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Tutorial: Using Layers and XYZ Files to Model Stratigraphy

PetraSim 5

Introduction

This model will begin from a new, empty model and walk through importing XYZ files that define layer stratigraphy and changing the XY bounds of the model to match.
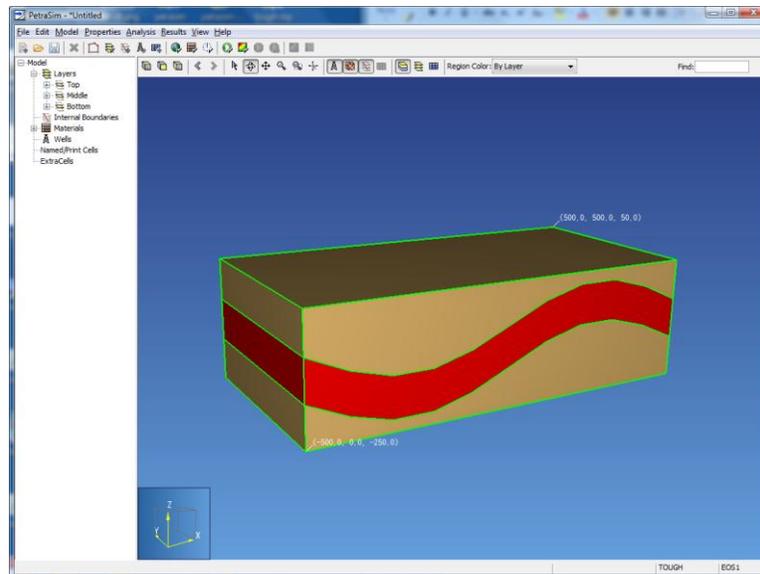

Figure 1: The layered model that will be created.

This tutorial uses two files provided in a resources archive on PetraSim's support web site. These files are located in the "using-layers" folder of the resources archive.

Create a New Model

To create a new, default model:

1. On the **File** menu, click **New**
2. Click **OK** to create a default model

Edit Layers

To create the curved layers, we will use XYZ files. These files were created in Excel, but some modeling packages (e.g. RockWorks) can export XYZ files that describe model stratigraphy.

PetraSim is flexible when defining layers, but the system is a bit more intuitive when working from the top layer downward. For each new layer we specify a base and the top will be taken to be the base of the layer above[1].

To edit the top layer:

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[1] Specifying a layer base that is above the top layer will cause the "Base" field to be reinterpreted as the top of the new layer.

1. On the **Model** menu, click **Edit Layers...** A layer named *Default* will be selected.
2. In the **Name** box, type *Top*
3. In the **Top** box, type *50*
4. In the **Base** box, select **From File** option, then load the file named *strat-high.txt*
5. Click **Apply** to save changes to the layer

To add the middle layer:

1. Click **New...**
2. In the **Name** box, type *Middle*
3. In the **Base** box, select **From File**, then open the file named *strat-low.txt*
4. Click **OK** to add the layer
5. Click **Color**, on the **Palette** tab select a shade of red, then click **OK**
6. Click **Apply** to save changes to the layer

To add the bottom layer:

1. Click **New...**
2. In the **Name** box, type *Bottom*
3. In the **Base** box, select **Constant**, then type *-250*
4. Click **OK** to add the layer

Click **OK** to close the **Edit Layers** dialog. If you rotate the 3D model display a bit, you can see the layers as shown in Figure 2.
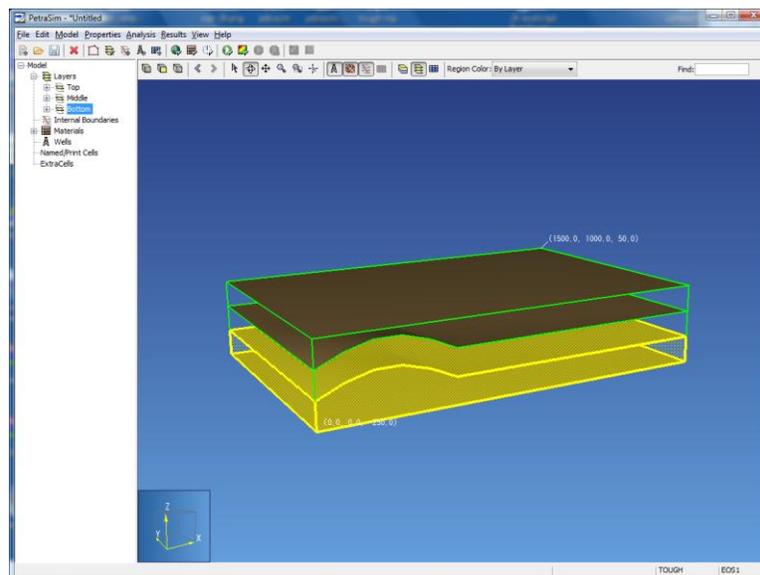

