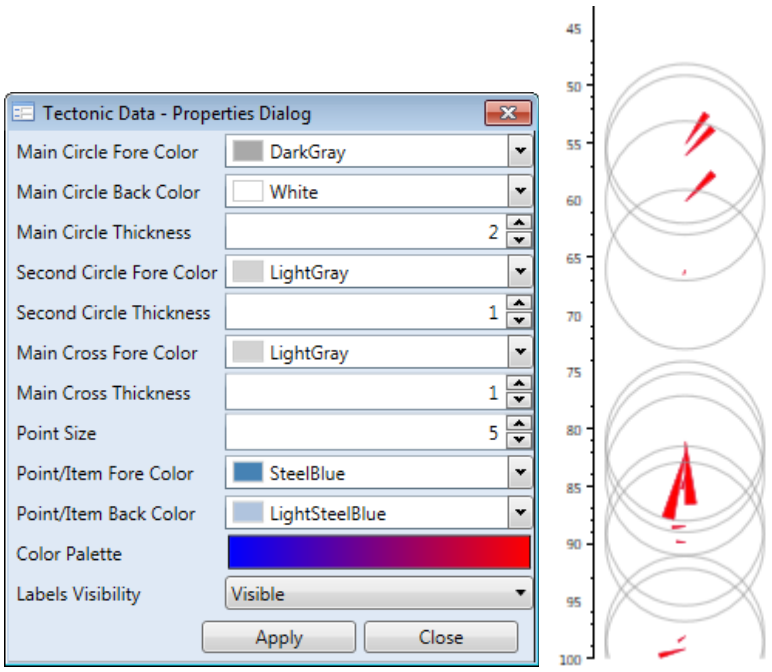


Fig. 142: ***Left*** *– dialogue for adjusting tectonogram properties;* ***Right*** *–example of property combinations for displaying values at their actual depth.*

5.4.4.8 Time Series Data

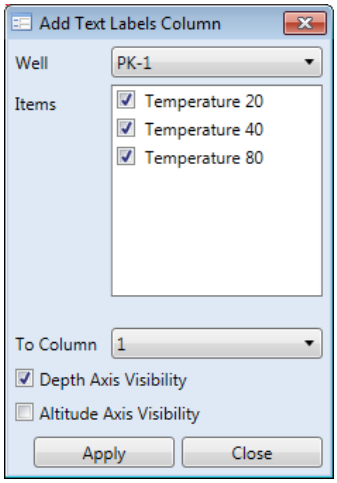


Fig. 143: *Help window for definition of time series to be displayed in the well's vertical profile.*

The last data type to render in your plot is the **time series of numerical values**. This visualization is used where you have continuous measurements at various well depths. **Using data loggers** allows continuous measurements of the water **temperature**, **TDS** and the **electrical conductivity of water**. This displays your values in depth graphs after you have prepared individual time series using the **Data Source** panel. When you want to view them, click **Add - Time Series** in the ribbon toolbar and this displays the form in Figure **143**. Here, you select the well you want to view then select your data from the list and press **Apply**.

After inserting this in your profile and redrawing it by clicking **Refresh**, the data is displayed in the predefined format of Figure **144 Right**. This example illustrates continuous measurements at three well depths. For specific visualization adjustment, you use the **Properties** function in Figure **144 Top Right**).

Clicking on the **Properties** function displays this form where you can modify your graph's visual properties (Fig. **144 Right**). Here, you adjust graph background colour, grid line colour and you can show or hide the X and Y -axes and adjust the colour and size of your font. The following text boxes allow you to edit the graph margin values and adjust the colours of your imported series. The first series in each chart is displayed in steel blue colour. The **Color Dialog** property allows graph display in **up to 20 Color series**. This is used when you import several value columns, such as those defining concentrations of dissolved solid components, Clicking **Color Dialog** in your selected item also allows you to change colours. The last text box lets you adjust your chart height. Figure **145** gives an example of the adjusted visualization for three time series in vertical profile. Here, the chart border colour and grid lines have been set to fully transparent and the X and Y axis labels are hidden. The chosen display colour for this series was red, in order to clearly illustrate the final visualization of continuous measurements at three points in your well.

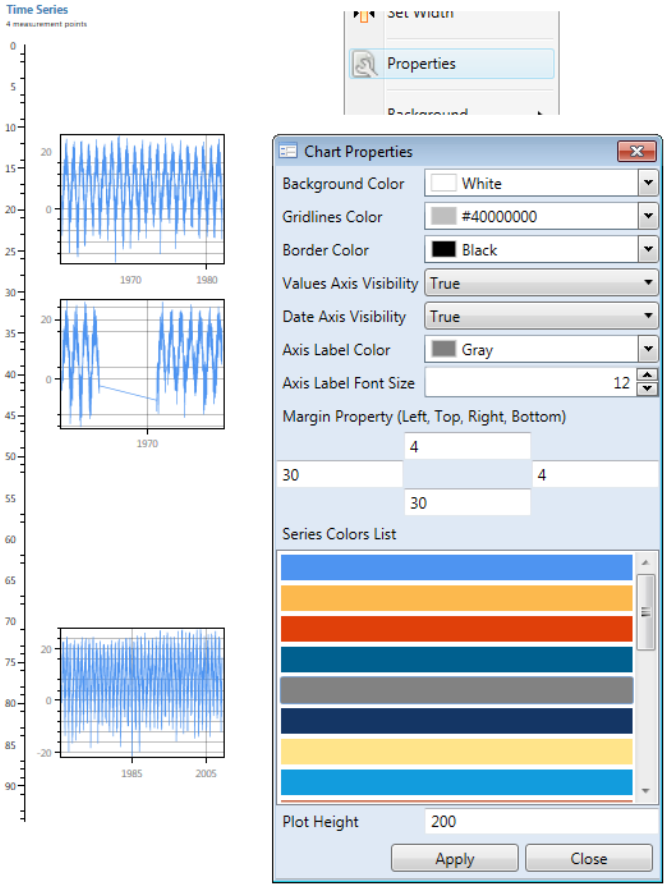


Fig. 144: ***Left*** *– example of predefined display of time series in the well's vertical profile.;* ***Top Right*** *– function for graph adjustment in the context menu;* ***Bottom Right*** *– help form for adjusting your graph's visual properties.*

5.4.4.9 Custom text column

There is one more addition to complete the description of data visualizations in the 1D Well Log Plot. By pressing **Add** you can insert a **Custom Text Column** which is empty. Here, you can enter any of your own required textual data such as well descriptions and photographs. You just define the columns where you want these items to go and use **Copy-Paste.** After its insertion, you can directly edit the content. Selecting any part of your added data brings up the classic contextual toolbar if you need formatting changes. An example of self-generated textual content is given in Figure **146**.

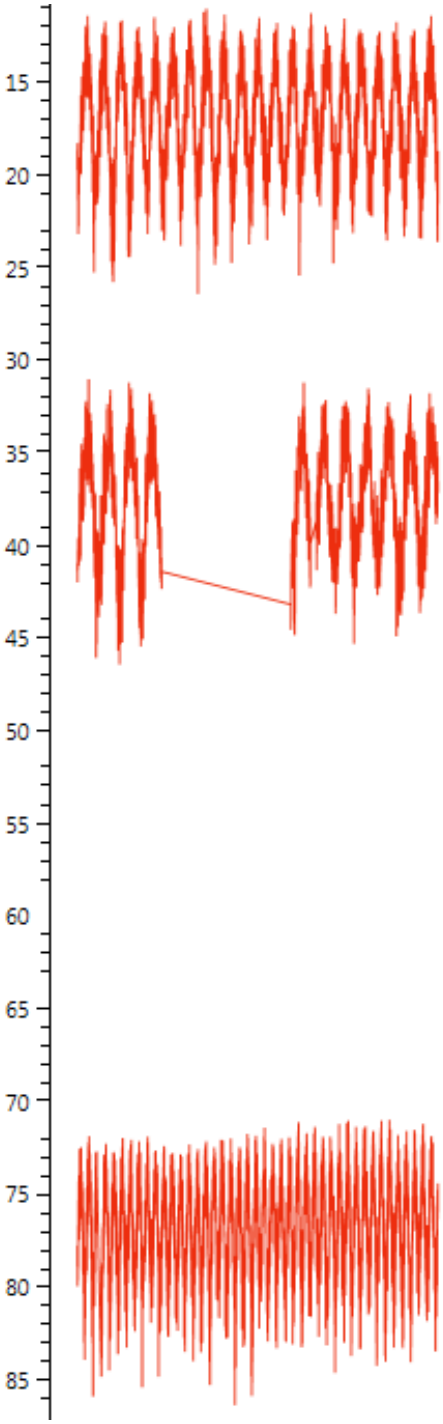


Fig. 145: *Example of the adjusted object in the plot with three time series values at different depths*

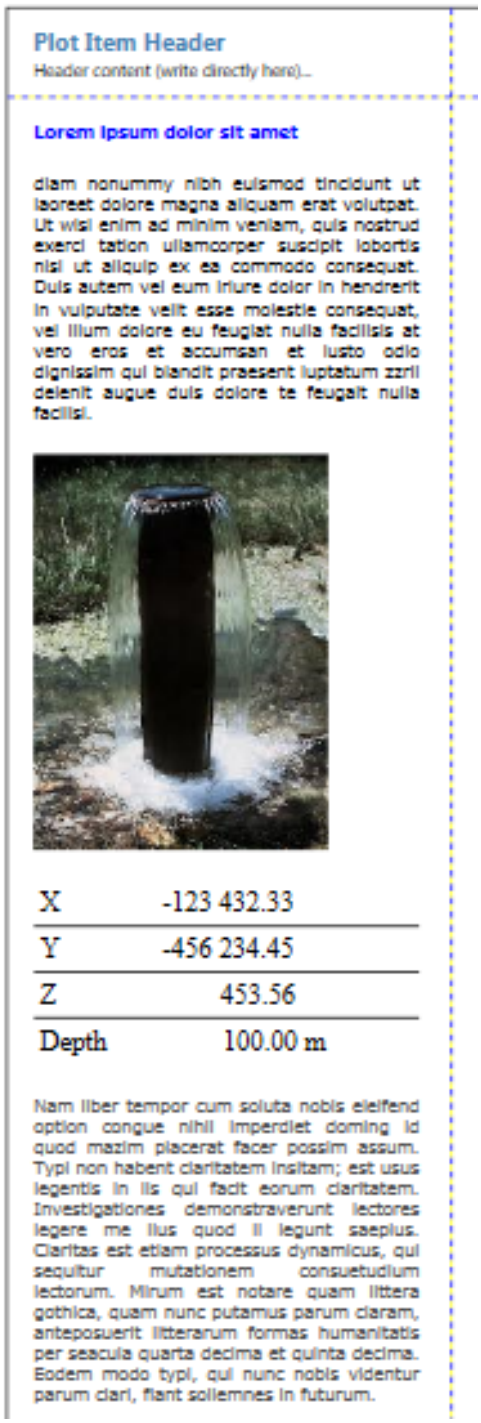


Fig. 146: *Example of text content generated in an external text editor and inserted by Copy-Paste.*

5.4.4.10 Conclusions

This ends chapter **5.4** description of display options for different data types in the 1D Well Log. It explained insertion and editing modification for extremely variable types of data in your plot so that you now have the most impressive display of well data and measurements.

Following your entire visualization, you now have printing and export options. Right-clicking in the grey area outside the fence displays these functions (Fig. **147**). The first is **Full Screen** where you can re-size your window to monitor full-screen and convert the plot into an-**image** (Fig. **148**). You can quickly zoom and scroll visualization in this new image size. Then **Active Plot - Export** displays options for **direct printing of your plot** and **exporting** the created visualization from the program as an **image** (Fig. **149**). Beneath Figure **149** is the final depiction of your **1D Well Log** created in **Well Plotter.**

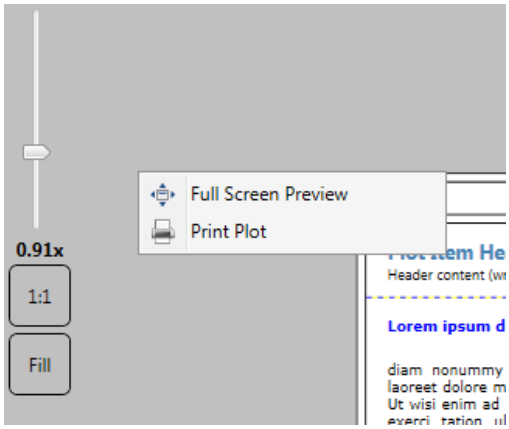


Fig. 147: *Functions in the context menu when you click outside the plot.*

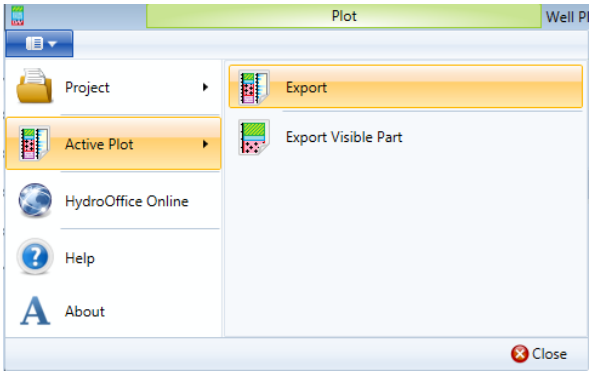


Fig. 149: *Plot export from your program as an image file.*

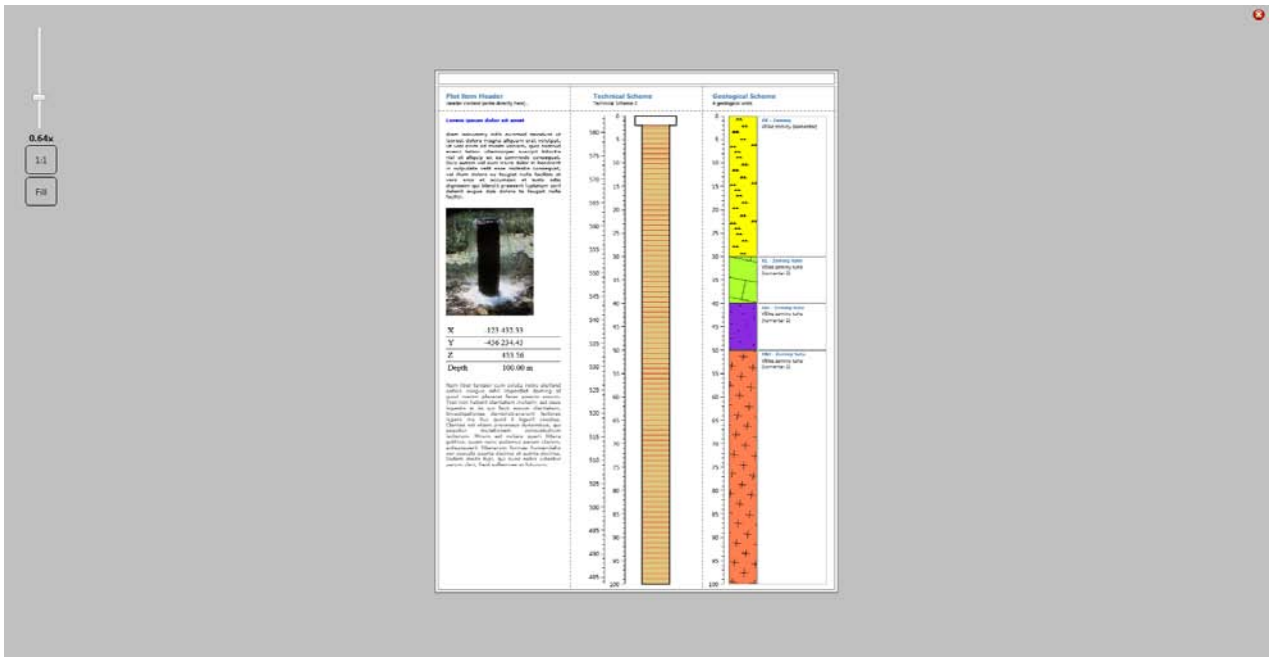


Fig. 148: *Full Screen display of your plot.*

PK-1

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Technical Scheme

Schema 1

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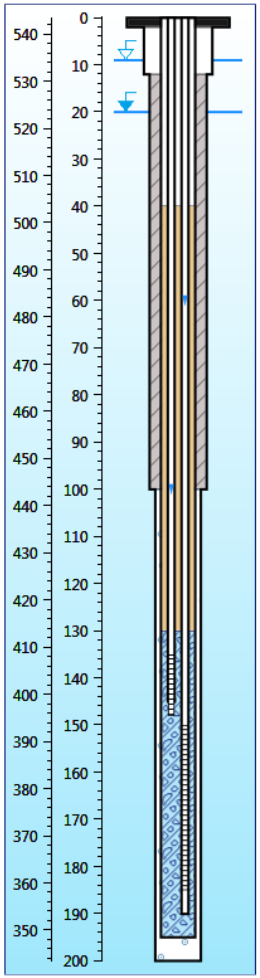

Geological Scheme

6 geological units

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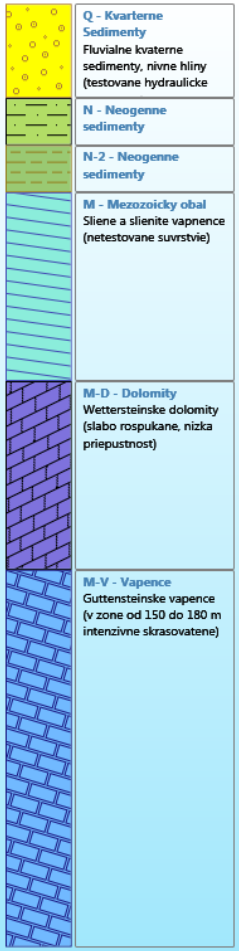

Foto

5 images

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Samples

6 items

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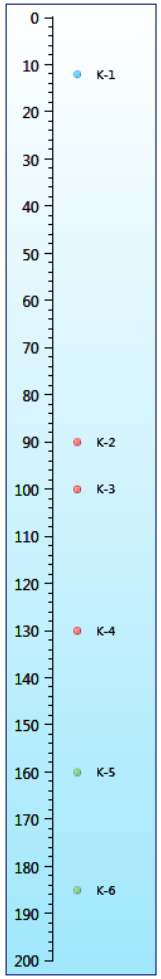
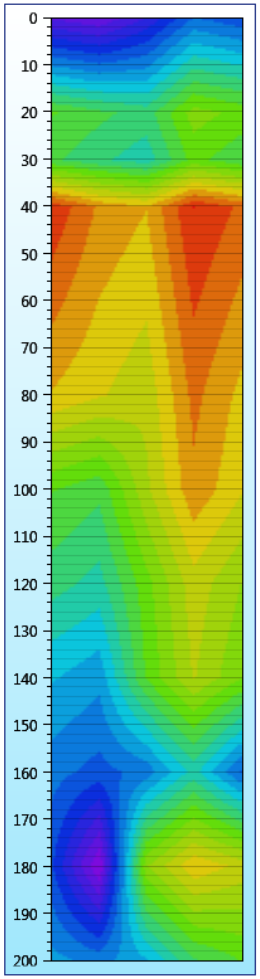


Conductivity in Time

Lorem ipsum

445 950

0 10 20 30 40

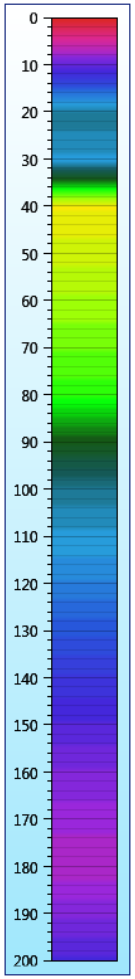


Geophysical

Lorem Ipsum

450 900

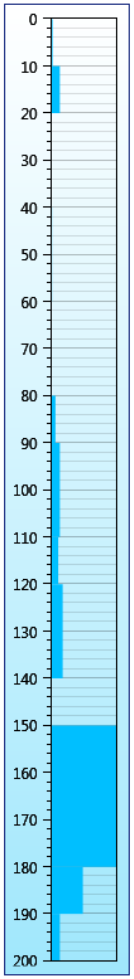
0 1



Inflows

Load individual series into plot manually.

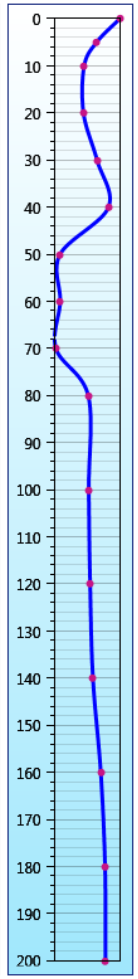
0 20 40



TDS

Load individual series into plot manually.

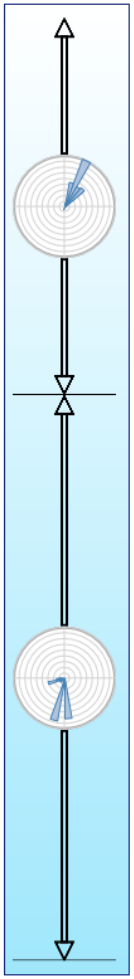
600 800



Structural Data

14 measurements

consectetur adipisicing Lorem ipsum consectetur adipisicing Lorem



Time Series (Temperatue)

3 measurement points

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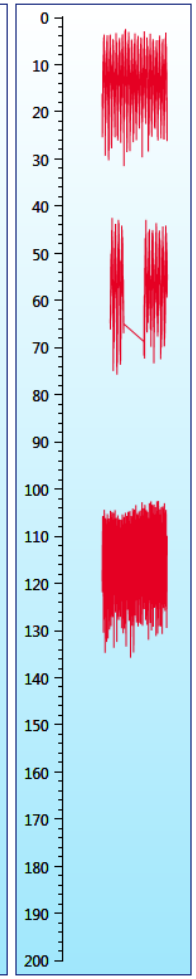


6 Well Plotter 3D

Chapter **6** now explains **2D** and **3D visualization** of your well data. To use these features, you need a licence for **Well Plotter 3D,** but you can try the program's Demo version first. The 3D edition is an extension of the basic version so you must be able to prepare basic data as explained in Chapters **4** and **5**. There is minimal visual difference between these two editions. The ribbon toolbar includes two additional buttons for viewing your data in 3D space (**3D View**) creating your final **2D / 3D diagram.** (Fig. **150**), Inside the window there is also one extra panel, called **Section Data**. Functions for these additional features are described in the following text.

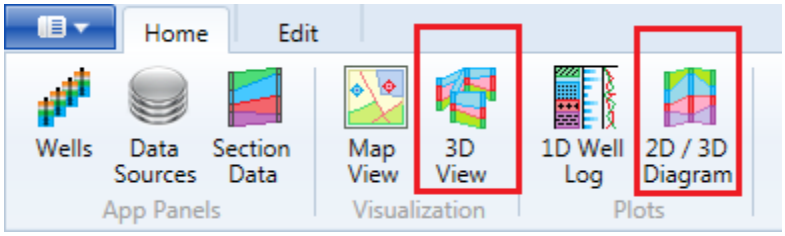


Fig. 150: *Function additions in the Well Plotter 3D program.*

6.1 Section Data Panel

The 3D edition **Section Data panel** displays the list of 2D sections appears between pairs of wells (Fig. **151**). When you click in the panel's empty area, Figure **151 Top Right** context menu appears. Using **Add New**, you can create a new 2D section. The second item on of this menu deletes all created sections simultaneously. If you right-click on an existing item, the context menu appears as in Figure **151 Bottom Right**.

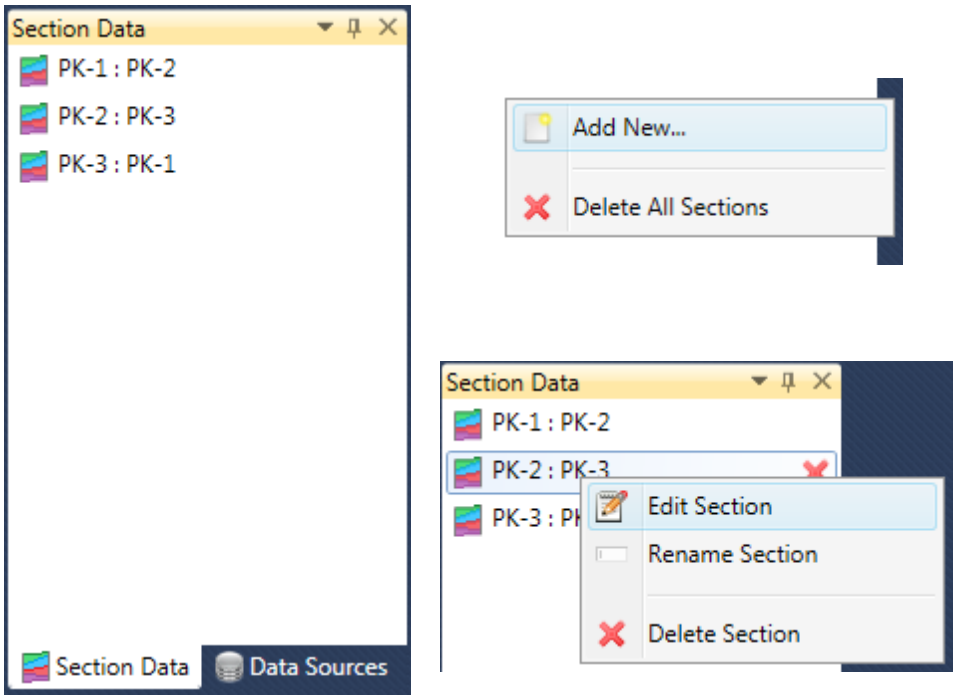


Fig. 151: **Left** - Section Data Panel; **Right** - functions in the context menus.

Using these functions, you can edit, rename or delete a selected section. Clicking on **Add New** gives the window in Figure **152**. Here the combo boxes allow you to select two wells for your 2D profile. You define its name, click **Apply** and your, new section is displayed in the panel.

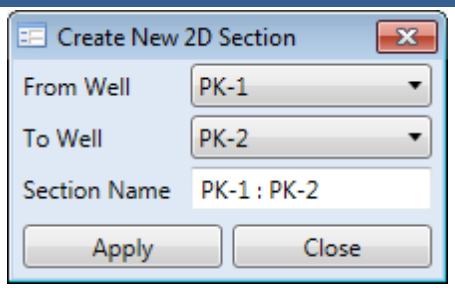


Fig. 152: *Dialog for adding a new 2D section for two selected wells.*

It is crucial in creating a 2D profile of several 2D sections that you understand that the final visualization of your geological profile is always based on the creation of your individual sections. For example, if you want to display the profile between wells PK-1, PK-2 and PK-3 in this order, you need to create two separate sections: PK-1/PK-2 and PK-2/PK-3. The current version does not contain horizontal flipping of your created sections and therefore if you create a section PK-3/PK-2, it is impossible to combine and compare it with the PK-1/PK-2 section. This factor is not important for 3D visualization, where both PK-2/PK-3 and PK-/PK-2 sections can be included and compared to your PK-1/PK-2 section.

If you add a new section to the panel, double-clicking on it will open it for editing in a separate window. The new blank area in the document part appears as in Figure **153.** In addition, the ribbon toolbar contains the new **2D Section** context tab shown in Figure. **154**.

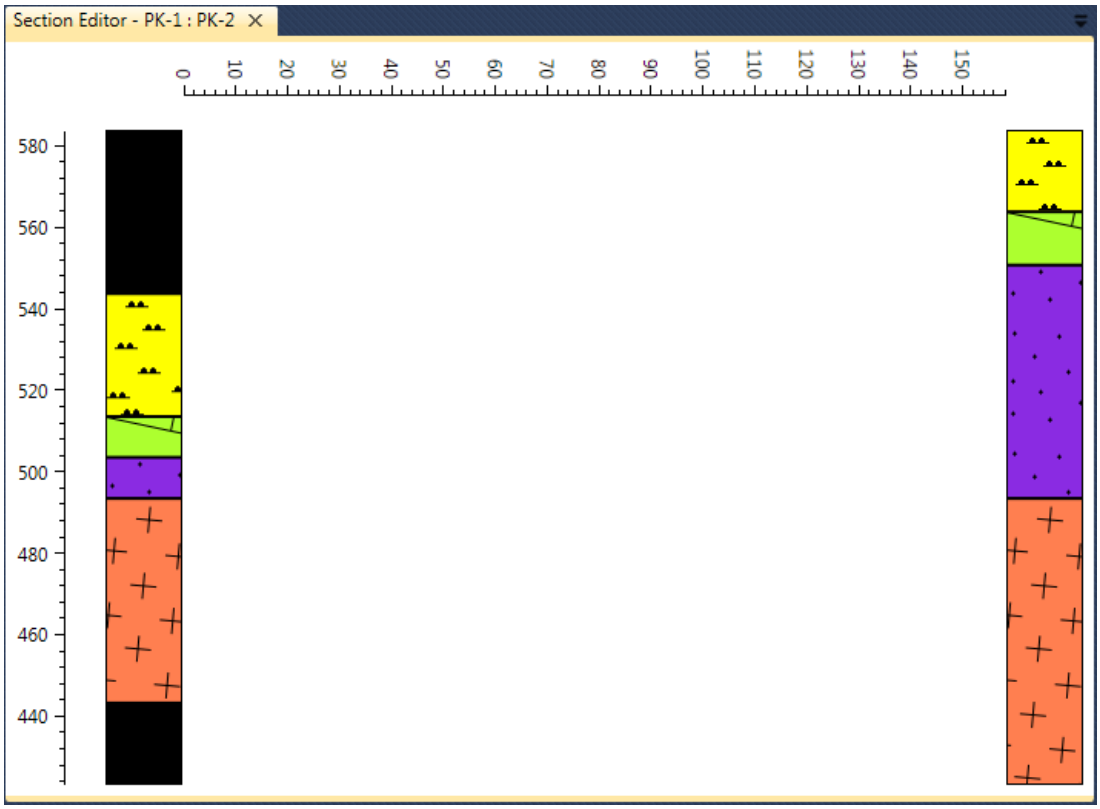


Fig. 153: *Display of the newly-created 2D sections for two selected wells.*

Before editing, this document window contains four objects. Two are for horizontal and vertical axis. The horizontal axis in the upper part shows the distance between the selected wells in metres; or in your defined metric coordinate units. The vertical axis shows the wells' location altitude. This data is read from your basic well properties described in Chapter **5.1**. The remaining two objects are black rectangles where you import the wells' geological profiles referenced to their actual altitudes. You edit your 2D section in this window, using features in the contextual ribbon tab (Fig. **154**).

