

Target Lithology Voxels

The Target Lithology Voxels tool enables you to create a 3D grid (voxel) based on data contained in a string channel within a from-to drillhole database. A lithology voxel can be created from any geological attribute that is expressed as a string; common examples include rock type, alteration, weathering and mineralization.

A lithology voxel is created by calculating top and bottom surfaces for each attribute (as defined from the string channel), and then filling up the spaces between the top and bottom surfaces with 3D cells, each of which contain the attribute string code. The cells are clipped to the convex hull of any drillholes containing the individual unit at each Z level. This process is repeated for each attribute found in the string channel until a complete voxel for the attribute is created.

Lithology voxels are displayed in the 3D Viewer . Using the 3D Tool functions, you can manipulate the display of the voxel, such as selecting individual or multiple "lithology" units for display, data extents, transparency, etc.

This How-To Guide walks you through the recommended workflow for creating a lithology voxel, as outlined below:

1. Create a drillhole project and import collar, survey, and from-to data.
2. Select the desired from-to data to use for gridding. Available data channels will be displayed in the dropdown menu within the *Create Lithology Voxel* dialog.
3. Choose an appropriate gridding method (minimum curvature or natural-neighbour TIN)
4. Check that the resultant voxel is to the user's satisfaction. If not:
 - ▶ Adjust gridding parameters (e.g., cell size, compositing gap, non-contact radius, and/or gridding method) or select/de-select drillholes as required
5. Iterate through steps 2 – 5 until the desired result is achieved

For more information on creating lithology voxels in Target, including descriptions of the available options and parameters, click the Help button on the dialog of interest.

Starting a New Target Drillhole Project

When you start a new Drillhole Project an empty "Collar" database is created and displayed in the project window. With the Drillhole system, individual 'data type' databases are created to enable easier data management, and are displayed in the Project Explorer. These databases are linked by a common project name, which appears at the start of the individual database names. For example, separate databases for collar, survey, assay, and geology are created and linked by project name.

In a Drillhole Project named "Prospect" the following databases could be created:

- ▶ Prospect_Collar.gdb (collar information)
- ▶ Prospect_Survey.gdb (hole dip-azimuth survey information)
- ▶ Prospect_Geology.gdb (geology information – The "Geology" label is user specified)
- ▶ Prospect_Assays.gdb (assay information - the "Assay" label is user-specified)

 When the Drillhole system is used, it scans the open project for all the project databases currently loaded in the project to see which data is available. If you close one of the project databases, it will not be visible to the system and will not be used when processing your data. While working with a Drillhole Project, if you wish to "hide" one of the project databases, minimize it instead of closing it in order that Target can continue to access it. You can see which databases are in your project by viewing the list under Databases in the Project Explorer.

Projections can be set during project set-up when the "Specify coordinate system on import?" is enabled on the *Edit|Oasis montaj Settings* dialog.

Preparing Collar, Survey, and Lithology Data

To create subsurface topography grids, as well as lithology voxels, you require three Geosoft databases:

- A collar database
- A survey database
- A geology database that includes a From (depth) column, To (depth) column and a string column containing lithology information



A string column (channel) contains plain text values, for example "LMSTN" for "limestone" or "SDSTN" for "sandstone".

Selecting Holes

A key requirement for the geologists and geochemists that are evaluating and presenting drillhole data is the ability to select various combinations of drillholes for optimal visualization and plotting. Selecting holes is also necessary for querying and creating data, as one may need to interpolate across holes to fix how their data is displayed. The Target system provides a comprehensive set of options for performing this task. The basic methods of hole selections are listed below.

- **Selecting (or Deselecting) All Holes:** Enables quick development of master plan maps or resetting of drillholes prior to making new selections.
- **Selecting Holes by Name or Name Mask:** Enables batch selection of multiple holes with systematic drillhole identifiers. Requires a standard drillhole naming scheme for identifying related holes. For information on Name mask parameters, click the **Help** button on the *Select holes by name* dialog.
- **Selecting Holes by List:** Enables custom selection of single or multiple holes via a list of all the holes in the database. Requires pre-existing knowledge of holes.
- **Selecting Holes by Plan map:** Enables rapid visual selection of single or multiple holes by using a polygon defining tool to select holes along regular or irregular sections, on a plan map. Useful for quick evaluation of project data.
- **Select Holes by Collar table data:** Enables custom selection of holes based on values from a channel in the collar table channel. Once a channel from the collar table has been selected, the two-panel selection tool is displayed with all the available items which can be selected. Select one or more, and then all holes with corresponding matching values will be selected.
- **Select Holes by Polygon File:** Enables the selection of holes based on a polygon (PLY) file. This is useful for claims boundaries, etc.

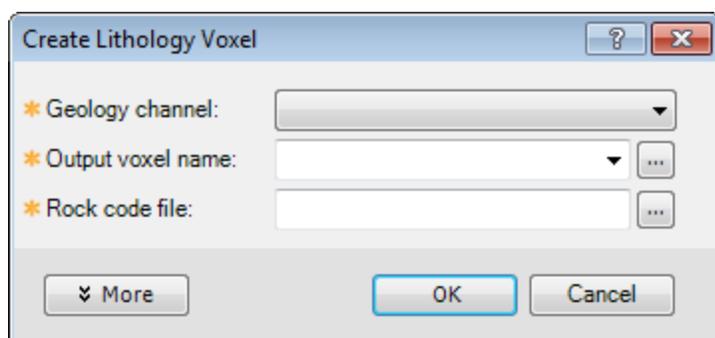
- **Select Holes by the Selection Tool:** Enables interactive selection of single or multiple holes by area. The Hole Selection Tool includes a plan view of the drill survey area as well as display and selection tools.
In addition, the system also enables you to save and load your selections.
- **Save and/or Load Selections:** Enables you to save the current hole selections, or load previous hole selections from a selection file (*.sel).

Creating Lithology Voxels

With this procedure, you can create a relatively simple lithology voxel using the default settings of the *Create Lithology Voxel* feature.

