ITERATIVE FAULT ENHANCEMENT WORKFLOW

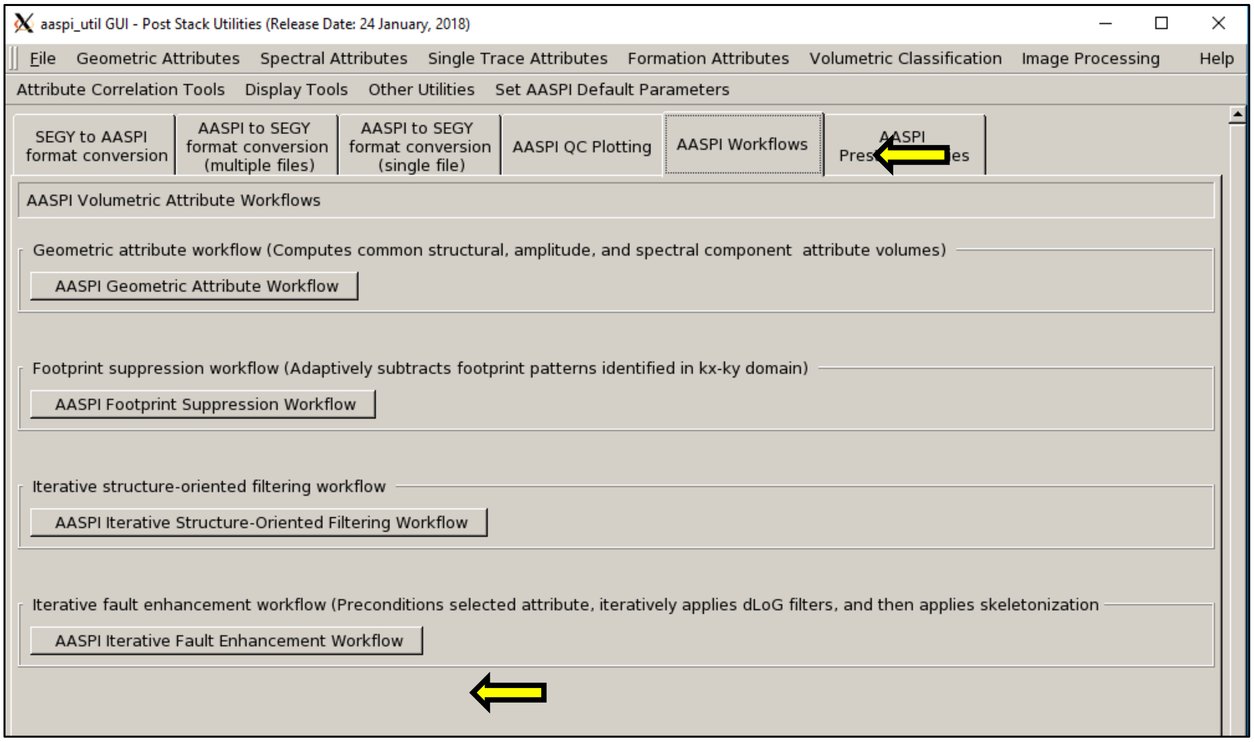
Contents

Introduction

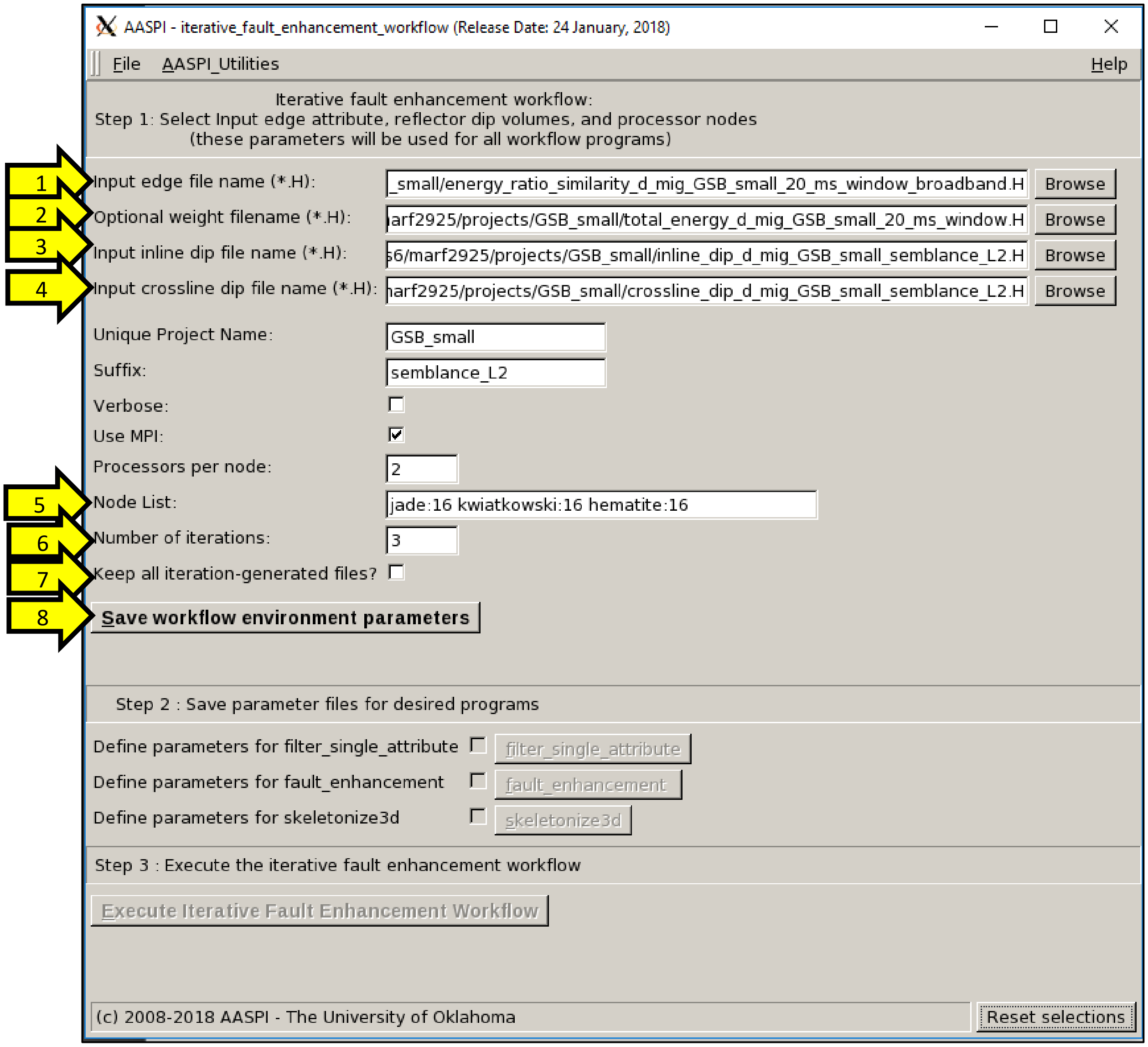
A greater degree of filtering can be obtained using three methods: (1) applying more aggressive filter parameters using the original window, (2) applying the original less aggressive filters but using a larger filter window, or (3) cascading the original less aggressive filters using the original filter window in an iterative manner. Iterative application has three advantages over using a larger window size: (1) cascaded filters will implicitly provide a tapered response, (2) cascaded filters adapt to structure, and (3) cascaded filters are more economic to apply than a single filter of the same effective length.

