Preliminary Results on Downward Continuation of Multi-Offset Sections and Velocity Estimation

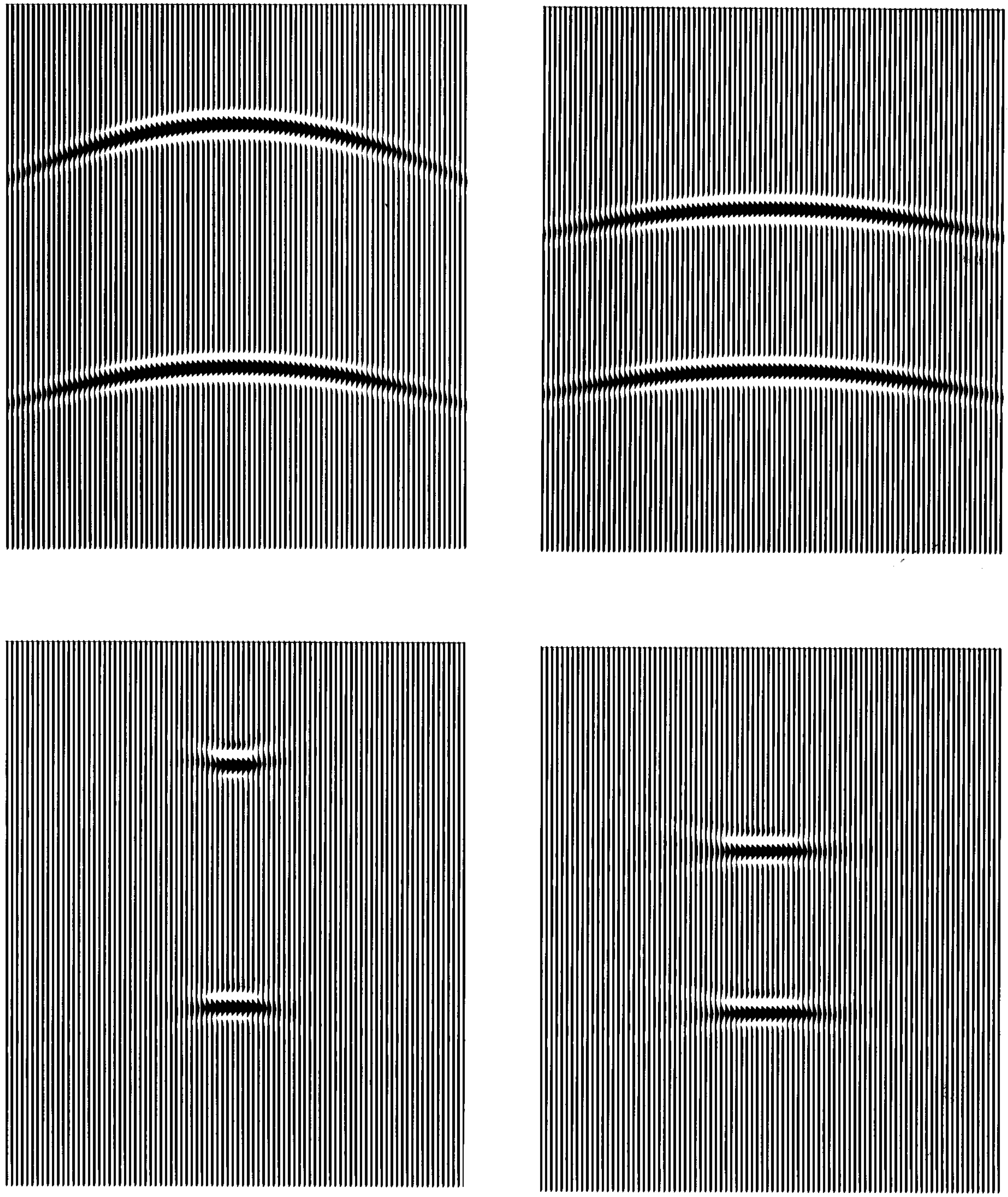

Figure 1. Migration of multi-offset sections. The top two frames depict two moveout corrected common offset sections. Moveout velocity was 5500 ft/sec. The two hyperbolas were constructed with two different true velocities (top is 5000 ft/sec, bottom is 5500 ft/sec). Since we are not simulating a variable velocity

medium, these initial conditions should be thought of as two separate models that have been displayed on the same grid. Trace spacing is 31 ft. Time ranges from 1.52 to 2.42 seconds. The left frame is a zero offset section. The right frame is a far trace section (shot-receiver separation is 8000 ft). Notice that the arrival time of the apex of the deep hyperbola is independent of offset. This occurs because the true velocity of this event equals the moveout velocity. Residual moveout causes the upper hyperbola to appear late on the far trace section. The far trace section has less angular bandwidth than the near trace section.

