



## 5.4 Wells

### 5.4.1 Well Log Tools

### 5.4.2 Tie Well to Seismic

#### 5.4.2.1 Well-Tie Selection Window

#### 5.4.2.2 Well-Tie Checkshot Editor

#### 5.4.2.3 Well-Tie Display Panel

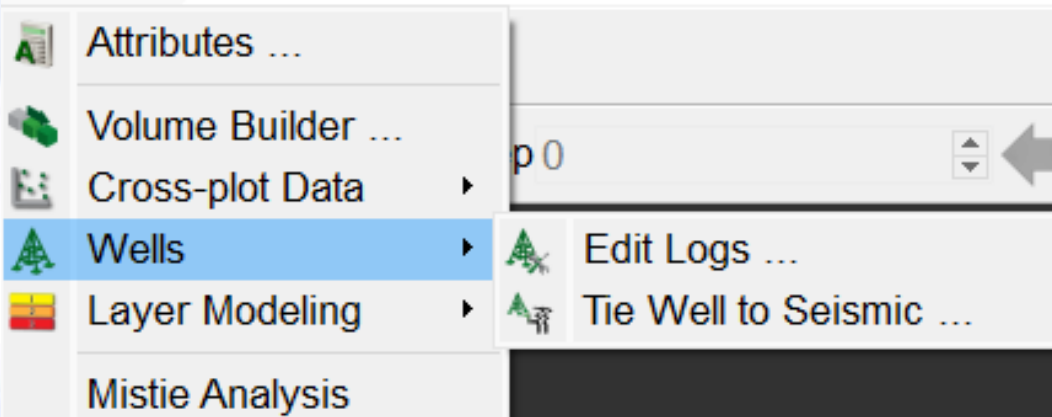
#### 5.4.2.4 Well-Tie Crosscheck Parameters



## 5.4 Wells


The *Wells* element in the Analysis menu gives you access to three features: Edit logs..., Tie Well to Seismic... and Rock Physics...

Analysis Processing Scene View Utilities TerraNubi

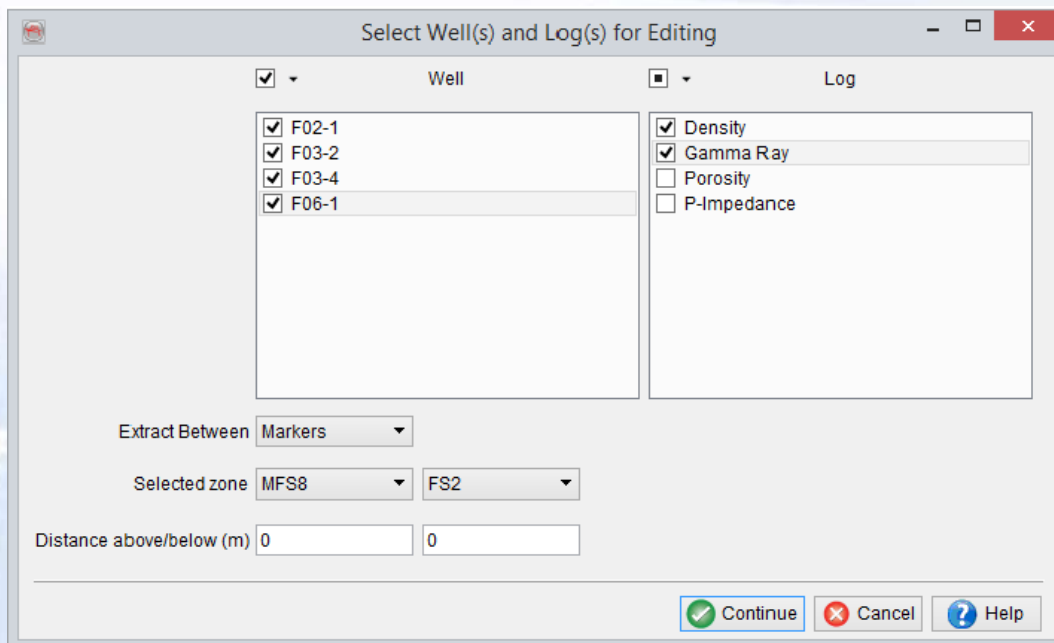




## 5.4.1 Well Log Tools

The well log tools can be used to remove spikes, smooth and clip the logs. it can also accessed by using the  icon in the Manage Wells window. Multiple wells can be selected at once along-with the various logs. The logs can be extracted between:

