



# FracTex

## Plug-in for Petrel® 2020

USER MANUAL

Geo5 GmbH

## ABOUT THIS DOCUMENT

This document provides a guide for the user to the FracTex plug-in for Petrel for the 2020.1 release.

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## Introduction

FracTex plug-in includes two different types of attributes. First, directional GLCM-based attributes, and second the FracTex attributes. The gray level co-occurrence matrix (GLCM) is a textural attribute that measures the textural variability within an analysis window. The FracTex attribute uses the directionality of the GLCM computation to derive factors for anisotropy.

### Directional GLCM-based attributes

Multi-trace attributes that return textural information based on a statistical texture classification.

Gray level co-occurrence matrix (GLCM) and its derived attributes are tools for image classification. Principally, the GLCM is a measure of how often different combinations of pixel brightness values occur in an image. It is a method widely used in image classification of satellite images, sea-ice images, magnetic resonance and computed tomography images, and many others.

The calculation of GLCM-based attributes can be done in separate space directions. The principal workflow of GLCM-based attribute calculation consists of transformation of the amplitude cube into a gray level cube, the counting of pixel co-occurrences within a given analysis window, and the calculation of attributes based on the co-occurrence matrix.

### FracTex attributes

Anisotropy refers to directional properties. In geophysics, we often refer to seismic anisotropy, the dependence of velocity on direction or upon angle. Variation in seismic velocity with direction may reflect lateral changes in facies, the presence of faults or fractures, or differences in pore fillings, among many factors that may influence velocity. In principal, seismic data can be used to estimate volumetric azimuthal anisotropy. The gray level co-occurrence matrix (GLCM), initially described as a tool for image classification, is a measure of how often different combinations of pixel brightness values occur in an image. GLCM-based attributes can be calculated in different directions, yielding an array of radial responses.

FracTex plug-in computes GLCM-based attributes in different directions and compares these results. Based on that comparison a factor for seismic anisotropy is computed and the azimuth of the direction with most variability in seismic character is determined. This information can then be correlated with seismic facies changes or fracturing.

The default output type is the anisotropy factor, which gives in principal the relationship of the highest and lowest GLCM-based attribute responses for each sample point. This anisotropy factor can be linked with fracture intensity in a fractured reservoir. For a homogeneous formation, the theoretical value for the anisotropy factor would be 1. Higher values indicate higher anisotropy.

The azimuth of fracture dip indicates the azimuth in which the highest variability in data occurs. For a fractured reservoir this would correspond with the azimuth of fracture dip. To avoid overestimation of fractures it is advisable to apply a threshold value for the azimuth of fracture dip calculation. In this case a simultaneous calculation of anisotropy factor and azimuth of fracture dip is done, and for sample points where the anisotropy factor is below this threshold value, the azimuth of fracture dip is set to undefined.

## User Interface

### Getting started

After installing the FracTex plug-in, the FracTex and GLCM attribute workstep dialogs can be accessed under Seismic Interpretation tab.



Figure 1 Ribbon

Seismic Interpretation tab -> Geo5 group -> GLCM attributes / FracTex attributes



Figure 2 GLCM/FracTex attributes

The workstep processes are also available via Processes -> Plug-ins.

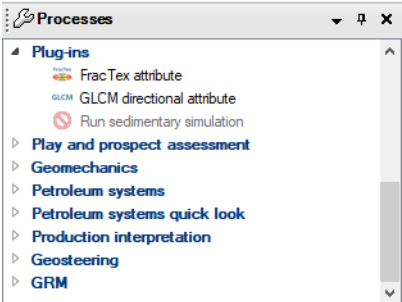


Figure 3 Processes

To view the processes tree, it may need to be displayed first: Home -> Panes -> Processes.

## Directional GLCM-based attributes

Example of a GLCM directional attribute dialog.