To Create a Lithology Voxel

1. From the *DH-Plot* menu, select **Create Lithology Voxel** .
The *Create Lithology Voxel* dialog is displayed.

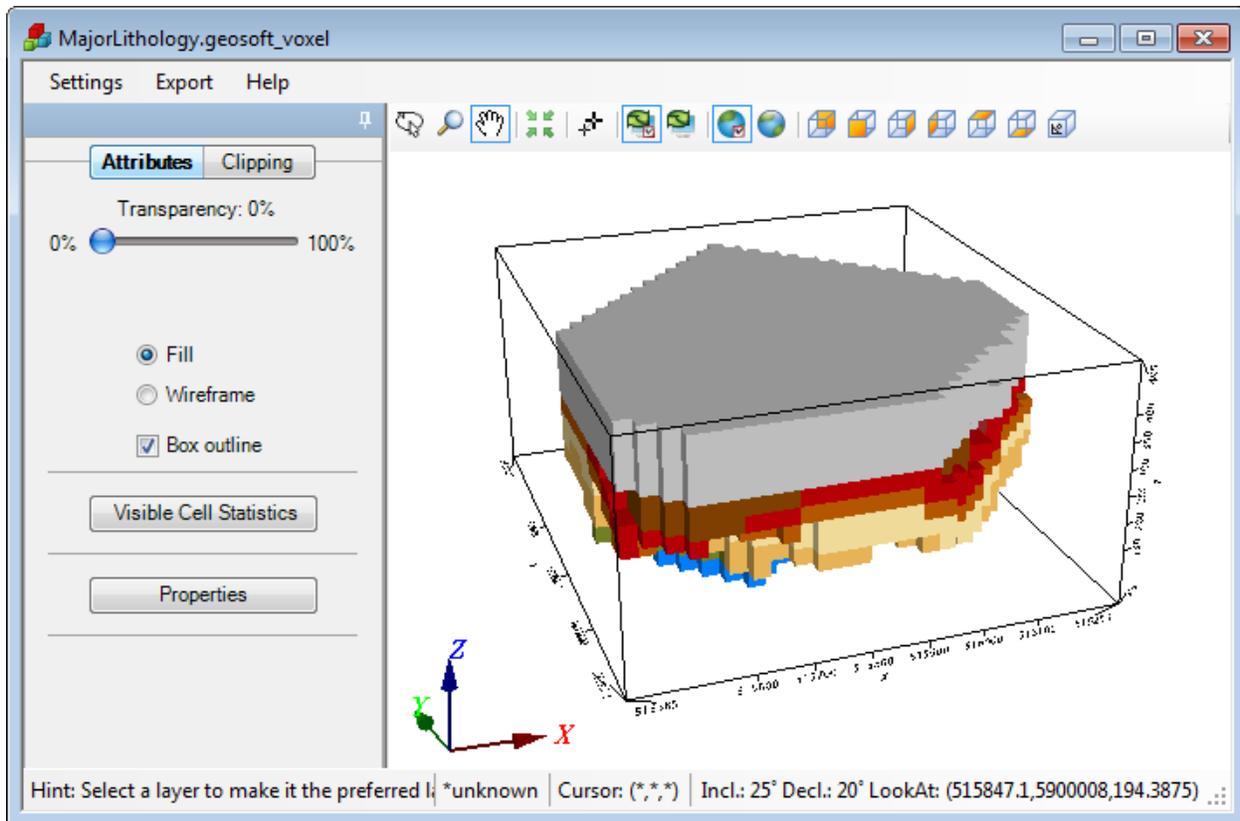


2. From the *Geology channel* dropdown list, select the required lithology channel.
3. In the *Output voxel name* field specify a voxel name, or use the **Browse** button to select the required voxel name.
4. Use the **Browse** button next to the *Rock code file* field to select a file containing the required table of rock (lithology) codes.
5. Click the **More** button to access the advanced gridding parameters.



For more information, click the **Help** button on the *Create Lithology Voxel* dialog.

6. Click **OK** . The lithology voxel is created and displayed on the new map. It is also displayed in the 3D Viewer on top of the map.



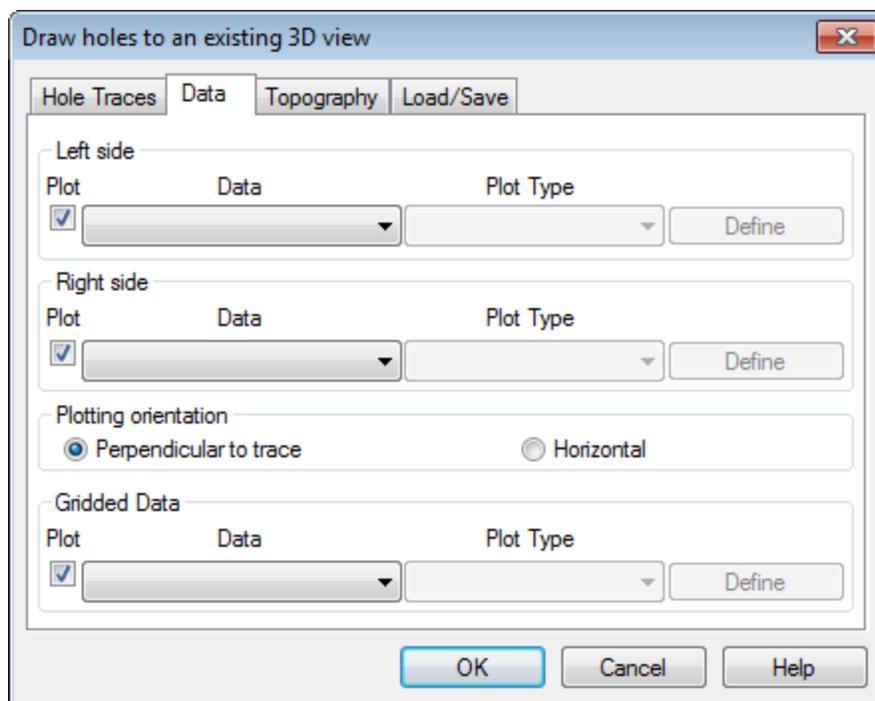
7. Use the 3D View and 3D Tool functionality to rotate, resize, re-colour, and otherwise enhance the graphical representation of the created voxel. For more information on these tools, see the *3D View* and *3D Tool* help files in the Application Help.

