

FLATTENING AND GENERATING STRATAL SLICES – PROGRAMS `flatten`, `vector_flatten`, `stratal_slice`, and `vector_stratal_slice`

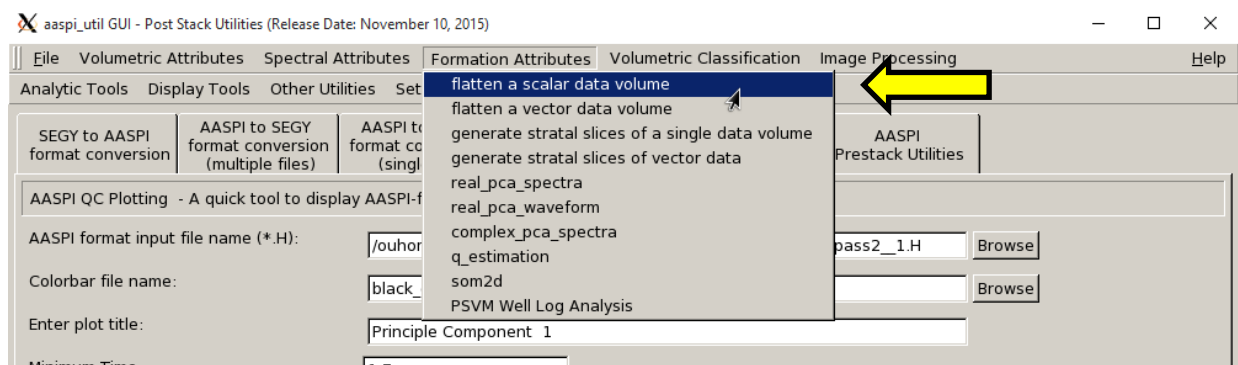
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Overview

Extracting phantom horizon and stratal slices is one of the more common interpretation activities performed in interpretation workstation software. Since this is where you have picked your horizons, this is the obvious place to do such slicing and subsequent analysis. Nevertheless, there are reasons to use flattened or stratal sliced subvolumes in the AASPI software. Generating flattened volumes has value if your commercial software does not have a state-of-the-art spectral decomposition algorithm, and you wish to generate a suite of volumes about a target horizon. Similarly, AASPI provides horizon-based clustering (also so called classification) algorithms. Future AASPI applications will provide Q estimation between two picked horizons. AASPI program **`flatten`** and **`vector_flatten`** flatten a user-defined window of input data defined about a picked horizon. AASPI program **`stratal_slice`** and **`vector_stratal_slice`** generate a suite of stratal (proportional slices) between two user-defined horizons. Both flattened and stratal slices are computed by interpolating the input data using a $\varphi=2\pi f\Delta t$ Fourier phase shift of each Fourier component. Both programs read a 3D input volume, one or two horizons, and outputs a window of data keyed to the picked horizons. **`flatten`**, **`vector_flatten`**, **`stratal_slice`**, and **`vector_stratal_slice`** are launched from the *Formation Attributes* within the main **`aaspi_util`** GUI:

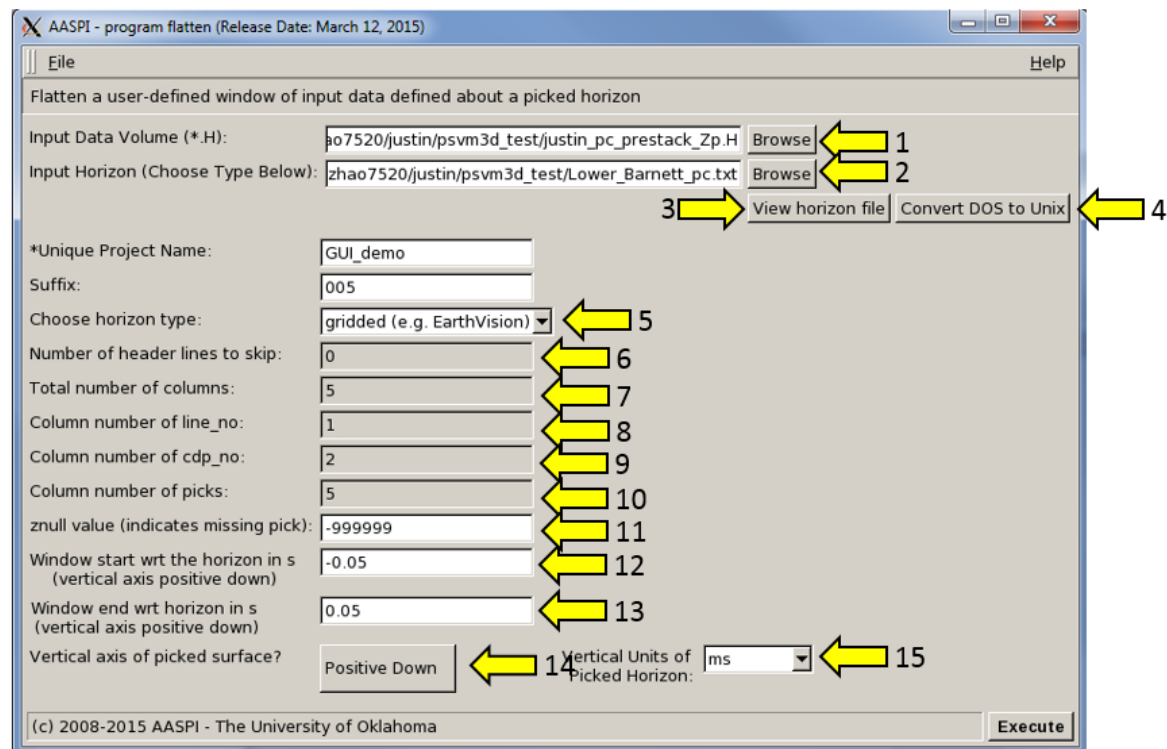
Formation Attributes: flattening and generating_stratal_slices



Computing flattened subvolumes

After invoking program **flatten**, use the browser on the first two lines to choose (1) the 3D input seismic data file and (2) the horizon file to flatten about. Currently we support Earth Vision Format; in the future we will support general x,y,t triplets as well. AASPI software assumes that the vertical axis is *positive down*. While this is the default for most interpretation workstation software, at least one, Petrel, uses the opposite convention. Be sure to select the correct setting for **Button 14**. The program can either take a *gridded horizon* (e.g. EarthVision in Petrel) or an *interpolated horizon* (e.g. SeisX, ASCII free format). The module requires the user to (12 and 13) define a small window above and below the given horizon to flatten.

The GUI is shown below:



Formation Attributes: flattening and generating_stratal_slices

Button 1: Browse input AASPI .H file.

Button 2: Browse horizon file.

Button 3: View the horizon file content (Figure 1).

Button 4: If the file is generated from Windows based software (e.g. Petrel), they will have the annoying carriage return (^M) at the end of each line (Shown in Figure 1). Use this button to delete those carriage returns if you prefer to.

Note: This function depends on your Linux environment therefore it may not always work. However, **it will not affect reading in the file.**

Selector 5: Choose horizon format. Currently **gridded** (e.g. EarthVision in Petrel) and **interpolated** (ASCII free format, e.g. SeisX) formats are supported. Gridded horizon is x, y location based, and interpolated horizon is inline, crossline based. Examples of both format are shown in Figure 1. If **interpolated** is selected, the user needs to manually define each column in the file.

Blank 6: Number of header lines to skip in the **interpolated** horizon files.

Blank 7: Total number of columns in the **interpolated** horizon files.

Blank 8: Which column is inline in the **interpolated** horizon files?

Blank 9: Which column is crossline in the **interpolated** horizon files?

Blank 10: Which column is time in the **interpolated** horizon files?

Blank 11: Znull value (indicate missing picks) in the horizon files.

