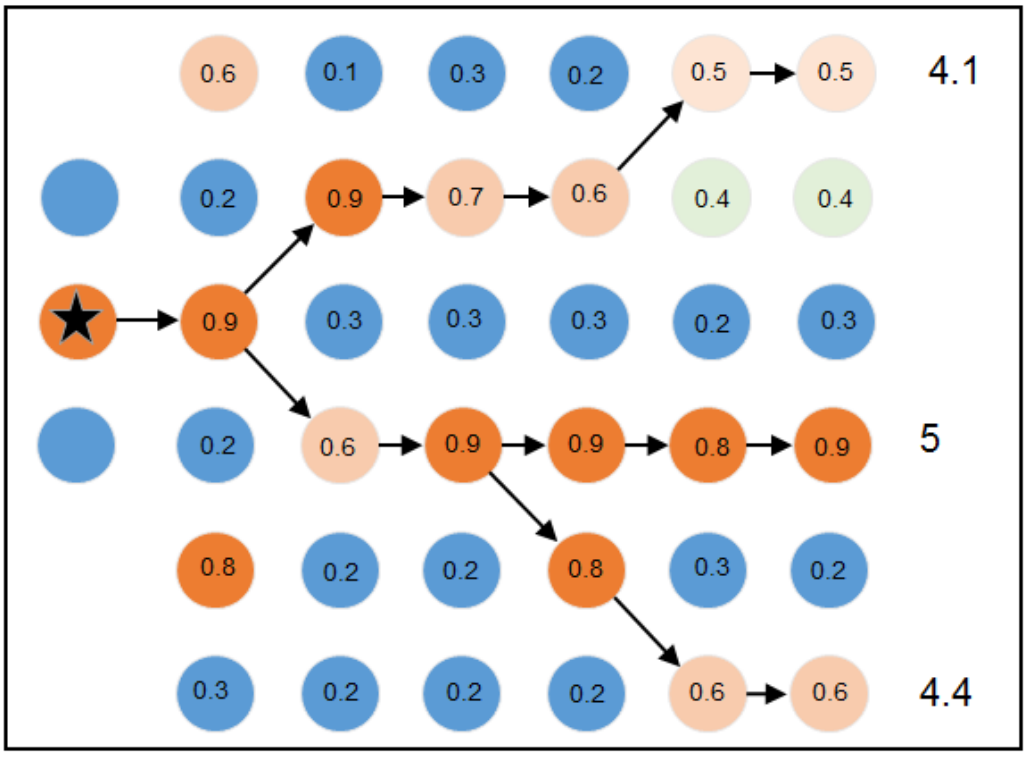
Adaptive Interpretation

Adaptive Horizons

Introduction

GeoTeric's new Adaptive Interpretation System will unify horizon and fault interpretation. Both the horizon and fault interpretation use Regional Structural Awareness to give the Interpreter options to determine the most accurate horizon or fault interpretation.

GeoTeric's Adaptive Horizon Interpretation tool utilizes Graph Theory to find the most accurate interpretation. Graph theory correlates all the points in the data and determines all the potential paths. The path with the highest score will be selected as the interpreted horizon. All the other paths are remembered creating the Regional Structural Awareness. The Regional Structural Awareness enables an interactive preview of alternative interpretations, which makes the Geoscientist aware of the correct interpretation but also what else is going on in the data.

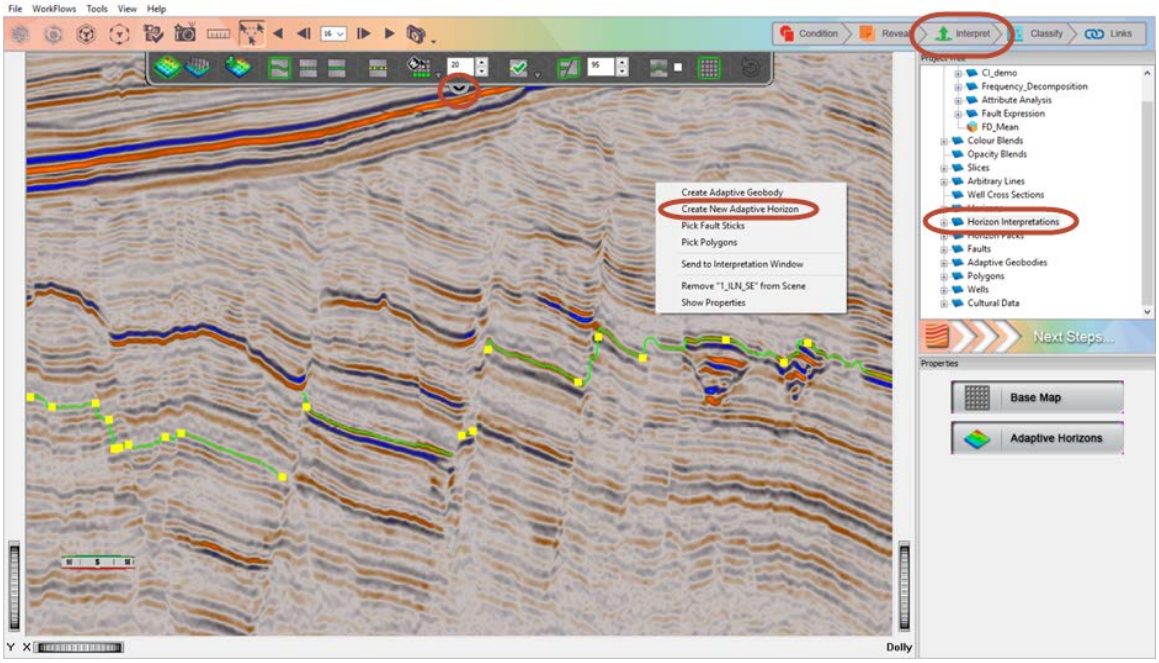


Example of Graph Theory.

