3GSM

TUTORIAL 4

GEOMETRY, OCCURRENCES AND AREA PARTITIONING

Analyst is a convenient tool designed for visualising and assessing 3D models. It allows users to perform geometric measurements like dip direction and dip angle, areas, distances, point locations etc. directly on a 3D model by marking the appropriate location on the model with the computer mouse. Analyst is specifically designed for analysing 3D models of rock faces or terrains across various scales, such as tunnel faces, drift faces, caverns, rock slopes, quarries, open-cut mines, laboratory samples, and constructions like dams.

In this tutorial you will become familiar with using the **Geometry**, **Occurrences** and **Area Partitioning** auxiliary tools in **ShapeMetriX's Analyst**.

Note:

Geometric Measurements and Structural Mapping are discussed in more detail in *Tutorial 3 – Geometric Measurement and Structural Mapping.*

TOPICS COVERED IN THIS TUTORIAL

- 3D Model Input
- Basic Settings & Tools
- Geometry Measurements and Tools
- Occurrences
- Area Partitioning

FINISHED PRODUCT

The finished product of this tutorial can be found in the *Tutorial 4 - Geometry, Occurrences and Area Partitioning* file, located in the *Tutorial 4 - Geometry, Occurrences and Area Partitioning*.zip folder.

1.0 INTRODUCTION

Analyst features a fast and detailed visualisation of single, multiple and merged 3D models by the measurements of orientations, distances, lineaments, rock bridges (non-persistent elements), coordinates, occurrences (water, single events), partitioning of areas (lithology and homogeneous areas), and many more, which are called **Annotation Elements**.

In addition, **Analyst** also includes attributes like grouping measurements into **Structure Sets**, semi-automatic trace detection, automatic joint set clustering, orientation of areas and traces including stereographic projection and statistics, defining scanlines and mapping regions, lithologic region and homogenous area mapping, etc. to streamline the geological and geotechnical assessment of rock and terrain surfaces.

Once a 3D model is ready, **Annotation Elements** can be placed directly on the model. These elements are organized into individual groups:

- **Structures** – includes orientation, trace, area measurements, analysis zones and scanlines, discontinuity model, trace map and stereonet analysis, clustering, etc.
- **Geometry** – includes volume, area, linearity measurements, contour line, cutoff plane, depth colouring, etc. tools.
- **Occurrences** – includes water, punctual and non-punctual occurrences.
- **Area Partitioning** – includes lithological region and homogeneous area mapping.

2.0 3D MODEL INPUT

If you have not already done so, run the ShapeMetriX (SMX) program by:

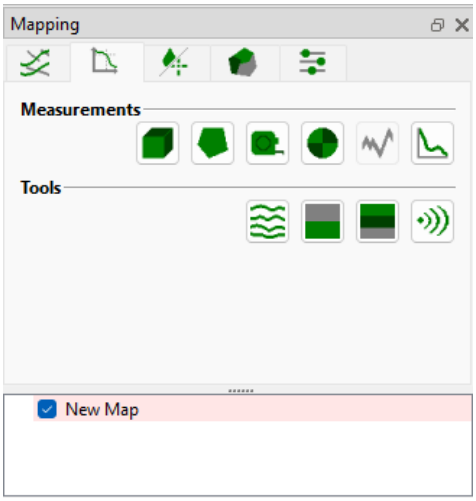
1. Double-clicking the **SMX** icon on the desktop, in your installation folder or by selecting **Programs > ShapeMetriX > ShapeMetriX** in the Windows Start menu.
2. When the program starts, select **Analyst** to run the Analyst tool. When the Analyst tool runs, a blank project page opens as shown in the image below.

ShapeMetriX comes with several example images and files installed with the program. For this tutorial though, we will use the **Bench** in the *Blocky Rock Mass.jm3x* file found in your downloaded *Tutorial 4 - Geometry, Occurrences and Area Partitioning.zip* folder to demonstrate the geometry measurements, occurrences and area partitioning features of ShapeMetriX.