**Markers:** The bounding markers have to be specified. If necessary, the distance above/below these bounding markers (from where the actual extraction of the logs is going to start/stop) can also be specified:



Select Well(s) and Log(s) for Editing

<input checked="" type="checkbox"/> Well	<input checked="" type="checkbox"/> Log
<input checked="" type="checkbox"/> F02-1	<input checked="" type="checkbox"/> Density
<input checked="" type="checkbox"/> F03-2	<input checked="" type="checkbox"/> Gamma Ray
<input checked="" type="checkbox"/> F03-4	<input type="checkbox"/> Porosity
<input checked="" type="checkbox"/> F06-1	<input type="checkbox"/> P-Impedance

Extract Between: Markers

Selected zone: MFS8 FS2

Distance above/below (m): 0 0





**Depth range:** The logs can be directly extracted between a particular depth range:

Select Well(s) and Log(s) for Editing

<input checked="" type="checkbox"/> Well	<input type="checkbox"/> Log
<input checked="" type="checkbox"/> F02-1	<input checked="" type="checkbox"/> Density
<input checked="" type="checkbox"/> F03-2	<input checked="" type="checkbox"/> Gamma Ray
<input checked="" type="checkbox"/> F03-4	<input type="checkbox"/> Porosity
<input checked="" type="checkbox"/> F06-1	<input type="checkbox"/> P-Impedance

Extract Between

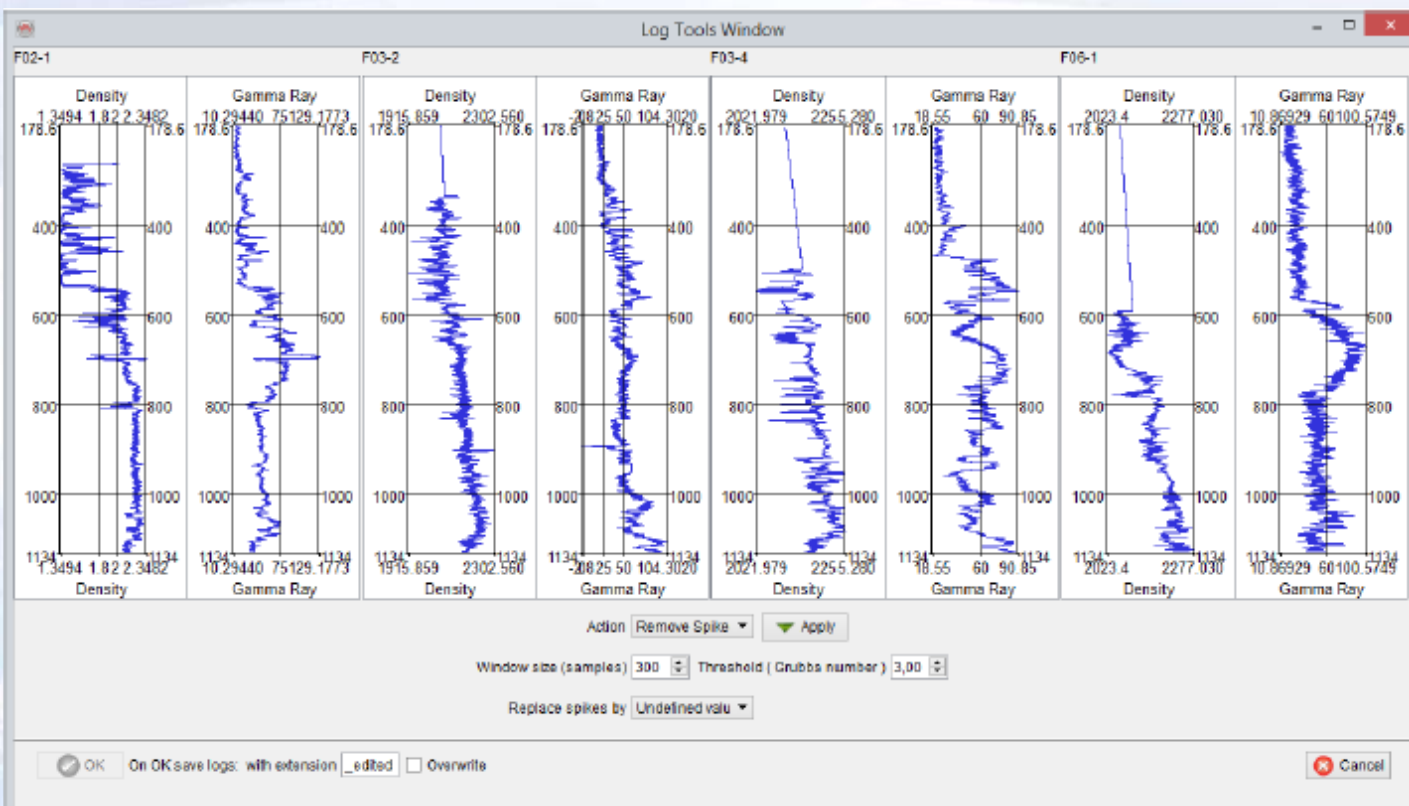
Start / stop (m)

