SEISMIC IMAGING - ASSIGNMENT 1

BEN GREMILLION

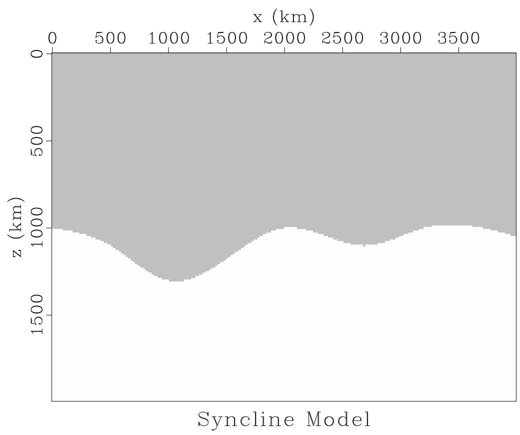

Figure 1: Syncline reflector used for modeling data in this assignment.

CONVOLUTIONAL MODELING

Convolutional modeling consists of convolving a wavelet with a given reflectivity series directly below a coincident source and receiver. This modeling technique is only accurate when reflectors are flat-lying. In our syncline example, the results of convolutional modeling are actually what would we would hope to achieve with time migration.

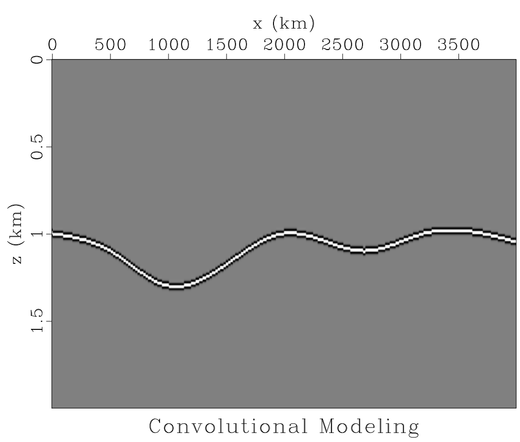

Figure 2: Results from convolutional modeling.

EXPLODING REFLECTOR MODELING

Exploding reflector modeling assumes that every point of a reflector is a source whose strength is proportional to the reflectivity of the interface at that point and that the wavefronts created move at half the interval velocity. This means that wavefronts move perpendicular to the interface, rather than only vertically as in the covolutional model, which gives much more accurate modeling representations of dipping structures such as synclines and anticlines. In the exploding reflector model of our example, we can see that anticlines appear broader than in the real geology and a bow-tie has been created at the left syncline. Despite accurately modeling dipping reflectors, exploding reflector modeling breaks down at diffractions since there are an infinite number of normal directions to a diffractor.

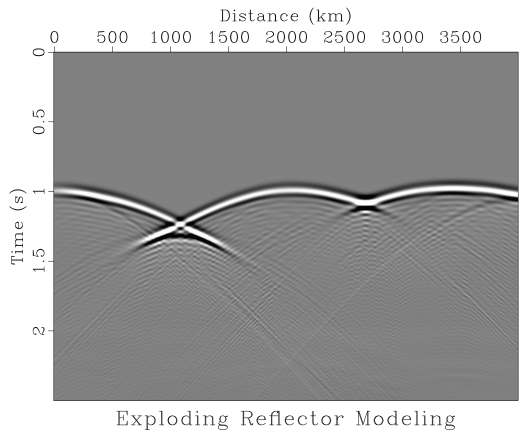

Figure 3: Results from exploding reflector modeling.

RAY-BORN (KIRCHHOFF) MODELING

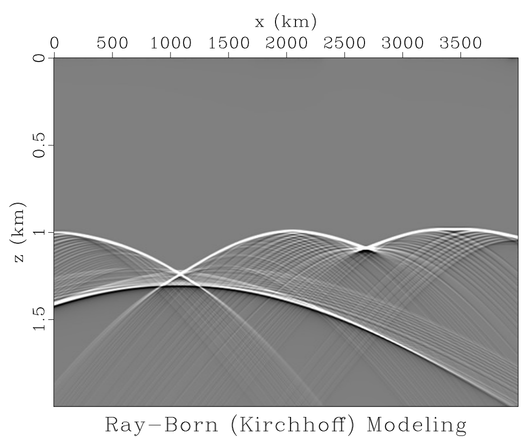

Figure 4: Results from Kirchhoff modeling.