3. Select **Open 3D Model**.
4. Open *Bench in Blocky Rock Mass.jm3x* file

3.0 BASIC SETTINGS & TOOLS

The 3D model is now imported into **Analyst**. Notice that mapping tools now became visible in the sidebar, and a **New Map** has been created under **Geometry, Occurrences** and **Area Partitioning** tabs by default. The **Properties Pane** is also enabled which displays the information of selected **Annotation Elements**.



Note:

Annotation Elements of Geometry, Occurrences and Area Partitioning are organised within individual lists (Volumes, Tapes, Measuring Points, Water, Lithologic Regions, etc.). Annotations cannot be moved between the different lists.

The 3D model can be edited, panned, zoomed in and out, oriented, rotated, toggled between projections, etc. using the **navigation bar** (located in the top right of the 3D model view) or the **mouse wheel**.

- **Scroll** the mouse wheel to **zoom in** and **out**.
- **Click** and **hold** the mouse wheel to **pan** the model.

Hint: Analyst toggles between the **Edit** and **Navigate** mode by pressing the ESC key. The tool is active when it is blue.

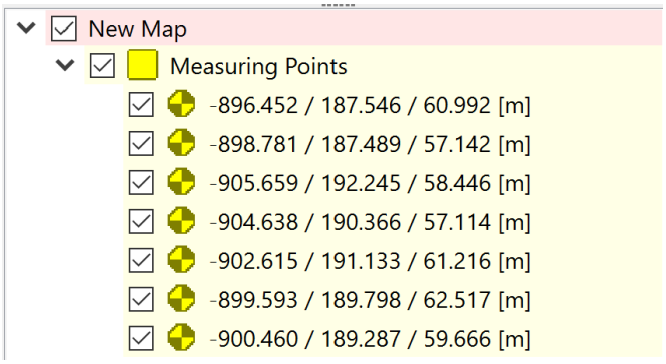
4.0 GEOMETRY MEASUREMENTS

The **Geometry** tab includes volume, area, line, point measurements, section cuts as well as contour lines, cutoff plane, depth colouring tools.

4.1 POINT MEASUREMENT

The **Measuring Point** tool provides the 3D coordinates of a specific point on the 3D model. These coordinates can be displayed in either local or global reference frames, depending on the model's reference system.

1. Zoom into an arbitrary region in the 3D model that you would like to perform a point measurement.
2. Select the **Geometry** tab.
3. Under **Measurements**, select the **Measuring Point** tool.
4. Mark the point for the measurement with a left button mouse click (clicking on a different location resets the measurement).
5. Complete the **Point Measurement** by pressing the **ENTER** key. Coordinates of the Measured Point will be provided instantly under the **Measured Points** list under the **Geometry** tab.
6. Repeat steps 2 – 4 to add additional point measurements.

