Contents

INTRODUCTION

This document describes the new features and enhancements that make up the T7.210 release and differentiate it from the latest T7.20x releases. T7.210 is distributed as patch and must be installed over an existing T7.20x installation using the T7 patch installation procedure. For a more detailed description of the new features please refer to the relevant sections in the T7 Reference Manual. Both this document and the T7 Reference Manual use the term "T7" when referring to the current release version of the software.

Important Notes:

1) T7.210 license feature versions are “7.2”. T7.210 will not function with a T7.1 (or earlier) license. If a new license is required, please send a license request to support@badleys.co.uk.

2) T7.2 uses FlexNet 11.18.2 for its licensing. The installation will include the 11.18.2 version of the FlexNet license manager daemon.

3) Once installed, T7.210 will need to run a database upgrade on existing projects when they are first opened. **Please backup you projects before using them with T7.210**. Once a project has been upgraded it will not be accessible using older versions of T7.

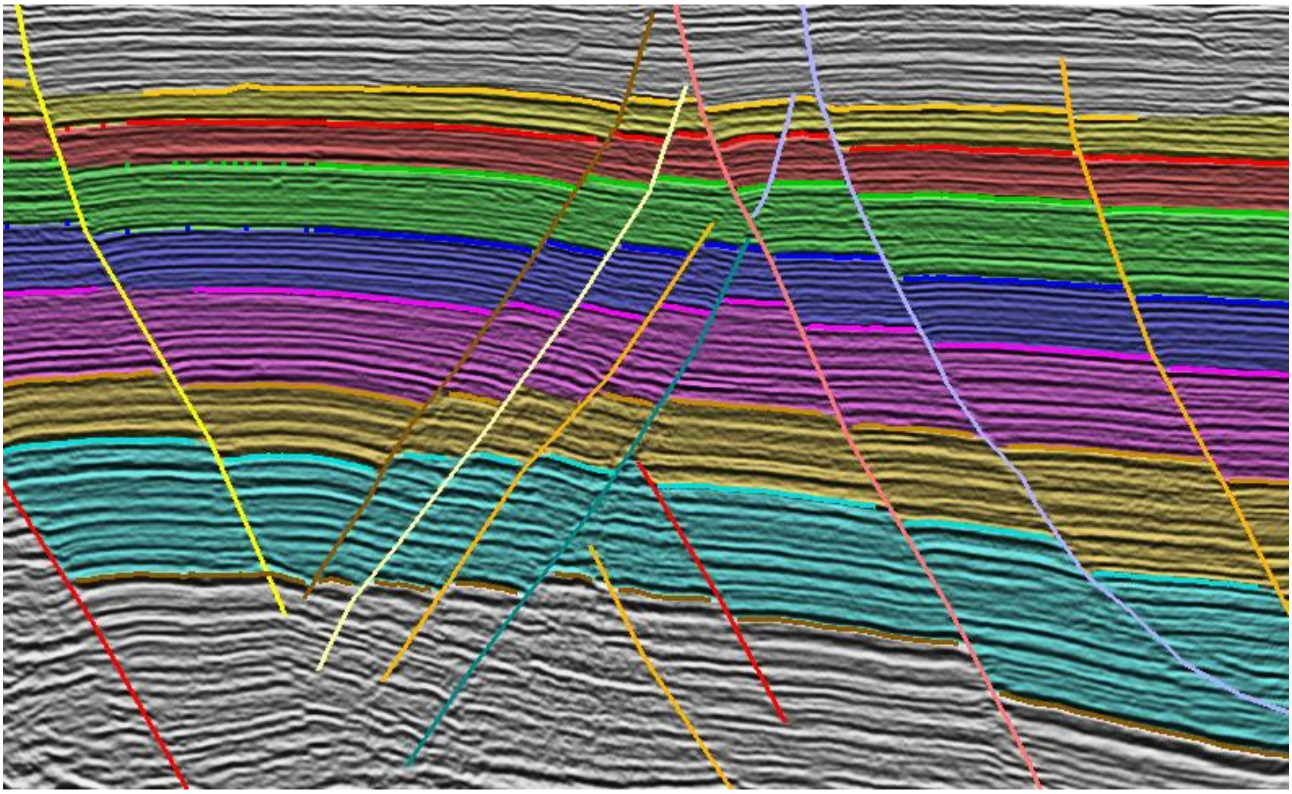
4) After a project has been upgraded, the T7 Volume Editor’s default shortcut file (defining hotkeys) will be replaced with a more fully featured set of hotkeys and shortcuts. The original shortcut file will be renamed to "default.7.2xx" where xx is the currently installed patch level.

MAIN FEATURES

Structure Colour-Fill

The new Structure Colour-Fill option is included as part of the Interpret Module in the Volume Editor and is currently available on any loaded 2D or 3D vertical seismic section.

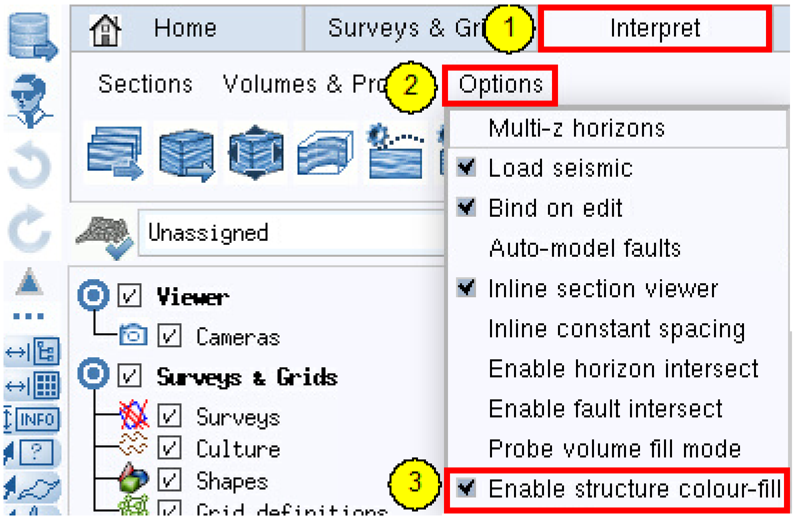
The Structure Colour-Fill system uses the horizon and fault interpretation on a given section to define areas of solid colour-fill. This can provide an extra degree of realism to the section displays as well as a clearer indication as to the consistency of the interpretation.



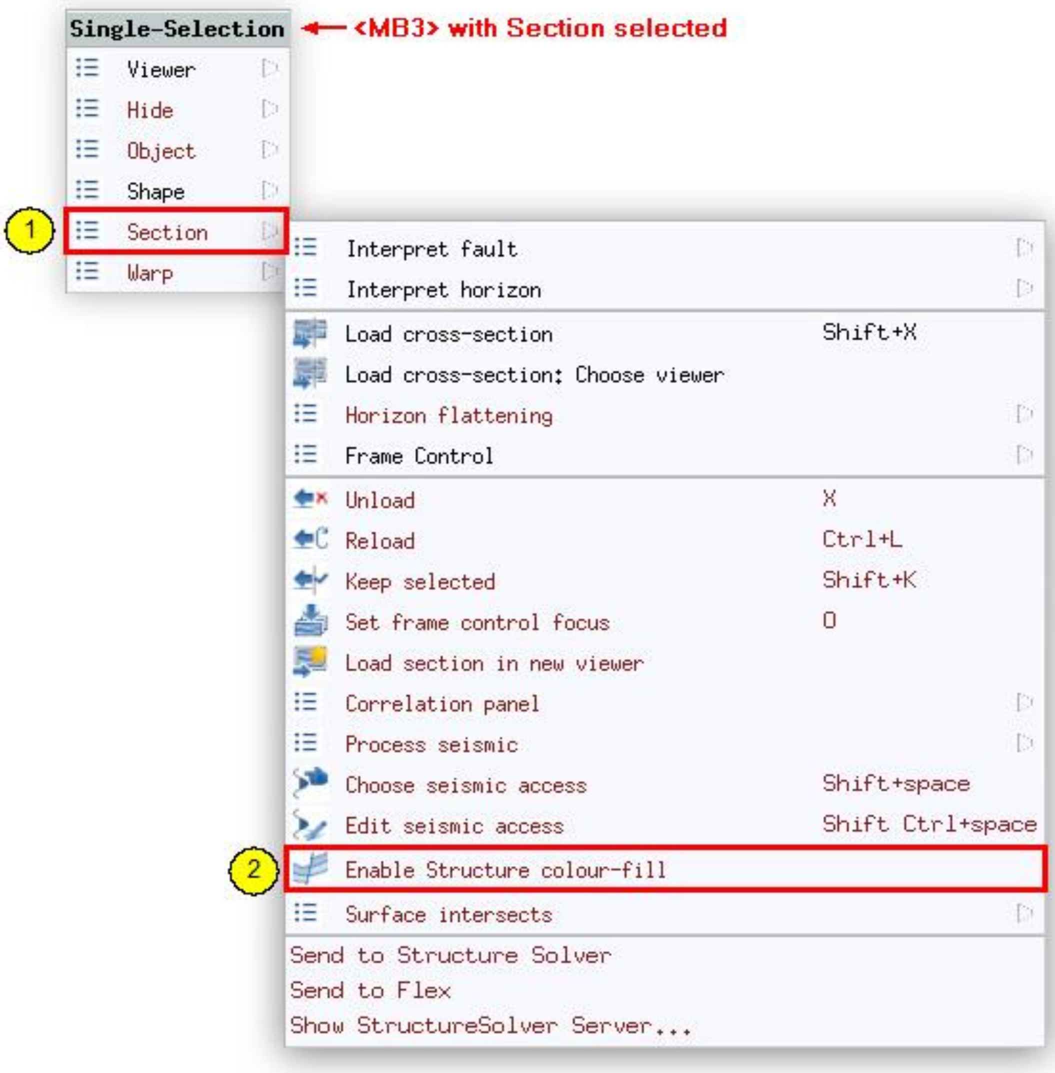
As can be seen in the above image, the colour-fill is blended with the seismic data, and it will automatically update as the interpretation is adjusted. It provides a much better feel for how interval thicknesses change across faults than using a non-filled display. The colour-fill interpolates between sparsely picked horizons and will account for cases where horizon data over-shoots fault sticks.

