



Oasis montaj How-To Guide

VOXI Earth Modelling - Extending a Model



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Geosoft Incorporated
Queen's Quay Terminal
207 Queen's Quay West
Suite 810, PO Box 131
Toronto, Ontario
M5J 1A7
Canada
Tel: (416) 369-0111
Fax: (416) 369-9599

Website: www.geosoft.com

E-mail: info@geosoft.com

Support

For obtaining technical support, email support@geosoft.com

If you wish to speak to a technical support representative in your region, please visit the Geosoft Support page at: www.geosoft.com/about-geosoft/contact-us/world-offices for contact information.

Extending a Model

Overview

This document describes how to extend a model by padding the active volume. It focuses solely on the functionality in the VOXI Earth Modelling interface and assumes that you are familiar with the Oasis montaj environment.

In this example, you will:

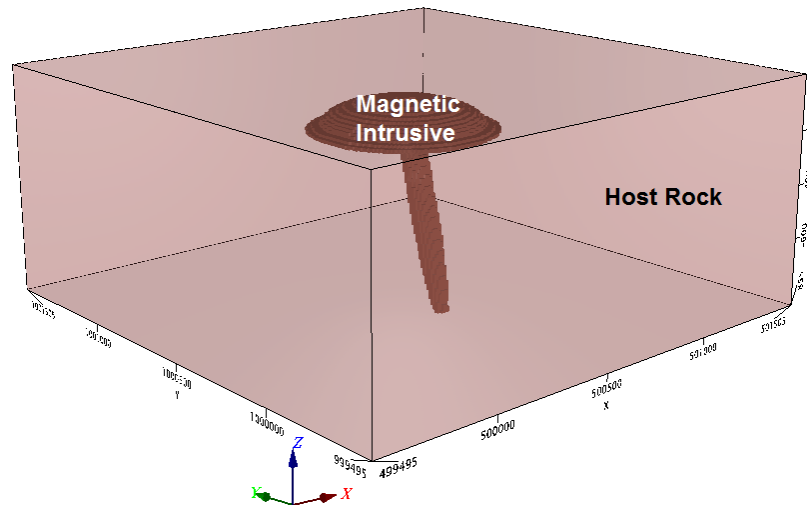
- Create a new VOXI session from a voxel
- Add data to the model
- Run a forward model
- Pad the active volume
- Run a forward model again
- View the predicted response database
- Compare the predicted response grids in the 3D Viewer

Introduction

The active volume, for which the potential field is calculated, is surrounded by Earth that contributes to the potential field response over the area of interest. In practice, the contribution of the surrounding material is of a regional nature. Padding is introduced to compensate for this regional effect. The absence of padding is equivalent to the surrounding material having a zero-effect; however, in reality this is not the case. When calculating the predicted field, the absence of surrounding Earth material results in a distinct drop towards zero around the edge of the earth model. The objective of padding the active volume is to mitigate this effect. Padding is added in the computational phase and is removed before generating the output Earth model and its predicted field. In this example, you will examine the effect of varying the amount of mesh padding.

In order to isolate the padding behaviour, in this document you will use a simple, synthetic magnetic intrusive model hosted in a less magnetic homogeneous rock. To further simplify the model, the geomagnetic field is set to the magnetic pole.

Figure 1.1 Magnetic intrusive body in a homogeneous host rock of a lesser magnetic signature



In this synthetic model, the intrusive body has a susceptibility of 0.005 SI, while the host rock has a lesser susceptibility of 0.001 SI.

To examine the effect of padding the active volume, the predicted response of the above synthetic model will be calculated with:

- Default padding (5 cells)
- No padding (0 cells)
- Increased padding (10 cells)

No other parameters will be changed in order to isolate and compare the effect of extending the cell padding.

The data used in this guide can be downloaded [here](#). Please refer to the *README.txt* file for a description of the files and where to save them.

The folder includes the following:

- The voxel model for which to calculate the potential field.
- A database containing observation coordinates in 3D space and a potential field channel. The database must have a projected coordinate system defined. The potential field channel need not have meaningful data; however, this channel must exist to perform a forward potential field calculation.
- Colour tables for displaying the voxel and comparing the predicted response



Because this example uses a synthetic model, only the horizontal padding is examined. Depending on the geologic structure you are modelling, you may need to adjust the vertical padding as well. An unexplained long wavelength effect may be due to the structure in depth and may be mitigated by increasing the vertical padding.

You will begin by creating a new project and loading the VOXI menu.

To load the VOXI menu:

1. Start Oasis montaj and create a new project in the **VOXI Extending a Model Data** folder named **VOXI.gpf**.

- From the **GX** menu, select **Load Menu**.

The Load Menu window opens.

- Select **vox1.omn** and click **Open**.

The VOXI menu is added to your menu bar.

New VOXI from Voxel

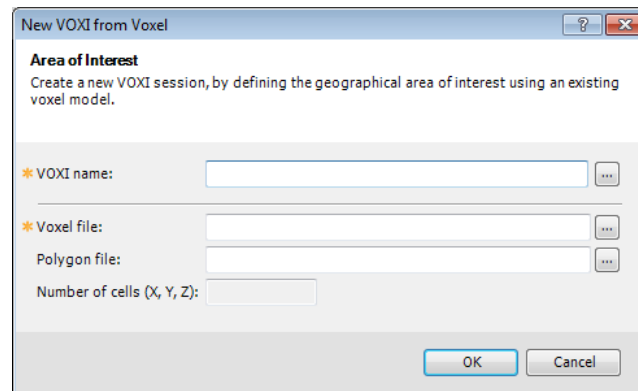
VOXI offers two approaches for defining the area of interest (AOI); you can either use a polygon that outlines the area, or you can supply a georeferenced voxel model compiled from other sources, the outline of which will be automatically calculated. In this example, you will use a supplied voxel model to define the area of interest.

