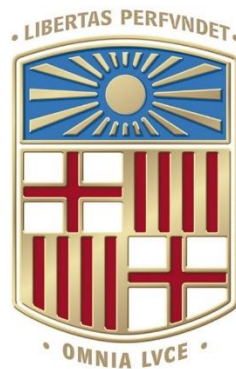**Geomodels Research Institute**

AÑISCLO ANTICLINE SEFL PROCESSING

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- Processing - Module I

Añisclo Crest

The scanning of the crest of the Añisclo anticline (Spain) has been completed with 42 scanner images from 10 stations equipped with DGPS (Differential Global Positioning System. The images have been aligned in a single reference system that has been translated and rotated to the UTM WGS84 31 T reference system. For computer reasons, 200000 m has been subtracted from the X coordinate and 470000 from the Y coordinate.

Once the point cloud has been referenced, it has been divided into two sectors (West and East) to facilitate its management and better model the fractures.

The processing to model the fractures begins with the identification of the points belonging to surfaces, vectorizing the points with their neighbors pointsts. The process starts in *SEFL/Load/Load Point Cloud* with the 3D point Cloud of Añisclo anticline. The input files are available in: Repositori de dades de recerca (csuc.cat) (DRAFT) and SEFL Manual in: https://github.com/Geomodels-UB/SEFL Añisclo_Example.

East:

File Input Name: Anisclo_CrestEast_PC_I.txt
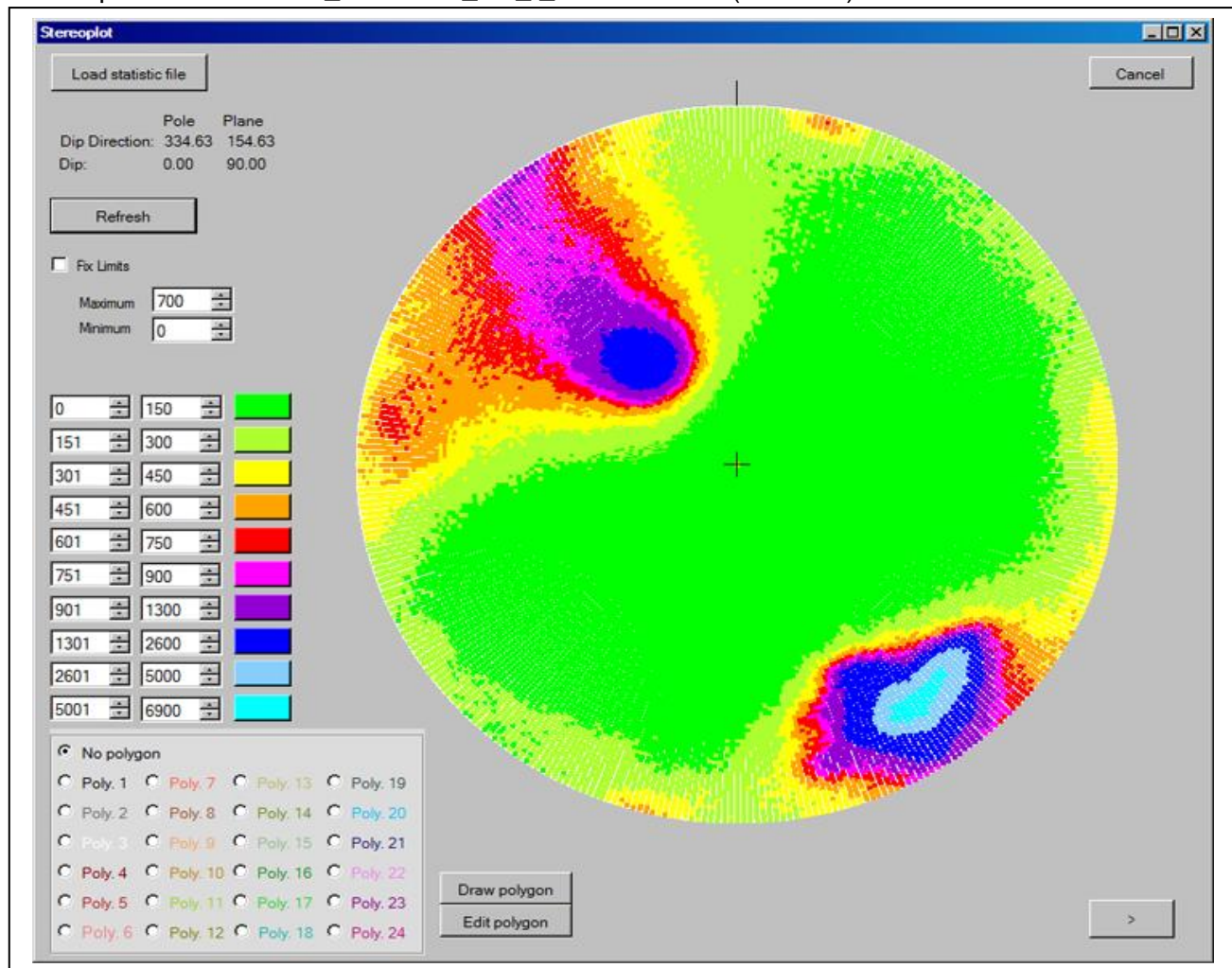File output Name: Anisclo_CrestEast_PC_I_Vectorized.txt (1.362Gb)