This ribbon tab contains all editing features you require, and the **Close** button then closes this contextual tab. The functionality of other buttons is explained in the following two sub-sections. The first sub-section describes options for generating 2D profiles with geological layers and the second explains creating 2D heat maps from numerical data.

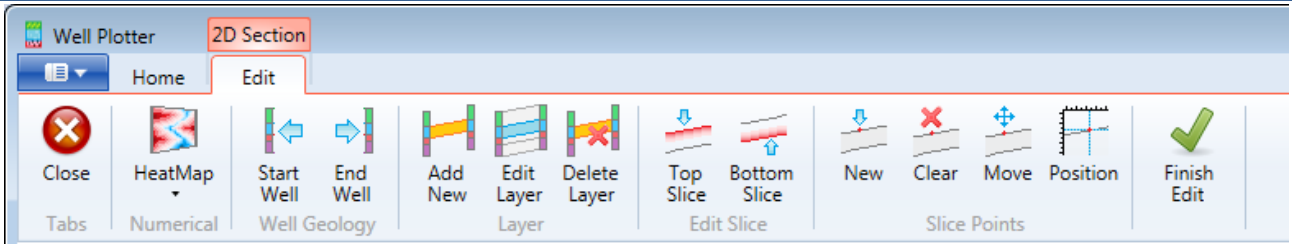


Fig. 154: *Contextual tab in the ribbon toolbar for 2D section editing.*

6.1.1 2D Geological Section

The most common use for 2D sections is to produce **geological profiles**. This chapter explains how they can be created in Well Plotter 3D. When you create individual sections for pairs of wells, these are then used to render your geological profile in 2D and 3D view.

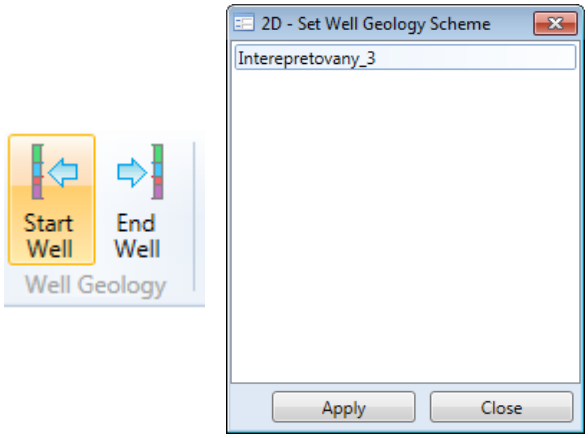


Fig. 155: *Selection of geological profiles to be displayed in your document.*

The rectangles in the previously empty 2D section are now filled with your wells' geological profiles, and these are automatically displayed. But if you have a well in the Data Sources panel with several geological profiles (such as schematic and classified), the program automatically selects the first one it finds. If you want to use a different profile to the one automatically selected, press the ribbon button in the **Well Geology** group (Fig. **155 Left**), and Figure **155 Right** window comes up.

All existing geological profiles can be loaded in this window. Selecting your alternative geological scheme and pressing **Apply** changes the profile in the document.

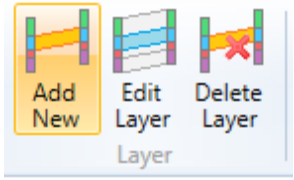


Fig. 156: *Basic features for definition of your 2D geological profile.*

The **Layer** group in Figure **156** has three basic but very important buttons. Here, you can **Add** a new layer to your profile, **Edit** existing layers and **Delete** unnecessary ones. Clicking on **Add New** gives you the window in Figure **157**.

You can manually set the description and visual properties of new layers in Figure **157** window. If you want to apply texture already used in the program, you can choose this from a **Geo ID** combo box. All unique Geo ID-s used in your previous work are loaded here. If you want to edit the texture, just click on it to get the standard window for hatch editing. Then edit and press **Apply**.

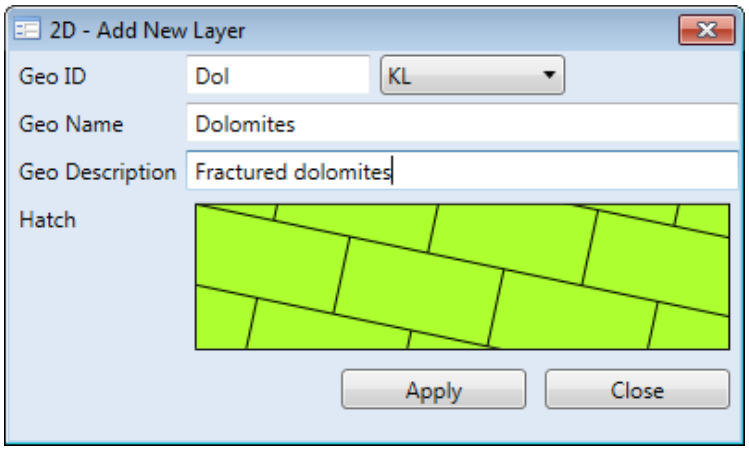


Fig. 157: *Window for adding a new layer to the 2D section.*

When you have added a new layer, that dialogue closes and you get the next choice of buttons in the ribbon toolbar in Figure **158**.

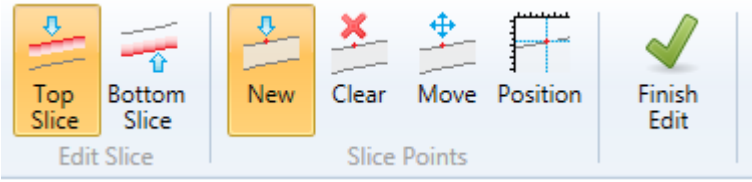


Fig. 158: *Commands for layer editing in the 2D section.*

Each layer you add into the 2D section is defined by the **top** and **bottom slices**. The first two buttons in the **Edit Slice** group are used to select the slice that you currently want to edit. If you want to edit the top slice, click the first **Top Slice** button. Subsequently, you use buttons from the following group **Slice Points** to define the geometry of your layer. Clicking on the **New** button adds new points to the layer slice. The following **Clear** button deletes profile points. The **Move** button allows you to manually move existing points in your section. The last button is used for precise definition of the point position in the 2D section. Finally, when you have finished editing the layers, click on the **Finish Edit** button.

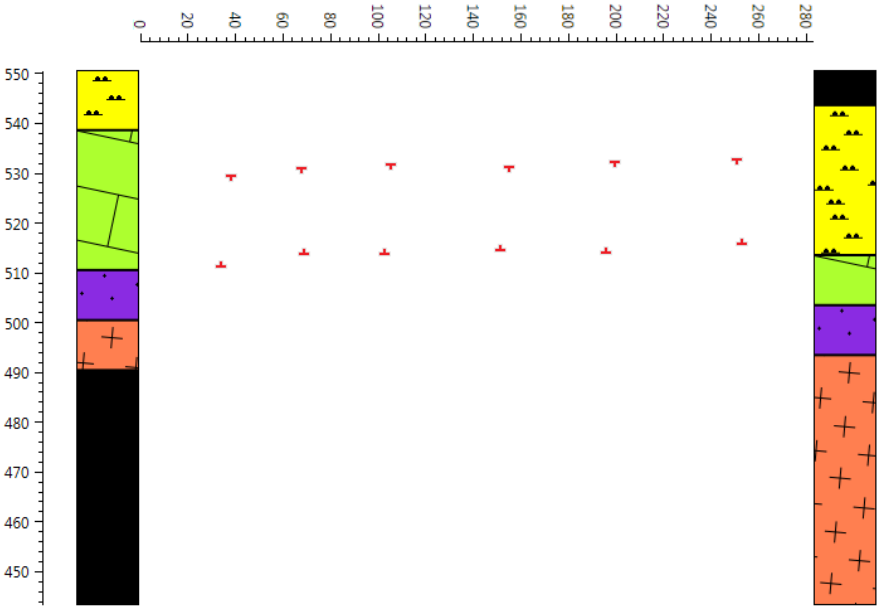


Fig. 159: *Formation of new layer in the 2D profile defining your boundary points.*

Figure **159** gives an example of a constructed layer, with visible points limiting the extent of your created layer. This figure shows that the profile has two types of points. The ones that look like a **T** limit the layer top (Top Slice) and those that resemble a vertically rotated **T** limit the layer bottom (Bottom Slice).

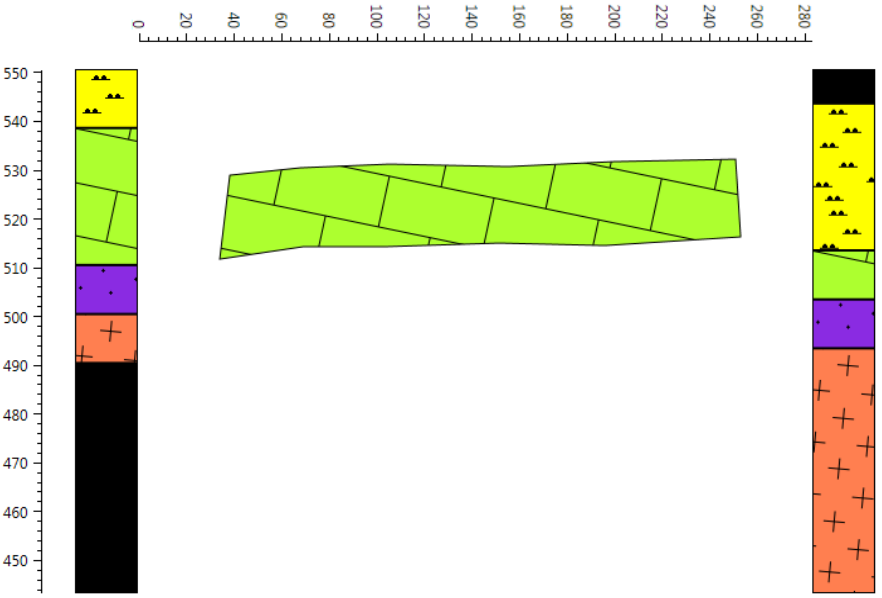


Fig. 160: *Example of created layer using the boundary points in the previous figure.*

After adding these points, click on the **Finish Edit** button and the layer in Figure **160** is created. This layer now shows the visual parameters you defined in its preparation.

You can freely edit the created layer. Pressing the **Edit Layer** button gives you the dialogue in Figure **161**. Select a layer and press **Apply**. That window closes and the selected layer is displayed again showing your boundary points. Click on the **Move** button and these points can be for example moved with the mouse. An example of this type of point shift from the bottom slice is shown in Figure **162**. At the end of each item in this window is an icon for editing the layer's visual properties. An example of its use here is alteration of texture colours.

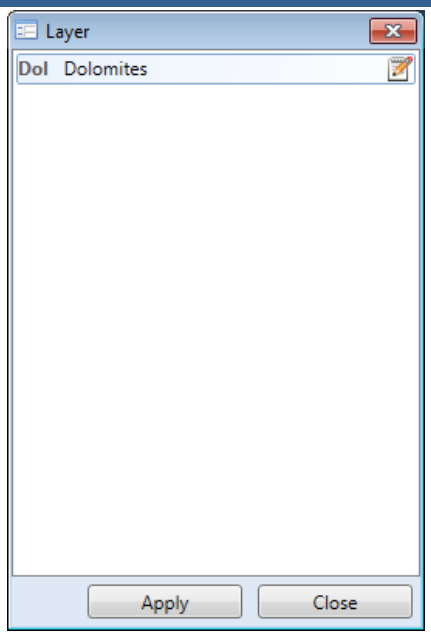


Fig. 161: Window for selecting layers to edit.

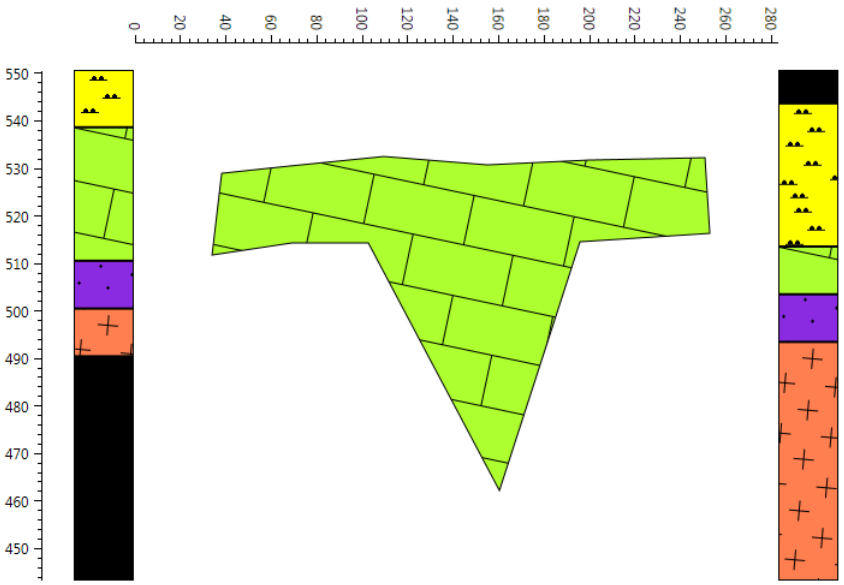


Fig. 162: Example of layer editing by manual shift of one boundary point.

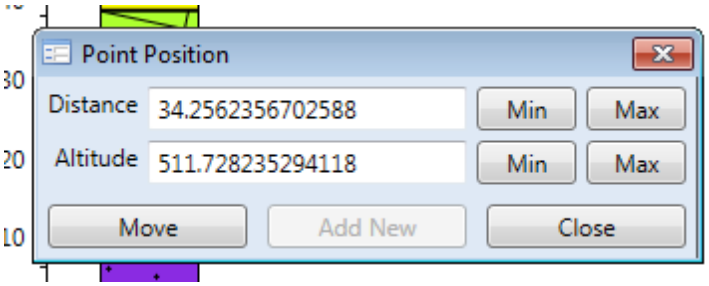


Fig. 163: Form for exact positioning of the slice point.

The last button from the **Slice Points group** is **Position**. This precisely defines the position of current and new points. Clicking on a selected item gives the form in Figure **163**, with text boxes to coordinate the points you change. In addition, this form contains four buttons in the right half of the window. These buttons move the point to a selected edge of your section. For example, if you want to move the start point to the left edge, click on the **Min** button on the **Distance** line. Your selected point is then moved to this edge. This option is used especially to clip layers to the edge of your 2D section, because it is difficult to click the mouse on the border pixel. Similarly, if you want to clip the layer to the right edge, you use the **Max** button. Results of these modifications are highlighted in Figure **164**.

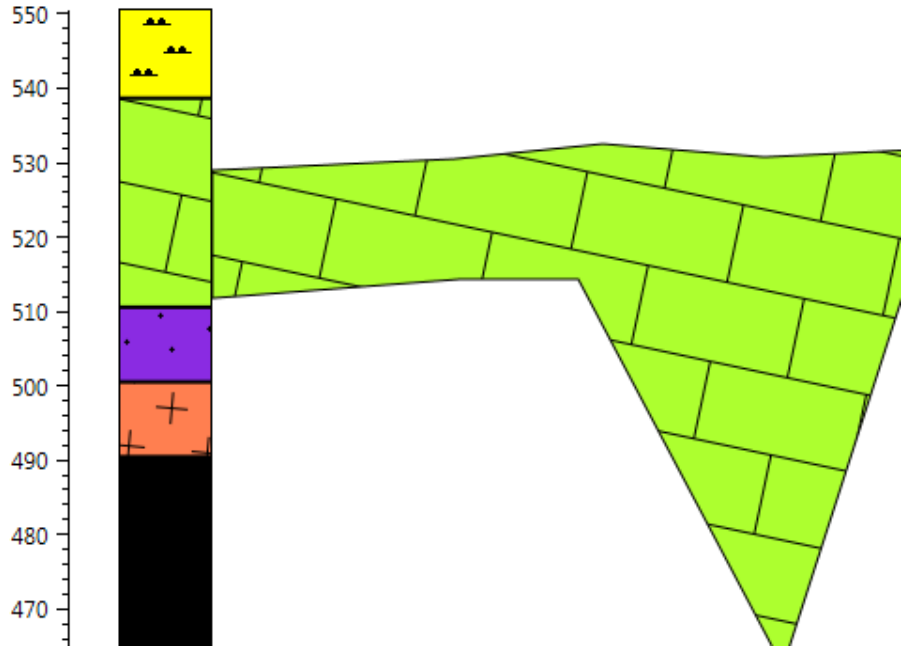


Fig. 164: An example of layer clipping to the edge of 2D sections using the Position function.

In addition, you can also use this form if you have created overburden or ground layer. Here, it is necessary that the edges of the layers overlap. An example is given in Figure **165**. This

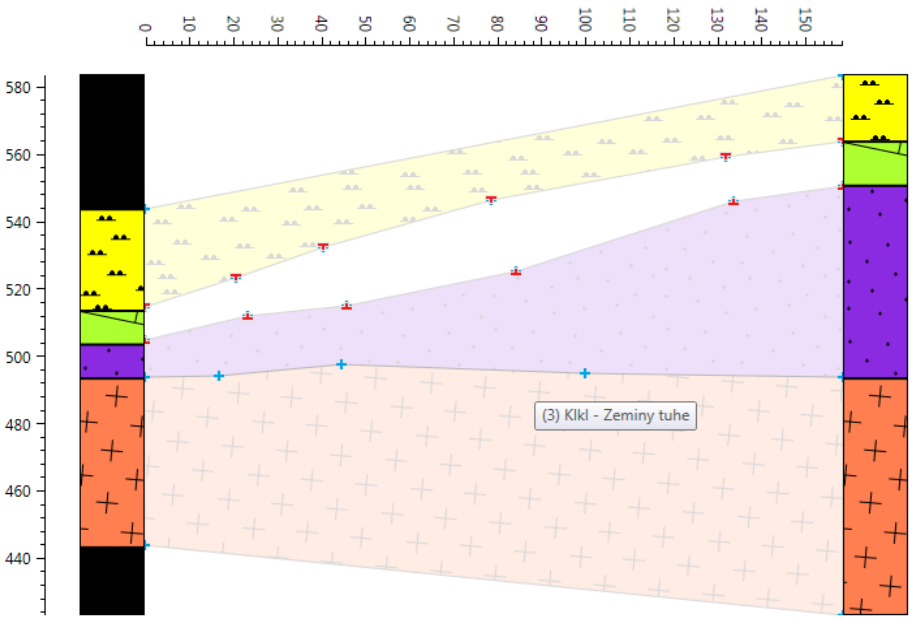


Fig. 165: An example of selected layer editing by clipping points from points in previous layers.

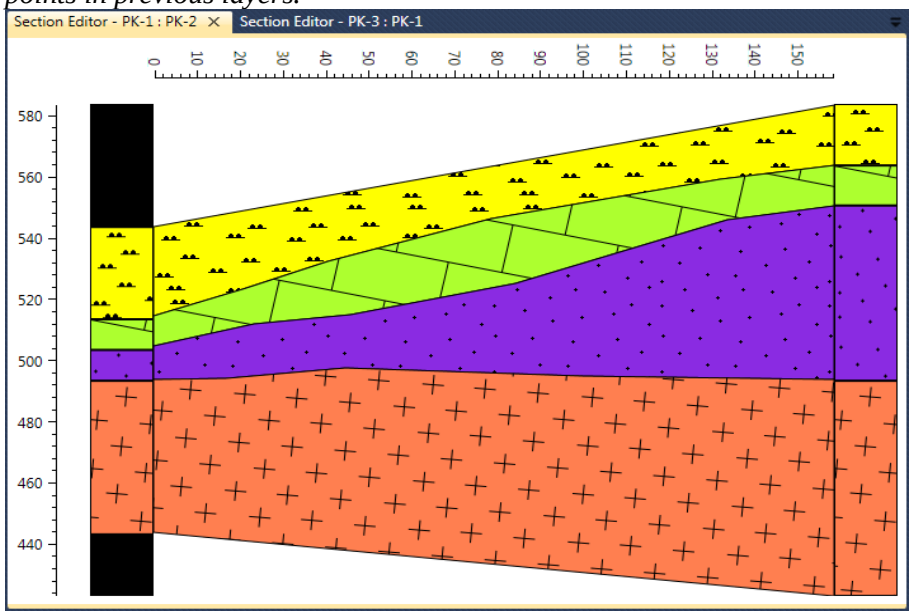


Fig. 166: Example of a 2D geological section created in the Well Plotter program.

shows creation of the second layer from the top. Actually existing layers are displayed with increased transparency and their definition points are in blue colour. If you want to add a new layer clipped to the edges of the existing layer, click on the **Position** button in the ribbon toolbar and then click on the boundary points from an existing layer. Click on one these points and the form from Figure **163** reappears, and the **Add New** button can be used. The coordinates of the point you clicked on are now in the text box. When you press **Add New** above the existing point from the previous layer, a new point for the new layer is displayed. This operation precisely defines the new point position with no holes or overlaps between layers.

After layer editing, click **Finish Edit**, and all created layers are displayed in their actual form; without showing the help points from the top or bottom slices. An example of a 2D geological profile created in this manner is shown in Figure **166**. If you have any problems with your geological profile preparation, the video tutorial shows all described features in actual use. Although the preparation of 2D geological sections is labour-intensive, your resultant realistic course of geological layers between selected pairs of wells is completely satisfying. This result surpasses the simple linear inter-connection available in other programs.

The following chapter briefly describes 2D section creation using bi-linear interpolation of numerical values between two wells. If you require more complex types of geological sections, **Annex 4** contains further options for their construction.

6.1.2 2D Heat Map Section

Figure **167** illustrates commands for creating a 2D heat map. Heat maps can be constructed from the numerical point datasets using simple bi-linear interpolation between the nearest four-

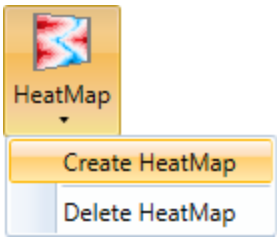


Fig. 167: Features for working with 2D heat maps.

point values. This methodology is optimal when wells are located in relatively planar areas and your measurement depths are approximately equal. However, 2D heat map creation between wells in the Plotter Well 3D program is currently in the initial testing phase, because present methodology is unsuitable for wells located on a slope. Future extended versions of this program will cover this deficiency. To create your heat map, click on **HeatMap** in the ribbon toolbar and select **Create HeatMap**. The next button in Figure **167** deletes 2D heat maps from your section.

2D heat maps are produced using Figure **168** help window; with similar settings to those explained in Chapter **5.2.7** for 1D Well Log heat maps. You first choose the data documents you want to use in the top two combo boxes.

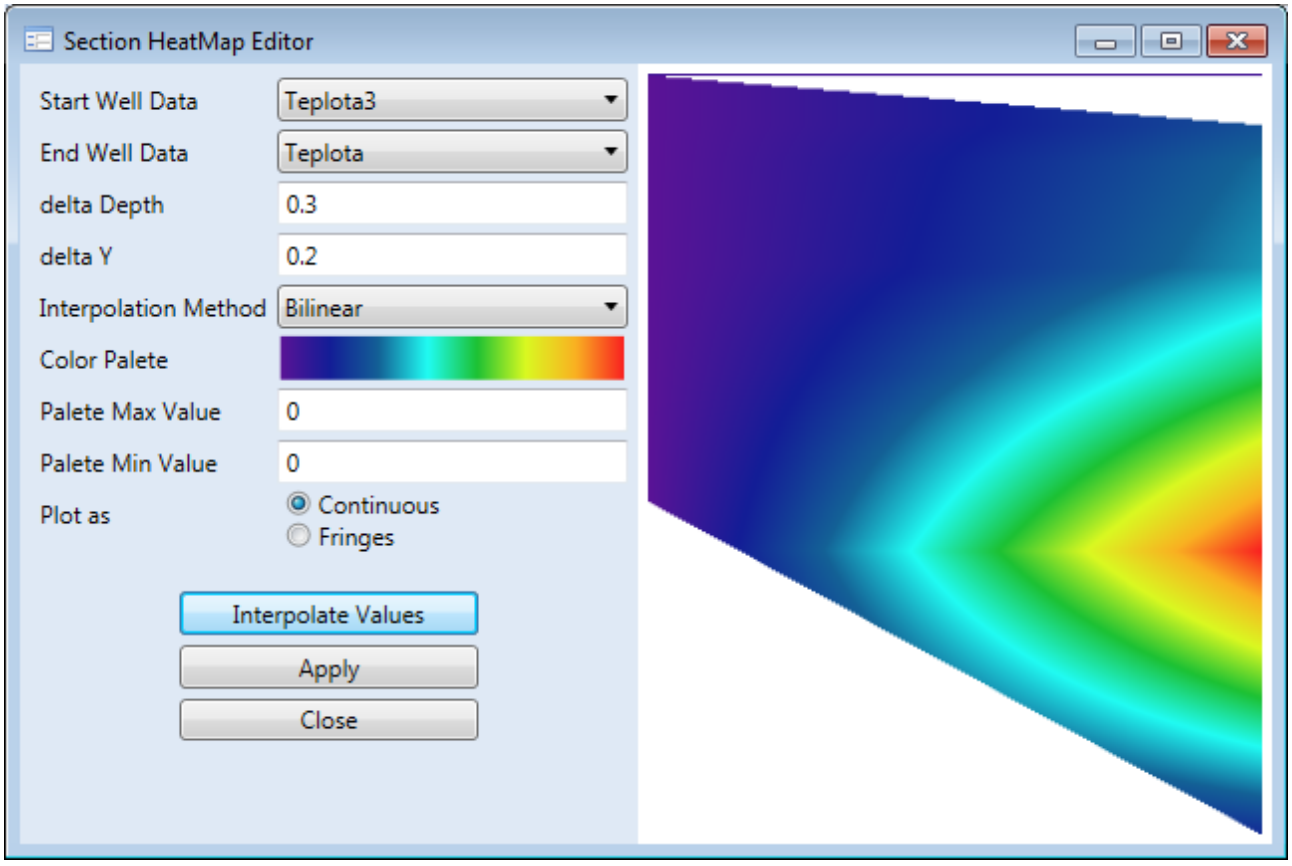


Fig. 168: The window for set-up and production of section 2D heat map.

You can adjust map resolution exactly as in 1D Well Log heat map modulation. The smaller your values, the sharper the heat map will be through longer calculation processes. Using the Colour Palette, you define the colours to be used in your heat map. The most important features are **Palette Max** / **Min Value**. Leaving these text boxes at zero in individual sections ensures that the colour scale in the heat maps will always be adjusted to your current range of numerical values. However, if you want to use 2D heat maps in several sections you put absolute minimum and maximum values. These are then generated in your heat map so that identical values in all sections have the same colour. The last radio buttons give you the option of setting heat maps as a continual transition of colours or having **sharp transition**. Examples of 2D heat maps with different parameters are shown in Figure **169**.

Clicking **Apply** produces the heat map displayed in Figure **170**. Both the heat map and your geological profile are added inside each 2D section; with the heat map displayed in the background

of the 2D section

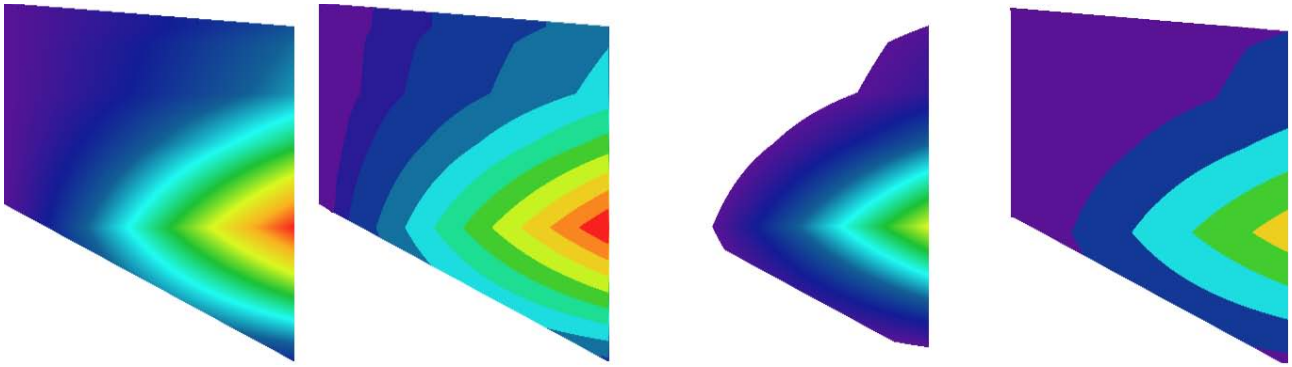


Fig. 169: *Examples of 2D heat maps using the same numerical values but different settings.*

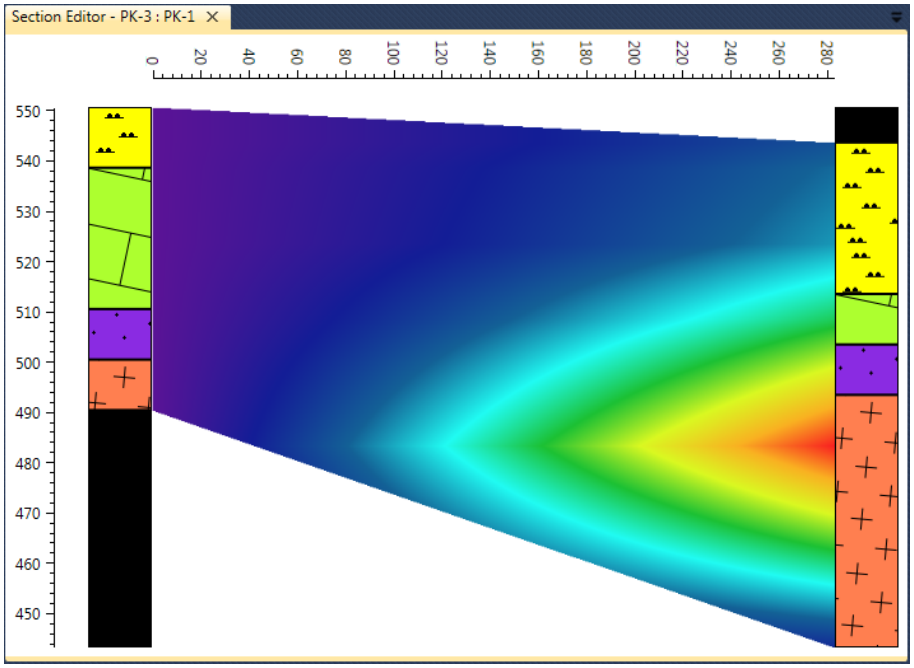


Fig. 170: *Resultant heat map displayed inside the 2D section document window.*

This chapter completes input data creation in Well Plotter 3D. The following chapters under paragraph **6** focus on the final 2D and 3D visualizations of all prepared data in the program. Chapter **6.2** deals with data display in 3D space, and chapter **6.3** describes the formation of your final 2D/3D plot.

