5 Analysis

5.1 Attributes

5.1.1 Attribute Set Window

5.1.2 Attribute Set Toolbar

5.1.3 Auto-Load Attribute Set

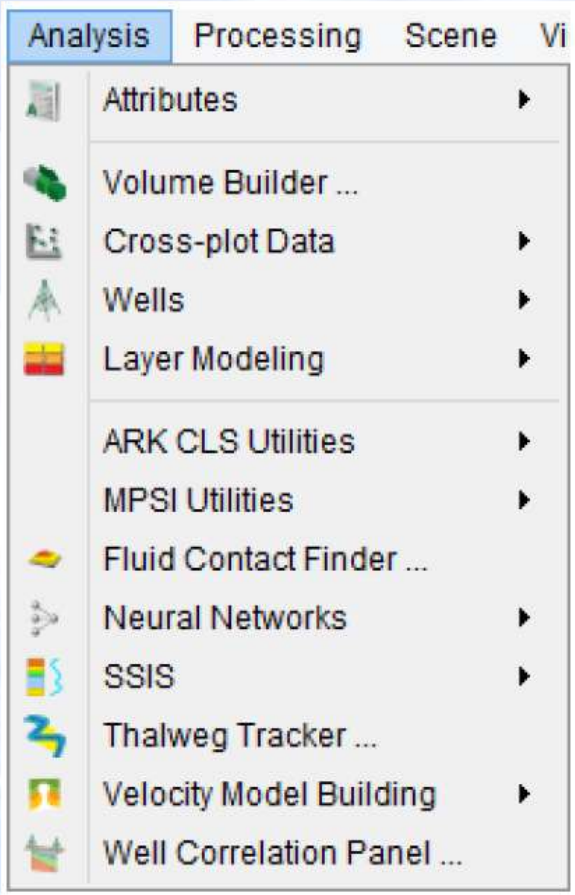
5.1.4 Default Attribute Sets

5.1.5 Input Selection

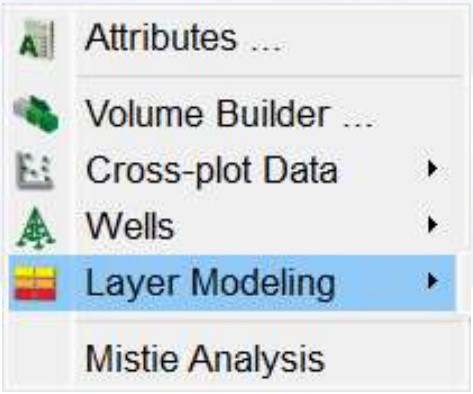
5.1.6 Import an Attribute Set from

5.1.7 Calculate Attributes

5分析(Analysis)



手册截图



GNU版本

Pro用户

5.1 Attributes

In OpendTect, seismic attributes are calculated/evaluated by using *Attribute-set Window*. In this window, many single/multi trace, pre/poststack, dip-steered/non dip-steered attributes are available. Moreover, it also contains special filters (e.g. Gap decon, Frequency filters, dGB-special filters etc). The attributes are explained individually in Appendix A.

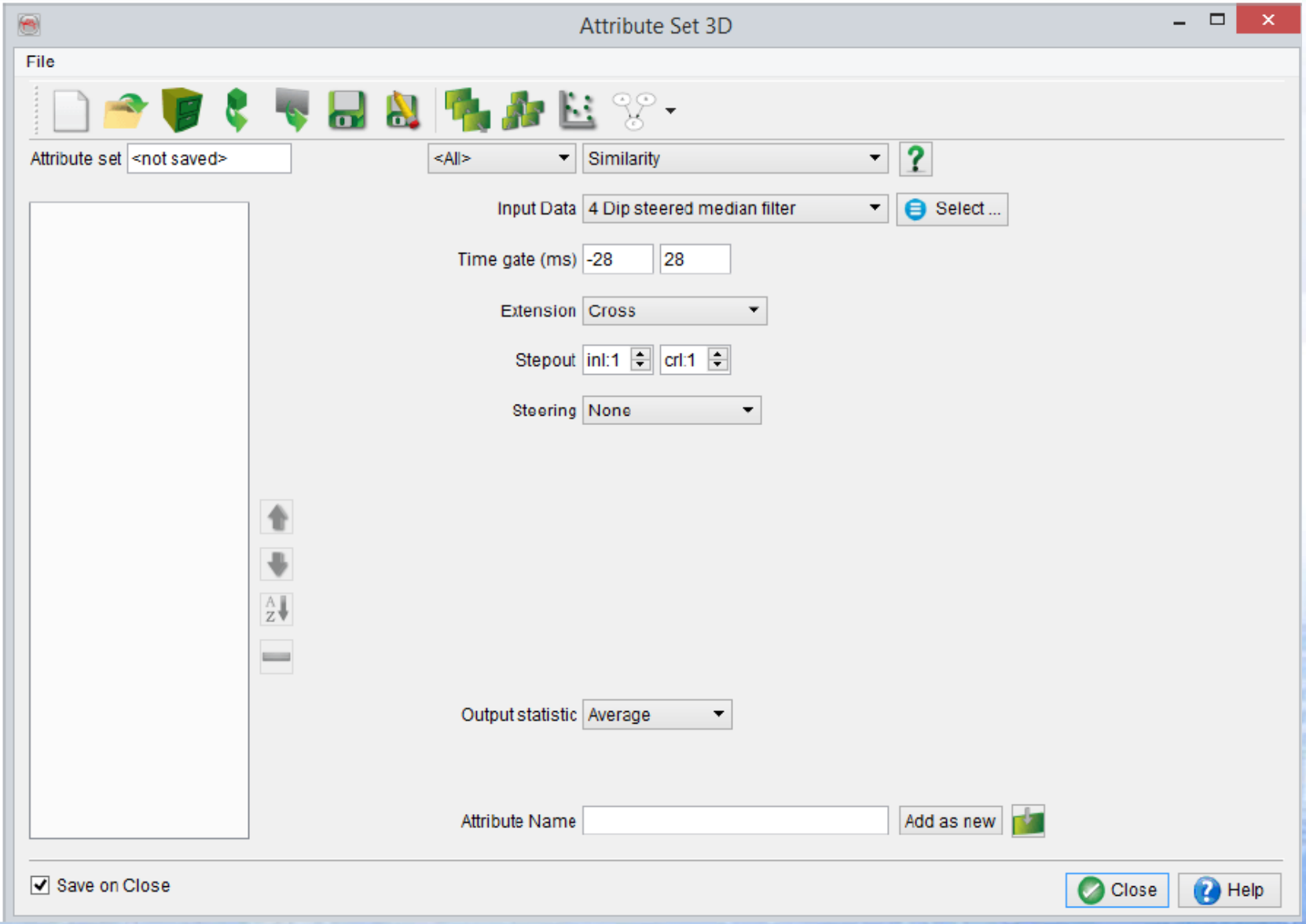
地震属性使用Attribute-set窗口计算。
地震属性见附录A。

5.1.1 Attribute Set Window

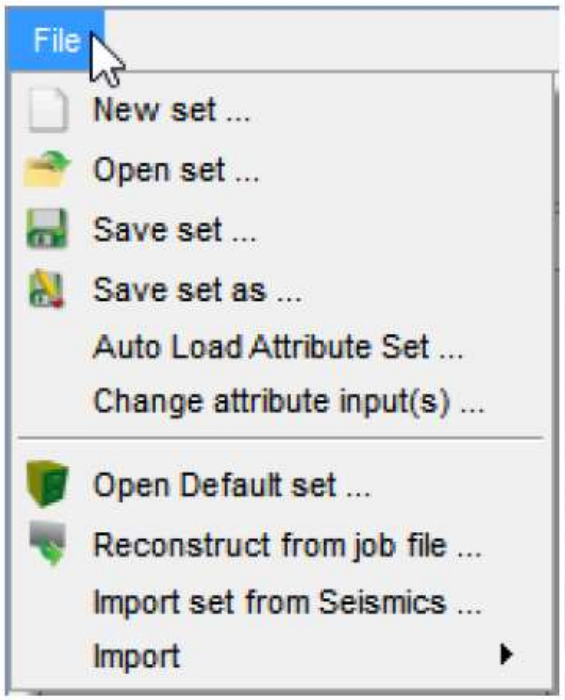
The attribute set window contains a set of seismic attributes definitions to be evaluated/calculated. While defining the attributes it is possible to work in the active scene. Attributes can also be calculated after saving the attribute set. In broad sense following workflows are applicable in OpendTect attribute calculation process (on sections and horizons):

- Evaluate attribute
- On-the-fly attribute calculation
- Creating an attribute output (2D/3D)

In following figure, different attributes are defined as an attribute set. It is considered as a routine practice in OpendTect environment (especially to define a meta-attribute). These attributes can be: evaluated on sections and horizons, applied on-the-fly and created as an output attribute. Importantly, some attributes show *steering selection* in the input parameter settings : the dip steering plugin created by dGBdGB provides various advanced steered attributes.