Iterative Fault Enhancement Workflow

The AASPI iterative fault enhancement workflow GUI can be invoked from the main **aaspi_util** by first selecting the AASPI Workflows tab:



The following workflow GUI will then be displayed (see next page).



Step 1. Defining input data and data parameters used by all programs in the workflow

The input data consists of (1) an attribute that is sensitive to edges, typically one of the similarity (coherence) volumes, or total aberrancy if we wish to enhance faults that appear as flexures. If we wish to enhance axial planes, one would choose the most-positive principal curvature, k_1. The confidence in an edge attribute can be sensitive to the amplitude of the seismic reflectivity or to some other measure of signal-to-noise ratio. In this example, we have used energy-ratio coherence as the input edge attribute and (2) total energy as the optional weight. If no weight file is chosen, all edge attribute values are treated equally (i.e. the weight is set to 1.0). The algorithms used in this workflow are sensitive to structure, requiring the use of (3) inline and (4) crossline components of reflector dip.

The *unique project name, suffix*, and *verbose* options are the same as in most AASPI applications. The *use mpi* and *number of processors* options are common to all AASPI programs that run in parallel (which is the case for **filter_single_attribute**, **fault_enhancement**, and **skeletonize3d** used in this workflow). In this example, we are running across (5) three different workstations, each with 16 processors, for a total of 48 processors in all.

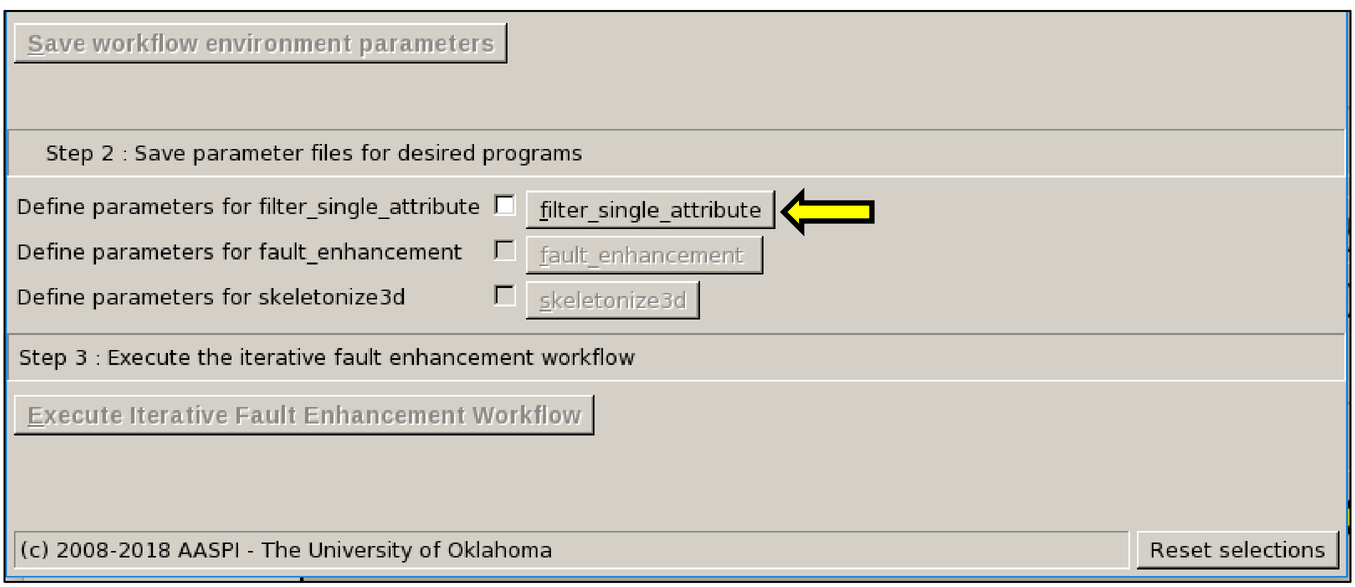
Improved smoothing and sharpening is achieved by defining (6) the *number of iterations*. We've found that for the default, smaller windows, only minimal changes occur beyond three iterations.

If this is your first time running the iterative fault enhancement workflow, you may wish to check (7) *keep all generated iteration-generated files*. In this case with three iterations, there will be a file for fault dip azimuth, fault dip magnitude, and fault probability with the strings "__1", "__2", and "__3" appended to their names. The default is to not keep the intermediate iteration output in order to save disk space.