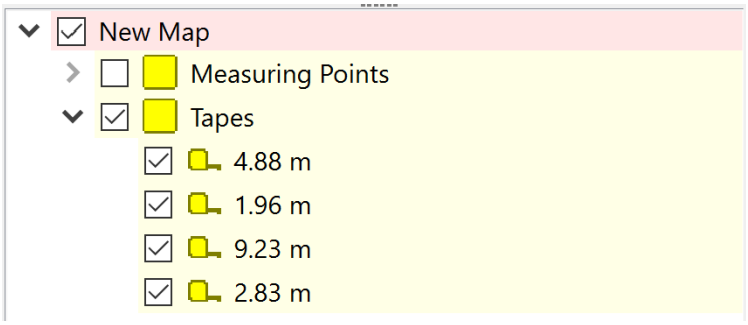


4.2 TAPE MEASUREMENT

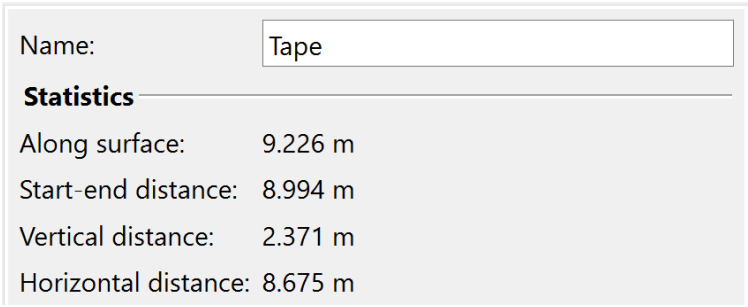
The **Tape** tool enables the measurement of any arbitrary stretch on a 3D model. It provides values for various lengths and distances, including the length along the surface, the distance between the start and end points, the vertical distance, and the horizontal distance.

1. Zoom into an arbitrary region in the 3D model that you would like to perform a tape measurement.
2. Under **Geometry** > **Measurements**, select the **Tape** tool under the.
3. Mark the starting point for the measurement with a left button mouse click.
4. Mark the end point for the measurement with a left button mouse click. (The position of the point closest to the mouse cursor can be changed by clicking with the left mouse button, if required.)
5. Complete the **Tape** measurement by pressing the **ENTER** key. Length along the surface will be provided instantly under the **Tapes** list in the **Geometry** tab.

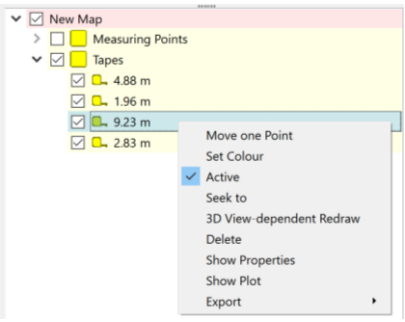
6. Repeat steps 2 – 5 to add additional tape measurements.

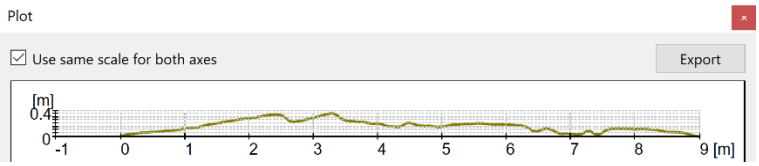


Click on **Tape** measurements to see the length along the surface, the distance between starting and end point, the vertical distance and the horizontal distance statistics for each measurement.



Right-click on a **Tape** measurement and select **Show Plot** to plot the profile along the surface.



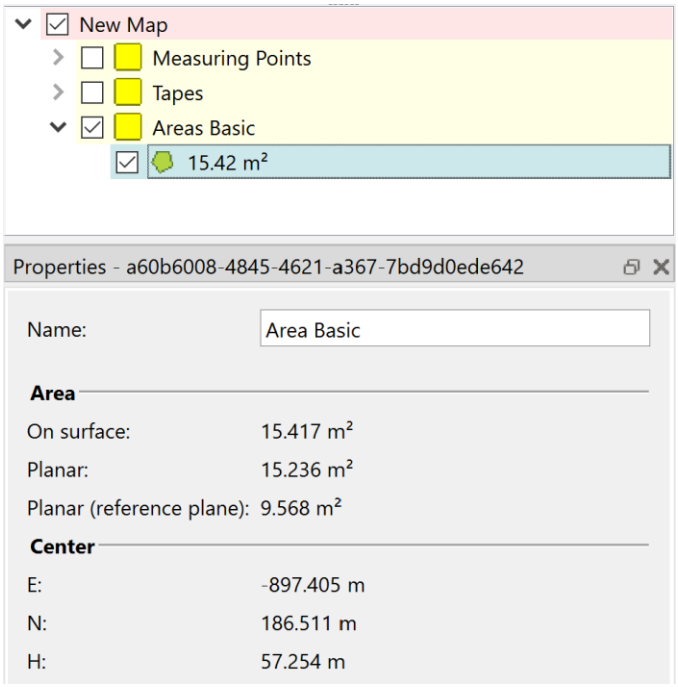


4.3 AREA BASIC MEASUREMENTS

Area Basic measurement tool is used for annotating area-based structures (i.e. discontinuity surfaces) or for regions of common geological attributes. It is similar to the **Area Measurement** tool under the **Structures** tab; however, the **Area Basic** tool only provides information about the **position** and the **size** of the area. It does not provide information about the **orientation** of the area.