Attribute Set 3D
File
Attribute set
<not saved>
<All>
Similarity
Input Data
4 Dip steered median filter
Select ...
Time gate (ms)
-28
28
Extension
Cross
Stepout
inl:1
crl:1
Steering
None
Output statistic
Average
Attribute Name
Add as new
Save on Close
Close
Help

OpendTect works with the concept of an "active" attribute set. At start-up, there is no active attribute set. To create a new one (*New set...*), or to select an existing set (*Open set ...*) , select the corresponding option from the *File* menu (See below). OpendTect is also delivered with a collection of default attribute sets for some general testing (Fault, Chimney,Salt default attribute sets). This set can be selected from the Default set option under the *File* menu. To use a default set, the input seismic data and a SteeringCube (if steered attributes are available in the default set) have to be selected.



Clicking any attribute in the list will show its parameter settings. Notice that OpendTect uses SI units. For details on each of the attributes see Appendix A. Note that some of the parameter options depend on whether you are using 2D or 3D data as input. For example, the inline and crossline stepout field will be replaced by a single trace stepout field. Generally, an attribute set can only contain 2D attributes or only 3D attributes. Mixed attribute sets are not possible.

When parameters of an attribute are updated, the modified attribute can be added to the attribute set with a new *Attribute name* by clicking *Add as new*. Clicking on any other attribute in the list means that the updated parameters are accepted, while keeping the original attribute name. The *Revert changes* button only reverts changes to the original state before clicking on another attribute in the set. When *Ok* is pressed, the (updated) attribute set becomes the "active" attribute set. The attribute set is saved to disk when *Save on Ok* is ticked. To save an attribute set under a different name, use the corresponding option under the *File* menu.

File - Change input... can be used to change the input data of all attributes in the "active" set simultaneously, which is useful in case, for example, a new seismic volume has become available.

File - Auto Load Attribute Set ...

It is now possible to have an attribute set already open at start up using the " *Auto load Attribute Set* " option in the *File* menu. This enables to choose the attribute set which will be active the next time the survey is opened.

 Allows for the creation of a new attribute set

 Open an existing attribute set

 Open one of the default attribute sets (provided within the OpendTect package)

 Import an attribute set from another survey

 Reconstruct an attribute set from file

 Save the attribute set

 Save as...

 Re-display the element with the current attribute

 Evaluate the attribute (parameters)

 Cross-evaluate attribute (parameters)

 Cross-plot the attribute.

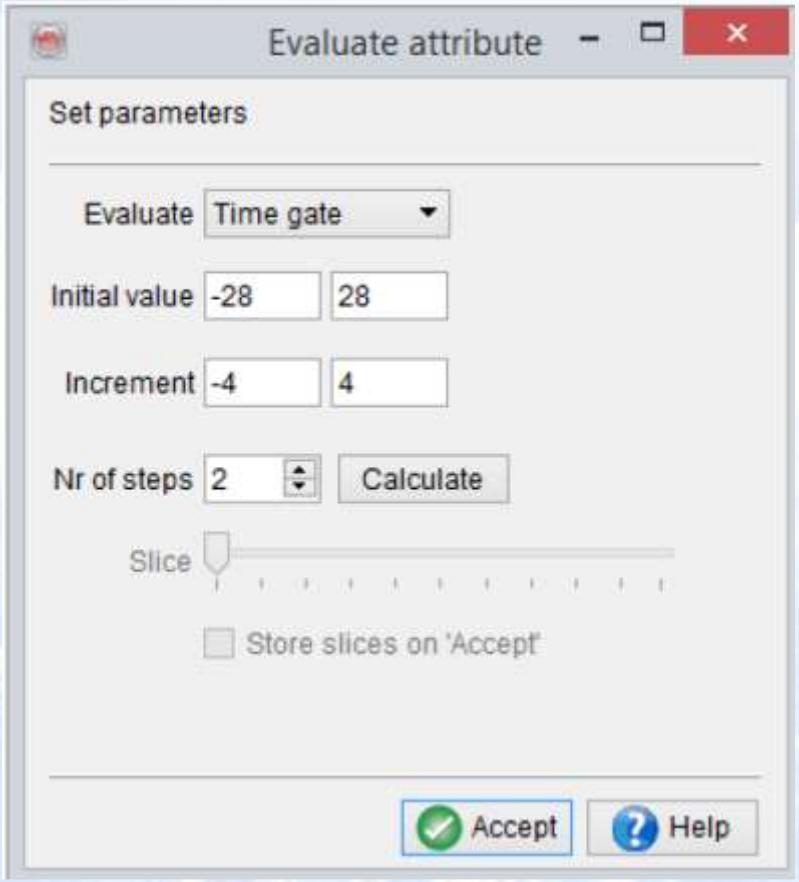
5.1.2 Attribute Set Toolbar

The attribute set toolbar comprises the following icons.

Also accessible via the File menu, these are, from left to right:

- *New set* clears the window to create a new attribute set. The attribute set name can be specified when saving it (press OK, or select File - Save set menu option).
- *Open set* opens a previously saved set in the current project (from the directory Attribs/).
- *Open default attribute set*. Filenames for input data must be re-specified.
- *Import attribute set from another survey*. Filenames for input data must be re-specified.
- *Reconstruct set from job*
- *Save set* saves the "active" attribute set in the Attribs/ directory of the current project.
- *Save as set* saves the "active" attribute set in the chosen folder
- *Redisplay element with current attribute* is used for direct display of the selected attribute on the active display element (shown in reverse video in the tree). The main graphic interaction buttons and options remain active while the attribute set window is open, so the active element can be changed. However no new element can be added to the tree

- *Evaluate Attribute* allows the automatic variation and evaluation of attributes and attribute parameters. If you have an "active" attribute and the current display element is a slice (inline, crossline or Z slice) or a horizon, a new window will pop up where it can be specified how to vary the parameters of the displayed attribute. For example, Spectral Decomposition:



Here six slices are created, with time gates of [-4,4], [-8,8] etc.... Use the slider to move through all the slices. When an attribute has been evaluated on a surface, the parameter can be updated in clicking on *Accept*. Enable this by checking *Store slices on Accept*.

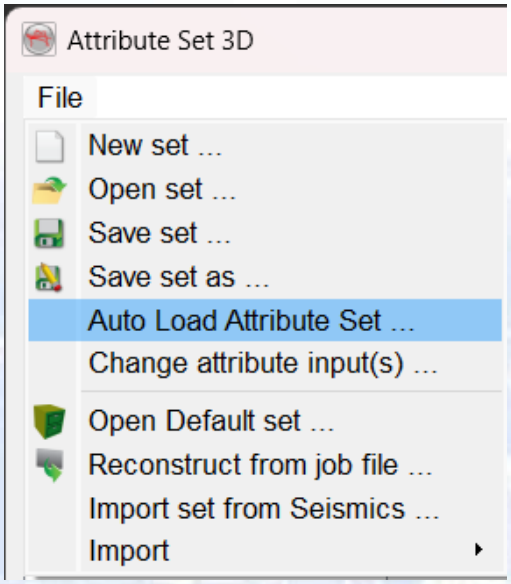
As shown above, the "*Evaluate Attributes*" set contains a general selection of various attributes. It is intended as a guide or starting point for a scan through the wide range of different attributes and may be a starting point for an effective attribute analysis.