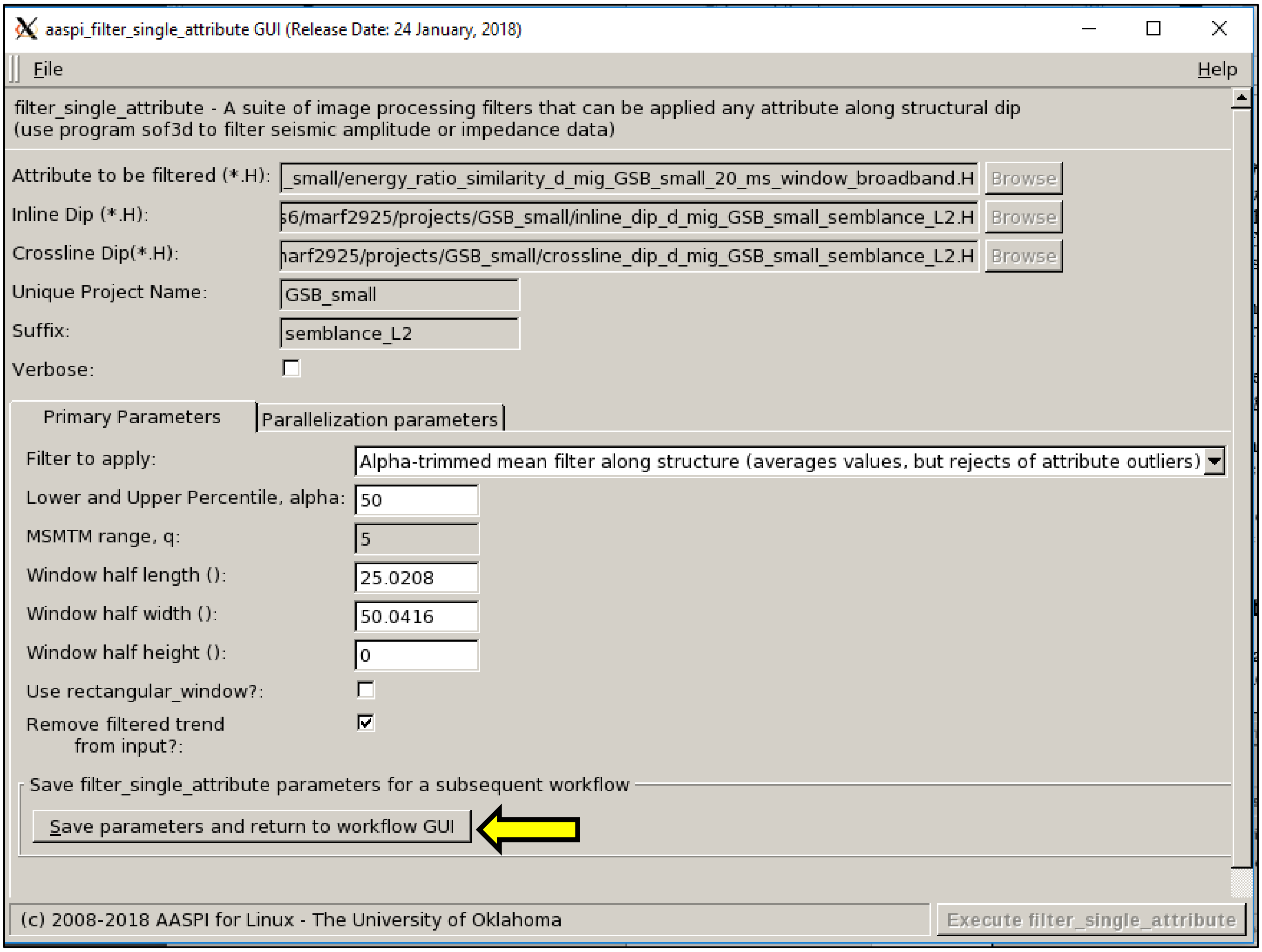
Finally, (8) click *Save workflow environment parameters*. These parameters will be shared with the successive programs. Once saved, *Step 2* becomes activated, application program by program.

Step 2. Defining application program parameters

Once the parameters are saved, the first application program in the workflow, **filter_single_attribute**, becomes active:

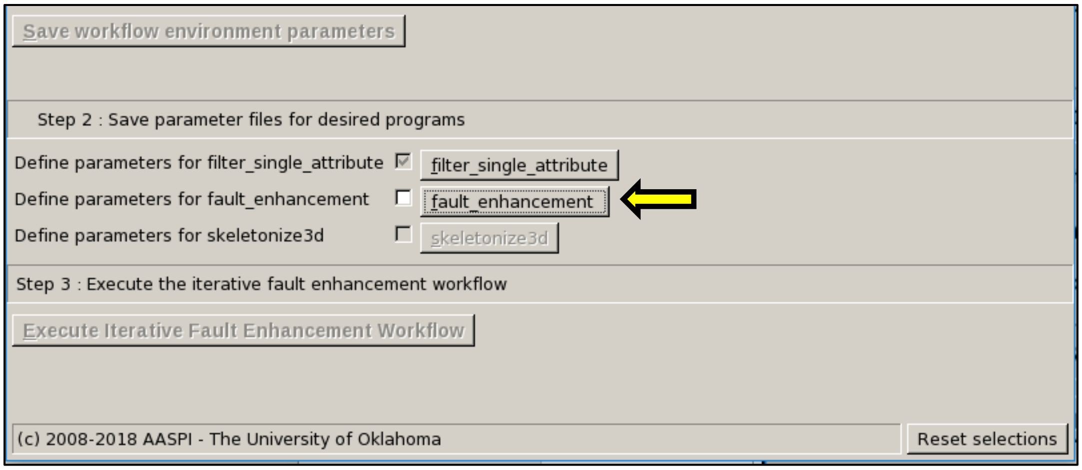


Clicking the **filter_single_attribute** button invokes the corresponding GUI (see next page):