☒ Continue ☐ Cancel



**Time range:** The logs can be directly extracted between a time window. The extraction may be done in time domain by toggling on 'Extract in time'.

On pressing Go the extracted logs are displayed and 'smoothing', 'clipping' and 'spike removal' can be performed on these well logs:





**Smoothing:** A window size (samples) should be defined in which the smoothing of the well log data will be performed.

**Clip:** Percentage *Clip rate* has to be defined.

**Remove spikes:** De-spiking of the logs can be done by specifying a window size (samples) and the *Threshold* for the Grubbs algorithm. Further, the removed spike values can be replaced by 'Undefined values', 'Interpolated values' or can be manually specified.

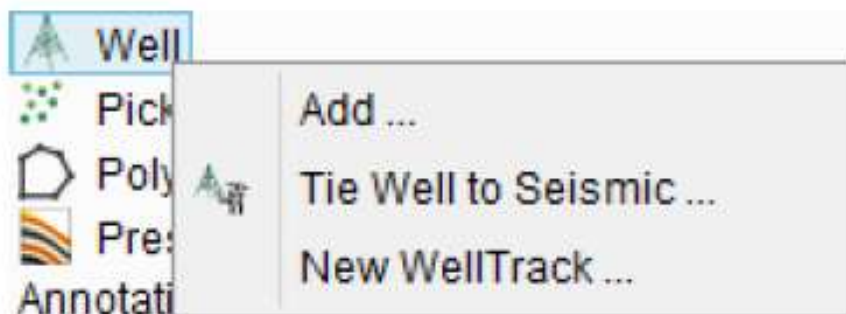
Finally, the edited logs can be saved with an extension or can be overwritten.





## 5.4.2 Tie Well to Seismic

Launch the Well-Seismic Tie window from the main menu or, optionally, the Well-Seismic Tie window can be launched from the tree.



Well to the seismic tie is a major task for interpretation projects. It is used to correlate the well information (logs) to the 3D seismic volume or 2D seismic lines. This enables the comparison (crossplots, ...) of well-based and the 2D/3D seismic data.

## Well-to-Seismic tie workflow:

### 合成地震记录的工作流

素 求真务实

#### 1. Data preparation

- Import the seismic volume or 2D line.
- Extract a wavelet.
- Import the wells: Each well requires a track, checkshot or time-depth curve and sonic log.
- Import the additional data: 3D/2D Horizons, well markers, additional time-depth curve if a checkshot was loaded.
- Edit the log database: Fill the missing sonic parts, create a density log from the sonic (constant value or Gardner's equation) if not available.

#### 2. Synthetic-to-seismic tie

- The module is launched from the Analysis menu or via the right-click menu of each well.
- The input fields must be selected.
- Based on the available data the density and sonic logs will be combined into impedance and reflectivity, depth-time converted (includes an upscaling) and convolved with the wavelet. The result is a synthetic seismic traces for the well. This trace will be compared with a composite seismic trace extracted in the volume along the (deviated) well path, on the nearest trace. Both synthetic and composite seismic traces are cross-correlated, and the output value is an indication of the alignment and matching quality.
- The alignment will be carried out either by shifting the synthetic trace up or down, or by selecting several locations in both seismic traces, specifying and applying a shift function that varies with the travel time. The applied changes must be validated,

before being converted into a new time-depth function that replaces the previous one. No changes are being applied to the well logs.

- At each step of the tie a deterministic wavelet can be estimated using the time-converted reflectivity log and the composite seismic trace. This deterministic wavelet should vary per well, and is known to link the well data to the seismic data more reliably.