6.2 3D View

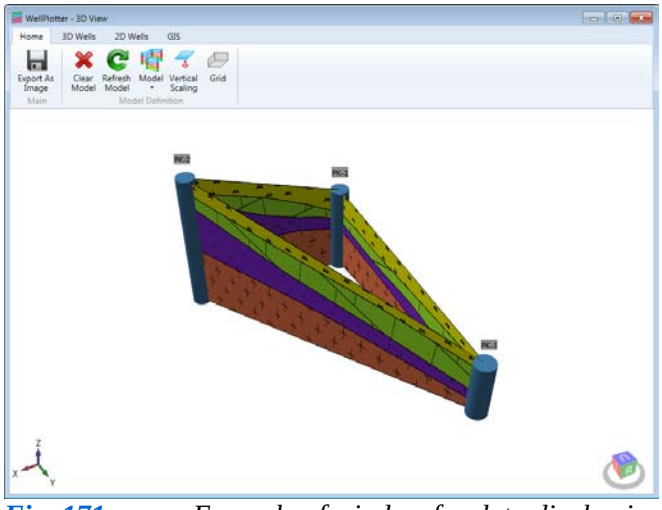


Fig. 171: *Example of window for data display in 3D space.*

Now that you have prepared all data associated with your wells' defined coordinates and altitudes, you can create the spatial 2D and 3D visualizations. The 3D visualization is described first because resultant 3D displays can be later combined with your 2D data display. To display data in 3D, just click on the **3D View** button in the ribbon toolbar to bring up the window in Figure **171**. This automatically loads all data in your program.

Your automatically loaded data appears as follows; Wells are shown as simple cylinders in steel blue colour and 2D sections

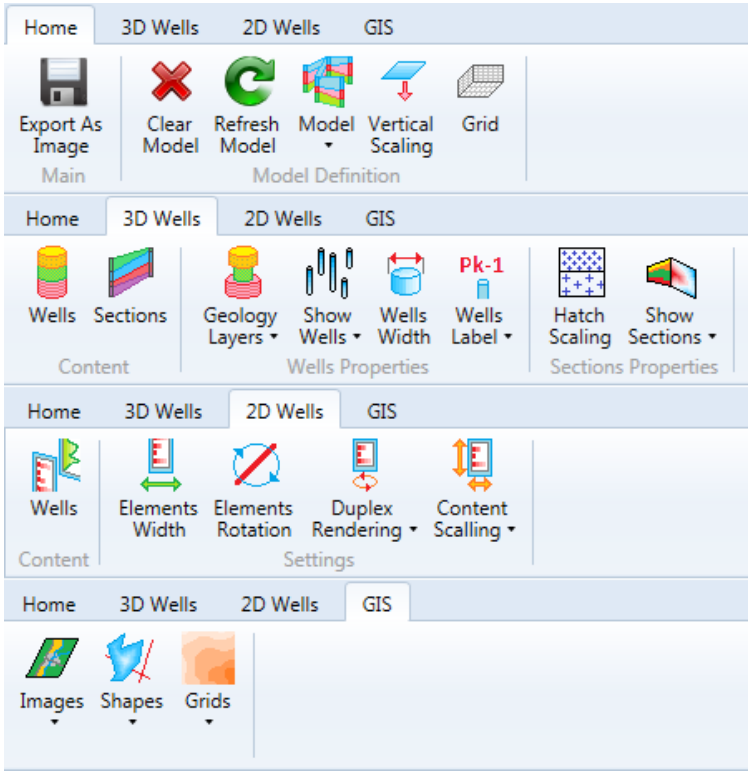


Fig. 172: *Features for 3D visualization of well data.*

are shown as geological layers. This 3D model can be fully adjusted using the features in the four ribbon toolbar tabs in Figure 172.

Each tab has a different function. (1) The **Home** tab gives the basic visualization set-up, (2) The **3D Wells** tab edits the display of 3D objects, (3) The **2D Wells** tab adjusts the settings of 2D objects and (4) The last tab is **GIS** which imports spatial data from ESRI GIS files in the form of **Shapes** (points, lines and polygons) and **Grids**.

The following sub-sections are divided according to those ribbon toolbar tabs; beginning with the basic set-up and functionality of the **3D View**.

6.2.1 Basic properties of 3D View

The basic settings for 3D visualization are on the **Home** Tab (Fig. 173). These features define the **basic properties of the 3D image**. The **Export As Image** button is then used to export the visualization from the program to an image file.

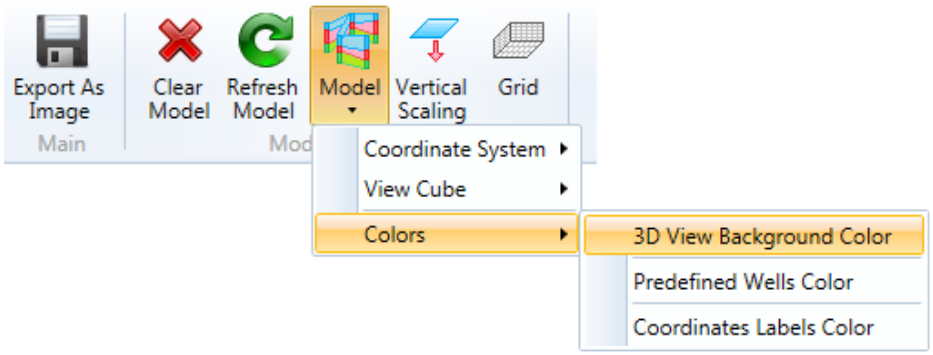


Fig. 173: *Features on the Home tab.*

The **Clear Model** and **Refresh Model** buttons erase and redraw the entire 3D scene. The first two functions under the **Model** button display or hide auxiliary objects in the 3D scene. These are the coordinate-system axes / **Coordinate System** and the cube of the model / **View Cube** (Fig. 174). The **View Cube** object has the specific function that allows you to click on one side of the cube and automatically rotate the whole model to that side. An example of this function is that you can automatically rotate the entire model to view it from any side or from above.

Fig. 174: *Auxiliary objects from the 3D scene (**Left** – coordinate system; **Right** – view cube).*

The **Colors** item defines the colour of the following three objects; the background of the scene and coordinate system labels (Pictured in Figure 175), and also the predefined colour of displayed wells.

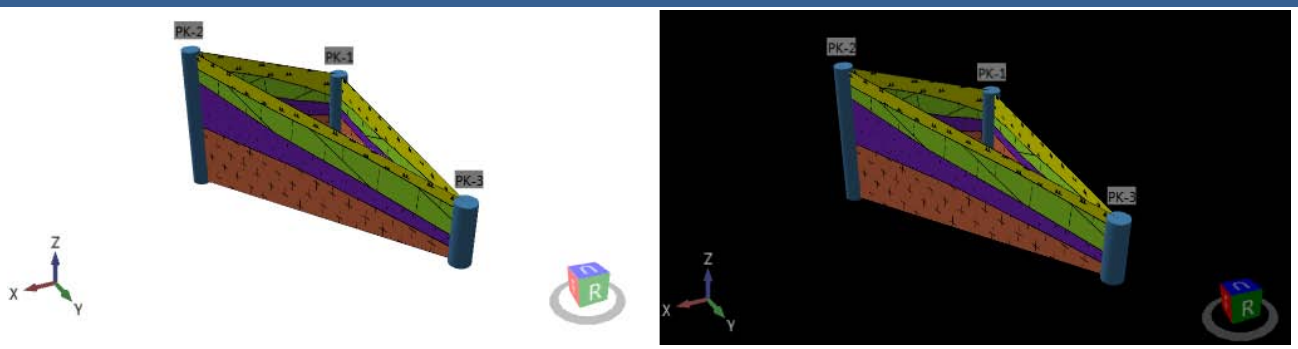


Fig. 175: *Example of colour setting for scene background and axis labels.*

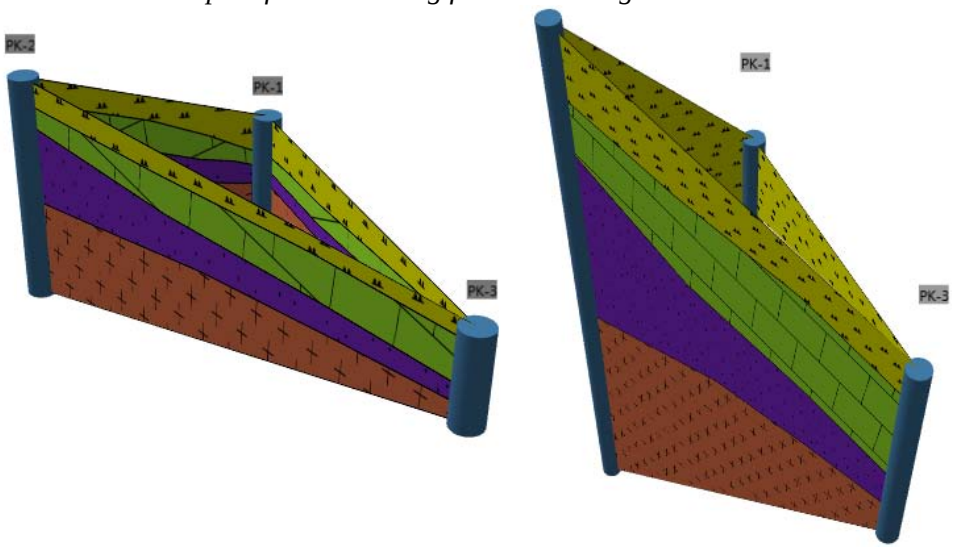


Fig. 176: *Example of vertical scaling of your model.*

Vertical Scaling changes the scale of the vertical axis. This feature is used when you display shallow wells over a relatively large surface area. Here, you can scale the vertical parameter so that the horizontal extent of your wells is maintained while the vertical data of shallow wells is also clearly visible. An example of this scaling is shown in Figure **176**.

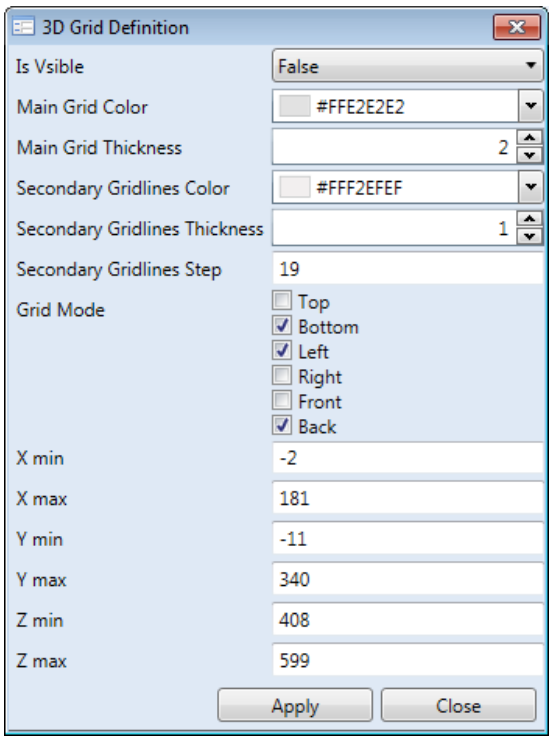


Fig. 177: *Dialogue for grid set-up.*

The **Grid** button delineates a 3D cube enclosed in grid lines, with boundary conditions set automatically according to the well's position. Pressing **Grid** brings up the dialog in Figure **177**. In this window you can adjust all your grid parameters. You can show or hide the grid, define the colours and thickness of the main and secondary lines and display or hide individual cube walls. The text boxes also allow you to adjust the size of the cube by changing the boundary coordinates. An example created grid is shown in Figure **178**.

Finally, this chapter explains interactive control of the 3D model. Here, your displayed 3D model can be dynamically controlled – **rotated**, **moved** and **zoomed**. You can do this using the mouse or the keyboard. Table **2** shows the individual **Gestures** and **Commands** and the functions they perform in the 3D image. Figure **179** gives an example of **Field of View** property changes. Orographic and Perspective displays are initiated by pressing Alt + right mouse

button + shift.

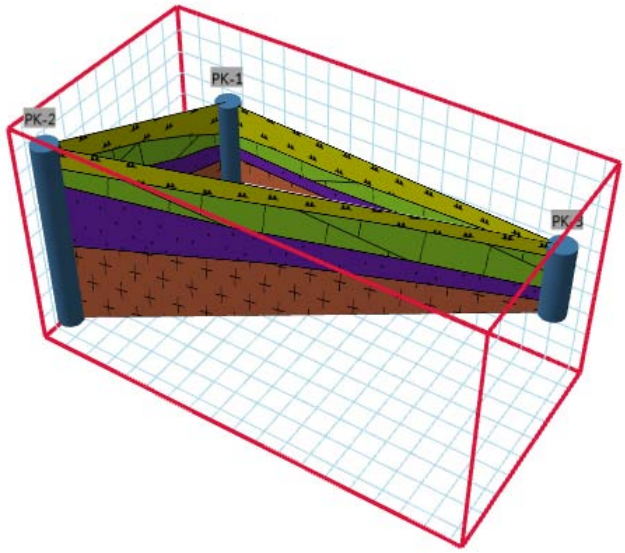


Fig. 178: Example of created grid.

Table 2: Mouse and keyboard gestures for interactive 3D control.

Gesture	Command
RMB	rotate
Shift + RMB	pan
Ctrl + RMB	zoom
Ctrl + Shift + RMB	zoom rectangle
Alt + RMB	change field of view
Mouse Wheel	zoom
Shift + Mouse wheel	change field of view
Double-click RMB	set target point
Double-click MMB	reset camera
Home	zoom extents
Page Up / Page Down	zoom
Arrow keys	rotate
Ctrl + U / D / L / R / F / B	look from side

RMB - Right mouse button
MMB - Middle mouse button

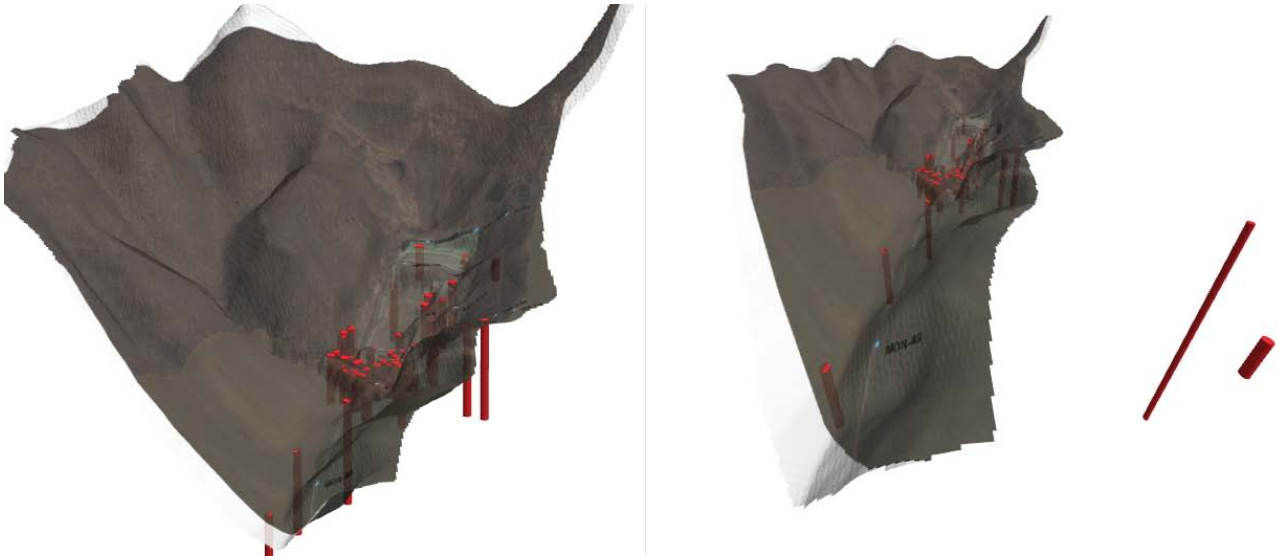


*Fig. 179: Examples of 3D Projection / Field of View changes (**Left** – orographic view, **Right** – perspective view).*

6.2.2 3D Content

This chapter explains options for adjusting the display of 3D objects in space. Functions in the **3D Wells** tab customize well displays as three-dimensional cylinders (Fig. **180**), while 2D

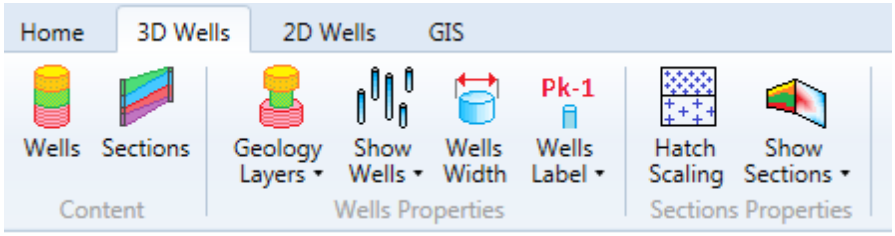


Fig. 180: *Commands for 3D objects adjustment.*

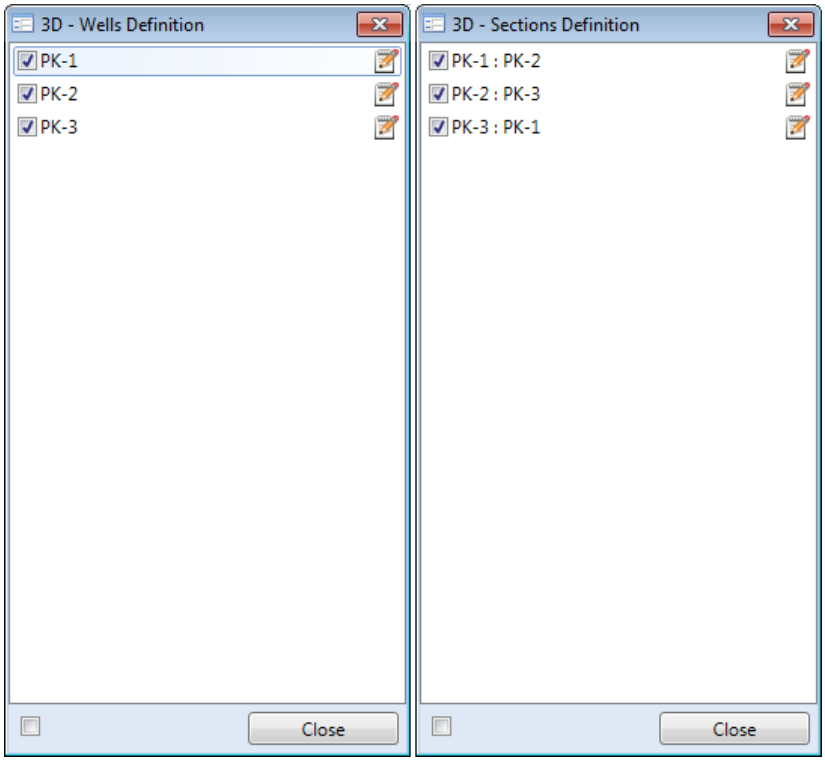


Fig. 181: *Dialogs for 3D object set-up (**Left** – dialogue for wells; **Right** – dialogue for 2D sections).*

sections are oriented as two-dimensional planar objects.

All well objects and 2D sections are initially imported into this window. Using the first two buttons **Wells** and **Sections**, you can you show or hide them, and also set their visual properties. These can be individually moderated by using these buttons to bring up the help window in Figure. **181**.

All objects are displayed in the list in Figure **181** windows. The check boxes at the beginning of each line select objects to be hidden or displayed. Clicking on the check box below the list immediately sets this property for all wells and 2D sections. Clicking on the icon at the end of each row of the list displays the help window to individually set properties for each object.

Figure **182** gives an example of this sub-dialog for wells. The first line has a label for your selected well. Using the combo box in the second row, you can set the well display. Here, you can choose from three options. (1) You can leave the original predefined colour, (2) you can define individual colours or (3) you can display different colours for different geological layers. If you use colours for different geological profiles, then the texture background colour remains exactly as it was previously defined in your geologic hatch patterns. The next row lets you define the width of the well. The pre-defined program value for this is 10, but you can change this to suit your needs. The last combo box shows or hides your 3D well caption. Clicking on **Apply** sets your properties.

Figure **182 Bottom** shows an example of the various well display settings. The first example shows wells with a predefined colour. The middle example displays a defined unique colour (Here, the well width property is increased), and the third example has different colours for individual geological profiles.

Figure **183** gives the dialog for editing 2D section properties. As described in a previous chapter, one 2D section document can simultaneously include a 2D heat map and a 2D geological profile.

Figure **183** dialog shows or hides objects in the 3D scene. You can set the display of either or both the geological section and 2D heat map, and you can define different degrees of transparency. An example of various settings is shown in Figure **184**.

Figure **185** ribbon tab provides additional features. Functions beneath the **Show Wells** button set the type of display simultaneously for all wells. This feature is very fast if you have a large number of wells in your 3D image; and manual modification can be time consuming.

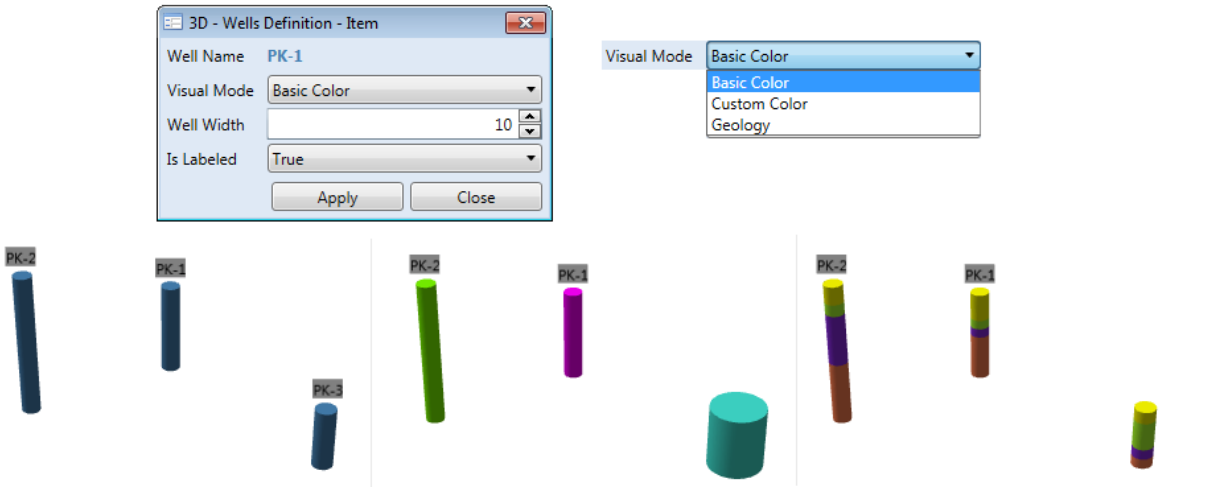


Fig. 182: *Visual modifications for well display (**Top** – help dialogue for editing visual properties; **Bottom Left** - wells with predefined colour; **Bottom Middle** - wells with individual colours and widths; **Bottom Right** - wells with colours defined for different geological profiles).*

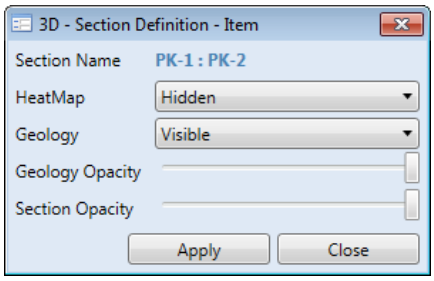


Fig. 183: *Dialog for setting-up 2D section properties.*

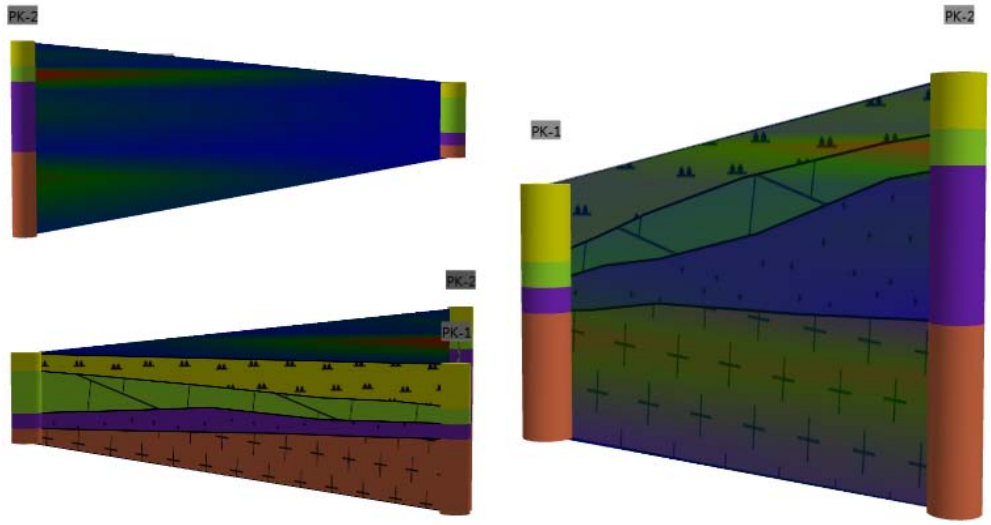


Fig. 184: *Examples of visual variations of 2D sections.*

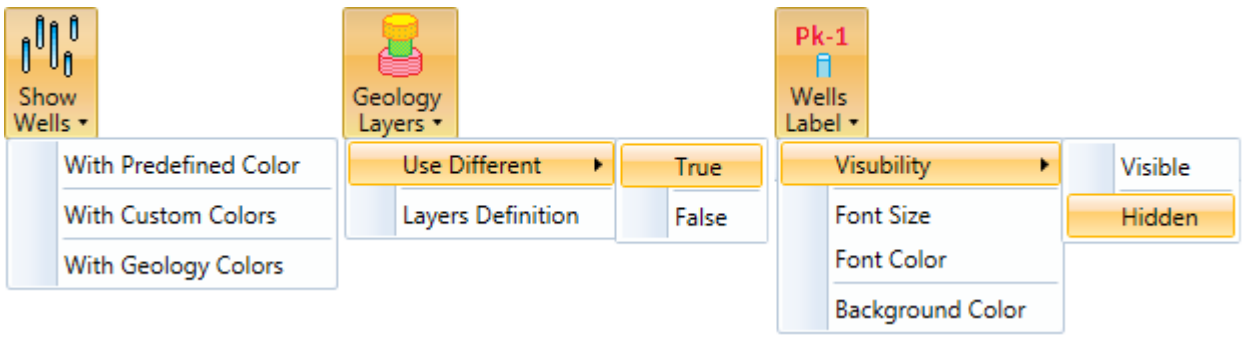


Fig. 185: *Additional features in the 3D Wells ribbon tab.*

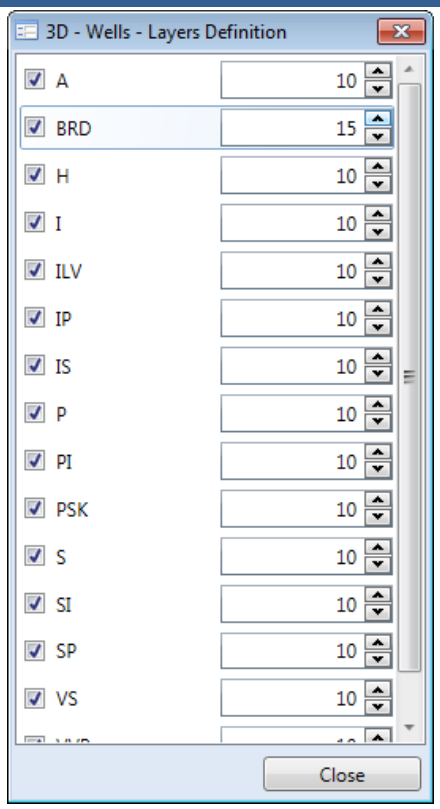


Fig. 186: *Dialogue for width definition of individual well segments according to their geological structure.*

Functions under the **Wells Label** button set your label parameters. You can show or hide them and set the background and also the size and colour of your font. The **Geology Layers** button hides functionality. This is very practical because you can set different widths for well sections which have the same **Geo ID** units. To achieve this, press the **Use Different - True** menu item, click on **Layers Definition** and adjust the width of your individual geological units. Clicking this menu item brings up Figure **186** help dialog.

All geological indexes used in your wells are automatically loaded in this window. You can the set their width. Closing this dialog ensures that your prepared settings are now in 3D image. An example is given in Figure **187**.

In this example there are a large number of wells in a small area. Widths can be adjusted depending on what you want to display. Here, sandy layers are distinguished by using larger widths for sediments with higher sand content.

The described ribbon tab also contains **Hatch Scaling** and **Show Sections** functions for 2D geological sections. **Hatch Scaling** sets the scaling of hatch patterns in geological sections as shown in Figure **188**. This feature is used when there are large distances between wells. If you enter a number less than 1, the texture will be less dense, and conversely a number greater than 1 results in greater texture density. Where your wells have a large distance between them, sometimes the texture becomes deformed when you change the default scaling. Therefore, for your geological section 2D representation in these circumstances, it is best to use a simple solid colour which doesn't need scaling.