To create a new VOXI session from a voxel:

- From the **VOXI** menu, select **New VOXI from Voxel**.


The New VOXI from Voxel dialog box opens.

Figure 1.2 New VOXI from Voxel dialog box



- For **VOXI name**, enter **Padding Effect**.
- For the **Voxel file**, click the **Browse** button (...).
- From the **VOXI Extending a Model Data** folder, select **Intrusive Model.geosoft_voxel** and click **Open**.

The Number of cells (X, Y, Z) updates based on the size of the input voxel.

 *Optionally, a polygon file can be used to define the extents of the area to be modelled; if one is not selected, the footprint of the voxel will be modelled.*

- Click **OK**.

The VOXI Viewer opens and displays the voxel mesh to be modelled and a polygon defining the area of interest; the Add Data to VOXI message window opens asking if you would like to run the Add Data wizard.

Figure 1.3 VOXI Viewer

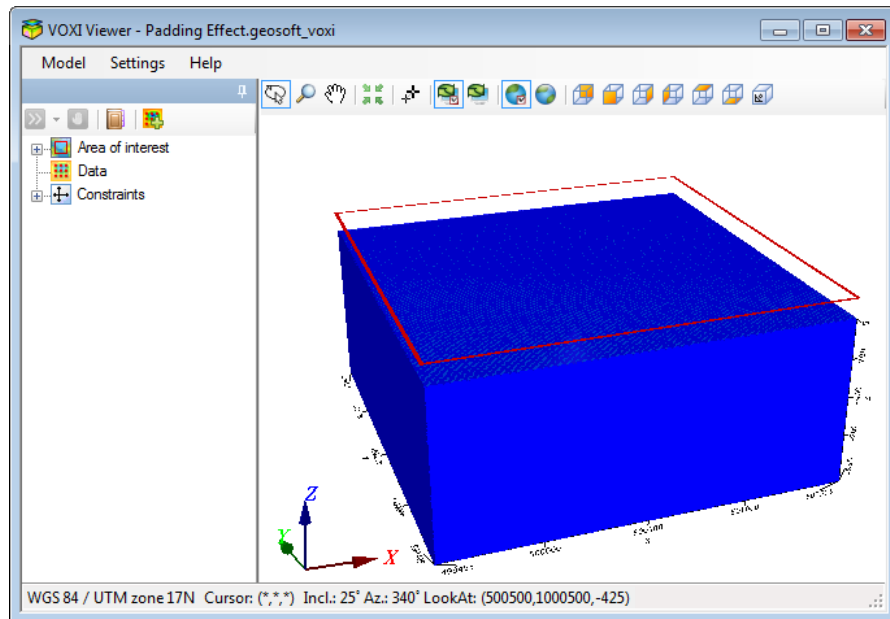
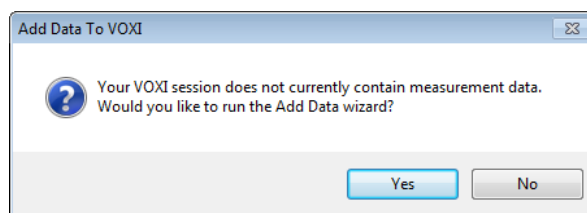


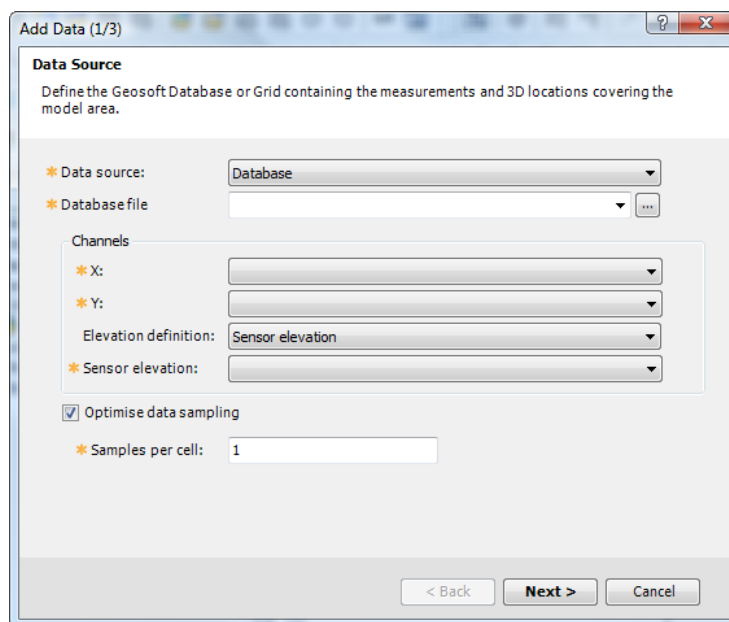
Figure 1.4 Add Data To VOXI window



6. For this example, click **Yes**.

The Add Data (1/3) dialog box opens.