The bottom frames show the sections after migration with the equation

$$Q_{dr} + \frac{h}{d} Q_{yr} = - \left(1 + \frac{4h^2}{v^2 d^2} \right) \frac{v}{8} \left(\frac{d}{d-r/v} \right)^2 Q_{yy}$$

The hyperbolas have collapsed to focuses on both sections. The focuses on the far trace section are wider because of the smaller angular bandwidth of the surface data. The shallow focuses are narrower than the deep focuses for the same reason. Notice that the zero offset section is symmetric about the scatterer position while the far trace section shows a small asymmetry. This is the result of inclusion of the Q_{yr} term in the continuation equation. Because the migration velocity was 10% too high for the shallow hyperbola, we should expect it to be over-migrated. The focus does have some upward curvature but the effect is small. Migration quality is not very sensitive to velocity error.

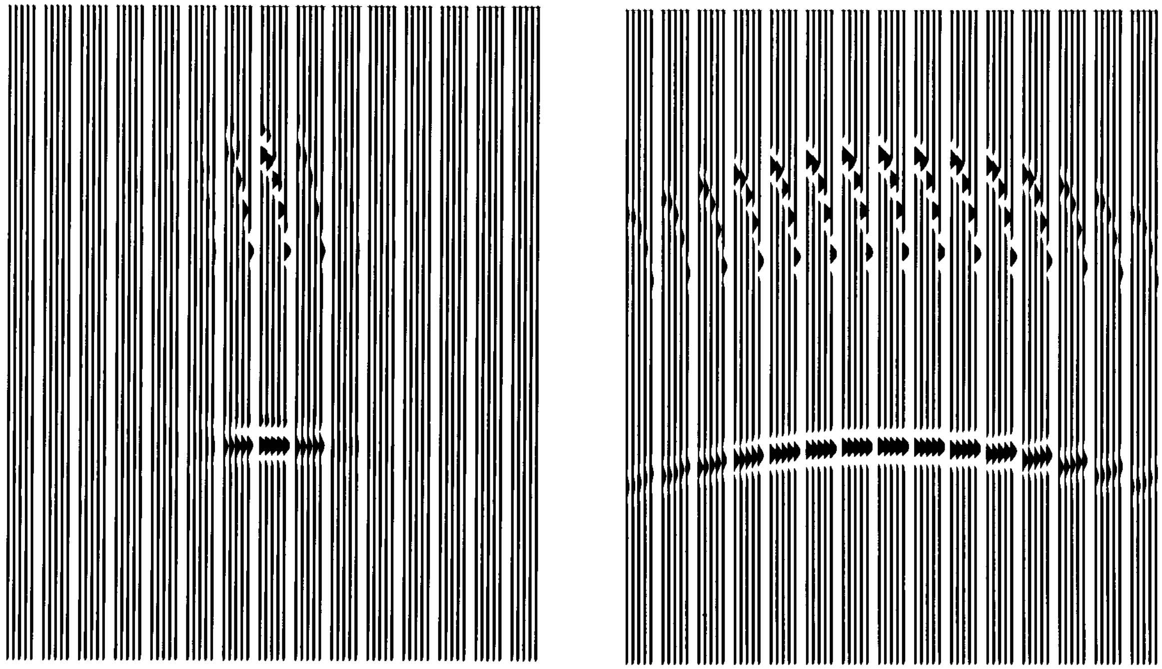

Figure 2. Moveout corrected common midpoint gathers for the data of figure 1. Axes for this figure are indicated in figure 2 of the previous section. The offsets depicted are 0, 1000', 2000', 3000' and 4000' . The right frame depicts the surface data. Notice the residual moveout of the deeper hyperbola. Since this data was moved out with true velocity any residual moveout results from the 'Levin effect'. The residual moveout of the upper hyperbola is larger because the moveout velocity was 10% higher than its true velocity. The Levin effect causes residual to decrease near the edge of the frame.