1. Zoom into an arbitrary region in the 3D model that you would like to perform an **Area Basic** measurement.
2. Select the **Area Basic** tool under **Geometry** > **Measurements** tab.
3. Map the borderline of the **Area** to be measured on the 3D model by clicking the left mouse button. A polygonal line will grow instantaneously.

4. Complete the **Area Basic** measurement by pressing the **ENTER** key. The **size** and the **position** of the area will be provided instantly under the **Areas Basic** list in the **Geometry** tab.



5. Repeat steps 2 – 4 to add additional area measurements.

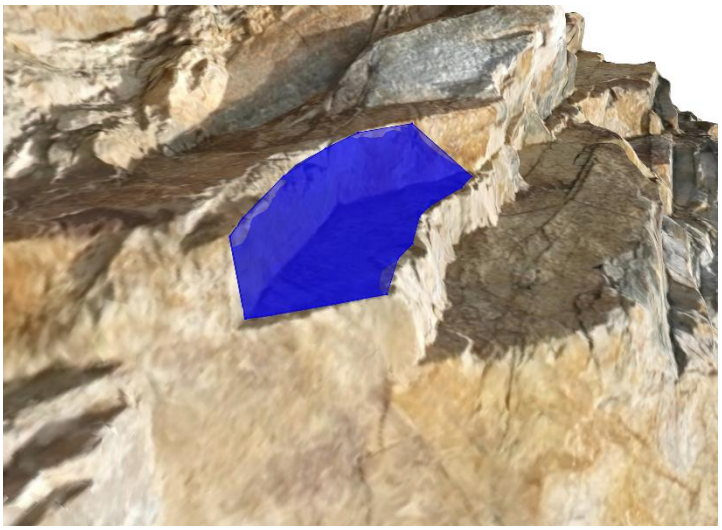
4.4 VOLUME MEASUREMENTS

The **Volume** tool is utilised for estimating the volume of molds defined by a polygon on a 3D model.

1. Zoom into an arbitrary region in the 3D model that you would like to perform a volume measurement.
2. Under **Geometry** > **Measurements**, select the **Volume** tool.
3. Draw an area on the 3D model by subsequently clicking on the 3D model with the left mouse button. The drawn area will have the following properties:

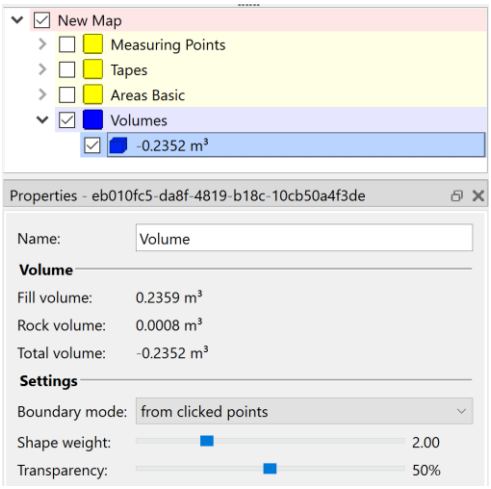
- encloses the prospective volume body along the 3D model
- forms an artificial surface for closing the prospective volume body

4. Complete the **Volume** measurement by pressing the **ENTER** key. The calculated **volume** will be provided instantly under **Volumes** list in the **Geometry** tab.