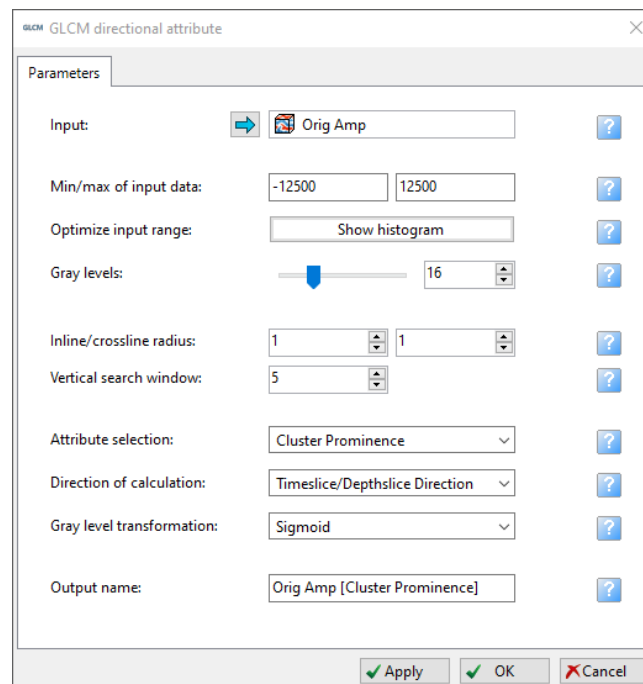


Figure 4 GLCM parameters

## FracTex attributes

Example of a FracTex attribute dialog.

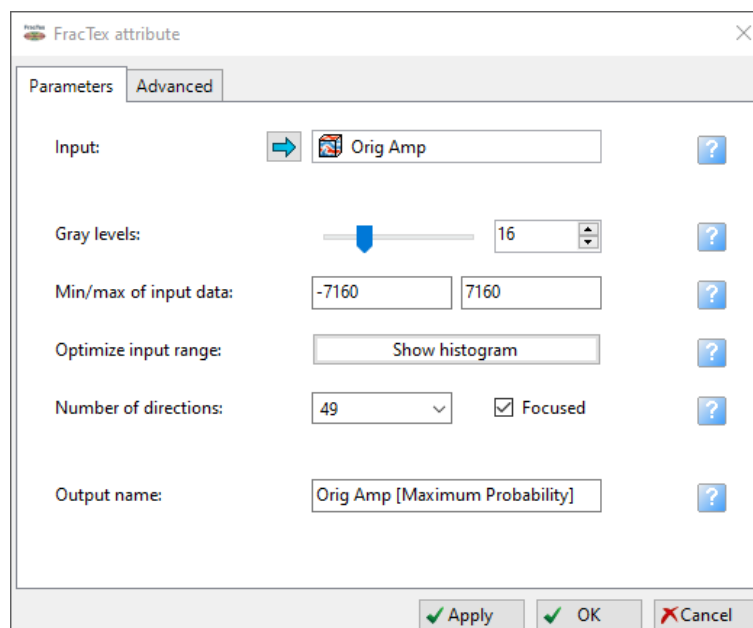


Figure 5 FracTex parameters

Tab 'Advanced'.

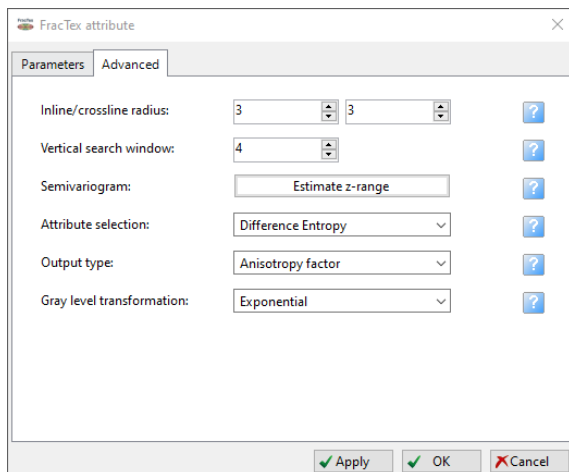


Figure 6 Anisotropy factor

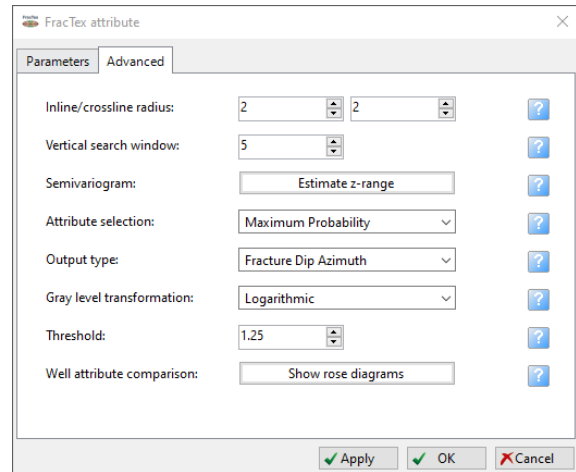


Figure 7 Fracture Dip Azimuth

## Description of parameters

### Input

The input for FracTex and directional GLCM-based attributes can be any 3D seismic volume in time or depth domain.