Blank 12: Operation window upper limit from the horizon.

Blank 13: Operation window lower limit from the horizon.

Button 14: Choose between *Positive Down* and *Negative Down* for the horizon files (e.g. Petrel uses negative down).

Selector 15: Choose the time unit in the horizon files (usually s or ms, depends on the input attribute).

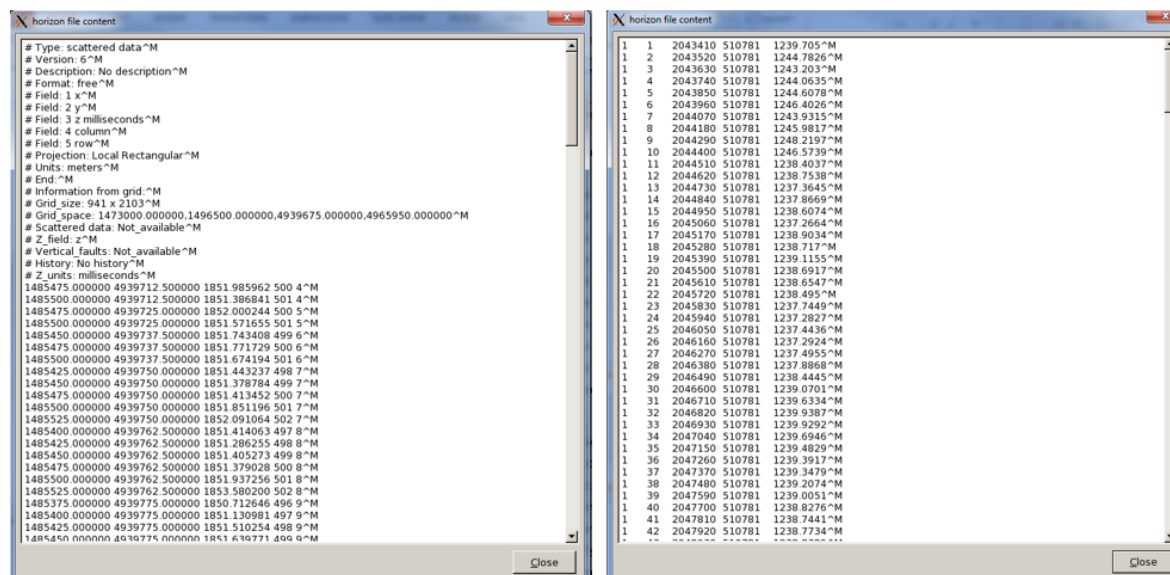


Figure 1. (left) A gridded horizon file (EarthVision format). (right) An interpolated horizon file with five columns (ASCII free format).

Formation Attributes: flattening and generating_stratal_slices

The output flattened seismic data is shown in the figure below. Flattened volumes can be used as input to clustering programs **sof2d**, **sof3d**, and **gtm**.