Kirchhoff modeling treats each point in the subsurface as a diffractor, meaning that every point on a reflector creates a hyperbola in the seismic section. This technique doesn't require normal incidence and obviously models the response of diffractors very well. One drawback of this method is that it doesn't model the entire wavefield, i.e. multiples won't be seen on the seismic section. Although no diffractors are present in our syncline model, the diffractions created by the Kirchhoff modeling can clearly be seen. Also present is a large, high-amplitude hyperbola centered beneath the left syncline of the model that displays signal at all receivers. Although a bow-tie is expected at the left syncline, I'm not sure what is causing the bow-tie to be so large in the data.

FINITE-DIFFERENCE MODELING (ZERO-OFFSET TRACES COLLECTED FROM SHOT GATHER)

Finite-difference modeling has an advantage over other modeling methods in that finite-difference methods model the entire wavefield. In this section, I used finite-differences with a coincident source and receiver, moving the source and receiver along the surface with increasing iterations. The results from this finite-differences model appear similar to the exploding reflector results, with an exception being some faint signals appear near 2 seconds and at x coordinates 1750 and 2250 meters in the finite-differences section.

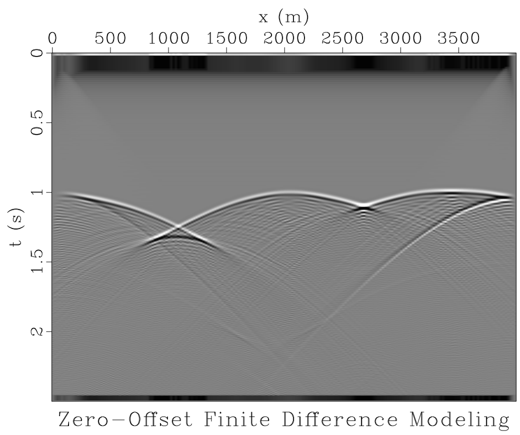

Figure 5: Results from finite-difference modeling by collecting zero-offset traces from shot gathers.

FINITE-DIFFERENCE MODELING (PLANE WAVE INJECTED AT SURFACE)

In this section, I implemented finite-difference modeling by injecting a plane wave at the surface with many receivers listening on the surface. Multiples can clearly be seen in the section starting at around 2 seconds near the center. Although this method is computationally effective (i.e. it has a short runtime), plane-wave finite differences isn't completely realistic since in reality we don't have many sources set off at once. Additionally, wavefronts from different sources can interfere with one another in this modeling scheme.

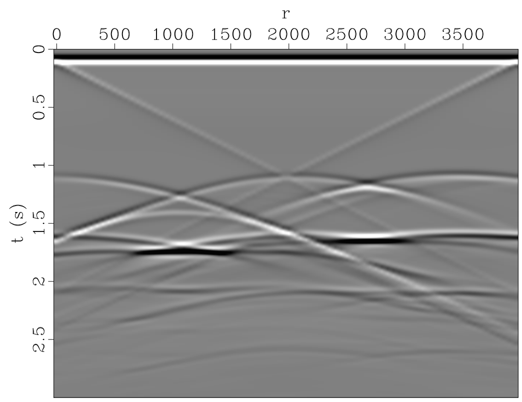

Figure 6: Results from finite-difference modeling by injecting a plane wave at the surface.

FINITE-DIFFERENCE MODELING (REAL SHOT GATHER)

Although I didn't have time to complete this modeling technique, finite-difference modeling shot gathers is the most realistic and computationally expensive modeling method in this assignment. This is due to the fact that many shot gathers must be created, sorted into CMP gathers, have velocity analysis performed on them, and finally stacked to create a zero-offset section. This result would then be ready for post-stack migration to create a final image.