5. Repeat steps 2 – 4 to add additional volume measurements.

Notice that when you click on the measured volume entity, there are **three** volume calculations provided under **Properties** tab.



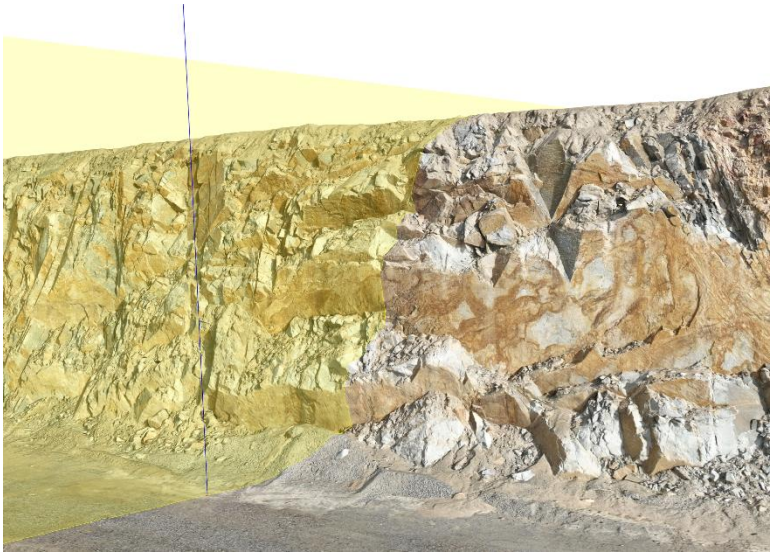
- **Fill Volume** – bounded by the area and the portion of the 3D model in front of it ("in front of the rock mass")
- **Rock Volume** - bounded by the area and the section of the 3D model behind it ("in the rock mass")
- **Total Volume** - calculated total volume (difference between the rock volume and fill volume calculations)

4.5 GENERATING A SECTION

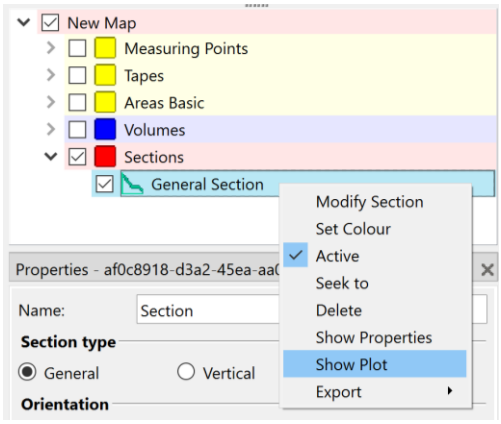
A **Section** in the Analyst tool is a planar polygonal line formed by the intersection of a **Cutting Plane** and the **3D Model**. The cutting plane is defined by its position (three coordinates) and orientation (inclination and strike).

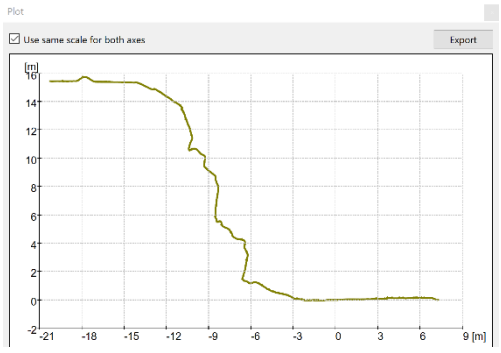
1. Under **Geometry** > **Measurements**, select the **Section** tool.
2. Define the Configuration of the Section under the **Properties** tab:

- **Section Type = General**
- **Inclination = 90°**
- **Strike Direction = 245°**



3. Confirm the **Section** by pressing the **ENTER** key. The **section** will be provided instantly under Sections list in the **Geometry** tab.
4. Right-click on a **Section** and select **Show Plot** to plot to see the profile of the section.