Figure 1.5 Add Data (1/3) dialog box



Adding Data

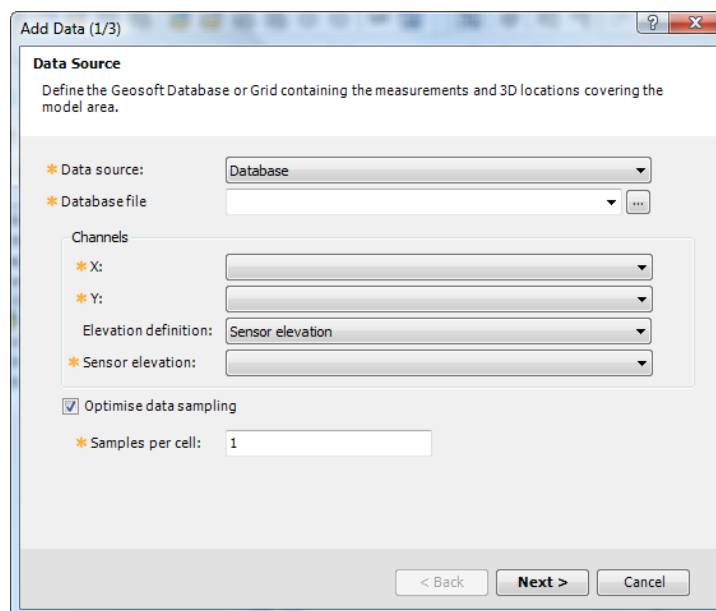
Now that you have supplied the voxel model, you will add data by selecting the measurement database.

To add data:

1. In the VOXI Viewer tree list, right-click **Data** and click **Add Data** or click the **Add Data** button  on the VOXI toolbar.

The Add Data (1/3) dialog box opens.

Figure 1.6 Add Data (1/3) dialog box



2. From the **Data Source** list, select **Database**. For the **Database file**, click the **Browse** button.
3. From the **VOXI Extending a Model Data** folder, select **ForwardModel_Observation.gdb** and click **Open**.

Because the coordinate channels in this database are already defined, the X and Y channels are automatically set. If you have an alternate pair of X and Y channels, you can select them as long as they have a defined projected coordinate system.

4. From the **Elevation definition** list, select **Sensor elevation**. From the **Sensor elevation** list, select **Z**.
5. Clear the **Optimise data sampling** option.

With this option, you can decimate the data if it is too highly sampled relative to the size of the voxel model element. In this example, the synthetic database contains data points at the locations where the field is to be calculated; therefore, this option is not needed.

6. Click **Next**.

The Add Data (2/3) dialog box opens. Here you will select the type of model you want. You have the choice of Susceptibility, Density or Vector magnetization model. When you select the **Model type**, the **Type of data** field will update according to your choice.

Figure 1.7 Add Data (2/3) dialog box

Add Data (2/3)

Measurements
Define the type of potential field data, acceptable error level and relevant parameters.

Model type: Susceptibility

Type of data: Magnetic

✓ Mag

* Field data: mag_final

* Fit error: Absolute error

* Error value (nT): 5

IGRF

Date (YYYY/MM/DD): 2011/11/26

* Field strength (nT): 56666

* Inclination (degrees): 74.1

* Declination (degrees): -10.7

< Back **Next >** Cancel

7. From the **Model type** list, select **Susceptibility**.

The Type of data automatically changes to **Magnetic** and additional options are now available in the dialog box.

8. From the **Field data** list, select **Obs**.

The Obs channel in the supplied database is set to a constant value and can be used for this purpose.

By default, the Absolute error value is set to 5% of the standard deviation of the data. Since in this example the Field data channel is set to a constant value, the Error value default is 0.0; however, in order to proceed, you need to enter a non-zero value.

9. For the **Error value (nT)**, enter a value **greater than 0** (e.g., **0.1**).

In the case of a susceptibility model, you can specify or modify the IGRF parameters. If the survey date is stored as a property of the lines in the database, then the IGRF parameters are calculated automatically. Otherwise, you have to supply the survey date in order for the IGRF parameters to be calculated.

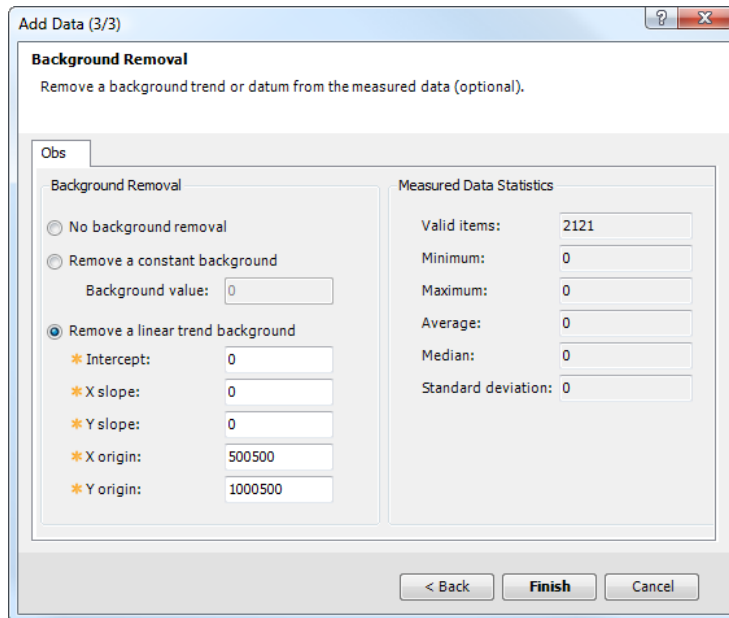
However, to simplify this example, you will override the geomagnetic fields and set them to magnetic north.

10. For **Field strength (nT)**, enter **52000**.
11. For **Inclination (degrees)**, enter **90**.
12. For **Declination (degrees)**, enter **0**.

13. Click **Next**.

The Add Data (3/3) dialog box opens.