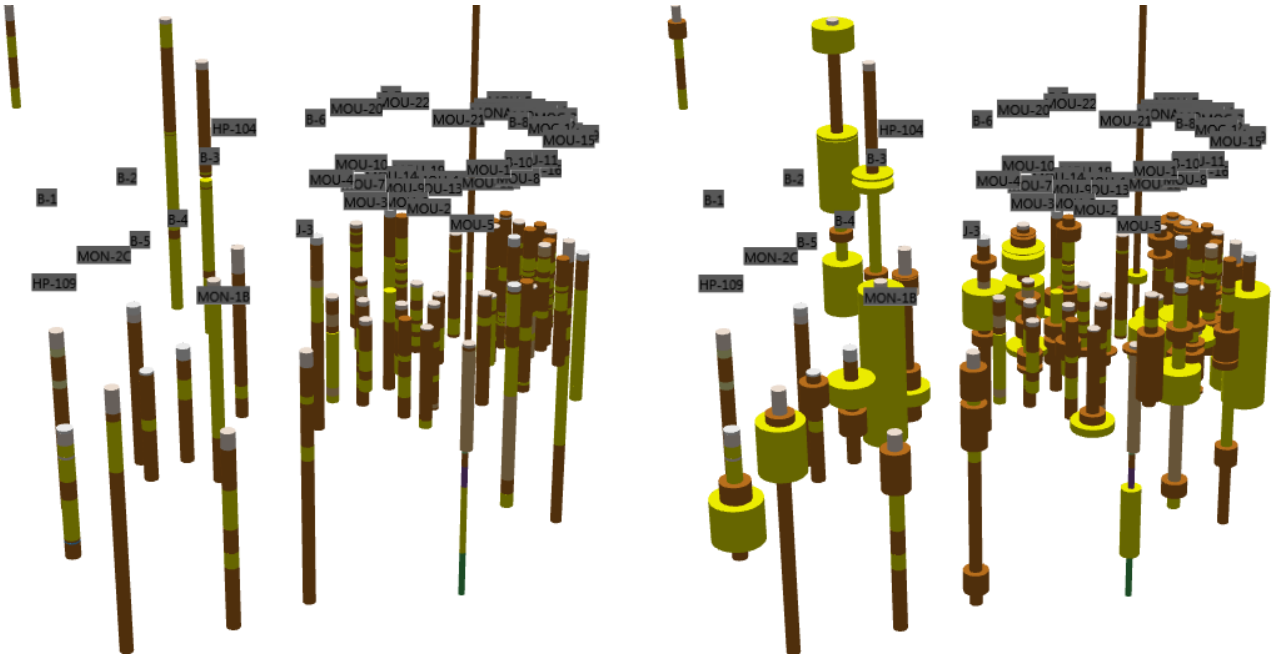


Fig. 187: *Example of different well segment widths according to their geological structure.*

The **Show Sections** menu contains two commands which simultaneously define the type of view for all sections. Here, you have the option to display your 2D Sections as geological profiles or heat maps.

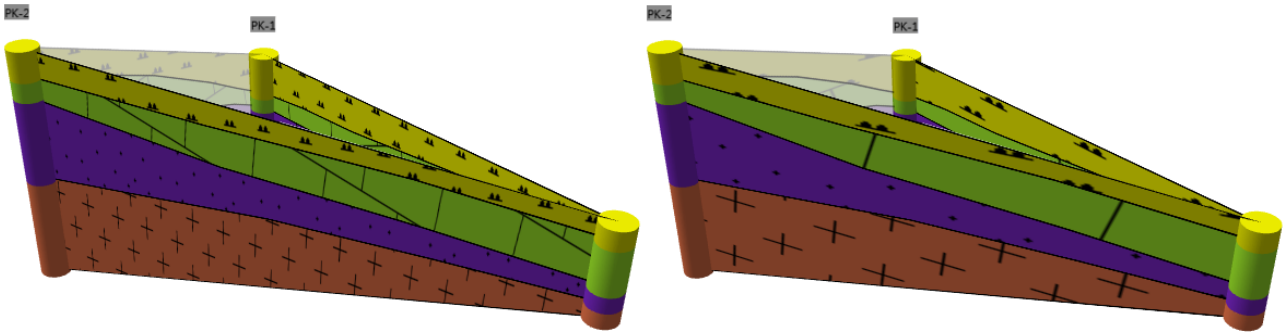


Fig. 188: *Example of hatch pattern density change using the hatch-scaling property.*

6.2.3 2D Content

The next tab is called **2D Content**. This includes functions for adding 2D objects into the 3D space (Fig. **189**). This program function is in the experimental stage, so some parameters must be set manually. You must also remember that computer rendering of 3D objects relies on you first displaying each well's data as 2D objects. The program then converts this to a 3D image.

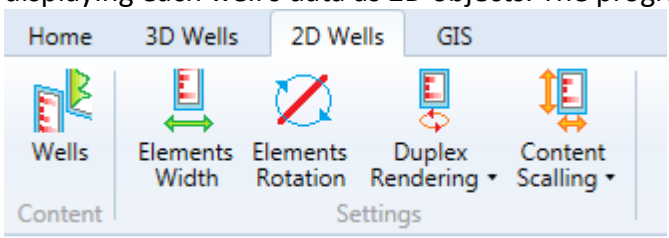


Fig. 189: *Features for displaying 2D objects in 3D space.*

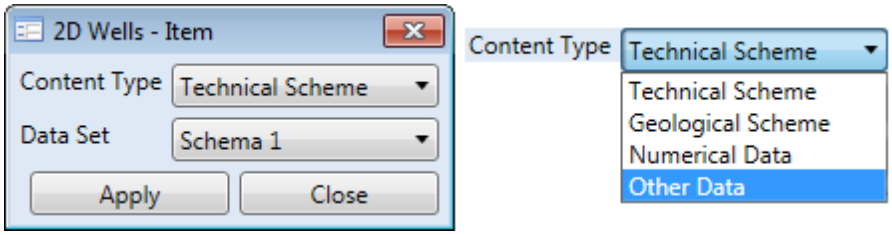


Fig. 190: *Dialog for setting-up 2D object contents.*

Your 2D objects are displayed at the positions of individual wells. When you want to display them, you must first hide 3D wells because the 3D objects have higher priority in program. Otherwise, if you show a 3D well and also a 2D object, your 2D object will not be displayed. Display and data definition is performed using the first button in the ribbon toolbar – **Wells**. A dialog similar to that for 3D wells appears. Clicking on your selected well gives you Figure **190** help window. Here, you set the data type you want to display and select the document. When you press **Apply**, you return to the previous dialog of all wells, and when you close this help window your changed settings are applied to the 3D image.

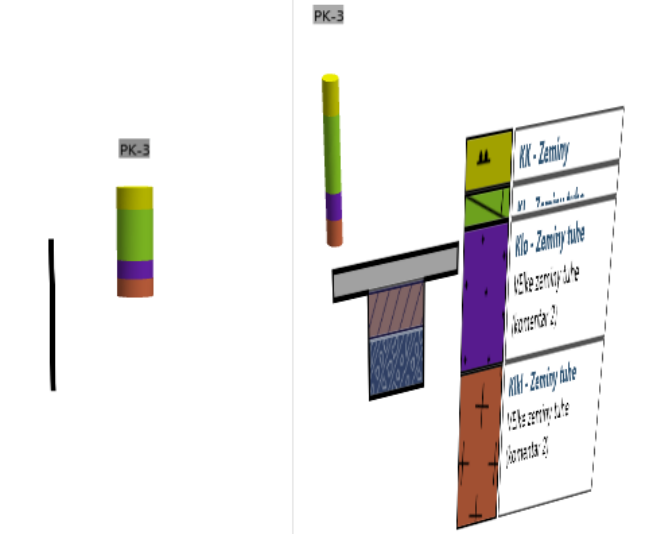


Fig. 191: ***Left*** *– initial display of 2D objects in a 3D scene;* ***Right*** *– 2D object visibility after increasing the width.*

After applying your settings, your work looks like Figure **191 Left**. Here, you have a 3D well with its 2D object, but your 2D object is most likely invisible due to its small width. For different sized 3D models you need to modify the width and content scaling of your 2D objects using those **Elements Width** and **Content Scaling** buttons. The height of each 2D object is computer defined as well depth, but you must manually adjust width using **Elements Width**. This value must be defined by

gradually varying the predefined values until your 2D objects have sufficient width. Figure **191** has an example of sufficiently increased width value, so that now both the well's 2D technical and geological schemes become visible in the 3D image.

Although the width is now sufficient and all objects are visible, the graphic resolution content remains insufficient, and your geological section's text may not be entirely visible or it may be vertically stretched. The **Content Scaling** button rectifies this so that you can set both horizontal and vertical resolution. Again, you change these values gradually until content is correctly visible.

The **Elements Rotation** and **Duplex Rendering** functions remain in the toolbar. As previously explained, 2D objects appear in the model at the well's position; and these are always oriented in the X-axis direction. Model rotation changes the visibility of 2D objects, so if you want to change the orientation of 2D objects in your 3D image, press the **Elements Rotation** button and change the predefined value. Figure **192** gives an example of this change. Here, the model was not rotated and it remains in the same position in both figures. Only the 2D object's orientation is altered.

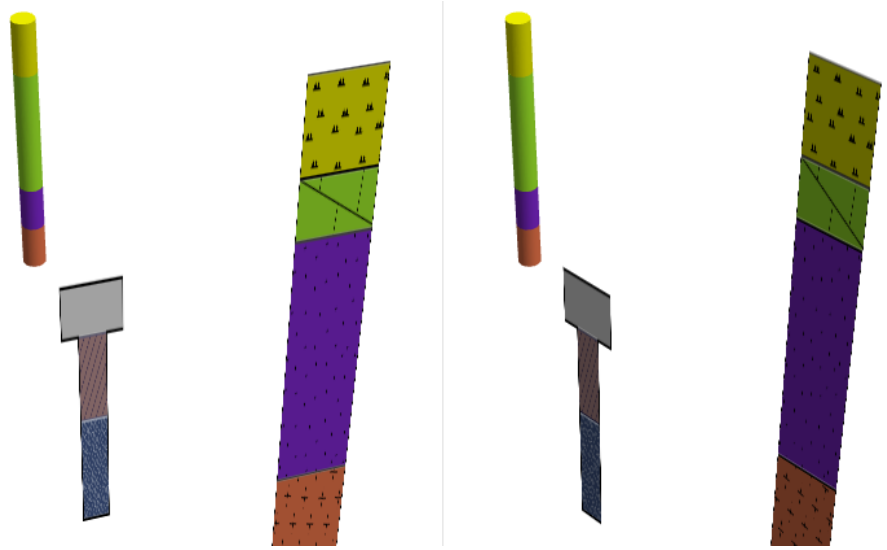


Fig. 192: *Example of 2D objects orientation in 3D space.*

Rotation of your model around the Z-axis gives you 2D content visible only from one side, with the second side fully transparent. If you also want to display the content from the reverse side, clicking the **Duplex Rendering** button displays the same content from both views.

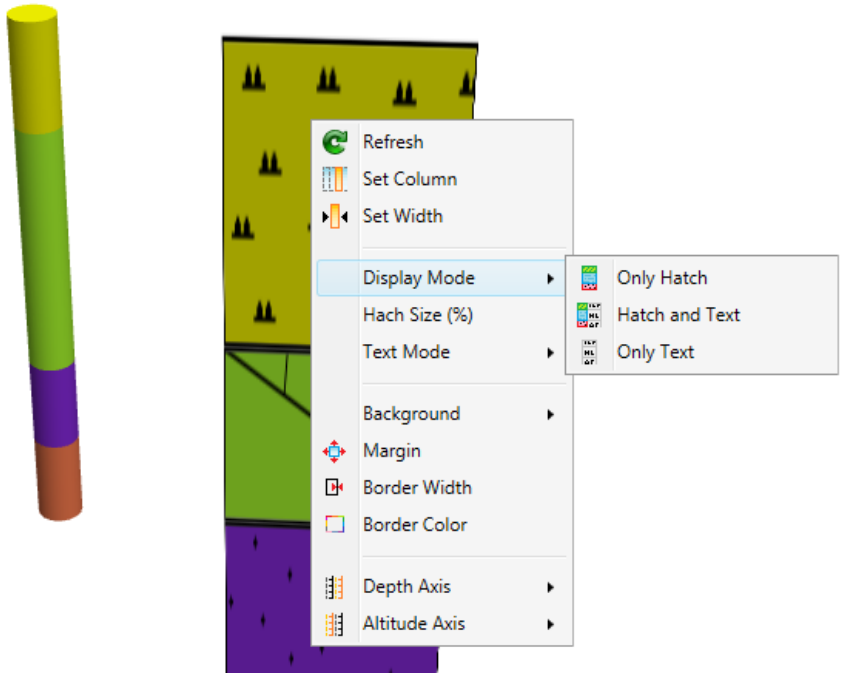


Fig. 193: *Example of direct adjustment of 2D objects in the 3D image.*

Setting these parameters perfectly takes practice, but they allow you to display extremely variable data types in 3D view. The greatest advantage of using these functions is that all the visual properties of 2D objects described in Chapter **5.4.5** are accessible. An example is shown in Figure The **193** example highlights that all displayed objects can be individually adjusted according to your requirements. These include setting the background colour or the vertical axis for altitude. It is most important to remember here that all

your adjustments are active only if the model is not redrawn. Take care, because redrawing occurs automatically if you click on any button in the ribbon toolbar. Finally, Figure 194 gives examples of various data displayed as 2D content in 3D space.

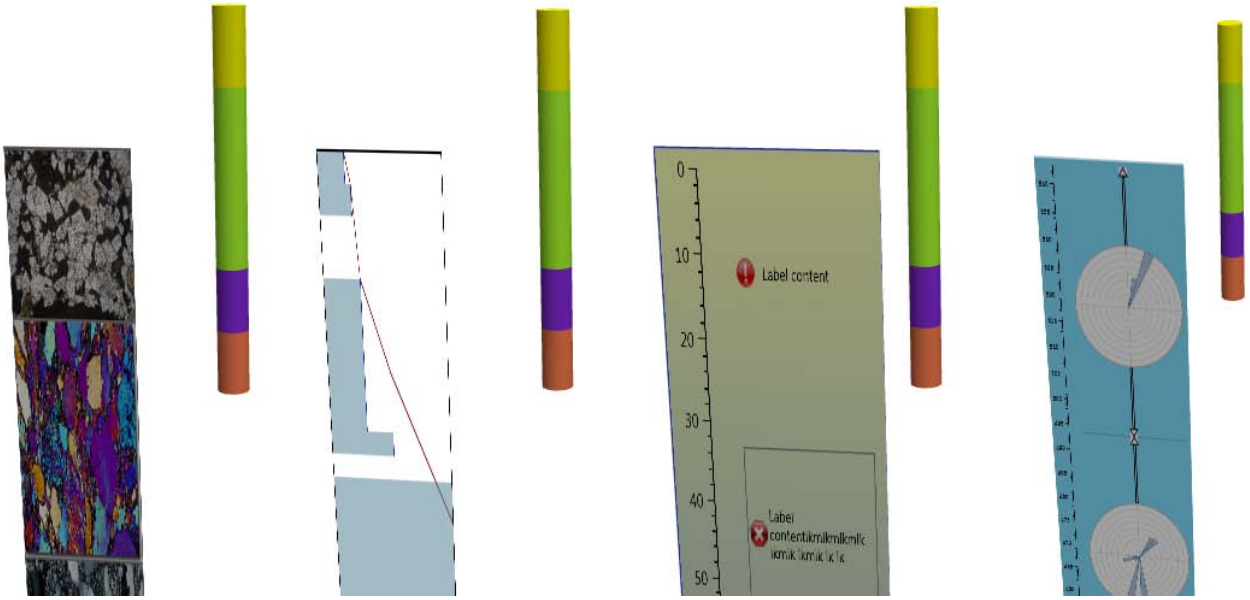


Fig. 194: *Example of data displayed as 2D objects in 3D space.*

6.2.4 GIS Data

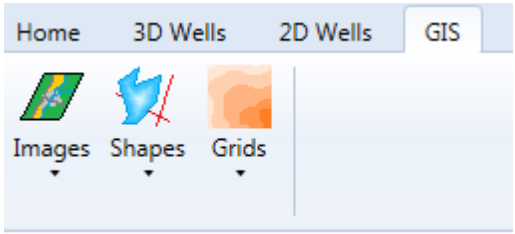


Fig. 195: *Features for working with GIS data.*

This chapter explains the final data category to be displayed in a 3D image. Buttons on Figure 195 ribbon tab enable display of **GIS spatial data**

Using these buttons you can import three basic types of spatial data into the program; (1) 2D images such as satellite maps and schemes, (2) points, lines and polygons from ESRI ShapeFiles and (3) grids, such as digital terrain models.

Addition of Image Data is achieved when you press **Images - Add Image** and open Figure 196 help form. Here, you can insert any 2D picture, such as area satellite images or geological maps, into your 3D image. The **Open** button allows you to choose images you want to import from the disk and load them in the right window pane.

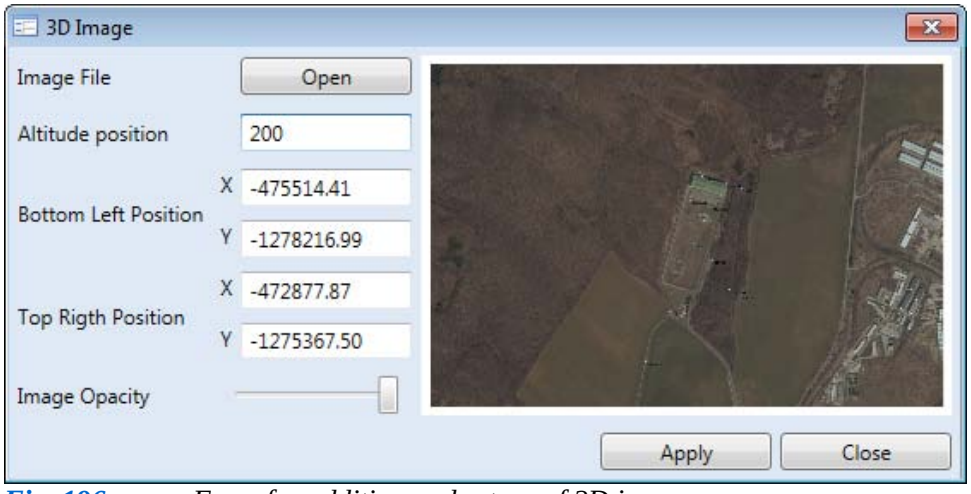


Fig. 196: *Form for addition and set-up of 2D images.*

Subsequently, you must define parameters required for correct display in 3D space. Since this is a 2D object, the **Altitude Position** at which the image is displayed must be kept constant. You then define the coordinates of the image edges with your **X** and **Y coordinates** of the

bottom left and **top right corner** of the image, respectively. The image is inserted at this defined position, and you can modulate **image transparency** using the slider. When the slider is moved to the left, the image is more transparent, while right movement gives greater opacity. After setting these parameters and pressing **Apply**, the 3D image appears as in Figure **197**.

Individual parameters of your imported images can be edited after insertion, using the **Images** button to open a window listing all your imported images. Double-clicking on the selected dialog in the image returns Figure **196** for alteration of your imported parameters.

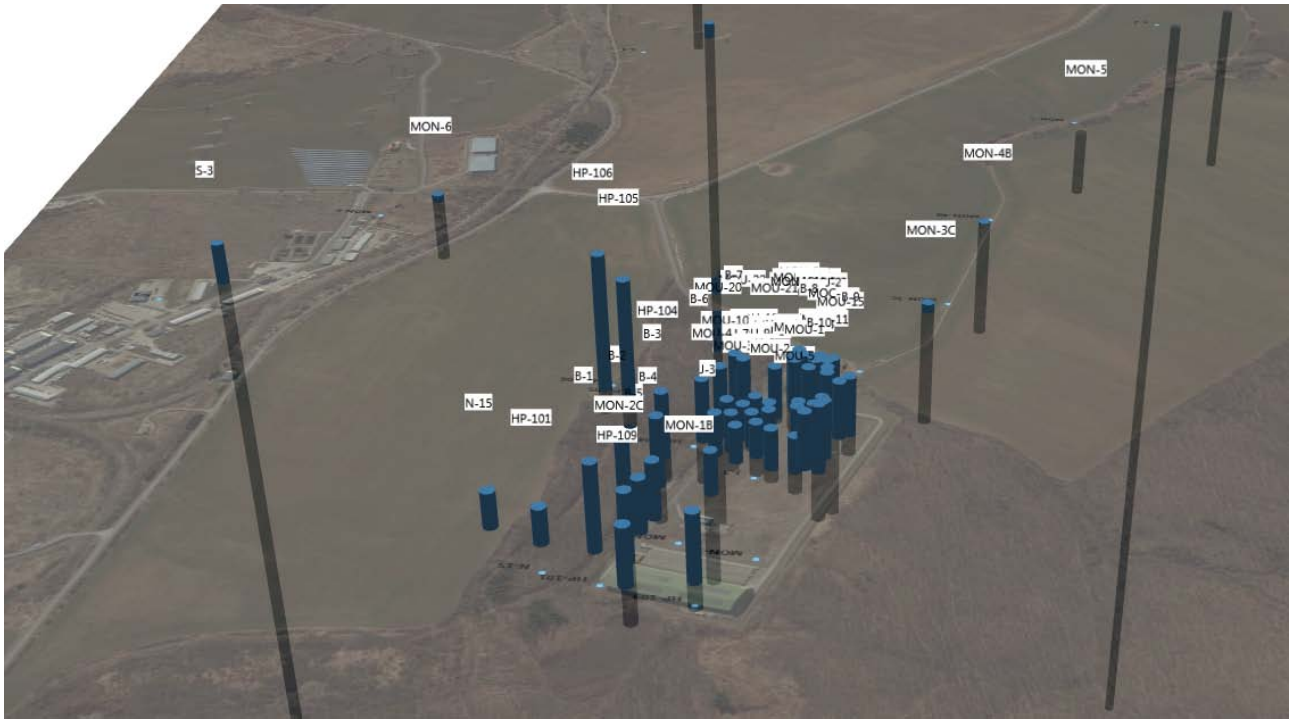


Fig. 197: *Example of a satellite map displaying the 3D image with partial transparency.*

The second button has features for working with objects stored as **points**, **lines** or **polygons** in **ESRI Shape Files** (Fig. **198**). Clicking **Add Shape** imports all type of ShapeFiles to the program. Editing an existing ShapeFile requires the following menu items; where each type of objects has a separate control window. Clicking **Add Shape** displays the **Open File Dialog**. Here, you select the file on disk where your data is stored. The program allows you to import files with *.shp file extent. After data selection, the Figure **198 Right** dialog is displayed. If you want to insert GIS data into the 3D space, you must know both its X/Y space and vertical positions. The program assumes that the **altitude position** of each object is defined in the shapefile's attribute table. Therefore, in the **attribute table** dialog, you only need to select the column where your objects' altitude values are stored. Clicking on **Apply** imports this data into your 3D image.

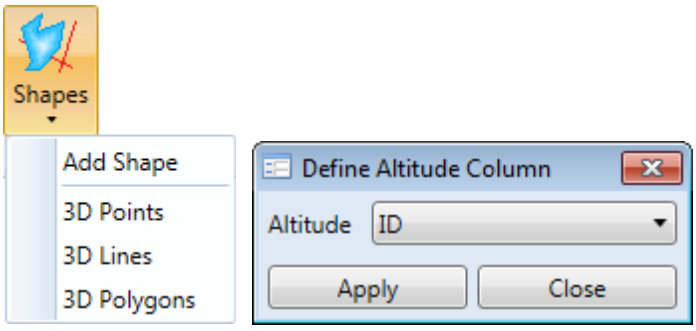


Fig. 198: ***Left*** *– features for working with ESRI Shape Files;* ***Right*** *– dialog for altitude coordinate definition in the attribute table.*

Examples of this 2D imported points and lines method are shown in Figures **199** and **200**. Importing gives all objects in the steel blue predefined colour. If you want to change their visual characteristics, press the **Shapes** menu items to give you a prepared window with your imported data, ready for you to select and edit visual properties. The example dialog for visual adjustment of 3D points is given in Figure **199**. Here, you can set point size and colour. You can define the visual properties of 3D

objects as a single colour as in Figure **199 Left**. If you want a combination of colours, choose the colour palette, and your points are coloured-coordinated with your altitude values (Figure **199 Right**). In the same way, you can modify the visual characteristics of the 3D lines as in Figure **200**.

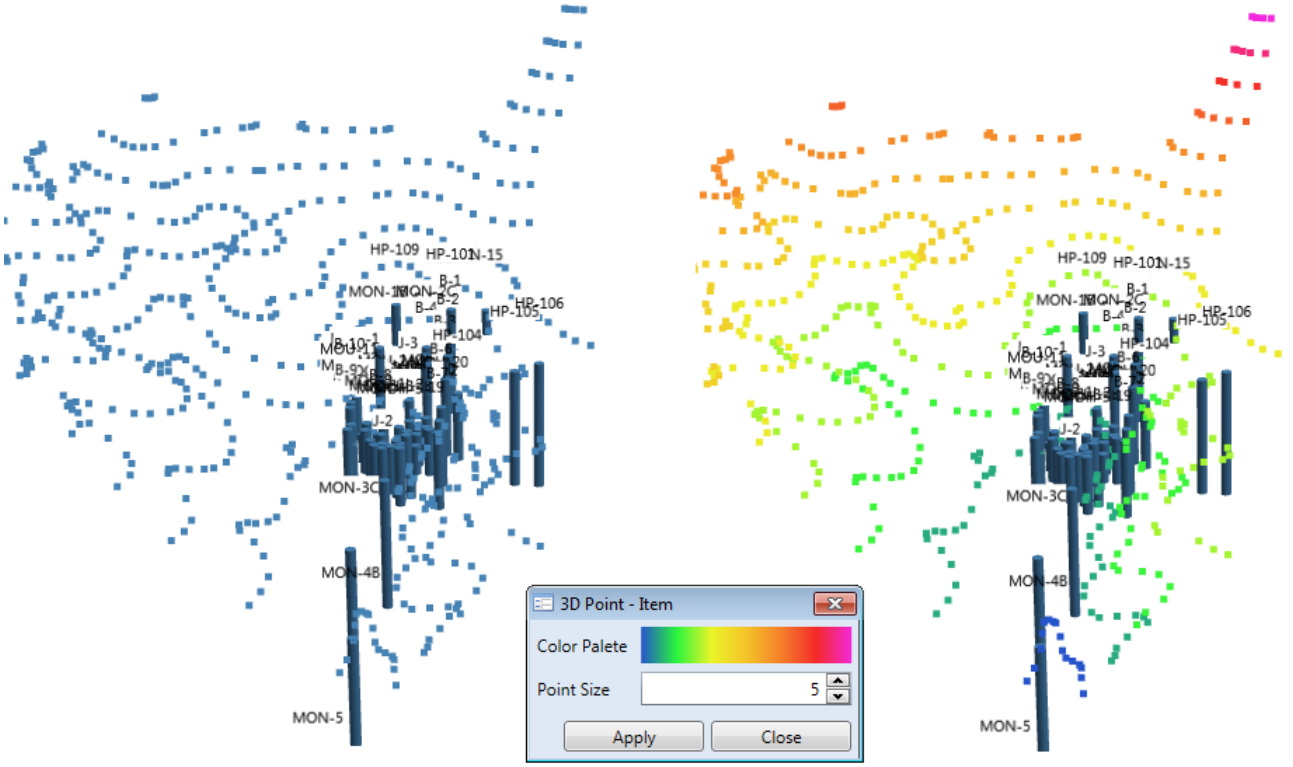


Fig. 199: *Example of visual properties adjustment for 3D Points in your model.*

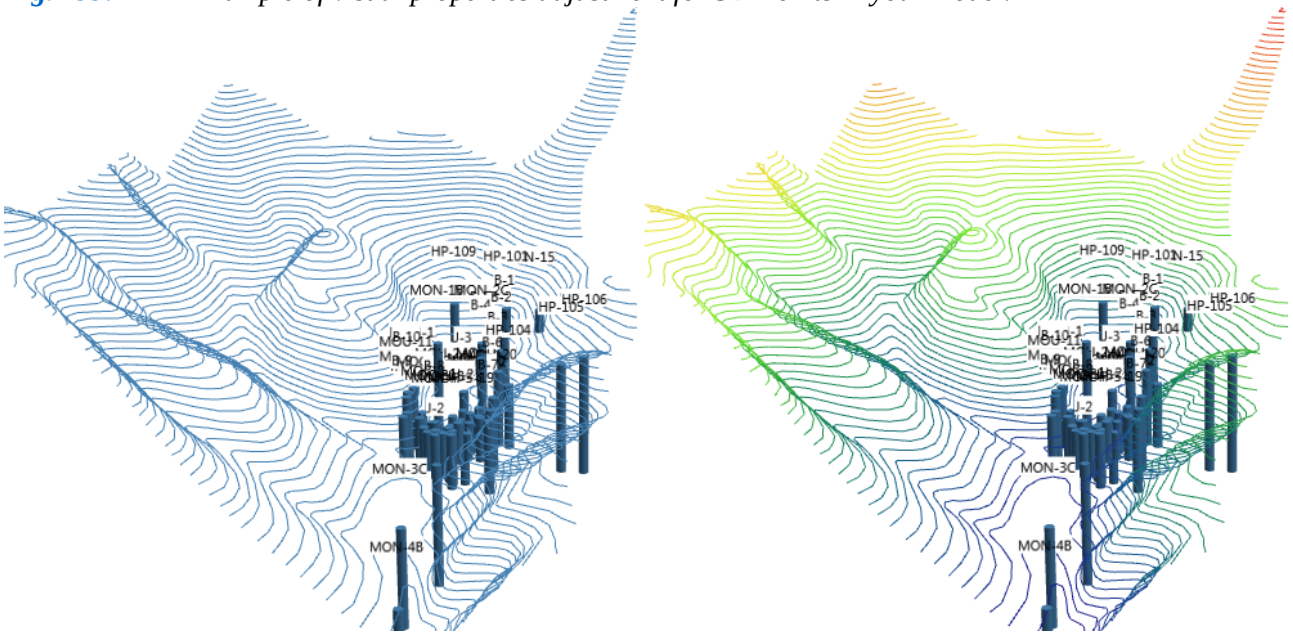


Fig. 200: *Example of visual properties adjustment for 3D Lines in your model.*

The **import** of **polygon shapes** has a **specific purpose** in Well Plotter 3D. Information about 3D objects, such as buildings, can be stored in this type of shape file.