In order to use the Structure Colour-Fill there are two steps that need to be taken:

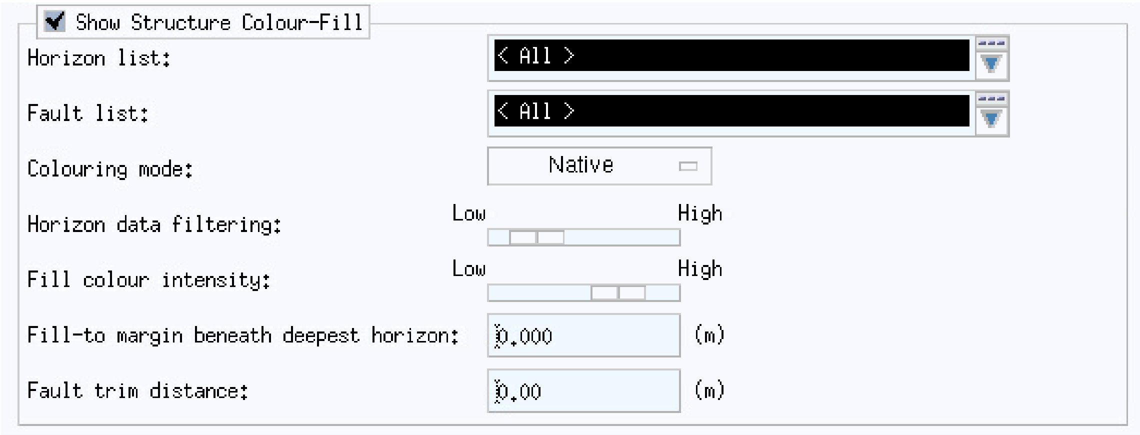
Firstly, the Structure Colour-Fill capability must be enabled for a loaded section (this is the default behaviour for new and newly upgraded Volume Editor sessions). This is an option in the Volume Editor Interpret Tab's options menu where it will control the setting for new section loads.



There is also an option on the <MB3>-Pop-up Menu for selected section(s) where the setting can be turned on or off.



Secondly, once a section has been enabled with the capability to show the Structure Colour Fill the display must be enabled using the Interpret Module's Style Editor controls.



The style controls are:

Horizon list: A list defining which horizon intervals to colour-fill

Fault list: A list defining which faults to use to control the structure colour-fill

Show Structure Colour-Fill: toggle on to display the colour-fill for sections that have been enabled.

Colouring mode: set to **Native** (the horizon colour), **Lithology** or **Reservoir quality**

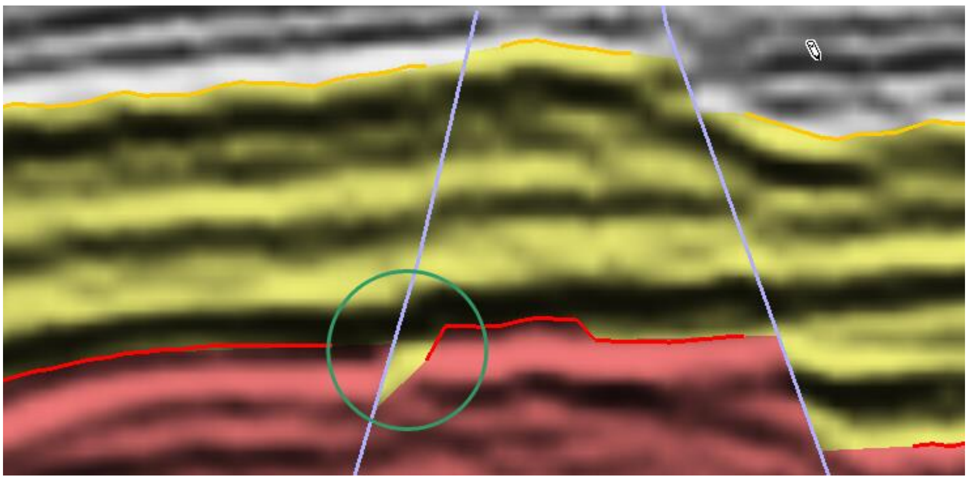
Horizon data filtering: The level of filtering applied to the horizon interpretation data. A higher value will result in less conformance with the interpretation but is faster to process.

Fill colour intensity: The colour intensity used when blending the fill-colour with seismic.

Fill-to margin beneath deepest horizon: The distance below the deepest horizon to fill down to. Set to zero for no fill below the deepest horizon.

Fault-trim distance: the horizontal distance around fault segments in which horizon interpretation data will not be used to process the colour-fill.

The image to the right is a blow-up of part of the above example and shows how the colour-fill can help highlight mis-picks.



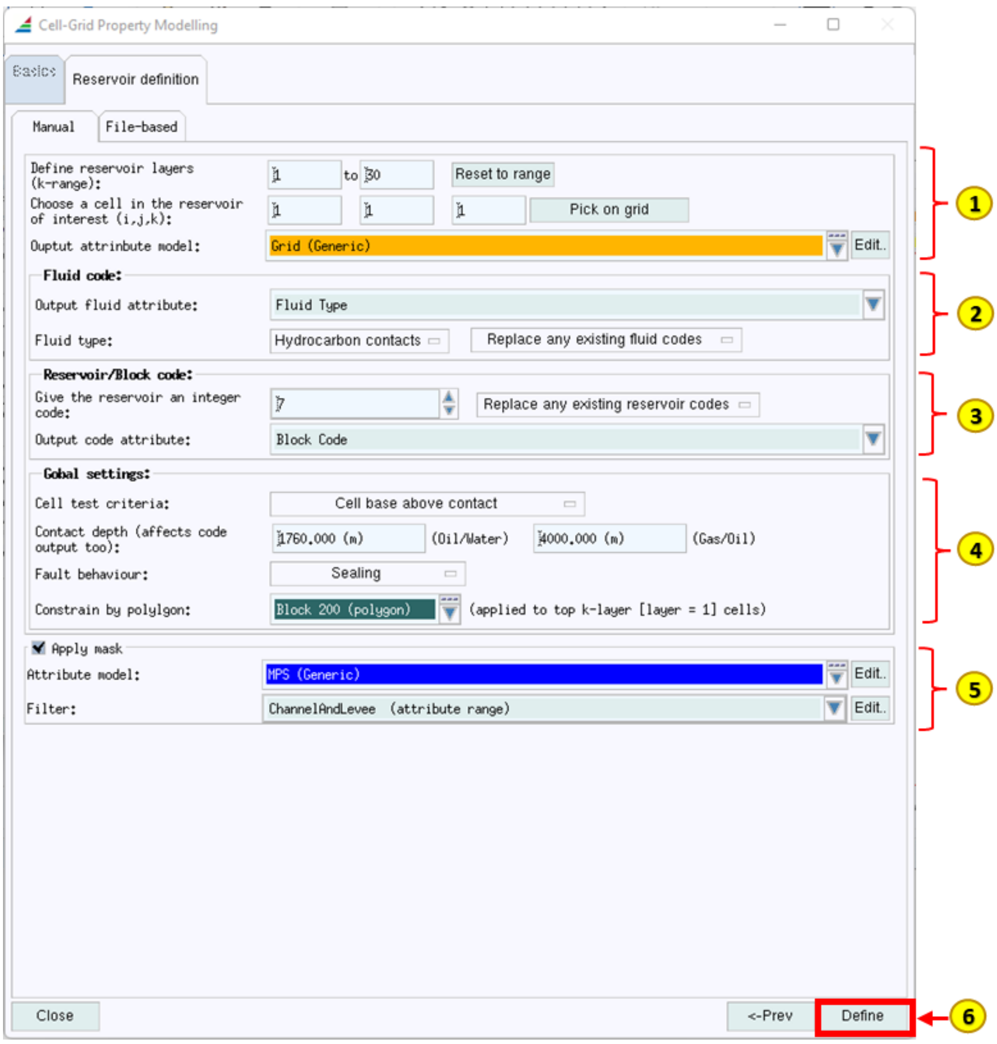
Reservoir Volumetrics Toolkit

A new set of tools have been added to T7's static reservoir modelling toolkit (grid property modelling). These enable the definition of reservoir units, compartments and water/oil/gas legs as attribute models for further analysis. When used together, these can be automatically interrogated to produce reservoir volumetric reports.

Defining reservoir units and compartments

The user can use one of two methods for defining the geological confinements of the reservoir of interest as well as the fluid legs: **Manually** or **File-based**.

When using the **Manual** workflow, the compartments/units and contacts can be automatically extracted from the corner point grid based on grid geometry, structural elements, sedimentology and arbitrarily defined regions.



1: Select the constraints and the output attribute model – to which the output attributes in step 2 and 3 belong. The constraints include k-layer range and a location (i,j,k) on the grid that is within the region of interest. This can be achieved by picking (Shift+MB1) in the viewer.

2. Here the output fluid attribute is chosen along with the type of fluid contact. Fluid contact depths are entered in the global settings (step 4)..

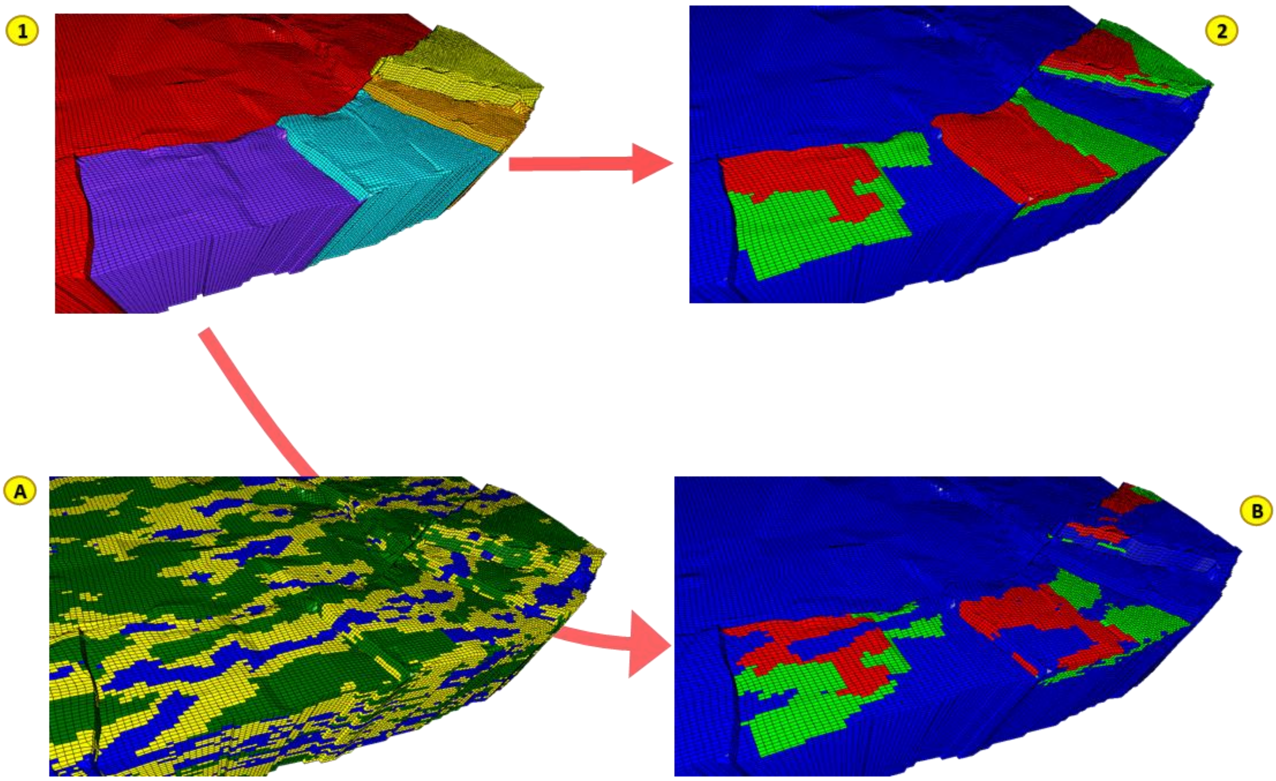
3. Similar to step 2 but for unit or compartment definition. Both units (layers in the model) and reservoir compartments (e.g. fault blocks) can be defined here. The user must give the unit/compartment an integer identification code that will be stored in the output attribute.