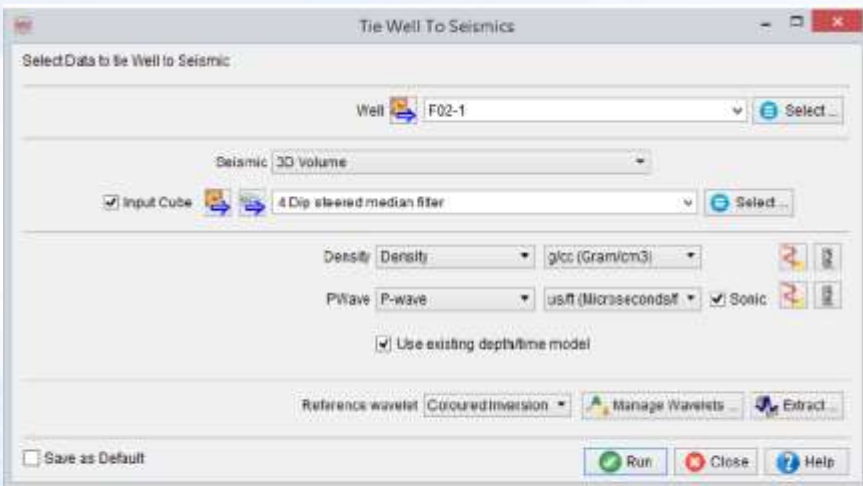




## 5.4.2.1 Well-Tie Selection Window

The tie well to seismic window is used to select the necessary data for the Well-Seismic tie workflow. Please have a look at the introduction to see how to prepare the necessary data.

Well tie can be used to tie the well with the 3D seismic volume or 2D seismic line.






Well to 3D seismic tie window



Well to 2D seismic tie window



In both the 2D and 3D windows, there are additional features accessed via the following icons:

-  Opens the Calculate New Log window
-  Displays the particular log in the log viewer
-  Opens the Wavelet Manager window

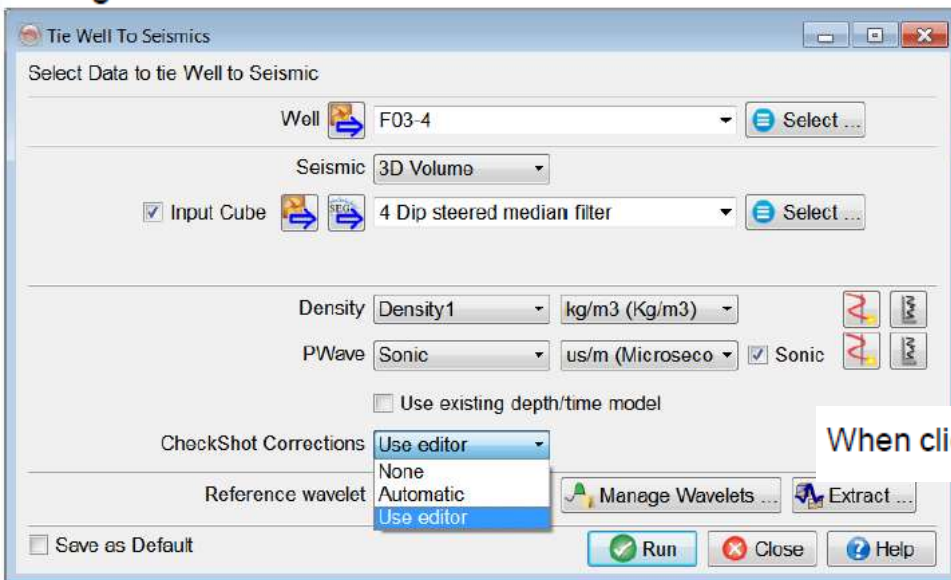




## 5.4.2.2 Well-Tie Checkshot Editor

In OpendText, CheckShot corrections are applied before launching the Well to Seismic Tie window. If you have no depth/time model or have not selected any existing one, you will be proposed to correct the sonic integrated depth/time model, provided you imported a CheckShot model for your well.

The choices given are "None", "Automatic" or "Use editor". In the first case, the time depth curve will be computed directly from the sonic log without any correction (note, this is also the default mode if you do not have any CheckShot). In the automatic mode, the time/depth curve will be calibrated to the CheckShot without any user interaction. In the last case, you will be allowed to edit the calibration yourself using an editor window.