The left frame depicts the downward continued gathers. Notice that the data corresponding to the deep hyperbola is virtually independent of offset. Levin effect residual moveout has been removed by downward continuation. Structurally caused residual moveout has also been removed from the shallow event. Careful measurement shows that the residual for the gather centered over the shallow scatterer is the same in both frames. True velocity can be easily estimated from leftmost frame. Most velocity estimation procedures which are designed for surface data can be applied to the left frame without modification.

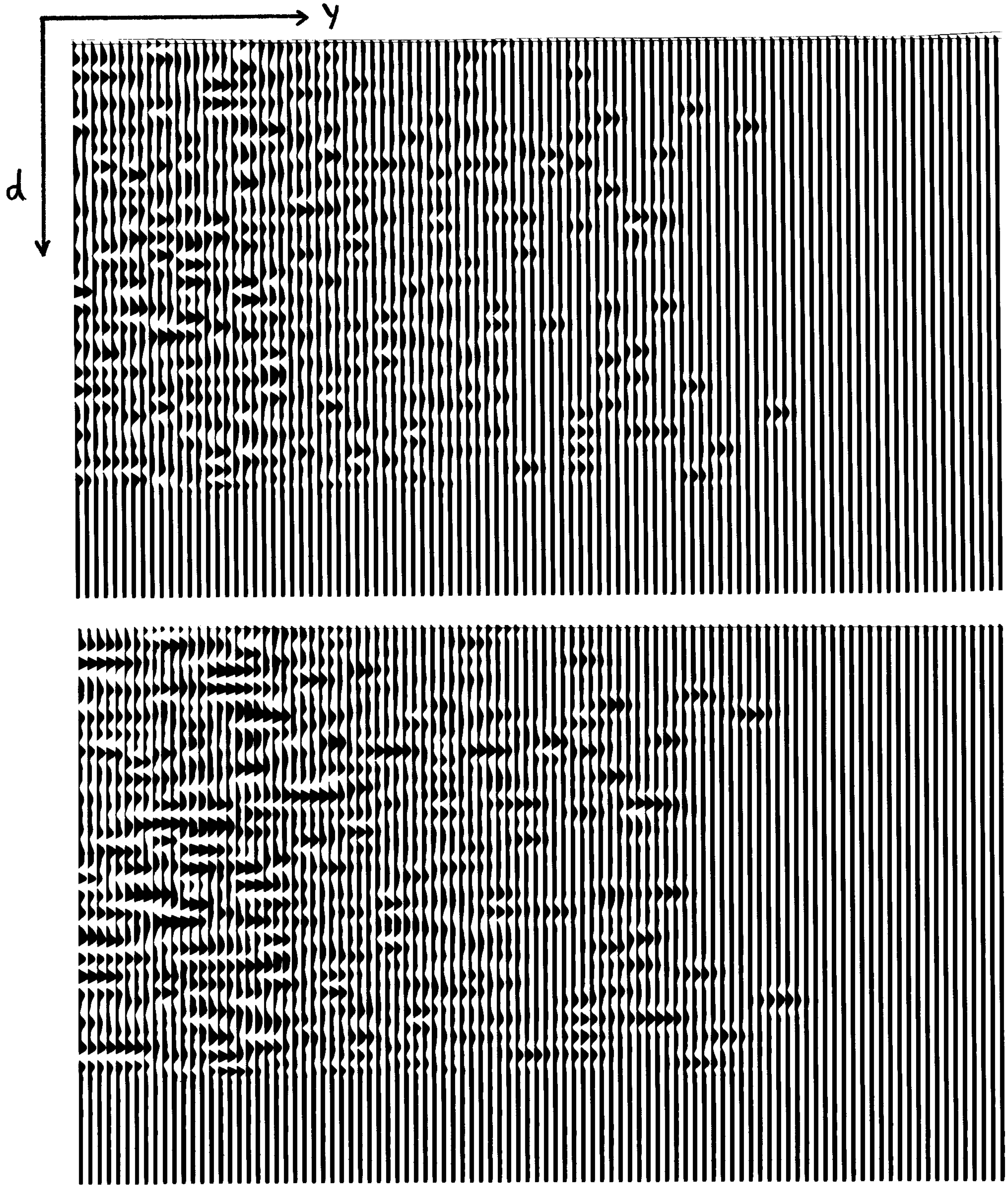

Figure 3. Earth model and reconstructed earth model for the cover data. The top frame is the earth model. The bottom frame is the earth model reconstructed from the surface data of figure 4. Scatterers are wider (in y) on the reconstructed earth model due to dip filtering during construction of the surface data.