This can either be an amplitude cube or a derived seismic attribute, but general recommendation is to use amplitude cubes as input.

It is highly recommended to use a realized seismic volume (available file, e.g. ZGY or SEG-Y) as input, as otherwise computation times can be very high.

### Gray levels

The number of gray levels have an influence on the quality of the resulting attribute.

In image analysis the number of gray levels is typically a power of 2, but in principal any number can be taken.

The minimum value is 4, the maximum value is 1024.

### Min/max of input data

The clipping range of the input data for the gray level transformation. To avoid misinterpretations from amplitude outliers, it is advisable to use threshold values for the gray level transformation.

When a new input data cube is selected, the actual range of this cube is written into the two input fields.

The selected values do not have to be symmetric but must be within the limits of the actual range of the input cube.

### Number of directions (FracTex only)

13, 49, 109 or 193 spatial directions can be selected.

Please note that 49, 109 and 193 directions require a minimum inline/crossline radius of 2, 3 and 4 respectively and also a significantly higher computation time.

In order to shorten the calculation time, a fast algorithm can be selected for more than 13 directions. This algorithm first calculates 13 spatial directions. Depending on this calculation, additional directions are calculated which, based on step one, represent the highest probability for the resulting output.

### Inline/crossline radius

Defines the number of traces used in the computation. The resulting search window will be  $2 * \text{radius} + 1$ .

Minimum value is 1, maximum value is 5, resulting in a search window of 3 up to 11.

### Vertical search window

Defines the number of samples used in the computation. The resulting search window will be  $2 * \text{radius} + 1$ .

Minimum value is 3, maximum value is 10, resulting in a search window of 7 up to 21.

### Attribute selection

The algorithm used for the attribute.

Directional GLCM-based attributes have 21 options and FracTex attributes have 8 options.

The algorithms can be divided into three categories:

- Contrast group
  - Measurements based on the distance from the GLCM diagonal
  - e.g. Contrast, Homogeneity, Dissimilarity
- Orderliness group
  - Measurements of how organized the GLCM is
  - e.g. Energy, Entropy
- Statistics group
  - Standard statistical parameters computed from the GLCM
  - e.g. Mean, Variance, Correlation

### Output type (FracTex only)

The default output type is the anisotropy factor, which gives in principal the relationship of the highest and lowest GLCM-based attribute responses for each sample point. This anisotropy factor can be linked with fracture intensity in a fractured reservoir. For an isotropic formation, the theoretical value for the anisotropy factor would be 1. Higher values indicate higher anisotropy.

The azimuth of fracture dip indicates the azimuth in which the highest variability in data occurs. For a fractured reservoir this would correspond with the azimuth of fracture dip.



### Direction of calculation (GLCM only)

By default, all thirteen spatial directions are calculated. It is also possible to select a spatial direction of particular interest.

### Gray level transformation

For the gray level transformation different approaches exist. The most common method is a simple linear transform (a), where the range between the minimum and maximum values is divided into equidistant ranges.

Other methods include logarithmic (b), exponential (c), sigmoid (d), and logit (e) gray level transformation.