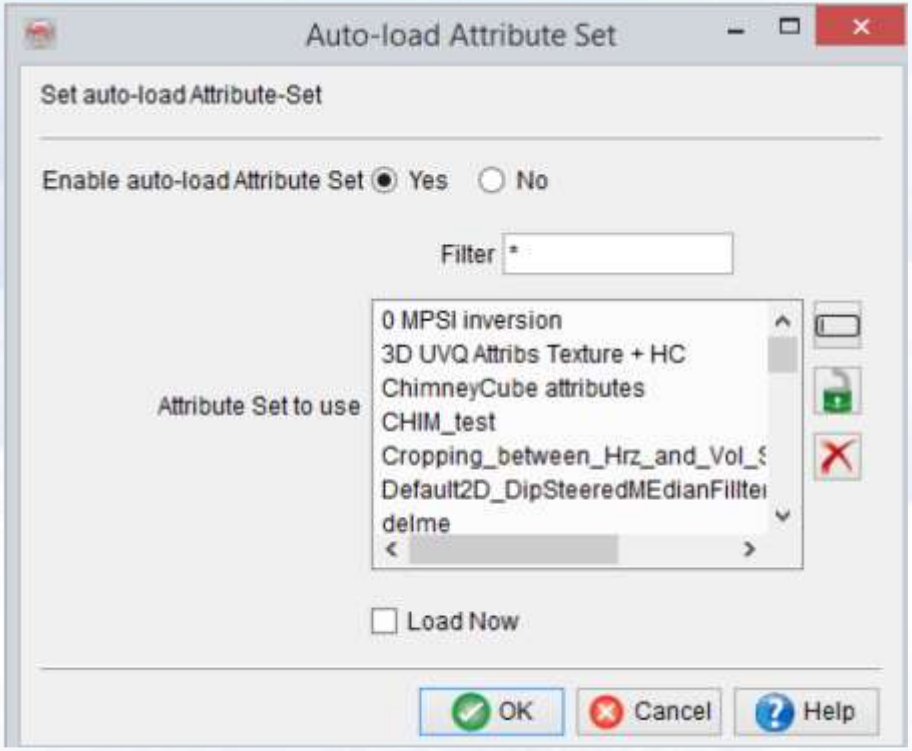
For more information on *Evaluate Attribute*, watch the tutorial on the OpendTect YouTube Channel.

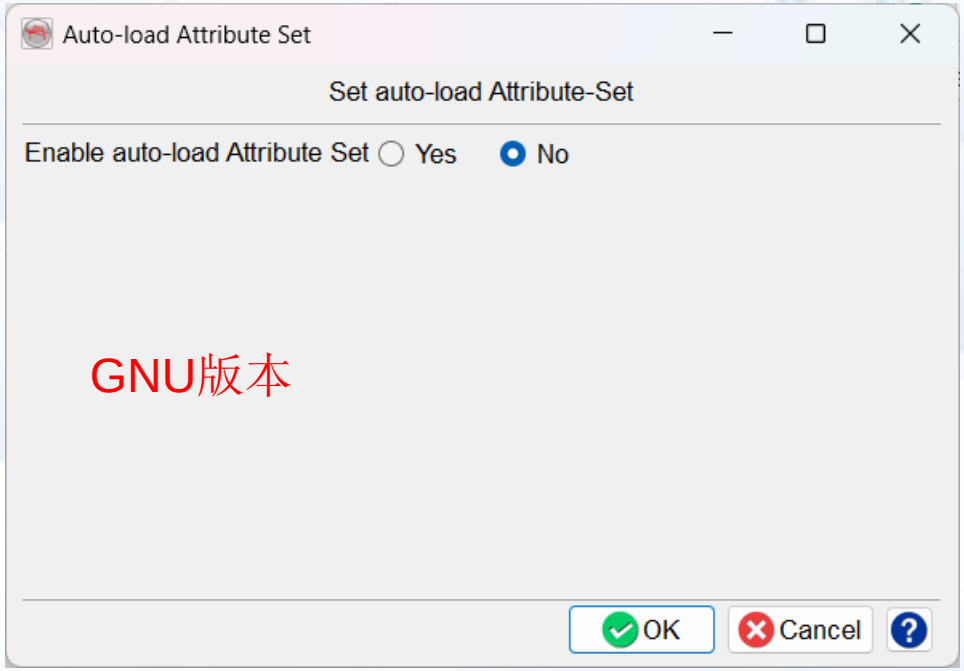
- *Cross-evaluate attributes* Allows for the cross-evaluation of parameters within the attribute.
- *Crossplot attributes* allows to crossplot attributes from the current attribute set and saved volumes. Multiple attributes can be selected. The attribute values are extracted at picked locations (see how to create a new pointset). Once attribute values are calculated, a crossplotting table is generated and crossplot(s) can be achieved.

5.1.3 Auto-Load Attribute Set

By default, no attribute set is loaded at startup. These settings can be over-ruled by selecting a specific attribute set to be auto-loaded in the list each time the OpendTect window is started. This can be set from the attribute set window under *File > Auto Load Attribute Set* sub-menu. If selected, it will launch the auto-load attribute set window. Selecting Yes will show the list of attribute set that can be be auto-loaded. Select one attribute set and press *Ok* button. This will save the settings and next time, whenever the OpendTect is started, the selected attribute set will be auto loaded. Such practice becomes useful when working with attributes evaluation at different stages of a project and that the same attribute set need to be updated.







Load Now will directly load the selected attribute set. If not selected, the attribute set will be loaded the next time the survey is opened.

Please note that a similar function exists for sessions.

5.1.4 Default Attribute Sets

OpendTect is provided with "*Default attribute sets*" to get you started. By selecting a default attribute set, a window appears to select the correct input volume(s) and the correct SteeringCube (see images below). These attributes (except "*Evaluate Attributes*") require the following dGB plugins: 需要dGB插件的许可证

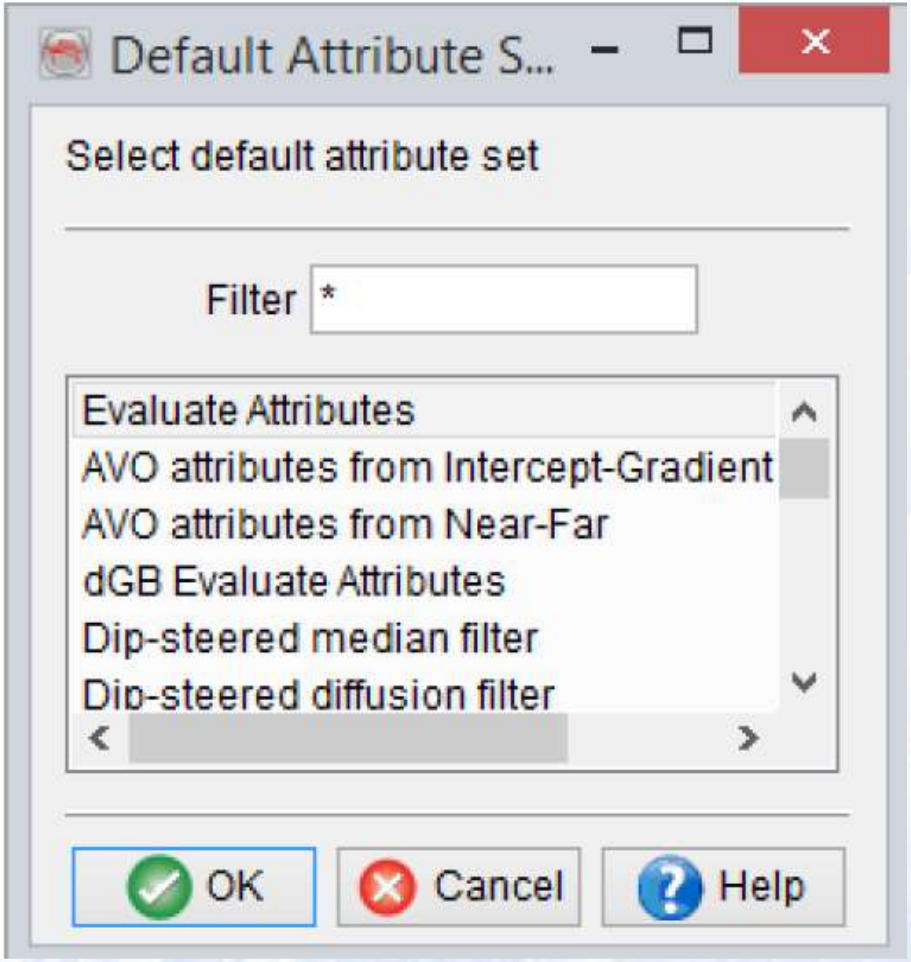
- *SteeringCube*: attributes and filters are calculated along user-driven, or data-driven directions
- *Neural Network*: Both supervised and unsupervised neural networks allow generation of meta attribute volumes that highlight any object of interest (e.g: Chimney, Faults, Salt,...).