4. Global settings: here we define contact depth(s), depth-test criteria (e.g. are cells partially or completely above the contact) and how faults are treated (sealing or non-sealing). An optional arbitrary polygonal region can be defined to constrain the extent of a compartment (these are defined by drawing, or using an existing polygonal region of interest in the viewer).

5. A mask can be applied to deal with more complex scenarios – for example, we can define sedimentologically isolated reservoir compartments by using a facies-based filter.

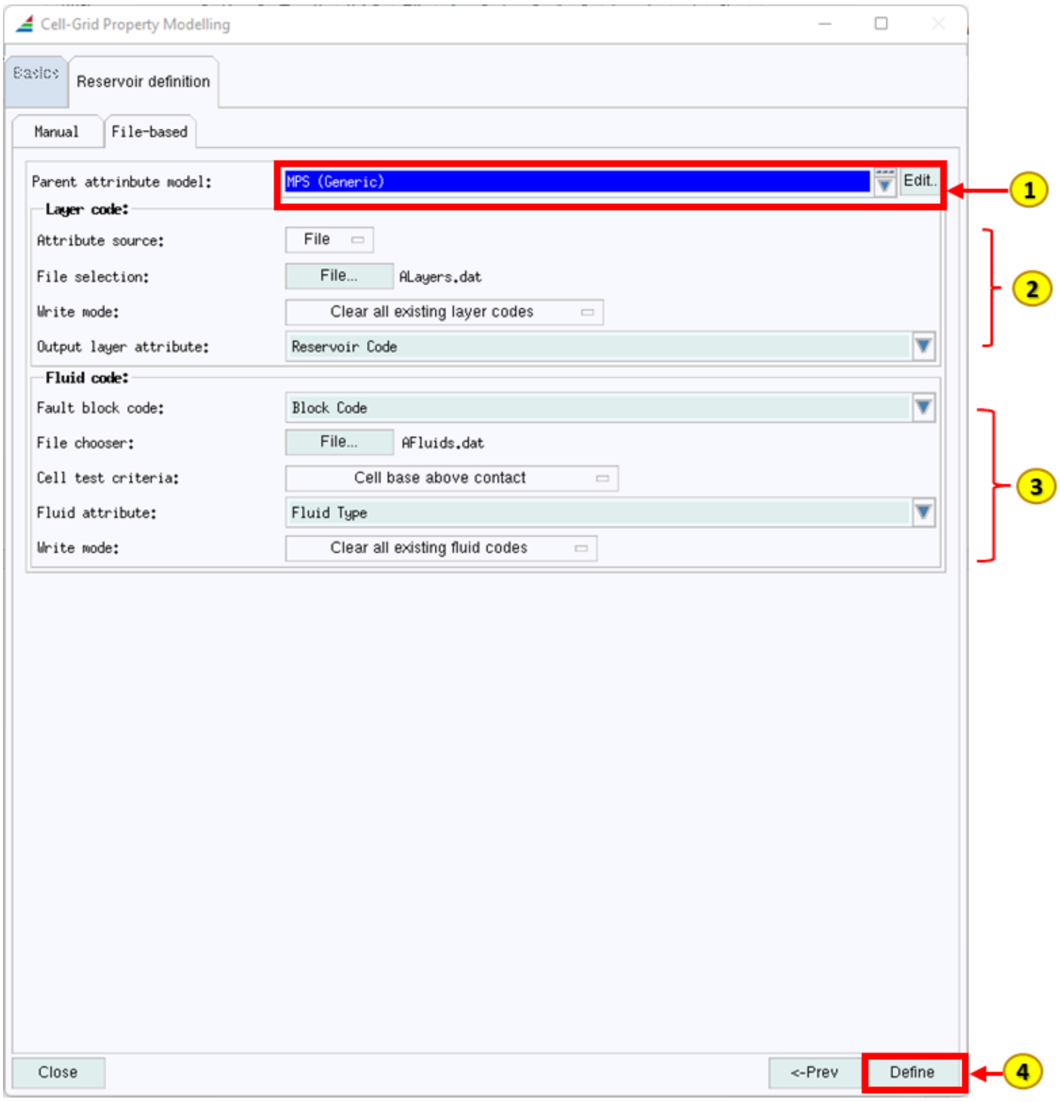
6. Press the *Define* button to create attributes.

1: Compartments (based on structural elements) => **2**: reservoir fluid attribute per compartment (the reservoir).



1: Compartments (based on structural elements) => **A**: facies model for mask (sandstone facies) => **B**: same fluid contacts but reservoir now “compartmentalised” in terms of structure and sedimentology.

The **File-based** method requires ASCII files that define the inputs. This has the benefit of being less tedious than the manual approach when there are multiple reservoir units (layers/horizons).



1. Choose the output attribute model to which the output attributes belong.

2. Select an optional layer file – an existing, previously defined, layer attribute (representing the reservoir units) can be used instead. If an input file is provided this must follow a strict pre-prescribed file structure:

ASCII file as viewed in spreadsheet…

	A	B	C
1	From	To	Code
2	2	4	6
3	8	10	12
4	20	24	24

Header must have three entries in order: From | To | Code

From and to columns: denote the top k-layer and bottom k-layer in the model that define the unit.

Code column: integer id for reservoir unit (as outputted to the attribute model)

3

input contact depth file has predefined format that must be adhere to that includes a header. An example is given below:

ASCII file as viewed in spreadsheet…

	A	B	C	D	E
1	Block	Fluid	6	12	24
2	8	O	1900	2050	2472
3	16	O	1892	2118	2678
4	32	O	1860	2150	2642
5	128	O	1890	2090	2668
6	8	G	1750	1899	2402
7	16	G	1780	2101	2578
8	32	G	1790	2100	2583
9	128	G	1800	2050	2620
10	8	W	1700	0	0
11	8	O	1650	0	0

Header must have and follow, in order: Block | Fluid | N unit codes (here N = 3)

These refer to the reservoir blocks/compartments (lateral limits) and the fluid type: O = oil; G = gas and W = water.

Contact depth data for each unit in each block and per-fluid type.

It should be noted that columns and header have to follow a predefined format but the order in which the reservoir blocks (i.e. compartments) and reservoir units are listed doesn't matter as long as the depths are entered for the right unit, block (i.e. compartment) and fluid.

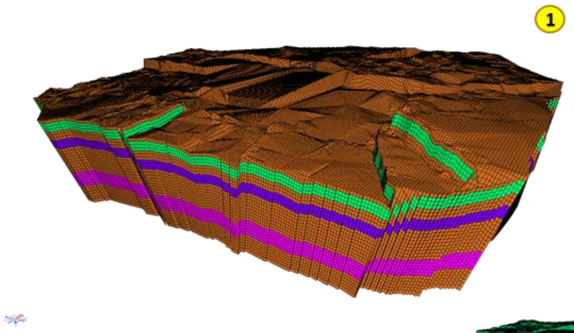
Note that only three units are listed in the example above but as many columns as required can be generated after the fluid column.

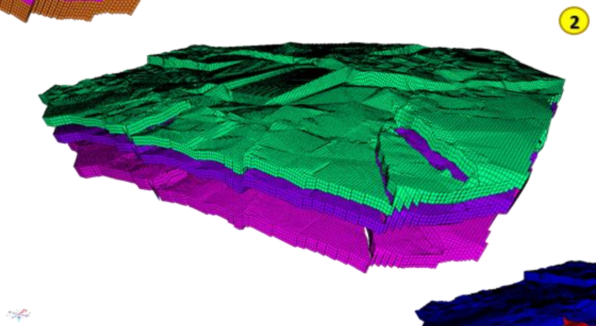
4. Press the *Define* button to populate the attribute model(s).

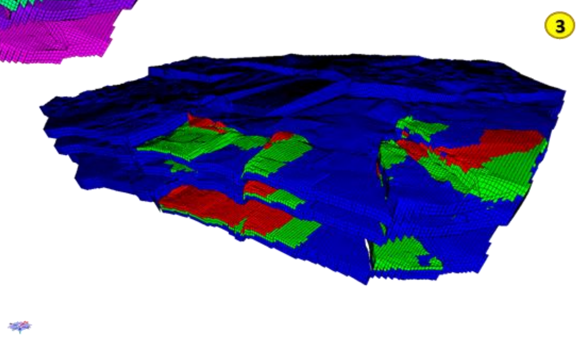
1: Unit/layer attribute created from file in context of CPG.

2: Just reservoir units/layers shown.

3) Fluid attribute model for units as displayed in 2.