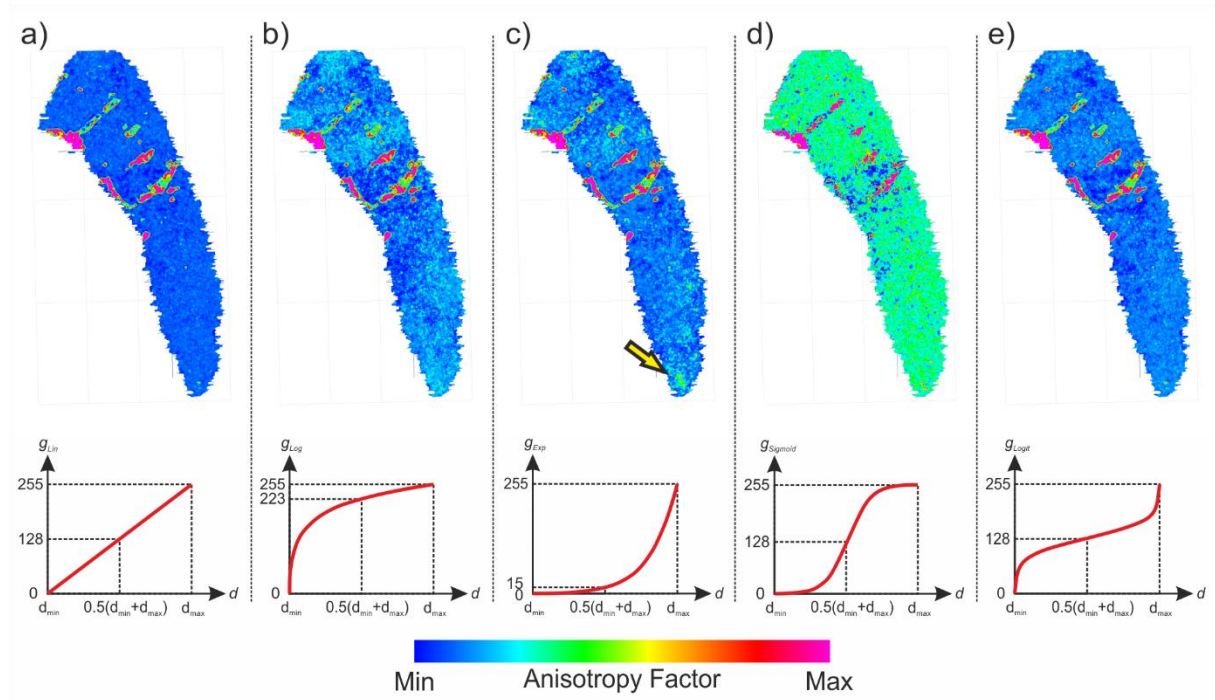


Figure 8 Gray level transformation

### Threshold (FracTex only)

Only available, when output type 'Fracture dip azimuth' is chosen.

To avoid overestimation of fractures it is advisable to apply a threshold value for the azimuth of fracture dip calculation.

In this case a simultaneous calculation of anisotropy factor and azimuth of fracture dip is done, and for sample points where the anisotropy factor is below this threshold value, the azimuth of fracture dip is set to undefined.

### Output name

The name of the resulting attribute. The resulting attribute is a child of the selected input cube in the tree.

When no name is selected, the automatically generated name has the following form: <Name of input cube> [<Name of algorithm/attribute>] <Numbering, if necessary>

## Histogram

The 'Show histogram' button opens a new window that shows the amplitude distribution for the input cube. The defined threshold values (min and max) for the gray level transformation are shown as blue lines in the histogram. The position of the threshold values can be changed by clicking onto the plus and minus buttons. To accept the values for the current attribute, click on button 'OK' or 'Apply'.

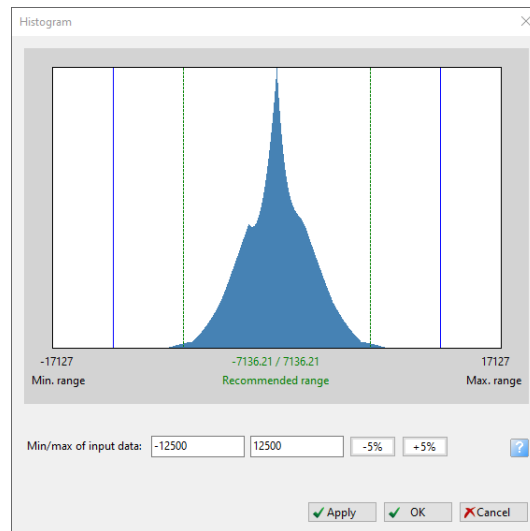


Figure 9 Histogram

## Rose diagrams

Rose diagrams represent directional data for 'Fracture dip azimuth' attributes and an optional comparison log.

