

CMP->VSP deconvolution - VSPCMPdec

1 Function

This program provides for CMP-VSP tie and additional deconvolution of CMP surface seismic section based on VSP reflectivity trace in order to expand available frequency band of surface seismic data and deliver true zero-phase waveform.

The tie between surface and borehole seismic data is performed via estimation of cross-correlation function of VSP trace and CMP trace corresponding to the borehole location. Parameters of correlation are available for adjustment. Time shift of cross-correlation maximum represents the necessary correction for different reference levels of surface and VSP data. In case when the location of a borehole is unknown the distribution of best correlation coefficient values can help to indicate it.

After the tie is made (VSP trace is shifted and matches to surface seismic data) the deconvolution of CMP section may be applied. Operator providing the best similarity of VSP trace and corresponding CMP trace is evaluated and applied to all traces in surface section. The efficiency of this procedure can be controlled via new cross-correlation function which should feature the increased value of maximum correlation coefficient and amplitude spectra of VSP trace and CMP section before and after deconvolution displayed on the right from seismic data sub-area.

2 Input and Output Data Descriptions

2.1 Input Data

2.1.1 Seismic data

The program requires input surface seismic section and VSP reflectivity trace. Input seismic data is allowed to be either single-component, or three-component (XYZ). In case of multicomponent seismic data the user will be suggested to choose one of the available components.

2.2 Output Data

The result of program is GeoEast database operator table to store obtained operator of deconvolution and GeoEast seismic file with the resulting surface seismic section after additional deconvolution.

3.1 Main window

The main window includes menu bar, tool bar, status bar and work area which are presented in figure 1.

