Oasis montaj Best Practice Guide

VOXI Earth Modelling - Building Geologic Models with NODDY

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Building Geologic Models with NODDY

Introduction

To understand geophysical responses, it is often helpful to be able to construct a geological model, to populate that model with appropriate physical properties, and to compute a geophysical response. Sometimes all that is required is the response from a simple compact body, for example, a prism, sphere, etc. in which case, it is simplest to use voxel math in Oasis montaj to construct the geological model. However, to model more realistic geological scenarios requires a geological model building tool. There are several commercial tools available, as well the publicly available tool: NODDY, developed by Mark Jessel and found at the following link http://www.tectonique.net. This Beset Practice guide describes how NODDY can be used with VOXI. We will not discuss the principles and methods used in NODDY for which there is abundant documentation. Instead, we focus on how to export results from NODDY into Oasis montaj.

The ShearZone Model

We begin by building a shear zone model in NODDY. This model has zero susceptibility everywhere and remanent magnetization of 40 A/m with inclination 0°, and declination 90°, in one horizontal layer before the shear event. The remanent magnetization direction is deformed with the shear event. The inducing field direction is 50000 nT, inclination 30°, and declination 90°. Creating the model is straightforward and requires a single event history as shown in *Fig. 1*.
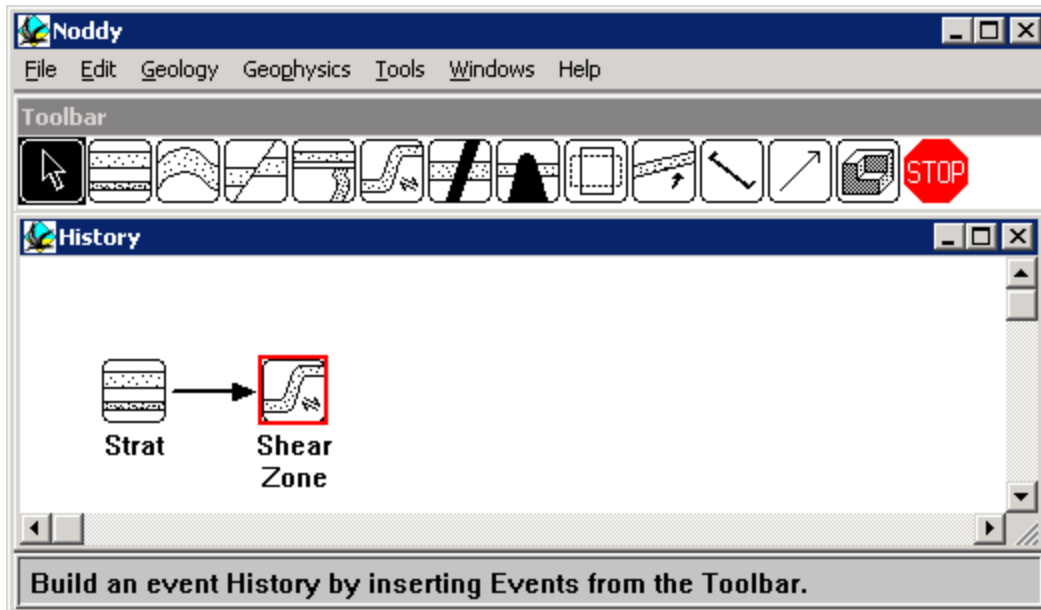

Fig. 1: The NODDY ShearZone model history.