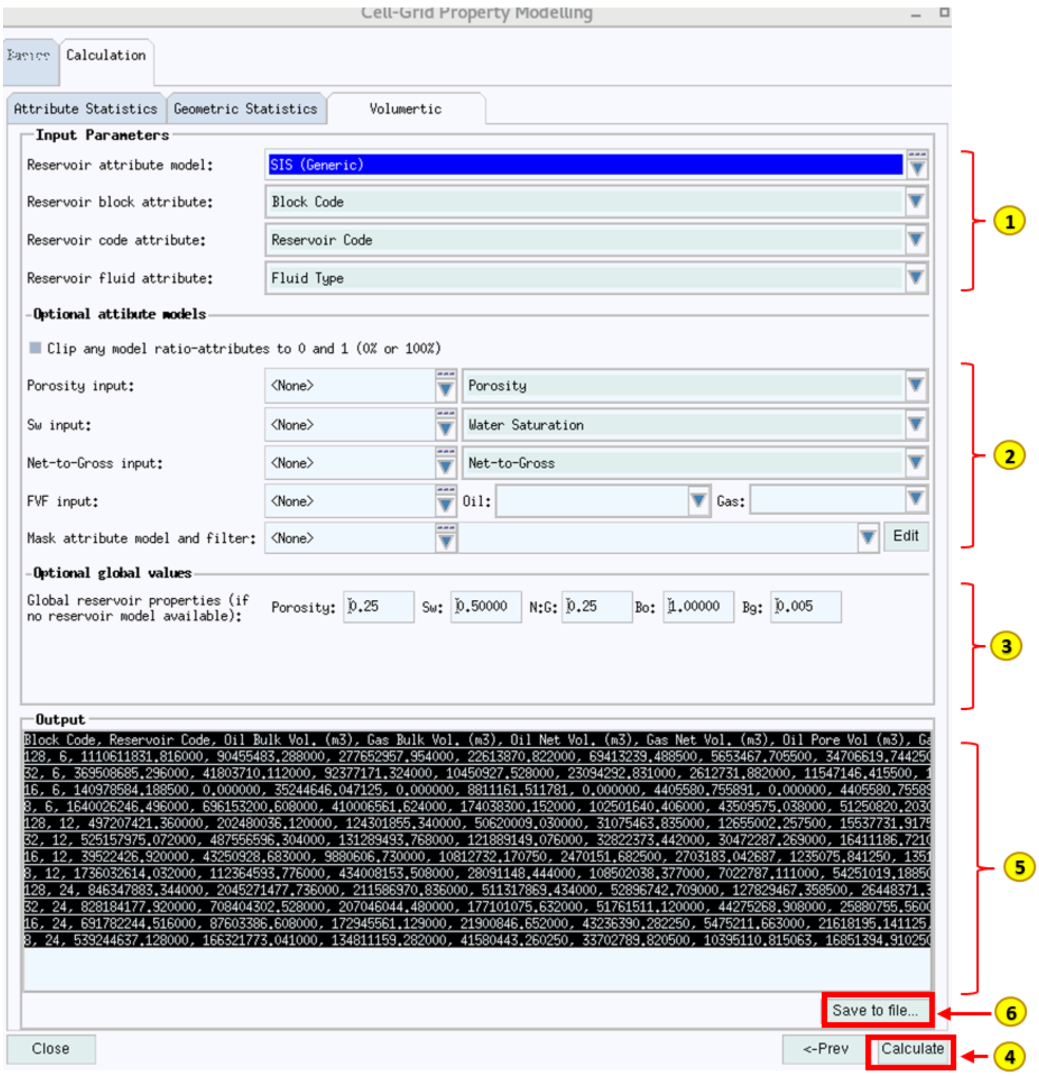






Volumetric analysis and reporting

This is an addition to the “Calculation” tool in T7’s cell property modelling toolkit (static reservoir modelling toolkit). This computes a series of standard volumetrics based on required and optional input parameters. All the various reservoir volumetric calculations are some modification of the bulk cellular volume based on a simple scalar(s) modification (e.g. such as porosity and pore oil saturation). These modifications can be done on a cell-by-cell basis or using global values applied to the accrued cell volume for the reservoir. All reporting is per reservoir block-unit pairing and fluid type.



1. These are required fields and refer to input attributes typically computed using the new tools described above: block attribute (compartment), reservoir code attribute (reservoir units/layers) and fluid attribute (containing the reservoir fluid codes).

2. These are optional input attributes typically computed prior to volumetric analysis using T7's other static reservoir modelling tools (e.g. SGS, Kriging, MLBS etc.). If chosen, these are applied on a cell-by-cell basis to the bulk cell volume to transform it into more specific reservoir volumetrics (e.g. HCPV). If these are not available (or not chosen) then global values are substituted in their place – see step 3.

3. If a corresponding attribute is not selected these global values are applied to the aggregated bulk cell volume computed for each fluid leg in each "block-unit" pairing.

4. To run the analysis press "*Calculate*" button.

5. Results are reported in the "Output" text field.

6. The results shown in step 5, can be saved into ASCII file and viewed in detail in other software such as MS Excel.

ASCII report viewed in spreadsheet…

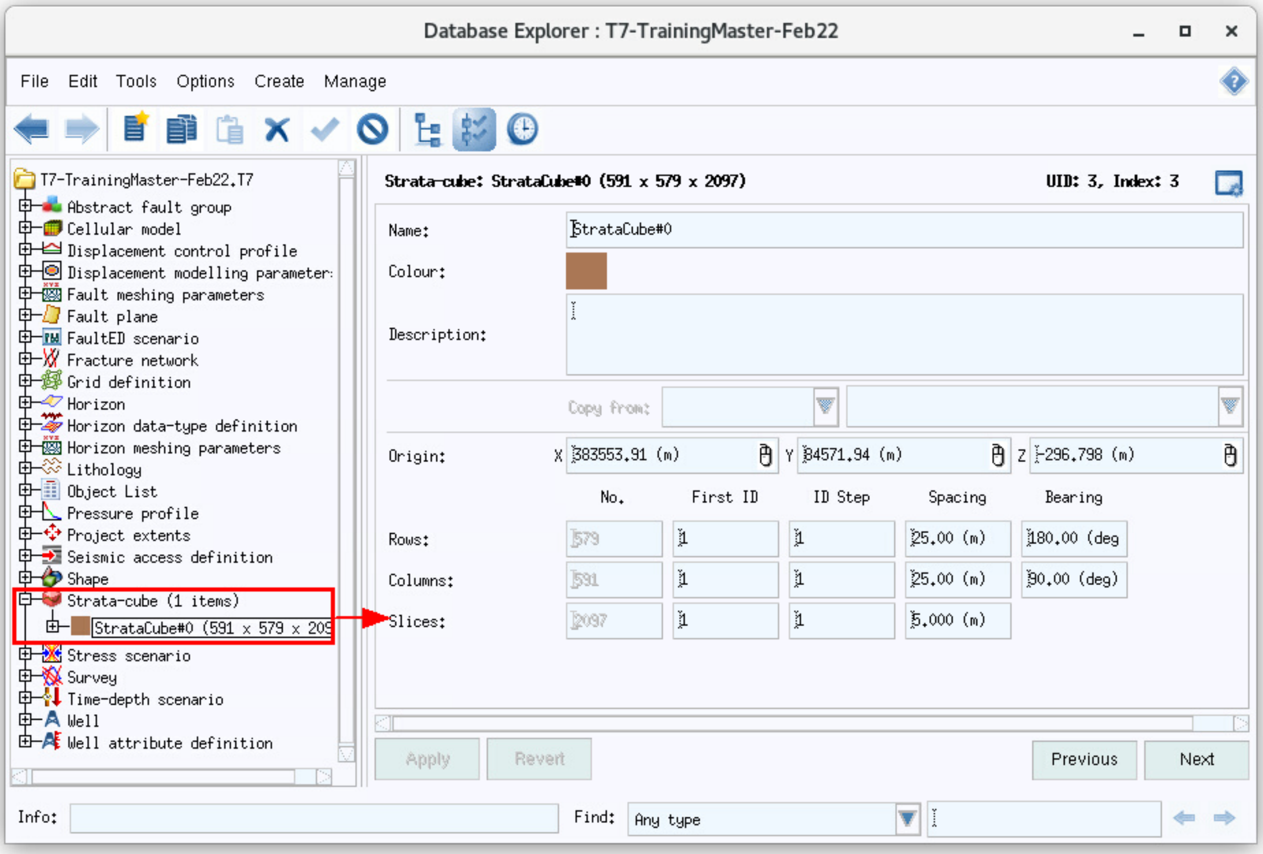
Block Code	Reservoir Code	Oil Bulk Vol. (m3)	Gas Bulk Vol. (m3)	Oil Net Vol. (m3)	Gas Net Vol. (m3)	Oil Pore Vol (m3)	Gas Pore Vol (m3)	Oil HCPV (m3)	Gas HCPV (m3)	STOIIP (m3)	GIPP (m3)
128	6	1110611832	90455483	277652958	22613871	69413239	5653468	34706620	2826734	34706620	565346771
32	6	369508685	41803710	92377171	10450928	23094293	2612732	11547146	1306366	11547146	261273188
16	6	140978584	0	35244646	0	8811162	0	4405581	0	4405581	0
8	6	1640026246	696153201	410006562	174038300	102501640	43509575	51250820	21754788	51250820	4350957506
128	12	497207421	202480036	124301855	50620009	31075464	12655002	15537732	6327501	15537732	1265500225
32	12	525157975	487556596	131289494	121889149	32822373	30472287	16411187	15236144	16411187	3047228725
16	12	39522427	43250929	9880607	10812732	2470152	2703183	1235076	1351592	1235076	270318304
8	12	1736032614	112364594	434008154	28091148	108502038	7022787	54251019	3511394	54251019	702278711
128	24	846347883	2045271478	211586971	511317869	52896743	127829467	26448371	63914734	26448371	12782946734
32	24	828184178	708404303	207046044	177101076	51761511	44275269	25880756	22137634	25880756	4427526886
16	24	691782245	87603387	172945561	21900847	43236390	5475212	21618195	2737606	21618195	547521168
8	24	539244637	166321773	134811159	41580443	33702790	10395111	16851395	5197555	16851395	1039511081

Introducing Strata-Cubes

T7.210 introduces Strata-Cubes for the first time and in this release the functionality is mainly aimed at providing a means of processing seismic volumes using user-defined macros. Going forward, Strata-Cubes will form the basis of further new and novel functionality in future T7 releases. Refer to the accompanying document, **SpecialNotes.pdf**, for a more detailed description of current workflows using Strata-Cubes.

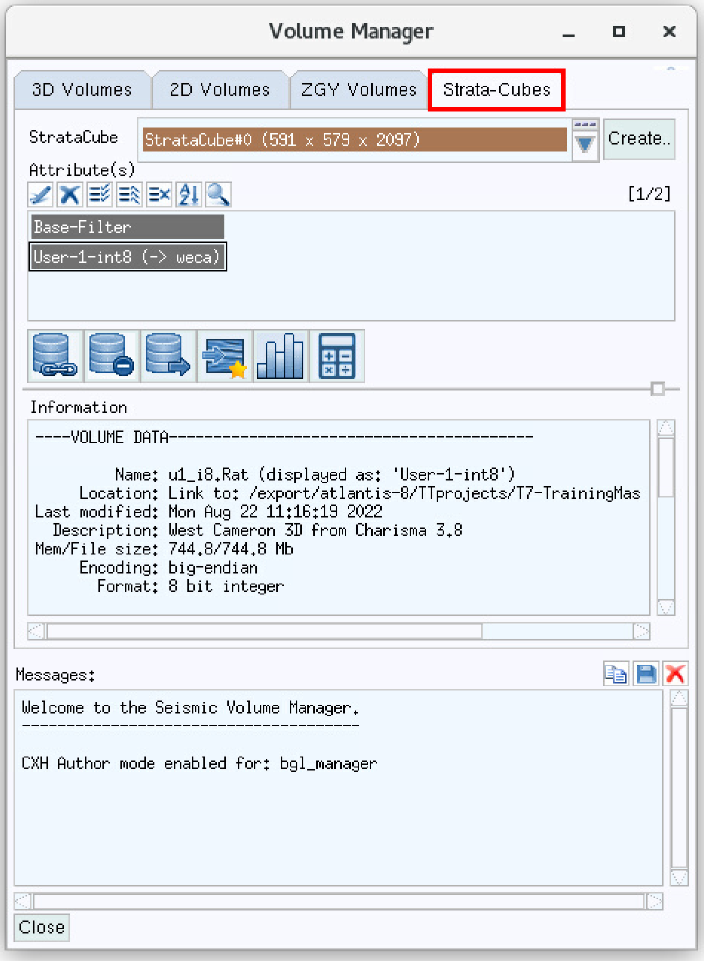
In essence, a Strata-Cube is a "container grid" for hosting 3D attribute (or seismic) volumes that conform to a common set of geometric parameters i.e. the same number of rows, columns and z-slices, the same origin, spacings and orientation.