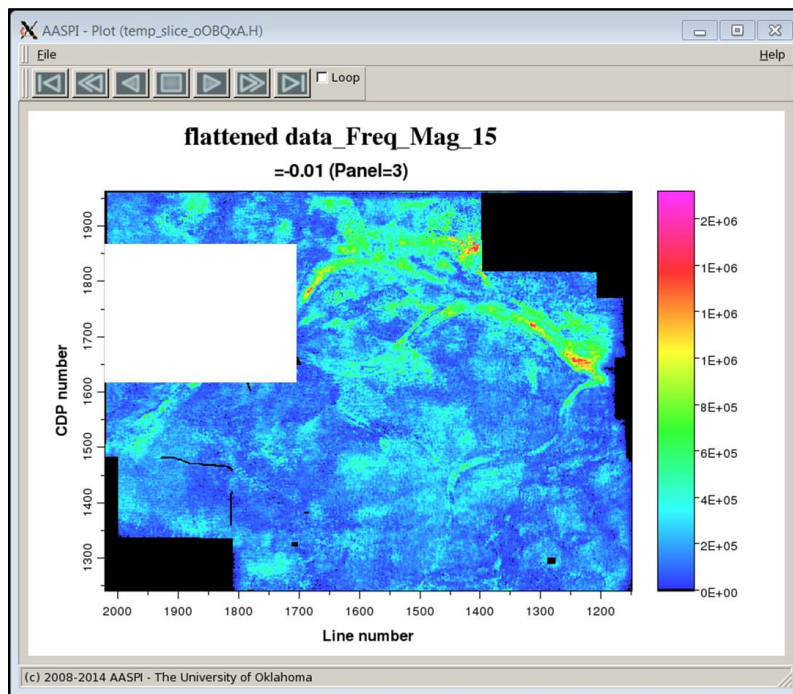


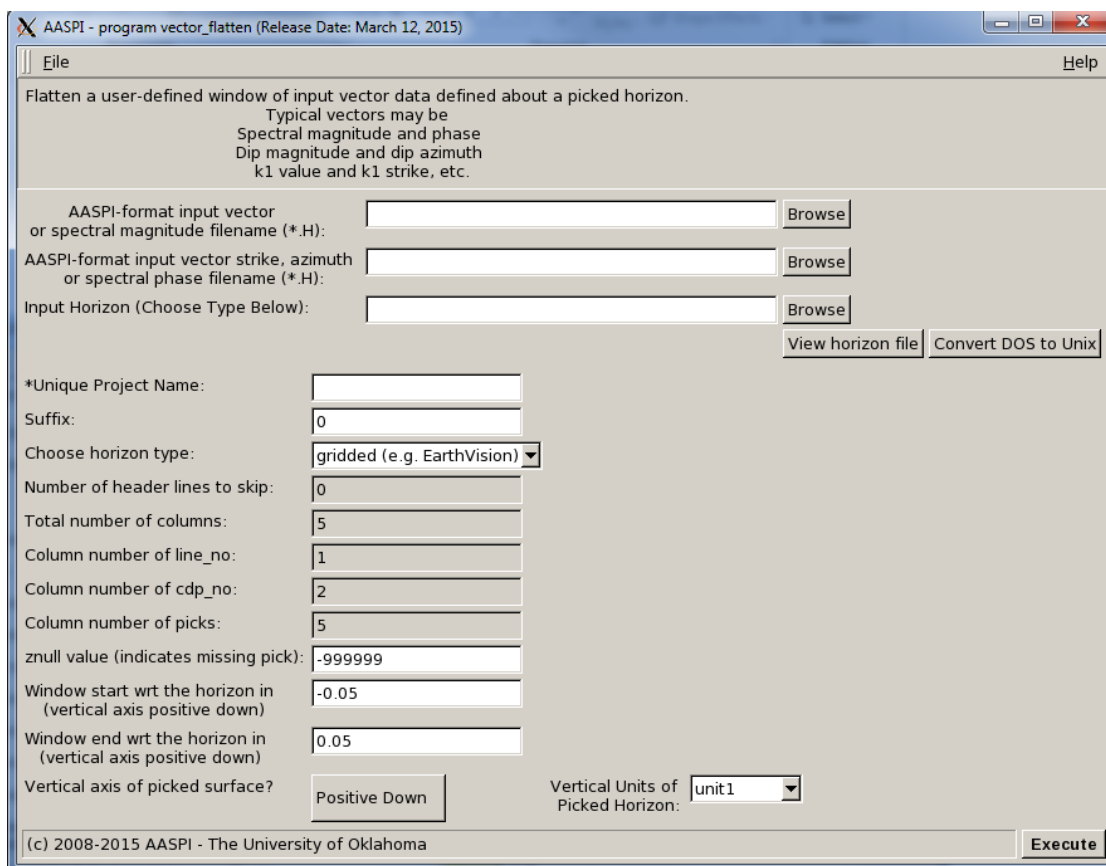
Figure 2. A flattened horizon (more formally called a “phantom horizon slice” through the 15 Hz spectral magnitude volume of a survey acquired in the Anadarko Basin, OK, showing incised Red Fork channels.