Verifying Surface Correctness

A surface you have created and displayed might not correspond to your drillhole data with desired precision. With this procedure, you can check the new surface against the lithology data associated with individual drillholes.

To Verify Surface Correctness:

1. Display your created surface in the 3D Viewer window (*3D|Open 3D Viewer*).
2. From the *Add to 3D* menu in the 3D Viewer, select **Drillholes** .
The *Draw holes to an existing 3D view* dialog will appear.

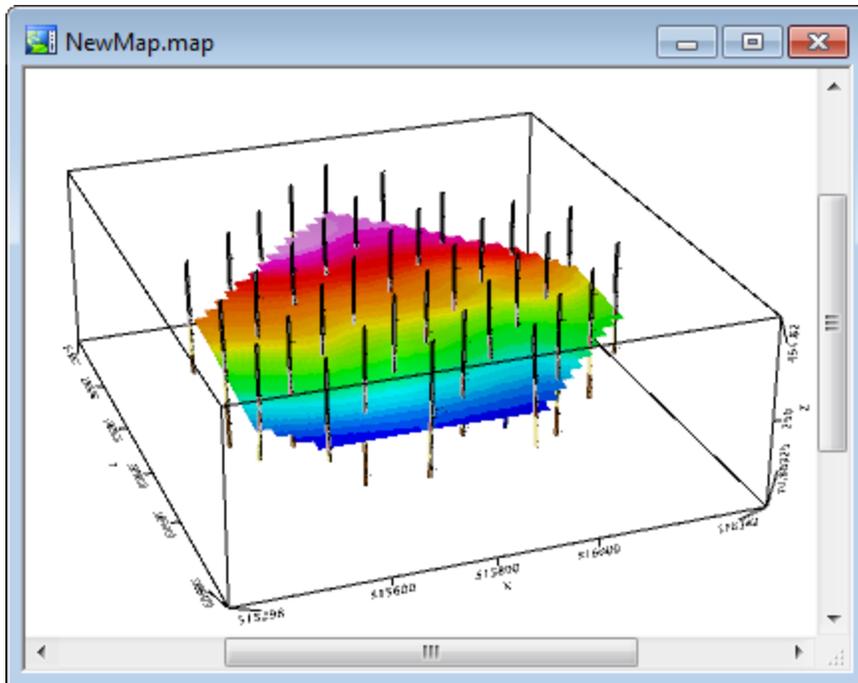


3. Click the **Data** tab. The *Data* page opens.
4. Under the *Left side* section, from the *Data* dropdown list, select a channel that contains the required data and using the *Plot Type* dropdown, select *Rock patterns*.
5. Click **Define**. The *Pattern Bands - Rock Codes* dialog opens.



For more information, click the **Help** button on the *Pattern Bands - Rock Codes* dialog.

7. Click **OK** to close the dialog and return to the *Drawn holes to an existing 3D view* dialog.
8. Under the *Right side* section, from the *Data* dropdown list, select a channel that contains the required data and using the *Plot Type* dropdown, select **Post Text**.
9. Click **Define** if you would like to define this plot type for your data, and click **OK**. The selected drillholes, along with the subsurface topography grid you created earlier, are displayed in a new map and in the 3D Viewer.



As you zoom into the resulting 3D map, you can see that sections of the displayed drillholes are coloured and text-labelled according to the selected table of rock type codes.

10. Use the 3D Tool panning, resizing, and rotation functions to examine intersections of your subsurface topography grid with the individual drillholes.

You might find that one or more intersections of the created surface does not correspond exactly with the geological boundary you have requested. You can achieve more precise results by adjusting the surface gridding parameters and choosing more specifically the holes to use.

Having adjusted a parameter's value, you will need to repeat the surface creation procedure and examine the results. Achieving satisfactory results may require several iterations.

 *It is recommended that you give each new version of the resulting grid a new name. If you need to keep the same grid name, you will need to first delete the original grid from the map and from the Planes & Surfaces section of the 3D Tool . Otherwise, the new grid will be displayed on the relief surface of the original grid, and the subsurface topography grid changes will not display.*

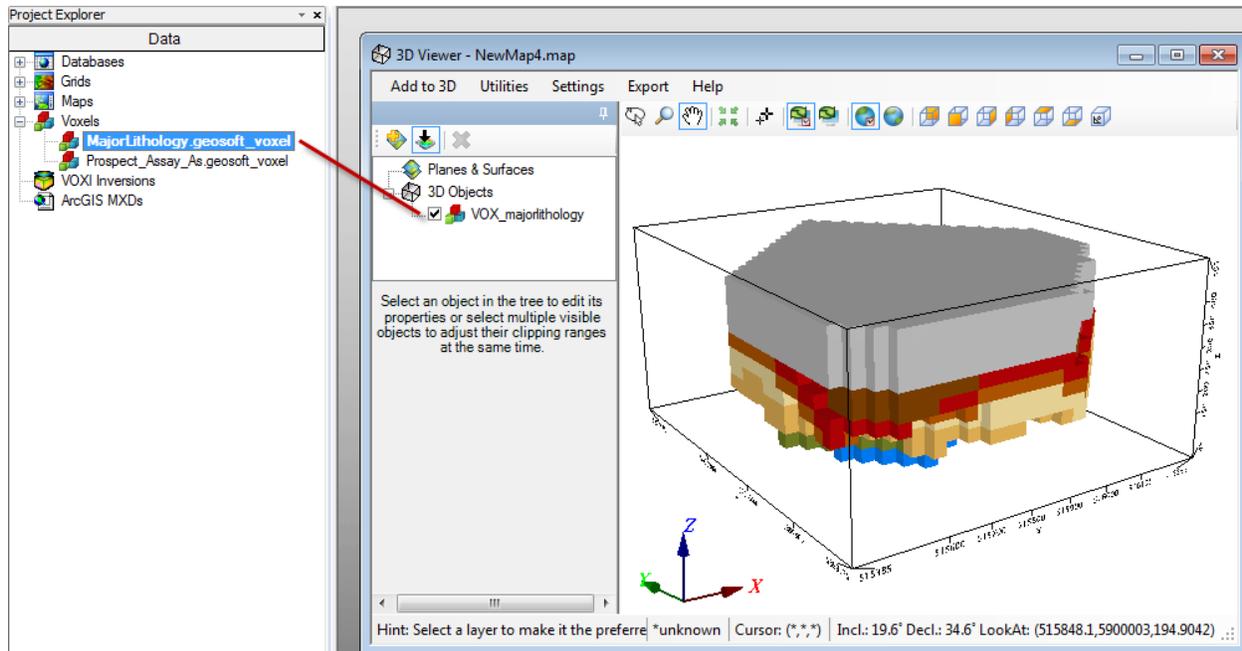
 *It is not recommended that you change multiple parameters in a single iteration. The results of several changes made simultaneously might be contradictory and difficult to analyse.*

Display Drillhole Data In a Voxel 3D View

You can easily add data to your 3D View while working in the 3D Viewer, via the *Add to 3D* menu.

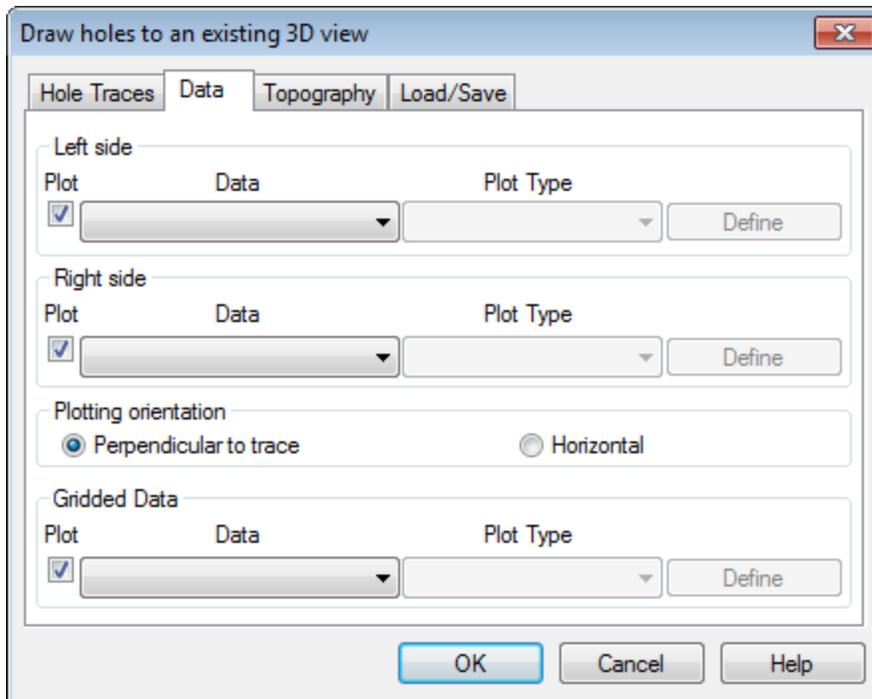
To Display Drillhole Data in a Voxel 3D View

1. Open your voxel in the 3D Viewer (*3D|Open 3D Viewer*). Note that if your voxel is not yet displayed in your 3D map, you can drag it from the Project Explorer (under Voxels) to the centre of the 3D Viewer. Your voxel will be displayed in both the 3D Viewer Explorer and the Project Explorer Windows lists, as shown below:



The name of the voxel as it appears in the Project Explorer differs from how it appears in the 3D Viewer Explorer. Voxels in the 3D Viewer Explorer have the VOX_ prefix, although they can be edited at any time by clicking twice on their name.

2. From the *Add to 3D* menu, select **Drillholes**. The *Draw holes on an existing 3D view* dialog is displayed.



3. On the *Data* tab, in the *Left side* section, from the *Data* drop-down list, select the channel that contains the required data.
4. From the *Plot Type* dropdown list, select the type of plot you are making.
5. Click the **Define** button if you would like to select a file that contains the codes for your plot type. Click **OK** to close this dialog.
6. In the *Right side* section, from the *Data* dropdown list, select the channel that contains the required data.
7. From the *Plot Type* dropdown list, select the type of plot you are making.
8. Click **OK** . The selected drill holes are displayed in the 3D Viewer along with the voxel you created earlier.

 *If you see only some or none of your holes (because they are hidden within the voxel volume), there are ways to expose the drillholes in the voxel view:*

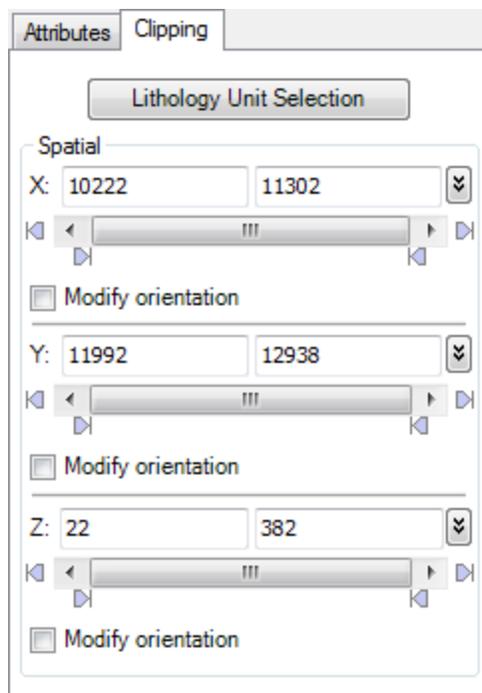
- > To *Clip* the voxel along X, Y, and/or Z axes
- > To *Clip* the voxel to specific lithology unit(s)
- > To *Clip* the voxel along a specified azimuth and dip (Angled Clipping)
- > To use the *Transparency* control to manipulate the voxel and drillhole groups