Figure 1.8 Add Data (3/3) dialog box

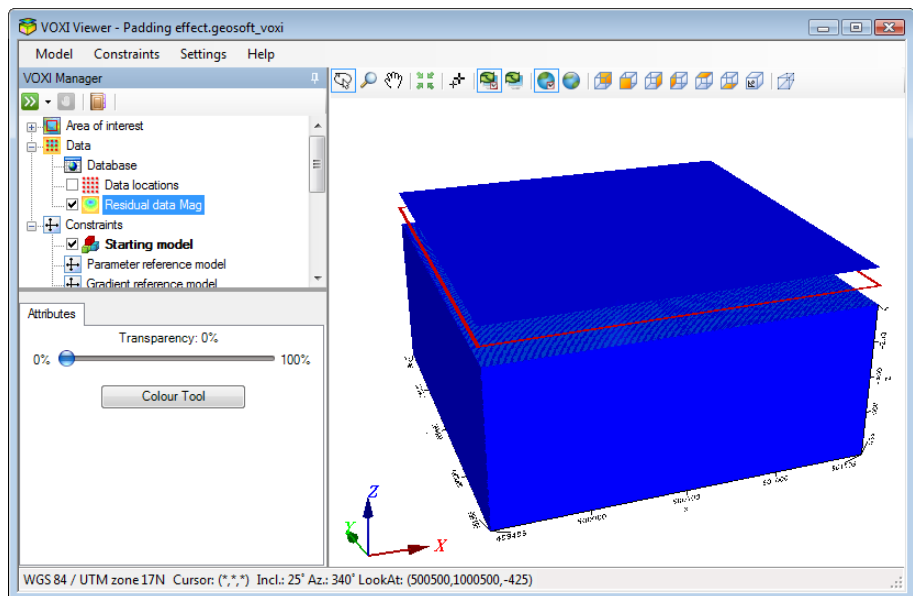


The option of performing Background Removal only applies when using observed field data; since this example does not need or use observed field data, this option is not necessary.

14. For this example, select **Remove a linear trend background** and click **Finish**.

The selected data is added to the VOXI document and displayed in the VOXI Viewer. Note that the Run Inversion button  on the VOXI toolbar is now active.

Figure 1.9 VOXI Viewer with data added to model



The Database, Data locations and Residual data items are now listed under Data in the VOXI Manager. By default, the field data is gridded and displayed in the VOXI Viewer.

The input voxel model is set as the Starting model in the Constraints branch in the VOXI Manager.

In this example, the residual field grid created by VOXI is meaningless and is not necessary to display; however, it may be useful to display the location of the observation points.

To adjust the display of the model:

1. In the Data tree, turn **on** the display of the **Data locations**.
2. Turn **off** the display of the **Residual data**.
3. Expand the Area of interest tree and turn **off** the display of the **Mesh** and the **DEM**.
4. Expand the Constraints tree and select the **Starting model**.

This is the input voxel model you selected earlier. You will now use tools on the Clipping tab to visualise the shape of the intrusive.



Clipping only affects the 3D view of the data; the host rock has not been removed.

5. Click the **Clipping** tab which appears below the VOXI Manager tree list, enter a minimum data value of **0.0011** and press **Enter**.



You can use the standard Oasis montaj 3D visualisation tools available in the VOXI Viewer to further adjust the display of your model.

Figure 1.10 3D visualisation tools

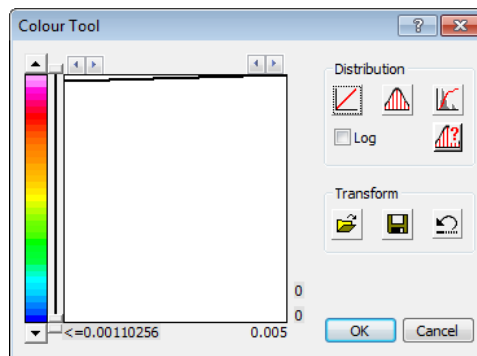


To apply a custom colour table to the voxel model:

1. With the Starting model selected in the Constraints tree, click the **Colours** tab.
2. Click **Colour Tool**.

The Colour Tool dialog box opens.

Figure 1.11 Colour Tool dialog box



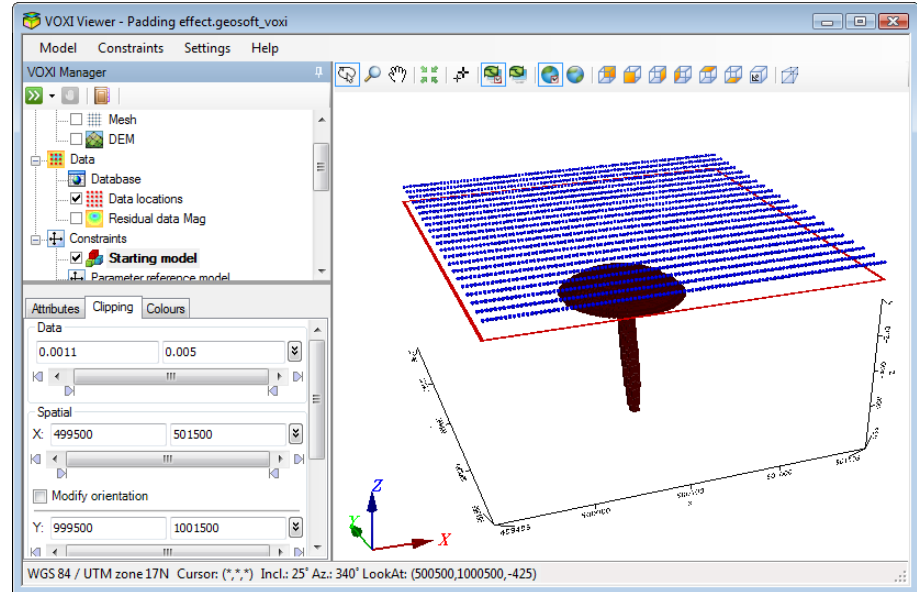
3. Click the **Load from file** button .

The Load Color Transform dialog box opens.

4. Click **Go to Working Directory**, select **Susceptibility.tbl** and click **Open**.
5. Click **OK**.

The display of the model updates based on the selected colour table.