Once the model is created, it is a simple matter to export it in UBC format, provided that the correct index ordering is chosen, as shown in Appendix 1. Then importing into Oasis montaj produces the lithology model shown in *Fig. 2*. NODDY produces models for susceptibility, components of anisotropy, remanent magnetization strength, inclination and declination, as well as the lithology index.
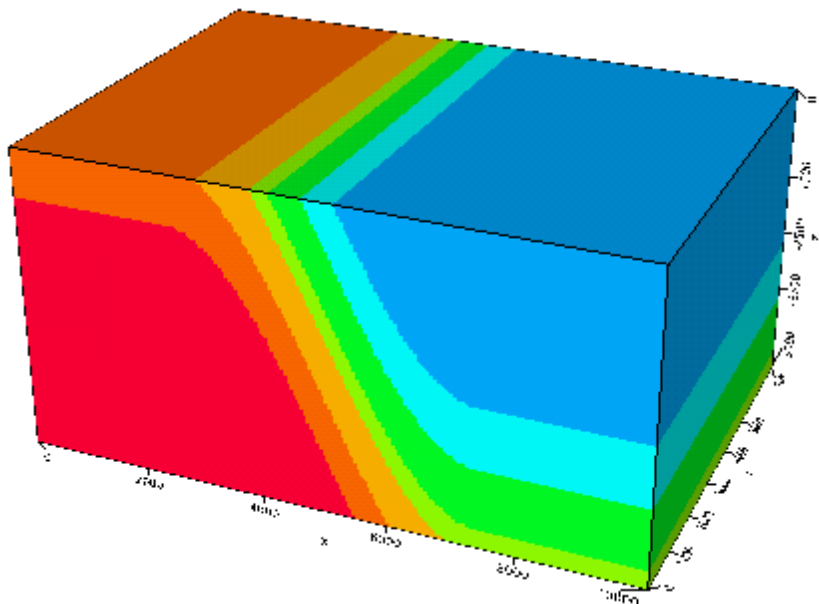

Fig. 2: The NODDY ShearZone model lithology in Oasis montaj. The light orange layer has deformed remanent magnetization.
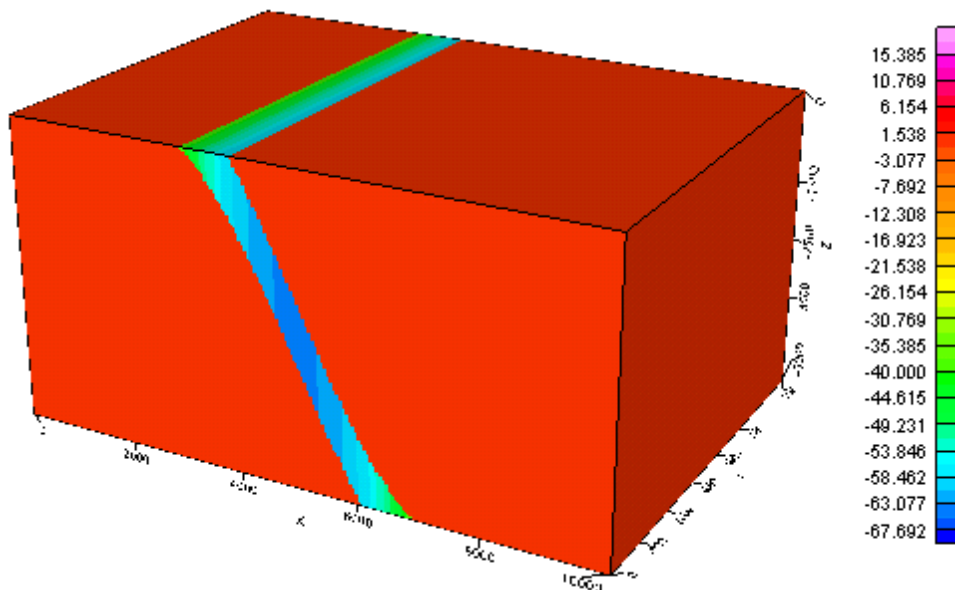

Fig. 3: The NODDY ShearZone model remanent magnetization inclination direction (in degrees), displayed in Oasis montaj.

The ShearZone Data

NODDY performs forward modelling which can be useful for generating test data for VOXI. Of particular interest is the ability to forward model deformed remanent magnetization. As described above, the only magnetization in this example is the remanent magnetization confined to the light orange layer. The declination is $90°$ and the inclination is variable due to the deformation event, as shown in *Fig. 3*.