Clipping Voxel Along Axes

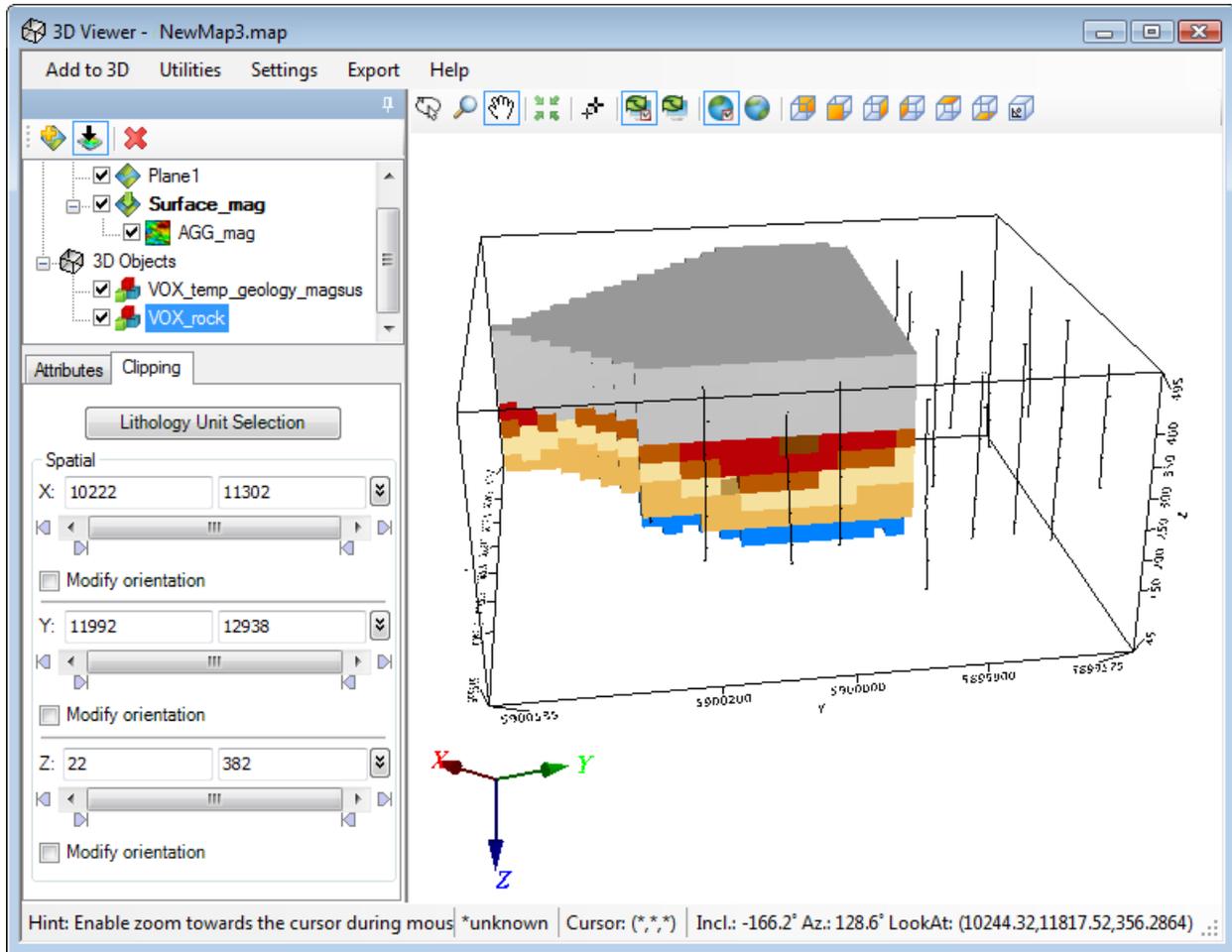
Using the *Clipping* tab on the 3D Viewer, you can apply clipping to each of the 3 independent axes (X, Y, Z) enabling you to clarify the required details within your 3D view.

To Clip Voxel Along Specific Axes in Order to Reveal Drillholes:

1. In the *3D Viewer Explorer* window, highlight the name of your voxel (the file with the  icon beside it).
2. Select the **Clipping** tab.



3. Use the X, Y and/or Z sliders to clip the displayed voxel along the corresponding axes, which adjusts the extents of the voxel in the 3D Viewer window accordingly. You can now also modify the orientation of the X, Y, Z Axes in order to perform Angled Clipping. Angled clipping works for all types of groups and planes.