Figure 2: The model after modifying the layer settings.

You may notice that the layer is only curved near the min corner of the model. This is because the XY bounds (i.e. boundary when viewed from above) have not yet been fit to the extents of the files we are using to set layer elevation. To correct this, we need to edit the model boundary.

Edit Model Boundary

To edit model boundary: on the **Model** menu, click **Edit Boundary**.

The Edit Boundary dialog shows the 2D XY bounding box for the model and has some editing controls in a toolbar at the top. In the toolbar, click **Show Layer Boundaries** ( ). After enabling this setting, a white box in the lower left corner should appear (Figure 3).
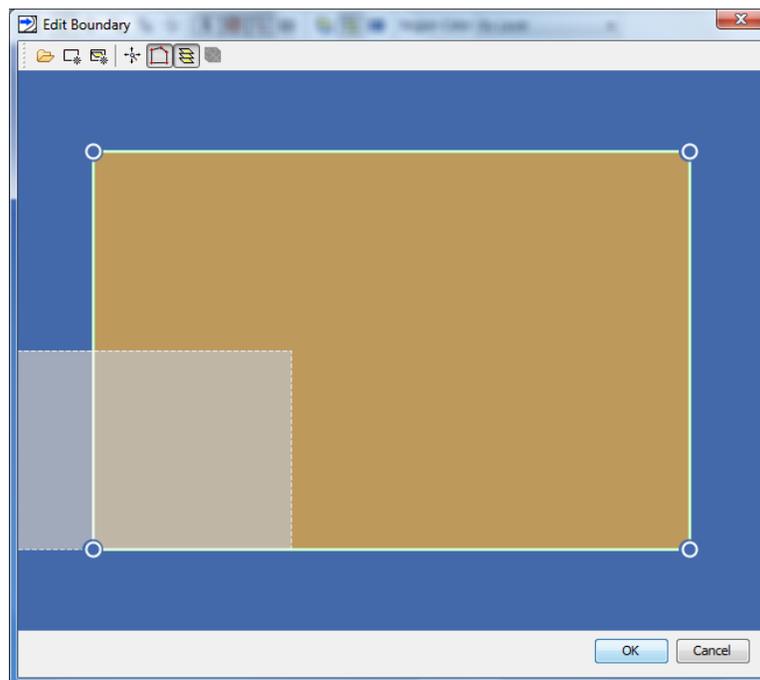

Figure 3: The current boundary with the layer boundaries shown.

This white box represents the extent of the data given in the XYZ files used to define layer elevations. The next step is to match the model boundaries to the extent of the data. This can be accomplished by manually adjusting the boundary, but PetraSim provides a quick set utility to help in this case.

To match the model boundary to the layer data extent:

1. On the toolbar, click **Auto Size to Layers** ( )
2. Click **OK**

The boundary, represented by white circles joined by solid white lines, will have shifted to match the shaded layer extents.