There are several ways in which the interpretation can be carried out, on a probe, on a slice or a 2D inline and crossline section. To interpret on the probe or a slice, these can be done in the 3D scene, to interpret

on a 2D inline or crossline section, right click on the slice and select Send To Interpretation Window. Any horizon imported into GeoTeric, or older surfaces from previous version of GeoTeric can be converted to an Adaptive Horizon for editing. To start a new Adaptive Horizon, see image below:

1. From the Interpret Module at the top right of the main menu tool bar.
2. Click on the semi-circle below the main tool bar to bring down the Interpretation Bar.
3. Right click in the project tree on the Horizon Interpretation folder and in the menu, click on Adaptive Horizons.
4. Right click on the slice or probe in the 3D scene and select Create New Adaptive Horizon.



Once activating the Adaptive Horizons, the Interpretation Bar will come down from below the main menu. This is what it looks like:

From left to right the icons on the Interpretation Bar are:

1. Horizon Interpretation
2. Fault Interpretation
3. New Adaptive Horizon – used to create a new Adaptive Horizon.
4. Full Line Tracking – this will utilize Graph Theory to find the best possible interpretation across the entire line. This can be used on a slice or a probe using Shift+MB1. This option is useful to

interpret the sea bed and regional events that regionally continuous and not heavily faulted. If Stop at Faults in enabled, it will stop at discontinuities and noisy data.

5. Piecewise Tracking – allows the user to pick points along a horizon using Shift+MB1, the tracker will find the best path between points along the horizon. A preview of alternative interpretations is available to aide with the interpretation across faults.
6. Manual Tracking – a straight line will be drawn between points using Shift+MB1. This is helpful when the data quality is very poor and the interpreter would like to force an interpretation through.
7. Complete Line – this option will join up previously tracked points along a slice. This is useful to quickly create a grid of the interpretation if the horizon has been interpreted in 1 direction.
8. Horizon Fill options with the acceptance level to the right. The higher the acceptance level the more of the tracked area will be filled.
9. Accept Lines – the user has the option to accept filled lines, making them part of the interpretation to quickly build up the final interpretation. There is also the option to unaccept line.
10. Stop at Faults, with the acceptance level to the right. With this button active and the acceptance level set to a high value the full line tracking will stop at discontinuities in the data or extremely noisy data.
11. 3D Edit – a filled horizon can be edited in the 3D scene by simply using the piecewise tracking to move the mis-pick. An area around the mis-pick will then be corrected. If the tick box next to the 3D Edit is ticked, this will over-ride interpreted lines/ accepted lines.
12. Base map – this will bring up the base map in a separate window
13. Undo – 1 step undo

Usage:

To start interpreting, choose the method of interpretation - full line or piecewise. Shift+MB1 on the event of interest and begin interpreting. If the event is a very regional event, like the sea bed for example, the full line tracking is very effective.

To begin interpreting with the piecewise tracker, hold down the Shift+MB1, then continue to add seed points with MB1, to release the piecewise tracker, hold down the Shift and double click MB1. The Esc key will also release the tracker.

When interpreting on a probe, the outside faces of the probe are tracked. The interpretation can then be QC’ed by rotating the probe. The area inside the probe can then be filled, in the 3D scene, by clicking on the icon to fill.

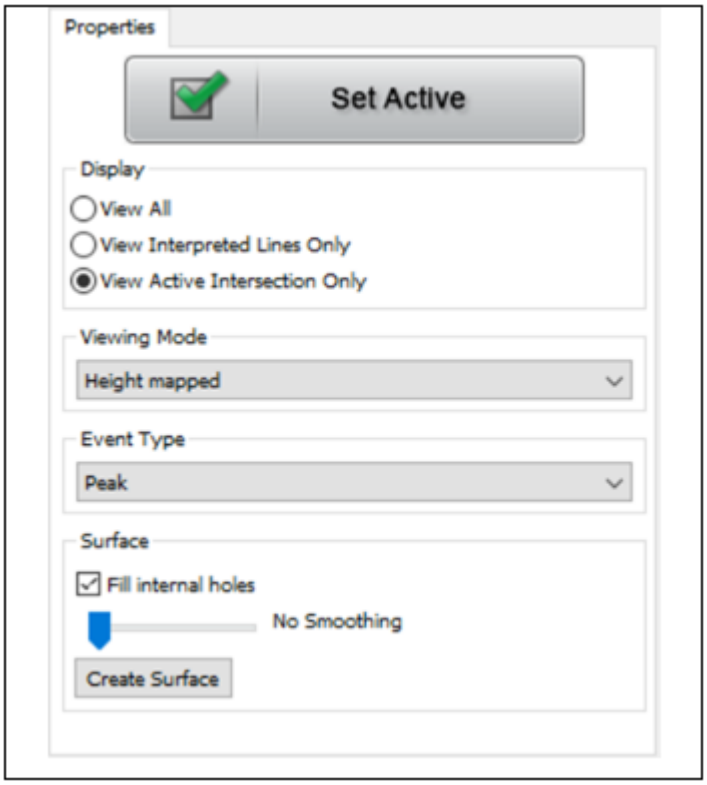
To delete any interpretation or filled area in the 3D scene or in the 2D Interpretation Window, Shift+MB3 and move over the area to delete.

To move slices in the 3D scene and the 2D Interpretation Window, click on the arrows on the main menu tool bar and the slice will move in multiples of 4.