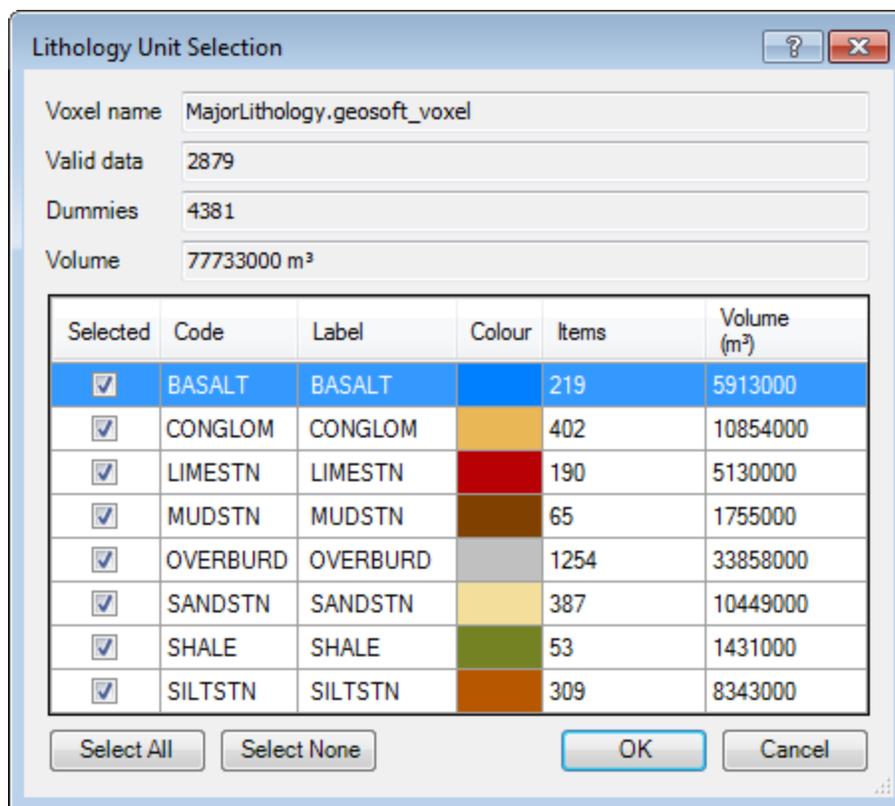
- The drillholes are now revealed.

Clipping Voxel to Specific Lithology Units

The *Lithology Unit Selection* dialog, available on the *Clipping* tab of the 3D Viewer, enables you to select the individual lithology units to display.

To Clip Voxel to Specific Lithology Units to Verify Correspondence with Drillhole Data

- On the *Clipping* tab of 3D Viewer, click **Lithology Unit Selection**.
The *Lithology Unit Selection* dialog is displayed.



2. Clear/check the *Selected* check boxes of to hide/display the corresponding lithology units in the voxel 3D view.
3. Use the 3D Tool panning, resizing, and rotation functions to examine intersections of the bedrock surface with the individual drillholes.



You can achieve more precise results by adjusting the voxel creation parameters. For instance, you can adjust the voxel cell size, compositing gap, or noncontact radius.

Having adjusted a parameter's value repeat the voxel creation procedure and examine the results. Achieving satisfactory results may require several iterations.



It is not recommended that you change multiple parameters in a single iteration. The results of several changes made simultaneously might be contradictory and hard to analyse.

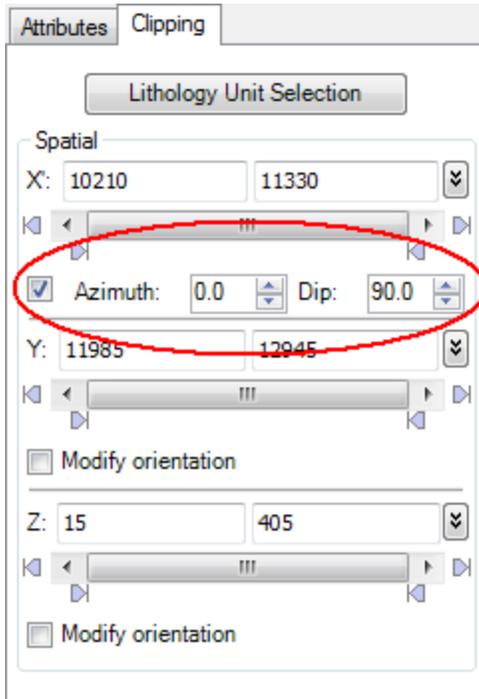
Angled Clipping

The 3D Viewer provides the option to modify the orientation of the X, Y, Z Axes in order to perform Angled Clipping. Angled clipping works for all types of groups and planes.

To Apply Angle Clipping to a Voxel

1. In the *3D Viewer Explorer* window, highlight the name of your voxel (the file with the  icon beside it).
2. Select the **Clipping** tab.

- For the X (Y and/or Z) axes, check the *Modify orientation* checkbox. The *Azimuth* and *Dip* parameters are enabled.



- Using the Arrows (↕) or by typing in a specific value, modify the *Azimuth* and *Dip* parameters to angle clip the displayed voxel along the corresponding axes, which adjusts the extents of the voxel in the 3D Viewer window accordingly.

Apply Transparency

The 3D Viewer enables you to apply Transparency to your Voxels, Grids and Images, providing a light-table effect, enabling you to view all of your data simultaneously.

To Apply Transparency to a Voxel

- In the *3D Viewer Explorer* window, highlight the name of your voxel (the file with the  icon beside it).
- Select the **Attributes** tab.
- Using your cursor, move the slider on the *Transparency* bar (). To increase the transparency, slide the bar to the right and to decrease the transparency slide the bar to the left.

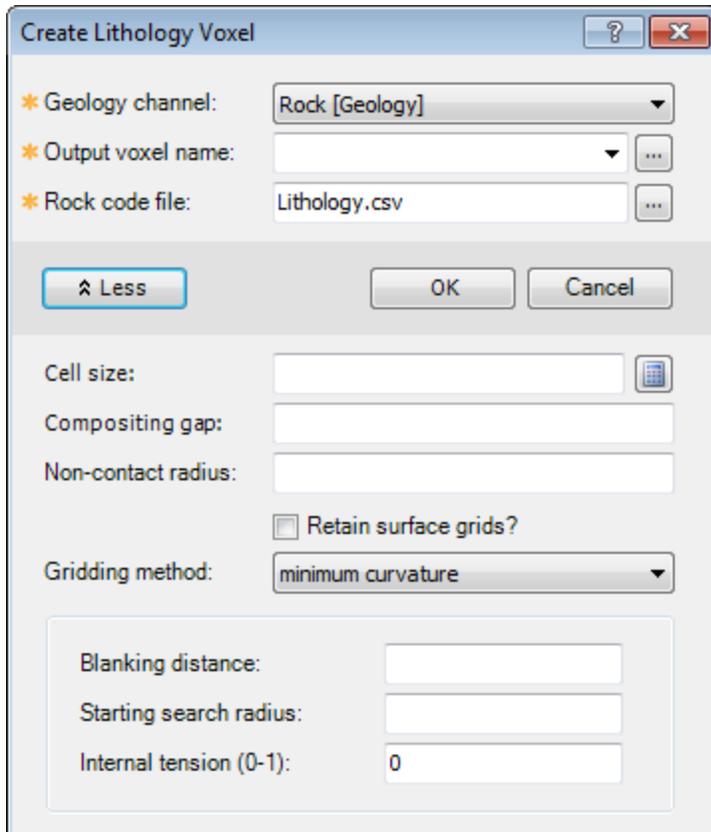
Adjust Voxel Cell Size

In your project, a lithology voxel created with the default parameters may disagree with some of the data in individual drillholes. A better agreement between the hole data and the surface might be achieved by decreasing the voxel cell size.

