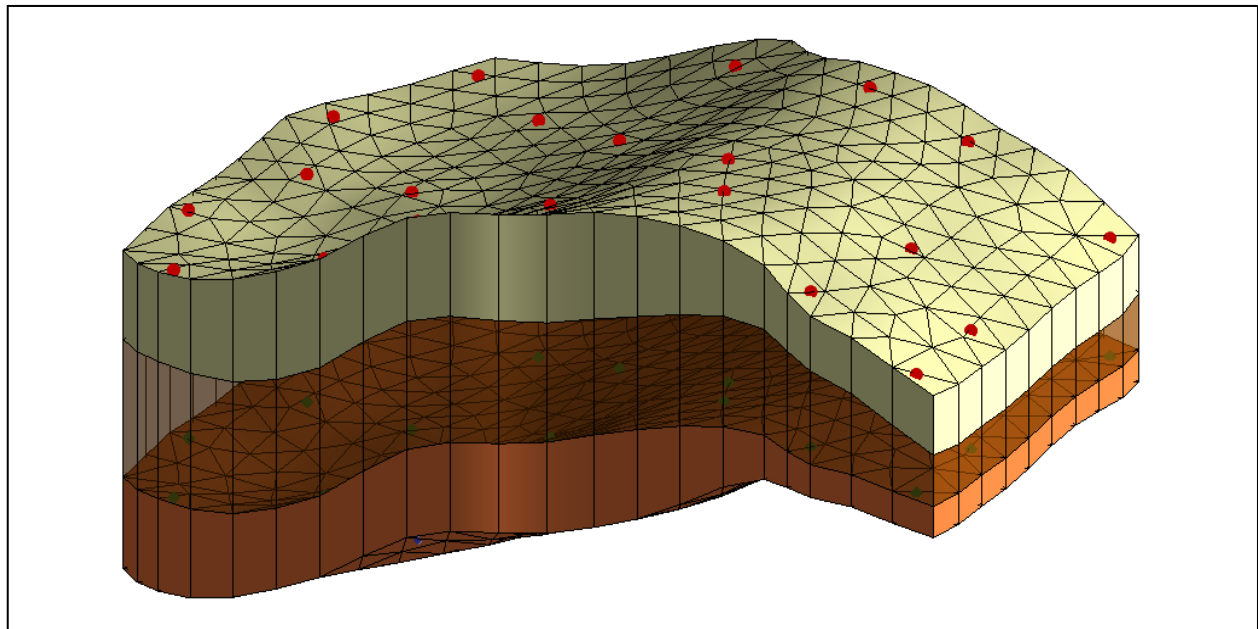


*GMS 10.0 Tutorial*

## **Stratigraphy Modeling—Horizons, TINs, and Meshes**

Use TINs with horizons to create 3D, finite element meshes



### Objectives

Learn how to use TINs to assign horizon surfaces and how to create three-dimensional, finite element meshes from the horizon data.

#### Prerequisite Tutorials

- Stratigraphy Modeling - Horizons and Solids

#### Required Components

- Geostatistics
- Map Module
- Mesh Module
- Sub-surface Characterization

#### Time

- 15-30 minutes



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# 1 Introduction

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This tutorial builds on the concepts taught in the tutorial entitled “Stratigraphy Modeling—Horizons and Solids.” In that tutorial, the user created solids using horizons defined on boreholes and cross sections. In this tutorial, there is instruction on how to use TINs to assign horizon surfaces and how to create three-dimensional, finite element meshes from the horizon data.

## 1.1 Outline

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These are the steps of the tutorial:

1. Import scatter data.
2. Create a meshing conceptual model.
3. Create horizon TINs
4. Create a 3D mesh from the horizons.

# 2 Getting Started

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Do the following to get started:

1. If necessary, launch GMS.
2. If GMS is already running, select the *File / New* command to ensure that the program settings are restored to their default state.

### 3 Overview

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Creating a three-dimensional mesh of soil stratigraphy using the horizons approach in GMS is quite simple. First, it is necessary to read in some scatter set data. The second step is to create a meshing conceptual model. Then it will be necessary to use the conceptual model and scatter data to create the TIN horizon surfaces. Finally, it will be possible to execute the **Horizons → 3D Mesh** command to create a three-dimensional mesh.

### 4 Reading Scatter Data

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The first step in the construction of the 3D mesh is to import the scatter data. Scatter data can be entered into GMS manually, or the data can be read in from a file. In the interest of time, the user will read in a previously prepared file.