If you wish to store building shapes in your files, these can only have a maximum of four sides. If the polygon has more than four edges, only the first four are read and the rest are ignored. You first prepare two numeric columns in the attribute table for this shape file. In one you store the altitude of your 3D object's base in metres above sea level, and the second contains the height of your object in metres. This prepared file can then be imported into the program. When you choose

your file from the disk, the dialogue in Figure **201** is displayed. Then using the combo boxes you assign columns from the attribute table to the properties and press the **Apply** button. The selected file is now imported into the 3D scene; as in the example in figure **201 Right**. Your 3D polygons can be edited using the built-in dialogs; exactly as you edited previous 3D object types.

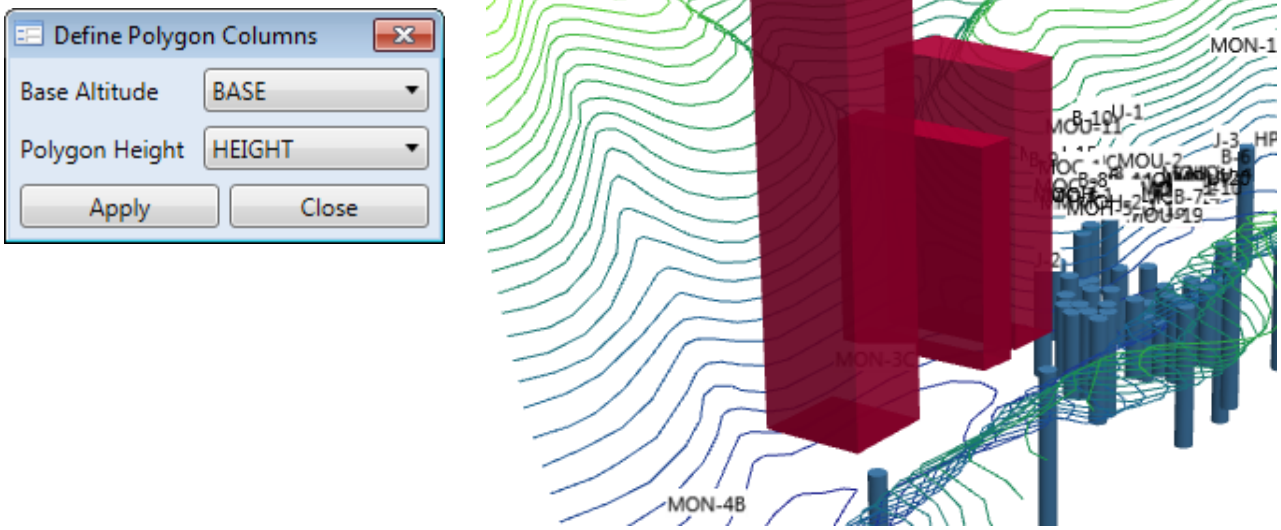


Fig. 201: ***Left*** *– dialogue to assign the required properties from the attribute table for shape files;* ***Right*** *– example of rendered 3D polygons.*

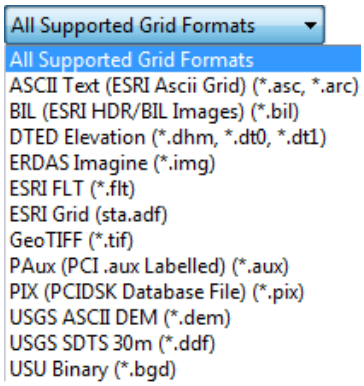


Fig: 202: *Grid data import options.*

The last type of file that can be imported into the program contains grids, and here the program enables you to read a relatively large number of grids types, including ESRI ASCII Grid, GeoTiff and USGS ASCII DEM (Fig. **202**).

For grid import and management, you use functions below the last ribbon button. After loading your file, the grid is displayed in your 3D image as in Figure **203**. Each imported grid is initially rendered in opaque steel-blue colour. You can then optionally edit them. When you click on the **Grid - Grids** item in the ribbon toolbar, Figure **202** dialog listing all imported grid choices appears. Double-clicking on your selection brings up the next dialog where you can visually adjust your grids.

The window initially resembles Figure **204 Top Right** where the dialog has a predefined palette and combo box. You can then make the visual adjustments to the grid shown in Figure **204**. If you want to change the colour palette, just click on it with your mouse. You have the option of the following four described display types; **One Colour**, **Wire Frame**, **Heat Map and Image**.

The first display type is **One Color**. Here, you choose one colour for the entire grid from the colour palette. An example is shown in Figure **205**, where the predefined colour was changed so that individual wells are visible (transparency property). The second display type in Figure **206** is used to draw your grid as a **Wire Frame** in one colour. The third **Heat Map** grid display is rendered using the colour palette to define altitude. This mode gives you the option of continuous transition or

sharp colour definition, as shown in Figures **207** and **208**.

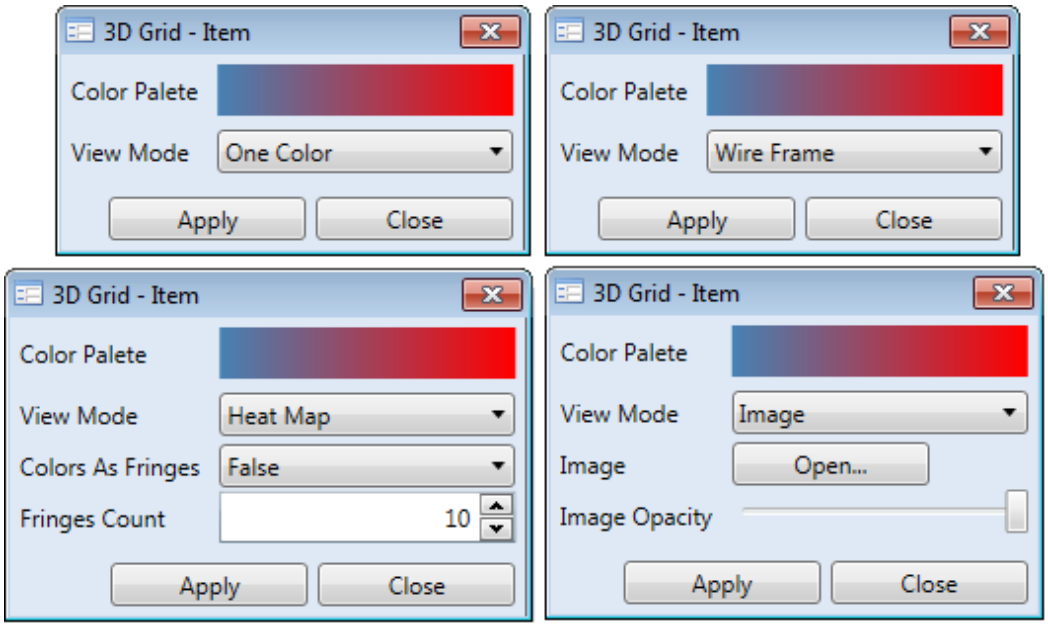


Fig. 204 *Dialog for adjustment of your selected grid's visual properties.*

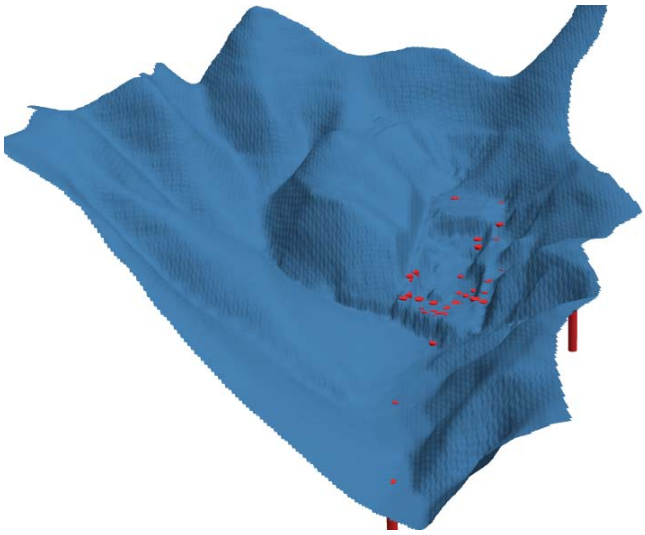


Fig. 203: *Initial display of imported grid.*

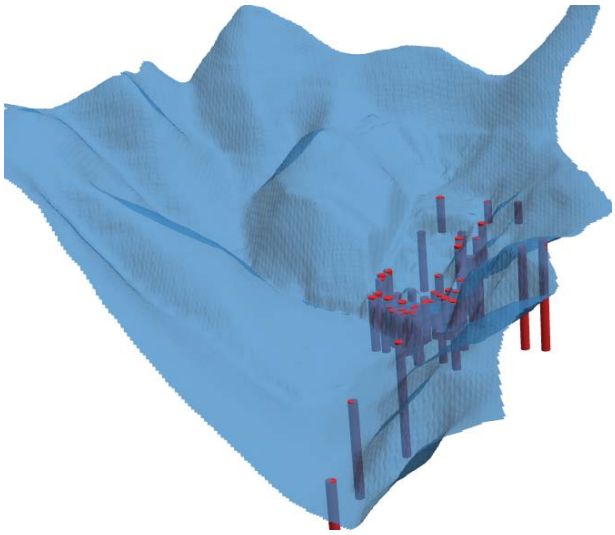


Fig. 205: *Example of grid display in One Color mode.*

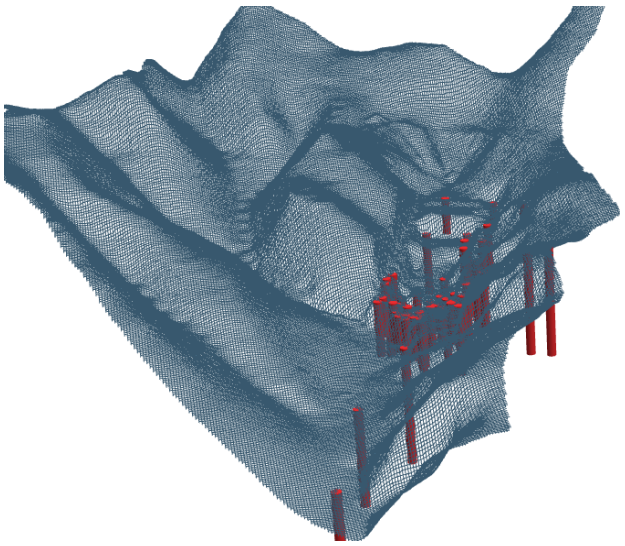


Fig. 206: *Example of grid display in Wire Frame mode.*

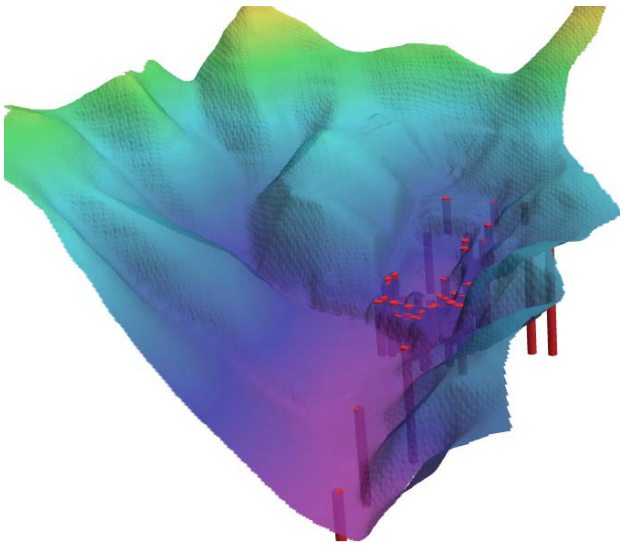


Fig. 207: *Example of 3D grid display using a continuous coloured heat map for altitude.*

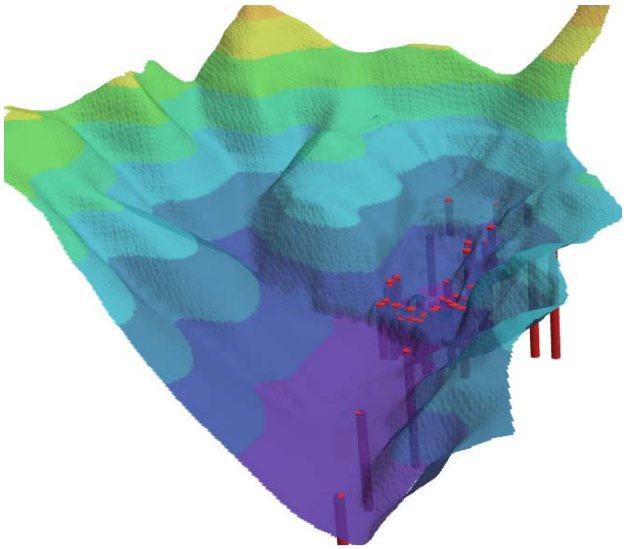


Fig. 208: Example of 3D grid display using a heat map with colours fringes.

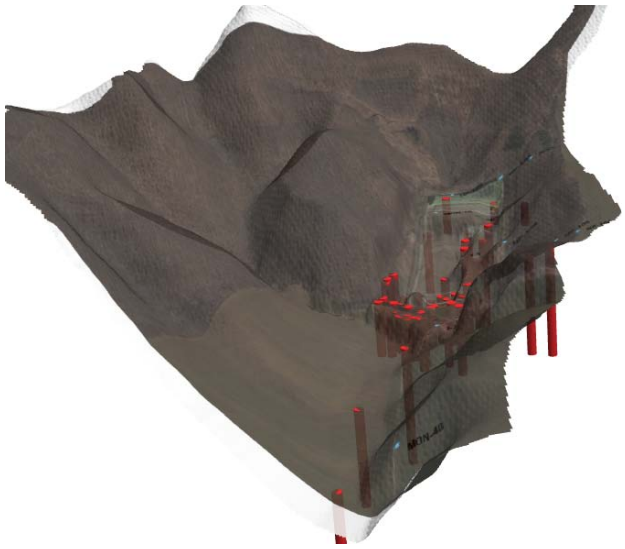


Fig. 209: Example of a satellite image for your 3D-grid background.

The last mode is **Image**. Here, you display the grid's satellite background image from your disk, as pictured in Figure **209**. The spatial extent of both axes (X_{min}, X_{max}, Y_{min} and Y_{max}) must be identical in both your grid and image, otherwise the image will be incorrectly displayed.

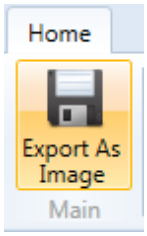


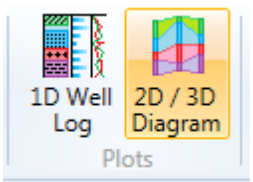
Fig. 210: Command for 3D model export from program to disk as an image file.

All possibilities for importing and editing 3D image visual properties have now been covered. The described functions can be combined in various ways to get your 3D visualization in its desired form. You can export this image from program to disk as an image file by choosing the **Export As Image** button on the toolbar (Fig. **210**).

The exported image can be used in the next step for producing your final 2D/3D plot, which will be described in following chapter. In addition, **Annex 5** shows some examples of 3D scenes based on real data.

6.3 2D/3D Diagram

2D/3D Diagram is a specific type of visualization for spatial data that you create in Well Plotter 3D. The result is an image-file displaying selected data in a structured form. You can create this visualisation by pressing the **2D / 3D Diagram** button situated under the **Home** ribbon toolbar tab (Fig. **211 Left**). Pressing this button gives you the form in Figure **211 Right**.



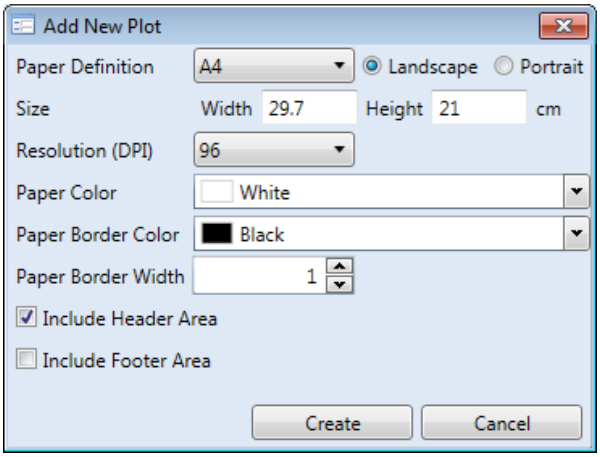


*Fig. 211: **Left** – function for 2D / 3D Diagram plot display; **Right** – help form for defining the basic properties in your Diagram plot.*

This form helps you set the basic characteristics of your visualisation plot.

This includes its **size**, **orientation**, **background colour**, **thickness** and **border line colour.** Here you can also set **header** and **footer visibility**. Parameter Resolution (DPI) does not function here as it does in the 1d-Well-Log and it does not define your final rendering resolution. Here, the DPI only increases paper size. Clicking on the **Create** button displays the empty document for your plot shown in Figure **212**.

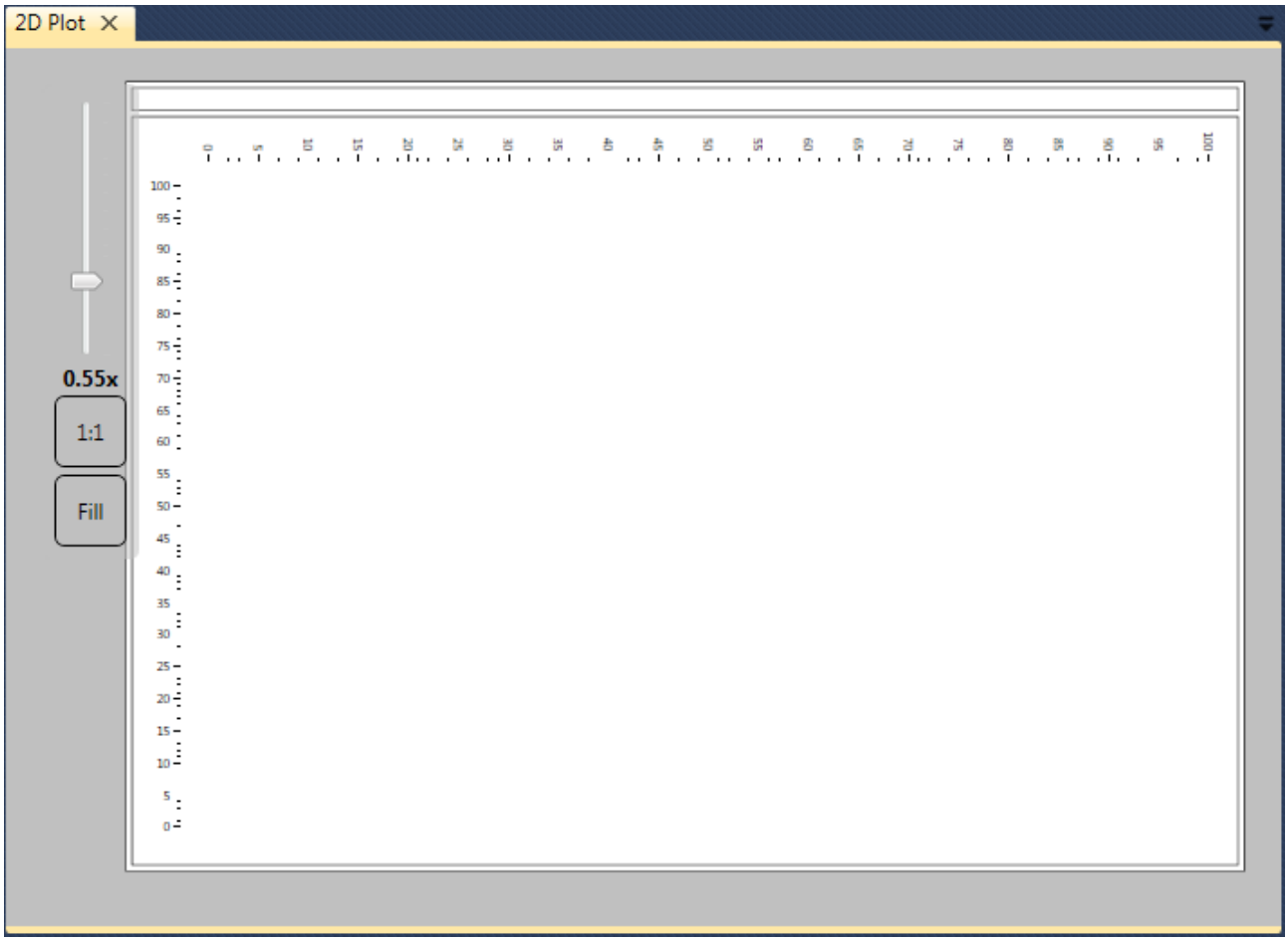


Fig. 212: *Example of the empty newly-created 2D / 3D Diagram.*

This document initially contains only one empty 2D Section, with the option of empty header and footer areas. The ribbon toolbar is also altered to give contextual tabs designed for work with the Diagram, as illustrated in Figure **213**.

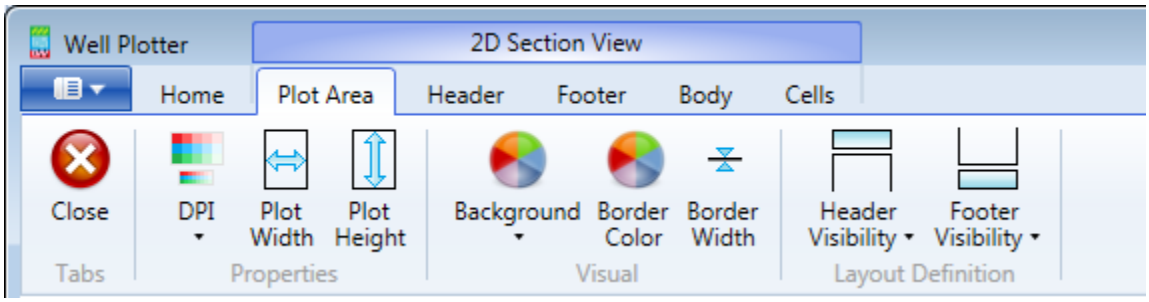


Fig. 213: *Ribbon context tabs for working with the 2D / 3D Diagram.*

The functionality of the contextual tabs is very similar to those in the 1D Well Log described in **Chapter 5.4**. Work with the basic functions, such as definition and creation of header and footer areas and setting the visual parameters for the paper and its parts is described in detail in that chapter; and it works exactly the same here. Therefore, only the features specific for the 2D / 3D Diagram are now described. The first difference in functionality is in the ribbon tab called

Body, where you process the **Body Area** of the plot displaying your data (Fig. **214**).

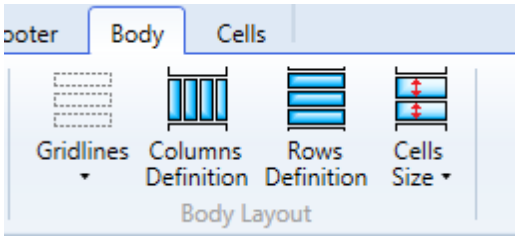


Fig. 214: *New features in the Body ribbon toolbar tab.*

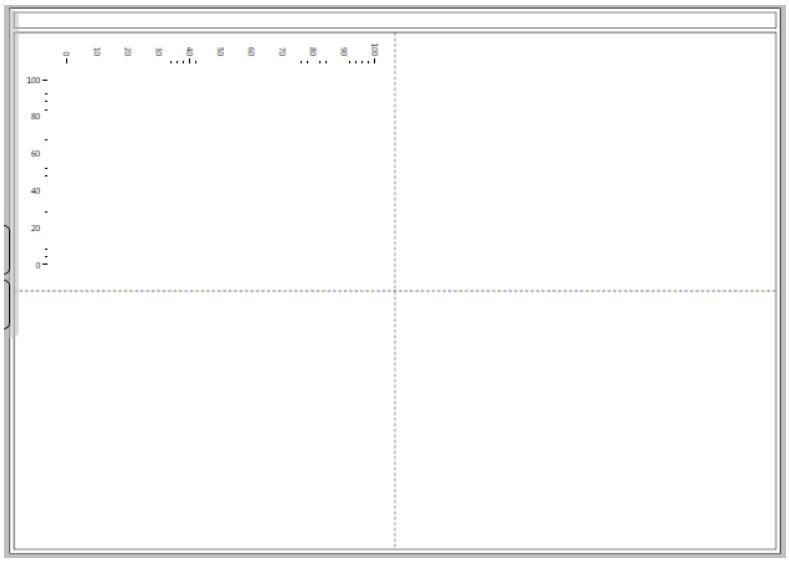


Fig. 215: *Row and column definition in the Body area of the Diagram.*

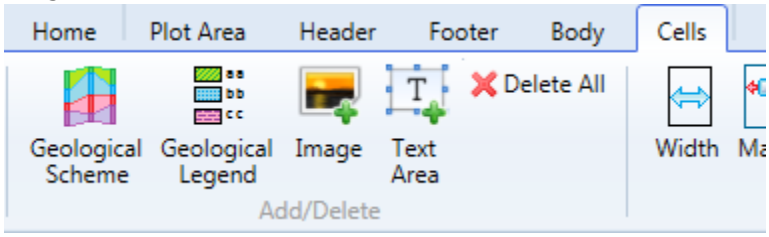


Fig. 216: *Ribbon tab with features for adding graphical content to your plot.*

In contrast to the 1D Well Log, here you can use functions to define both the number of columns and the number of rows. The resulting diagram can be divided into any number of areas and cells. Figure **215** below illustrates body area division into four cells.

You can add graphical content in these cells by choosing the last ribbon tab, called **Cells** (Fig. **216**).

Four types of visual objects can be added to your diagram. These are the **2D Geological Scheme**, the **Legend** for geological schemes, the **Image** object, and the **Text Area** object. Figure **217** shows addition of these graphical objects, and the next four sub-chapters describe your work with these objects, beginning with the **2D Geological Scheme**.

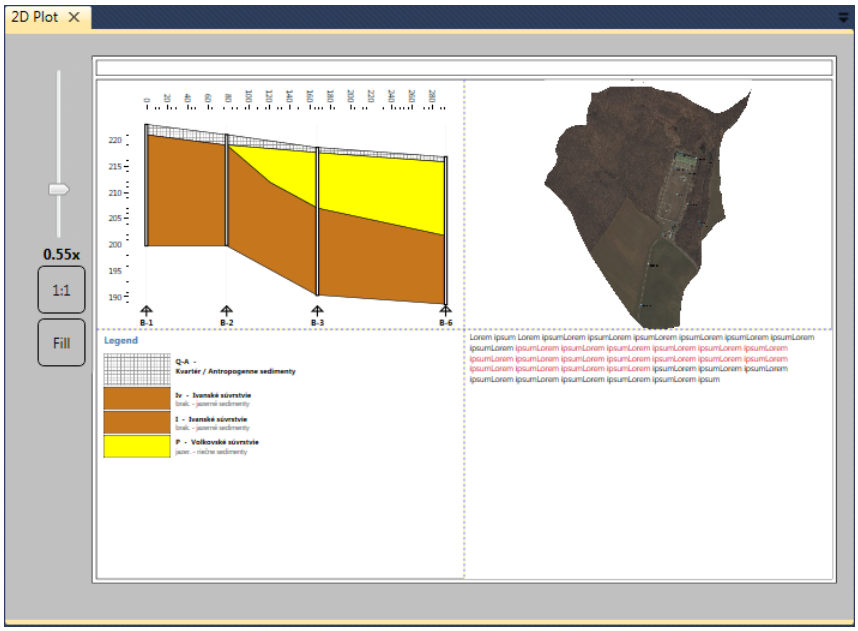


Fig. 217: *Example of graphical objects you can add to your Diagram.*

6.3.1 The 2D Geological Scheme

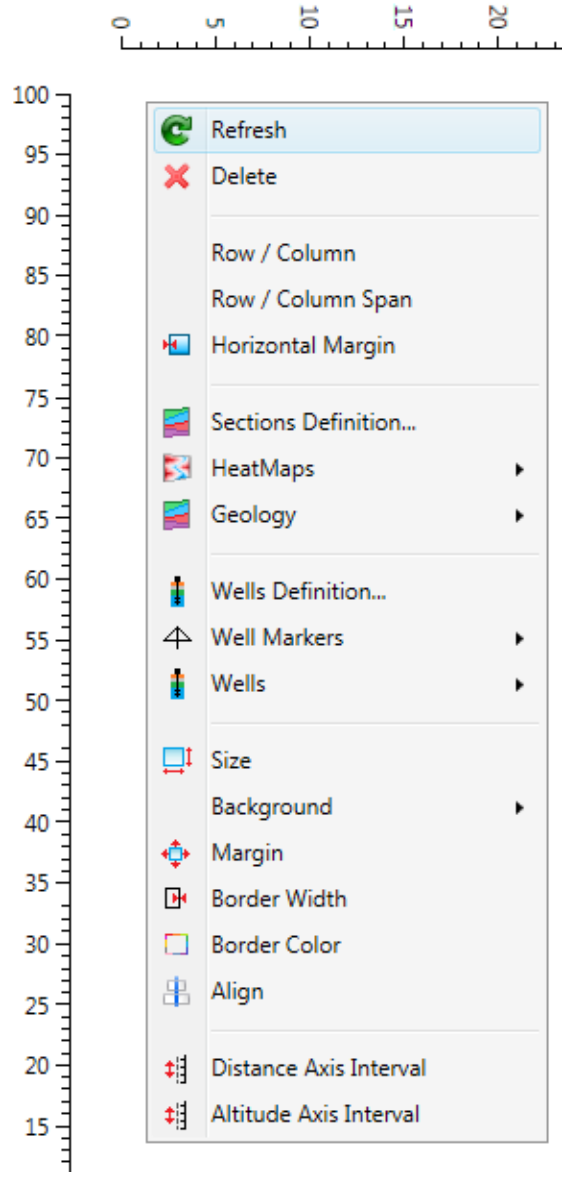


Fig. 218: *Functions for working with the 2D Geological Scheme hidden in the context menu.*

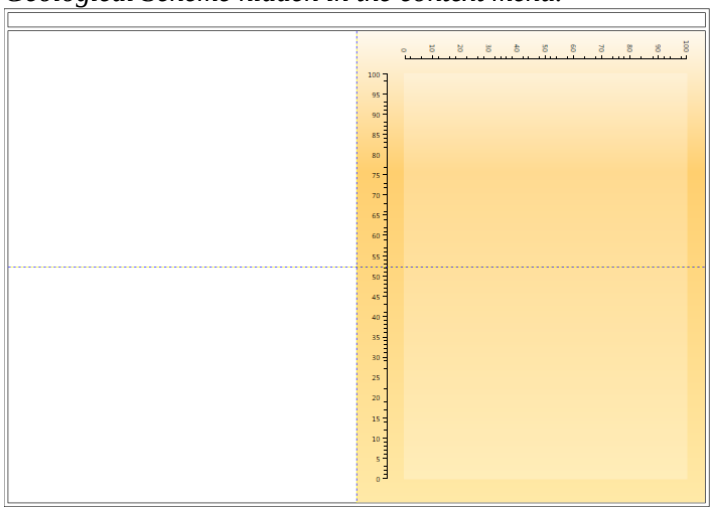


Fig. 219: *Object position set-up in the Body area cell structure.*

The initial display of your 2D / 3D Diagram contains only one empty 2D Scheme. This Scheme consists of two axes; the vertical elevation axis and a horizontal axis for the distance between wells. Each time you add a new **2D Geological Scheme**, you always start with an empty rectangle with two axes. To work with this object, use "**features hidden in the context menu**" which is displayed when you right-click on the Scheme (Fig. **218**).