 *Smaller cell size means longer processing time and a larger output voxel file. When dealing with large datasets, be aware of the trade-off between the processing accuracy and processing time (as well as disk space).*

To Adjust Voxel Cell Size:

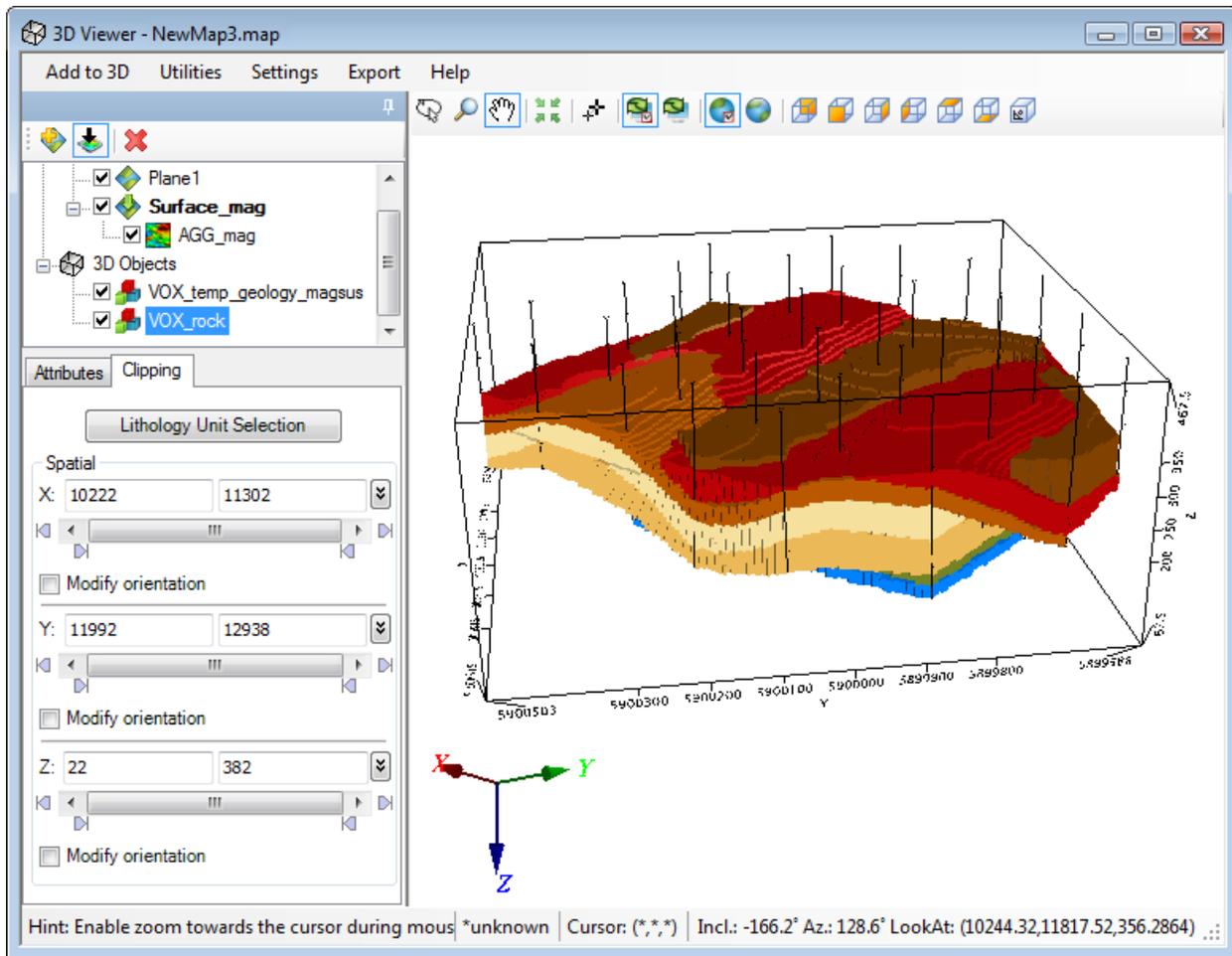
1. With the map open and selected in the 3D Viewer, select *Utilities*, and then select **Create Lithology Voxel**. The *Create Lithology Voxel* dialog appears.
2. Using the *Geology channel* dropdown list, selected the channel to be processed and then click the **More** button. The dialog expands to display additional parameter fields.



3. Change the output voxel name so that you don't overwrite the original voxel.
4. Click the **Calculator** button next to the *Cell size* field. The system calculates the default cell size and displays it in the *Cell size* field.



5. Change the value of the *Cell size* field to a smaller number. You can actually use a real number for the cell size, for example a voxel cell size of 0.5 or 2.5m (any decimal fraction) is acceptable if you desire.
6. Click **OK**. The system creates the requested voxel using the specified cell size and displays it on the current map, as well as in the 3D Viewer .



7. In the View/Group Manager Tool window, uncheck the original voxel to reveal the updated one (unless you overwrote the original voxel).
8. Using the 3D Tool functions (including clipping along axes and clipping to specific lithology units), navigate to the individual holes and verify whether the updated voxel satisfactorily corresponds to the drillhole data. You can now also modify the orientation of the X Y and Z Axes in order to perform Angled Clipping. Angled clipping works for all types of groups and planes.