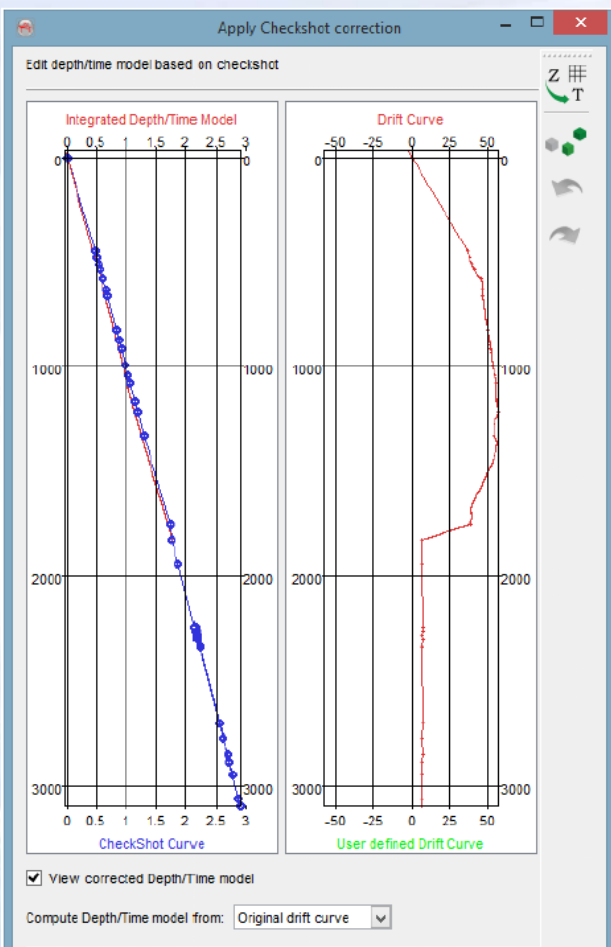


When clicking on 'Run', the 'Apply Checkshots correction' window pops up.






## Apply Checkshots correction




The above window is divided in two panels. On the left one, the sonic 'Integrated Depth/Time Model' (red) and the 'Checkshot Curve' (blue) are plotted. The right panel displays the drift curves. The original 'Drift Curve' (red) shows the variations between the CheckShot and the sonic integrated model.

By adding points to the right display you can additionally generate a new 'User defined Drift Curve' (green). This is done by clicking the  icon. Once this is done, select the correction to apply, either from the Original or from the User Drift Curve and push the Apply button. The newly computed depth/time model will appear in green on the left panel. You can modify the drift curve and re-apply the corrections until you are satisfied with the depth/time model. Push the OK button and the main well tie window will appear using the new calibrated depth/time model.



### 5.4.2.3 Well-Tie Display Panel

The display panel is the main window where the wells are tied to the seismic data. This module is primarily used to update the current (loaded) time-depth curve. Previous, intermediate and final TD curves can be exported to ascii at any moment using the following icon .

A secondary output of the synthetic-to-seismic tie is the estimated wavelet, that is estimated at any time and must be saved explicitly.

The view is separated in three frames, from left to right:

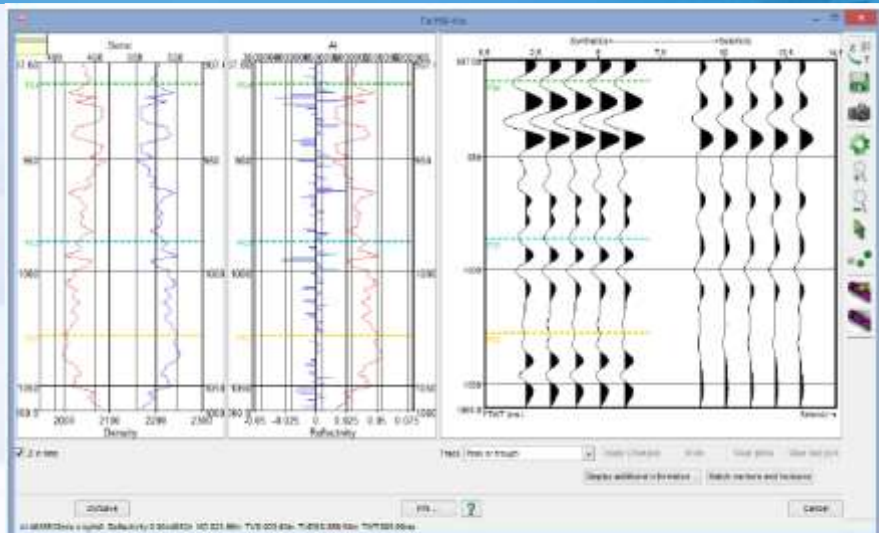
- The sonic (red) and density (blue) logs.
- The computed impedance (red) and reflectivity (blue) logs.
- The computed/extracted synthetic and composite seismic traces.