Strata-Cubes are managed under the T7 “task-based" system that is already used for Faults, Horizons and a number of other T7 data-types. In this way, the Strata-Cube Attributes adhere to a pre-set list. The Attributes themselves, when defined, are stored on disk in exactly the same way as BGL 3D seismic volumes. Indeed, it is possible to use a BGL 3D seismic volume to define a Strata-Cube's geometry and to link it as a Strata-Cube Attribute. Strata-Cube Attributes can be processed and manipulated in the same was as other T7 task-based attributes; they are available in the Attribute Calculator where new Attributes can be created using user-defined macros, and in Plot Viewer where they can be cross-plotted. It is also possible to create a Seismic Access Definition that refers to a Strata-Cube Attribute - this feature provides the ability to treat the Attribute in the same way as standard 3D seismic data whereby it can be loaded and displayed in the Volume Editor on appropriate 3D survey sections or as a cube. Strata-Cubes can be created in the Database Explorer or in the BGL Volume manager. The BGL Volume Manager provides a number of tools that act on Strata-Cube Attributes.



StrataCubes in Database Explorer

The BGL Volume Manager has been extended with a dedicated tab to handle the management of Strata-Cubes and their attributes. From here it is possible to link 3D seismic volumes as Strata-Cube attributes, create Seismic Access Definitions and export the data in SEGY format.



The Strata-Cubes tab also contains a button providing direct access to the Attribute Calculator. The Attribute Calculator provides the ability to process existing attributes to create new ones based on the content of a user-defined macro. Some example macros are provided that perform smoothing and simple pseudo-relief operations.

The image below shows a seismic volume linked and processed as a Strata-Cube attribute to create two new attributes. See the 7.210 **SpecialNotes.pdf** document for more details.

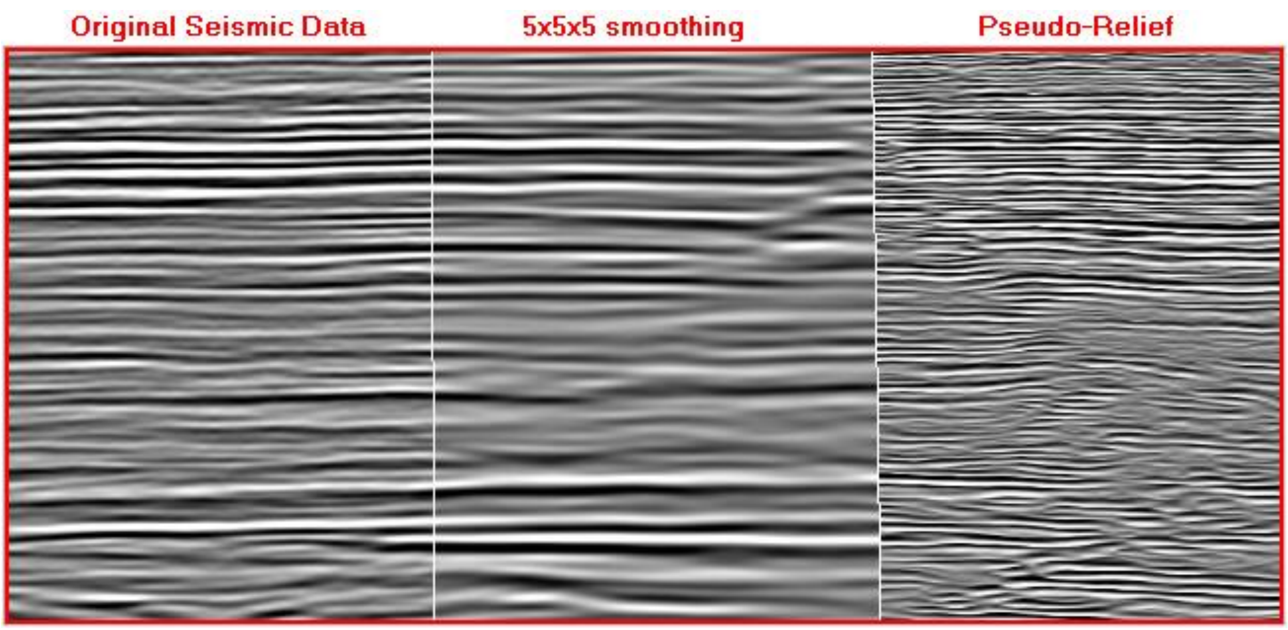


Table-Based Object Manager for Well Picks

Database Explorer now provides table views for well fault and horizon picks:

Well horizon pick

	Well	Horizon	Name	Scale mode	Control value	Upper scaling horizon	Lower
1	Well-1	K1	HrzPick.3	Absolute positioning	1682.687	N/A	N/A
2	Well-1	PGB1	HrzPick.1	N/A	N/A	N/A	N/A
3	Well-1	K2	HrzPick.4	Absolute positioning	1850.281	N/A	N/A
4	Well-1	K3	HrzPick.14	Absolute positioning	1884.164	N/A	N/A
5	Well-1	K4	HrzPick.15	Absolute positioning	1911.353	N/A	N/A
6	Well-1	K5	HrzPick.5	Absolute positioning	1990.181	N/A	N/A
7	Well-1	K6	HrzPick.6	Absolute positioning	2099.149	N/A	N/A
8	Well-1	K7	HrzPick.7	Absolute positioning	2228.908	N/A	N/A
9	Well-1	K8	HrzPick.8	Absolute positioning	2494.573	N/A	N/A
10	Well-1	K9	HrzPick.9	Absolute positioning	2582.436	N/A	N/A
11	Well-1	PGB2	HrzPick.2	N/A	N/A	N/A	N/A
12	Well-1	K10	HrzPick.10	Absolute positioning	3055.920	N/A	N/A
13	Well-1	K11	HrzPick.11	Absolute positioning	3189.506	N/A	N/A
14	Well-1	K12	HrzPick.12	Absolute positioning	3205.225	N/A	N/A
15	Well-1	PGB3	HrzPick.0	N/A	N/A	N/A	N/A
16	Well-1	K13	HrzPick.13	Absolute positioning	3687.802	N/A	N/A

In addition to providing a useful overview, picks may be renamed and re-assigned to faults or horizons. This reproduces much of the functionality found in the Well Pick Assignment Tool, although this tool will remain available as an alternative.

The horizon pick table also allows the scaling mode, control value and scaling horizons to be modified:

Scale mode	Control value	Upper scaling horizon	Lower scaling horizon
Lower scaled	0.90220	PGB1	PGB2
Lower scaled	0.87913	PGB1	PGB2

When changing the scaling mode, control value or control horizons, an invalid configuration will be indicated by a yellow warning triangle in the Scale mode field. Hovering the mouse over the triangle will display a tooltip indicating the issue:

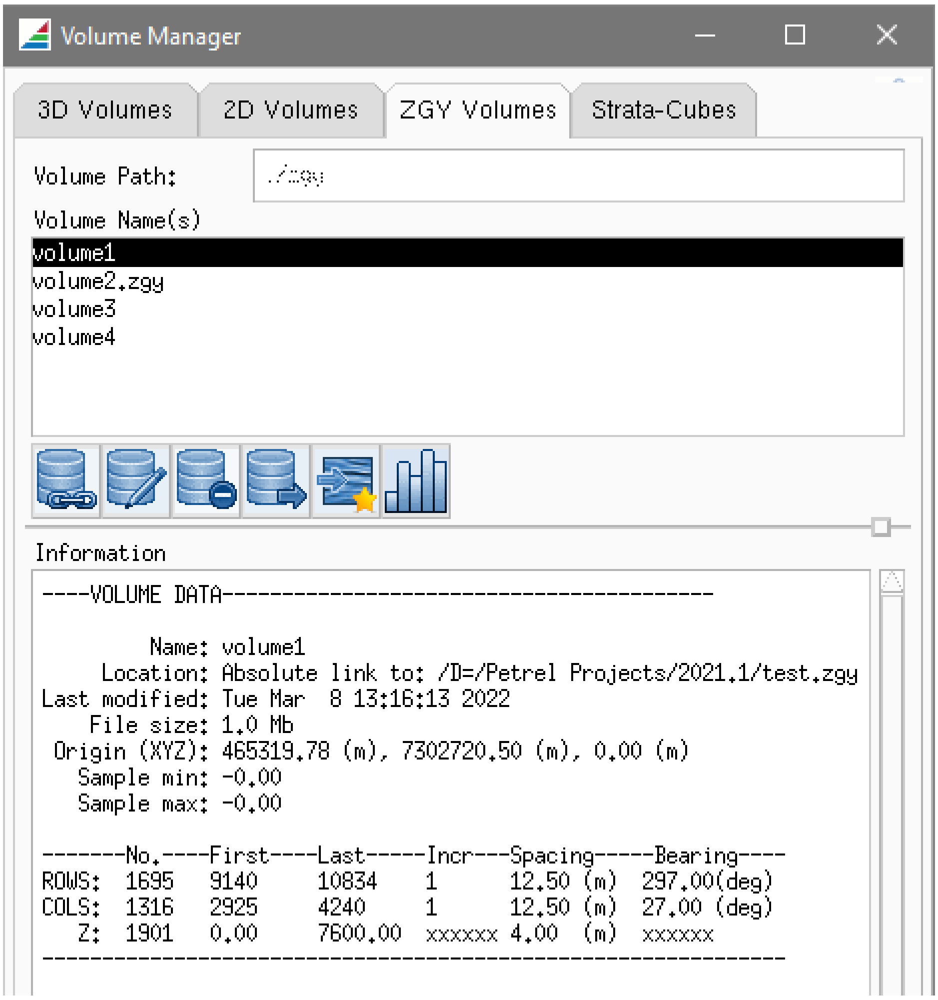
Scale mode	Control value	Upper scaling horizon	Lower scaling horizon
Lower scaled	0.[illegible]0220	None	PGB2
No upper scaling horizon	[illegible]7913	PGB1	PGB2

This interface provides a convenient alternative to the “Control Horizons” functionality in the Well Editor application.