Computing vector_flatten

Recall that flattening is computed by interpolating the input data using a $\varphi=2\pi f\Delta t$ Fourier phase shift of each Fourier component. Spectral components are stored as two volumes – amplitude and phase. The magnitude experiences abrupt discontinuities in slope when the magnitude approaches zero, while the phase experiences discontinuities as progresses from -180° to $+180^\circ$. In contrast, the real and imaginary parts of a complex number are continuous.

The GUI is shown in the next page:

Formation Attributes: flattening and generating_stratal_slices



Using the module is similar as using **flatten**, the only difference is it takes two input volumes (typically a magnitude volume and a phase volume).

Computing stratal slices

Stratal slices (less formally called proportional slices) are the method of choice in displaying stratigraphic features. In this you need to input two horizons (2 and 3) apart from seismic input data (1). You can decide whether to use a time or frequency domain operator (4) and how many slices you want between two horizons (5). If time is chosen for (4), the interpolation is performed in time domain using a five-point Lagrange Interpolation. Here, the example shows that the Redfork channels are clearly visible on stratal slices along the channel level. All the horizon options are similar as in **flatten**.

The GUI is shown on the next page:

Formation Attributes: flattening and generating_stratal_slices

AASPI - program stratal_slice (Release Date: April 2, 2015)

File Help

Generate stratal (proportional) slices of input data between two picked horizons

AASPI-format Input filename (*.H): Browse 1

Input shallower horizon filename: Browse 2

(Choose Horizon Type Below:)

Input deeper horizon filename: Browse 3

(Choose Horizon Type Below:)

View horizon file Convert DOS to Unix

View horizon file Convert DOS to Unix

Unique Project Name:

Suffix: 0

Choose operation domain: Frequency 4

Number of slices: 11 5

Choose horizon type: gridded (e.g. EarthVision)

Number of header lines to skip: 0

Total number of columns: 5

Column number of line_no: 1

Column number of cdp_no: 2

Column number of time or depth picks: 5

znull value (indicates missing pick): -999999

Window start wrt shallower horizon in (vertical axis positive down) -0.05

Window end wrt deeper horizon in (vertical axis positive down) 0.05

Vertical axis of picked surface? Positive Down

Vertical Units of Picked Horizons: unit1

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Execute

The default number of slices is 11. In the example above, the first slice starts 0.050 ms *above* horizon 1, while the last (11th) slice ends at 0.050 ms *below* horizon 2. Intermediate slices are 1/10th of the way between these two extremes such that slice 6 is exactly in the middle. Since the output time of each slice is highly variable, the sample increment is stored as 0.0, 1.0, 2.0, ..., 11.0. The actual times of the samples are stored in the trace headers so that with a little work, the location of each stratal slice can be computed.