Using these functions, you can set-up all the following for correct 2D Section display; (1) the **Refresh** function is used to redraw the whole 2D Section, (2) the **Delete** item deletes your object from the plot, (3) the **Row / Column** and **Row / Column Span** functions define the object's location in the cell structure, as depicted in Figure **219**. Here the object is moved to the second column and stretched across two rows, (4) several menu items following this are used for 2D Section definition related to the well data you want rendered, and (5) all the remaining functions from **Size** to the end serve for graphical adjustment of your entire object. These adjust the **size** of your section, the **background colour**, the **offset** from the edges, the **horizontal** and **vertical alignment**, the **colour** and **thickness** of the **border line** and the **interval** for **axes label** display.

If you want to display selected **wells** and **2D Sections** in this object, you use the commands from the central part of the contextual menu in Figure **220**.

The first three menu items in Figure **220** set-up your 2D Scheme and the rest display the well data. Clicking on **Sections Definition** brings up the dialogue in Figure **221** where you can choose individual 2D Sections you want to display in one Scheme from the list on the left side. An important condition here

is that the individual sections must follow each other. After your selection, click on the **Apply** button and the selected Sections are displayed as a 2D Scheme illustrated in Figure **222**. Depending on the data you import, you can adjust values on the X altitude axis and the program automatically calculates distances between selected wells on the Y horizontal axis. The position of individual wells in the final 2D Scheme is displayed as a simple white rectangle with black-coloured border lines, and the well names are displayed under the scheme.

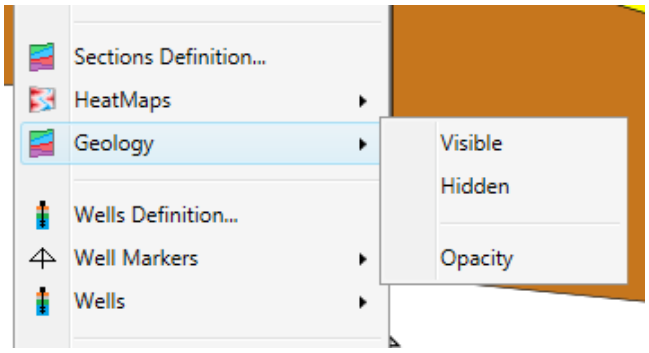


Fig. 220: *Commands for selected data you can display in the 2D Scheme.*

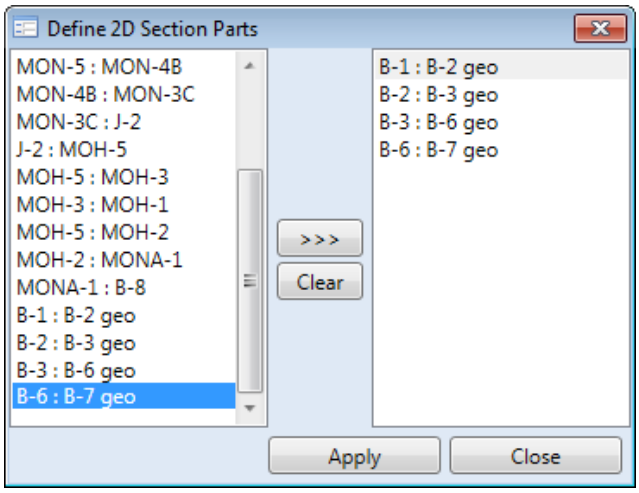


Fig. 221: *Dialog for selection of individual 2D sections.*

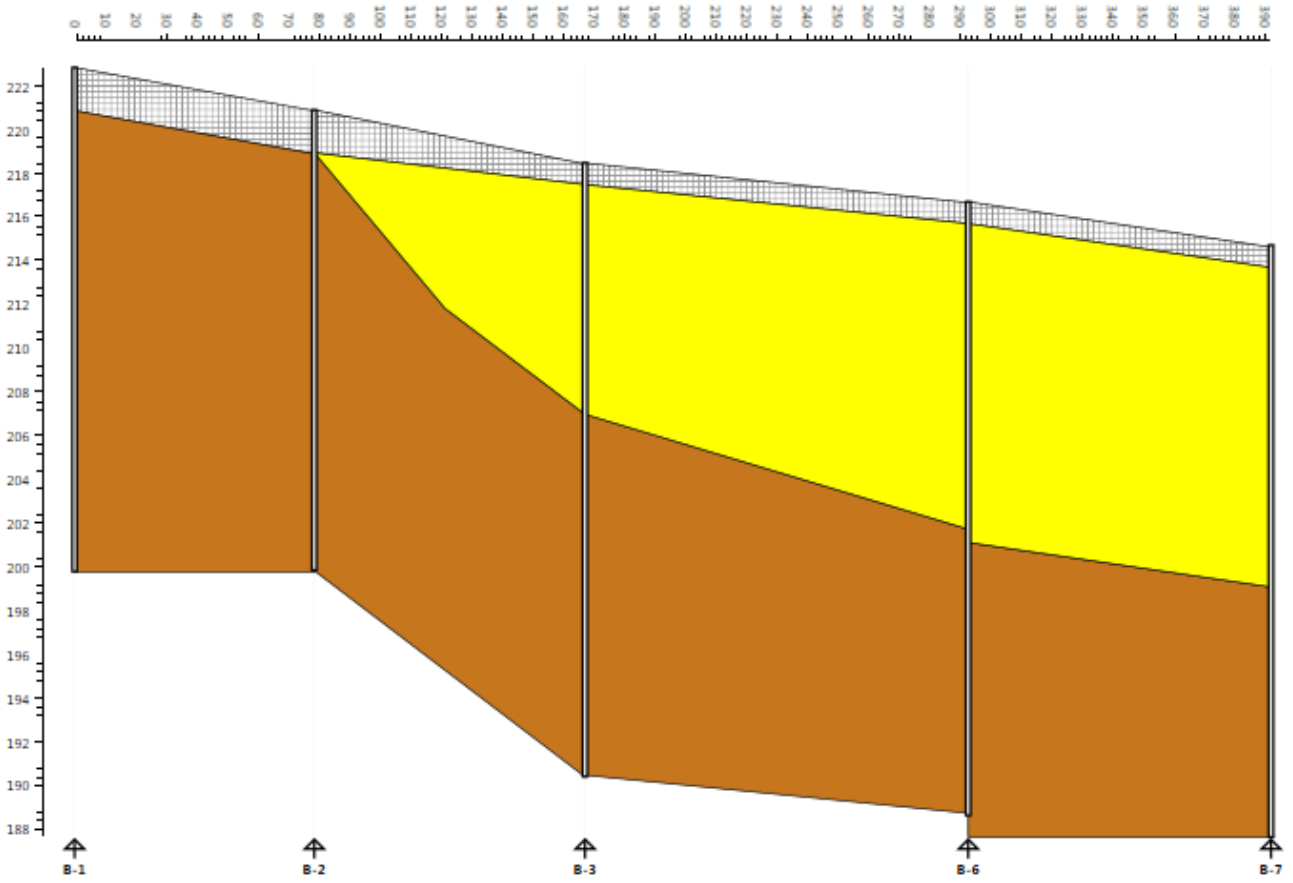


Fig. 222: *Example of 2D Scheme based on selected 2D Sections.*

If an individual 2D Section contains both geological strata and a 2D heat map, you can choose which you want to display using **Sections Definition – HeatMaps** and **Geology**. Using these features, you can set the visibility of these elements and the degree of transparency, as shown in

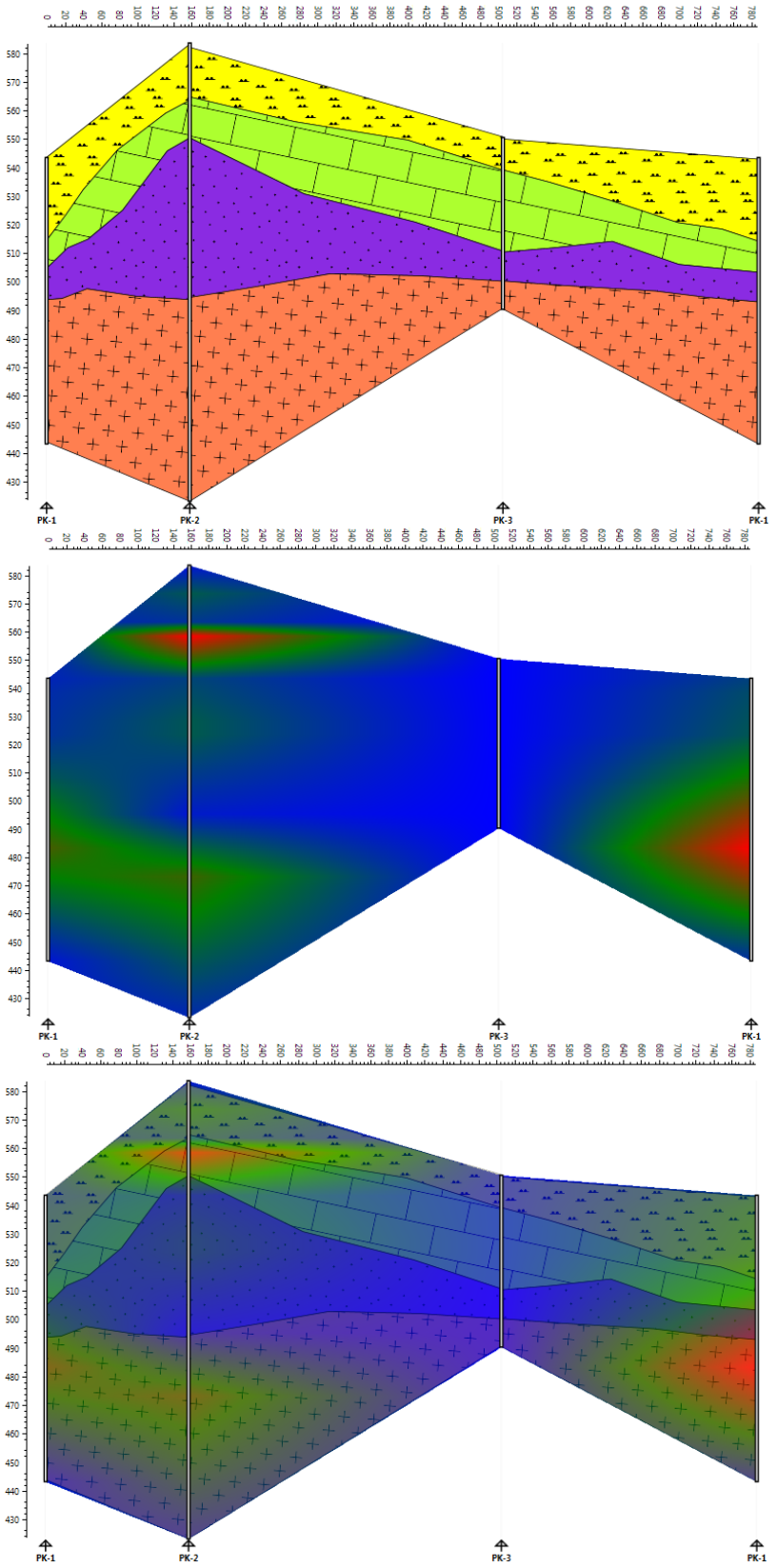


Fig. 223: Examples of combined views consisting of geological structure and numerical 2D heat map.

Figure 223. You can therefore display either the geological structure or numerical heat maps in a 2D Scheme. Alternatively, these objects can be combined using different transparency settings.

The **Wells Definition** item in the context menu allows you to define well data and related data documents you want displayed in the 2D Scheme. Clicking on this item gives you Figure 224 dialog. With the **Well**, **Data Type** and **Data Set** combo boxes, you must define the exact data that you want in your 2D Scheme. You nominate your Well in the first of these, and Data Types are automatically loaded. The third combo box lists individual data documents for your selected well. Then, press **Apply**, and your selected data is displayed in the 2D Scheme shown in Figure 225.

Figure 225 2D Geological Section has adjusted transparency to give clear distinction. These well data objects have dynamic visibility, when you adjust them using the features in their related context menu which appears when you right-click on the object. However, again you must remember that these customized adjustments are inactivated when you press the Redraw function for the entire 2D Scheme. The example of an adjusted geological object is shown in Figure 226. This can then be edited exactly as for 1D Well Log objects described in Chapters 5.4.5.1 to 5.4.5.9. Figure 227 gives an example of different well data types used in 2D Schemes.

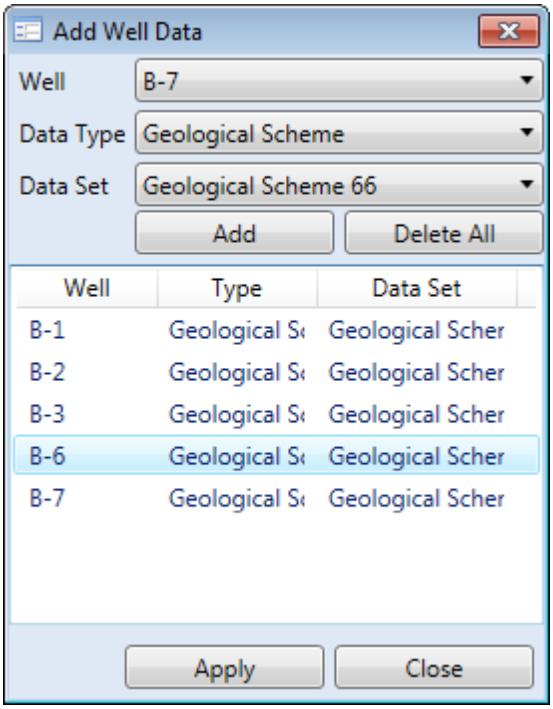


Fig. 224: *Dialogue for well data selection.*

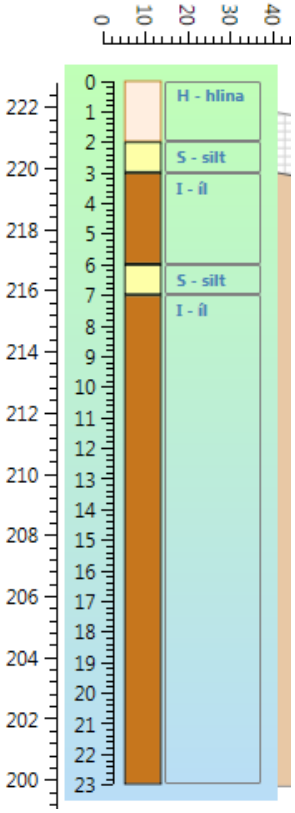


Fig. 226: *Example of manually adjusted geological object in your 2D Scheme.*

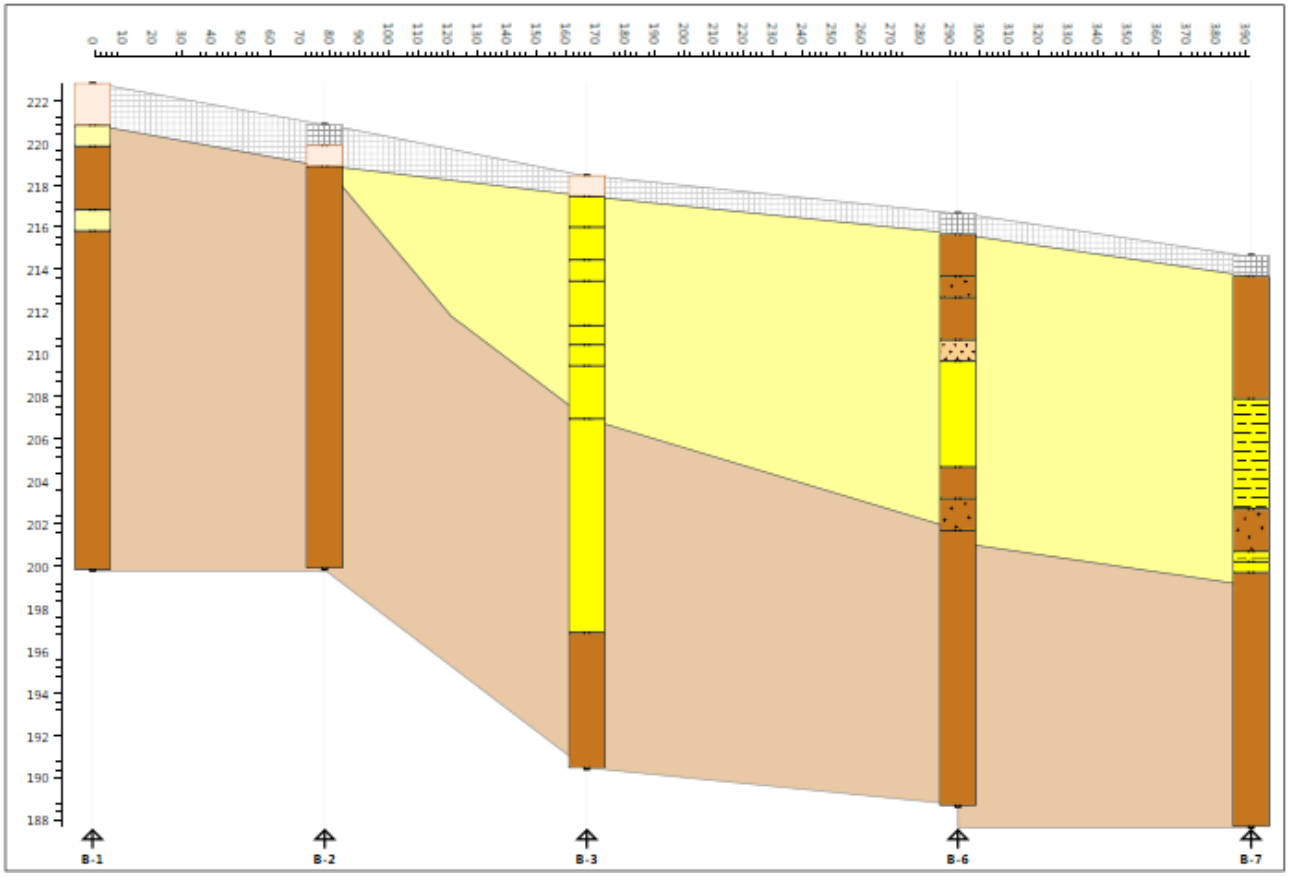


Fig. 225: *Example of imported geological schemes for individual wells.*

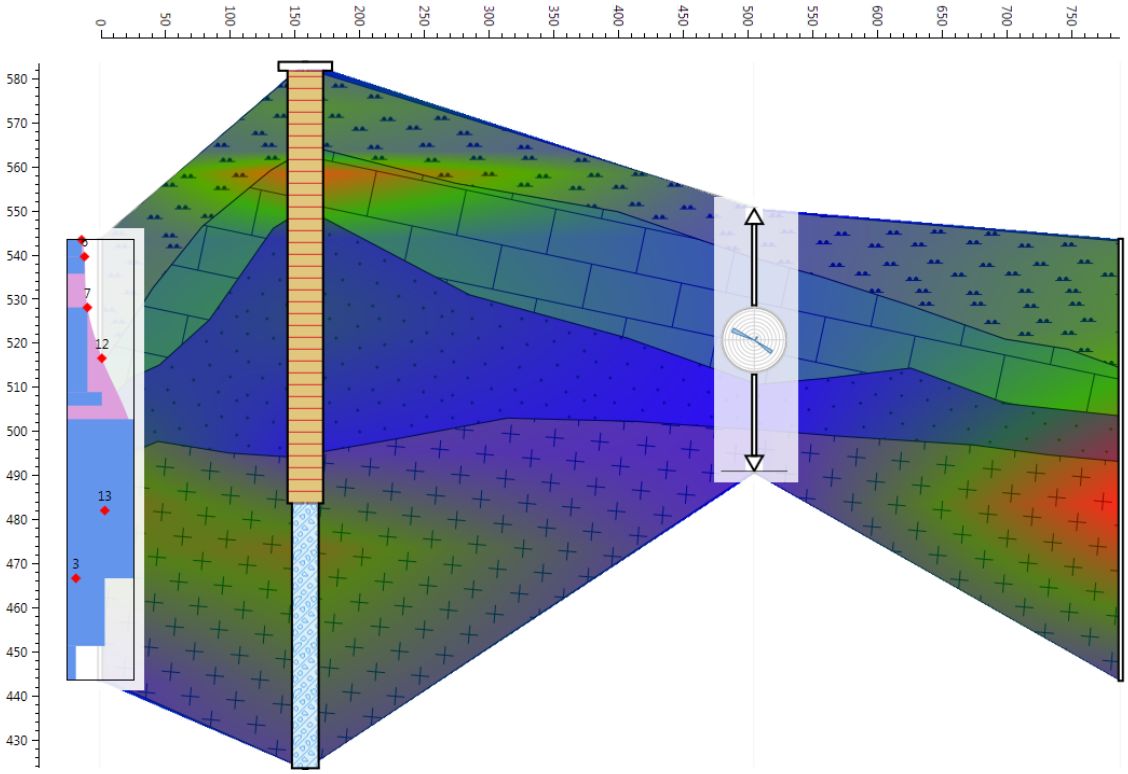


Fig. 227: *Example of different well data types used in 2D Schemes.*

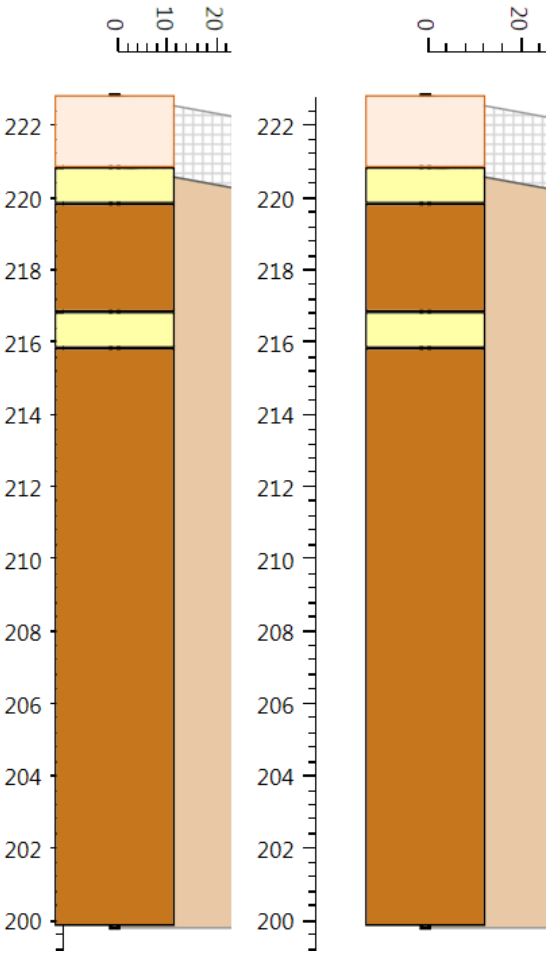


Fig. 228: *Example of Horizontal Margin adjustment to correctly display your well data.*

It may occasionally happen that your viewed well data extends beyond the vertical altitude axis (Fig. **228 Left**). Alternatively, data may be excised from the end of the Scheme. Here, the **Horizontal Margin** property in the context menu extends the space before the first well and after the last one to provide sufficient space to correctly display your well data (Fig. **228 Right**).

6.3.2 Legend

This chapter deals with the display and set-up possibilities for your 2D geological Scheme Legend in the 2D / 3D Diagram. The **Legend** object is closely related to your 2D Geological Scheme objects displayed in the 2D/3D Diagram. It displays labels for individual rocks types used in your 2D schemes. When you first add this to visualization, it appears empty with only the description label, as in Figure **229**. You must then import your individual items. Exactly as in 2D Schemes, all **Legend** features are hidden in the contextual menu (Fig. **229 Right**). Using the **Delete** item removes your object from visualization.

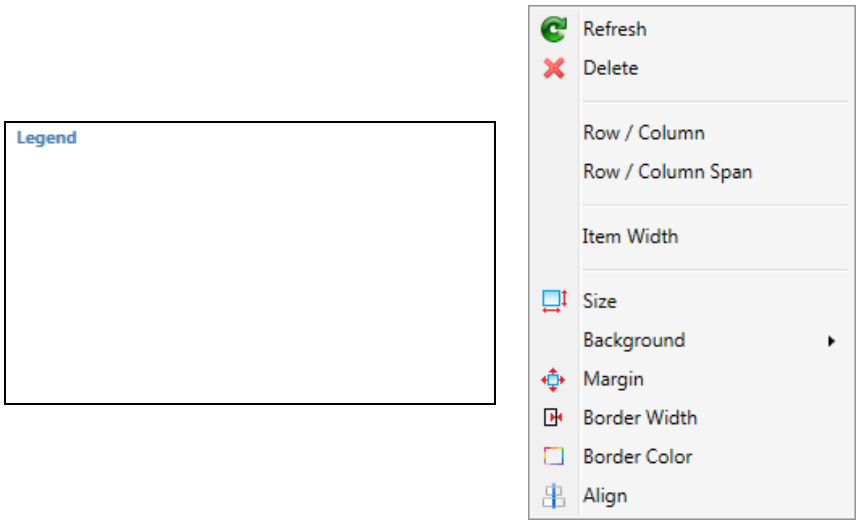


Fig. 229: ***Left*** *– empty legend after inserting it into the 2D / 3D Diagram;* ***Right*** *– context menu functions for working with your legend.*

The **Row / Column** and **Row / Column Span** functions set the location of the legend in your grid cell structure. You can then adjust the width of the legend items using the **Item Width** option. The following properties in the context menu are used for visual adjustments to the legend. For example, you can adjust the size of your legend object, set-up the background colour or adjust the Horizontal and Vertical alignment of your object in the cell. Individual legends items are loaded automatically when you click **Refresh** in the context menu. The program automatically scans all 2D Schemes in your current plot and selects all unique geological indexes. These unique Id's in all 2D Diagrams are sorted alphabetically by **Geo ID** parameters and displayed in the Legend. An example is shown in Figure **230**. Because the program scans all 2D Schemes, it is sufficient to add only one Legend object into the Diagram.

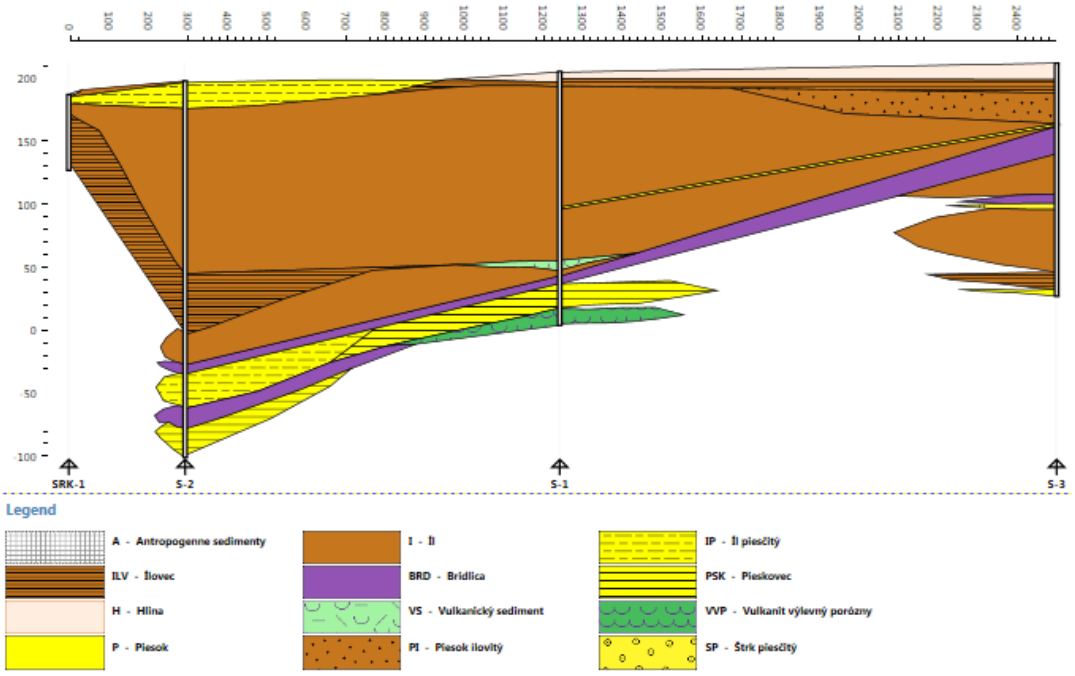


Fig. 230: *Example of a Legend created for your 2D Geological Scheme.*

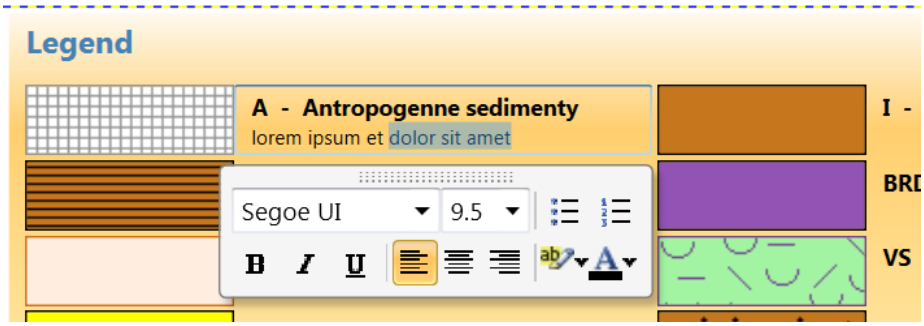


Fig. 231: *Example of direct editing of legend items.*

The text content and legend header can be manually edited after they are load into the legend; as in Figure **231**. Remember again that manual editing will be lost, if you press the **Refresh** item in the context menu.