To read in the file:

1. Select the **Open** button .
2. Open the directory entitled *Tutorials\Stratigraphy\_Modeling\Horizons\_TINs\_and\_Meshes*.
3. Select the file named “scatter.gpr.”
4. Click on the **Open** button.

It should now be possible to see a 3D view of some scatter sets.

### 5 Constructing the Meshing Conceptual Model

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The user will first construct a conceptual model using the map module. The conceptual model will contain a coverage that is used to define the TIN layers and a 2D mesh. The 2D mesh will then be used to define the topology and boundary of the 3D mesh.

#### 5.1 Setting up the Conceptual Model

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
1. In the Project Explorer, right-click on the empty space and then, from the pop-up menu, select the *New / Conceptual Model* menu command.
2. Change the *Name* to “Case1.”
3. Change the *Type* to “FEMWATER,” and select **OK**.

The user isn't actually going to create a FEMWATER model, but it is necessary to have a coverage that can be used to create a 2D mesh, which is something that the FEMWATER conceptual model has.

4. Right-click on the new conceptual model, and select the **New Coverage** command.
5. In the *Coverage Setup* dialog, change the *Coverage name* to “mesh1.”
6. In the list of *Areal Properties*, turn on *Meshing options*.
7. Select **OK** to exit the *Coverage Setup* dialog.

## 5.2 Creating the Meshing Polygon

Do the following to create a polygonal boundary:

1. Click on the new coverage “mesh1.”
2. Select the **Plan View**  button.
3. Select the **Create Arc**  tool.

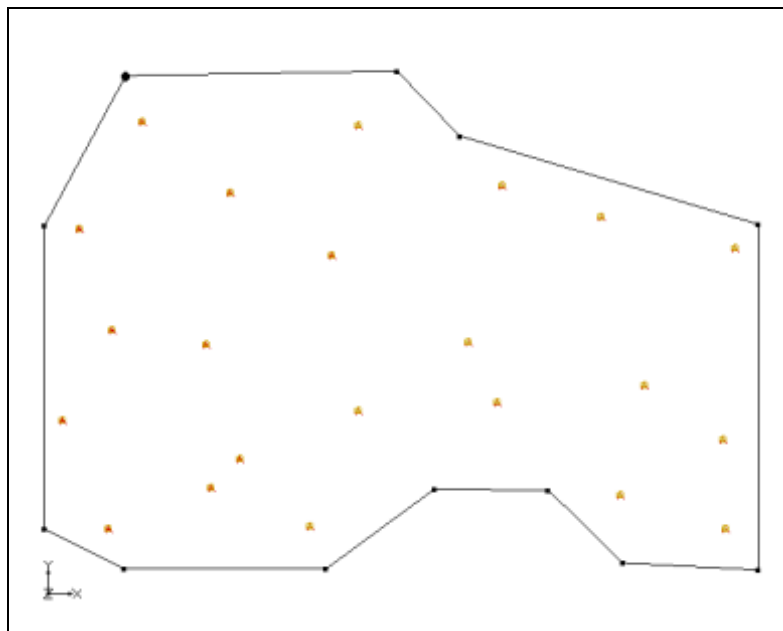



Figure 1 Map polygon surrounding scatter data

4. Do the following to click out a polygon similar to the one in the figure above: Single-click in the upper left portion of the graphics window to begin creating the polygon; click out the rest of the points that make up the polygon; double-click on the starting point to finish creating the polygon.
5. Select the *Feature Objects* / **Build Polygons** menu command.
6. Switch to the **Select**  tool.

7. Right-click on the arc that was just created, and select the **Redistribute Vertices** command from the pop-up menu.
8. The *Redistribute Vertices* dialog will appear.
9. In the *Specify* section of the dialog, make sure that the *Specified Spacing* option is selected.
10. Enter a value of “150” for the *Average spacing*, and click **OK**.

## 6 Creating Horizon Surfaces

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It will now be possible to use the newly defined polygon to create the TIN horizons.