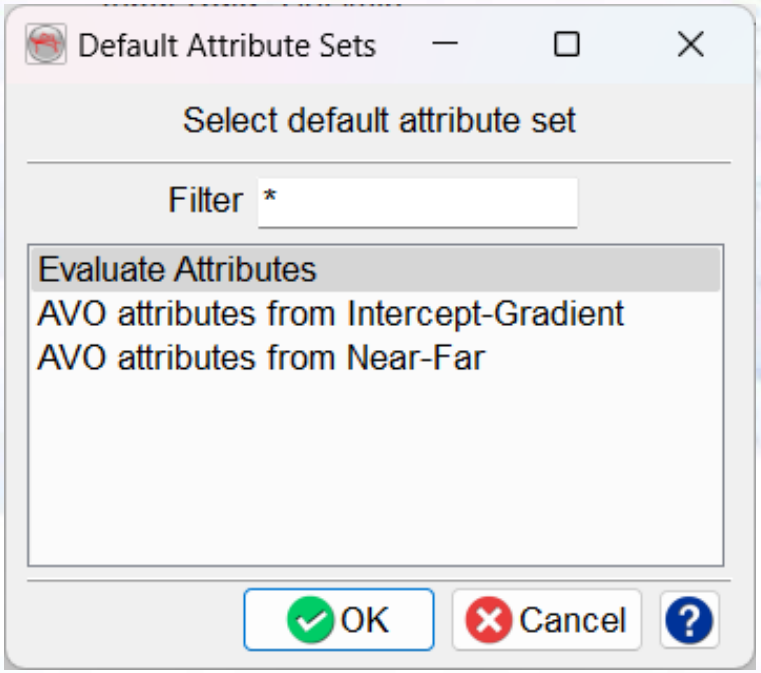
The OpendTect version comes out with new "default attribute-sets" in addition to the already existing attribute sets like NN ChimneyCube, NN SaltCube, Unsupervised Waveform Segmentation, dGB Evaluate Attribute, etc .

- **Evaluate Attributes:** This default attribute set contains the default definitions of several basic attributes grouped together to give an idea of attributes evaluation in OpendTect. This default attribute set can be selected to start with OpendTect. After selection, only input seismic data is required.
- **dGB Evaluate Attributes:** This default attribute set is similar to above attribute set with additional dGB attributes (using dGB plugins). For this set, both seismic and steering data are required as input.
- **AVO attributes from Intercept-Gradient:** This attribute set requires two inputs; Intercept and Gradient (from AVO analysis) as first and second inputs respectively. It computes attributes like Envelope, Fluid Factor and Rp-Rs.
- **AVO attributes from Near-Far:** The input for this attribute set are the Near and Far stacked data sets in the same order. This includes attributes like Envelopes and Enhanced pseudo gradients.
- **Dip-steered median filter:** This default attribute set contains the definition of dip-steered median filter. It cleans up the seismic data by removing random noise. Both seismic and steering data are required as input.
- **Dip-steered Diffusion Filter:** This filter is mainly used to sharpen faults. Both seismic and steering data are required as input.
- **Fault Enhancement Filter:** This type of filter is used in the Fault/Fracture analysis, it dramatically sharpens the faults by suppressing random noise. It is a combination of the diffusion filter and the dip-steered filtered. Both seismic and steering data are required as inputs.
- **Fault Enhancement Filter (Expert):** This is a more sophisticated version of the basic Fault Enhancement Filter and uses similarity and dip-steered filtering. It also requires both seismic and steering data as input.

GNU

- **Ridge Enhancement Filter:** This filter detects lateral lineaments using different steered similarities (in inline, crossline and diagonal directions)
- **Ridge Enhancement Filter (Expert):** This filter is an advanced version of the above described filter and uses steered similarities in addition with their second derivatives (in inline, crossline and diagonal directions).
- **NN Fault Cube:** dGB standard default attribute set containing the definitions of all attributes that are used in neural network (NN) training to create meta-attribute i.e. NN Fault Cube.
- **NN Chimney Cube:** dGB standard default attribute set containing the definitions of all attributes that are used in neural network (NN) training to create ChimneyCube (meta-attribute).
- **NN Salt Cube:** dGB standard SaltCube meta-attribute.
- **NN Slump Cube:** dGB standard SlumpCube meta-attribute.
- **Unsupervised Waveform Segmentation:** attribute set containing the definition of attributes that are used in unsupervised waveform segmentation (a.k.a UVQs).
- **Seismic Filters Median-Diffusion-Fault-Enhancement:** This is an advanced version of the "Fault Enhancement Filter". It enables the user to have much control on the input parameters by modifying the parameters of the dip-steered median filter, dip-steered diffusion filter and fault enhancement filter.
- **Fault Enhancement Attributes:** expandable attribute set containing the list of the attributes that are useful for fault visualization and fault interpretation. 地质建模需要的断层属性
- **NN Fault Cube Advanced:** most superior FaultCube (meta-attribute) attribute set that is used as input for neural network training to create fault probability cube.



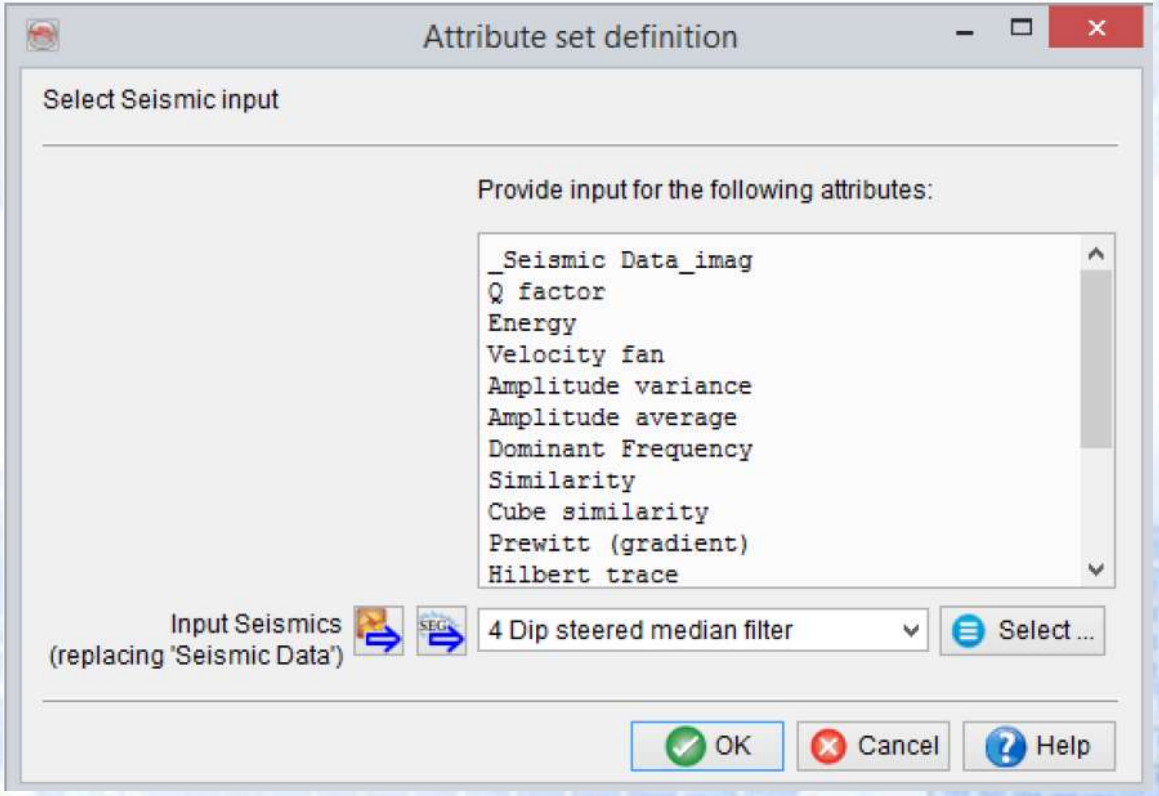


GNU版本软件

Default attribute sets window containing the list of all available default attributes

When one of these default attribute-sets has been selected, a window pop-ups (see image below) to select the input seismic and optionally a steering (the attribute sets based on AVO analysis, the Fault enhancement filter and the Ridge enhancement filter require inputs as outlined in their respective descriptions).