6.3.3 Image

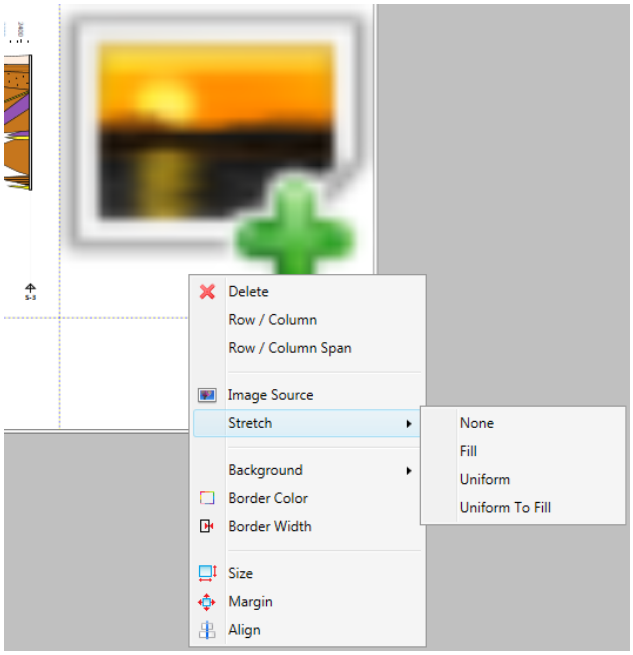


Fig. 232: *Example of inserted Image object.*

Image objects can also be inserted in the 2D/3D Diagram (Fig. **232**). As in previous cases, you can modify properties such as the position of the object and its visual characteristics using features hidden in the context menu.

If you want to insert an image from a computer disk, click **Image Source** and select your image in the **Open File Dialog**. The **Stretch** property can then be set to your image to keep the original size, or to fill all available space with visual deformation, or it can be stretched to avoid deformation. An Example of using a satellite photo to display your area of interest is given in Figure **232**.

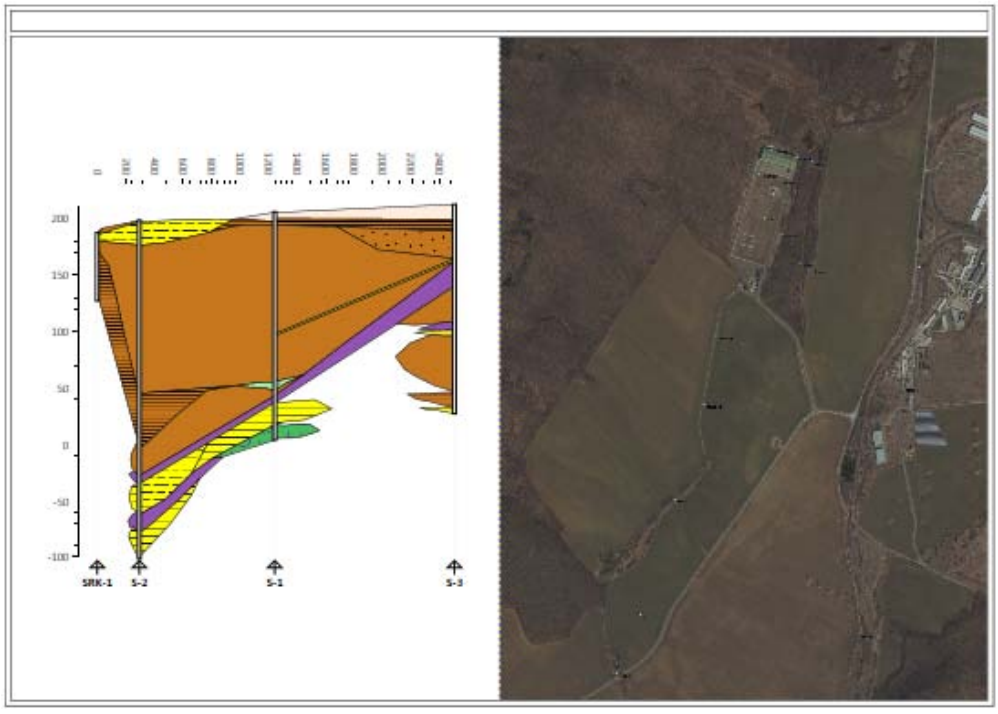


Fig. 233: *Example of a satellite image in your 2D / 3D Diagram.*

6.3.4 Text Area

The last type of object that can be embedded in a 2D/3D Diagram is the **Text Area**, where you insert all text content. Functions for the content's location and visual adjustments are hidden in the context menu shown in Figure **234**. This **Text Area** object completes the description of possible 2D/3D Diagrams. You can always create quite diverse visualizations using the available combinations and modifications. An example of an actual visualization prepared in Well Plotter 3D is shown in Figure **235**.

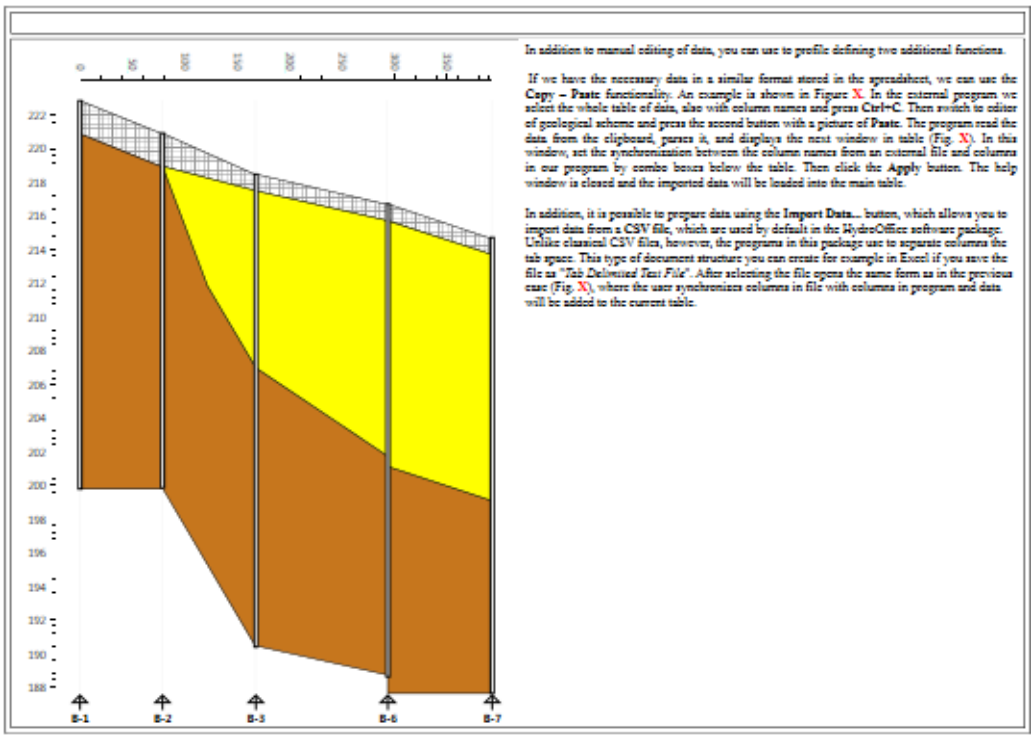


Fig. 234: *Example of Text Area component in your 2D / 3D Diagram.*

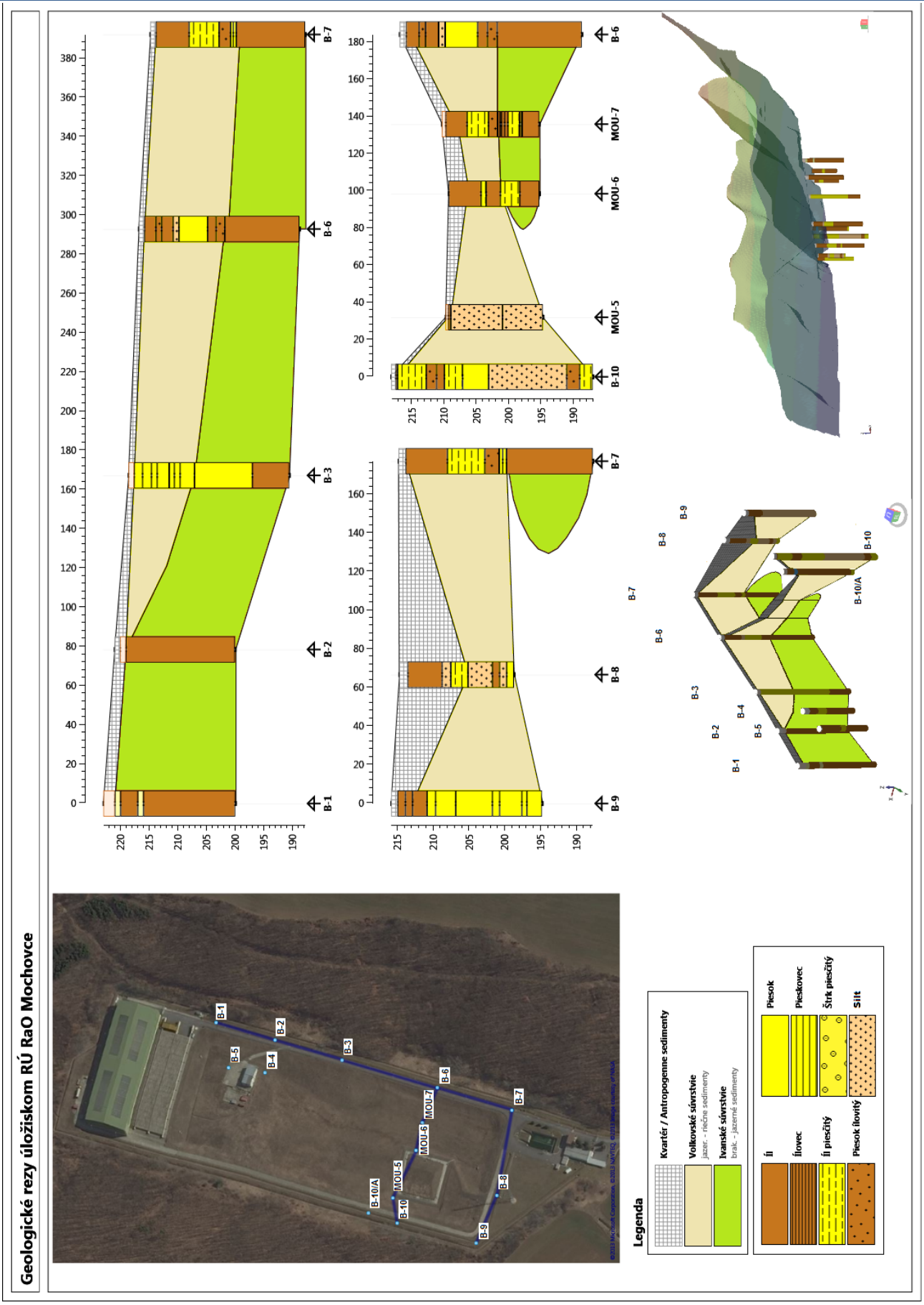


Fig. 235: *Example of an actual complete 2D / 3D Diagram prepared in Well Plotter 3D.*

7 Saving your project

It is often necessary to do your work in stages and store your data on disk for later continuation. Therefore, the program allows storage of your progressive work. These management features are found under the Main Ribbon Menu Button in the **Project** section (Fig. **236**). Here you can open and save your project during interruptions to your work on it.

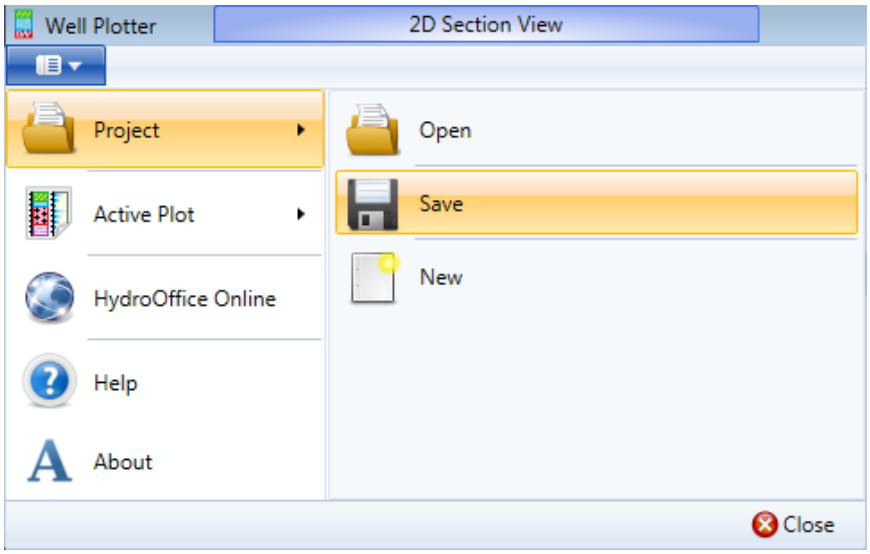


Fig. 236: *Features for project management.*

This program allows you to save your project file with ***.wpt** extension, so that all data is stored. Although the current version does not save visualizations in both a **Well Log 1D** and **2D / 3D Diagram**, your project stored in one edition of the program can then be opened in the second edition. For example, a project created in the 3D Edition can be opened in both the 3D and Basic Editions of the program.

8 Exporting Visualisations

Completed visualizations can be exported from the program using commands under the Main Ribbon Menu Button in the **Active Plot** section (Fig. **237**). These commands export your **1D Well Log** and **2D / 3D Diagram** visualizations using the **Export** and **Export Visible Part** commands. If you choose the **Export** option, the whole visualization is exported in your defined size, and if you choose **Export Visible Part**, the program only exports the part you see in the document window. This therefore depends on the extent of your zooming. Examples of these two options are illustrated in Figures **238** and **239**.

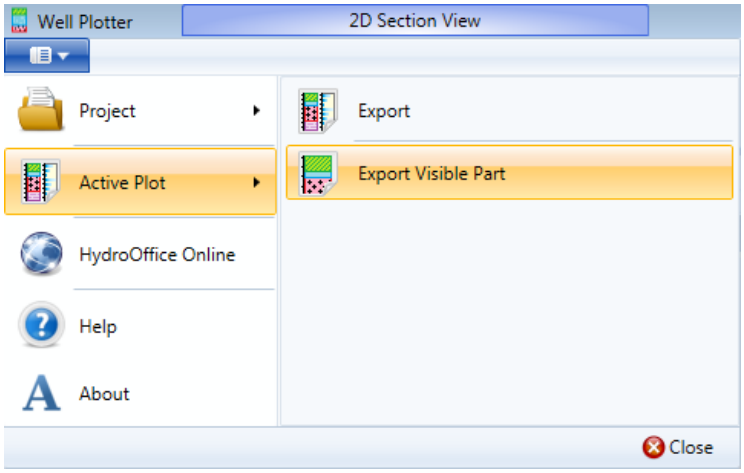


Fig. 237: *Features for exporting visualisations from the program.*

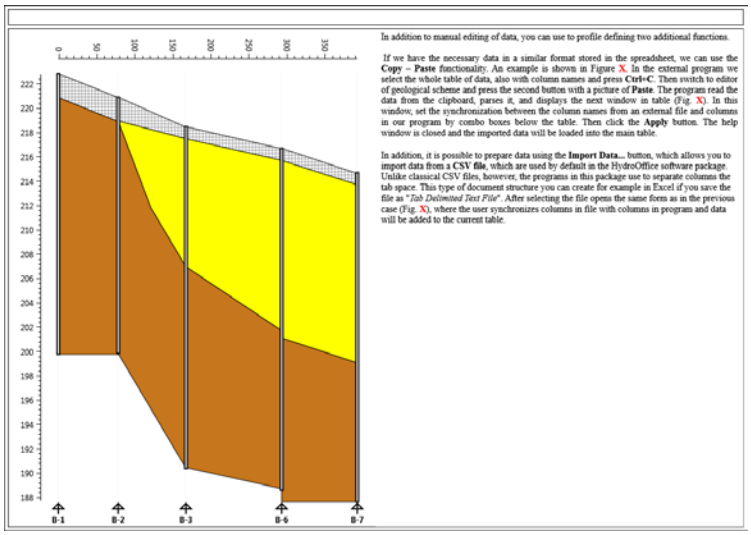


Fig. 238: *Example of export using the Export command.*

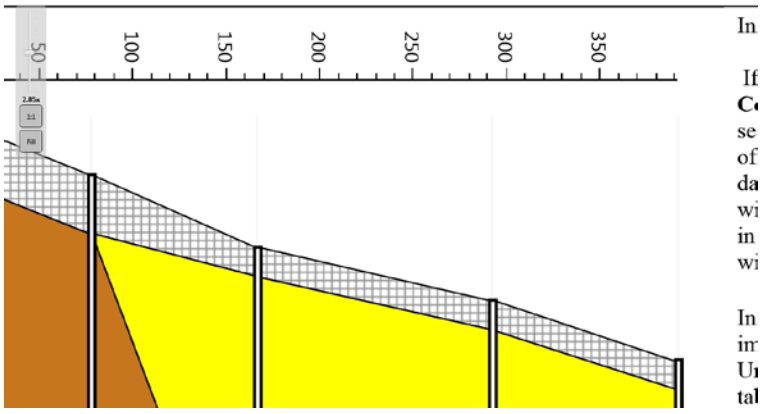


Fig. 239: *Example of export using the Export Visible Part command.*

9 Conclusion

The previous text completely describes the functionality of **Well Plotter** software in its two editions. Reading this manual thoroughly will enable you to fully utilize its functionality and all **1D**, **2D** and **3D** data visualization techniques. The program does not provide absolute control over rendering, but possibilities for its use are far wider. In addition to this manual, demonstrations of working with this program and video tutorials clearly illustrating individual parts of its functionality are available on both the **HydroOffice.org** website and on **YouTube**

Since this edition of the program is its first version, this program will continue to evolve. Its development can be followed on **HydroOffice.org** in the blogs section. The final **Appendix** section describes working with selected specific features of this program.

If you have any queries about the program, any problems with its control or you have any comments for its improvement, please **feel free to contact me** in the forum, or directly through email. I will be grateful for all your responses.

Annex 1 Custom hatch pattern

The manual text informs you how to use more than 500 predefined hatch pattern textures to fill-in objects in all your technical and geological schemes and in your 2D geological profiles. However, you can also create your own customized textures using **MS Paint.** This is a simple graphics program containing each operating system.

The basis for each texture is as follows; you lay out images side by side, and a resultant image is created with the same structure. The only difference is its size. An example of this new texture preparation generated in **MS Paint** is illustrated in Figure **1**. This example has black and white texture, but you can choose any colours you want.

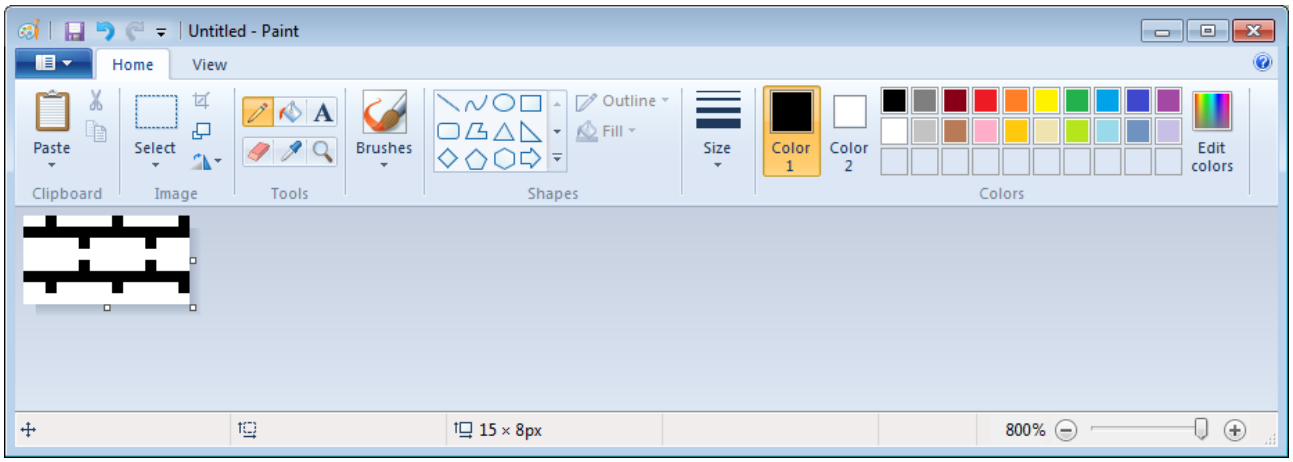


Fig. 1: *Example of a newly created texture in 15 by 8 pixel size.*

If you save your new texture to disk, you can use it directly in this program. Here, you choose the option to import customized textures in **Textures Editor** and press the **Open** button (Fig. **2**). After importing it, your selected texture is used to fill the selected object.

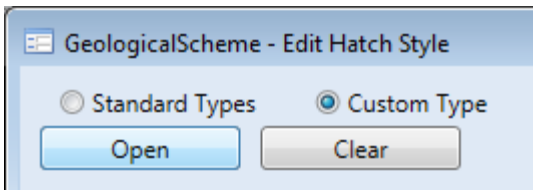


Fig. 2: *Option for customized texture import in the Textures Editor.*

An example of texture use is given in Figure **3**. Here, an external texture filled the geological unit. You can thus apply external texture to any object that can be edited in the **Textures Editor**.

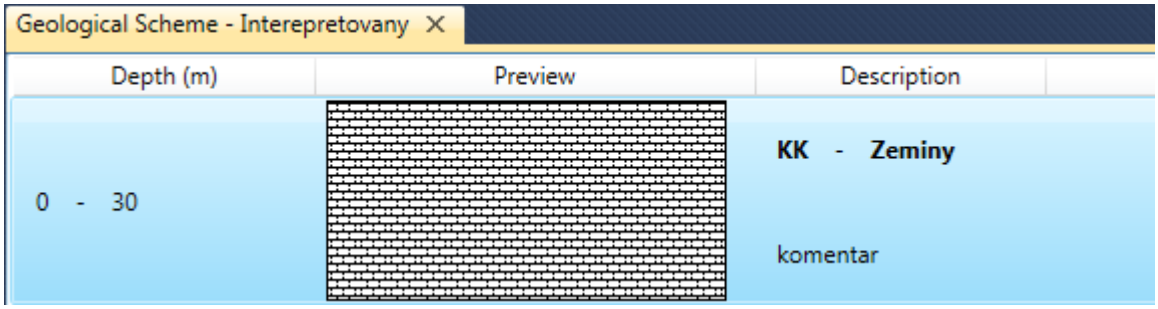


Fig. 3: *Example of customized texture use for filling a geological unit.*

Annex 2 1D Heat map

Chapter **5.4.5.4**, described options for creating a 2D heat map from numerical data for depth measurements and time. This type of visualization can also be used to display 1D heat maps where numerical data is related only to depth measurement.

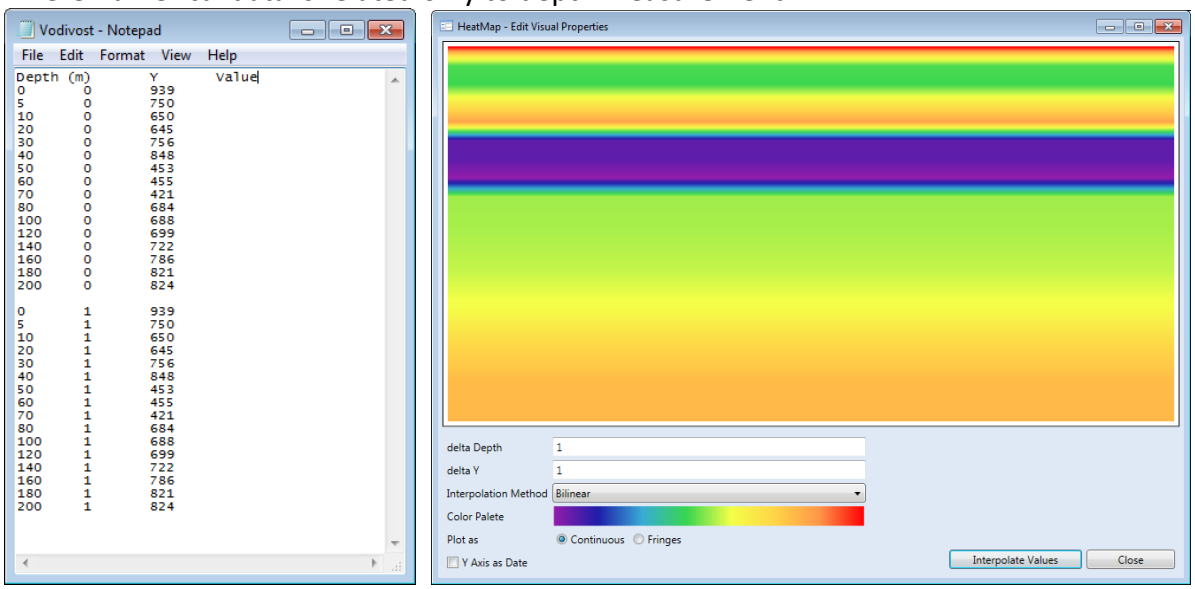


Fig. 1: ***Left*** *– example of a source document prepared for processing in your program;* ***Right*** *– example of 1D Heat Maps created from your source document.*

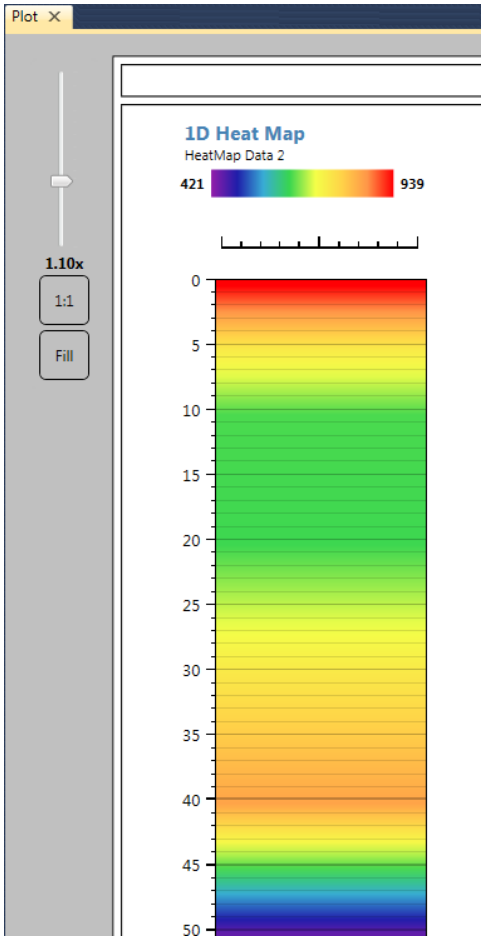


Fig. 2: *1D Heat Map example of groundwater mineralization changes related to depth measurement.*

For example, you can display groundwater mineralization changes with depth. To create your 1D Heat Map you use the same data object, but you add the following innovation. You load depth and measurement values twice in the source file as series values below, The first series defines the Y value = 0 and the second series uses the value of Y = 1. You then import this prepared document into the program as in Figure **1 Left**. Utilizing the **Heat Map Editor** as you did for 2D Heat Map formation, you achieve the result in Figure **1 Right**.

You then add this prepared 1D Heat Map to the 1D Well Log to give the result shown in Figure **2**. Here, you can use continuous or sharp transition between selected colours from the colour palette; exactly as you did in your 2D Heat Map creation.

Annex 3 Description of your geological scheme

Fig. 1: *Example of geological layers where the entire text description is not fully visible.*

This manual annex covers options in the Well Plotter program for plotting geological schemes. If you simultaneously want both a coloured texture and a view of your geological unit's text description, it may occasionally happen that the text description in some layers is not fully visible. This aberration is depicted in Figure **1**.

The current version of this program does not allow manual replacement of your geological legend in geological layers. Therefore, this problem is solved by increasing the size of your visualization paper or, increasing the geological scheme's width. If these processes are insufficient, you can alternatively reduce the font size of your selected item; as shown in Figure **2 Top Left**.

A further alternative is to adapt your text label as described in chapter **5.2.8.1**. This is shown in Figure **2 Top Right**. Using this document approach allows you to precisely define the position of each label in your profile without overlap. Here, you can insert your text label object in the next column, and then adjust its depth as required.

Finally, you can add the **Custom Text Column** to your plot, as described in section **5.4.5.9**. When this is inserted, you add all your descriptions. Then press the **Enter Key** and move each item to its appropriate depth. An example of this method is shown in Figure **2 Bottom Left**. These alternative methods avoid text overlap in your geological scheme.