Once a horizon has been filled and there is a mis-pick, click on the 3D Edit icon, re-interpret the area using piecewise tracking and area will be corrected in 3D.

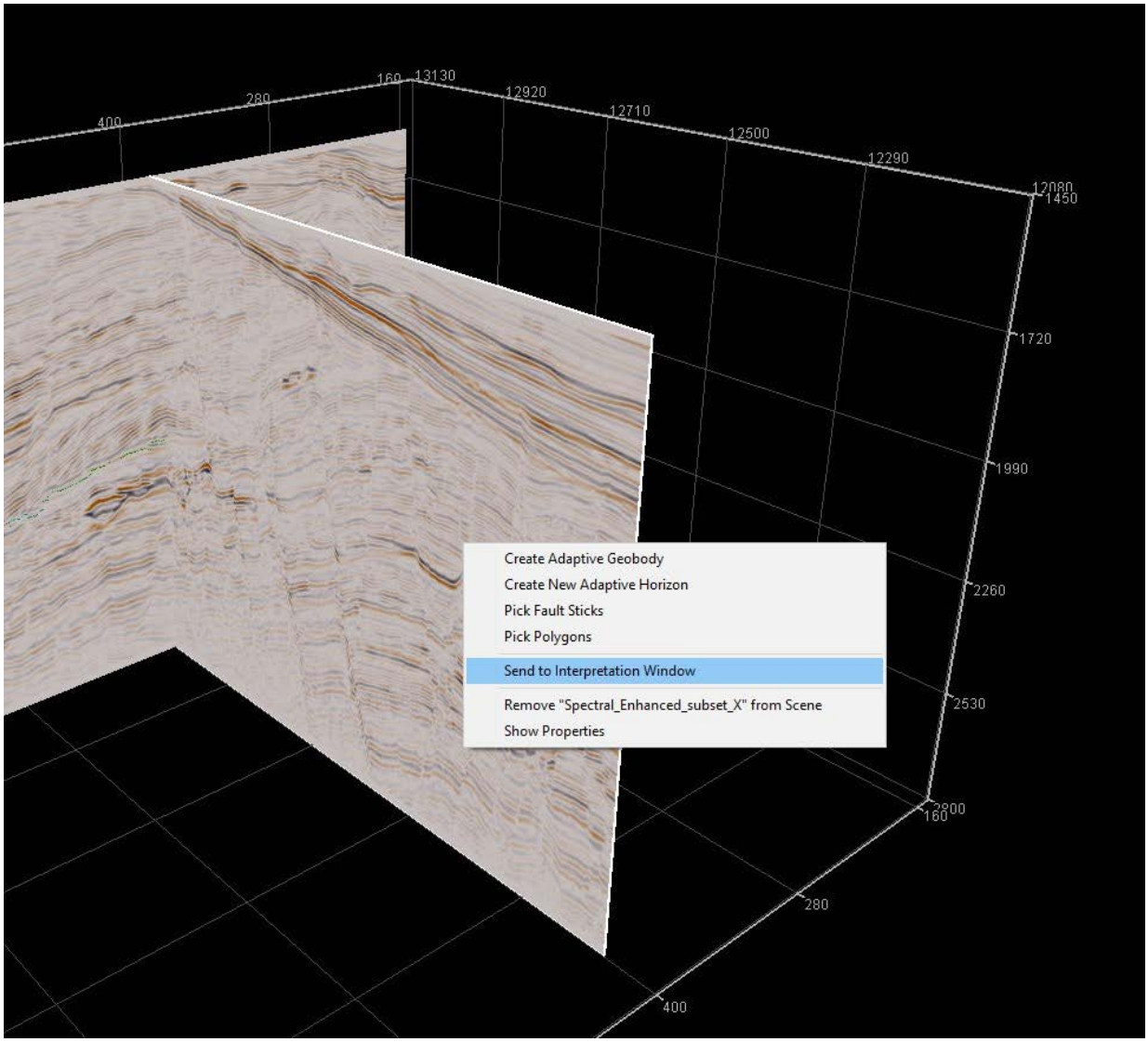
The Horizon Interpretation Properties panel, below, contains options on how to display the active horizon. The user has the ability to view all of the interpretation, which will include any tracked areas and the interpreted lines; view only the interpreted/accepted lines; or just view the active intersection only. Besides mapping the time or depth values to the horizon, other attributes can be mapped, for instance an RGB blend. This is very useful to view the frequency blend to help determine if the interpretation across the faults is accurate. The event mapped to the horizon will be visible in the 3D scene and in the base map. The software will automatically determine the event type from the seed points, but horizons imported to GeoTeric and converted to Adaptive Horizons for editing will be classed as Unknown, until edited.

Once the interpretation is complete, the surface is created in the properties panel by clicking on Create Surface. The default amount of smoothing is zero, but can be increased as needed.



