Seismic Reflection Lab for Geology 594

BEFORE YOU DO ANYTHING – INSERT THE DONGLE ON THE LEFT SIDE OF THE KEYBOARD (LIGHT SIDE UP). The little green light will come on – showing the dongle is activated. You must have this dongle in order to run SPW.

Then, double click on the "Users Space – Mac #" icon. Inside you will find a file called "G594." Open this folder and double click on the "594 lab" icon. This will start SPW and open the data file you will be using for this activity.

The data file that you will be looking at is an example taken from the SPW FTP site. This data has been pre-filtered to remove direct and refracted arrivals, so you will only be looking at reflection signals (and noise). There is a total of 38 seismic records in this set. You will start with the beginning of the flow chart for this analysis and will add onto it as you go along. The actual data set you will start working with is called "Data Example." (To look at this data, simply double click on it.) Some observations will also be pointed out in each section along the way.

NOTE: Feel free to play with any of the functions/items in SPW – that is probably the best way to learn. However, if you are going to save these changes, please save them with a NEW file name in a NEW location. For example, you could make a new folder on the "User Space" (labeled with your name) in which you can store all of your work. Saving it on a disk is another option. Otherwise, if you don't do this, the original file will become corrupt and anyone using these files after you will have problems.

Pre-Processing

1) First, notice that there are a number of items (both data files and functions) preceding the "Data Examples" file. The left-hand column of these show how the data was imported from a SEG-B Tape into SPW. Most seismograms record data in some type of SEG file, usually SEG-B or SEG-Y. The second column lists two "notes" files. These files are used to create the header data for the seismic records and include all the geometry information about the locations of the sources and receivers. This information will be needed for analysis. You do not have to do anything with these files, but you can look at them if you wish. This is an just example of how data is initially setup to be processed.

Processing

Now we will have you do a number of different processing steps to the "Data Example" file using the functions in SPW. Most of these functions are listed under the FLOWITEMS menu on the top. Start by double-clicking on "Data Example." This brings up one shot record.

PLEASE NOTE THAT THERE ARE QUESTIONS IN SOME OF THESE SECTIONS THAT ARE TO BE TURNED IN AS HOMEWORK.

2) Automatic Gain Control- As described in class, waves lose energy as they travel due to spreading and attenuation. The rate of energy loss can be calculated and compensated by applying gain amplification functions to data. This will restore some of the lost information. This is also described in the text on page 142.

   In SPW, you can turn on the automatic gain control (AGC) in the "seismic data display" menu in the seismic records (i.e. the little "A" in the upper corner). In this menu, click on the "condition…" box at the bottom. The AGC is in the upper left corner and can be turned on by clicking on the gray box. You can also vary the AGC length – or how long a time interval is used to determine the gain setting - here as well. Vary this value and see what happens to the seismic data.

Start with the AGC at 500 ms. What does the data look like? Now, try putting the AGC at 100 ms. What happens to the data? What do you think is the major problem with AGC? (Hint: Are you just increasing the amplitude of the useful reflection data or is it all the data in the record?)

Uncheck the AGC before you continue and close the "Data Example" window.

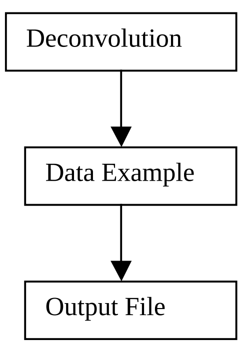
3) Deconvolution- There are 2 types of deconvolution: predictive and spiking. They are described in the book on pg. 142, but for the purposes of this lab we will only deal with spiking decon.

Your next step of processing will be to use spiking decon on the "Data Example" file. Choose "deconvolution" from the FLOWITEMS menu (under "wavelet shaping"). Open this file to look at the different parameters of the decon. You should use the following parameters in your setup:

Pre-Whitening Percent	0.1
Inverse filter Length	80 ms
Number of operators per trace	1
Overlap of design window	500 ms
Design window start	400 ms
Design window length	500 ms

(Do not apply moveout to the design window. Uncheck that box.)