Adjust Compositing Gap in 3D Drillholes

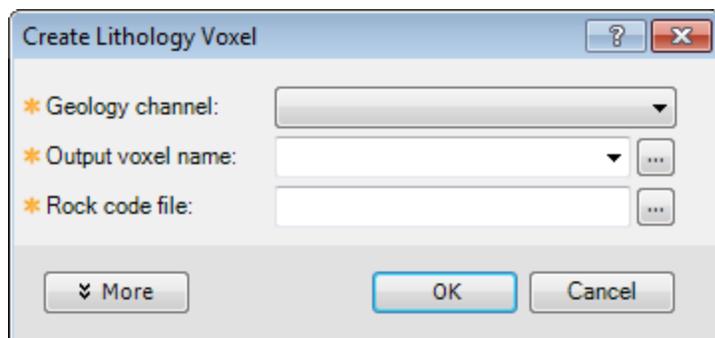
The compositing gap parameter allows for minor un-logged intervals in the data, where it can be assumed that the lithology has not changed from what is present above and/or below that interval.

Any gap between two lithology intervals of the same type that is less than or equal to the value in the Compositing gap field is “interpolated”; in other words, it is assumed that the gap contains the same lithology. If this field is left blank, all gaps are treated as real (no interpolation is performed).

 *Compositing only considers missing data – places where the lithology channel is blank. Thin layers of known lithology are not composited over, even if the compositing gap value is greater than the layer thickness.*

To Adjust Compositing Gap:

1. If you have not done so already, draw your drillholes on the current 3D view using a lithology channel that contains the required data (use *Add to 3D|Drillholes*).
2. On the **Utilities** menu select *Create Lithology Voxel*.
The *Create Lithology Voxel* dialog appears.



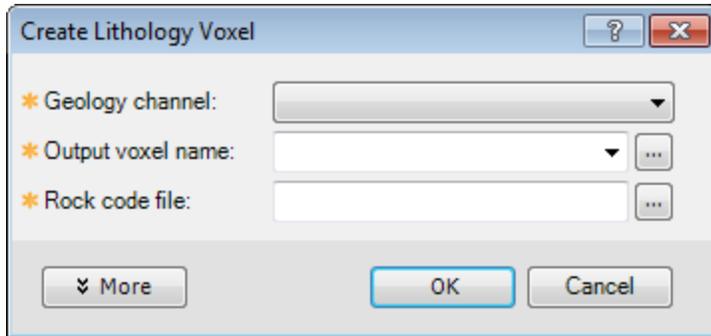
3. Change the default voxel name in the *Output voxel name* field to keep the original voxel intact.
4. Click the **More** button to expand the dialog.
5. In the Compositing gap field enter a value that is an estimate of the smallest visible gap in your data.
6. Click **OK**. The updated voxel is displayed on the new map and in the 3D Viewer.
7. Zoom in to individual drillholes to check and see if your gaps have been composited over.

Adjust the Non-Contact Radius in 3D Drillholes

The non-contact radius parameter defines the radius of a “hole” in a contact surface grid produced by a drillhole that did not intersect the contact surface lithology unit. This parameter is always set to a value smaller than or equal to 50% of the distance from the non-contact point to the nearest contact point. If the Non-contact radius field is left blank, the “hole” is sized for each contact individually, based on 50% of the distance to the nearest contact. If the field is set to zero, no dummyming is performed around holes with no contacts.

To Adjust Non-Contact Radius:

1. Select (highlight) your database in your project workspace.
2. Display your existing voxel, either by opening it or by going to *3D|Create a New 3D View* and dragging your voxel from the Project Explorer to the centre of the blank 3D map.
3. On the **Utilities** menu, select **Create Lithology Voxel**.
The *Create Lithology Voxel* dialog appears.



4. In the *Output voxel name* field, change the default voxel name (so that you don't overwrite the existing voxel).
5. Click the **More** button.
6. In the *Non-contact radius* field, specify a value in ground units.
7. Click **OK**. The updated voxel is displayed on a new map, as well as in the 3D Viewer.
8. Put the initial and the new voxel views side-by-side in your project workspace for comparison.

Other Parameters

You can change other parameters while refining your lithology voxels:

- Gridding method (Minimum curvature – default, or Natural-neighbour TIN)

For the Minimum curvature gridding method:

- Blanking distance
- Starting search radius
- Internal tension

For descriptions of these parameters and the potential results of changing their values, click the **Help** button on the *Create Lithology Voxel* dialog.

Practical Suggestions

This section presents some suggestions for overcoming known limitations of the Lithology voxel feature:

Pinched Out Layers

When a layer pinches out, it may not be possible to get reasonable results if there are more layers of the same lithology unit in the dataset. The suggested approach is as follows:

1. Create surfaces for layers above the pinch-out as usual
2. Create a surface for the last layer of the unit sequence using the “last layer” selection
3. Exclude holes while creating a surface for the pinched out layer
4. While creating surfaces for layers below the pinch-out, create two separate confined grids to represent a single layer

Folded and Faulted Layers

For folded and faulted layers, it may be necessary to adjust non-contact radius and/or blanking distance to better represent regions that are missing due to the complexity of the geology.

Differentiation between folded and faulted lithologies is difficult based on the surfaces created using the Geology 3D procedure. It may be possible to distinguish between folds and faults by considering behaviour of all the layers:

1. Folded layers bend about the same apex, while faulted layers may bend at different apexes.
2. Folded layers may have parts of the unit missing at the tops or bottoms of folds, while faulted layers may have parts of the unit missing in the vicinity of the fault plane (less likely to look like an apex of a fold).
3. When intruding units are involved, especially if there are several intrusions of the same type of unit, it may be necessary to exclude certain holes from the surface gridding to produce reasonable results.
4. In cases where a similar rock type has repeating layers in the subsurface, you achieve better results by differentiating these units by using different names for each layer. This way you can create surfaces for each successive layer.

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