Input selection Window

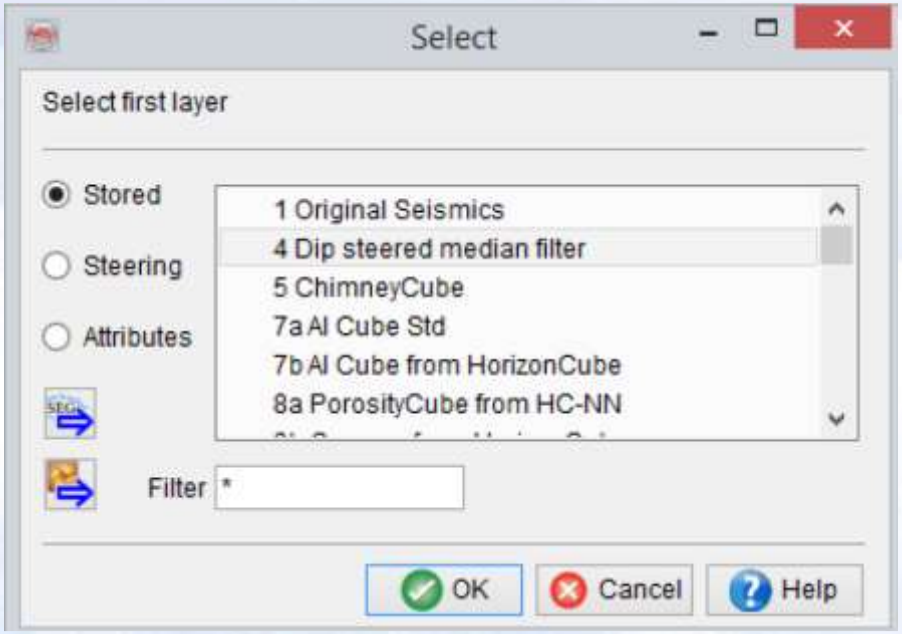


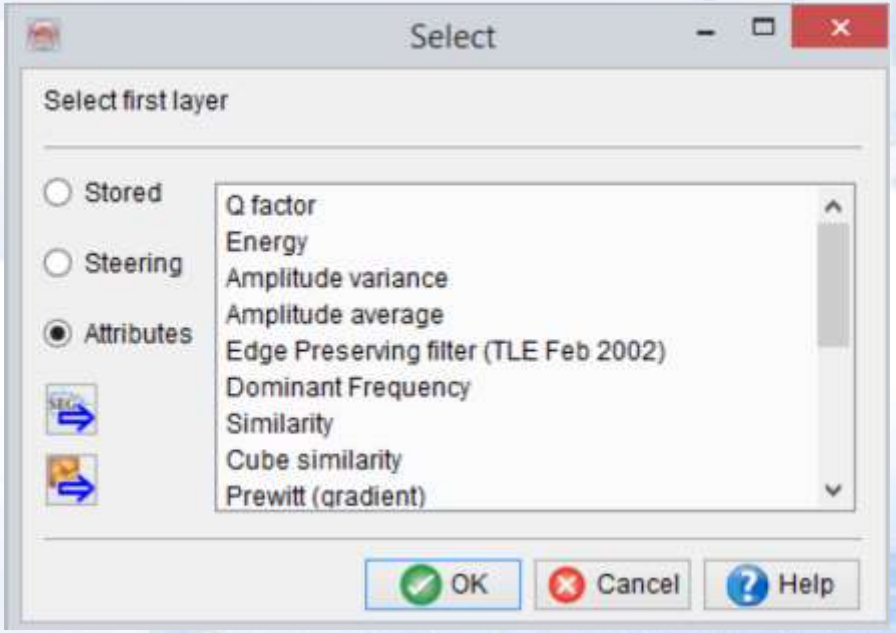
5.1.5 Input Selection

Every attribute requires input data. Both stored data and already defined attributes can be used as input to a new attribute. In other words, attributes can be embedded. However, circular references are not possible.

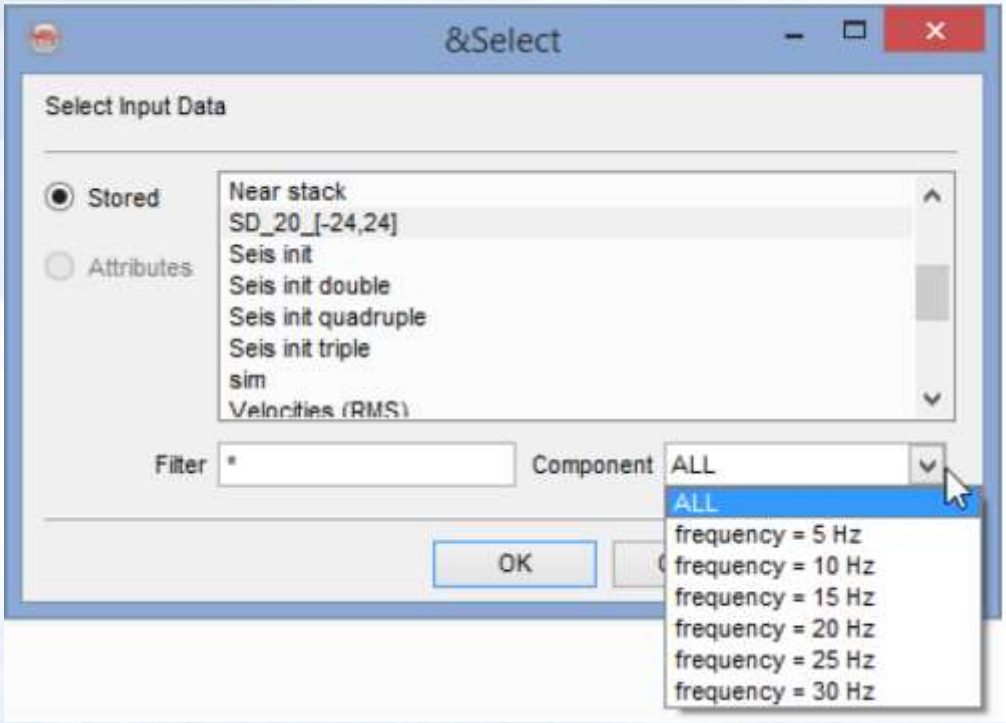
5.1.5.1 Input Selection for 3D Attribute Sets

Select from the stored data or from the list of defined attributes in the "active" attribute set.





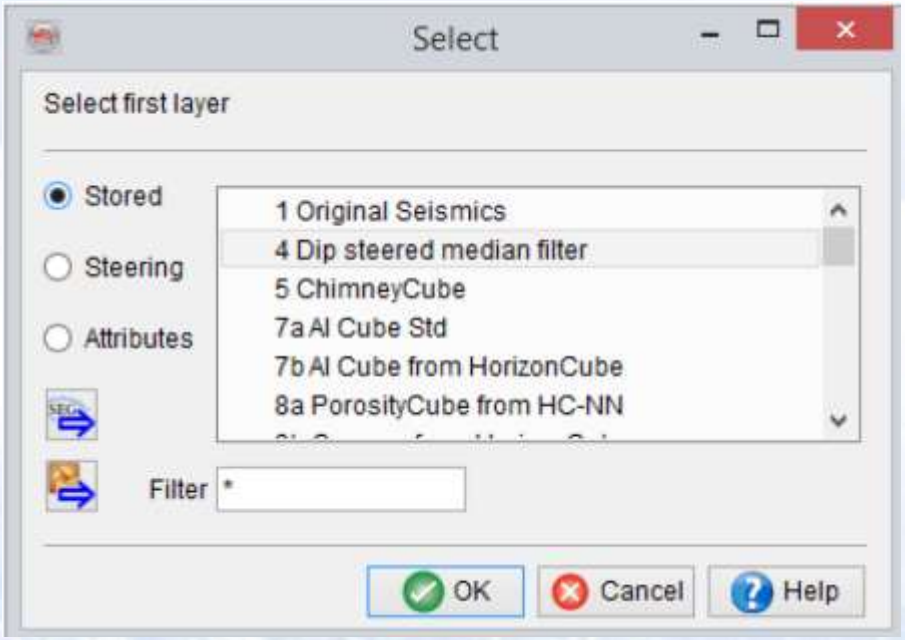
In case the input data is multi-component, it is possible to choose from the available components as shown below (or include *ALL*).

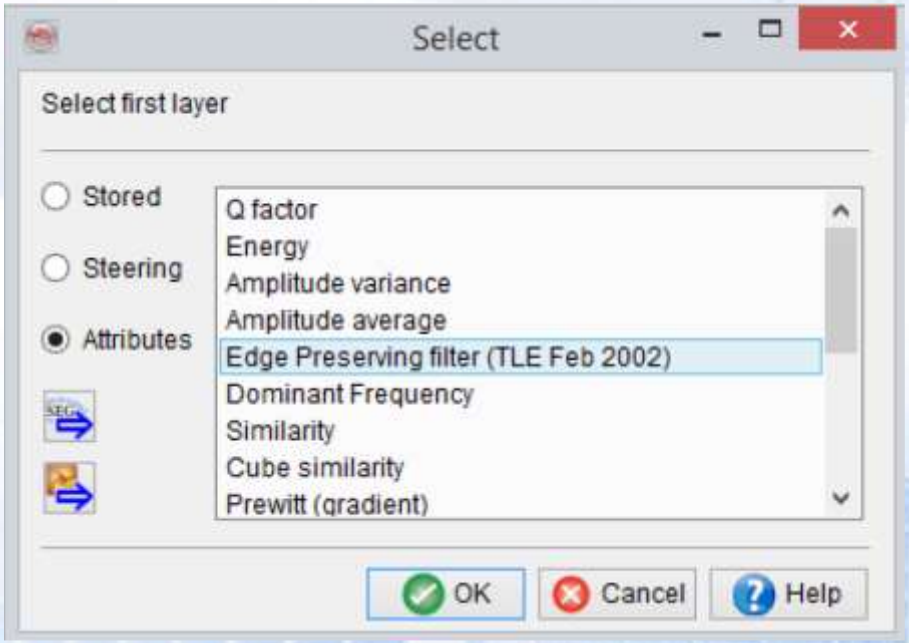


The Filter section allows to quickly find the right input. e.g type *S will look for all attributes/cubes started with S like Similarity.