NODDY produces a ASCII grid output in .mag format which is described in the NODDY documentation and to which the reader is referred for the details. Fortunately, NODDY has a *.gxf* format conversion allowing direct import into Oasis montaj. Doing so yields the TMI response grid shown in *Fig. 4*.
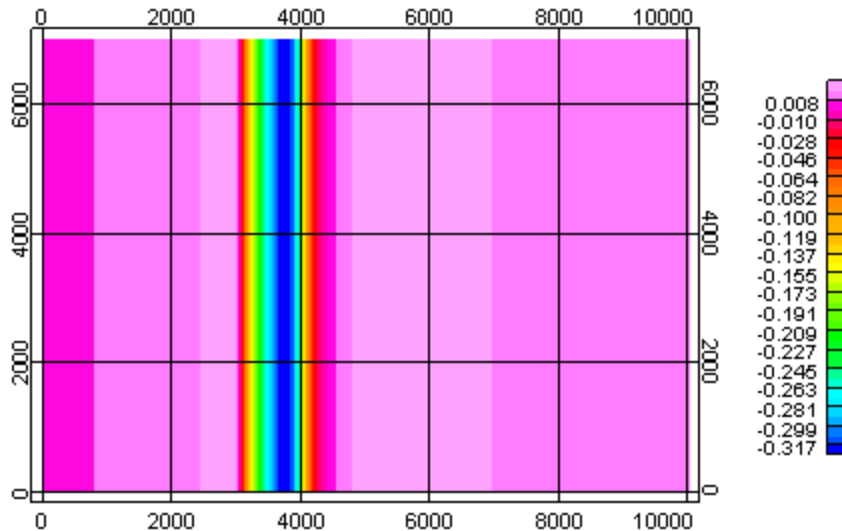
Fig. 4: The TMI response over the deformed remanent ShearZone model. The color scale shows the grid values in nT, divided by 50000.

Conclusion

The ability to create geologically based voxel models is a valuable addition to the inversion capabilities available through Oasis montaj's VOXI. The open source program NODDY allows the VOXI user to create geologically motivated voxel models that can be used in VOXI for forward modelling, and, as inversion constraints. NODDY also computes magnetic and gravity responses for modest numbers of voxel elements. In summary, NODDY is a highly recommend adjunct to VOXI.

Appendix A: Exporting Models from NODDY

Exporting models to UBC format from NODDY is straightforward if the index ordering and directions are set in NODDY as shown in *Fig. A.1*.
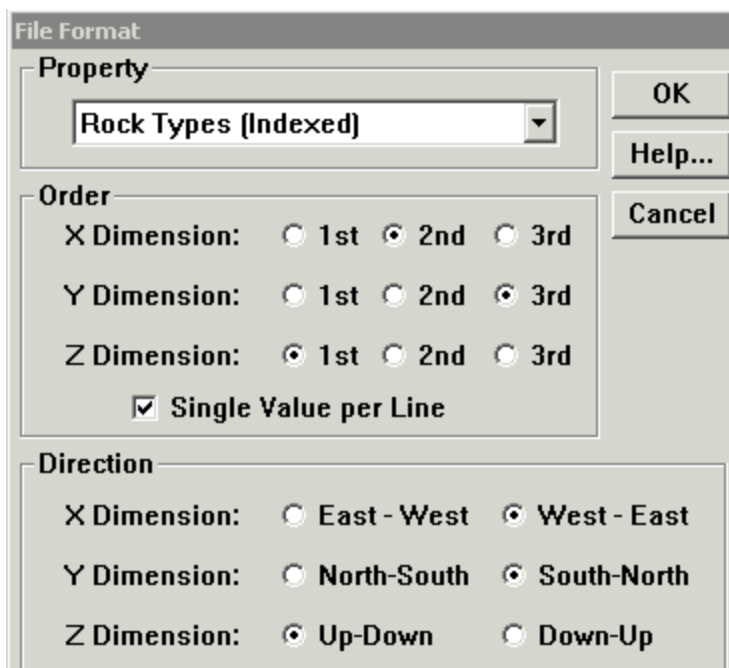
Fig. A.1: The index ordering to output to UBC format.

It is also necessary to create a UBC mesh file. *Table A.1* and *Table A.2* give an example of the process. NODDY produces the header file in *Table A.1* and this should be converted into the UBC mesh file shown in *Table A.2*. The reordering of the x,y,z indices in the UBC mesh file matches the ordering of the indices in the NODDY export shown in *Fig. A.1*.

```
#Noddy Raw Header File
#Version = 1.0
Dim 1 = 50
Dim 2 = 100
Dim 3 = 70
```

Table A.1: The NODDY header file.

```
100 70 50
0 0 5000
100*100
70*100
50*100
```

Table A.2: The mesh file in UBC format.