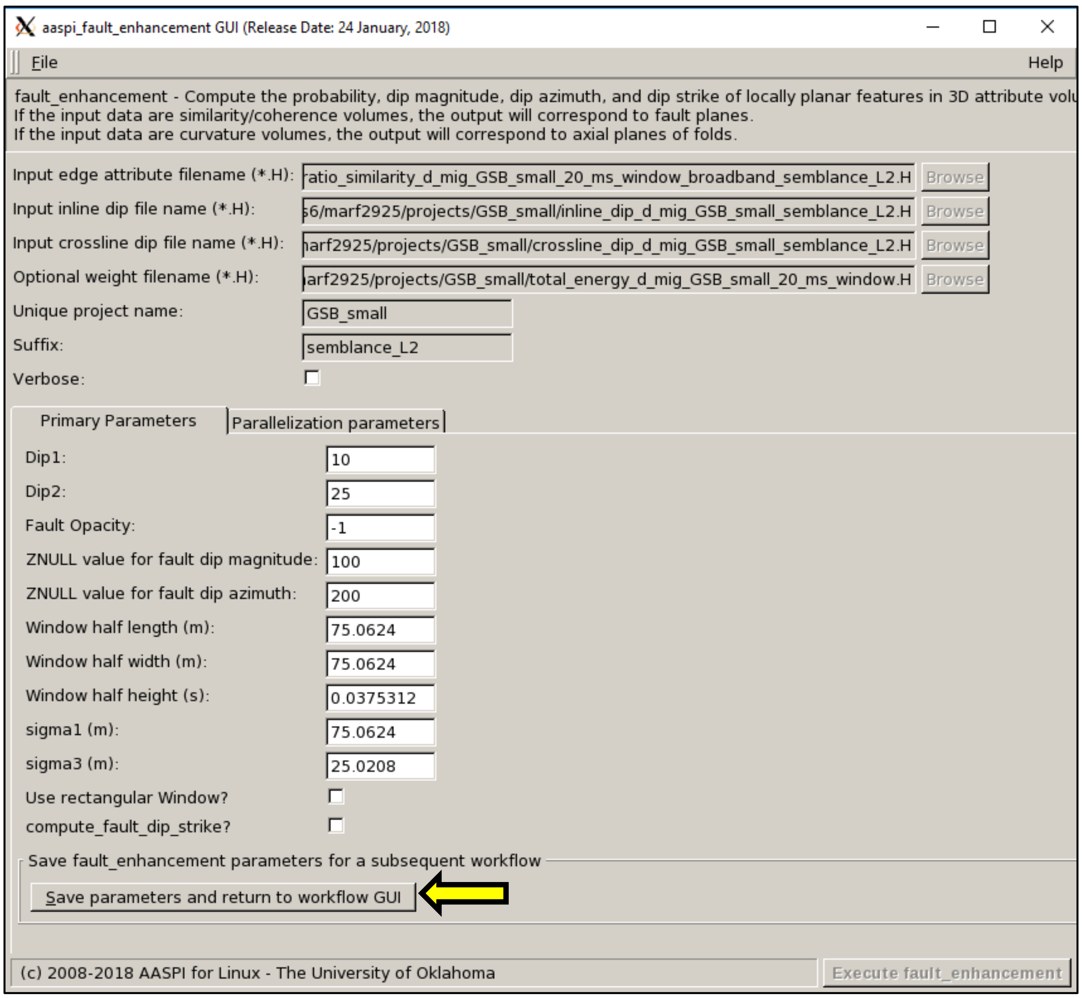


Note that the input data at the top of the GUI are grayed out and cannot be changed. They were defined previously by the workflow GUI. The default parameters for this filter are to apply a 50% alpha trimmed-mean filter to the similarity volume using an elliptical window of radius 25 m by 50 m by 0 ms, resulting in a zero-sample thick median filter being applied to the similarity volume along structural dip. This median filter will preserve similarity anomalies parallel to structure and suppress thin anomalies (such as faults) cutting structure at steep angles. The checkmark indicates that this filtered trend will be subtracted from the input similarity volume, resulting in a volume that favor faults, but suppresses anomalies subparallel to structure. Detailed description of this program can be obtained by bringing up the documentation using the Help button in the upper right. After inspecting and perhaps modifying these parameters, simply *Save parameters and return to Workflow GUI*, to return.

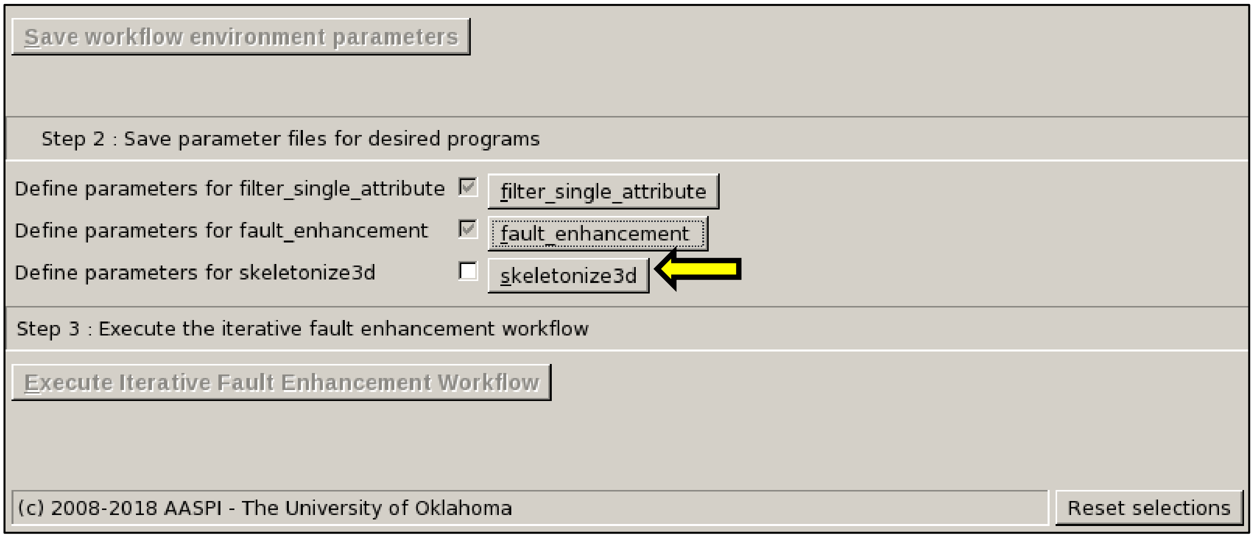
At this point, one can select the next application, **fault_enhancement**, in the iterative fault enhancement workflow GUI:



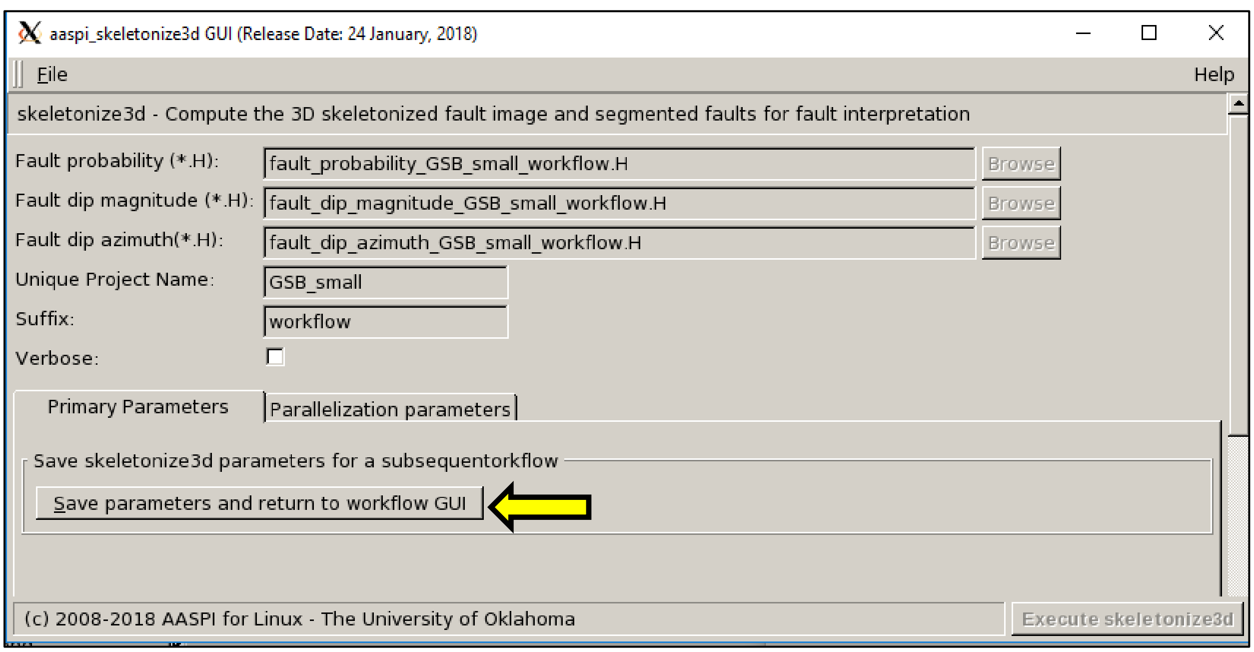
Clicking the *fault enhancement* button invokes the corresponding GUI:



As in the previous application, the input data at the top of the GUI are grayed out and cannot be changed and were defined previously by the workflow GUI. The default parameters for this filter is to apply a directional derivative of a Gaussian that smooths along the hypothesized fault plane using a Gaussian smoother with σ_1=75 m, and to sharpen perpendicular to this same hypothesized fault plane using a dLOG sharpening/smoothing parameter of σ_3=25 m. Detailed description of this program can be obtained by bringing up the documentation using the Help button in the upper right. After inspecting and perhaps modifying these parameters, simply *Save parameters and return to Workflow GUI*, to return.

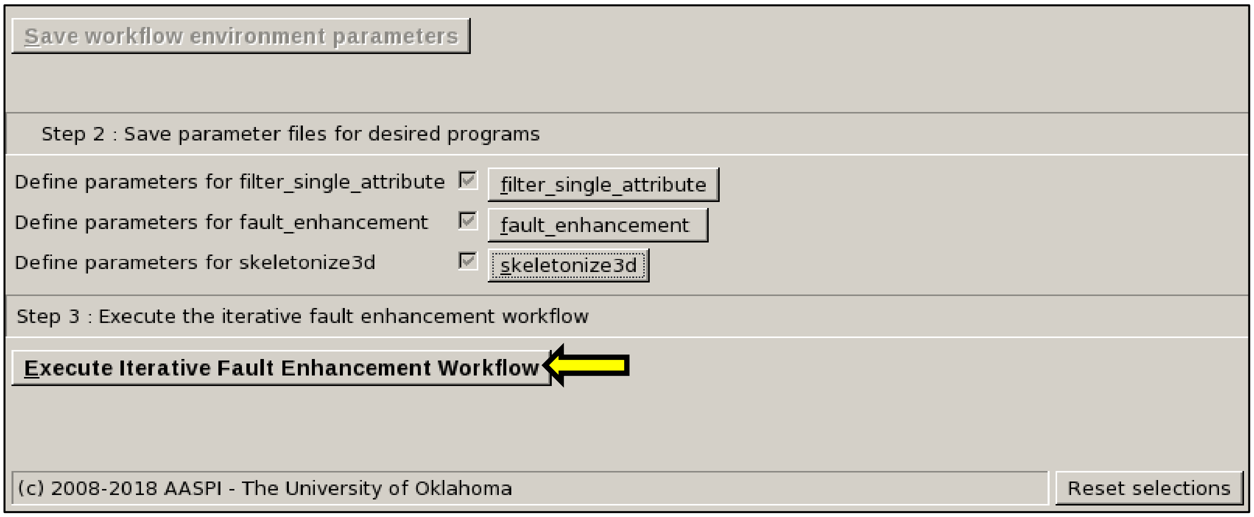


At this point, one can select the next application, **skeletonize3d**, in the iterative fault enhancement workflow GUI:



Note that there are no parameters to change in this GUI. Simply click *Save parameters and return to Workflow GUI* and find that *the Execute iterative fault enhancement workflow* button is now activated.

Step 3: Execute the workflow

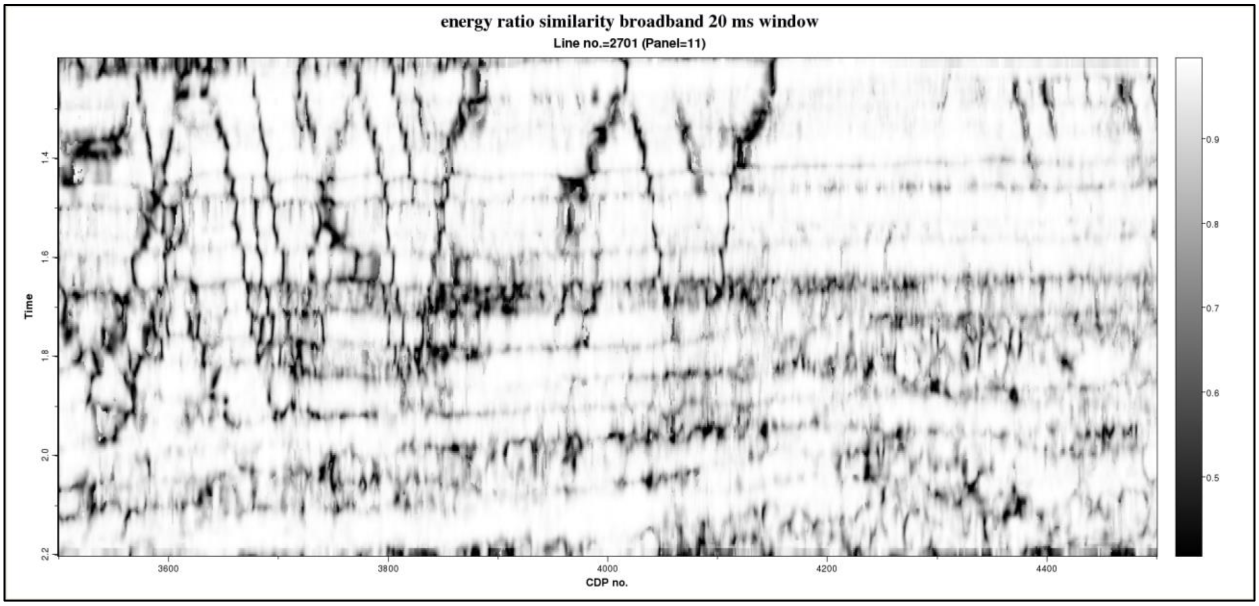


At this point simply click Execute Iterative Fault Enhancement Workflow button to submit the suite of processes.