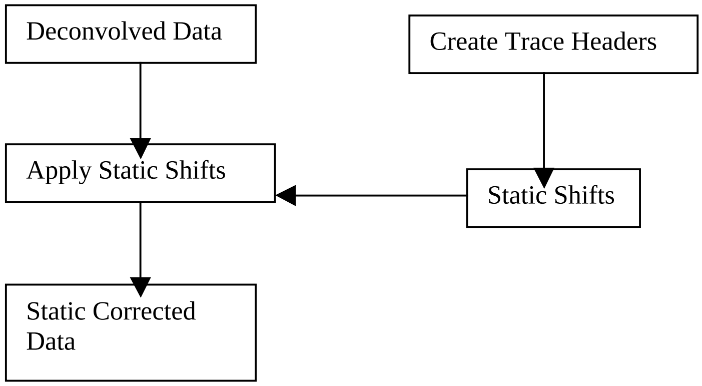
The purpose of these parameters is described in many geophysics books. After you set this up, go back to the flowchart and create an output file by going under FLOWITEMS, seismic data, seismic file. We need to give this file a name, so go under the FLOWCHART menu and chose "rename." Hit "new" and then specify a name and location to save the file to. Now, we want to run the decon and look at our results. So, click on the arrow (on top of flowchart) and connect the boxes on your flowchart with arrows like so:



Once connected, click on the "+" sign (so you don't have the arrow cursor anymore) and then click (once) on "Deconvolution". Choose "execute" from the FLOWCHART menu. This runs the decon. Once completed, double click on the new file you have created to open it. You can also double click on the original "Data Example" file to open it too (so you can look at both files).

Compare the original "Data Example" and the new seismic file (after decon). (NOTE: Make sure you are looking at the same shot records in each of the files! Move from record to record using the << and >> buttons.) Describe what you see. Do they look different? How? (You can print out any relevant images and include them with your answers if you wish. But, please, just turn in one or two records – not all 38 of them!)

4) Static Correction- Static corrections are used to correct for elevation differences along your survey line. For more details on this, see pgs. 135-136 in the text. Notice that you are given a file called "static shifts" – which contains the static corrections for this data set. You will need to apply these shifts to the data obtained after deconvolution. This will look like so in the flowchart:

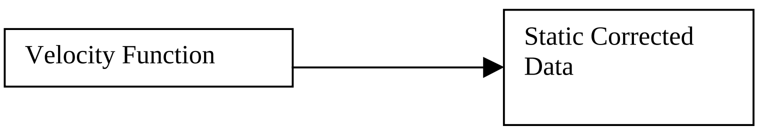


The "apply static shifts" function is listed under "application steps" in the FLOWITEMS menu. The new static corrected data is a new seismic file, that will need to be created and named just as we did when we looked at deconvolution.

Execute the "apply static shifts" function. Compare the deconvolved results to the static corrected data. Do they look different? How important do you think static corrections are for this example?

Close your seismic data windows before proceeding.

5) Velocity Analysis- In order to extract the most information from our data set about the subsurface, we need to have an idea of what the velocities in the subsurface are. This information is obtained using "velocity picking" in SPW. However, before we can pick the velocities, we need a place to store this data. So, under the FLOWITEMS menu, go to "card data" and choose the "velocity function" option. You will need to connect this to your static corrected data like so:



Then, open the static corrected seismic data. From the SEISVIEWER menu, choose the "velocity picking" option. This will open a new window, entitled "Velocity function." Recall that reflectors in seismic data look hyperbolic, so SPW allows the user to draw hyperbolas on the seismic records to fit each reflector. To do this, go back to the data window and click on the seismic record where you think the middle or apex of the hyperbola will be. HOLD THE MOUSE BUTTON DOWN and move the mouse sideways to fit this hyperbola to your reflector. When it looks good, let go of the mouse button. SPW will draw a hyperbola there and will list the velocity data in the "velocity function" window. If you do not like the fit of your hyperbola, click on it (so it turns blue) and hit delete.