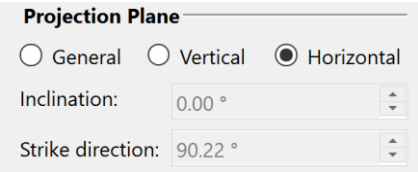


5. Click **Export** to export the section in *.csv* or *.dxf* format for further geometry generation purposes in other Rocscience 2D programs.

4.6 CONTOUR LINES

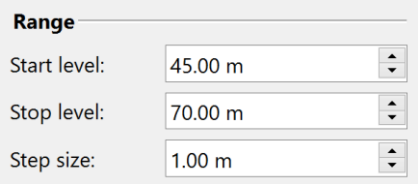
The **Contour Lines** tool in Analyst generates contour lines in respect to a user-definable projection plane (vertical, horizontal or general projection plane).

1. Under **Geometry** > **Tools**, select **Contour Lines**.
2. Select **Horizontal** projection plane.

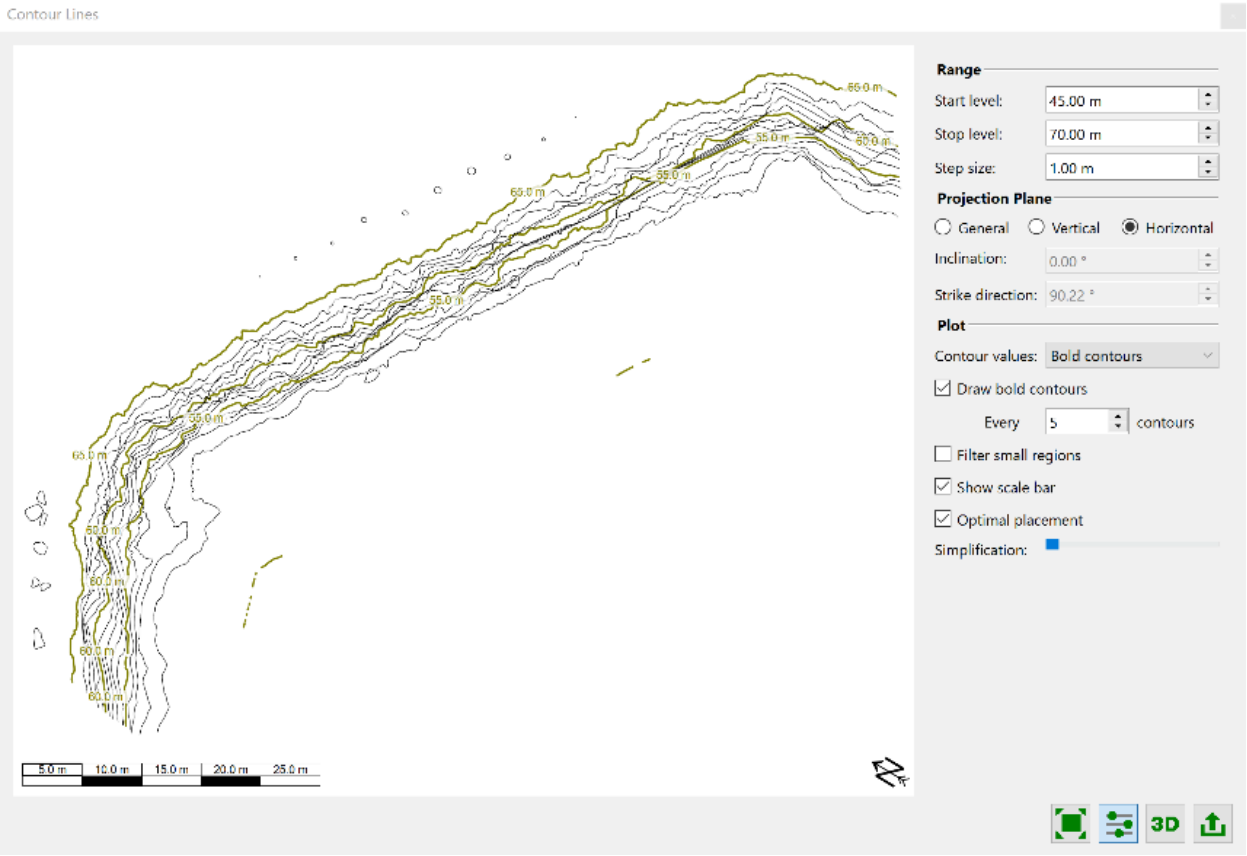


3. Define contour range:

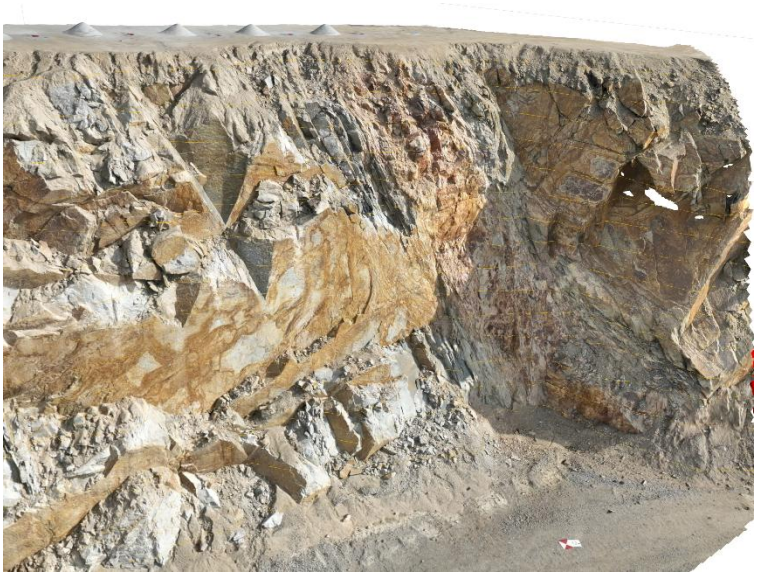
- **Start Level = 45.00m**
- **Stop Level = 70.00m**
- **Step Size = 1.00m**



4. The Contour map will be updated automatically.



5. Click **3D Show on 3D Model** to overlay contour lines onto the 3D model.



5.0 OCCURRENCES

An **Occurrence** in **Analyst** is a tool for mapping water or an event occurrence (single/punctual or non-punctual) on the 3D Model.

To map a water occurrence:

1. Zoom into an arbitrary region in the 3D model that you would like to map a water occurrence.
