GMS 10.4 Tutorial
Stratigraphy Modeling—Horizons with Rasters
Create solids from rasters using the Horizons → Solids tool.

Objectives
Learn what a raster catalog is and how it can be used to create subsurface models.

Prerequisite Tutorials
- Stratigraphy Modeling—Horizons and Solids

Required Components
- Sub-surface Characterization
- Geostatistics
- Map Module
- GIS Module

Time
- 20–30 minutes
1 Introduction

This tutorial builds on the concepts taught in the “Stratigraphy Modeling—Horizons and Solids” tutorial. In that tutorial, solids were created using horizons defined on boreholes and cross sections. In this tutorial, horizons will be assigned to rasters and then used to create solids. This tutorial will begin with a simple problem to illustrate the concepts involved in using rasters to create solids. Then this tutorial will apply the method to data from Sacramento, California, USA.

This tutorial will demonstrate the following:

1. Import a project with rasters.
2. Create a raster catalog and assign horizon IDs.
3. Create solids from the horizons.
4. Repeat these steps using data from the Sacramento, California region.

1.1 Getting Started

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.
2 Importing the Project

The first step in the construction of the solid models is to import a set of borehole logs. Borehole data can be entered into GMS manually, or the data can be read from a file. In the interest of time, import a previously prepared file by doing the following:

1. Click Open to bring up the Open dialog.
2. Select “Project Files (*.gpr)” from the Files of type drop-down.
3. Browse to the Horizons_with_Rasters\Horizons_with_Rasters directory and select “rasters.gpr”.
4. Click Open to import the project and close the Open dialog.

A TIN and multiple rasters have been loaded into this GMS project (Figure 1).

![Figure 1 Tin and rasters displayed in the Graphics Window](image)

3 Viewing Raster Elevations

The display options are currently set to view the rasters as points.

1. Switch to Oblique View.
2. Frame the project.

The two lower rasters slope upward toward the right of the image. The upper two rasters are at constant elevations (Figure 2).
The next step is to change the display of the raster to background imagery.

1. Change to **Plan View**.

2. Right-click on the “GIS Layers” folder in the Project Explorer and select **Display Options…** to bring up the **Display Options** dialog. Notice that “GIS Data” is already selected in the list on the left.

3. On the **GIS** tab in the **Rasters** section, select **Display as 2D image** and click **OK** to exit the **Display Options** dialog.

The Graphics Window should now appear similar to Figure 3.

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**Figure 2**  Raster surfaces

**Figure 3**  Rasters displayed as background imagery
4 Creating the Raster Catalog

A raster catalog is a table that allows assigning attributes to rasters. In this case, it is necessary to assign horizon IDs to the rasters.

1. Expand the “GIS Layers” folder in the Project Explorer and select “unit1.tif” raster.

2. While holding down the Shift key, select the “unit4.tif” raster. This should select all four rasters.

3. Right-click on the selected rasters and select New Raster Catalog… to bring up the Raster Catalog dialog (Figure 4).

![Raster Catalog](image)

Figure 4 Raster catalog

This dialog allows associating properties with a raster. First, it is necessary to assign horizon IDs and materials to each raster.

4. Enter values from the table below into the Horizon ID and Material fields for each raster.

<table>
<thead>
<tr>
<th>Raster</th>
<th>Horizon ID</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>unit1.tif</td>
<td>1</td>
<td>unit1</td>
</tr>
<tr>
<td>unit2.tif</td>
<td>2</td>
<td>unit2</td>
</tr>
<tr>
<td>unit3.tif</td>
<td>3</td>
<td>unit3</td>
</tr>
<tr>
<td>unit4.tif</td>
<td>4</td>
<td>unit4</td>
</tr>
</tbody>
</table>

5. Make certain the Fill column for each of the four entries is on.

6. Select OK to exit the Raster Catalog dialog.
5 Creating Solids

It is now possible to create solids using the raster catalog. The Horizons → Solids command allows using any combination of borehole, TIN, conceptual model, and raster data to create solids. In this example, only the raster catalog will be used to define the horizon elevations.

1. Select and right-click on “Raster Catalog” in the Project Explorer and select Horizons → Solids... to bring up the Horizon Elevations page of the Horizons to Solids dialog.

2. In the Raster Catalog section, select “Project\GIS Layers\Raster Catalog” from the drop-down.

3. Click Next to close the Horizon Elevations page and open the Top and Bottom Elevations page of the Horizons to Solids dialog.

There is only one TIN in this project and it will be used as the primary TIN. Additionally, it is necessary to use this TIN's elevations as the top of the solids and to use a constant elevation of “-145.0” as the bottom elevation of the solids.

4. In the Top elevation section, select TIN elevations and “tin (1)” from the tree list below that.

5. In the Bottom elevation section, select Constant elevation and enter “-145.0” in the field below that.

6. Click Next to close the Top and Bottom Elevations page and open the Build Solids page of the Horizons to Solids dialog.

7. In the Solids section, turn on Minimum solid thickness and set the value to be “1.0”.

8. Click Finish to close the Horizons to Solids dialog.

5.1 Viewing the Solids

The Horizons → Solids process should complete quickly, and a new folder of solids should appear in the Project Explorer.