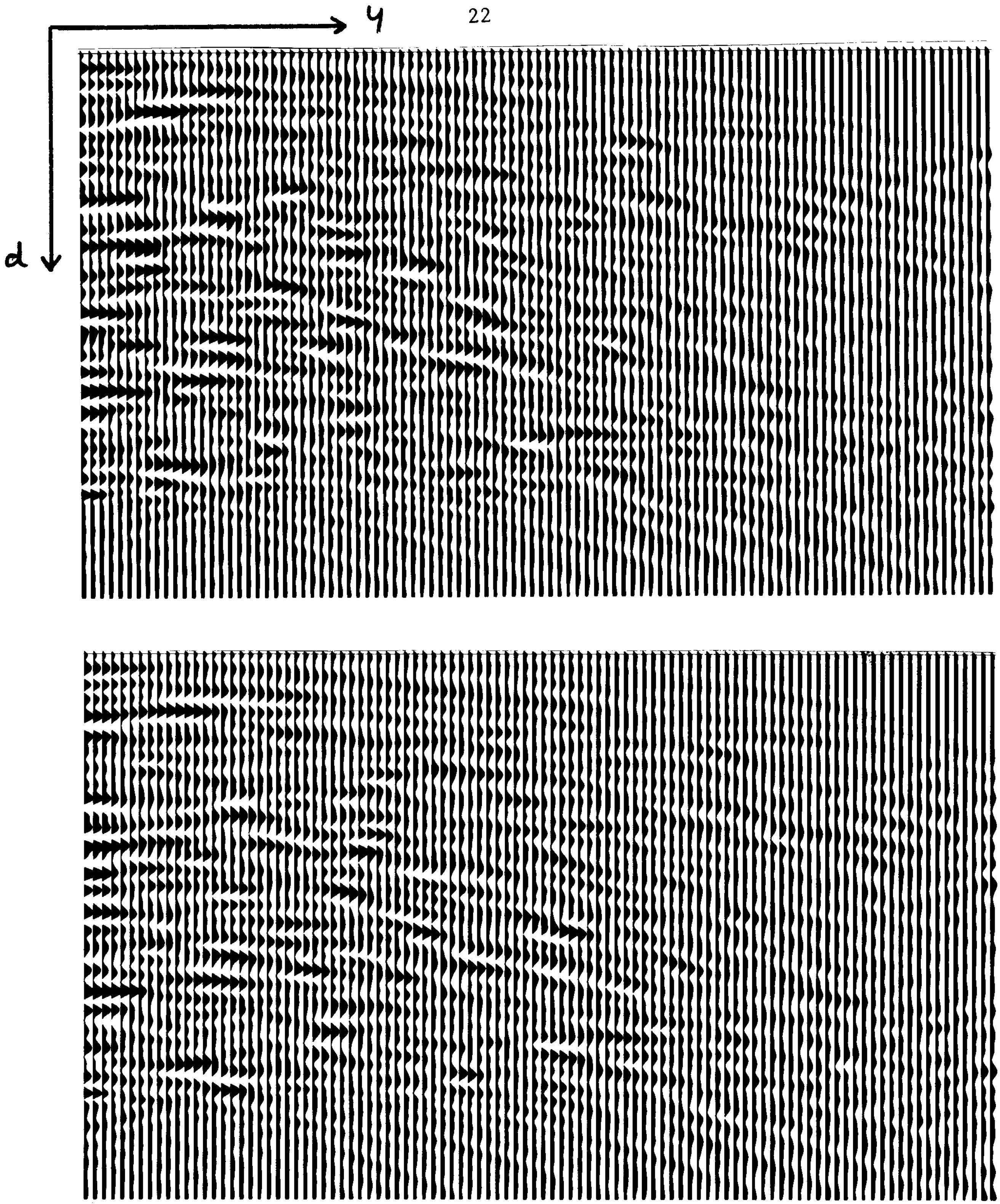

Figure 4. Sections from which the gathers on the cover were constructed. The top frame is a moveout corrected near trace section (h=600'). The bottom frame is a moveout corrected far trace section (h=3600'). Trace spacing is 31 ft. Time ranges from 2.5 to 3.5 seconds. Water velocity was used in constructing these frames from the top frame in figure 3.