Dialog to select a borehole and an optional comparison log.

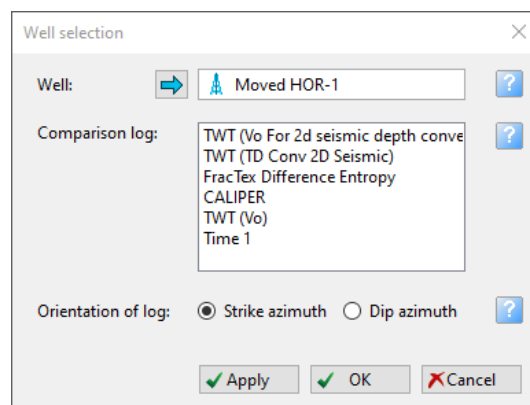


Figure 10 Well selection

Strike azimuth turns the actual values of the comparison log by 90° and reflects them. Dip azimuth presents the actual values of the comparison log and reflects them.

Dialog for rose diagrams to select depth range, step range, markers and attribute.

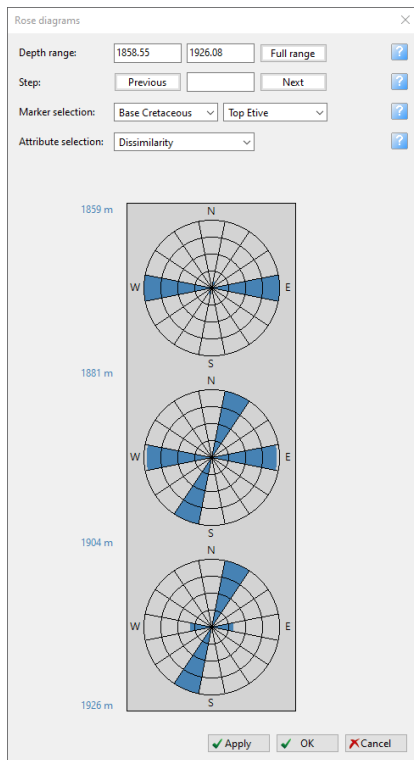


Figure 11 Rose diagrams

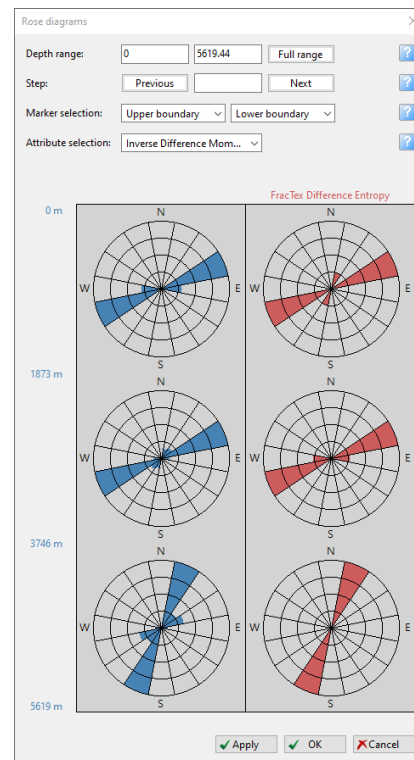


Figure 12 Rose diagrams comparison

Clicking on 'Apply' or 'Ok' button generates a log for the selected well.

## Semivariogram

Estimate z-range of the input cube. Depicts the spatial autocorrelation of the measured vertical sample points.