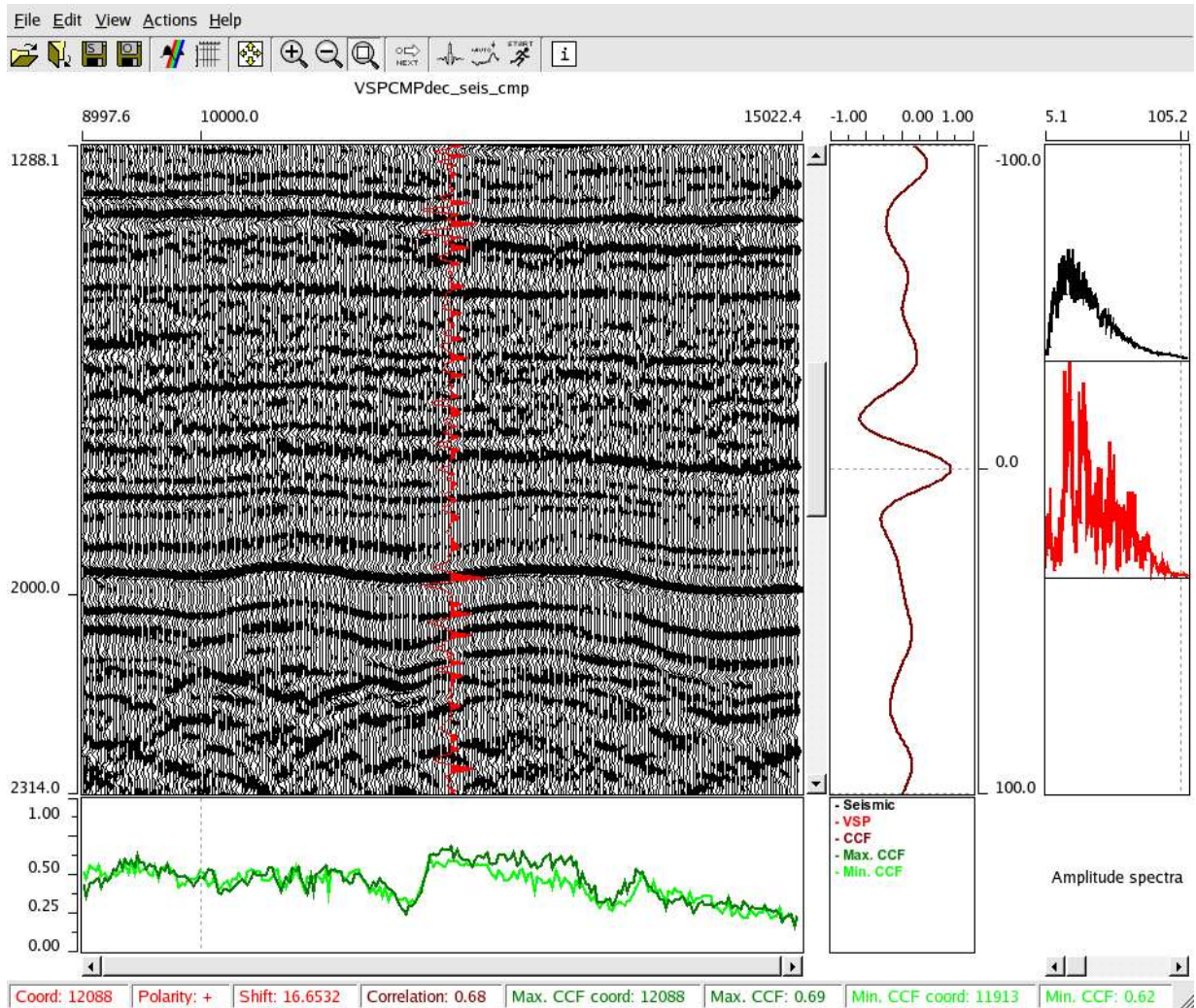


Figure 1

3.2 Menu bar

3.2.1 File

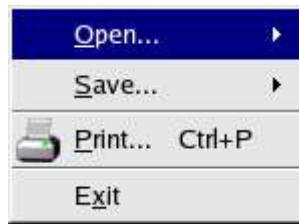


Figure 2

- *Open...* – load input data:

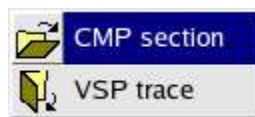


Figure 3

...*CMP section* – load surface seismic (common mid-point – CMP) section;
 ...*VSP trace* – load VSP reflectivity trace.

- *Save...* – save output data:



Figure 4

...*Seismic* – save seismic section after deconvolution;
 ...*Operator* – save deconvolution operator.

- *Print...* – provides printing of image.
- *Exit* – exit program.

3.2.2 View

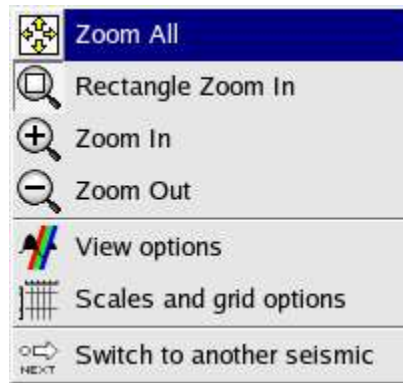


Figure 5

- *Zoom All* – provides displaying of the whole available coordinate range immediately for all natural groups.
- *Rectangle Zoom In* – provides interactive zoom in when the area to be displayed closer is being chosen with the mouse button 1 by defining rubber rectangle in the work area.
- *Zoom In* – seismic section only: single close-up of the whole area based on predefined scale factor.
- *Zoom Out* – seismic section only: single zooming out of the whole area based on predefined scale factor.
- *View options* – visualization options for seismic data (common dialog).
- *Scales and grid options* – tuning options for grid and scales steps and manual zoom mode when coordinate ranges for the displayed piece of seismic section are defined explicitly in corresponding text boxes of a dialog (common dialog).
- *Switch to another seismic* – option to switch between two views: original input seismic section and result of deconvolution.

3.2.3 Actions

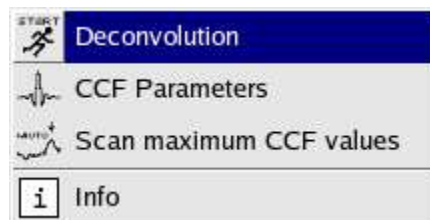


Figure 6

- *Deconvolution* – start deconvolution procedure. On choosing this option the deconvolution parameters dialog appears (figure 7):

Start coordinate	<input type="text" value="9013"/>
End coordinate	<input type="text" value="14988"/>
<hr/>	
Start time, ms	<input type="text" value="1500"/>
End time, ms	<input type="text" value="2500"/>
<hr/>	
Operator length, ms	<input type="text" value="500"/>
Operator delay, ms	<input type="text" value="0"/>
Regularization	<input type="text" value="0.01"/>
<input type="text"/>	
<input type="button" value="Run"/> <input type="button" value="Stop"/> <input type="button" value="Close"/>	

Figure 7

Start coordinate – left edge of section part to be processed.

End coordinate – right edge of section part to be processed.

Start time, ms – left edge of time interval by which deconvolution operator will be defined.

End time, ms – right edge of time interval by which deconvolution operator will be defined.

Operator length, ms – length of deconvolution operator.

Operator delay, ms – delay of deconvolution operator.

Regularization – regularization parameter of the deconvolution procedure; usually corresponds to the assumed noise level (noise/signal ratio) in the input data.

Run – start deconvolution.

Stop – interrupt deconvolution process.

Close – close dialog and cancel deconvolution.

- *CCF parameters* – call for dialog of cross-correlation function (CCF) parameters and VSP trace relative position on surface seismic section:

VSP trace position: 12088

CCF computation:

Start time, ms: 1500

End time, ms: 2500

Half-length, ms: 100

Invert VSP trace

VSP trace shift, ms: 16.6532

Auto shift

OK Cancel

Figure 8

VSP trace position – surface coordinate to which VSP trace is supposed to be attached.

