Due Friday, April 19, 2013 @ 5pm
TA: Yunyue (Elita) Li

Lab 2: 3-D preprocessing and prestack partial migration

Your name: Anne Boleyn

ABSTRACT

In this assignment you will carry forward the knowledge gained in the previous assignment to perform some preprocessing steps on a real 3-D dataset, using SEP3d tools. Then you will have a hands-on experience with Azimuth Move-Out, a 3-D prestack partial migration operator.

PREPROCESSING

Introduction

This lab is divided into two sections: SEP3D data manipulation and prestack partial migration by azimuthal moveout. In the first section, you will take a 3-D dataset of your choice from the SEP data library, manipulate the headers with SEP3D commands, and extract and plot various data cubes. Be judicious in your choice of dataset! Some are pretty big ... but is that not why we are all here? The second section of this lab is examining prestack partial migration operators. You are asked to define a number of different terms, and to demonstrate how the AMO operator works for various source-receiver geometries.

First log into the SEP system. From the course webpage, download the gzipped tarfile, `lab2.tgz`. Type `tar – xvzf lab2.tgz`; `cd GP280_lab2`.

Open the `paper.tex` file with your favorite editor, and begin the exercise by changing the name on this document to yours. From now on you will be building papers using the `Scons` system. In order to see the results of your editing you have to save the document and type `scons paper.pdf` on vostok. If you have permission errors, try `setenv DATAPATH /tmp/`. The document will rebuild with your changes.

SEP3D data manipulation

Open `Makefile` in an editor. The variable `DATA1` points to the location of a non-existent data set. Your first task is to pick a 3-D data set from the SEP data library. SEP students have a large library at `/data` on `gomorrah`. Non-SEP students have limited choices between the two datasets you used in the previous lab at `/net/server/myfusan/GP280`

Once you have found your favorite dataset, make a copy of the history file in your directory using a rule similar to the one in the Makefile. You will also see a rule which uses `Headermath` to build the file `math1.H` that converts from integer to floating point. The `Headermath` parameters are stored in the file `math1.P`. You will see four trivial equations which create s_x, s_y, g_x, g_y from the pre-existing SEGY headers.

1. Write a make rule to sort `math1.H` into shot gathers. You will need to figure out some survey parameters, then apply `Sort3d`.
2. Write a make rule which builds a `Cubeplot` figure of a representative shot gather and include the figure in this paper. You may find tools `Window_key`, `Infill3d` useful.
3. Write a make rule which builds a figure of a representative common receiver gather and include the figure in this paper.
4. Construct a "super common receiver gather" by stacking some the geophones in the array (or all if you have chosen your dataset wisely). Create a figure similar to the plot of your single common receiver gather, and include the figure in this paper.
5. Identify some of the events from the supergather. You can either annotate events on your figure using *vp_annotate or locate the events with coordinate values.*
6. *Stacking of the receivers in an array is the single most important way of suppressing direct-arrival events. Why is this so?*

   Your Answer:
7. *Has the array succeeded in its noise suppression capacity in this case? Why or why not?*

   Your Answer:

PRESTACK PARTIAL MIGRATION BY AZIMUTH MOVE-OUT

1. What is NMO? Briefly discuss its main characteristics.

   Your Answer:

2. What is DMO? Briefly discuss its main characteristics.

   Your Answer:

3. What is AMO? Briefly discuss its main characteristics.

   Your Answer:

4. What are the main differences between DMO and AMO? Briefly discuss.

   Your Answer:

5. Why are DMO and AMO called prestack partial migration operators and NMO is not?

   Your Answer:

6. Using `matlab`, compute and plot the impulse response of the AMO operator for $h_1 = 2km$, $h_2 = 1.8km$, $t_1 = 1s$, $\theta_1 = 10°$ and $\theta_2 = 30°$. Include the figure in your report. Give a copy of your `matlab` program in the appendix.

   HINT: read *Geophysics*, vol 63, no 2, 1998, p.574-588 "Azimuth moveout for 3-D prestack imaging". Refer to the section **Transformation of midpoint axes**. First, set the range from -1 to 1 for both ξ_1 and ξ_2. Second, compute Δm_x and Δm_y with equation (6). Then, compute t_2 with equation (7). Plot t_2 as a function of Δm_x and Δm_y (your figure should look like Figure 3 in the article). You may find the matlab functions `meshgrid`, `griddata` and `surf` useful.

7. What happens if you change the azimuth rotation $\theta_1 - \theta_2$ (increase and decrease it)? Illustrate your answer with figures.

8. If you look at your impulse response from the top, you should be able to see the spatial support of the AMO operator (Figure 2 in the article). How does the spatial support change with an increase or decrease of the azimuth rotation? Why? (Again, illustrate your answers with figures).

9. In the article in Geophysics, what is the difference between Figure 1 and Figure 3?

10. In your opinion, is AMO going to be more expensive to apply as an integral operator with land or marine data (if we want to transform the data to a single azimuth)? Why?

11. Is the AMO expensive to compute for deep targets? Why?

HINT: For the last two questions, think in terms of the spatial extent and compactness of the impulse response.

ALL DONE

When you are all done, save a pdf copy of this document. Submit to coursework dropbox. Update the cleaning rules in the Makefile so that they clean all the intermediate files produced by your code and Makefile and clean up your directory (`make clean`).

APPENDIX

```
include your matlab code here
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