# Lab #7: Seismic reflection imaging (migration)

Imaging is the process of obtaining the final depth image of the subsurface from processed reflection seismic data. The principal objective of imaging is placement of the observed reflections into their correct spatial positions and collapsing diffractions.

Most commonly used imaging methods that are not particularly careful about inverting the amplitudes are called "migrations". In this lab, you will use Matlab to implement a simple post-stack (which means using a zero-offset section) migration. The zero-offset section produced in lab #5 will serve as an input for migration.

Theory

Post-stack migration operates on a zero-offset section, i.e., seismic record obtained from numerous collocated sources and receivers. Ideally, the amplitude recorded from a source (and at receiver) **S** at time t is a sum of all reflections from a circle of radius $R=Vt/2$ and centered at **S**:
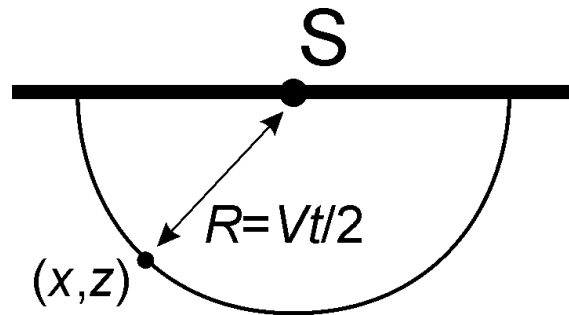
Conversely, the reflectivity at depth point (x,z) will be recorded from any source (=receiver) **S** at time $t = 2R/V$, where the distance R varies with x_S:

$$R(x,z,x_S) = \sqrt{(x-x_S)^2 + z^2} \tag{1}$$

Therefore, if we have a zero-offset section $u_{ZOS}(x,t)$, we can obtain the true section of reflectivity by adding contributions from all possible source/receiver positions:

$$u_{Depth}(x,z) = \sum_{All\ x_s} u_{ZOS}\left(x_S, t = \frac{2}{V}\sqrt{(x-x_S)^2 + z^2}\right). \tag{2}$$

True reflections originating from point (x,z) will contribute coherently to this sum. When evaluated for each (x,z), this expression yields the depth image. This type of migration is called "diffraction-stack".

Code

The code implemented by formula (1) is given in function `scattering_ellipse()`. Look into this code and try understanding its steps.

Plotting can be done by function `plot_Zsection()` (which is very similar to `plot_section()` you used before, but for depth domain and automatically applying plot scaling). Also look into its code and understand it.

Assignments

1. [20%] In the zero-offset section, reflection time t = $2R/V$ is plotted downward as a function of x_S. For a given (x,z), from equation (1), what is the shape of this curve $t(x_S)$?

2. [30%] Modify the Matlab in file `migration.m` so that it will load one of the reflection sections you produced in lab #5.

3. In file `migration.m`, there are three tasks that you need to perform separately. Use commands `pause` to separate the tasks, or comment some lines out create separate files for the tasks if you prefer.

4. [50%] Perform the tasks described in `migration.m`, create plots and discuss the results. In the final Task 3, and you should see an image of a reflector close to the one you created by function `picklayer()` in lab #5.

Hand in:

Zipped directories containing:

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