FLATTENING A SCALAR DATA VOLUME – PROGRAM flatten

FLATTENING A SCALAR DATA VOLUME – PROGRAM flatten	AASPI
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Overview

Extracting phantom horizon slices and stratal (or proportional) slices are two some of the more common interpretation activities performed in interpretation workstation software. Because the interpretation workstation is the place where you picked your horizons, it is the obvious place to do such slicing and subsequent analysis. Nevertheless, there are reasons to create 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 called classification) algorithms that you may wish to use. The AASPI software also streamlines the multistep flattening process that needs to be used phase, azimuth, and strike volumes. AASPI programs in flattening flatten. complex spectral flatten, and vector flatten flatten a user-defined window of input data defined about a picked horizon. AASPI program unflatten complex spectral unflatten, and vector unflatten reverse these processes. AASPI program stratal slice, complex_spectral_stratal_slice, and vector_stratal_slice generate a suite of stratal (proportional slices) between two user-defined horizons. Programs flatten and unflatten work on scalar data volumes. Because there is a discontinuity about ±180° for azimuth and at ±90° for strike, these vector components cannot be directly interpolated along the vertical axes. Program vector flatten addresses this problem by first converting a magnitude and azimuth (or curvature strength and strike) vector components into geodetic (e.g., Northing and Easting) components which can be directly interpolated and thus flattened. The flattened vector magnitude and azimuth components are then computed using simple trigonometry applied to the flattened geodetic components.

Computation Flow Chart

Program **flatten** reads in an input seismic or attribute volume as well as a picked horizon and generates a flattened output volume:



Output file naming convention

Program **flatten** will always generate the following output files:

Output file description	File name syntax
Flattened data volume	flattened_input_filename+unique_project_name_suffix.H
program log information	flatten_unique_project_name_suffix.log
program error/completion information	flatten_unique_project_name_suffix.err

where the values in red are defined by the program GUI. The errors we anticipated will be written to the **.err* file and be displayed in a pop-up window upon program termination. These errors, much of the input information, a description of intermediate variables, and any software trace-back errors will be contained in the **.log* file.

Invoking the flatten GUI

Program **flatten** is launched from the *Formation Attributes* within in the main **aaspi_util** GUI:

X aaspi_util GUI - Post Stack Utilities (Release	Date: 16_February_2022)	- 🗆 X
] <u>F</u> ile Single Trace Calculations Sp	ectral Attributes Geometric Attributes	Formation Attributes Volumetric Classification Image Processing Help
Attribute Correlation Tools Display T	ools Machine Learning Toolbox Surf	a flatten a single data volume amete
SEGY to AASPI format conversion AASPI to SEGY format conversion (multiple files) AASPI QC Plotting - A quick tool to d AASPI format input file name (*.H): Colorbar file name:	AASPI to SEGY format conversion (single file) AASPI QC Plott splay AASPI-fromat attribute volumes //ouhomes6/marf2925/projects/Tr black_gray_white.sep	unflatten e single data usluma in flatten a window of a single volume about a user-supplied horizon - flatten components of a vector data volume generate stratal slices of a single data volume generate stratal slices of components of a vector data volume generate stratal slices of complex spectral data volumes real_pca_spectra pca_waveform_classification
Enter plot title:	Input Seismic Amplitude Data	som_waveform_classification complex_pca_spectra
Minimum Time (s):	-0.152	q_estimation PSVM Well Log Analysis
Maximum Time (c).	12	

The following GUI appears:

X aaspi_flatten GUI (Release Date	15_May_2022)	- (
<u>E</u> ile		
Flatten a user-defined windo	v of input data defined about a picked horizon	
Input data volume (*.H): /ouł	omes6/marf2925/projects/Tui3d/Tui3D_FullStack_Shift_m180_cropped.H Browse	
Unique project name: Tui	D	
Suffix: 0		
Define reference horizon		
,	4 Help - Hori	zon De
Input horizon filename:	/ouhomes6/marf2925/projects/Tui3d/Zone2_Lower_Horizon.dat Browse	
(Choose horizon type below	:) View horizon file Convert I	OS to
Window start wrt horizon in (vertical axis positive down	s -0.3	
Window start wrt horizon in (vertical axis positive down	s 0.3	
Choose horizon type:	gridded (e.g. EarthVision) 💌	
Number of header lines to s	kip: 6	
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 missin	g pick): -999999	
Vertical axis of picked surfa	se? Positive Down	
Vertical units of picked horizons:	ms 💌	
(c) 2008-2022 AASPI for Lini	x - authors at Univ. Oklahoma, Univ. Alabama, Univ. Texas Permian Basin, and SISMO	_

Begin by (1) entering the input data volume file name. Then enter the (2) a unique project name and suffix. There is (3) only one tab in the flattening software so it appears by default. The parameters in this tab are described in the (4) *Horizon Definition Help* panel or or if you are accessing this documentation from the web by clicking http://mcee.ou.edu/aaspi/documentation/Software Structure-AASPI horizon definition.pdf.

Theory

Flattening of a scalar volumes d(t) is most easily done using its frequency components $D(\omega)$ computed using a Fourier transform:

$$D(\omega_j) = \sum_{k=0}^{K} d(t_k) \exp(-i\omega_j t_k).$$
(1)

If we wish to shift the data centered about a picked horizon time *T* to time *t*=0, we simply use the shifting theorem in the inverse Fourier transform

$$d(t_k - T) = \sum_{j=0}^{J} D(\omega_j) \exp(-i\omega_j T) \exp(+i\omega_j t_k)$$
⁽²⁾

where the normalization constants have been left out.

Example

A vertical slice through the input data from the Tui3D survey acquired in the Taranaki Basin alooks like this:

Formation_Attributes: Program flatten



Whereas a time slice at t=1.968 s through the original volume shows parts of a turbidite system:

Formation_Attributes: Program flatten



while the flattened volume ranging ± 1 s around the picked horizon (the strong black trough at approximately *t*=2.2 s) looks like this:

Formation_Attributes: Program flatten



Limiting the output range to be ± 0.300 s about the picked horizon gives a narrow analysis window:



The time slice through the flattened volume along the picked through at t=0 s is rather uninteresting, while that at t=-0.236 s shows that turbidites seen previously on the unflattened time slice extend to a much greater lateral distance:

