Preliminary Results on Diffracted Multiple Modelling and Removal

by Don C. Riley

This section represents our initial results of synthesizing and inverting diffracted multiple reflections with the wave equation.

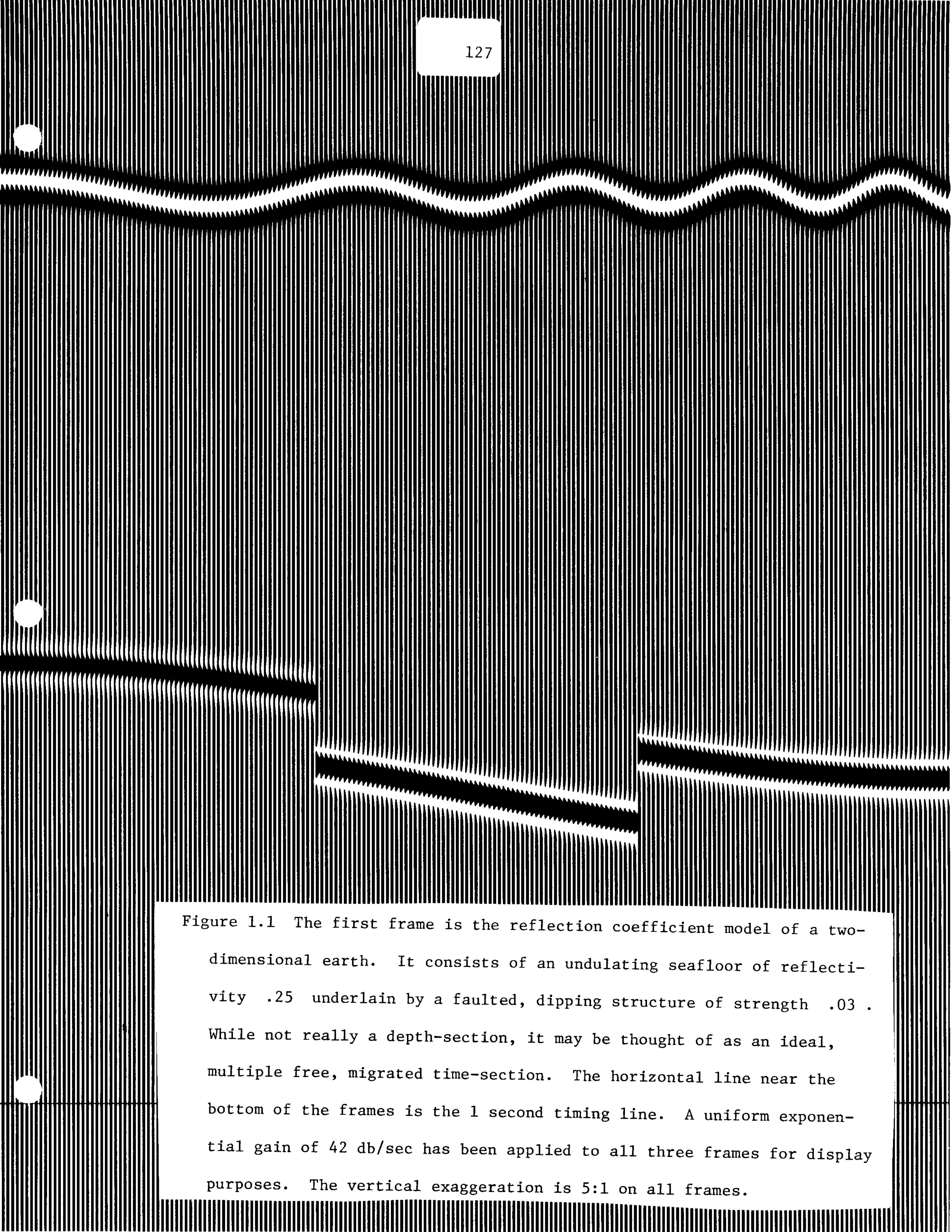

Figure 1.1 The first frame is the reflection coefficient model of a two-dimensional earth. It consists of an undulating seafloor of reflectivity .25 underlain by a faulted, dipping structure of strength .03 . While not really a depth-section, it may be thought of as an ideal, multiple free, migrated time-section. The horizontal line near the bottom of the frames is the 1 second timing line. A uniform exponential gain of 42 db/sec has been applied to all three frames for display purposes. The vertical exaggeration is 5:1 on all frames.