2. Under the **Occurrences** tab, select the **Water** tool.
3. Mark the **Water** occurrence with a left button mouse click on a desired location (clicking on a different location resets the position)
4. Complete adding the **Water** occurrence by pressing the **ENTER** key. **Water** annotation will occur as a blue sphere and the **position** of the occurrence will be provided instantly under the **Water** list in the **Occurrences** tab.

5. Click on the added **water occurrence** entity and edit the details in the **Properties** tab.

- **Radius = 1.00m**
- **Type = Wet Spot**
- **Ingress = 1.50 l/s**

6. Repeat steps 2 – 4 to add additional water occurrences.

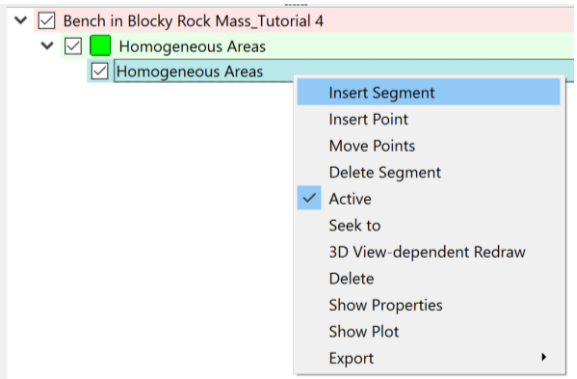
6.0 AREA PARTITIONING

Area Partitioning is a tool for partitioning and quantification of user defined areas (Lithologic Regions and Homogenous Areas) on a 3D model. The **Lithologic Region** option allows to define different rock types (lithologies) while the **Homogenous Area** option allows to define segments with similar properties.