Fig.1: Stereoplot showing the frequency of each point vector-orientation in Dip and Dip direction format. *SEFL/Attribute Tools/Stereoplot* with the files Statistic files produced in the compute planar regression.

SEFL set:
Coarse blocks Side: .1
Number of Coarse blocks: X: 961 Y: 661 Z: 123
Total Number of coarse blocks: 78132183
Minimum Range: 0.01   Maximum Range: 0.04
Maximum K: 100 Minimum M: 0
Number of points: 8907960
Number of accepted points: 8674127
Filtering: M>1.5 ;K<0.25

West

File Input Name: Anisclo_CrestWest_PC_I.txt
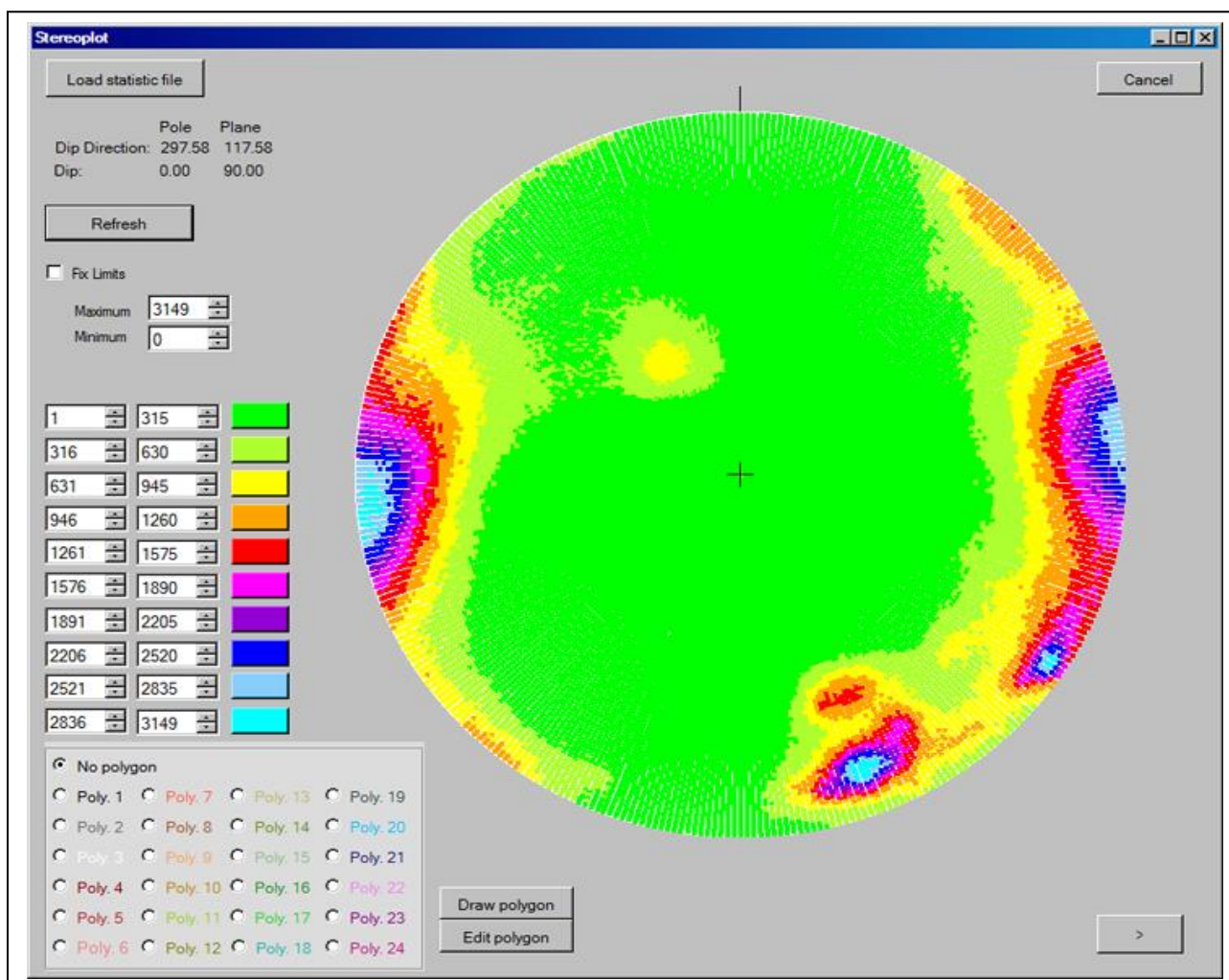File output Name: Anisclo_CrestWest_PC_I_Vectorized.txt (2.178Gb)