The raw logs are shown before upscaling. The vertical axis of all 3 frames is in travel time.

Key points:

- The time-depth conversion and synthetic seismic traces computation is done using the current time-depth curve and checkshot (if available).
- The checkshot data acts as a strong constraint, i.e. any input and output time-depth curve will be forced to honour the checkshot.
- The time of the depth TVDSD=0 will always remain at TWT=0 even when applying a bulk shift: The difference is absorbed between the point TVDSS=0 and the first sonic log sample. The reference datum elevations definitions are summarized in the well track import chapter.





Display panel for the well-seismic tie.

At the bottom right corner of this display panel, there are several tracking controls. The options are used to pick an event to match the seismic and synthetic traces. After picking the event, press *Apply Changes* to reflect the changes and update the time to depth model.



Launches the Edit Time/Depth model window. In the pop-up window, press Export button to export the time-depth model as an ASCII file.



Launches the save option.





艰苦朴素  
求真务实

You can either save the created logs:

Save current data

Check the items to be saved

☒ Log(s)

☒ AI

☒ Reflectivity

☒ Synthetic

Save as ☒ Log ☐ Seismic cube

Output Name ☒ with suffix

☐ Wavelet

☐ Initial wavelet

☐ Estimated wavelet

Or save the synthetic trace as a seismic volume.



Takes the snapshot of the display panel



Display settings/properties for the panel. The settings are similar to that of the normal 2D-viewer model



Zoom-in



Zoom-out



Toggles interact mode ON/OFF



Pick seeds on the seismic or synthetic to update the time to depth model.

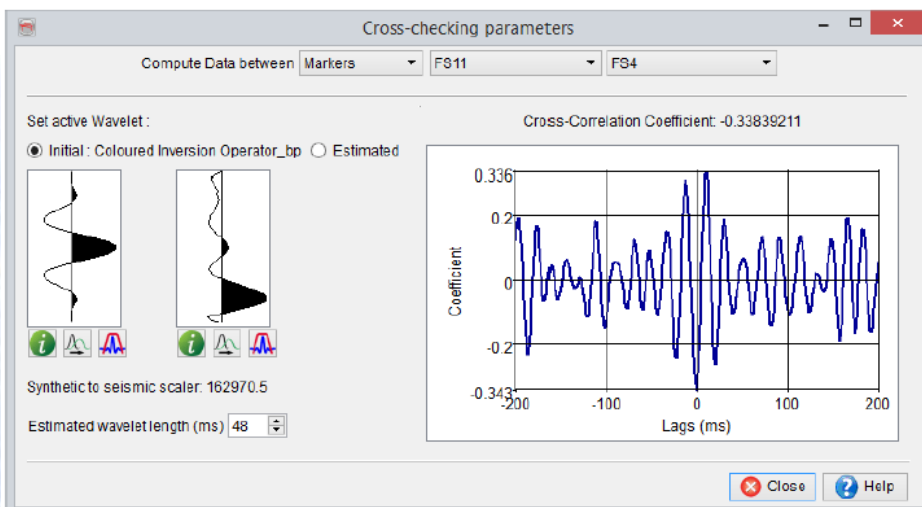


中国地质大学



## Change in depth/time model

- Choose a *tracking mode* (e.g. maxima, minima, zero-crossings etc.) and select events in the synthetics/seismic displays by first selecting the *Pick mode* button. Events can not be picked separately. Each event in the synthetics must be linked with an other event in the seismic.
- Once all the events are selected on both synthetics/seismic displays, press *Apply changes* button. The depth/time model and the whole computational workflow will be recomputed. If needed, repeat the operation.
- The *Display additional information* button will open the *Cross-checking parameters* window, and provide useful cross-checking tools, such as correlation coefficient and estimated wavelet in a specific depth range. The estimated wavelet displayed here can also be saved:







# 中國地質大學

China University of Geosciences

艰苦朴素 求真务实

校训

- The depth/time table can be saved between each state by pushing the Save button, in the toolbar to the right of the synthetics/seismic displays, and saving with an appropriate name. The *View/Edit Model* button allows the user to import a depth/time table.
- Once a good correlation has been established, click on *Ok/Save* and save the depth/time model.