1. Zoom into an arbitrary region in the 3D model that you would like to add Homogenous Region.
2. Under the **Area Partitioning** tab, select the **Homogenous Region** tool.
3. Create a rectangular outside border for the **Homogenous Region** (entire region) on the 3D model by subsequently clicking the left mouse button. A polygonal line will grow instantaneously.

4. Confirm the polygon for outside border of the Homogenous Region by pressing the **ENTER** key. The area will close automatically.

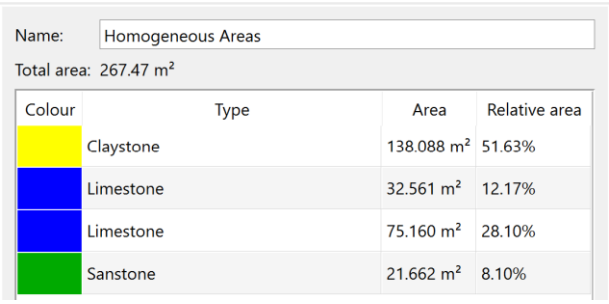
5. Right-click on the **Homogenous Region** entity and select **Insert Segment** to add segments inside the Homogenous Region.



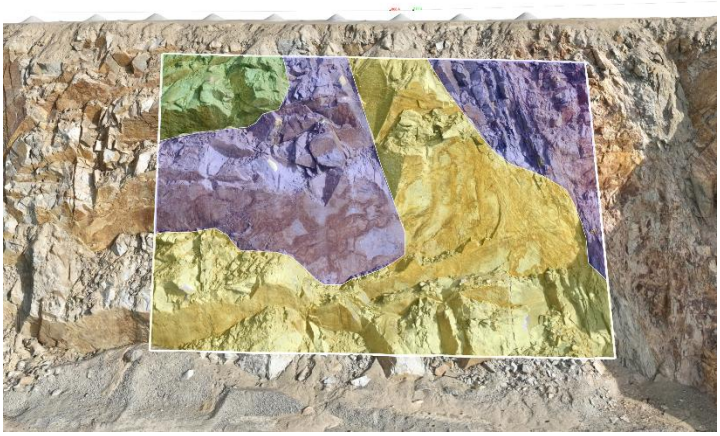
6. Split the area into segments by drawing:

- A polygon, which intersect the border of the Homogenous Region
- A closed polygon inside the border of the Homogenous Region

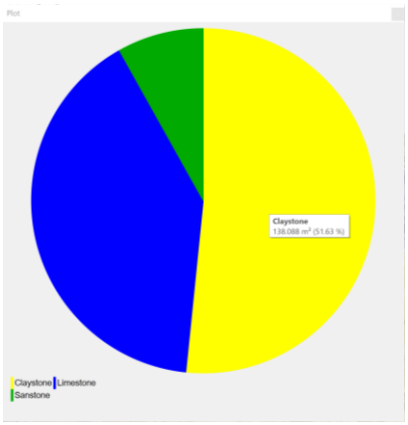
7. The segment will be automatically added under the Homogenous Region under the **Properties** tab.
8. Continue splitting the Homogenous Region until all segments have been defined.
9. Under the Properties tab, assign the desired color and rock type to the segment with biggest area size.



10. Continue assigning lithology types to all the individual segments.



11. Right-click on the Homogenous Region entity and select **Show Plot** to plot a pie chart of the area distribution of segments in the **Homogenous Region**.



Note:

Lithologic Regions and **Homogenous Regions** can be exported as *.dxf, .csv* and *.vrml* by right-clicking on the corresponding region entity and selecting **Export.**

That concludes the tutorial for Geometry, Occurrences and Area Partitioning.