**Geol 335.3**

# Lab #6: Common mid-point method

In this lab, you will study the principle of the common-midpoint (CMP) reflection method by making simple Matlab simulations. Tools and functions from the previous labs will be useful in this exercise.

## Theory

Unlike the common-shot seismic data studied in the previous lab, CMP records are collected by moving both sources and receivers in opposite directions so that their midpoint remains constant while the source-receiver distance increases. CMP gathers are usually presented in the form of time-offset seismic sections.

The primary use of CMP gathers is for *stacking velocity analysis*. In its simplest form, velocity analysis is performed by trying a set of stacking velocity values, $V_i$, and for each of them, stacking the energy along the reflection hyperbola:

$$Semblance(t_0, V) = \frac{1}{N}\sum_{i=1}^{N} u_i^2\left(\sqrt{t_0^2 + \left(\frac{x_i}{V}\right)^2}\right) \quad , \qquad (1)$$

where $u_i(t)$ is the signal it $i$-th channel, and $x_i$ is the source-receiver offset at its location. For a horizontal reflector, the stacking velocity equals the averaged (in a quite certain sense) velocity above it. When reflector dip $\alpha$ is present, the stacking velocity increases:

$$V_{\text{with dip}} = \frac{V_{\text{no dip}}}{\sin\alpha}. \qquad (2)$$

## Code

In your `model.m` file, rename `sources` to `midpoints`. For each midpoint, loop over all source positions to the left of the midpoint. For each of the sources, define a single receiver to the right of the midpoint and use your `diprefl` function to predict the corresponding travel time. Then modify you last week's code to produce a trace section with source-receiver offsets used as horizontal scaling instead of the receiver positions. As before, the resulting CMP gather will be a 2-D Matlab array.

Modify your previous Matlab program to plot the common-midpoint gather. The plot should show reflected rays and the corresponding synthetic reflection sections, similar to the previous lab.

To compute velocity spectra (1), you will need to interpolate the resulting amplitudes (sampled at fixed time increments) in time. This can be accomplished by using Matlab function `interp1`

## Assignments

1. [40%] Write the necessary Matlab code.

2. Put only one point into array `midpoints` (in the middle of the model). Execute the modified script `model.m` and pick 2 points to make a horizontal reflecting boundary.
3. [20%] Use your program to plot the common-midpoint gather. Make sure to save all the representative plots and include them in the report. How do the reflection points correspond to the midpoint?
4. Using the resulting CMP gather (2-D Matlab array), compute and plot the velocity spectrum (1) for stacking velocities v=1:0.05:2.0 m/ms (Note that these units are the same as km/s).
5. [20%] Run `model.m` again and pick 2 points to make a dipping reflecting boundary. Plot the corresponding common-midpoint gather. What happens to the reflection points? What happens if the dip is changed?
6. [10%] Plot the velocity spectrum for the dipping interface cases. How do the optimal stacking velocities change? Why? Compare the result to the prediction from formula (2).
7. [10%] Summarize the differences of the horizontal and dipping reflector cases.

## Hand in:

Zipped directories containing:

1. All Matlab codes (“m-files”);
2. Screen captures or Postscript/PDF figures;
3. Discussion in a Word file.