

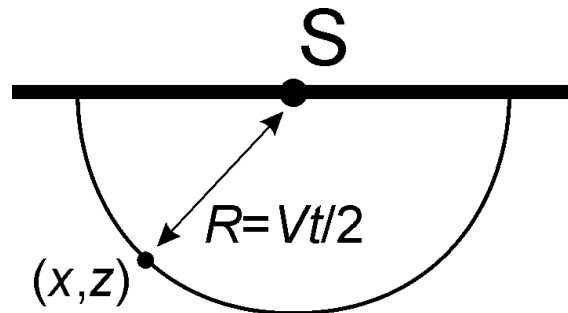
Lab #9: Seismic reflection imaging (migration)

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 migration. The zero-offset section produced in lab #6 will serve as the 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) \mathbf{S} at time t is a superposition (sum) of all reflections from a circle of radius $R=Vt/2$ and centered at \mathbf{S} :



Conversely, the reflectivity at depth point (x,z) can be determined by adding the amplitudes from all the sources (=receivers) \mathbf{S} , each taken at time $t=2R/V$, where:

$$R = \sqrt{(x - x_s)^2 + z^2} \quad (1)$$

is the distance from the imaging point to the source. True reflections will contribute coherently to this sum, and when evaluated for each (x,z) , this expression yields the “diffraction-stack” migrated depth image.

Code

The code will principally consist of a triple loop over x , source positions, and z . As before, use Matlab function `interp1` to obtain the reflection amplitudes at arbitrary times required by formula (1).

Assignments

1. [5%] For a given (x,z) , what is the curve in the zero-offset section (x_s,t) along which stacking is performed in expression (1)?

2. [30%] Write Matlab code to perform diffraction-stack migration using formula (1).
3. Build a reflector model with valleys and crests in the reflector as in lab #6.
4. [10%] Recompute the zero-offset section (use your code from lab #6)
5. [10%] Compare the resulting time section to the model. Note the differences in apparent reflector dips compared to the model.
6. [30%] Apply migration.
7. [10%] Compare the image to the original model and discuss the result.

Hand in:

Zipped directories containing:

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