Fig. 2: Stereoplot showing the frequency of each point vector-orientation in Dip and Dip direction format. *SEFL/Attribute Tools/Stereoplot* with the files Statistic files produced in the compute planar regression.

SEFL set:
Coarse blocks Side: 0.06
Number of Coarse blocks: X: 530 Y: 883 Z: 286
Total Number of coarse blocks: 133845140

Añisclo Anticline Procesado

Minimum Range: 0.01   Maximum Range: 0.04
Maximum K: 100 Minimum M: 0
Number of points: 13997690
Number of accepted points: 13865533
Filtering: M>1.5; K<0.25

The next step consists of sectioning the vectorized point cloud according to the manually identified planes based on each set of fractures. The orientation domains of each set of fractures can be drawn in *SEFL/Attributes Tools/Steroplot* and then classified into separate files in *SEFL/AttributesTools/Attributes Calssification*
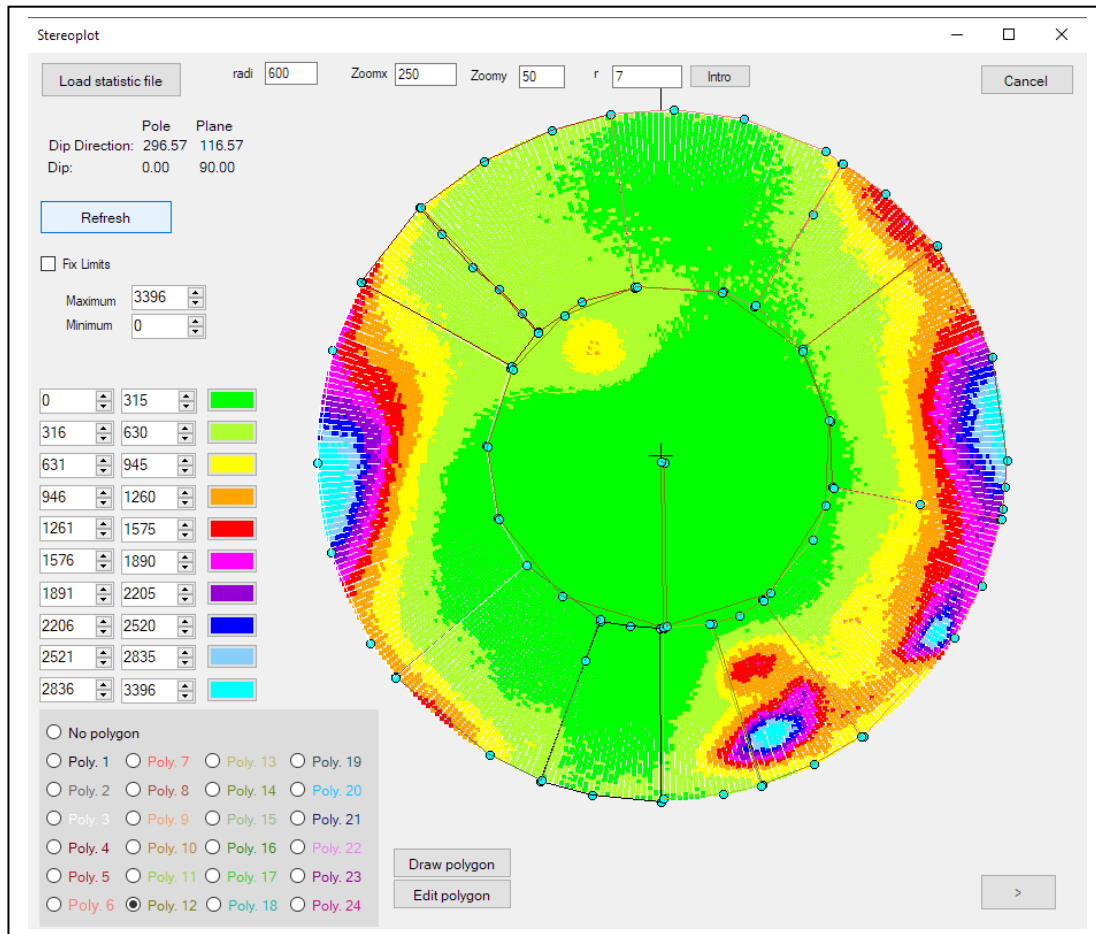