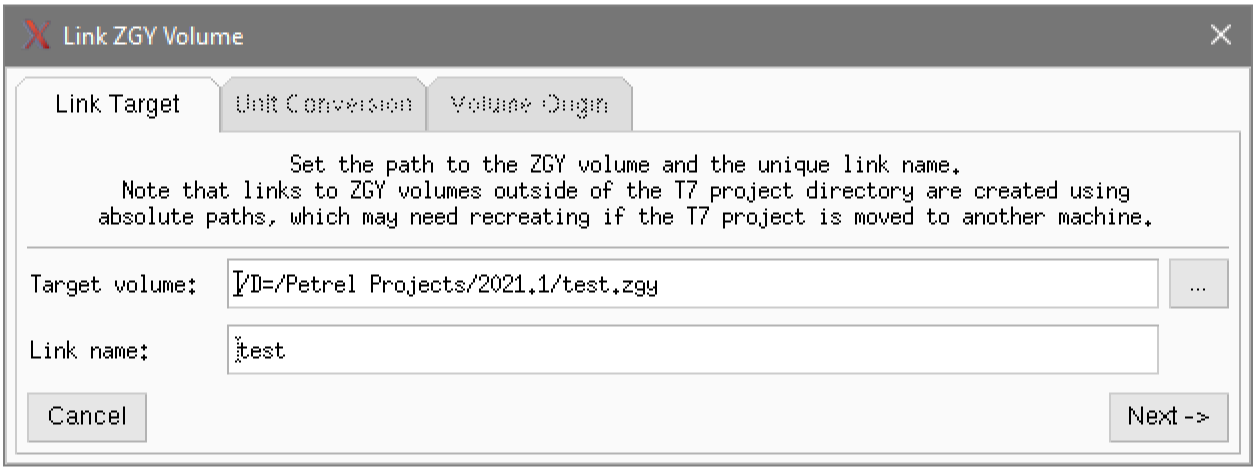
FUNCTIONAL ENHANCEMENTS

Support for Petrel ZGY Seismic Volumes

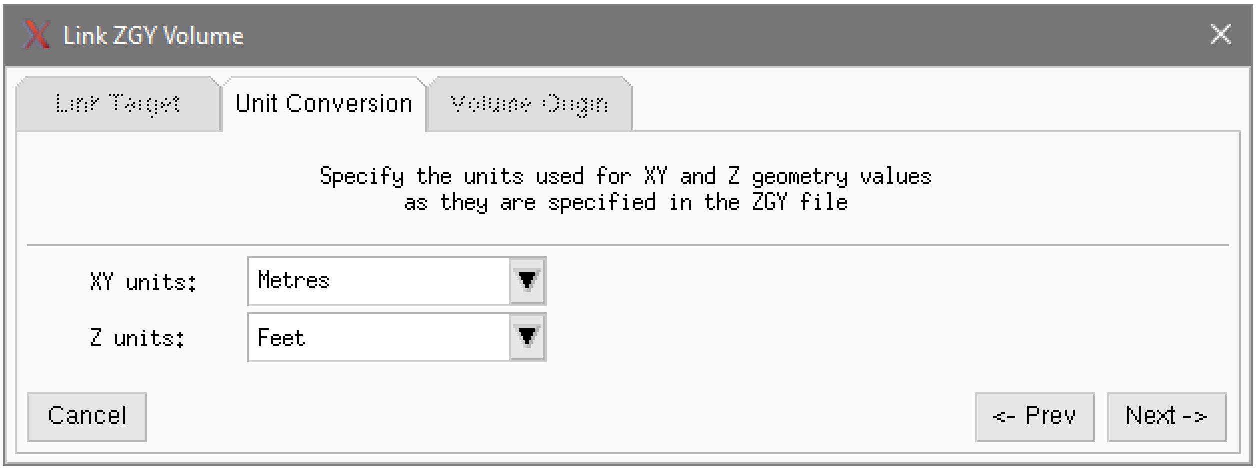
New to 7.210, T7 has the ability to directly load seismic from Petrel ZGY 3D volumes. A new tab is available on the Volume Manager for listing and working with ZGY volumes:



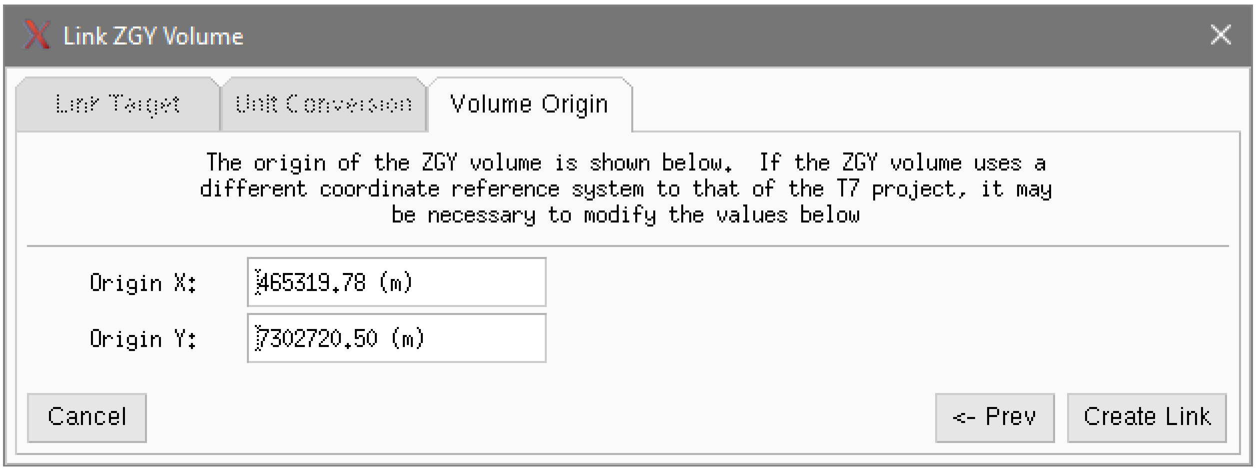
A new volume is added to the interface using the **Create link to volume** button which launches the Link ZGY Volume wizard:



The initial wizard page allows the target volume to be chosen and the link name (displayed in the Volume Manager) to be specified.



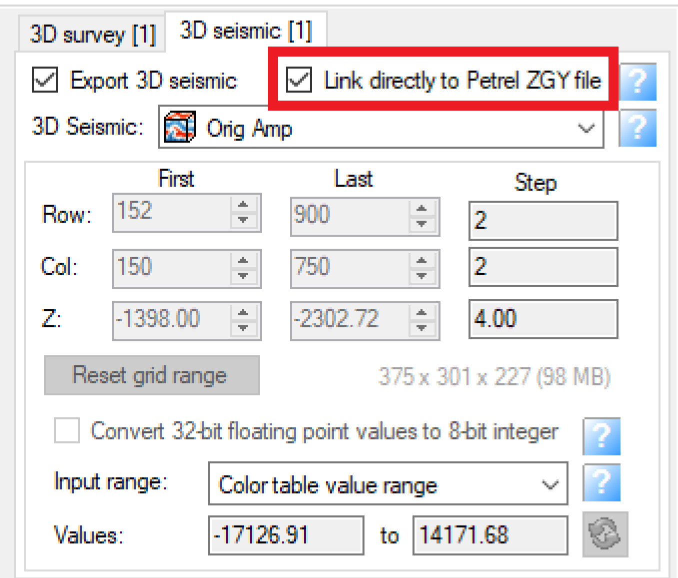
ZGY volumes do not contain the XY and Z units used for the volume origin and spacings. The second wizard page allows these units to be manually specified.



The final wizard page shows the origin as obtained from the ZGY volume. T7 does not perform conversions between coordinate reference systems, so if the ZGY volume uses a different coordinate reference system to that of the T7 project, it may be necessary to modify the values.

Once the link has been created, a Seismic Access Definition is automatically created to allow seismic to be loaded on Volume Editor sections and volume probes.

In addition to the Volume Manager changes, the T7 Petrel plugin has a new option to create a ZGY link rather than transferring seismic and creating a new BGL volume:



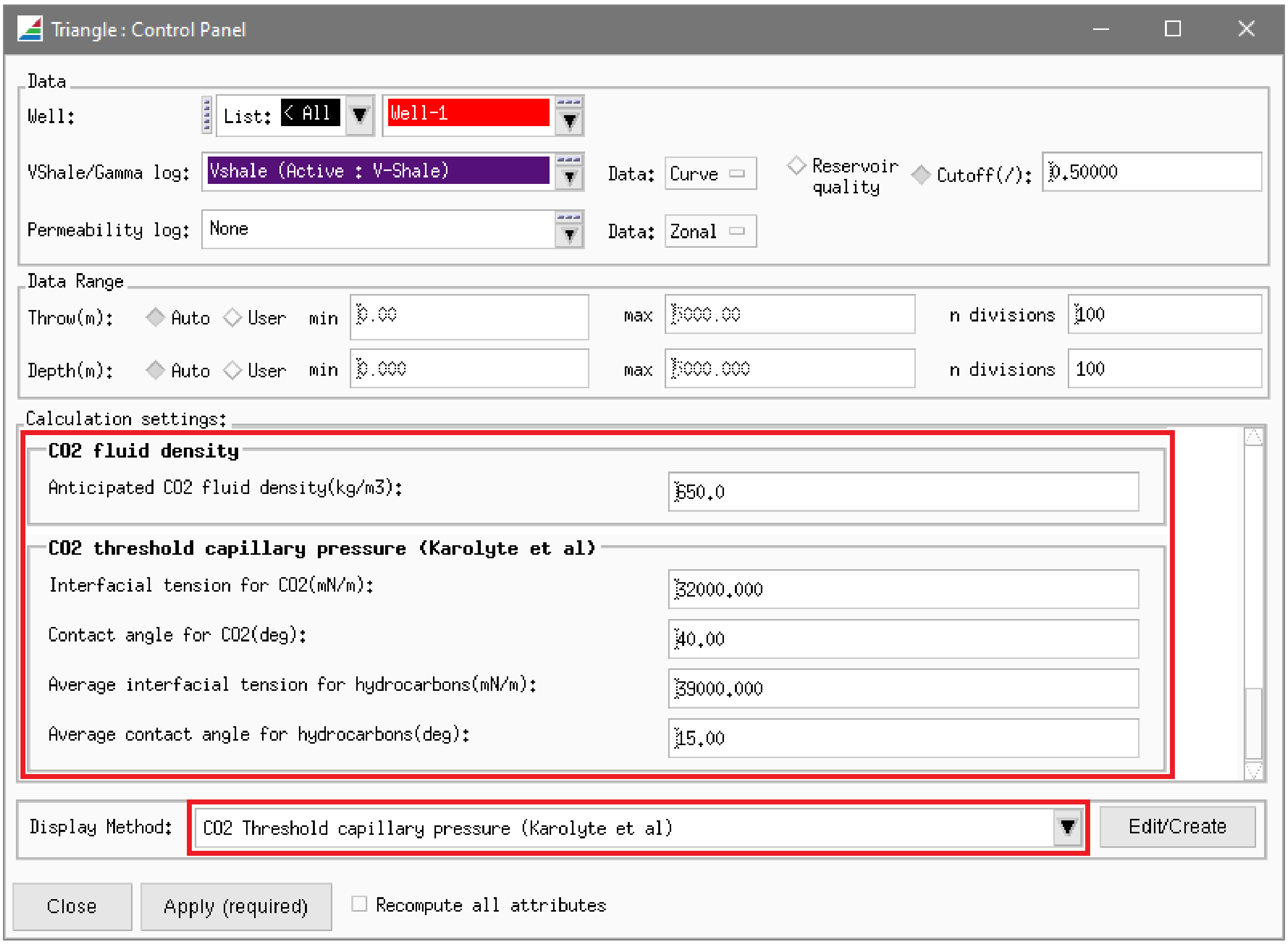
CO_2 Attributes in Triangle

T7.210 introduces support for CO_2-based property calculations in the Triangle application. In particular the following attributes can now be calculated and displayed on the Triangle plot:

- CO_2 Threshold capillary Pressure
- CO_2 Column Height

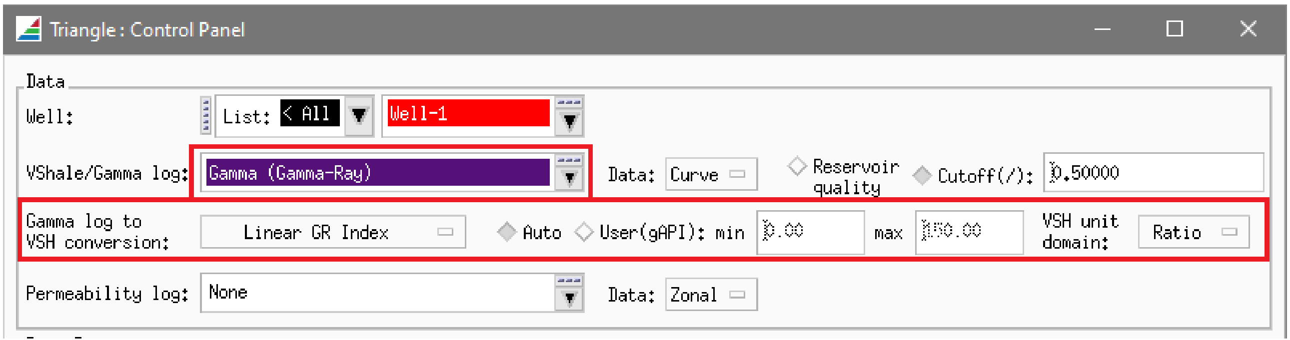
These attributes are based on the theory described in the 2020 Karolyte et al paper "**Fault seal modelling – the influence of fluid properties on fault sealing capacity in hydrocarbon and CO_2 systems**".