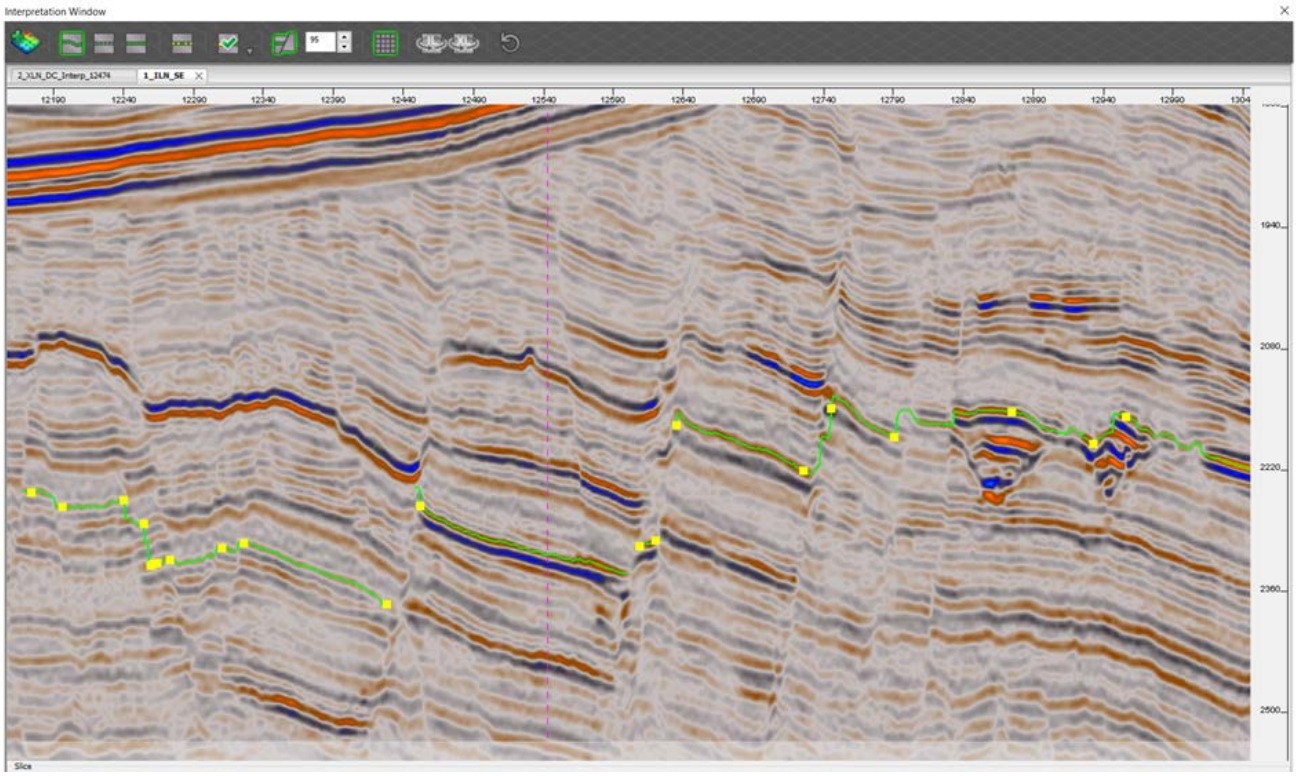
2D Interpretation

The 2D interpretation window is launched by right-clicking on a slice in the 3D view and selecting "send to interpretation window" from the menu:

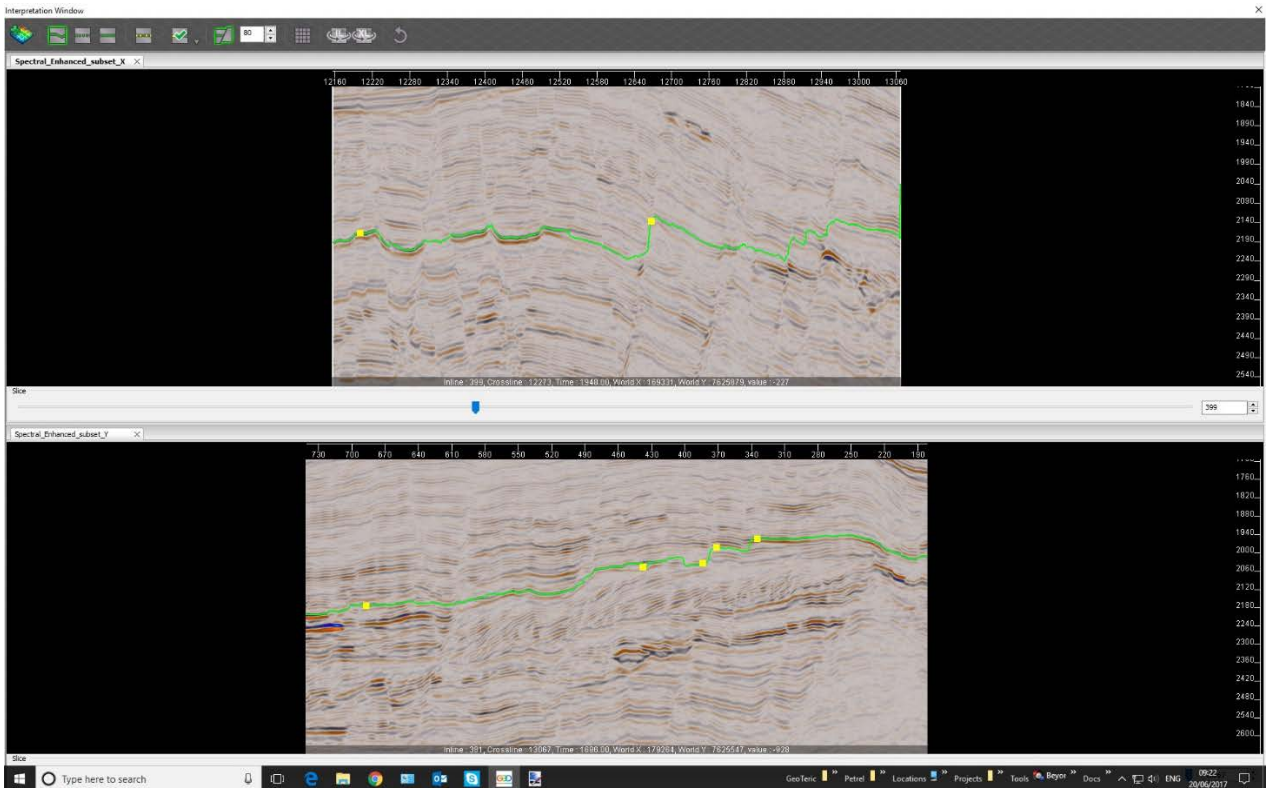


The 2D Interpretation Window has the same icons to choose the method of interpretation as the 3D scene. There is the ability to flip the way in which the line is displayed. The pink line denotes where the opposite line is located, if viewing an inline, the pink line will be the crossline.

