



Oasis montaj Best Practice Guide

VOXI Earth Modelling - Creating an Upper Bound Voxel



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Creating an Upper Bound Voxel model for the Upper Bound Constraint Inversion

Introduction

This document describes how to generate the upper bound voxel model used in the [Run an Inversion with an Upper Bound Constraint](#) How-To Guide.

As part of the electromagnetic (EM) survey and interpretation project of the Reid-Mahaffy ¹ area, quantitative depths to the top of the conductive zone have been produced. We stipulate that the Earth layer above the top-of-the-conductor horizon manifests minimal magnetic susceptibility and so the observed response is mostly due to the Earth layer below this horizon. This stipulation can be represented by a constraint voxel model, in which the susceptibility upper limit of the voxel elements above the top-of-conductor horizon is set to a small value while the upper limit for the layer below is set to a much larger value.

In order to create this voxel, you will:

- Generate a depth grid representing the top of the conductor horizon.
- Create the constraint voxel model using voxel math and the depth grid.

Voxel Model Preparation

The constraint voxel will be generated at the resolution and size of the voxel model resulting from the unconstrained inversion. To acquire the size and resolution, you will use the voxel model generated during the unconstrained inversion. Accordingly, the files required to generate the upper bound voxel are:

1. The inverted voxel model of an unconstrained inversion: *Mahaffy.geosoft.voxi*
2. The EM Anomaly database: *ReidMahaffy_EMAnomaly_DIG.gdb*

Generate a depth grid

The interpreted depths to the top of the conductors is provided in the Geosoft database format. If the data is in any other format, import it into a Geosoft database.

¹The Reid-Mahaffy property in Ontario, Canada, has been designated by the OGS as a test site and was flown by a number of airborne companies. The airborne Reid-Mahaffy magnetic data was flown in 1999 by Dighem as part of an airborne EM survey, commissioned by OGS, under the project number MRD-55

➤ Generate a depth grid

⚠ *The database must have projected coordinates, but does not need to be in the same projection as the survey data.*

✓ L10081:4	X NAD83	Y NAD83	ANOMALY NO	anomaly type	vert sheet depth	vert sheet conductance
1.0	460919.51	5401083.99	2	S	23.3	2.3
2.0	460917.92	5401382.49	3	S	14.0	0.9
3.0	460907.70	5402095.99	4	D	16.7	1.9
4.0	460908.86	5402548.49	5	S	0.8	0.4
5.0	460917.89	5403136.00	6	S	11.9	0.5
6.0	460917.01	5403702.50	7	D	39.8	3.4
7.0	460918.61	5403992.50	8	S?	8.6	0.4
8.0	460917.11	5404088.00	9	S?	12.1	0.5
9.0	460917.67	5405343.01	10	S	0.0	0.8
10.0	460915.73	5405725.51	11	S	0.0	0.5

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Figure 1: the EM Anomaly database

Grid the depth to the conductor using the Tinning method. Use the same grid cell size as the outcome of the unconstrained inversion of the same data.

⚠ *It is preferable to grid the depth data using the tinning method as it is well suited for gridding topography. If the Tinning gridding method is not available, use Minimum Curvature.*

The following parameters were used to generate the depth grid:

- Input Database: *Mahaffy_EManomalies_DIG*
- Channel: *Vert_Sheet_Depth*
- Cell size: *50m*

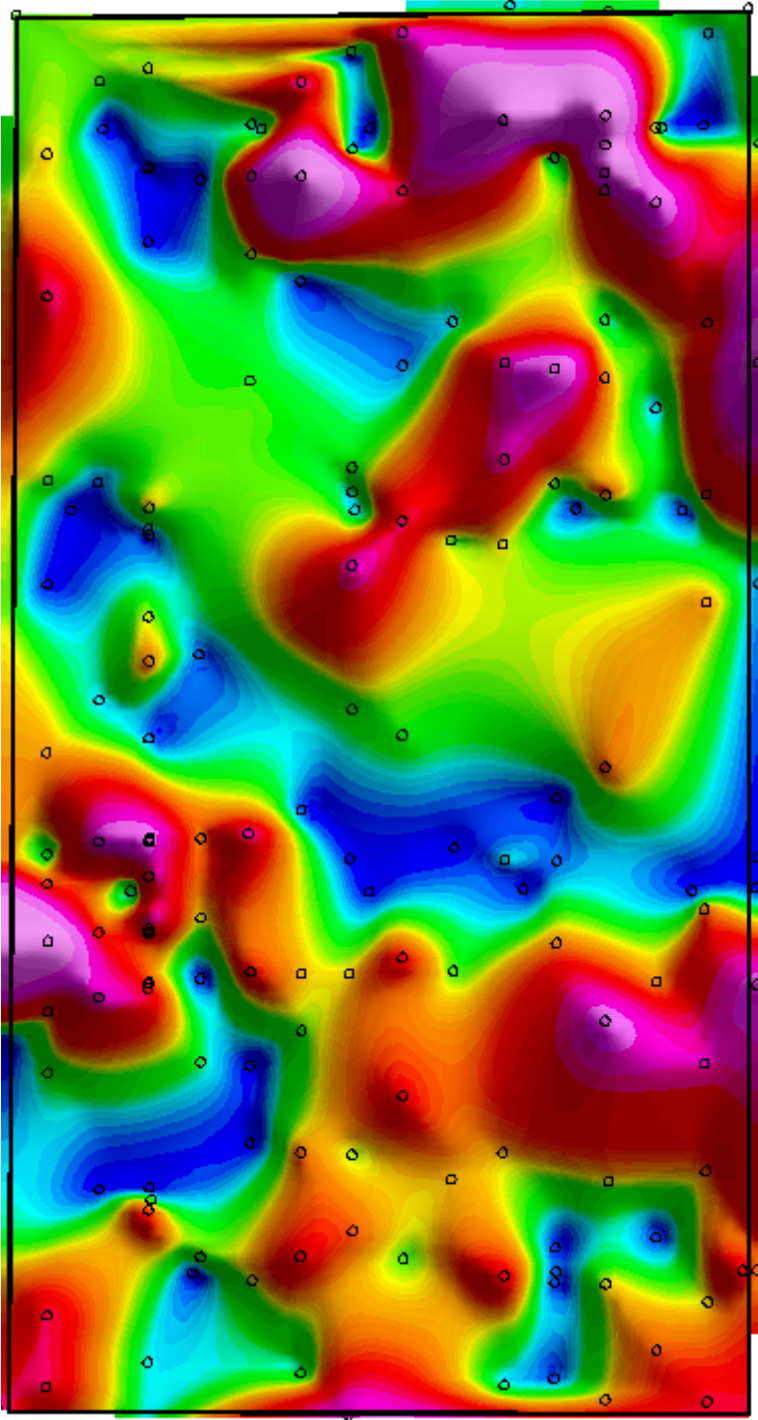



Figure 2: The conductor horizon. The symbols depict the locations for which depths have been calculated.

Create the upper bound constraint voxel

Use **Voxel Math** to generate the upper boundary voxel.

 As input, use the output voxel of an unconstrained inversion in order to generate a voxel model with the same resolution and size.

Statistics on the susceptibility of the unconstrained voxel model show that the susceptibility distribution is between -0.029 and 0.084 SI with a mean value of -0.003 and a Standard Deviation of 0.006. Considering this distribution, we would like to set the upper limit of the volume above the conductor horizon to mean +20% of the standard distribution to approximately 0.001 SI and allow the volume below to vary freely. To produce a similar response, the deeper the causative source, the stronger its susceptibility would be. As a result, the upper limit of the volume below the boundary layer should be much larger than 0.084 SI. For our purposes, we set it to 0.5 SI.

To create the voxel:

1. From the *Oasis montaj* toolbar, select **3D | Voxel Utilities | Voxel Math....**
2. Enter the following equations:

```
@V1=(Z>G0)?0.001:VI;
VO=(Z<=G0)?0.5:@V1;
where
VI is the input voxel. Set this to be the output of the unconstrained inversion.
V1 is a voxel variable.
G0 is the conductor depth grid.
VO is the output upper bound voxel.
```

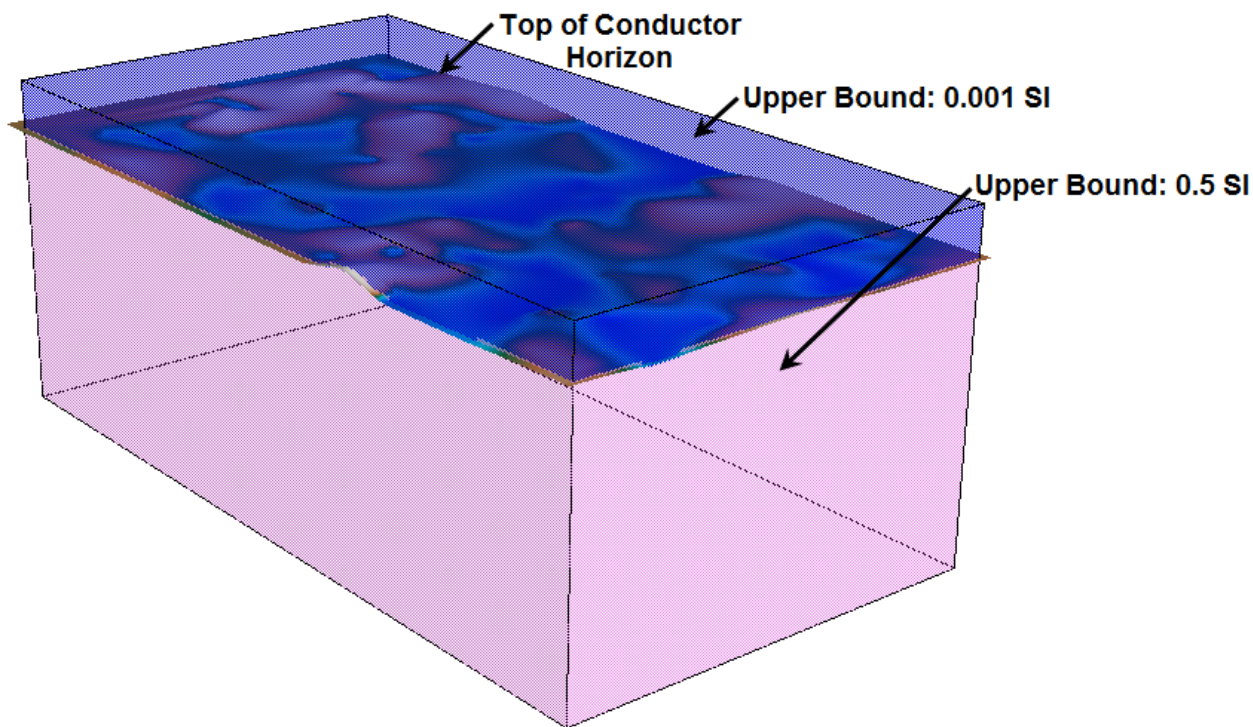


Figure 2: The upper bound constraint voxel