Figure 1.12 VOXI Viewer with adjusted model display and custom colour table.



Running the Forward Model

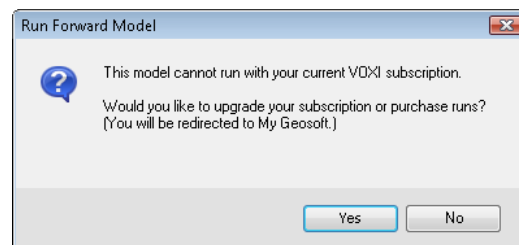
Now that you have supplied the voxel model defining your area of interest and added the database containing the data to be modelled you will run the forward model.

To run the forward model:

1. From the **Model** menu, select **Run Forward Model**, or click the arrow beside the **Run Inversion** button  on the VOXI toolbar and select **Run Forward Model**.

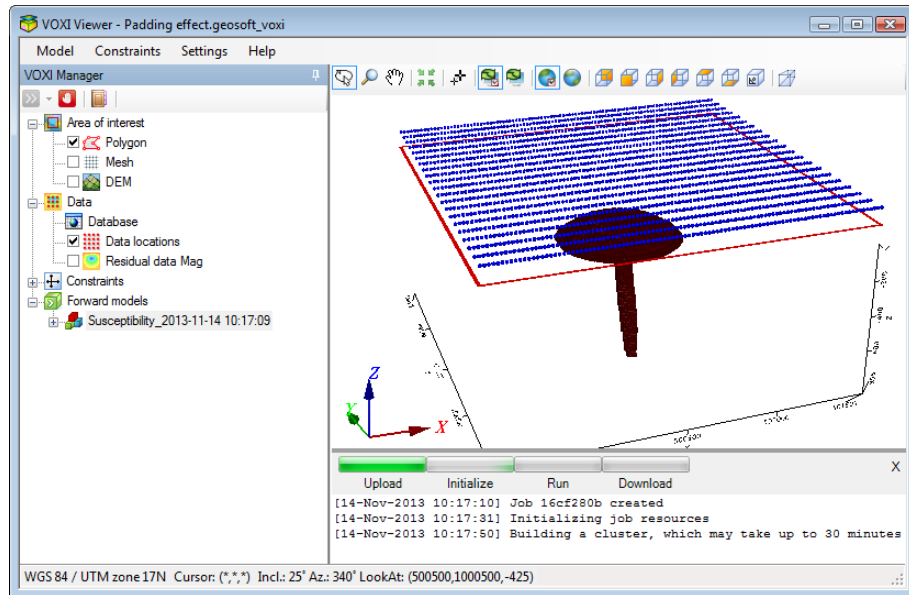
If your subscription does not support running a forward model or your number of runs have expired, a warning dialog prompts you to upgrade or purchase new runs from My Geosoft.


Figure 1.13 VOXI Subscription warning





After you start the forward model process, the Forward models item is added to the VOXI Manager and the progress of the forward model is reported in the Progress log pane in the lower-right of the VOXI Viewer.

Figure 1.14 VOXI Viewer with forward model in progress





 After the data has been uploaded, you can safely close the window without stopping the forward model. You can revisit the session at a later time, check the progress and ultimately the results of the forward model.

 If during the running of the forward model you realise you would like to edit your input data, you can stop the process by clicking the Stop Process button . The forward model will terminate immediately and the tokens will return to your account.

2. In the VOXI Manager, expand **Forward models** to see the item representing the forward model you are calculating.

The session name is composed of the type of model, suffixed by the current date and time stamp. All subsequent trials will appear under Forward models with their unique date and time stamp.

The Input data item contains a copy of the input data used for this forward model. In subsequent trials you may modify some of the model parameters; the snapshot of the input parameters together with the output modelled voxel allows you to review your settings for each forward model.

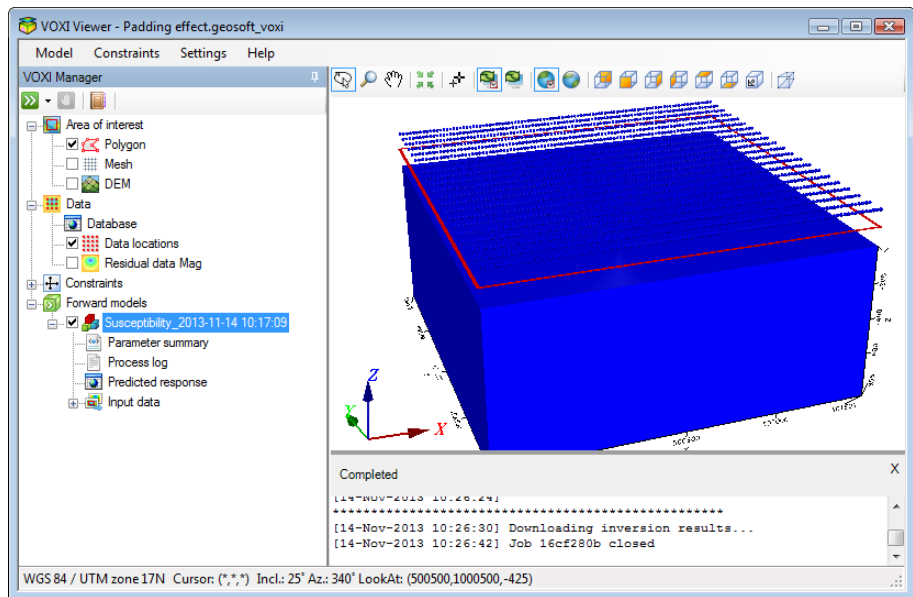
 Using the VOXI Journal  on the VOXI toolbar, you can enter comments to describe the specifics of individual forward model sessions and notes on the differences between your inversion results.