Interpretation completed in the 2D Interpretation Window will be updated in the 3D scene and vice versa.



The 2D interpretation window can have multiple views open at once, and these can be moved and their position changed by clicking and dragging the tabs around. The example below shows an inline and crossline view stacked vertically:

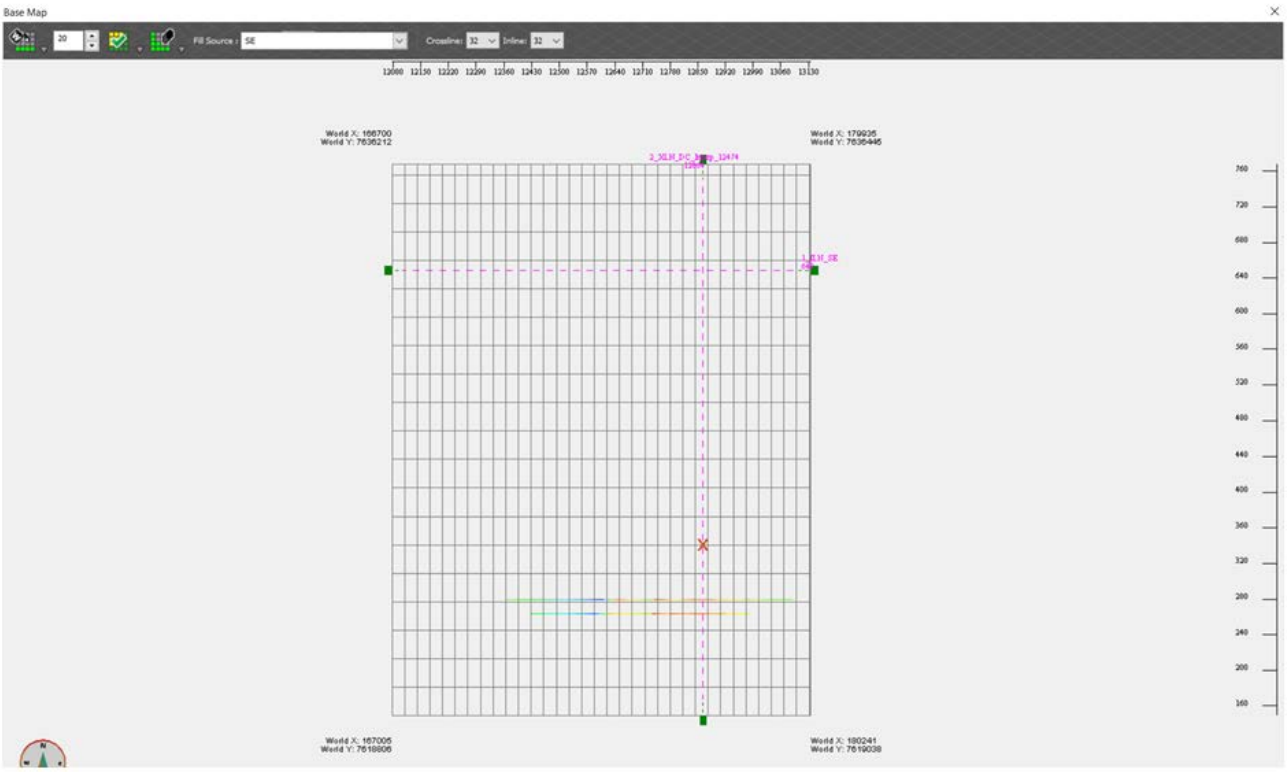


Base Map & Fill Options

The base map contains a grid of the survey, with the numbering of inlines and crosslines along the top and side. The current inline and crossline are highlighted in pink. As the interpretation is built up, the values on the base map can be displayed as time/depth or any attribute, this is set in the Adaptive Horizon Properties panel.

Across the top of the base map are the fill options and acceptance levels. The ability to accept the fill as interpreted lines, delete fill or delete both fill and interpretation within an area. The fill source in which to use for tracking is the volume selected in the middle of the tool bar. The ability to change the size of the squares for filling is on the right.

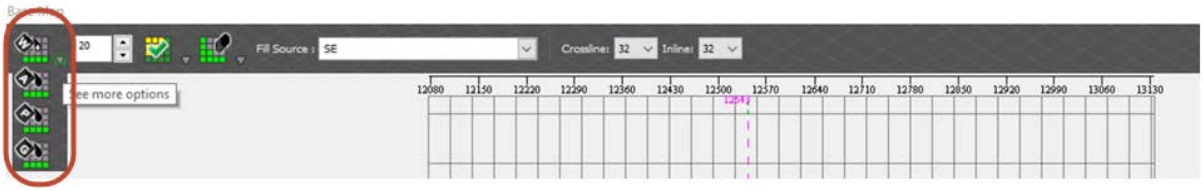
To begin tracking the horizon, simply highlight cells around your interpretation, choose a fill option, and set the acceptance level. It is suggested if you have a very course grid, to start with a lower acceptance level, QC the results in the 3D scene or 2D Interpretation Window, and accept which lines are correct. The acceptance level can then be increased to continue building up the horizon and QC in the 3D scene or 2D Interpretation Window. If you have a very fine grid or the structure is not steeply dipping and not very faulted, a higher acceptance level can be selected to start. The default value is 20.