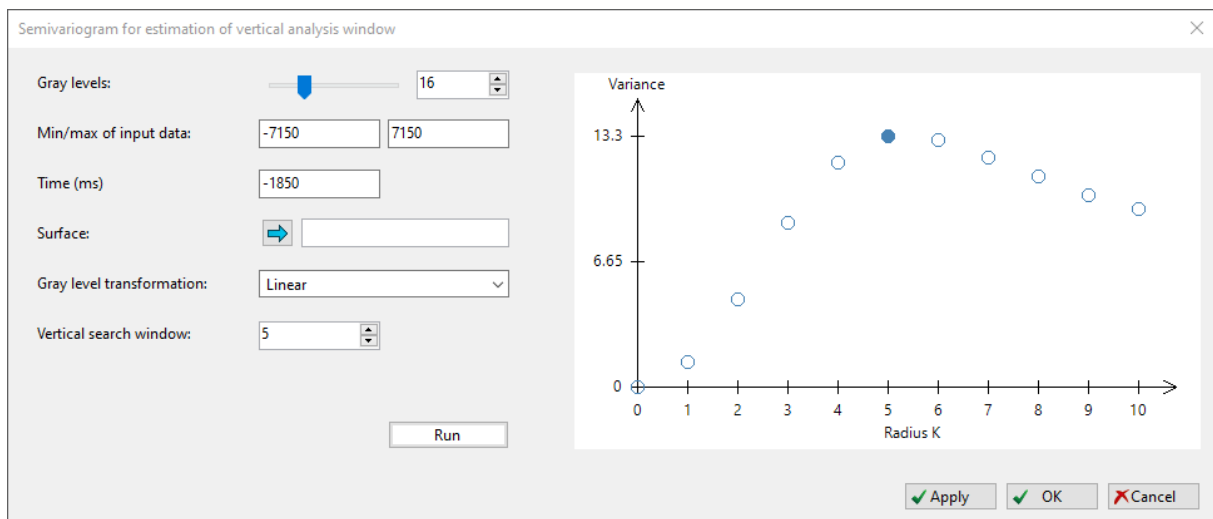


Figure 13 Semivariogram

Clicking on 'Apply' or 'Ok' button adopts the selected values for the attribute.

## Workflow

This section describes a typical workflow of creating a FracTex or directional GLCM-based attribute.

### Dialog start

As described above, in 'User Interface - Getting started' you can start a FracTex or directional GLCM-based attribute dialog via the Ribbon UI at the Ribbon tab 'Seismic Interpretation' or in the Processes tree at 'Plug-Ins'.

### Parameter settings

When started, most parameters will have a default value, with the exception of the seismic cube input ('Input'), the clipping range for the input data ('Min/max of input data') and the name of the output ('Output name').

#### Default parameters for GLCM

Graylevels	16 (Min: 4, Max: 1024)
Inline/crossline radius	1 / 1 (Min: 1, Max: 5)
Vertical search window	5 (Min: 3, Max: 10)
Attribute selection	Energy
Direction of calculation	All Directions
Gray level transformation	Linear

#### Default parameters for FracTex

Parameters tab:

Graylevels	16 (Min: 4, Max: 1024)
Number of directions	13

Advanced tab:

Inline/crossline radius	1 / 1 (Min: 1, Max: 5)
Vertical search window	5 (Min: 3, Max: 10)
Attribute selection	Energy
Output type	Anistotropy factor
Gray level transformation	Linear
Threshold (*)	1.00 (Min: 1.00, Max: 100.00)

(\*) Only available, when Output type 'Fracture Dip Azimuth' is selected.

## Input

The input must be a seismic cube. Directional GLCM-based attributes and FracTex attributes are also of type seismic cube and could therefore be used as input for another attribute.

Please note: It is highly recommended to use a realized seismic volume (available file, e.g. ZGY or SEGY) as input, as otherwise computation times can be very high.

## Min/max of input data

The clipping range of the input ('Min/max of input data') determines the impact of peak values. These threshold values for the gray level transformation avoid misinterpretations from amplitude outliers.

When a new input cube is selected, the actual range of this seismic cube are written into the two input fields. These values also represent the bounds of the values which are allowed for these fields.

## Create the attribute

When 'Apply' or 'Ok' button is pressed, the attribute will be created if the validation of the input fields is successful. The user will be informed via a message box when seismic input cube or the corresponding clipping range are not valid, and the attribute will not be created until all fields are valid.

In the process of creating the attribute, FracTex plug-in pre-calculates the output range of the resulting FracTex or directional GLCM-based attribute, which is used for opacity in the settings.

## Settings

Double-clicking on the attribute (or right-click -> Settings) will open the attribute's settings dialog where parameters can be edited and opacity values changed.

FracTex uses for its attributes the Seismic(default) template. You can change the colors either directly at 'Seismic Interpretation' tab or in the settings at 'Colors' tab.

# Support

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