At the successful completion of the forward model, a check box is added in front of the session name. The Process log is also saved in the tree list and can be viewed and saved at any time.

3. Within the Forward models tree, clear the check box beside the **Density** item.

This represents the starting model and does not need to be displayed.

Figure 1.15 VOXI Viewer with completed forward model






As in the Oasis montaj 3D Viewer, based on your selection of an item in the tree list, you can adjust Attributes, Clipping and Colours. For example, you can clip the output voxel model by selecting it and adjusting the Clipping parameters.

Padding the Active Volume

The mesh representing the Earth volume of interest is referred to as the Active Volume, which in this forward model example is defined by the supplied input voxel. Generally, you would add padding cells beyond the Active Volume laterally and at depth. These padding cells serve to maintain mathematical stability along the edges of your model (hence minimizing edge effects) during modelling/inversion, by mimicking a peripheral field contribution. The default padding extent is 5 cells.

The expansion ratio of the horizontal and vertical axis can be set to differing values. For example, you can set the expansion ratio to be larger along the direction of the predominant geologic strike than across it.

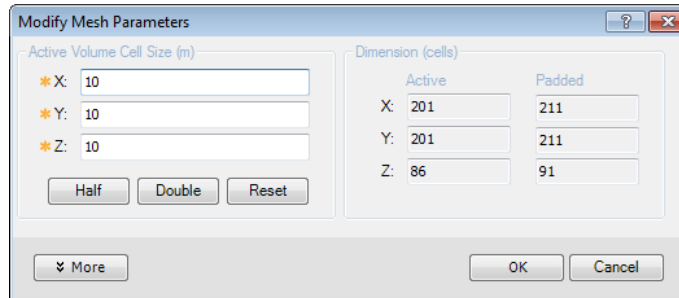
-  *If you omit this step, the resulting calculated forward field will taper off along the edges and exhibit edge effects.*
-  *Changing mesh parameters will create a new mesh.*
-  *Any results from a previous mesh will be overwritten.*

To pad the active volume:

1. In the VOXI Manager, expand the Area of interest tree.
2. Right-click **Mesh** and select **Modify**.

The Modify Mesh Parameters dialog box opens.

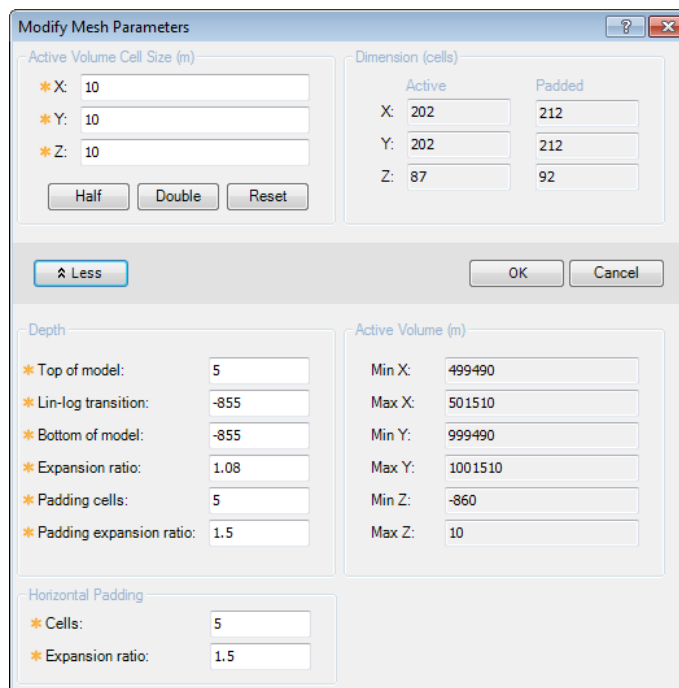
Figure 1.16 Modify Mesh Parameters dialog box



3. Click **More**.


The Modify Mesh Parameters dialog box expands. In the Horizontal Padding section, notice the default value for Cells is 5.

Figure 1.17 Expanded Modify Mesh Parameters dialog box



4. In the Horizontal Padding section, enter a value of **0** for **Cells**.
5. Click **OK**.


To run the forward model again:

1. From the **Model** menu, select **Run Forward Model** or on the VOXI toolbar click the arrow beside the **Run Inversion** button  and select **Run Forward Model**.
2. Click **Yes**.

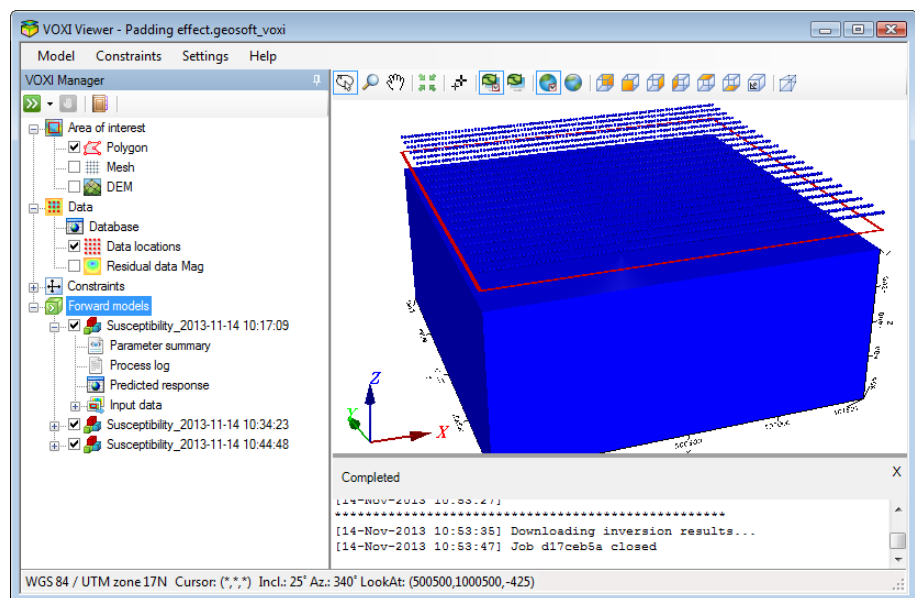
After you start the forward model process, an additional session is added to the Forward models list in the VOXI Manager. The session name is composed of the type of model, suffixed by the current date and time stamp.