Types of fill:

1. Fill using Waveform – correlates the waveform of each interpreted/accepted seed point to guide the tracking over a selected area on the base map or the probe. The acceptance level controls how close the tracked area needs to be to the seed points, the lower the acceptance level, the closer to the input, the higher the acceptance level, the more room for growth.
2. 2. Fill using Amplitude – correlates the amplitude of each interpreted/accepted seed point to guide the tracking over a selected area on the base map or the probe. The acceptance level controls how close the tracked area needs to be to the seed points.
3. 3. Fill using PFD – Calculates a Probability Density Function (PDF) of the interpreted/accepted seeds and uses this to guide the tracking. The acceptance level controls the PDF and how much of its data is used to track. When tracking on the HSV blend, all 3 volumes of the blend are used as inputs.
4. 4. Fill using Graph Theory – calculates the optimum surface that intersects with the interpreted/accepted seed points using graph theory to elevate alternative surfaces.

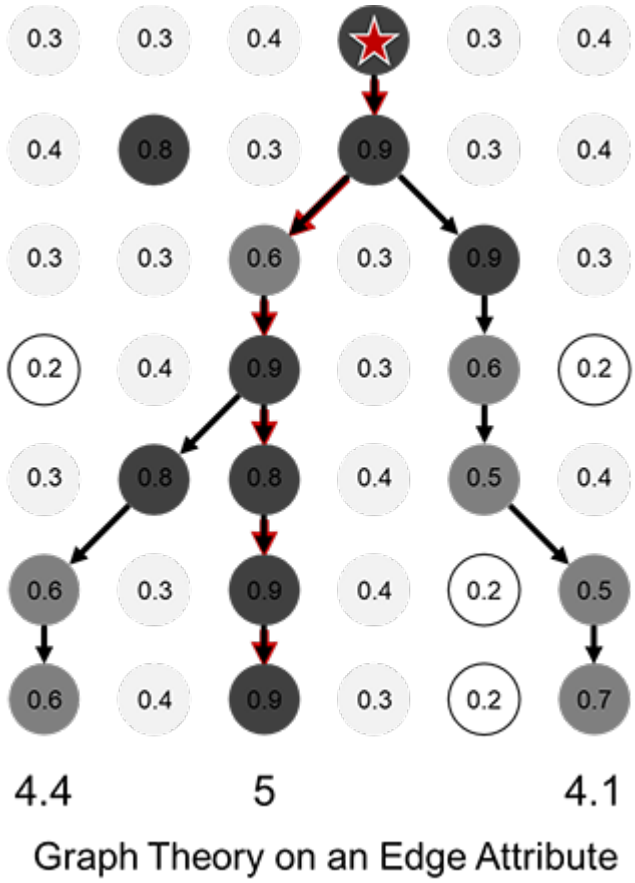
The various fill options can be found in the toolbar as shown below:



Adaptive Faults

Introduction

GeoTeric's **Adaptive Faults** tool utilizes graph theory to generate the most accurate fault interpretation. Graph theory correlates all the points in the data and determines all the potential paths. The path with the highest score will be selected as the interpreted fault stick. All the other paths are remembered creating the Regional Structural Awareness. The Regional Structural Awareness enables an interactive preview of alternative interpretations, which makes the Geoscientist aware of the correct interpretation but also what else is going on in the data. This coupled with the ability to interpret in 3D on reflectivity, attributes or blends allows for a powerful, quick yet precise structural interpretation.



Graph Theory on an Edge Attribute

Creation of fault sticks in this data following manner allows for the highest resolution of fault interpretation at an increased speed. Interpretation on CMY colour blends further allows for a multi-attribute interpretation. Combining 3 different edge attributes into a singular blend for interpretation allows for greater delineation of a fault in 3D, therefore structural interpretation of the fault stick has greater significance.

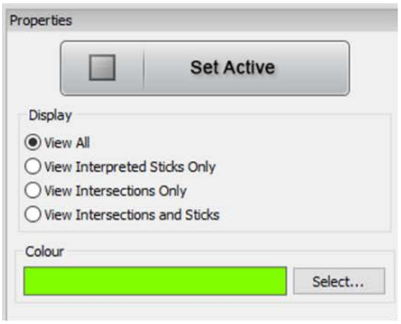
The data following sticks are supported by **data following fault planes** which utilises graph theory technology in a 3D perspective to increase the speed of fault interpretation, with minimal fault stick generation. The automatic 3D representation of the fault plane whilst interpreting allows the interpreter to visualise the response of the interpretation in 3D, allowing for 3D QC-ing against any attribute or blend on the fly