### 6.1 Create the Tins

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1. Right-click on the “mesh1” coverage and select the *Map To / TIN* command.
2. In the *Properties* dialog, change the *TIN name* to “Case1\_Hor4.”
3. Set the *TIN material* to “Fine Sand.”
4. Change the *Horizon ID* to “4.”
5. Select **OK**.
6. Repeat the steps 1–5 to create 3 more TINs from the coverage with the following properties:


	1	2	3
<b>TIN Name:</b>	Case1_Hor3	Case1_Hor2	Case1_Bot
<b>TIN Material:</b>	Silty Clay	Silty Sand	Bedrock
<b>Horizon ID:</b>	3	2	0

### 6.2 Interpolate

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The next step is to interpolate the layer elevations from the scatter sets to the TINs.

1. In the Project Explorer, select the TIN  titled “Case1\_Hor4” to make it active.
2. If necessary, in the Project Explorer, expand the “2D Scatter Data” folder.
3. Expand the *Case 1*  scatter set if necessary, and then select the “top1” dataset to make it active.

4. Right-click on the *Case 1*  scatter set and select the *Interpolate To / Active TIN* command.
5. In the *Interpolate → Object* dialog, select **OK** to interpolate the values.
6. In the Project Explorer, expand the “Case1\_Hor4” TIN so to see its datasets.
7. Right-click on the dataset titled “default,” and select the **Delete** command.
8. Repeat steps 1-5 above to interpolate all of the remaining layer elevations to the corresponding TIN horizons as seen in the following table:



Case 1 Scatter Set Dataset	TIN
bot1	Case1_Hor3
bot2	Case1_Hor2
bot3	Case1_Bot

9. After doing the interpolation for all the TINs, make sure to delete all the “default” datasets on all the TINs by right-clicking on them and selecting the **Delete** command.

### 6.3 View the Surfaces

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To view the horizon surfaces:

1. Select the **Oblique View**  button.
2. Select the **Rotate**  tool and drag the mouse in the graphics window to rotate the view.

### 6.4 Organize TINs Into a Folder

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Now it is possible to organize the TINs into a folder to be used in the horizons process.

1. In the Project Explorer, right-click on the “Tin Data”  folder and select the **New Folder** command.
2. Change the *name* of the folder to “Case1.”
3. In the Project Explorer, drag and drop each of the four TINs into the “Case1” folder (see Figure 2).

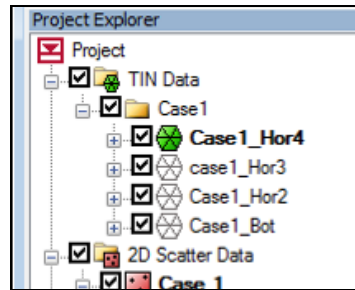


Figure 2 TINs organized into a folder

## 7 Creating the Mesh

Do the following to create the mesh from the TIN horizons:

1. Right-click on the “mesh1” coverage and select the *Map To / 2D Mesh* command. This 2D mesh is needed in order to generate the 3D mesh.
2. Select the “TIN Data” folder.
3. Select the *TINs | Horizons → 3D Mesh* menu command.



This brings up the *Horizons to 3D Mesh* wizard in which the user will pick the interpolation scheme used to create the mesh. Also, the next steps will specify how the top and bottom elevations of the stratigraphy model will be determined.

4. On the first page of the wizard, select the *Select TIN folder* option.
5. Select the “Case1” folder in the tree window, and click the **Next** button.
6. In the *Top elevation* section of the dialog, select the *TIN elevations* option. This means that the specified TIN surface will be used in interpolating to the top of the 3D Mesh.
7. Select the “Case1\_Hor4” TIN to be used as the top elevation in the tree window.
8. In the *Bottom elevation* section of the dialog, select the *TIN Elevations* option and select the “Case1\_Bot” TIN.
9. Click the **Next** button.
10. In the *Interpolation method* section of the dialog, select the *Inverse distance weighted* option.
11. Select the **Finish** button.

## 7.1 Viewing the 3D Mesh

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To view the mesh:

1. Select the “3D Mesh data” folder.
2. Select the **Display Options**  button.
3. Turn on the *Element faces*.
4. Select the **OK** button.
5. Select the **Rotate**  tool and drag the mouse in the graphics window to rotate the view.

The user has now created a simple 3D Mesh consisting of three different layers of materials.

## 8 Other Scenarios

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Included in the project file are four other scatter sets that can be used to create different layer elevations. The user could interpolate these values to the TIN horizons and create different meshes.

## 9 Conclusion

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This concludes the tutorial. Here are some of the key concepts in this tutorial:

- TINs can be used to create horizon surfaces.
- A 3D mesh can be created directly from horizon data.
- The **Horizons** command can operate on just a subset of the TINs or boreholes in the project.