You will now edit the cell padding value and run the forward model a third time, this time using a cell padding value of 10.

To pad the active volume and run the forward model again:

1. Open the expanded Modify Mesh Parameters dialog box.
2. In the Horizontal Padding section, enter a value of **10** for **Cells**.
3. From the **Model** menu, select **Run Forward Model** or on the VOXI toolbar click the arrow beside the **Run Inversion** button  and select **Run Forward Model**.
4. Click **Yes**.

You should now have three sessions listed in the Forward models tree list; the first is the results of the forward modelling run with the default cell padding of 5, the second with a cell padding of 0, and the third with a cell padding of 10.



Viewing the Predicted Response Database

At the completion of the forward model calculation, the input data as well as the calculated total magnetic field response at each provided data point are saved at the user-defined sampling rate. You will now view the predicted response database.



You can also export these fields to a Geosoft Database file (.gdb).*

To view the predicted response:

1. Within the first Susceptibility sessions in the Forward models tree, right-click **Predicted response** and select **View**.

The predicted response database opens.

Figure 1.18 Predicted response database

Line	X	Y	Z	Obs	INTERNAL	DEM	BProj_FWD
0.0	499500.0	999500.0	200.0	0.00000	0.10000	5.0	9.94899
1.0	499520.0	999500.0	200.0	0.00000	0.10000	5.0	10.18511
2.0	499540.0	999500.0	200.0	0.00000	0.10000	5.0	10.39681
3.0	499560.0	999500.0	200.0	0.00000	0.10000	5.0	10.58006
4.0	499580.0	999500.0	200.0	0.00000	0.10000	5.0	10.73848
5.0	499600.0	999500.0	200.0	0.00000	0.10000	5.0	10.87530
6.0	499620.0	999500.0	200.0	0.00000	0.10000	5.0	10.99332
7.0	499640.0	999500.0	200.0	0.00000	0.10000	5.0	11.09498
8.0	499660.0	999500.0	200.0	0.00000	0.10000	5.0	11.18243
9.0	499680.0	999500.0	200.0	0.00000	0.10000	5.0	11.25749
10.0	499700.0	999500.0	200.0	0.00000	0.10000	5.0	11.32177
11.0	499720.0	999500.0	200.0	0.00000	0.10000	5.0	11.37665
12.0	499740.0	999500.0	200.0	0.00000	0.10000	5.0	11.42336
13.0	499760.0	999500.0	200.0	0.00000	0.10000	5.0	11.46288
14.0	499780.0	999500.0	200.0	0.00000	0.10000	5.0	11.49611
15.0	499800.0	999500.0	200.0	0.00000	0.10000	5.0	11.52383
16.0	499820.0	999500.0	200.0	0.00000	0.10000	5.0	11.54675
17.0	499840.0	999500.0	200.0	0.00000	0.10000	5.0	11.56549
18.0	499860.0	999500.0	200.0	0.00000	0.10000	5.0	11.58056
19.0	499880.0	999500.0	200.0	0.00000	0.10000	5.0	11.59244

The BProj_FWD channel contains the calculated total magnetic response at each data point provided in the input database.

- View the Predicted response database for the other two sessions.

All three databases are now open and are listed in the Data section of the Project Explorer in **Oasis montaj**.

To grid the calculated total magnetic field channel:

- Using the **Bi-Directional Line Gridding** method in **Oasis montaj**, grid the calculated total magnetic field channel using the following parameters:

Database	Channel to grid	Output grid	Grid cell size
First VOXI session	BProj_FWD	PredictedMagResults_ Padding5	20
Second VOXI session	BProj_FWD	PredictedMagResults_ Padding0	20
Third VOXI session	BProj_FWD	PredictedMagResults_ Padding10	20

Comparing Results in the 3D Viewer

The results from the three forward model calculations can be compared in the 3D Viewer. The same colour distribution will be used to display all three grids in order to be able to compare them.

To compare the results in the 3D Viewer:

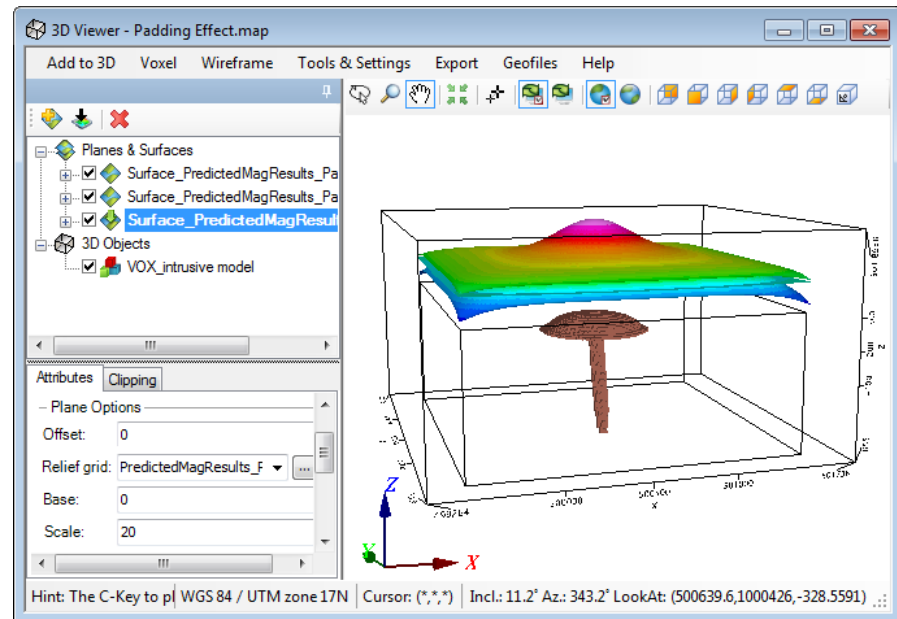
- From the **3D** menu in **Oasis montaj**, select **Create a New 3D View**.
- Add the **Intrusive Model.geosoft_voxel** to the 3D Viewer using the **Susceptibility.tbl** colour table.
- Using the **Clipping** tab, set the minimum **Data** value to **0.0011**.