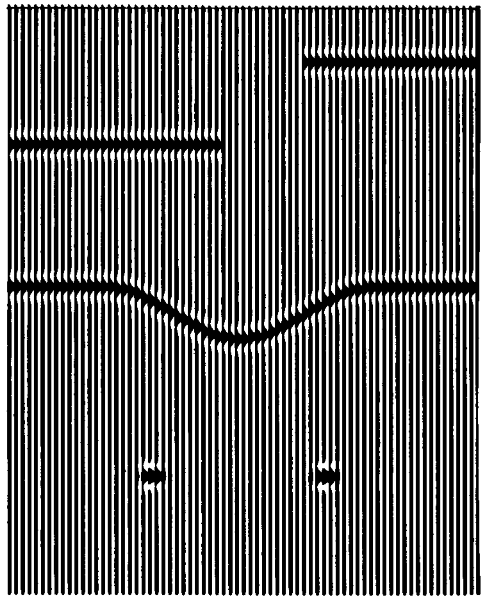

Figure 5. Earth model for figures 6 and 7.
Trace spacing is 55 ft. Time ranges from
2.5 to 3.5 seconds.

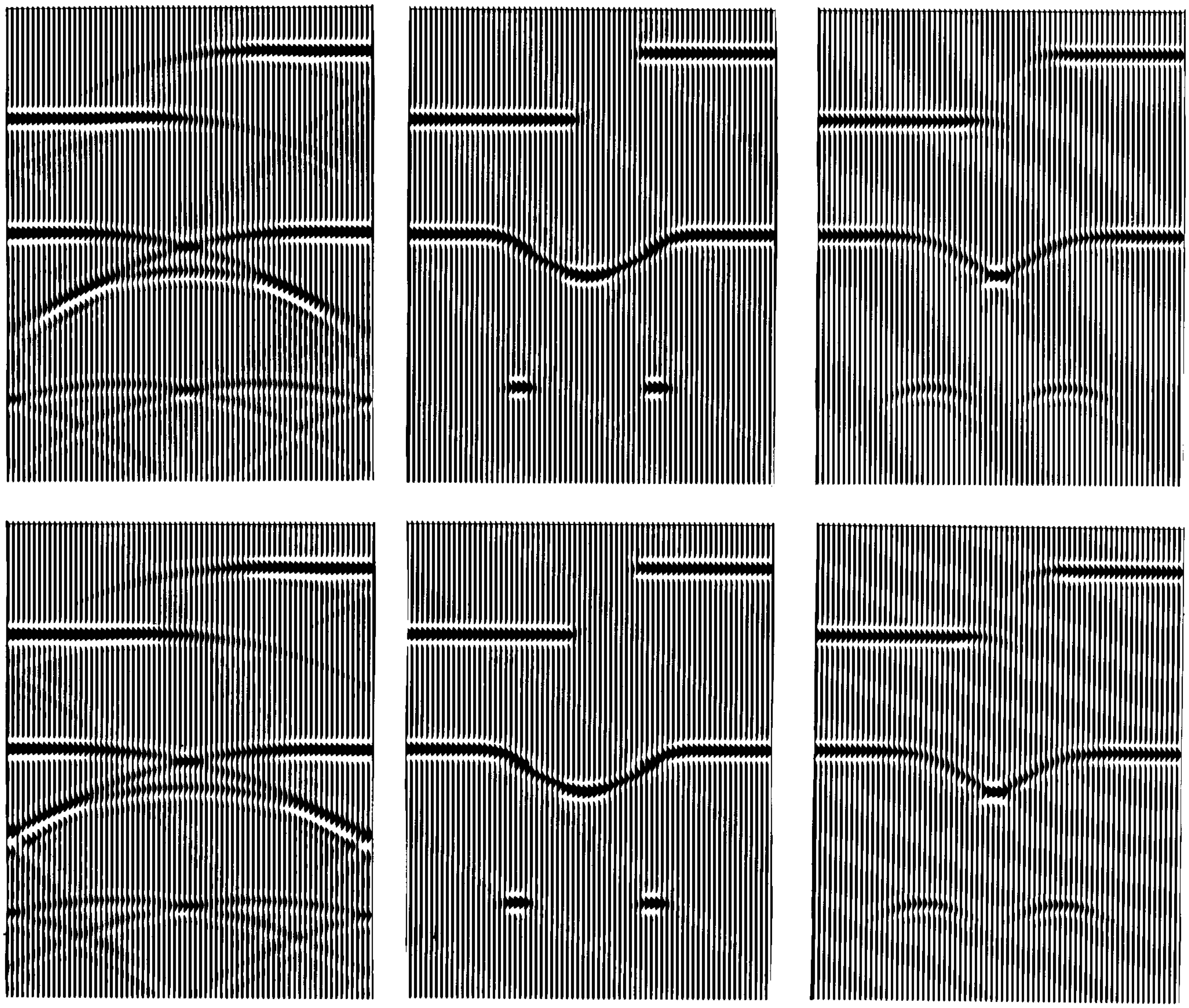

Figure 6. Surface data and earth reconstructions for the earth model of figure 5. The left most frames are the moveout corrected surface data. The top frame is a near trace section (h=600'). The bottom frame is a far trace section (h=3600'). Water velocity was used to construct these frames.

The center frames show the surface data after migration. Reconstruction is not exact due to dip filtering.