Formation Attributes: flattening and generating_stratal_slices

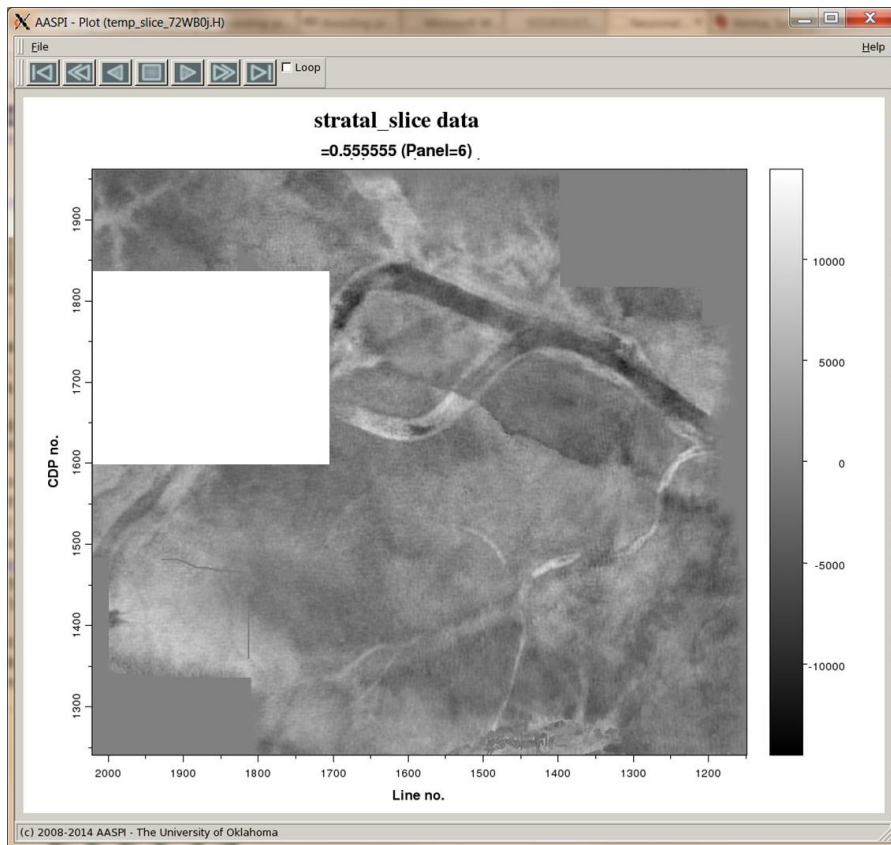


Figure 3. Stratal slice 5 of 11 between the Pink and Novi horizons showing incised channels in the seismic amplitude data volume.

Computing vector stratal slices

Recall that flattening and stratal slicing are computed by interpolating the input data using a $\varphi=2\pi f\Delta t$ Fourier phase shift of each Fourier component. Spectral components are stored as two volumes – amplitude and phase. The magnitude experiences abrupt discontinuities in slope when the magnitude approaches zero, while the phase experiences discontinuities as progresses from -180° to $+180^\circ$. In contrast, the real and imaginary parts of a complex number are continuous. For this reason, stratal slicing of complex spectra in preparation for Q estimation needs to be generated from complex input, requiring two input and two output volumes. Internal to program **vector_stratal_slice**, all interpolation is done on the continuous real and imaginary components.

Formation Attributes: flattening and generating_stratal_slices

AASPI - program vector_stratal_slice (Release Date: March 12, 2015)

File Help

Generate stratal (proportional) slices of input data between two picked horizons

AASPI-format input vector or spectral magnitude filename (*.H): Browse 1

AASPI-format input vector strike, azimuth or spectral phase filename (*.H): Browse 2

Input shallower horizon filename: Browse 3

(Choose Horizon Type Below:) View horizon file Convert DOS to Unix

Input deeper horizon filename: Browse 4

(Choose Horizon Type Below:) View horizon file Convert DOS to Unix

Unique Project Name:

Suffix:

Number of slices:

Choose horizon type:

Number of header lines to skip:

Total number of columns:

Column number of line_no:

Column number of cdp_no:

Column number of time or depth picks:

znull value (indicates missing pick):

Window start wrt shallower horizon in s (vertical axis positive down) 5

Window end wrt deeper horizon in s (vertical axis positive down) 6

Vertical axis of picked surface? Vertical Units of Picked Horizon:

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The input to program **vector_stratal_slice** are, (1) the 4D spectral magnitude and (2) 4D spectral phase components generated from programs **spec_cmp**, **spec_cwt**, or **spec_max_entropy**. As in the previously described real **stratal_slice** program, there are (3) upper and (4) lower user-defined horizons. The primary use of program **vector_stratal_slice** will be to define 4D complex spectral along (and possibly between) target horizons, so that the default time shift (5) above and (6) below the picked horizons is 0.0 s. The output will be 4D sliced spectral magnitude and phase volumes.