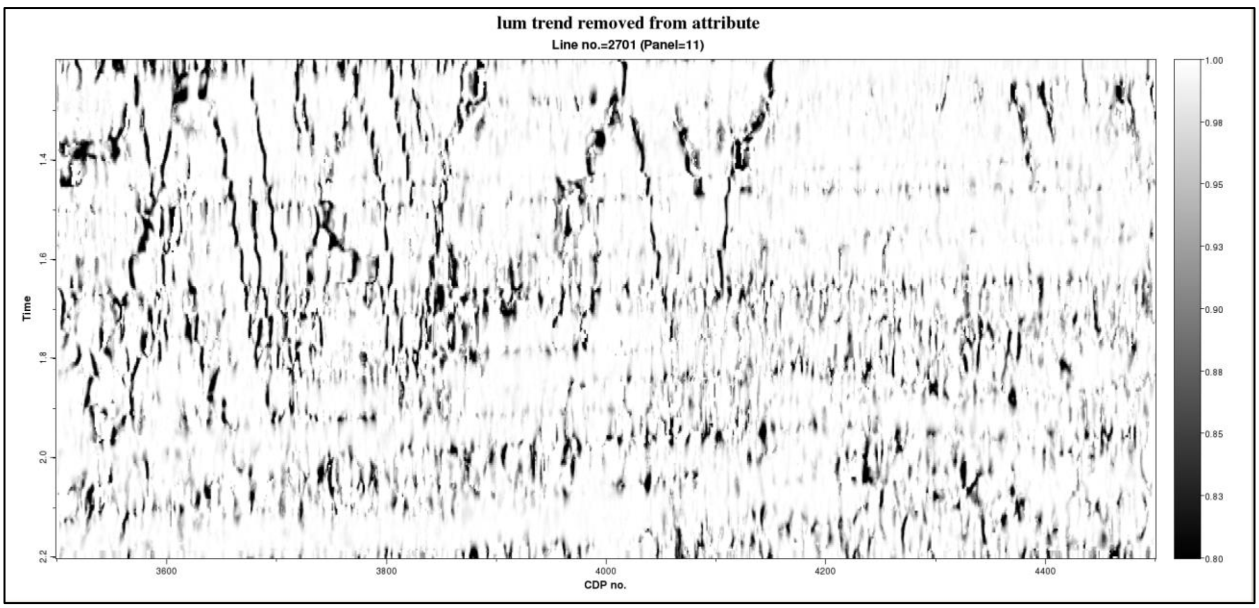
Examples

Detailed examples on the generation of each of these steps can be found in the documentation for **filter_single_attribute**, **fault_enhancement**, and **skeletonize3d**. In this documentation, we simply display the input similarity volume, the results of subtracting the median filtered similarity from the input, the results of three iterations of fault enhancement, and the final skeletonized image.

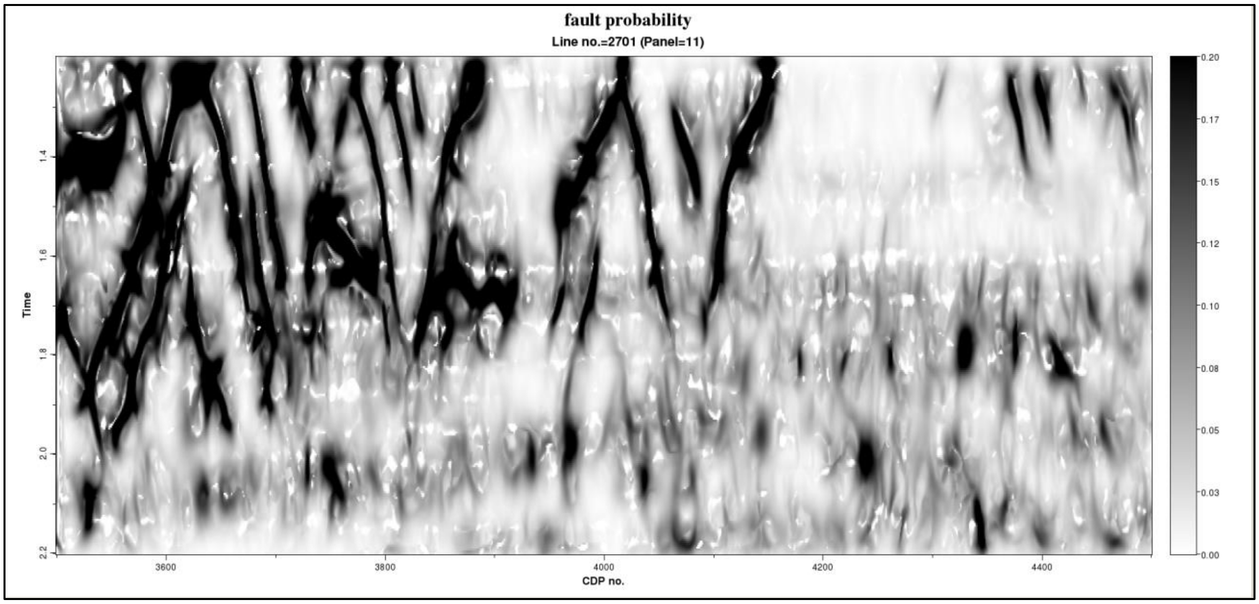
Vertical slices through these four volumes appear as follows:



