Geophysics 557 Seismic Data Processing with VISTA (5): Velocity analysis

We have now completed all of the processing steps that can be computed independently of seismic velocity (statics, FK filter, scaling, decon). The purpose of this lab is to improve the stacked image of the Spring Coulee data by picking a new velocity function and stacking with it. You will need your best set of shot records (amplitude scaled, groundroll removed, spiking decon applied, elevation/refraction/residual statics computed) to proceed.

1) **Create a processing flow to compute CMP gathers, semblance panels and Constant Velocity Stacks (CVS) for CMPS 150 to 850 in intervals of 50:**
   a) Copy the file Velan.flw from I:\CLASSES\goph557\Priddis2010\VistaLab5 folder to your own project directory on your **C:** drive. ***IMPORTANT*** *do not edit the original – copy it first!*
   b) Open your copied Velan.flw from Vista. Change the input data for **VelZone** to your best shot gathers from the previous labs. Update the header selection to include the CMP gathers from 150 to 850, incrementing every 50.
   c) Double click on the **ReadStat** command and click the FILE button. Browse for the residual statics file you created in Part IV of Lab 4.
   d) Look at the documentation for commands **OffSrtStk, Sembl** and **CVS**. Ensure you understand the purpose of these commands.
   e) Run the flow.

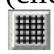
2) **Create a set of velocity curves**
   a) From the main window (top menu) choose **Velocity > Interactive Velocity Analysis.**
   b) Select the three outputs from the VELAN flow from part 2 (use the Shift button and click on them), then click ok.
   c) Click  and pick a velocity function using the semblance. You may need to change the semblance colorbar settings to get a better depiction of the semblance maximum: right-click on semblance window > semblance parameters > color-bar > make the max value smaller so you can see clearly the bright spots where the stack power is greatest.
   d) Look at the CMP gather to check that the velocity function flattens events.
   e) Also look at the CVS displays and verify that your picks give good stacks.
   f) Use the scroll bar at the top of the picking window to move to another CMP location. Pick a velocity function at each CMP location.
   g) You can see the velocity field you have selected by clicking on the **V** icon. Close the display to return to the interactive picking window.
   h) Save your velocities to a .vel file after you have picked all the CMP locations .

3) **Create a flow to output NMO-corrected CMP gathers**
   a) Create a new flow file. Input your best shot gathers, with the same CMP selections as you used in Part 1 of this lab. After input, insert an NMO command and select the brute velocity file in the command parameters. After NMO insert a Mean scaling command and then an output. Run the flow. This flow will output several CMP gathers that have been corrected for normal moveout using our brute velocities. Display the output with a CMP sort order.
   b) Modify the flow from part a). Add two Apply Statics commands before NMO correction, to apply the elevation and refraction statics, as you did in Lab 4. Add a Read Statics and

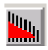
an Apply Statics command right after NMO correction to apply the residual statics, as you did in Lab 4. In the command parameters for the NMO correction, change the velocity file to be the new file you created in Part 2 of this lab.

c) Run the flow from part b), producing CMP gathers that have had statics applied and NMO correction using the new velocity file. Compare these results to the output from Part 3a). Look at the effect of the static corrections and the new velocities.

4) Create a top mute file to get rid of the first breaks and NMO stretch

a) Display the output from Part 3c), sorted by CMP (click the  icon on the left-hand side of the display window, hold and drag to select the  subicon.

b) Now sort each CMP gather by offset, by clicking the  icon.

c) Click on the  icon at the top of the window to start the mute picking process. Click on the  icon to pick a top surgical mute window.
   i) To define the window you will need at least three picks. Make picks far enough below the first breaks to ensure removal of the NMO stretch effect.
   ii) Use the sliding bar on the top to scroll through all the CMP gathers to see that this window effectively mutes the first breaks and NMO stretch on the whole dataset. Modify the mute if necessary.

d) Save the mute window as a MUTE-FILE .

5) Create and plot two stacks from your best shot records:

a) using the brute velocity function
b) using your new velocity function

Start with the flow you used in the last part of Lab 4. Remember to input shots in CMP order. Include a **Muting** command (found under TRACE EDIT) immediately before the CMP stacking command and select the mute file you created in part 4. Comment on improvements from the new velocities if any? Where did the stack improve most?

6) Migrate your final stack

Create a flow to:

a) Input the new stack.
b) Run Finite Difference Migration (**FDMig2D**). Use the new velocities and make sure your trace distance is set to 2.5m. If required, apply smoothing to the picked velocity.
c) Output the results.
d) Rerun the migration using the 45-65 degree solution. Comment on the difference between the results from the 15 degree solution and the 45-65 degree solution.
e) Try a 2D Kirchhoff Migration. Again set the trace spacing to 2.5m. Make the max dip angle 70 and the max # traces in diffraction 600.
f) Rerun the migrations using 90% of the velocity. What happens? Why might you want to do this? (Think about the difference between stacking and rms velocities. What type of velocity are you inputting to the migration? What type of velocity does it expect? What could make these velocities unequal?)

Questions:

1) What is normal moveout?

2) What is a stacking velocity?
3) What information is obtained from the Semblance and CVS during velocity analysis?
4) Did the velocities you picked seem geologically reasonable? Why or why not?
5) Can you distinguish geological features from your migrated section?
6) What happens when in Kirchhoff we reduce the diffraction aperture (example 200 instead of 600)?

Bonus:
Now that you have a better velocity function, go back and recompute residual statics. Apply the new residual statics - can you see improvement in the stack?