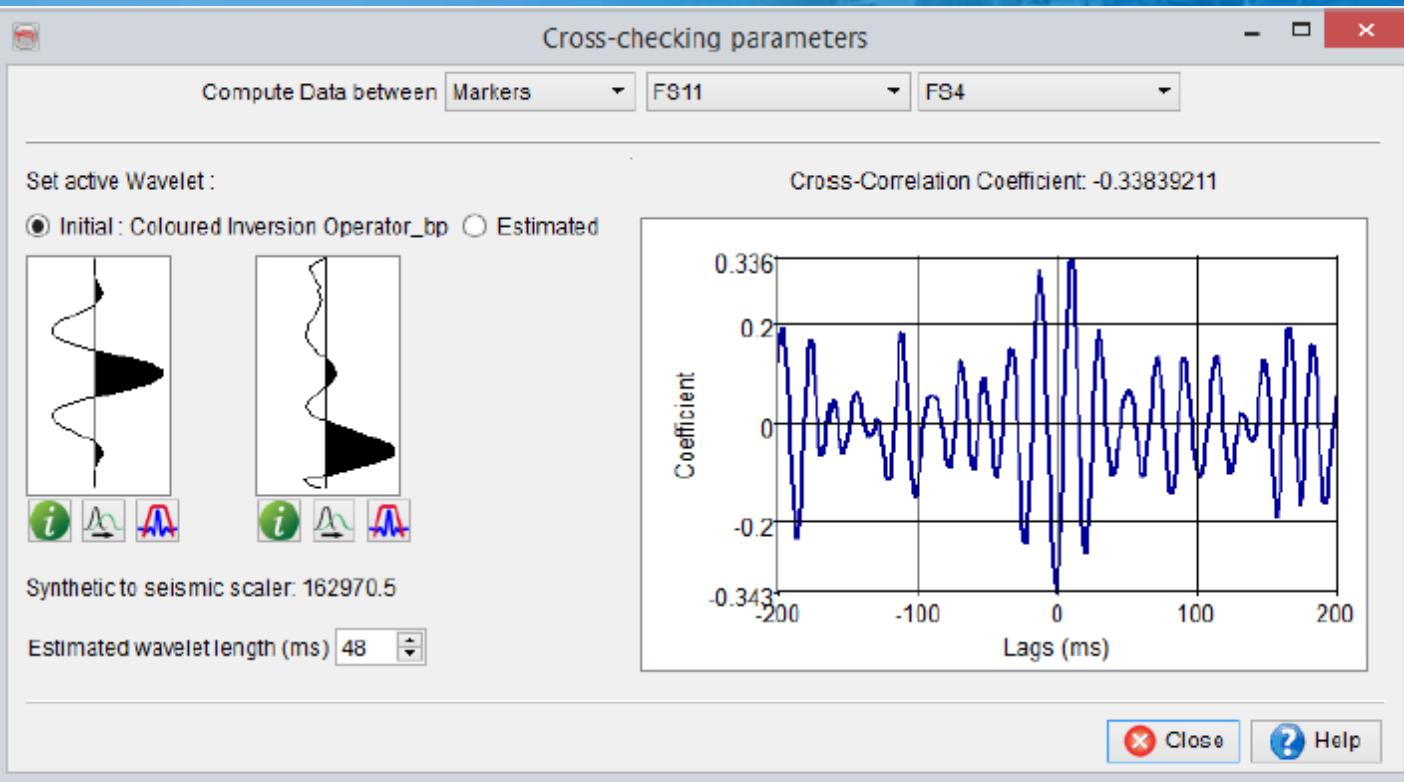
艰苦朴素  
求真务实

中国地质大学





## 5.4.2.4 Well-Tie Crosscheck Parameters

The cross-checking window is launched from the well ties display panel (Section-Well Tie: Display Panel) by clicking on the *Display additional information* button. The window contains the initial and estimated wavelet information. The wavelet can be computed between the two levels (start-end of data in time/depth or markers) that are provided at the top of this window. The window contains further key information: wavelets plot and the correlation coefficient. By changing the *compute data between* option, the correlation coefficient is auto-updated, this is done by using either Markers (Default) or Time/Depth. After achieving a high and positive correlation coefficient, the estimated wavelet can be saved. Importantly, the negative correlation coefficient shows that the polarity of the estimated wavelet is reversed. To avoid that the reference/initial wavelet's polarity has to be reversed.