The intrusive is now visible; this will be useful when viewing the predicted response field over the causative body.

4. Using the **Relief Surface** option, add the **PredictedMagResults_Padding0**, **PredictedMagResults_Padding5**, and the **PredictedMagResults_Padding10** grids using the provided **Mag.zon** colour zone file.
5. Select each surface, click the **Attribute** tab and change **Scale** to **20**.

The vertical scaling of the surfaces is exaggerated; this is so you can more easily compare the relief of the three grids.

Figure 1.19 3D Viewer with voxel and scaled grids

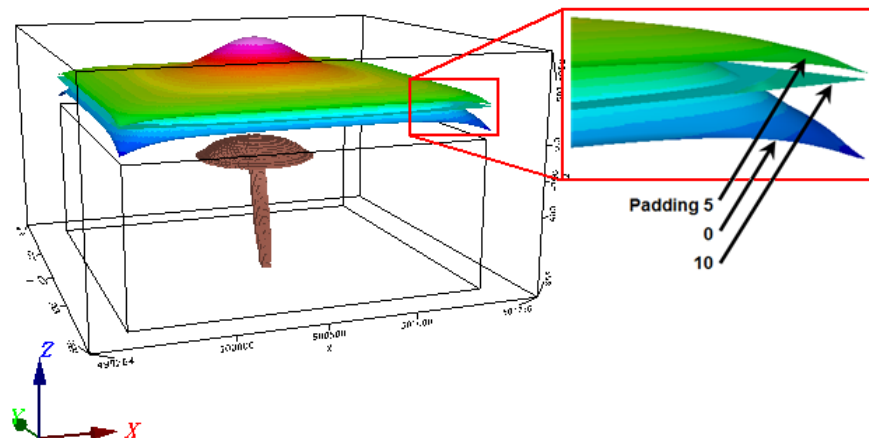


6. Examine the grids by turning the display of the three surface layers off and on; then zoom to a corner of the surface layers.

Although the positive anomaly over the intrusive is well replicated in the surface with 0 padding cells, the edges of the grid drop down towards 0; this is because the volume surrounding the voxel model does not contribute to the magnitude of the field at the observation points. The lack of contributions is responsible for the decreasing field along the edges.

The edge effect is also present in the surface with 5 padding cells, although to a lesser degree.

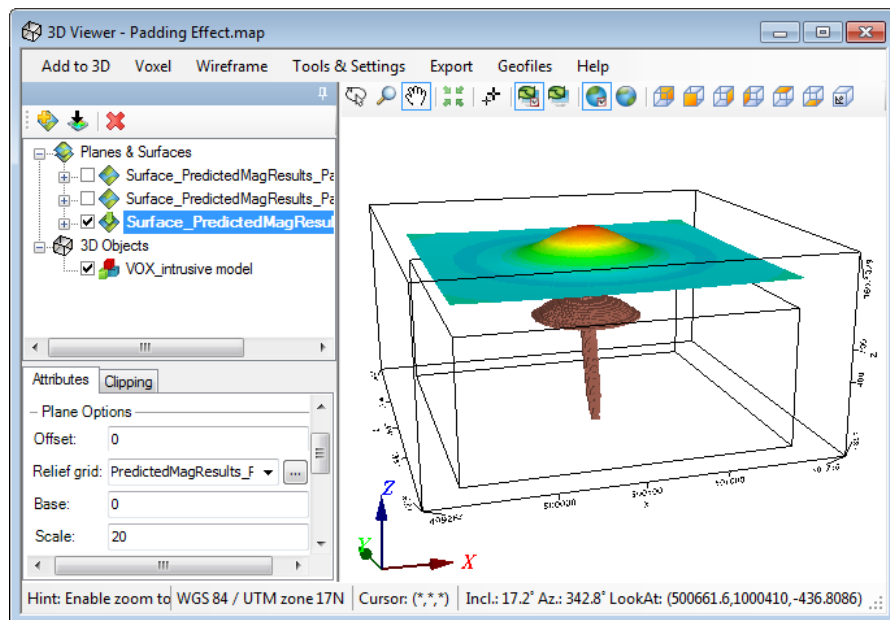
Figure 1.20 Edge effects



7. Turn off the display of the surfaces with 0 and 5 padding cells.

The surface with 10 padding cells yields the expected predicted field, which consists of a positive anomaly over the intrusive with no distinct effect from the homogeneous host rock. A relatively constant background surrounds the intrusive body.

Figure 1.21 3D Viewer displaying surface with 10 padding cells



You should gauge the amount of padding needed according to the nature of the Earth volume subject to modelling. Specifically, examine the behaviour of the predicated field along the edge of the active Earth volume. There should be no effect that is not explicable by the active volume.