The parameters that control the CO_2 attribute calculations have been added to the Triangle Control Panel settings. Additional display methods have been added that utilise the two new attributes:



Support for Gamma-Ray to V-Shale Conversion

Triangle now supports the use of Gamma-Ray logs as an alternative to Vshale. When a Gamma-Ray log is chosen, additional parameters are available that specify how the log is converted internally to Vshale:



Three methods of conversion are available:

- Linear GR Index (IGR) is the simplest method and uses the following equation:

$$\mathrm{VSH}_{LinearGRIndex} = \mathrm{IGR} = \frac{GR_{LogValue} - GR_{min}}{GR_{max} - GR_{min}}$$

- Larionov (1969) Old Rocks is based upon IGR and calculates shale for rocks older than Cenozoic Era:

$$\mathrm{VSH}_{LarionovOldRocks} = 0.33\ (2^{(2\,IGR)} - 1)$$

- Larionov (1969) Tertiary Rocks is based upon IGR and calculates shale for Cenozoic rocks:

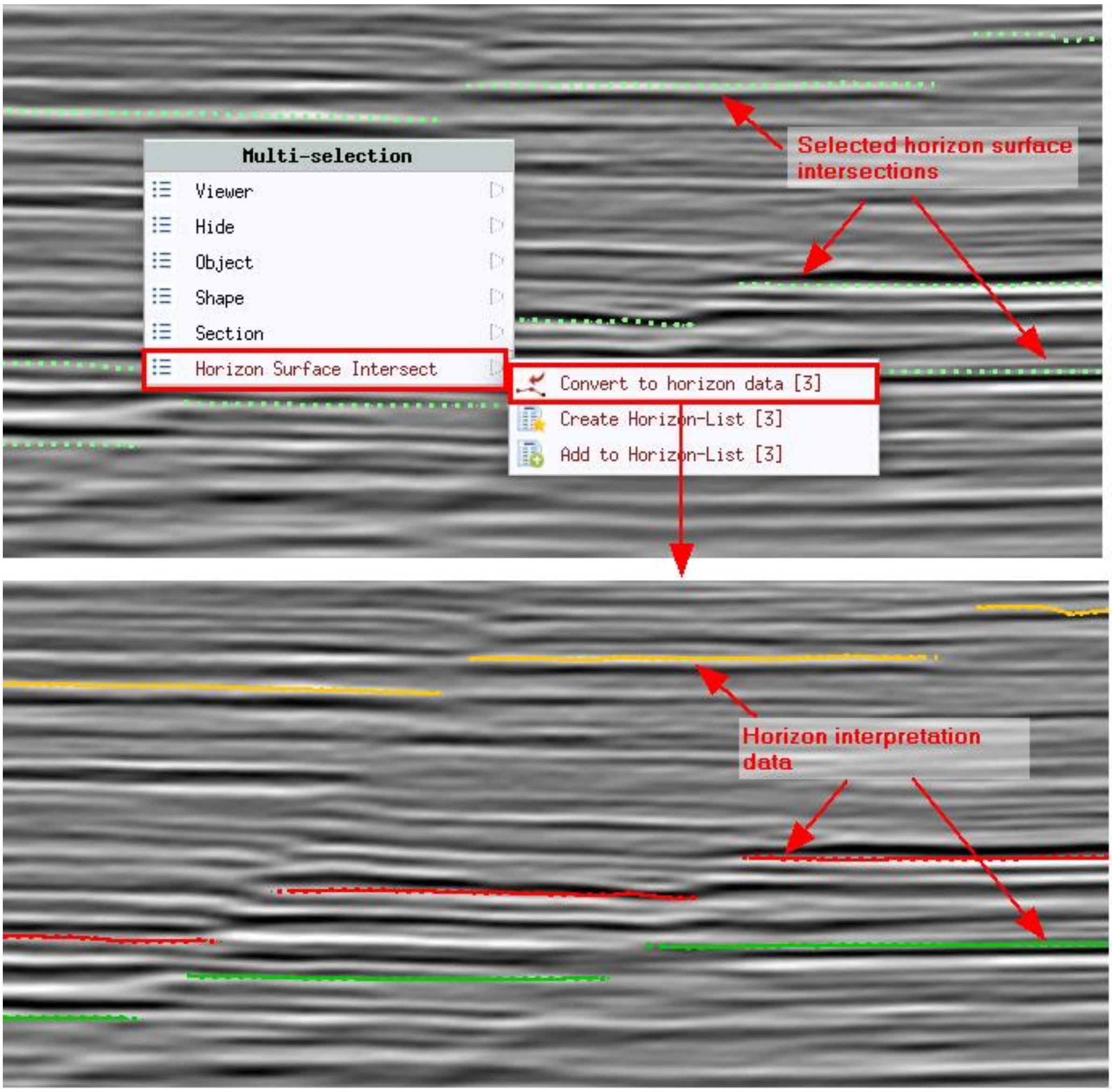
$$\mathrm{VSH}_{LarionovTertiaryRocks} = 0.083\ (2^{(3.7\,IGR)} - 1)$$

The min and max values for the above equations can be obtained automatically from the logs or by specifying values manually in the interface.

Convert Horizon Surface Intersects to Interpretation

A new option has been added to the Volume-Editor's Interpret Module to allow the conversion of horizon surface intersects (displayed on a vertical section or z-slice) to horizon interpretation data. This is a useful option when the horizon data in T7 exists in the form of a surface tri-mesh but without interpretation data on one or more survey-lines.

This option simply requires a section and relevant horizons to be loaded with horizon surface intersects enabled and displayed. The example below shows the option operating on multiple horizon intersection objects on a section (it will also operate over multiple sections).



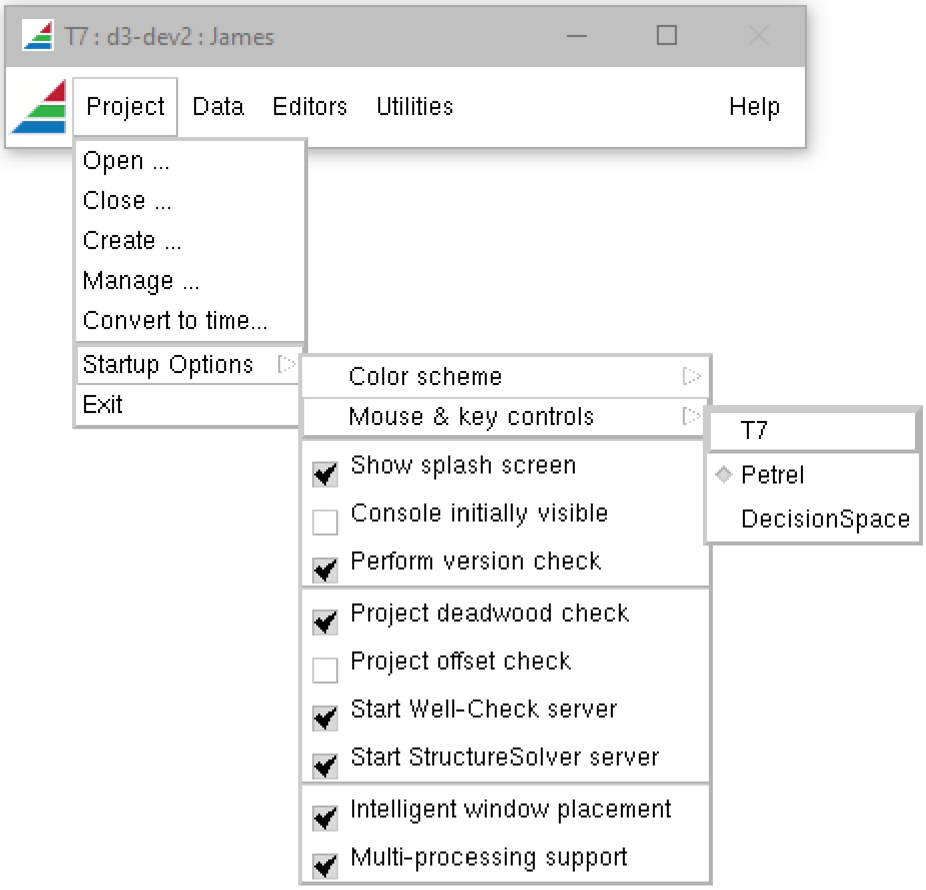
The horizon interpretation data created will be stored in a Horizon Data Volume. If the intersections contain reverse structure then the option for enabling "Multi-Z" horizons should be enabled in the Interpret Tab's Options menu prior to converting the horizon intersections; in this case, multiple Horizon Data Volumes will be used and created if required to store and preserve the reverse structure..

USABILITY IMPROVEMENTS

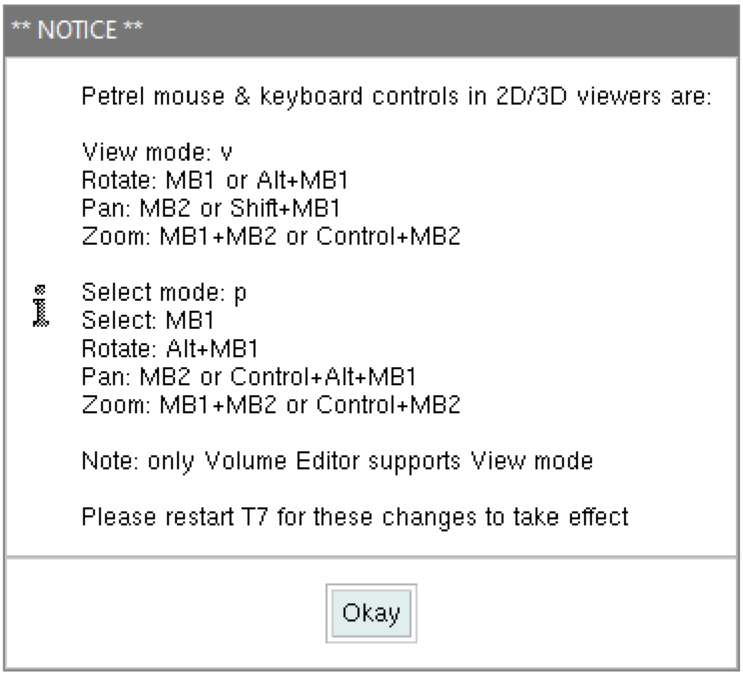
Petrel & DecisionSpace Mouse & Key Controls

To make working in T7 alongside Petrel and DecisionSpace easier, T7 now supports alternative mouse and key controls for manipulating 2D and 3D viewers. This primarily targets Volume Editor, but there is also support in 2D applications such as Triangle.