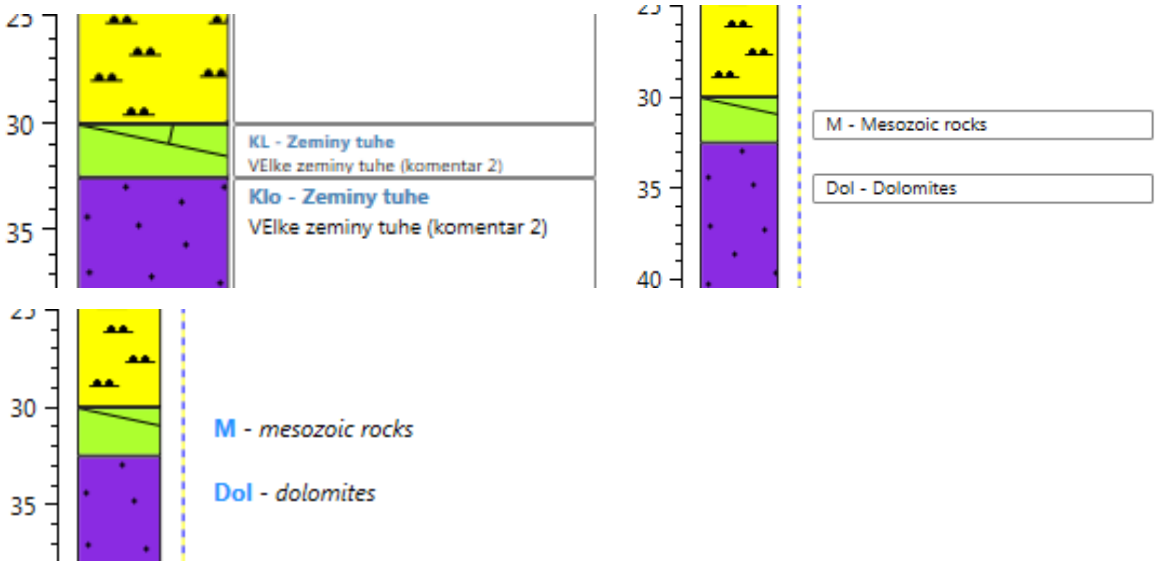


Fig. 2: *Examples of solutions to text item overlap in your geological scheme (**Top Left** – font size decrease; **Top Right** – using the labels document; **Bottom Left** – using the Custom Text Area to show text descriptions.*

Annex 4 2D Geological Section defining mixed sand and clay sediments

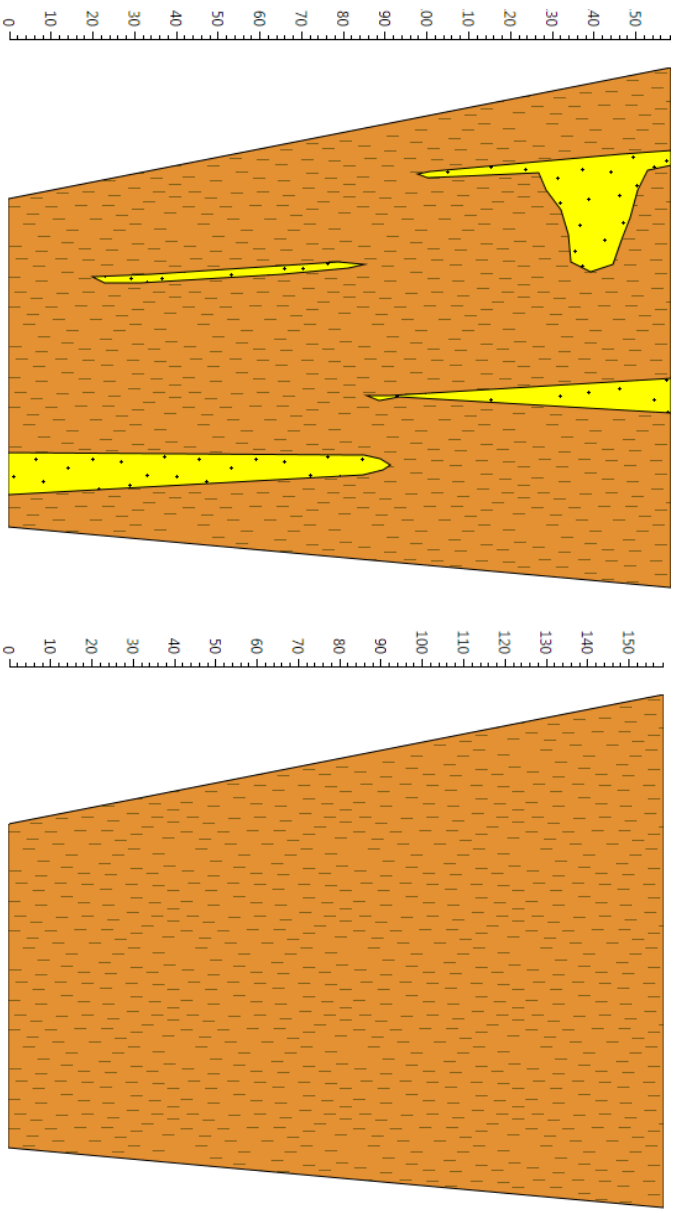


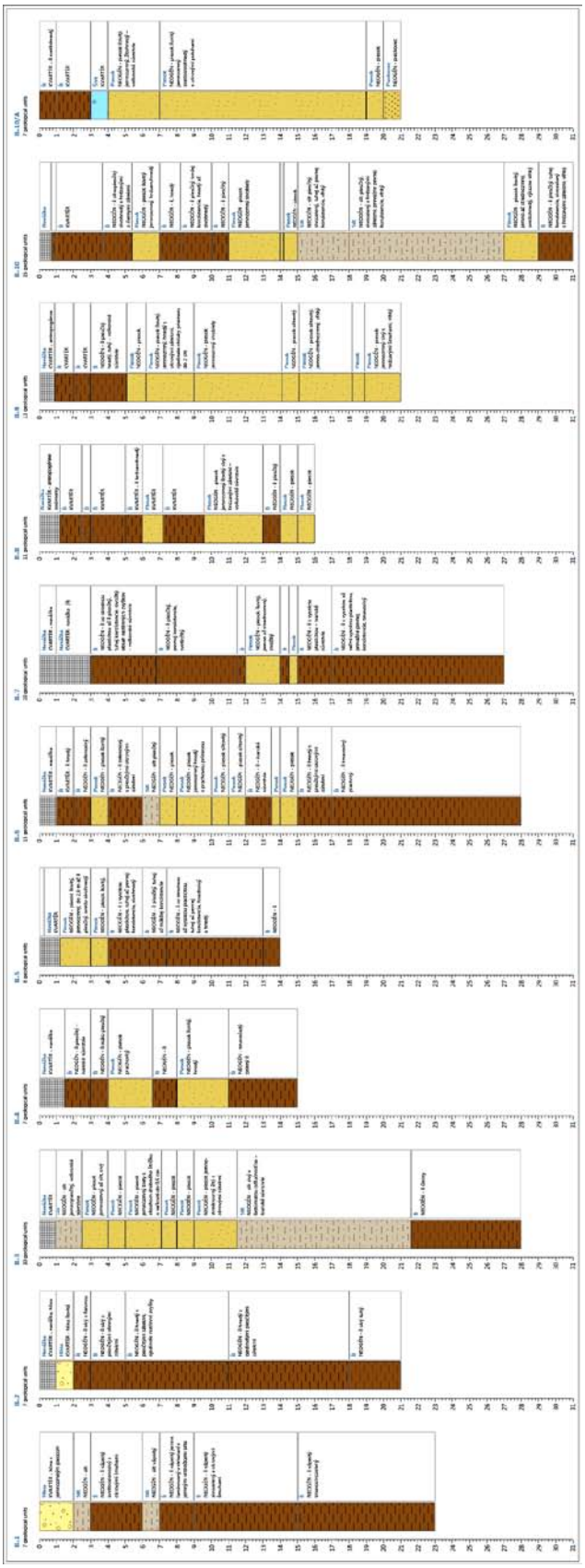
Fig. 1: *Example of complex geological profile creation.*

Chapter **6.2** described how to prepare 2D Geological Profiles in this program. This method is based on gradual addition of individual geological layers to your 2D section. Occasionally, your geological structure may be so complex that it is impossible to form a profile by progressively adding individual layers. This could occur, for example, when a block of clay sediments has chaotically distributed lenses and laminas of sandy sediments. In this case, you generate your 2D profile as depicted in Figure **1**, and described below it.

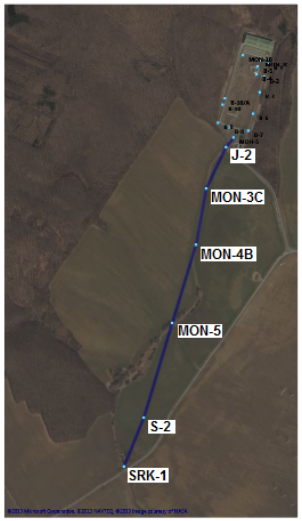
Here, you first create a profile background as one block of homogeneous sediments (Fig. **1 Top**). This basic block of sediments is selected according to the density of particular sediments types. You must always use the most abundant sediment in the prepared background, and then add required individual sediment laminas and lenses (Fig. **1 Bottom**). This example shows addition of chaotically distributed sandy sediments to a basic abundant loamy environment. This procedure will now create all type of 2D geological profiles; precisely according to your needs.

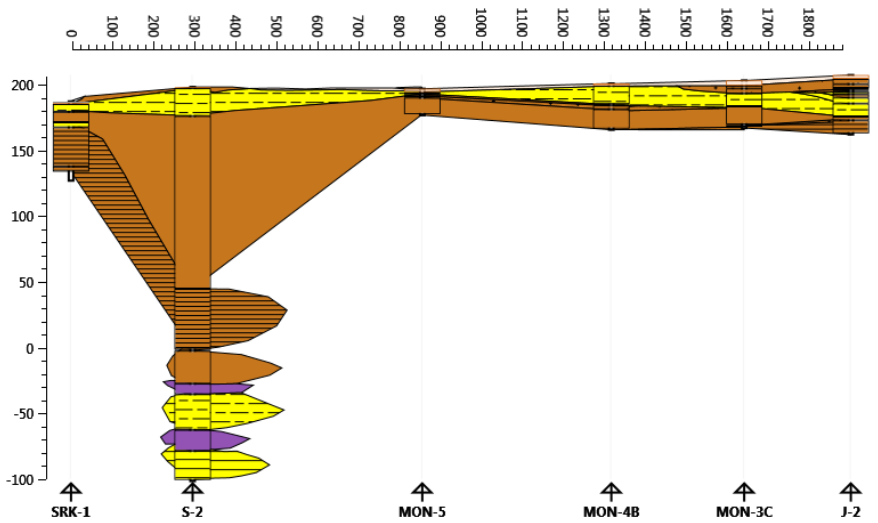
Annex 5 Examples of 1D, 2D and 3D visualisations in Well Plotter software

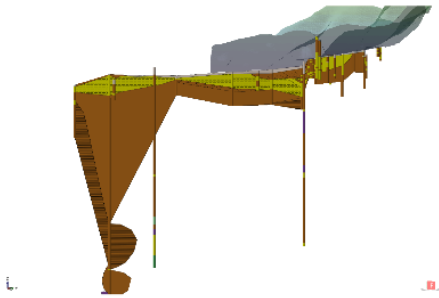
This final annex illustrates Well Plotter visualization based on actual data. It depicts drilling exploration for hydrological assessment in the temporary storage of low-radioactive waste.

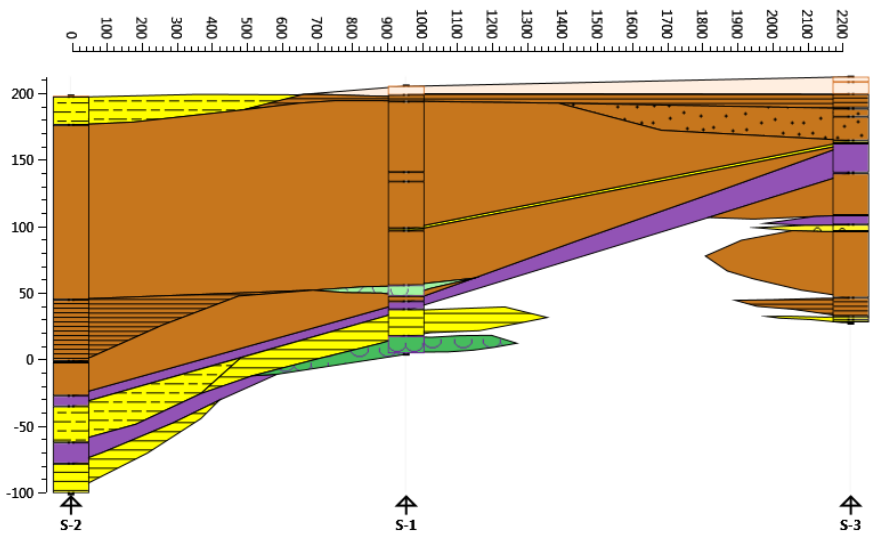


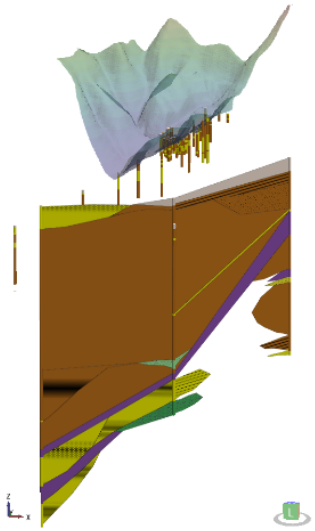
Geologické rezy okolím úložiska RÚ RaO Mochovce





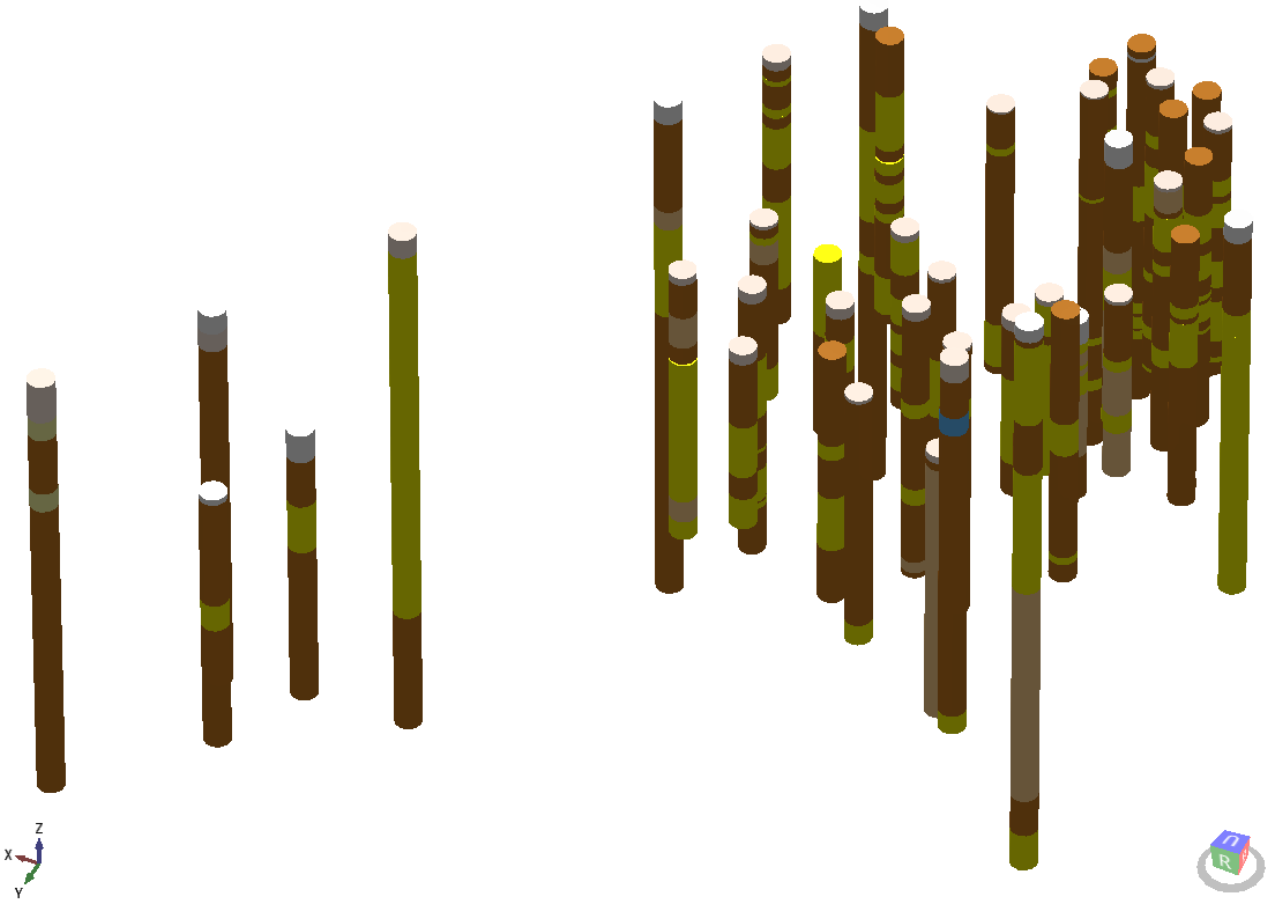




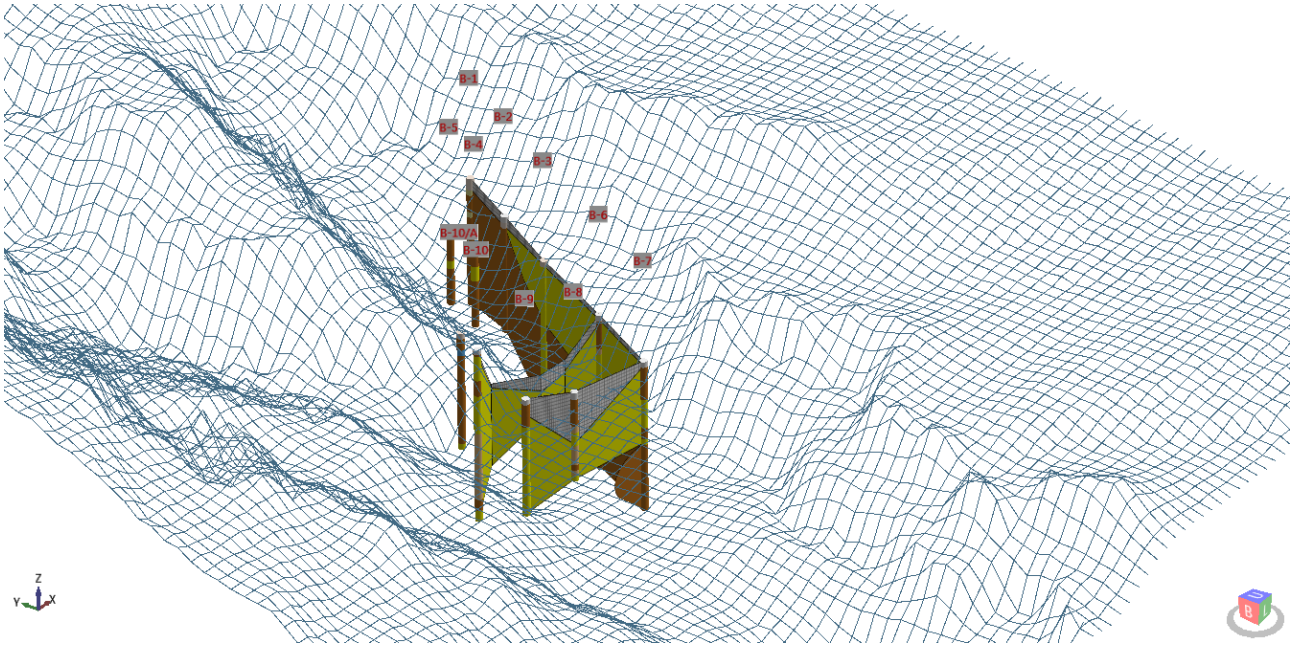


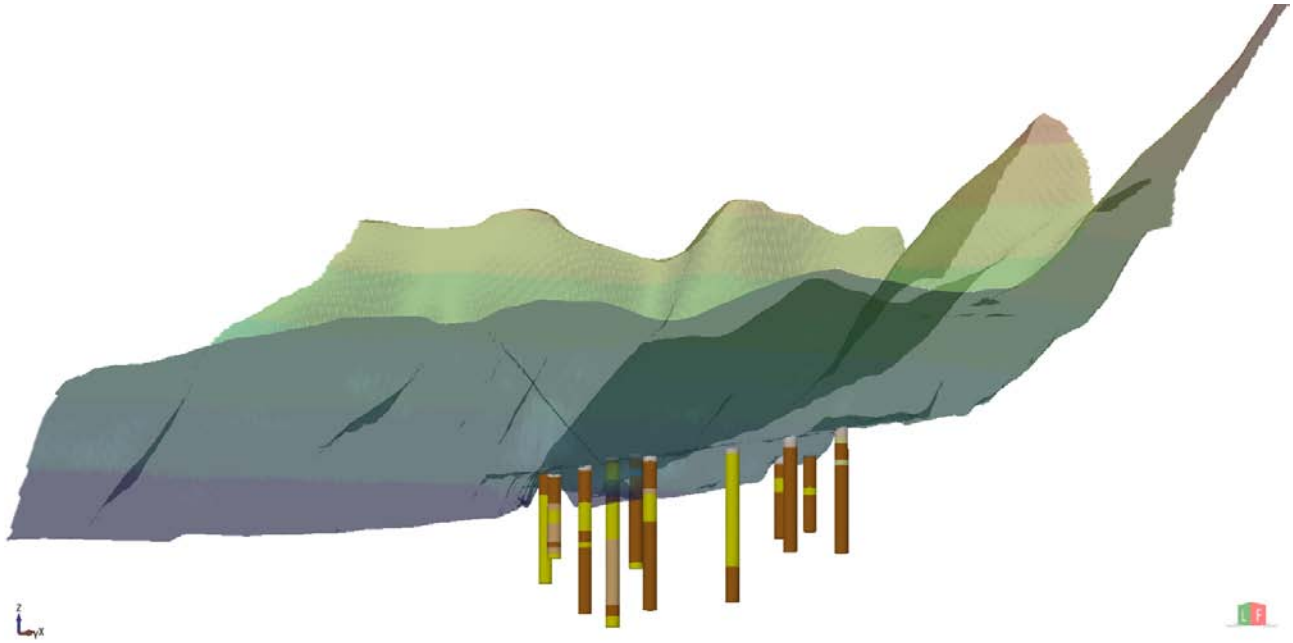
Legenda

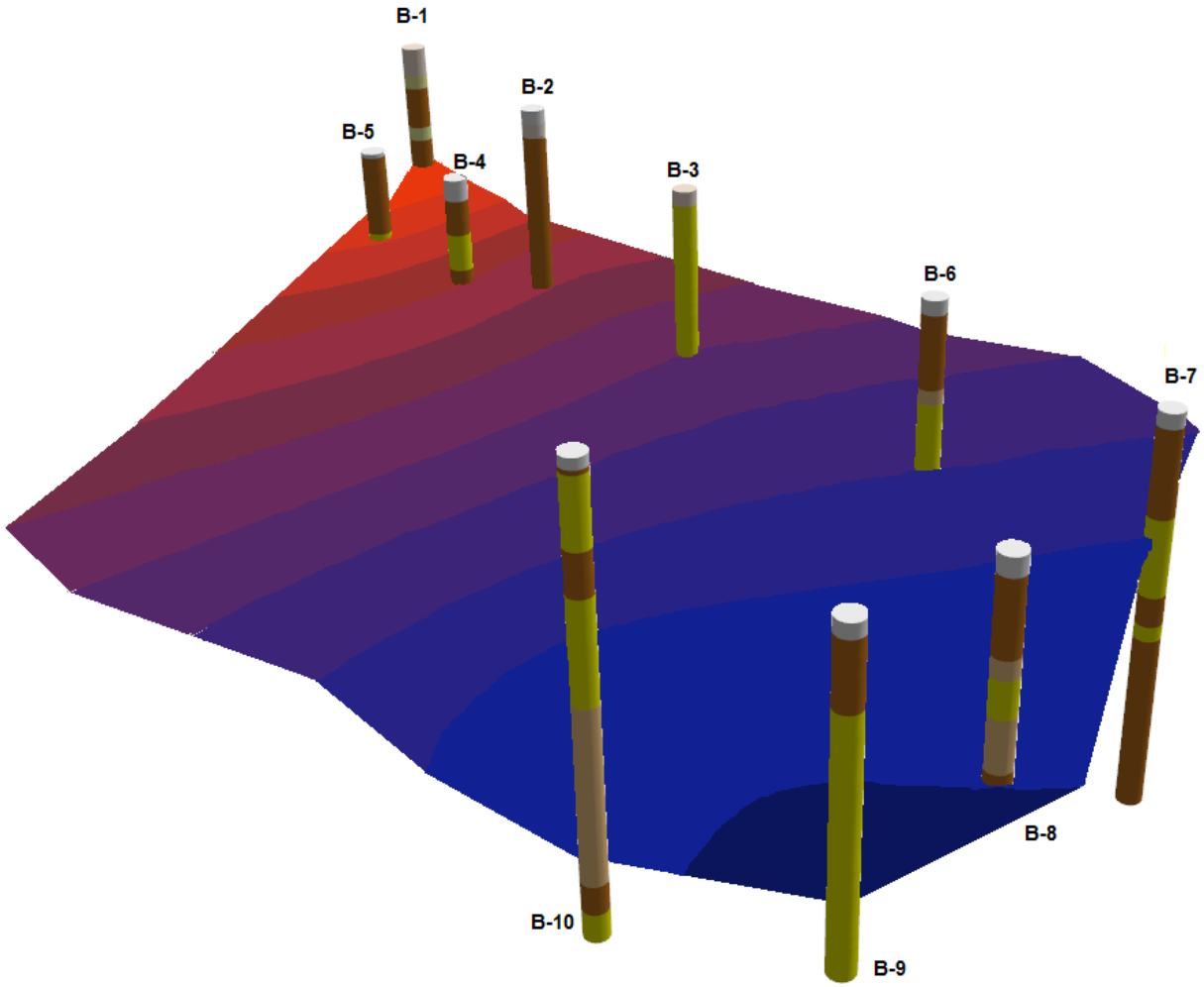
- Antropogenne sedimenty
- Hlina
- Íl
- Piesok ílovitý
- Íl piesčitý
- Piesok
- Ílovec
- Vulkanický sediment
- Bridlica
- Výlevný porózny vulk.
- Pieskovec
- Štrk piesčitý


Z
X
Y

B-7
B-6
B-8
B-9
B-3
B-10
B-2
B-10/A
B-1
B-4
B-5
Z
X
Y


B-1
B-2
B-5
B-4
B-3
B-6
B-10/A
B-10
B-7
B-9
B-8
Z
Y
X


Z
Y
X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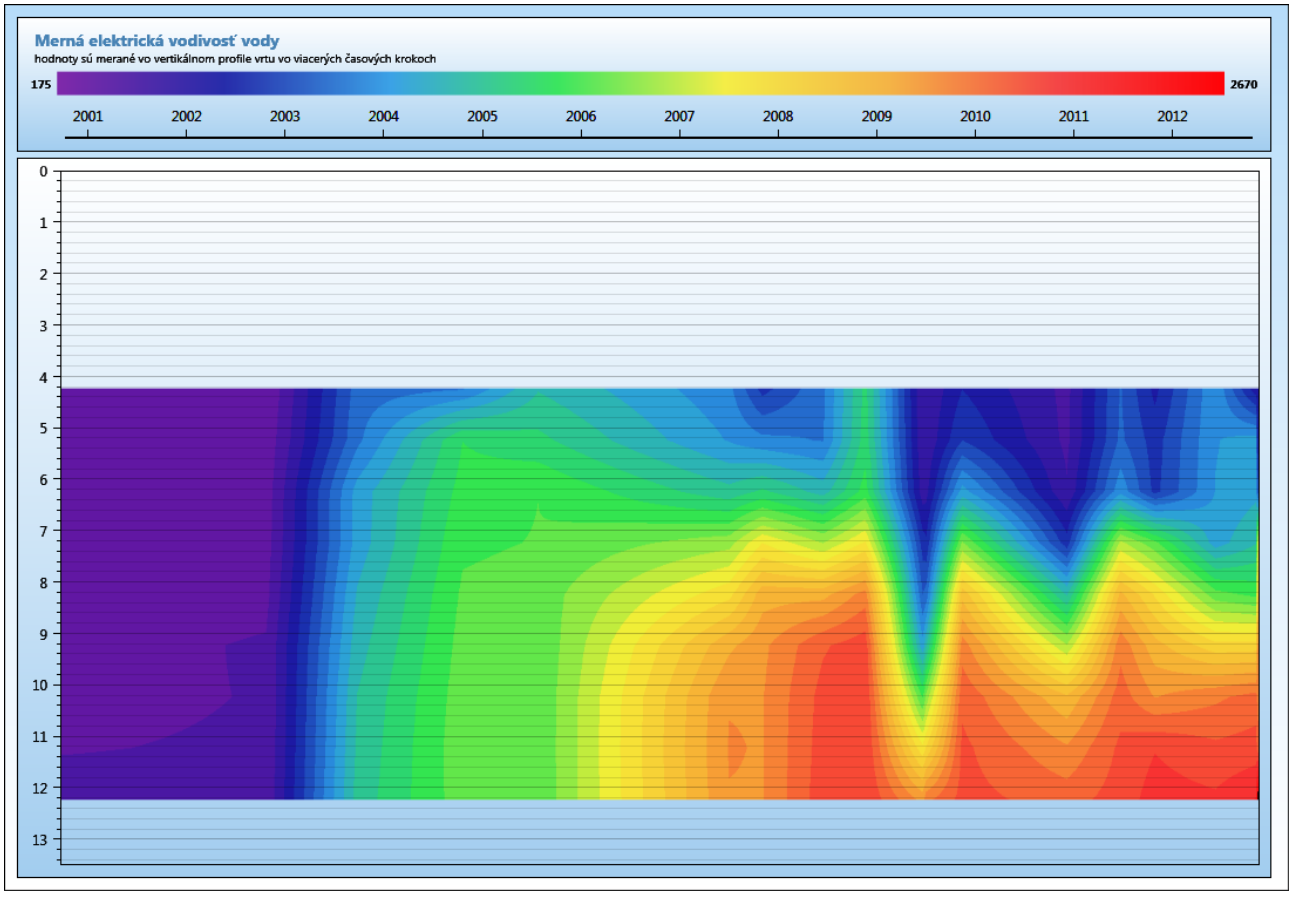
B-8
B-10
B-9


Merná elektrická vodivosť vody
hodnoty sú merané vo vertikálnom profile vrtu vo viacerých časových krokoch
175
2670
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
0
1
2
3
4
5
6
7
8
9
10
11
12
13