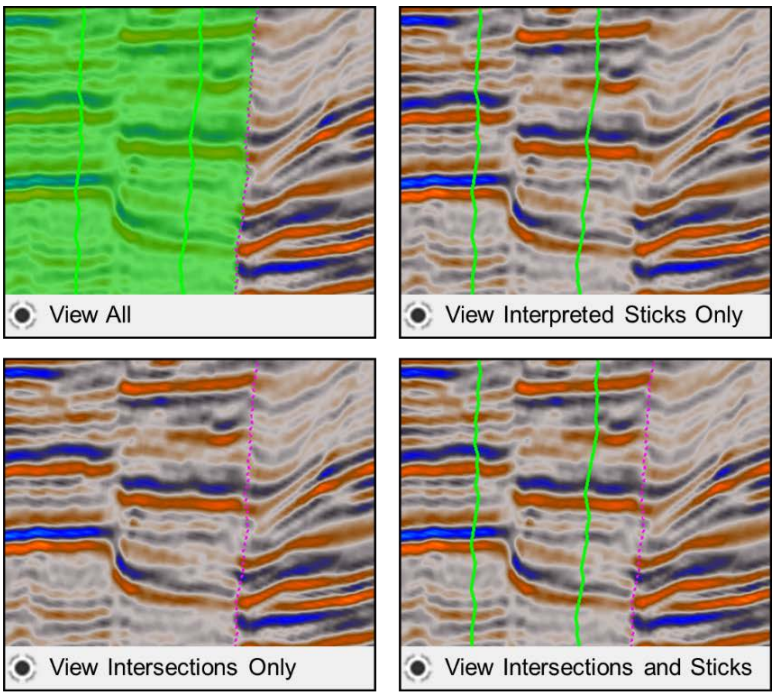
The automatic preview surface between fault sticks (which can be viewed as a linear or data following surface) can be accepted as interpretation and converted to a fault stick to build up a library of fault sticks per fault. Converting the preview surface into fault sticks whilst QC-ing on the fly further enables the interpreter to interpret faults and structures more quickly without compromising in accuracy.

Within area of extreme complexity, the data following sticks can be replaced with a traditional picker, which joins picked points in a linear fashion to form sticks. As with the data following sticks, an automated preview surface will be generated between the sticks to aid further interpretation.

Usage

To start the fault interpretation process, select the **Enable Fault Picking**  option on the interpretation drop down menu, then select **new fault set**  . This will generate a new fault set in the project tree under the Faults Folder. Within the properties tab for each fault set, it is possible to set the fault as active, change the display option and change fault colour. Selecting “View All” will show the Fault Sticks, Preview Surface and intersection of the preview surface on the slice/volume/blend. Other options such as “Interpreted Sticks Only” and “Intersections Only” will show purely the fault sticks and intersection of the preview surface on the slice/volume/blend respectively. The “Intersections and Sticks” option will show both of these components of the Adaptive Faults, without the 3D surface in view. These options can be changes throughout the interpretation process, to enable a fluid interpretation experience.



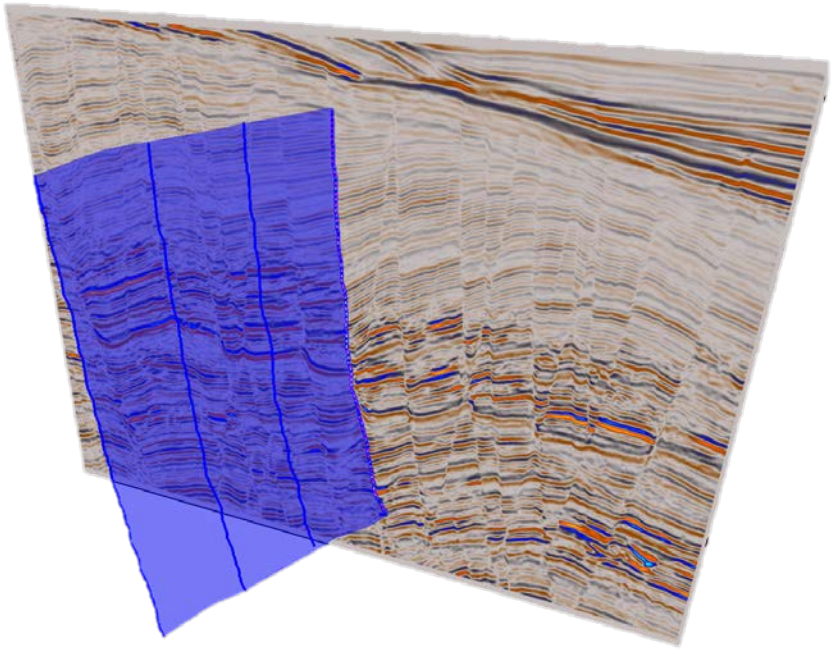


To begin interpreting the user must choose either the Data following Sticks  or Linear Sticks  option. Once an interpretation method has been selected (data following or linear), position the courser on the fault then press and hold Shift+left-click to plant the first point in the fault stick, then continue to place more seed points with a left mouse click. To release the tracker double left-click, or

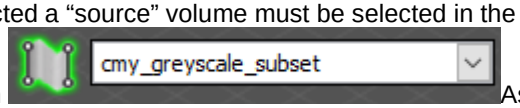
clicking the Esc button. With the Data Following sticks option, fewer seed points are often required as the fault stick snaps the fault, whether it be in a reflectivity volume, edge attribute or CMY blend. With fewer picks required, this often leads to a quicker interpretation, but due to the data following technology, accuracy of the interpretation is not compromised.

If any picks have been made in the wrong location, these can be undone by clicking on the “Undo” button  or by clicking the middle mouse button (scroll wheel), which will undo one picking step at a time.