Fig. 3: Stereoplot with the domains of each fracture set, established manually from observation. In the directory options (*SEFL/Directory Options*) must be loaded de 1-SetDomains files.

SetDomains:

Fracture Set I: Polygons 1,6,11

Fracture Set II: Polygons 2, 7

Fracture Set III: Polygons 3, 8

Fracture Set IV: Polygons 4, 9

Fracture Set V: Polygons 5, 10

Fig. 4: Interface to classify vectorized points by orientations with the tool *SEFL/AttributeTool/Attributes Classification.*

Each vectorized point belonging to a fracture set is merged according the 5 fracture set identified in the outcrop. Subsequently, the files are filtered with the intention of erase isolated point, with the tool *SEFL/ContinuityTools/Filter by Attributes* and the parameters used in table 1
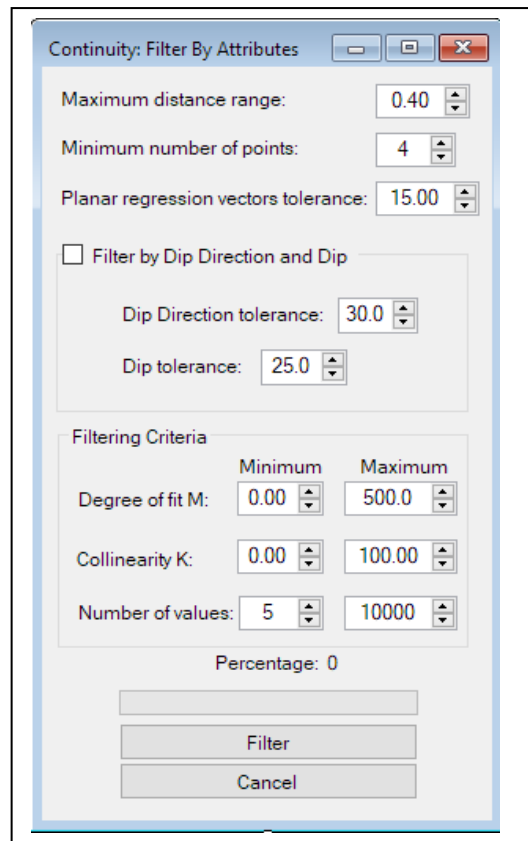
Fig. 5: Interface to classify vectorized points by orientations with the tool *SEFL/ContinuityTools/Filter by Attributes.*

Table 1. After differentiating by fracture set, the isolated points are eliminated with the following parameters with the tool *SEFL/ContinuityTools/Filter by Attributes*

#	Points	SET	Cell SEFL	Range	Minim points	Tolerance	Percentage	
1	1773148	3	0.1	0.10	5	15	98.389	O.K
2								
3	3512122	1	0.1	0.1	5	15	98.87	O.K.
4								
5	3398850	4	0.1	0.1	5	15	99.237	O.K:
6								
7	3635169	5	0.1	0.1	5	15	98.991	O.K.
8								
9	3008330	6	0.1	0.1	5	15	98.419	O.K.
10								
11	739103	2	0.1	0.1	5	15	96.957	O.K.