The left most frame shows the same surface data migrated with a velocity that was 10% too low. Migration quality is moderately insensitive to velocity error.

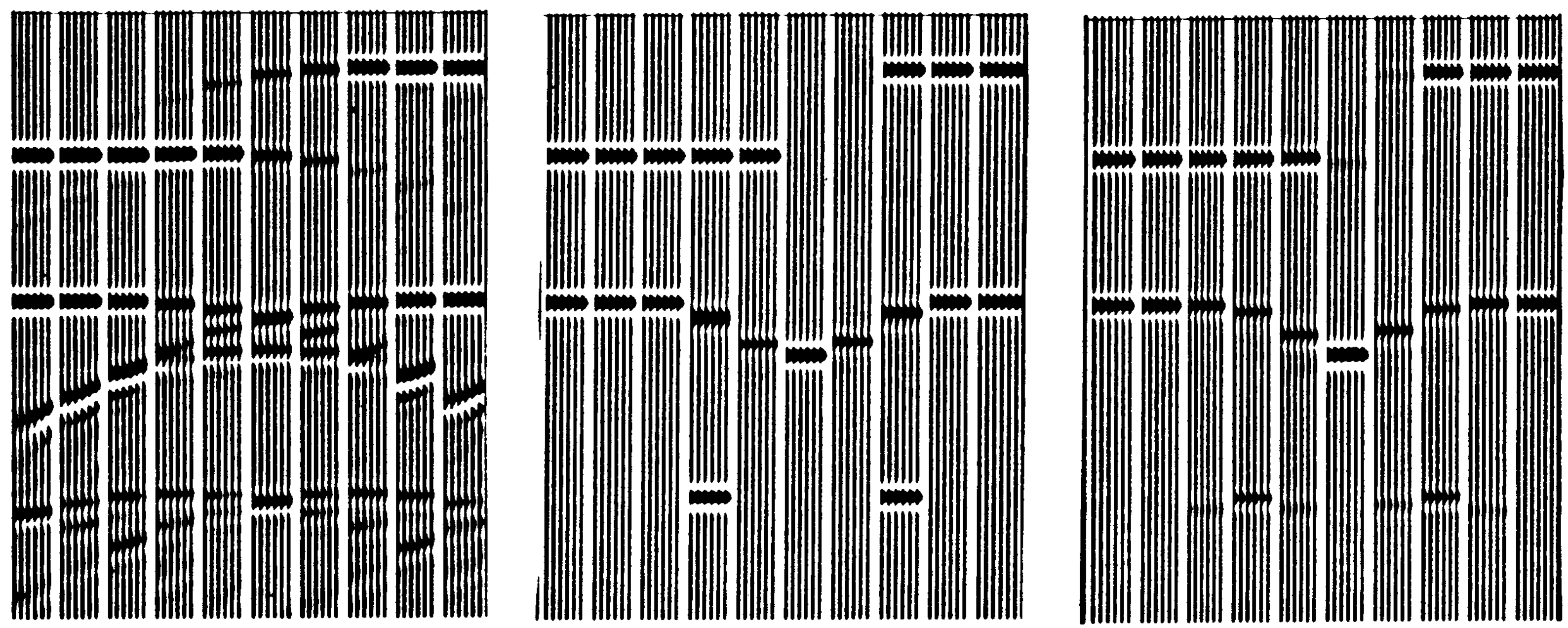

Figure 7. Common depth point gathers for the data of figure 6. The left frame shows gathers constructed from the surface data. The largest dips on this frame correspond to a velocity error of about 4%. The center frame shows gathers constructed from the properly migrated data of figure 6. The right most frame shows gathers constructed from the under migrated data of figure 6.