Start time, ms – left edge of time interval in which cross-correlation is to be computed.

End time, ms – right edge of time interval in which cross-correlation is to be computed.

Half-length, ms – maximum absolute relative shift between surface seismic trace and VSP reflectivity trace in estimation of cross-correlation function.

Invert VSP trace – optionally change polarity of VSP trace (when checked).

VSP trace shift, ms – relative time shift of VSP trace.

Auto shift – optionally estimate automatic VSP trace shift based on cross-correlation maximum position (when checked).

OK – accept changes and evaluate cross-correlation.

Cancel – reject changes.

- *Scan maximum CCF values* – calculate maximum cross-correlation values between VSP reflectivity and each surface seismic trace in both polarities, original (*Maximum CCF*) and inverted (*Minimum CCF*):

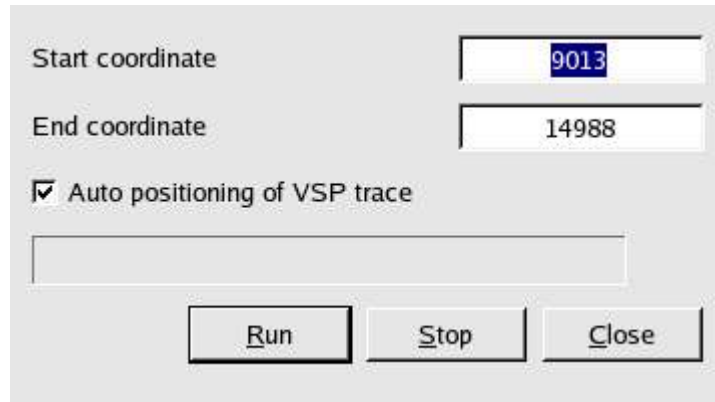


Figure 9

Start coordinate – left edge of part of surface section to estimate distribution of maximum correlation values.

End coordinate – right edge of part of surface section to estimate distribution of maximum correlation values.

Auto positioning of VSP trace – optionally attach VSP trace to coordinate where the greatest value of correlation coefficient was observed (when checked).

Run – start scan process.

Stop – interrupt scan process.

Close – exit dialog.

- *Info* – statistics dialog including three tabs according to three groups of program parameters: *Seismic*, *Cross-correlation* and *Deconvolution*:

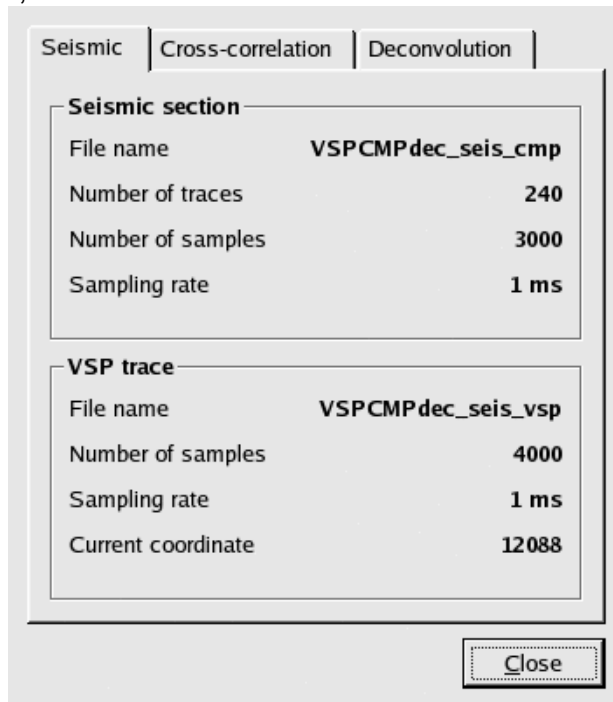


Figure 10

Seismic tab includes input seismic data parameters such as file names, sampling rates and current VSP trace coordinate.

Cross-correlation tab includes parameters of cross-correlation procedure and some information on current correlation coefficients estimations.

Deconvolution tab contains information on deconvolution operator and correlation coefficient value after deconvolution.

3.3 Tool bar



Figure 11

The function of buttons in the tool bar are similar with menu items.

3.4 Status bar



Figure 12

Status bar presents a brief statistics of the program parameters for user to be in touch with them.

4 Using Examples

To start working session load CMP seismic section first, and then load VSP trace. If input data is detected to be multi-component (for CMP section only), the dialog of component selection will be displayed where one of the available components of original wave field should be chosen for further processing:



Figure 13

As VSP trace seismic file is chosen the *CCF parameters* dialog will appear. Set up all parameters and press *OK* button.