- Processing - Module II

Clusters Creation

In the next step, the clustering of points to modelize fractures are established according parameters with the purpose of reproducing the fractures, with this purpose a file is created where each grouping

of points represents a fracture and its characteristics. The tool *SEFL/ContinuityTools/Creates* creates these files with the parameters shown in the Table 2.
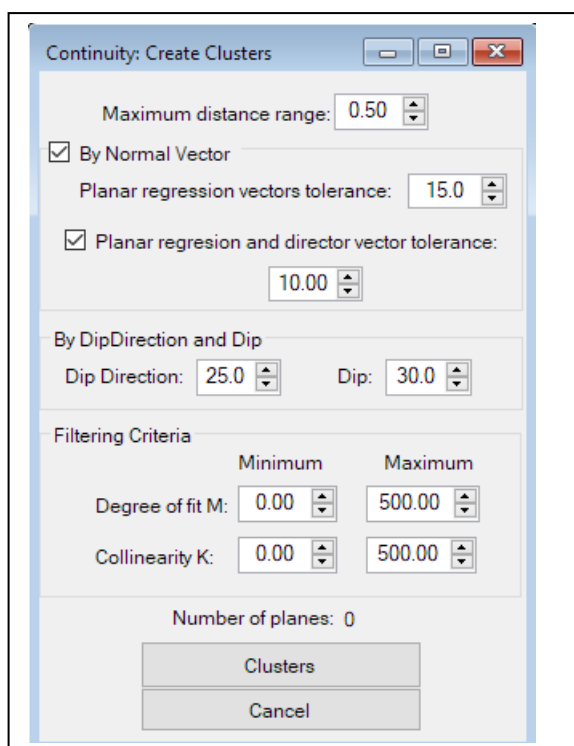

Fig. 6: Interface to create clusters with the too *SEFL/ContinuityTools/Create clusters.*

The parameters used in the processing of the crest of the Añisclos anticline are shown in table 2.

Table 2. Parameters used with the tool *SEFL/ContinuityTools/Create Clusters.*

#	Fracture set	Cell SEFL	Range	Normal vector	Vector director	M	K	Number of planes	
1	3	0.1	0.05	90	10			13176	O.K 0.05Area
2									
3	5	0.1	0.07	90	10			10661	O.K 0.05Area
4									
5	4	0.1	0.07	90	10			11551	O.K 0.05Area
6									
7	1	0.085	0.05	90	10			14605	O.K 0.05Area
8									
9	2	0.085	0.07	90	10			5144	O.K 0.05Area
10									

Finally, the cluster files are modeled in a geometric shape rectangle along with their geometric characteristics in the morphology files (*SEFL/AttributeTools/Morphology/Create Morphology File*) that can also be viewed without being exported in .ts format from the Gocad software. The minimum area was established in 0.5 m^2 for 5 points.

Fig. 7: Interface to model the fractures identified in the creation of clusters with the tool *SEFL/Attribute Tool/Morphology/ Create Morphology File.*

The nomenclature of the morphology files are as follows.

Morphometry_set1.txt   Morphometry_set1.ts………Fracture model belonging to Fracture Set I

Morphometry_set2.txt   Morphometry_set2.ts………Fracture model belonging to Fracture Set II

Morphometry_set3.txt   Morphometry_set3.ts………Fracture model belonging to Fracture Set III

Morphometry_set4.txt   Morphometry_set4.ts………Fracture model belonging to Fracture Set IV

Morphometry_set5.txt   Morphometry_set5.ts………Fracture model belonging to Fracture Set V

The txt files contain the characteristics of the fracture, centroid, orientation and dimensions, as well as which fracture set it belongs to. Files with .ts format are still suitable for viewing with the GOCAD program