Click **OK** to exit the **Edit Boundary** dialog. If you rotate the 3D model display and click **View Boundary** ( ) on the toolbar, you can see the layers with the corrected boundary (Figure 4).
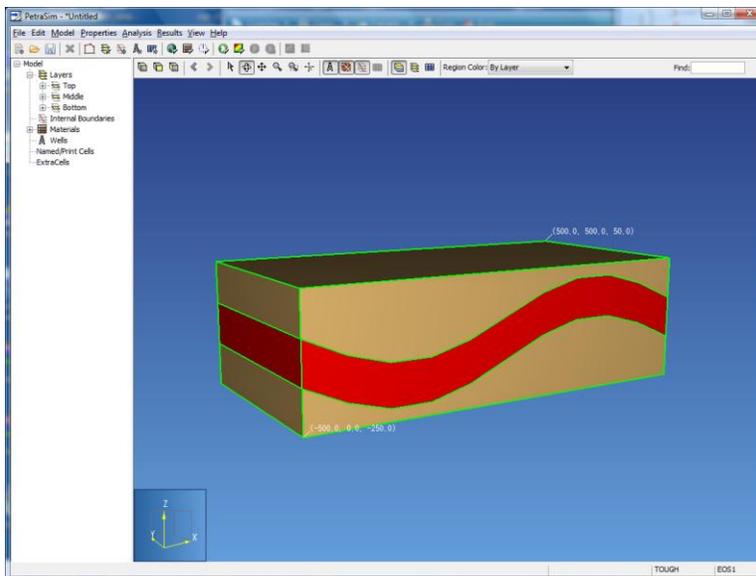
Figure 4: 3D view of the model with a boundary that matches the layer data extents.

Layers can be used to set material properties and to aid in working with large regions of cells, without editing the cells individually. When properties such as material and initial conditions are set at the layer level, rather than at the cell level, it is possible to experiment with multiple meshing strategies without having to re-enter simulation data.

Layers and the Simulation Mesh

Layers and divisions control the simulation mesh. Meshes in PetraSim will conform to layer contours. The number of divisions specified in each layer will control how many cells "thick" a layer is in the Z direction. The following steps illustrate the relationship between layers and the simulation mesh.

To create a simulation mesh:

1. On the **Model** menu, click **Create Mesh...**
2. In the **Mesh Type** box, select **Polygonal**
3. Click **OK**

These steps will produce a simulation mesh. Within each column of the simulation mesh, the X and Y coordinates of the cells will be identical throughout[2]. Within each layer, the Z-coordinates for each cell will vary to conform to the simulation mesh. This can be seen by looking at a side view of the model, or hiding the upper layer.

To hide the upper layer of cells:

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[2] This is required because the TOUGH2 input format does not have the flexibility necessary to specify permeability for an arbitrary mesh.

1. Right-click any cell in the middle (red) layer
2. On the popup menu, click **Hide Cells Above**

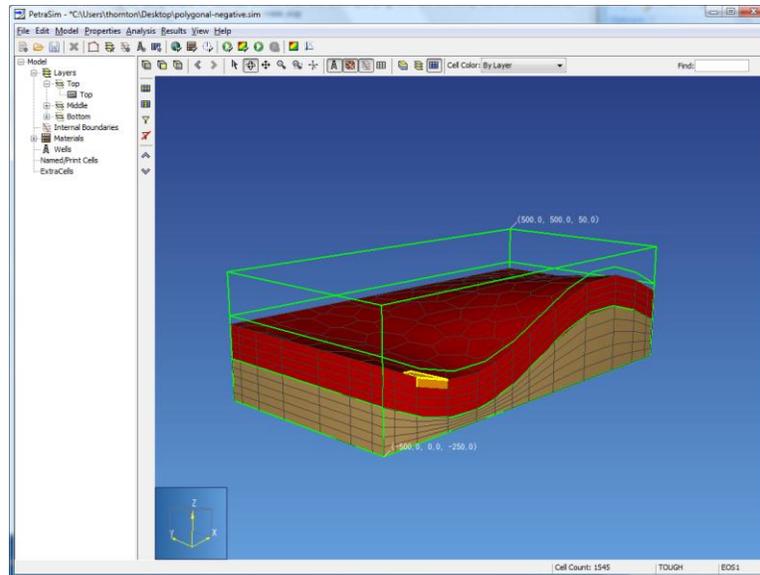The resulting view is shown in Figure 5.

Figure 5: 3D view of the model after hiding cells in the upper layer.

To show the hidden cells:

1. Right-click anywhere inside the 3D view
2. In the popup menu, click Show All Cells (✈)

By working with visibility settings, it is possible to edit individual cells anywhere in the model using the 3D view. Ideally, edits to individual cells should be avoided because this creates a dependence on a specific mesh (containing this data) and may make it more difficult to change the model in the future. Changes to layers, wells, and regions are all independent of the mesh. Using only these high-level constructs makes it possible to quickly re-run simulations with different meshes at a later time.