5.1.5.2 Input Selection for 2D Attribute Sets

Select from the stored data or from the list of already defined attributes in the current attribute set.





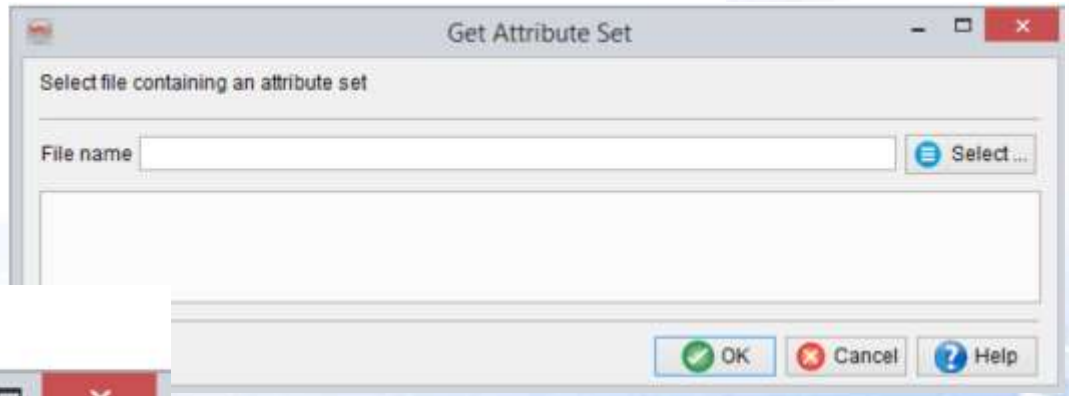
If the selected stored data set is multi-component, the user will get an option to choose which component to select as input data:

没有截图?

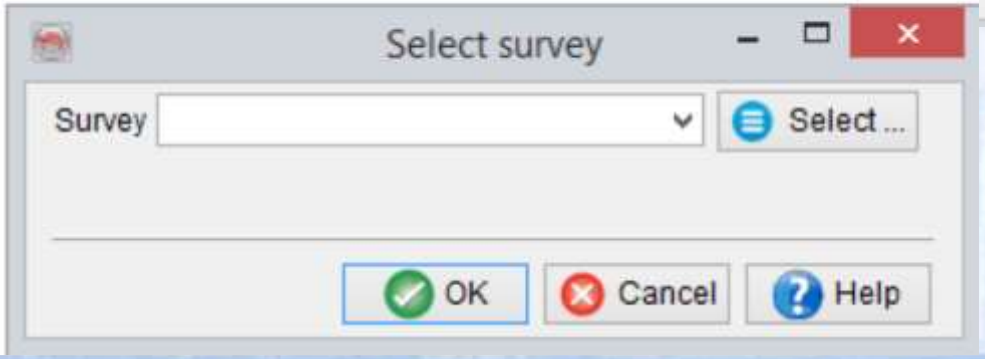
5.1.6 Import an Attribute Set from

Attributes are primarily stored in attribute set files of extension *.attr* Attribute definitions can also be found in the parameter files of a processing job when an attribute was used to process a volume or data set.

It is possible to import the attribute set of an attribute file from the menu: *File* > *Import set from file*. Existing attributes are stored in the *Attribs* folder of each survey. Optionally, attributes from another survey may also be imported: *File* > *Import set*. or by using

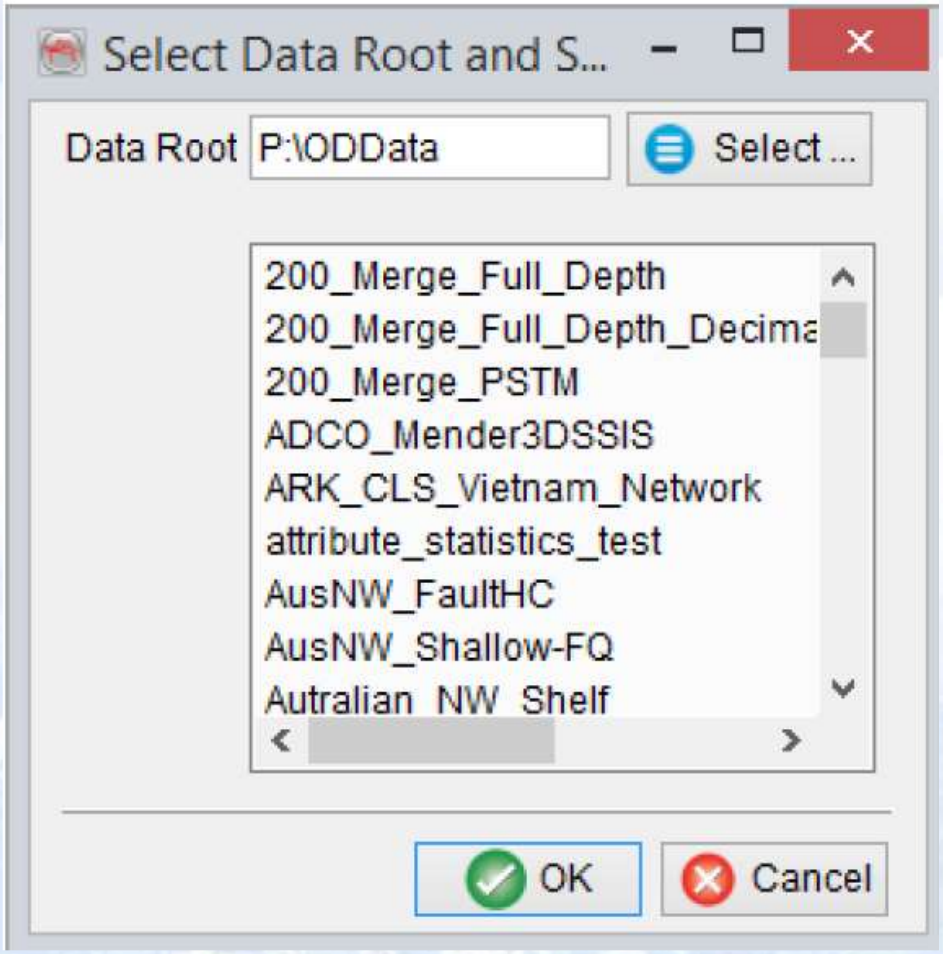


Import set from file

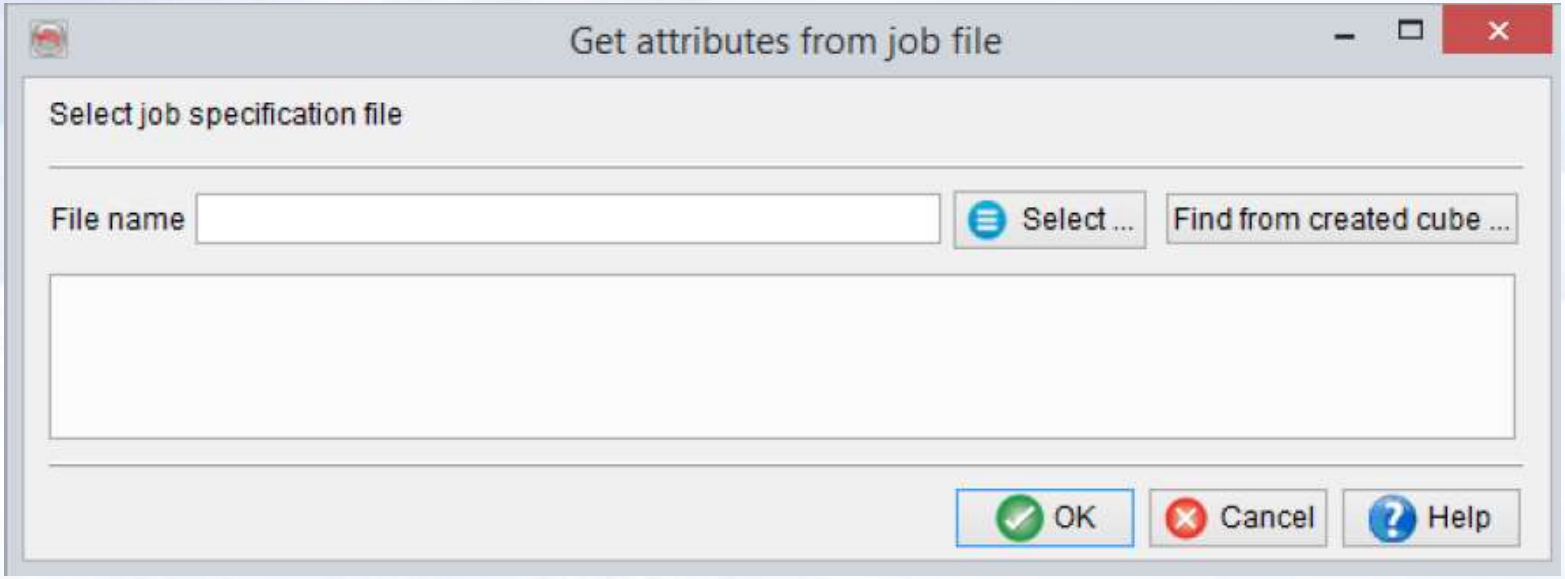


Import set from another survey

Pressing select in the above window brings the user here:

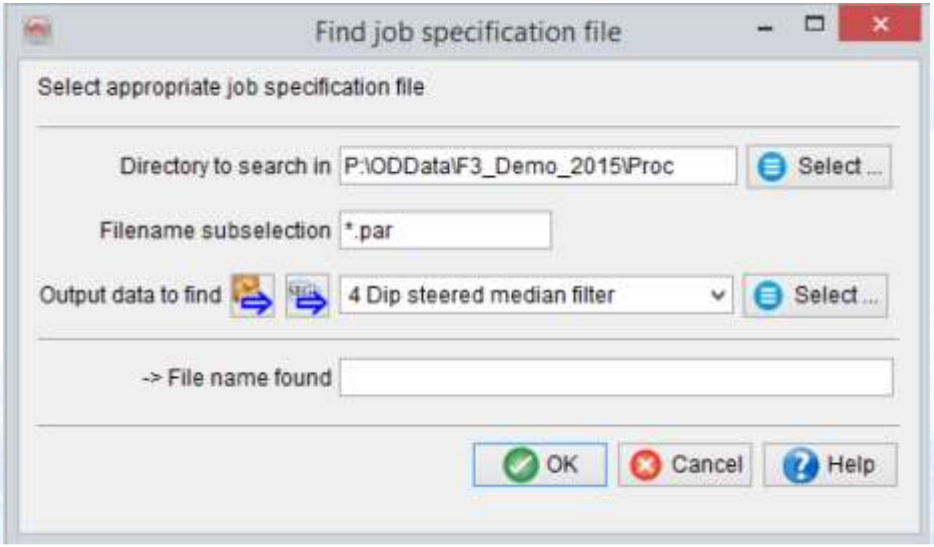


It is also possible to re-create the attribute set of existing processing file in the menu: *File* > *Reconstruct set from job file...* (or) brings the user here:



Existing jobs are stored in the Proc folder of each survey, with the extension par. There are two options available to reconstruct the attributes definition: from an existing par-file or from a created cube file. In first case (from par-file) select the input parameter (*.par) file. In second case (find from created cube), another window pops-up in which the input volume and the corresponding parameter file are selected. The file name is found automatically.

Pressing *'Find from created cube...'* will open up this search/select window:



Finds the attribute set from an existing (created) cube, which was calculated inside OpendTect.

When importing, new input volumes must be selected to replace the references stored in the input files.

5.1.7 Calculate Attributes

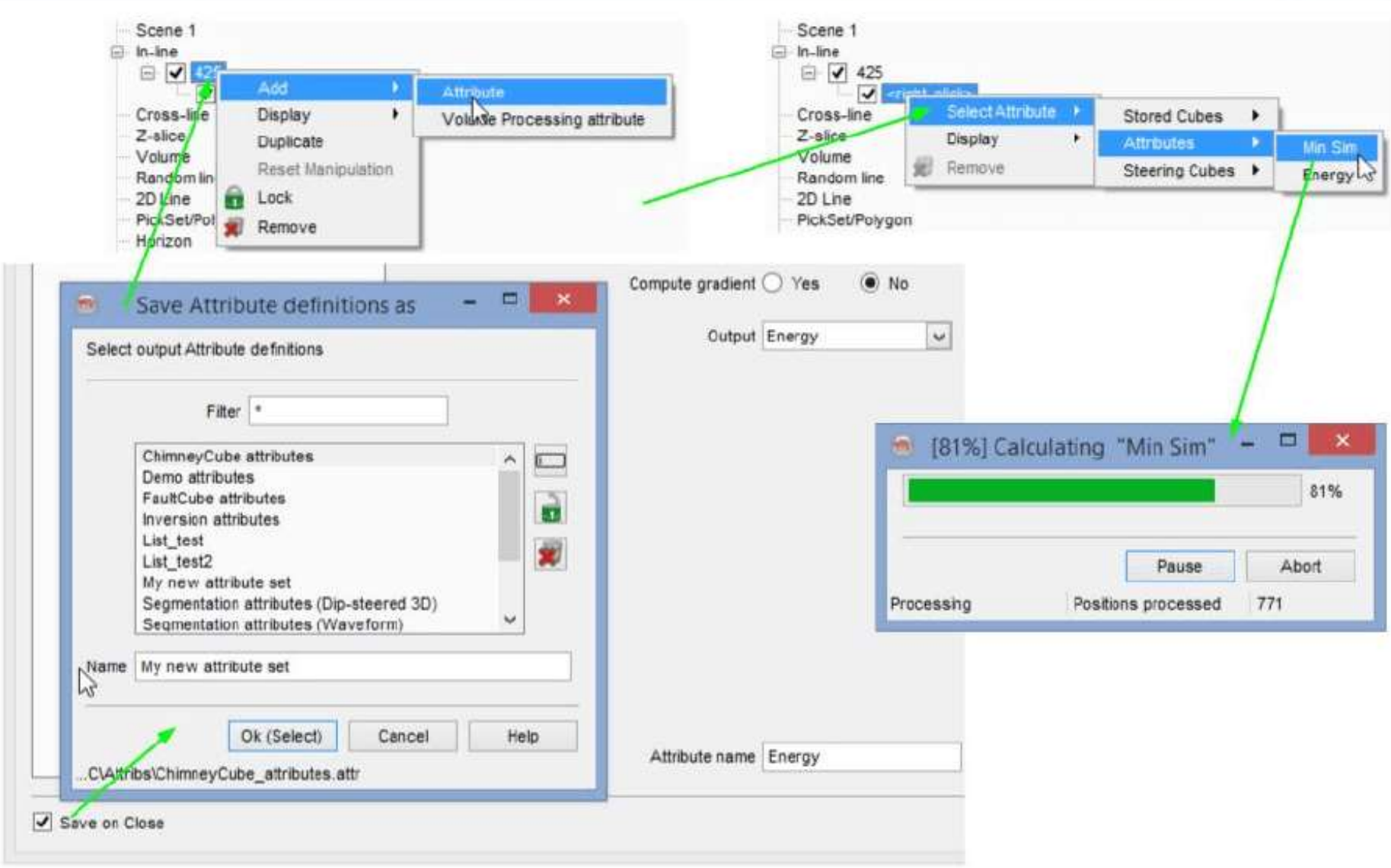
The attribute evaluation process has been considered critically and thus several key options are available for the user. For instance, *Evaluate Attribute*  is considered as intermediate (but not necessary) step to quickly analyze the different parameters of any attribute within the working environment (View tutorial-Evaluate attributes). Similarly, the user can create a list of seismic attribute definitions as a working set that later on can be updated. The attribute set is then used to calculate the seismic attributes along lines/surfaces.

There are two possible ways of calculating seismic attributes in OpendTect: First, in order to calculate the results of any attribute in the foreground, user(s) can do it on-the-fly. Second possibility is to calculate attributes after evaluation by running a secondary process in the background. In OpendTect, seismic attributes are applied on several elements (inlines, crosslines, Z slices, random lines, 2D lines, volumes, horizons etc).

The workflow to calculate the selected attribute is quite simple:

1. Define (or use existing) attribute Set and save. For details see earlier sections of this chapter.
2. Calculate on-the-fly or Create Seismic Output or Create horizon attribute output.
3. If attribute is not calculated on-the-fly, retrieve results by displaying attribute in tree.

The example of first step is given in following figure. It highlights the sequential process (notice green arrows form left to right) of on-the-fly attribute calculation. Firstly, several attributes are defined. Secondly, by default, when a user presses *Ok* button in *Attribute Set* window, the *Save Attribute definition* window will appear to save the attributes definition as an Attribute set. The attribute can then be applied on an inline (for instance) by adding a blank attribute (right-click on inline number). Right-click on the blank attribute and select the attribute (Select Attribute > Attributes > "*User Attribute*"). The listed attributes are those that are defined in the attributes set window. Selection of any one, would start a process of on-the-fly attribute calculation. By following same workflow (as elaborated in figure) the same attribute can be calculated along other elements (e.g. crosslines, Z-slices, volumes etc).