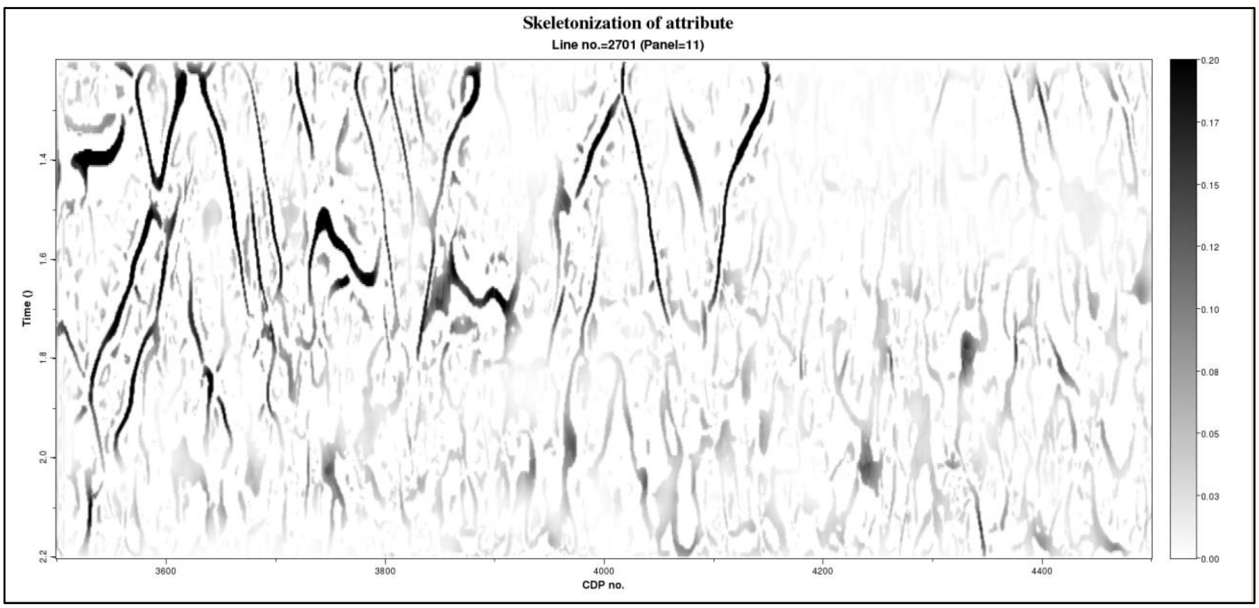
energy ratio similarity broadband 20 ms window
Line no.=2701 (Panel=11)
Time
CDP no.



lum trend removed from attribute
Line no.=2701 (Panel=11)
Time
CDP no.

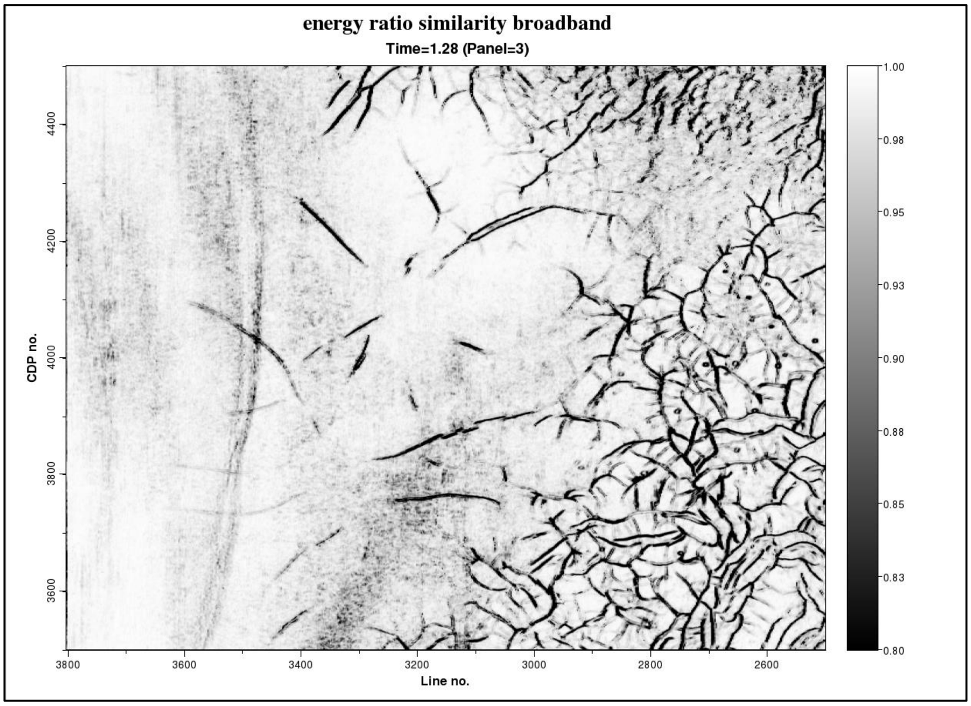


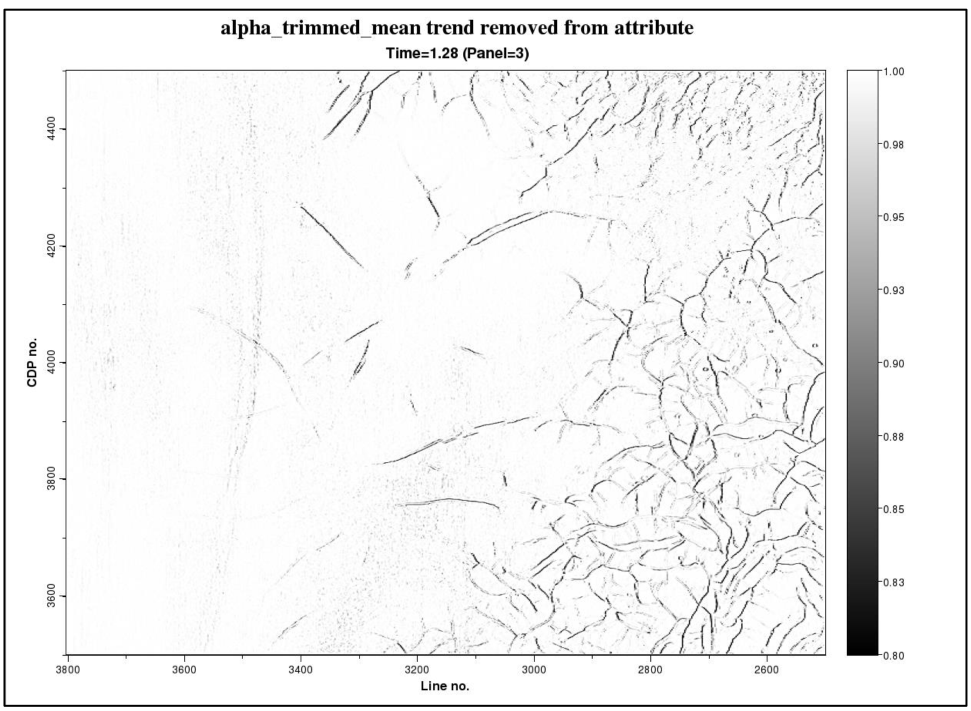
fault probability
Line no.=2701 (Panel=11)
Time
1.4
1.6
1.8
2.0
2.2
3600
3800
4000
4200
4400
CDP no.
0.20
0.17
0.15
0.12
0.10
0.08
0.05
0.03
0.00