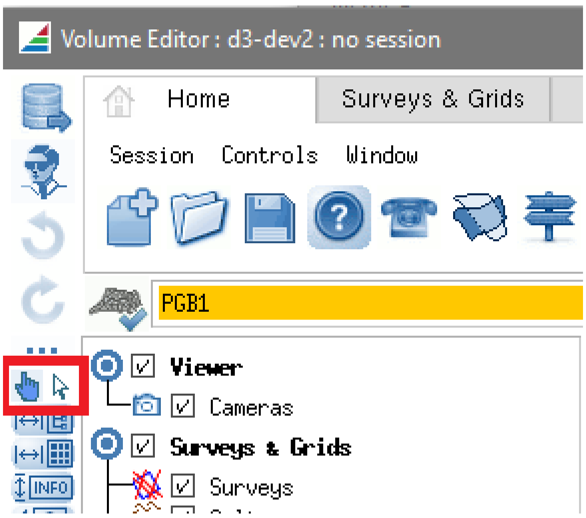
The mouse and key controls can be changed via the T7 Control Menu Startup Options menu:



Upon choosing a new control method, a dialog is shown detailing the method key and mouse controls:



Both DecisionSpace and Petrel support a distinct “view” and “select” mode. This is represented in Volume Editor via a new toolbar entry and associated hotkeys:

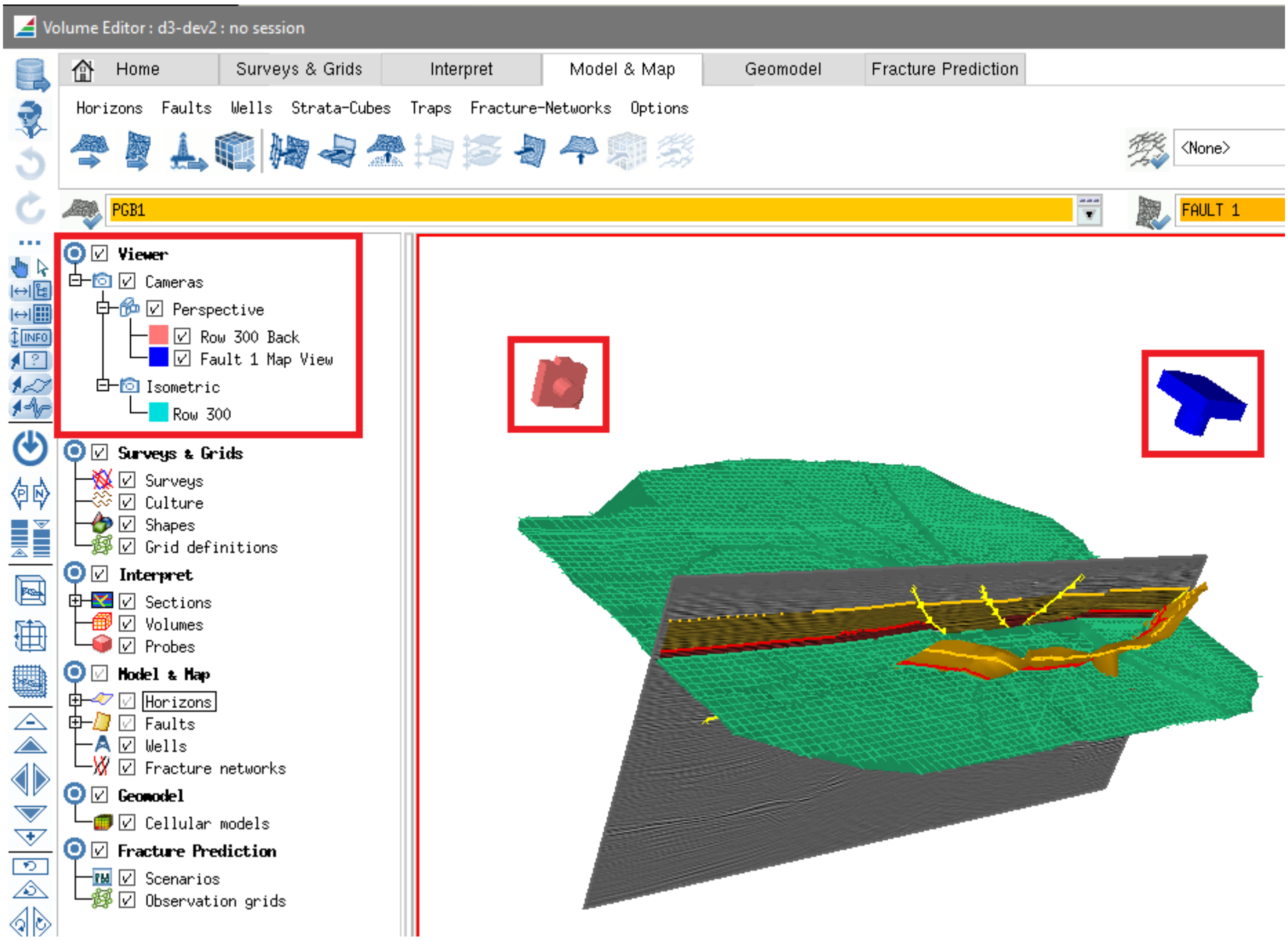


View and select mode may be toggled using hotkeys (‘v’ & ‘p’ for Petrel mode, ‘n’ & <Tab> for DecisionSpace mode). The mode is maintained on a per-viewer basis.

Note that many operations in T7 will require the viewer to be in select mode, this will typically be enabled when required.

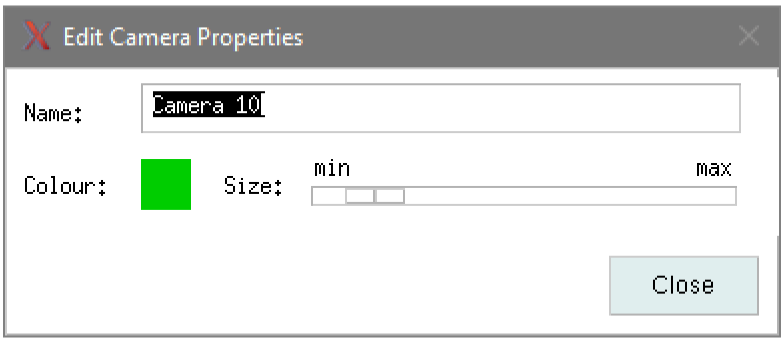
Volume Editor: Camera Views

Volume Editor now supports Camera objects which allow a viewer location and orientation to be stored and warped to at a later time.



Camera objects are represented in the Volume Editor object tree under a new Viewer node and within each Volume Editor viewer as camera objects. Cameras are saved and restored in sessions automatically.

A camera is added at the current viewer location by choosing Viewer->Add Camera from the MB3 context menu, or using the Alt+C keyboard shortcut:



The camera will be added at the current location and a dialog displayed (as above) to allow the camera name, colour and size to be modified.

Once a camera is created, double clicking the camera in the tree or viewer will warp the viewer to that location. A camera can be removed using the context menu or by pressing the ‘x’ shortcut key when one or more cameras are selected in the viewer. Finally, a camera may be hidden from the view by unchecking the camera in the tree. It is still possible to warp to a hidden camera by double clicking the camera icon in the tree.

Cameras are supported in both perspective and isometric viewer modes and are represented under different categories in the Volume Editor object tree. Warping to an isometric camera in perspective view will automatically switch the viewer into isometric view. The reverse is true when warping to a perspective camera when the view is in isometric mode. Note that due to current limitations, isometric cameras cannot be visually represented in the viewer. However, they can still be warped to using the associated object tree icons.

Volume Editor: Session Storage for Hidden Objects

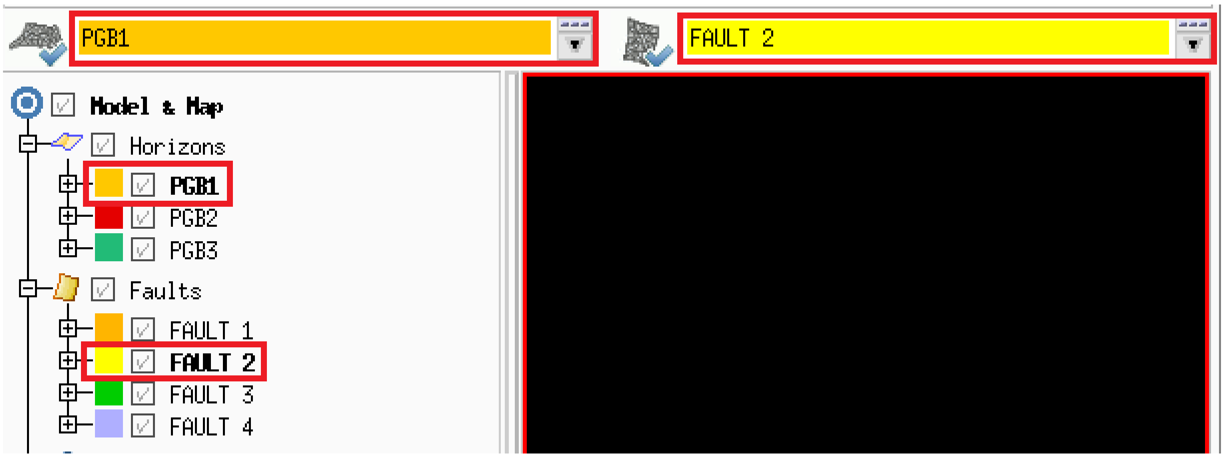
Previously, hidden objects only remained hidden for the duration of the Volume Editor session. Restarting Volume Editor or loading a session caused all hidden objects to re-appear in the viewer.

In 7.210, hidden objects (including the new camera objects) are now maintained within saved sessions ensuring they remain hidden when the session is later restored.

The sequence of the hidden state of objects is also preserved such that successive "Unhide" operations will bring the objects back into view in the reverse order that they were originally hidden.

Volume Editor: Setting the Active Object using the Tree

The active object for a particular type (*eg.* Horizon, Fault, Cell Model Scenario, *etc*) may now be set by simply clicking the appropriate object name in the Volume Editor object tree:



Note that this feature requires the relevant objects to be loaded in the Volume Editor.

Volume Editor: Direct Access to Attribute Information

For Display Method based attributes represented on Faults, Horizons, Fracture Networks, Cell-Grids and Cell-Faults there is now a direct way to access information and additional tools for the displayed attribute data from within the Volume Editor. The new "*Attribute Info…*" option is accessed either from the *<MB3> Popup-Menu* or shortcut toolbar (as shown below for a Fault). This option will popup the Attribute Texturemap window for the first attribute referenced in the Display Method applied to the Fault (or other object). From this window it is possible to access a histogram display for the attribute or go directly to the Attribute Calculator.