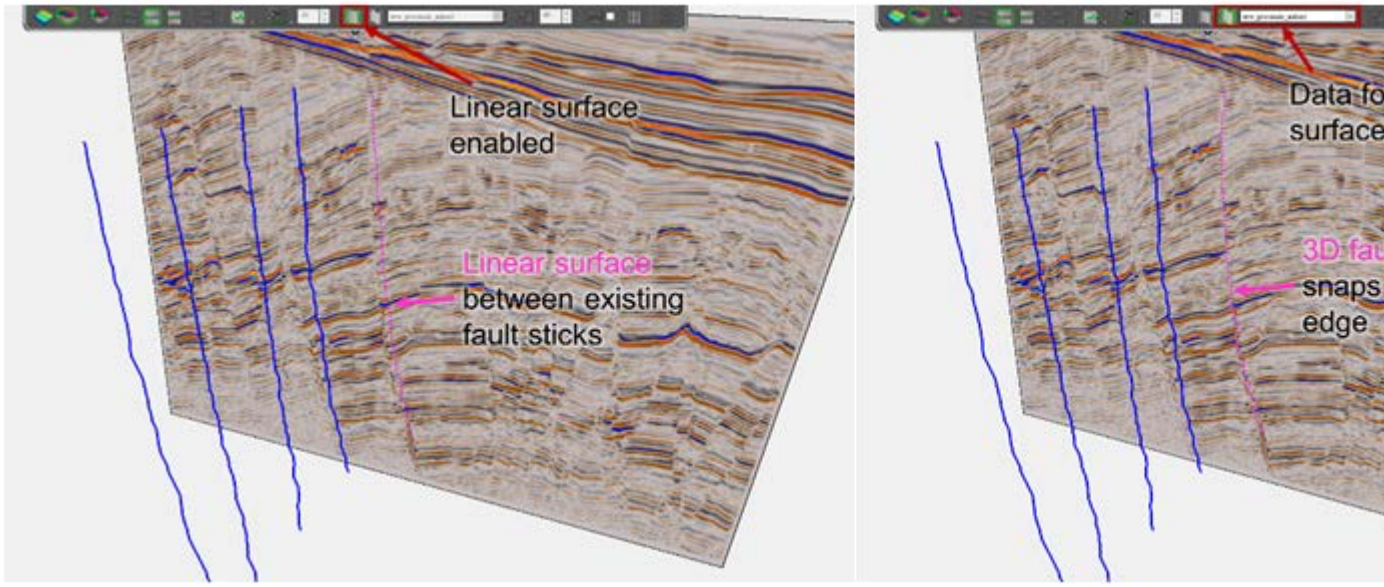
Once the second stick has been completed, this will automatically generate a preview surface between the sticks. Depending upon the display option, this can be viewed as a solid surface (if view all is selected) or as the surfaces intersection against the slice/volume/blend used to interpret the fault.



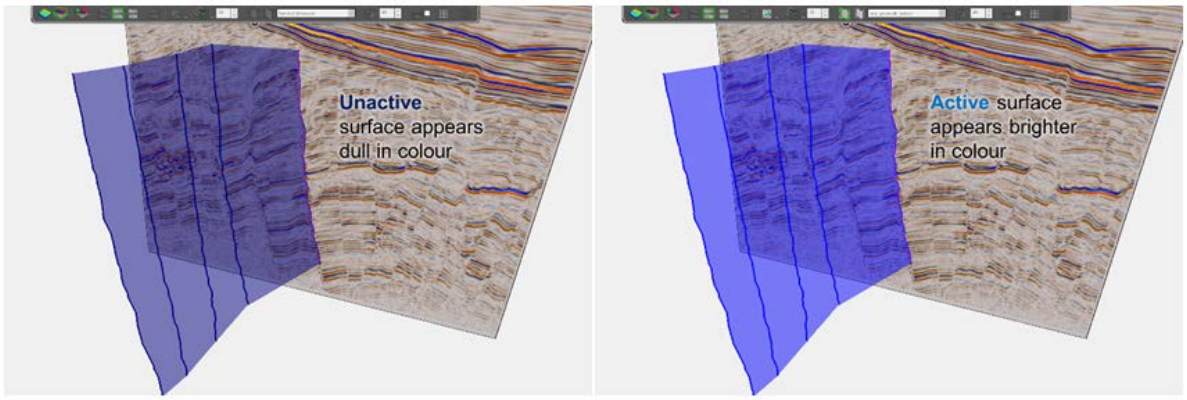
The preview surface can be generated in one of two ways. The default option is set to Linear  whilst a Data Following  option is also available. The Linear method will create a traditional linear surface between the existing sticks. This method of interpretation can be extremely useful for interpreting large scale regional faults, which often have large offsets. Having the ability to preview the surface on the fly and observing the intersection against any slice/volume/blend is an extremely powerful method of QC-ing an interpretation whilst picking. However, as this is a linear function, it may not be overly accurate in areas of complexity, between fault sticks. This is where the data following surfaces solve this issue. By enabling the Data Following option, tracking the fault event in 3D becomes possible.

Once this option is selected a “source” volume must be selected in the drop-down menu next to the Data Following surface option 

As the user continues to interpret and adds further sticks to the fault interpretation the data following surface will also update on the fly.



Working with multiple faults in the 3D scene is a common practice, especially during the interpretation and QC stage. The “Active Fault” will appear brighter in the 3D scene opposed to other faults in the viewer, making it easy to identify which fault set is active.



The automatic preview surface (pink dashed line) whether it be Linear or Data Following can be “accepted” and converted to a fault stick at any time. This acceptance process allows for rapid QC and the generation of multiple fault sticks which follow the data (without picking). This may be extremely useful if the user is looking to create a number of fault sticks so they can be extracted and used for model building.
An example video of this can be found here.

As the Adaptive Faults is part of the Adaptive Interpretation System in GeoTeric, the structural interpretation process can be undertaken in the 3D scene on a Volume, Intersection Slice, Arbitrary Line or Blend. The interpretation can also be undertaken in the 2D Interpretation Window, which can be accessed by right clicking on a slice and selecting “Send to Interpretation Window”. As all the windows are linked, any work undertaken in one of these windows will appear instantly on all of them, making for a complete interactive interpretation experience.