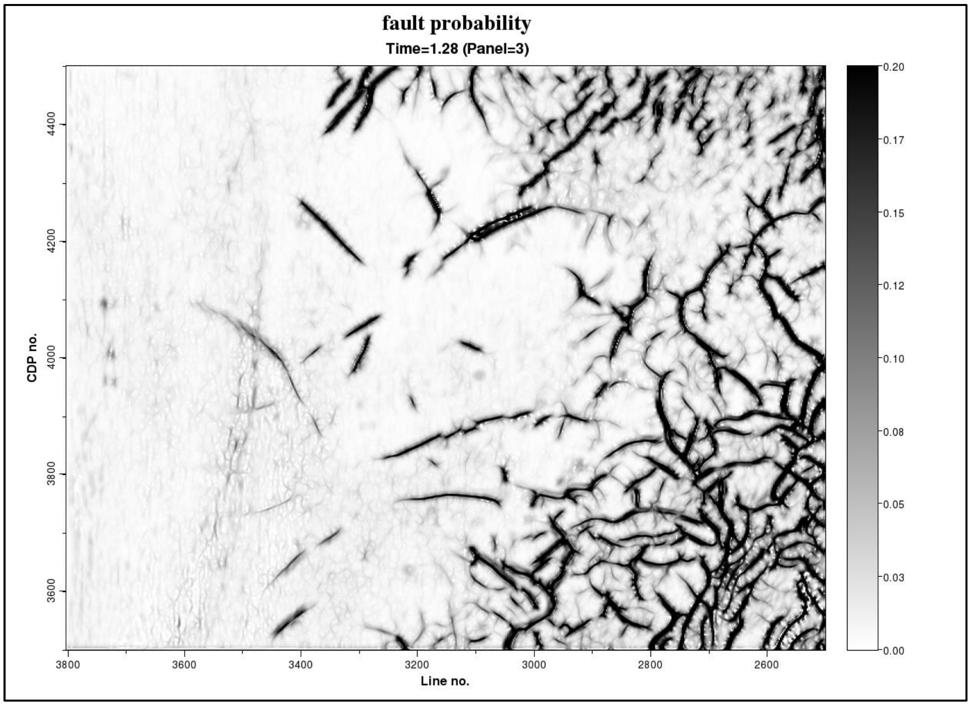


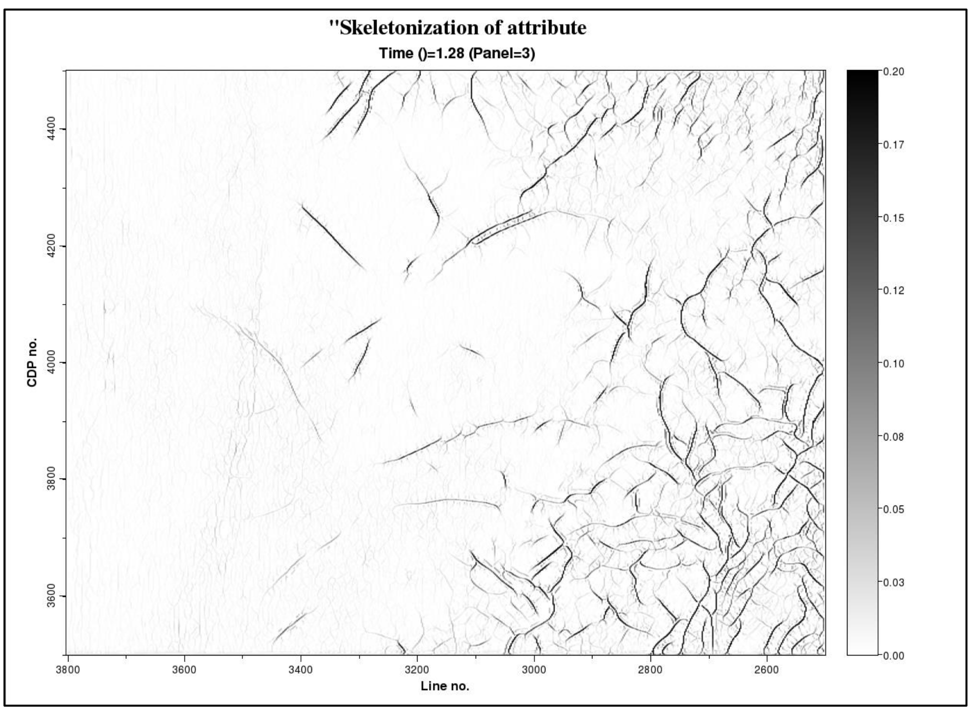
Skeletonization of attribute
Line no.=2701 (Panel=11)
Time ()
1.4
1.6
1.8
2.0
2.2
3600
3800
4000
4200
4400
CDP no.
0.20
0.17
0.15
0.12
0.10
0.08
0.05
0.03
0.00

Time slices at t=1.28 through these four volumes appear as follows:






fault probability
Time=1.28 (Panel=3)
CDP no.
4400
4200
4000
3800
3600
3800
3600
3400
3200
3000
2800
2600
Line no.
0.20
0.17
0.15
0.12
0.10
0.08
0.05
0.03
0.00


"Skeletonization of attribute
Time ()=1.28 (Panel=3)
CDP no.
4400
4200
4000
3800
3600
3800
3600
3400
3200
3000
2800
2600
Line no.
0.20
0.17
0.15
0.12
0.10
0.08
0.05
0.03
0.00