Check-crossings window and correlation panel

To save the estimated wavelet, press the  icon in the well tie main window .

The wavelet properties () can be shown as a graphical display of the wavelet, its amplitude spectrum and phase spectrum.





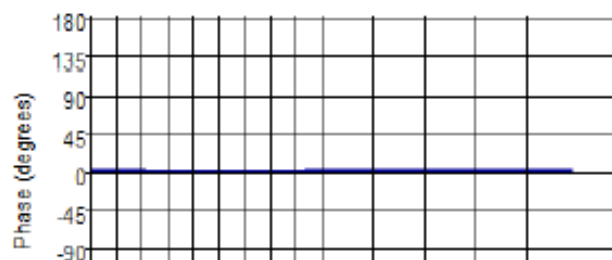
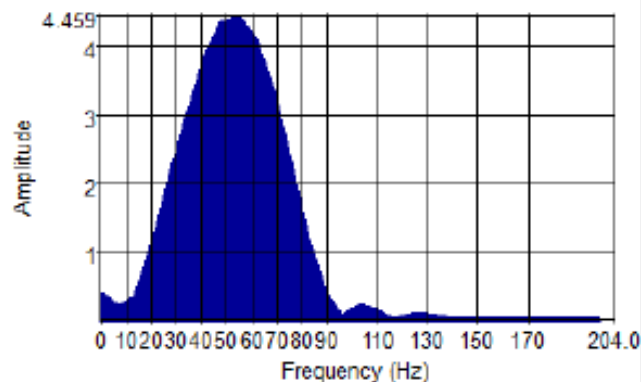
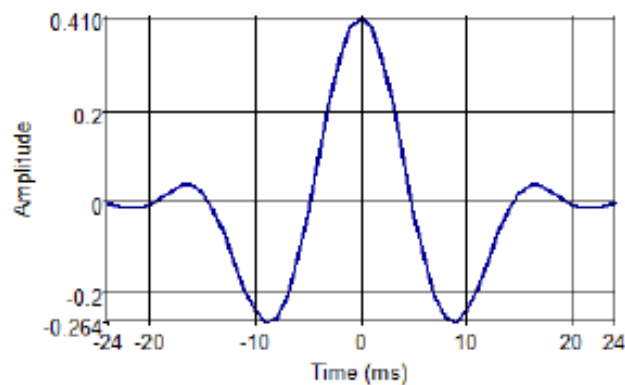
中國地質大學  
China University of Geosciences

艰苦朴素 求真务实

地大精神


艰苦朴素  
求真务实

Coloured Inversion Operator\_bp

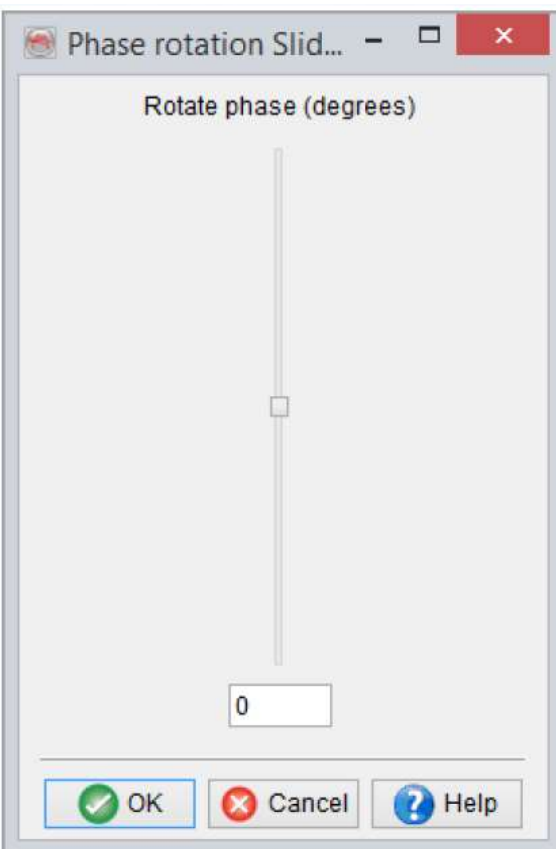





### Save the estimated wavelet

The user can also click on  to open a slider interface for shifting phase of the wavelet:

**Rotate Wavelet:** Using the slider, the user can edit the phase of a wavelet.





**Taper Wavelet:** This option enables the user to taper a wavelet by clicking on . The User will see the real-time changes in the amplitude spectrum.