1. Switch to Oblique View.

The solids should look similar to Figure 5. Notice how the lower two layers extend upward on the left side of the solids and cut off the upper two layers.
6 Changing the Fill and Clip Fields

Now see the effect of changing the Fill and Clip fields in the raster catalog. When the raster catalog was first created and the dialog appeared, the check boxes for the Fill field were on by default. The Fill field indicates to use the raster to create a solid. It means the Horizons → Solids operation will Fill between this raster and the lower surfaces. If the Fill field is turned off, then it will not create a solid that is associated with the particular raster. The Clip field is used to indicate a surface that “Clips” or truncates any lower surfaces. This process is best illustrated by the following steps:

1. Double-click on the “Raster Catalog” item in the Project Explorer to open the Raster Catalog dialog.
2. Uncheck the check box in the Fill field for “unit3”.
3. Select OK to exit the Raster Catalog dialog.
4. Right-click on the “Raster Catalog” item and select the Horizons → Solids command to open the Horizons to Solids dialog again.
5. Select the Finish button to close the Horizons to Solids dialog and generate a new set of solids.

6.1 Viewing the Solids

When the Horizons → Solids command is finished, multiple solids will have been created in the same location. The next step is to turn off the first set of solids that were created.

1. Uncheck the “solids” folder under the “Solid Data” item in the Project Explorer.

The solids should look like Figure 6 below. Notice that no solid was created for “unit3”. 

Figure 5 Solids created from raster catalog
6.2 Changing the Clip Field

Now it is possible to change the *Clip* field for the “unit3” raster and view the effect.

1. Double-click on the “Raster Catalog” item in the Project Explorer to open the *Raster Catalog* dialog.

2. Check the check box in the *Clip* field for “unit3”.

3. Select **OK** to exit the *Raster Catalog* dialog.

4. Right-click on the “Raster Catalog” item and select the *Horizons* → *Solids* command to open the *Horizons to Solids* dialog again.

5. Select the **Finish** button to close the *Horizons to Solids* dialog and generate a new set of solids.

6.3 Viewing the Solids

1. Uncheck the “solids (2)” folder under the “Solid Data” item in the Project Explorer.

The solids should look like Figure 7 below. Notice that while no solid was created for unit3, the raster was used to "clip" or truncate the units as seen in Figure 7.
Figure 7  Solids created with the "Clip" field on for the unit3 raster

7  Sacramento Data

It is now possible to use what has been learned to create solids of data from the Sacramento Valley.

1. Select the File | New command.
2. Select Don’t Save when asked to save the project.
3. Select the Open button to bring up the Open dialog.
4. Select “Project Files (*.gpr)” from the Files of type drop-down.
5. Browse to the directory entitled Horizons_with_Rasters\Horizons_with_Rasters\ and select the file named “sacramento.gpr”.
6. Click Open to import the project and close the Open dialog.

The Figure 8 image should be visible in the GMS graphics window. This project contains two TINs to define the top and bottom of the solids, a map coverage with the surface geology, multiple rasters to define top elevations for stratigraphic units, and an aerial photo of the Sacramento region.
Figure 8  Map view of Sacramento Region Data

7.1 Creating the Raster Catalog

It is now possible to create a raster catalog and assign horizon IDs to the rasters.

1. Expand the “GIS Layers” item in the Project Explorer.
2. Select the “TOP7.bil” raster in the Project Explorer.
3. Hold down the Shift key and select the “TOP1.bil” raster in the Project Explorer.

All five rasters should now be selected.

4. Right-click on the selected rasters and select the New Raster Catalog command to bring up the Raster Catalog dialog.
5. Fill in the Horizon ID and Material fields as shown in the table below.

<table>
<thead>
<tr>
<th>Raster</th>
<th>Horizon ID</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOP7.bil</td>
<td>1</td>
<td>Ione</td>
</tr>
<tr>
<td>TOP6.bil</td>
<td>2</td>
<td>Valley Springs</td>
</tr>
<tr>
<td>TOP4.bil</td>
<td>3</td>
<td>Mehrten</td>
</tr>
<tr>
<td>TOP2.bil</td>
<td>4</td>
<td>Turlock Lake Laguna</td>
</tr>
<tr>
<td>TOP1.bil</td>
<td>5</td>
<td>Riverbank</td>
</tr>
</tbody>
</table>

6. Select OK to close the Raster Catalog dialog.
7.2 Creating Solids

Do the following to create solids from the rasters:

1. Right-click on the “Raster Catalog” item and select the Horizons → Solids command to open the Horizons to Solids dialog.

2. Select the “Project\GIS Layers\Raster Catalog” item in the drop down list in the Raster Catalog section of the dialog (upper right).

3. Click Next to close the Horizon Elevations page and open the Top and Bottom Elevations page of the Horizons to Solids dialog.

4. Ensure that Tin elevations is the selected option for Top elevation (middle section of the dialog) and that “top” is the selected TIN.

5. Ensure that Tin elevations is the selected option for Bottom elevation (right section of the dialog) and that “bottom” is the selected TIN.

6. Click Next to close the Top and Bottom Elevations page and open the Build Solids page of the Horizons to Solids dialog.

7. Make sure that the Minimum solid thickness option is on and that a value “1.0” has been entered.

8. Select the Finish button to close the Horizons to Solids dialog.

7.3 Viewing the Solids

The Horizons → Solids process should complete quickly and a new folder of solids should appear in the Project Explorer.

1. Select the Oblique View button.

The solids should appear like Figure 9 below.
If desire, rotate the view, apply lighting, or cut cross sections through the solids.

8 Conclusion

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

- Rasters can be used to create solids.
- To use rasters with the horizons method, it is necessary to create a raster catalog and assign horizon IDs to the rasters.
- Rasters can be combined with any combination of boreholes, cross sections, TINs, and conceptual model data to create solids using the horizons method.