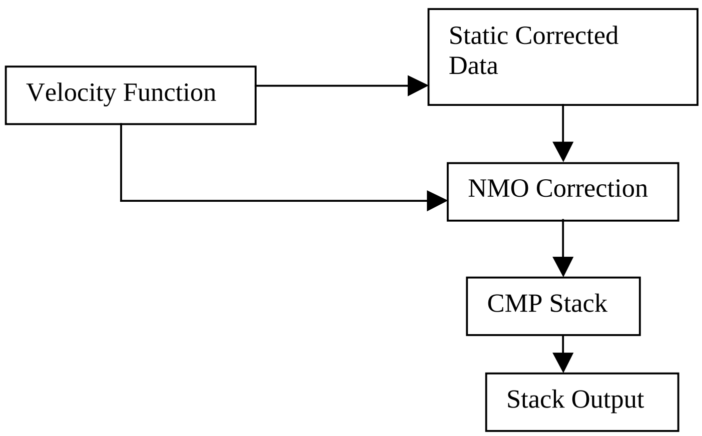
Go through your seismic records, fitting 2 or 3 hyperbolas to records 1, 7, 15, 23, 31, and 36. The velocity values should be increasing for each record as you go down (if they are not, you are probably picking on a multiple, which is not useful data). Make sure to delete hyperbolas which do not show this increasing trend.

In other words, only use the hyperbolas which show an increase in velocity with time. What is happening to the hyperbolas as you move farther down the time axis (i.e. how is their shape changing)?

When you close the "velocity function" window, it will ask you if you want to save this information. Click on YES.

6) Stacking- Stacking involves adding the signal along each trace together using special time delays called moveouts. The details of stacking can be found in the book on pages 135. In SPW, in order to stack the data, you must first apply the normal moveout correction (or NMO correction). We will not cover the details of this here, but if you interested see pgs. 136-137 in the text.

   In order to stack our data, we must input the seismic data and the velocity information. This will look like so on the flow chart:



   The "NMO correction" is listed under "application steps" while the "CMP stack" is listed under "signal enhancement" (both under the FLOWITEMS menu). Again, the stack output will be another seismic file that will need to be created and named just as we did before when looking at deconvolution and static corrections.

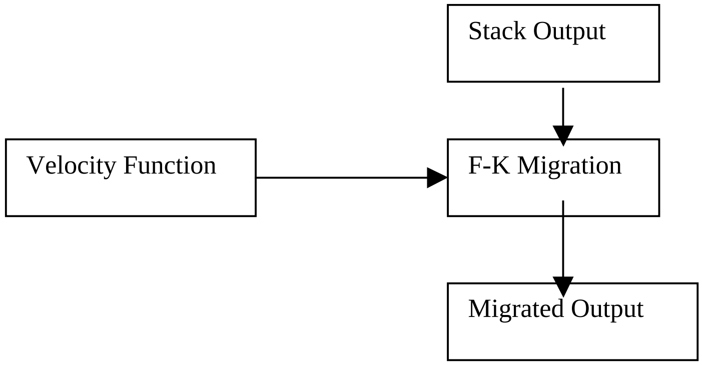
   Don't worry about the NMO right now. Just use it's default settings. You can just use the default setting of the CMP Stack too. To get your final stack output, click on the "NMO correction" and execute it. The result is a collection of CMP stacks for all available midpoints in the dataset – a record section!

   Take a look at this stack. What do you see? At what time values (approximately) does it look like your reflectors are present? Go to File and page setup – choose the "landscape" setting and set the scale to 45% (so the plot all fits on one page). Then print out a copy of your stack to turn in.

Post – Processing (Optional)

7) In many cases, post-processing steps are required. One such step is called migration, which is used to remove any possible diffractions that can be caused by dipping interfaces or structure complexities and to correct the dip of dipping interfaces. The details of migration are covered on pages 142-143 in the book.

In SPW, we will use the "f-k migration" to examine this function. The setup on the flowchart should look like so:



Notice that we again must include the velocity information as part of the input to the migration. (You can just copy and paste it). The “F-K Migration” is listed under “migration” in the FLOWITEMS menu. The output is another new seismic file.

Once complete, open up the migrated seismic data file. How does it compare to the stack you did in (6)? Do you see any difference? What does this say about the existence of diffractions in our data set?

This lab was just to give you a flavor of what seismic processing is like. Clearly, in real processing, your data would be more complicated, many more steps would be taken to improve the data, and more detailed analysis would be done. It takes YEARS to become very good at this because a lot of the best approaches are learned through experience.

<u>Turn in</u>: Answers to all of the questions in the lab, a copy of your completed flow chart, a copy of your stack, and any other relevant images you think should be included.