- **Processing - Module III**

The calculation of the geometric properties of the fracture network modeled in the previous modules begins with the identification of the limits of the Mechanical Units. If you do not have prior knowledge, module III provides the *SEFL/AttributreTools/Fracture Stratigraphy Measurement* tool to conduced multiple scanlines along the perpendicular of the outcrop and depending on the distance chosen to study. Input file: Merged Morphology Fracture sets in a single Morphology Fracture Set.txt and divided by sections (West and East). Vertical distance by multiple scanlines 10 cm. Tool: *SEFL/Attribute Tools/Fracture Measures/Fracture Stratigraphy Measures*
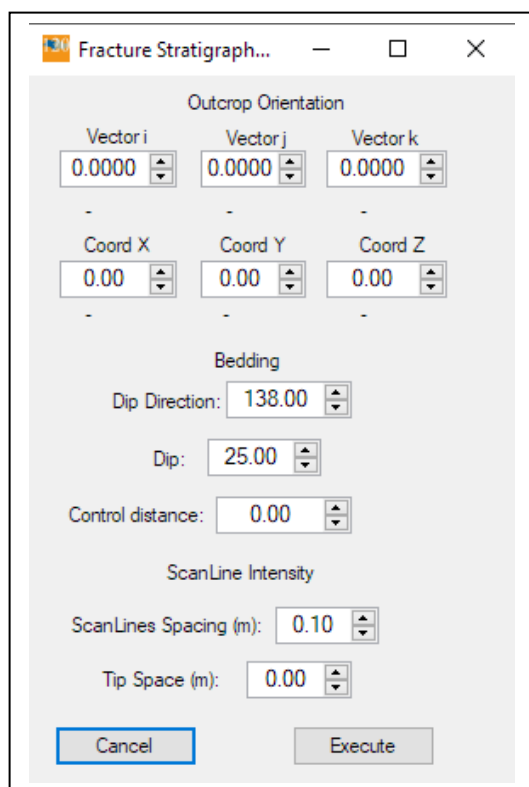

Fig. 8: Interface to model the fractures identified in the creation of clusters with the tool *SEFL/Attribute Tool/Morphology/ Create Morphology File.*

For a better fit to the terrain, the fracture models contained in the morphology files of the fracture set have been merged and subsequently divided into different sections according to the orientation of the outcrop. In this last arrangement, the fractures in each section have been counted until the limits of each Mechanical Unit are visually identified.

West:

Fracture_Boundary_1.txt
Bedding for west section: 154/23.78; Outcrop Orientation: -0.963356, -0.185079, 0.194142; Outcrop Coordinates: 61435, 9548.07, 920.18

East:

Fracture_Boundary_3.txt
Bedding for East section: 143.883/27.842; Outcrop Orientation: 0.634888, -0.610926, 0.472955; Outcrop Coordinates: 61464.58, 9541.59, 913.92

Fracture_Boundary_4.txt

Añisclo Anticline Procesado

Bedding for East section: 139.5/24.92; Outcrop Orientation: 0.679593, -0.601565, 0.419849; Outcrop Coordenates: 61482.34, 9559.69, 911.8

Fracture_Boundary_5.txt
Bedding for East section: 139.8/27; Outcrop Orientation: 0.620592, -0.732066, 0.280958; Outcrop Coordenates: 61508.89, 9580.83, 909.24

1) Mechanical Units Editor

Once the limits of the mechanical units have been identified, in the *SEFL/AttributeTools/Measures /Fracture Abundace* tool these limits have been edited either based on the position of their centroids or with the position of the lower limit with the position of the lower fracture.

Fig. 9: Interface to model the fractures identified in the creation of clusters with the tool *SEFL/Attribute Tool/Morphology/ Create Morphology File.*

The limits of the Mechanical Units are available in the 4_File_Measures folder of the repository:

Mechanical_Units_East_Anisclo_centroid.txt
Mechanical_Units_West_Anisclo_centroid.txt

Or

Mechanical_Units_East_Anisclo_Lower.txt
Mechanical_Units_West _Anisclo_Lower.txt

According to the option to define the Mechanical Unit.

2) Characterization
   The characterization tool needs the files where the mechanical units are defined (previous process) and the fracture modeling file.

Mechanical_Units_East_Anisclo_centroid.txt
East_Morphometry.txt

And

Mechanical_Units_West_Anisclo_centroid.txt
West_Morphometry.txt

Or

Mechanical_Units_East_Anisclo_Lowe.txt
East_Morphometry.txt

And

Mechanical_Units_West_Anisclo_Lower.txt
West_Morphometry.txt