If VSP trace position on a surface section is unknown, use automatic positioning or

locate it manually by pressing mouse button 1 following the cursor in the maximum CCF sub-area which is under seismic data sub-area. Similarly, VSP trace relative shift may be specified manually by picking cross-correlation maximum position with mouse button 1 in the CCF sub-area.

To implement deconvolution of surface CMP section go to the *Deconvolution* dialog, set up all parameters and press *Run*. When the procedure finishes operation the resulting seismic section will be displayed and new cross-correlation function will be calculated and shown along with amplitude spectrum of surface seismic data after deconvolution (dark blue) – see figure 14.

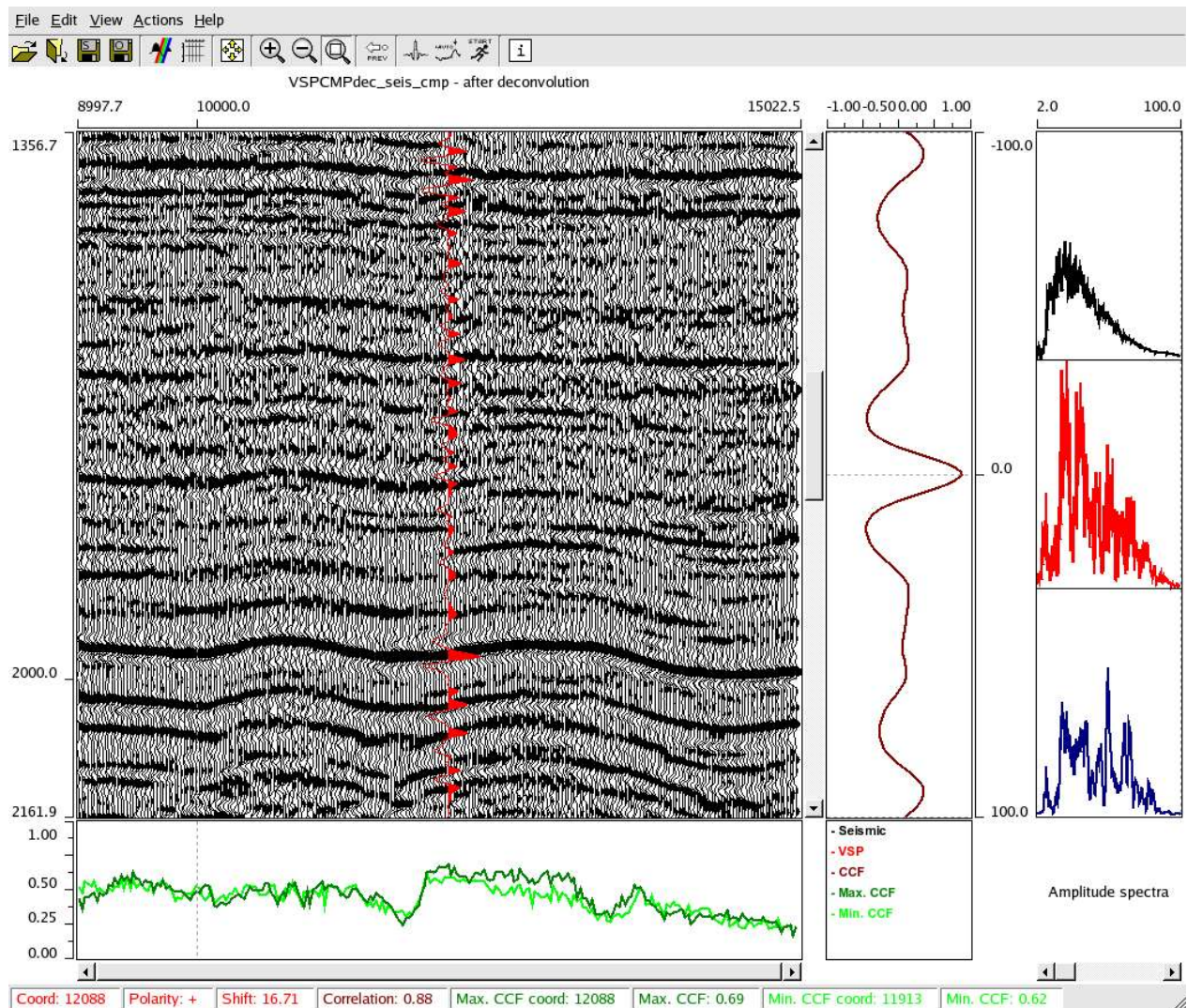


Figure 14

High correlation coefficient and symmetric form of cross-correlation function ensure the quality of deconvolution performed.

To save the results go to *Save seismic* and *Save operator* actions. In the appropriate standard output dialogs specify output seismic file name to store CMP section after deconvolution or database file name to store operator of deconvolution which may be later applied to any other set of data (via another program).

To end working session and exit the program go to *File->Exit* menu item.