Scene 1
In-line
425
Cross-line
Z-slice
Volume
Random line
2D Line
PickSet/Polygon
Horizon
Add
Display
Duplicate
Reset Manipulation
Lock
Remove
Attribute
Volume Processing attribute
Select Attribute
Display
Remove
Stored Cubes
Attributes
Steering Cubes
Min Sim
Energy
Save Attribute definitions as
Select output Attribute definitions
Filter *
ChimneyCube attributes
Demo attributes
FaultCube attributes
Inversion attributes
List_test
List_test2
My new attribute set
Segmentation attributes (Dip-steered 3D)
Segmentation attributes (Waveform)
Name My new attribute set
Ok (Select)
Cancel
Help
..C\Attribs\ChimneyCube_attributes.attr
Save on Close
Compute gradient Yes No
Output Energy
Attribute name Energy
[81%] Calculating "Min Sim"
81%
Pause
Abort
Processing
Positions processed 771

Schematic flow of on-the-fly seismic attributes evaluation on an inline.

1. There are some attributes that can take too much time during the on-the-fly calculatio process.

   This depends upon the type of attribute that how much calculation steps it considers e.g. multi-trace (e.g. Similarity) attributes normally take more calculation time than the single trace (instantaneous) attributes. Similarly, the attributes with steering normally takes more time in calculation. So, each time the attribute is displayed in the scene (as shown above), it is calculated in the fore-ground. If the user is committed with the attributes results, this can be resolved by creating seismic outputs (See Create Seismic Output and Create Horizon Output sections) in the background. This will also help to restore the saved sessions quickly.

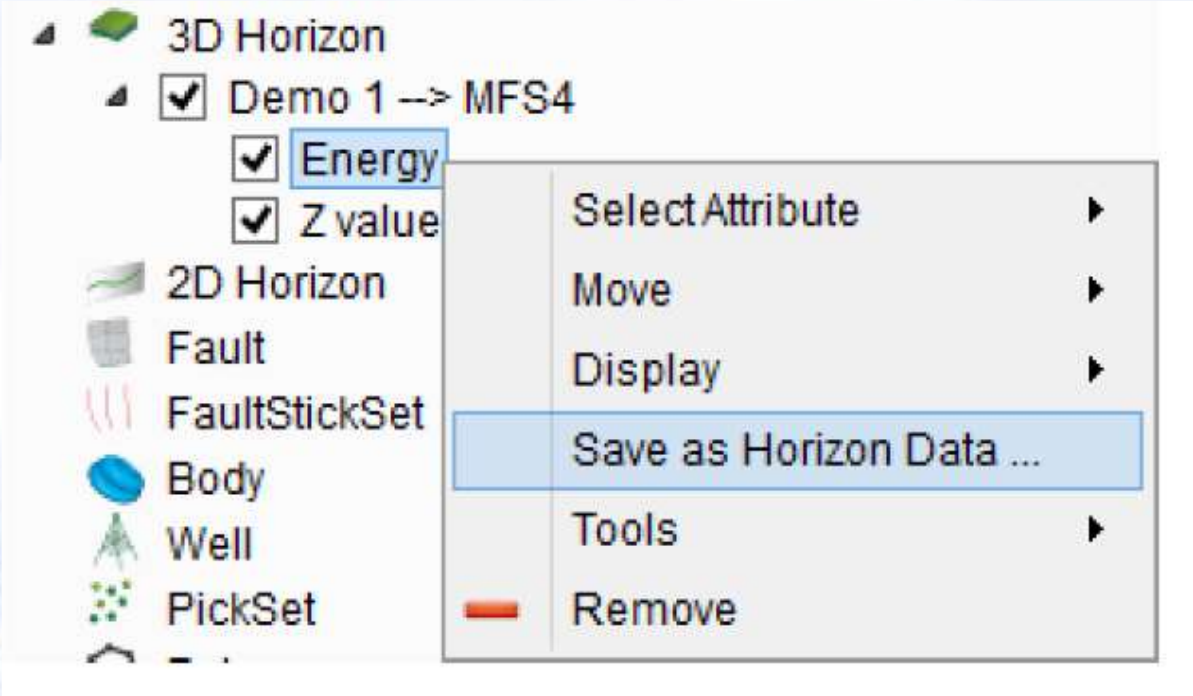
2. Additionally, **multi-component** output seismics-2D/3D (like spectral decomposition) are created by using create seismic output.

   Another example of second step, is shown in following figures. The attribute can be calculated **along the horizon** by following the same steps described above, for inserting and displaying the attribute (as shown below). In this example, Similarity is calculated on-the-fly along a horizon. This attribute normally takes time (depending

upon amount of traces involved). So, user can take benefit of saving the on-the-fly results that later on can be retrieved.

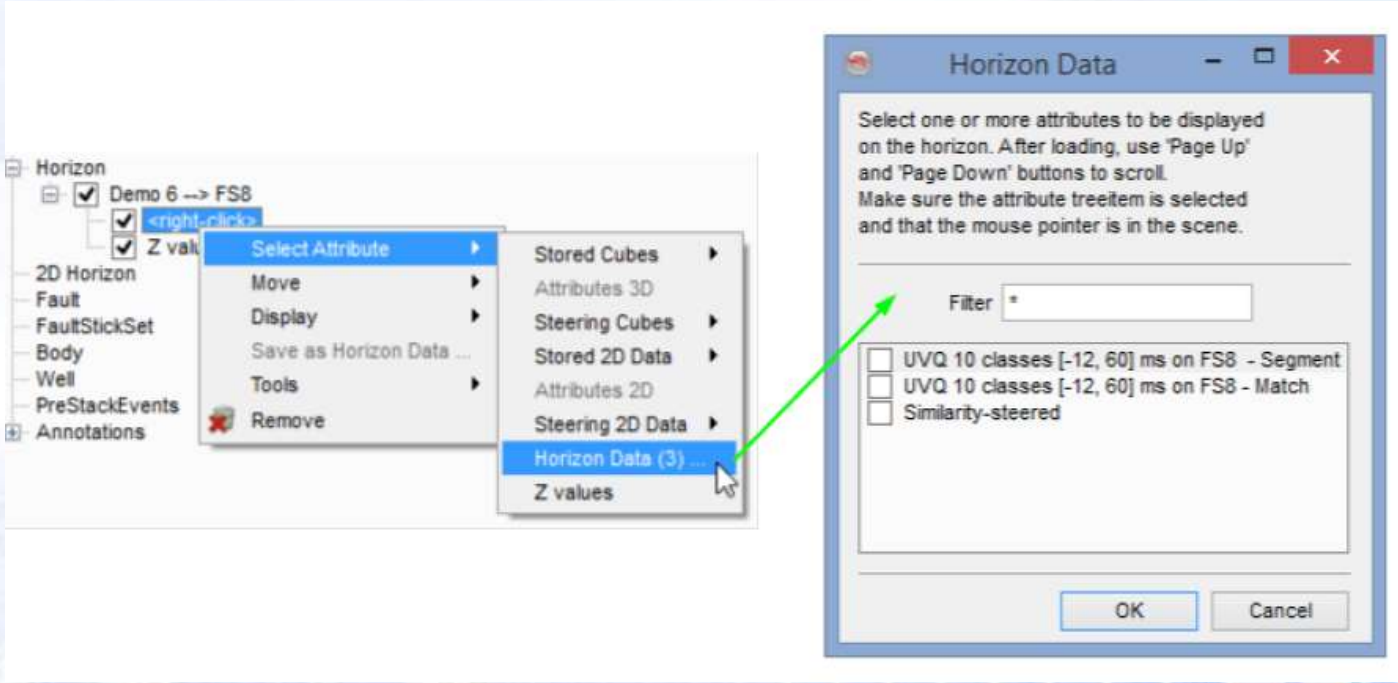
Schematic flow of on-the-fly seismic attributes evaluation at a horizon.

In order to save the calculated attribute as horizon data, right-click on the attribute and select *Save as Horizon Data...*. In pop-up window edit the name accordingly and press *Ok*. This will save the horizon attribute as its horizon data. That can be managed later on by using horizon management window. (see Management horizon)



Result of calculated similarity attribute. Saving the horizon attribute as horizon data

The stored attributes along horizon can be retrieved as horizon data. Right-click on horizon and add blank attribute. Right-click on the newly inserted blank attribute and locate Horizon data item in the sub-list of attribute (as shown below). In the horizon data selection window, select the desired attribute. This will display the selected attribute in the scene.



Retrieving the stored horizon data (attribute) of a horizon.