Figure 1.2 The second frame is the reflection time-section synthesized from the given model. A better reproduction of this section appears on the report cover. The simple seafloor multiples do not begin to significantly diffract on the right until the third bounce. The hyperbolic tails on the structure primary represent scattering off the sharp edges of the fault. Below the primary arrival are the pegleg multiples. Compare the amount of diffraction on the first seafloor multiple and the first pegleg. Both have experienced the same amount of stretching due to the seafloor. The reason for the more intense diffraction of the pegleg is due to the much longer path the deformed wave travels.

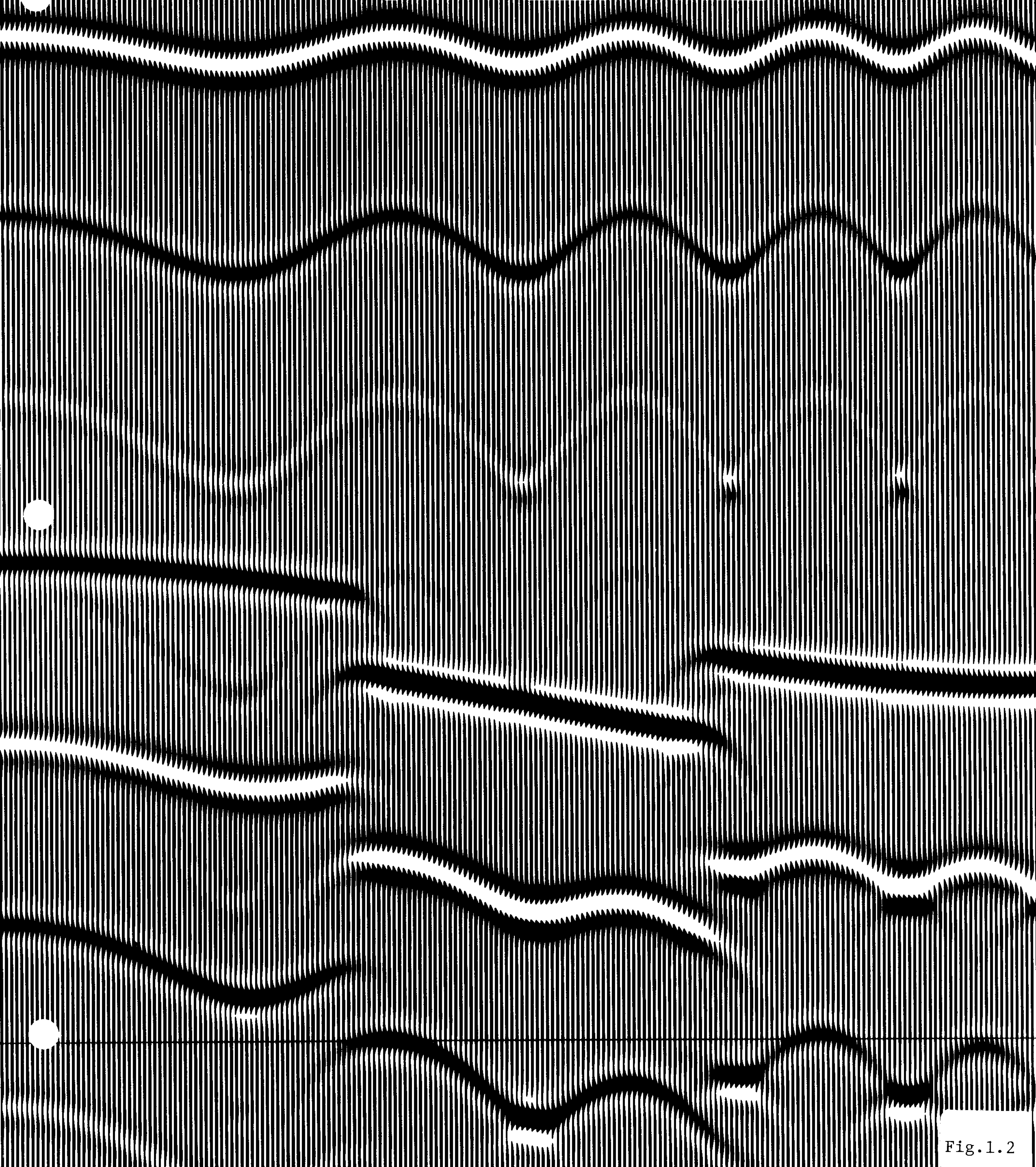

Fig.1.2

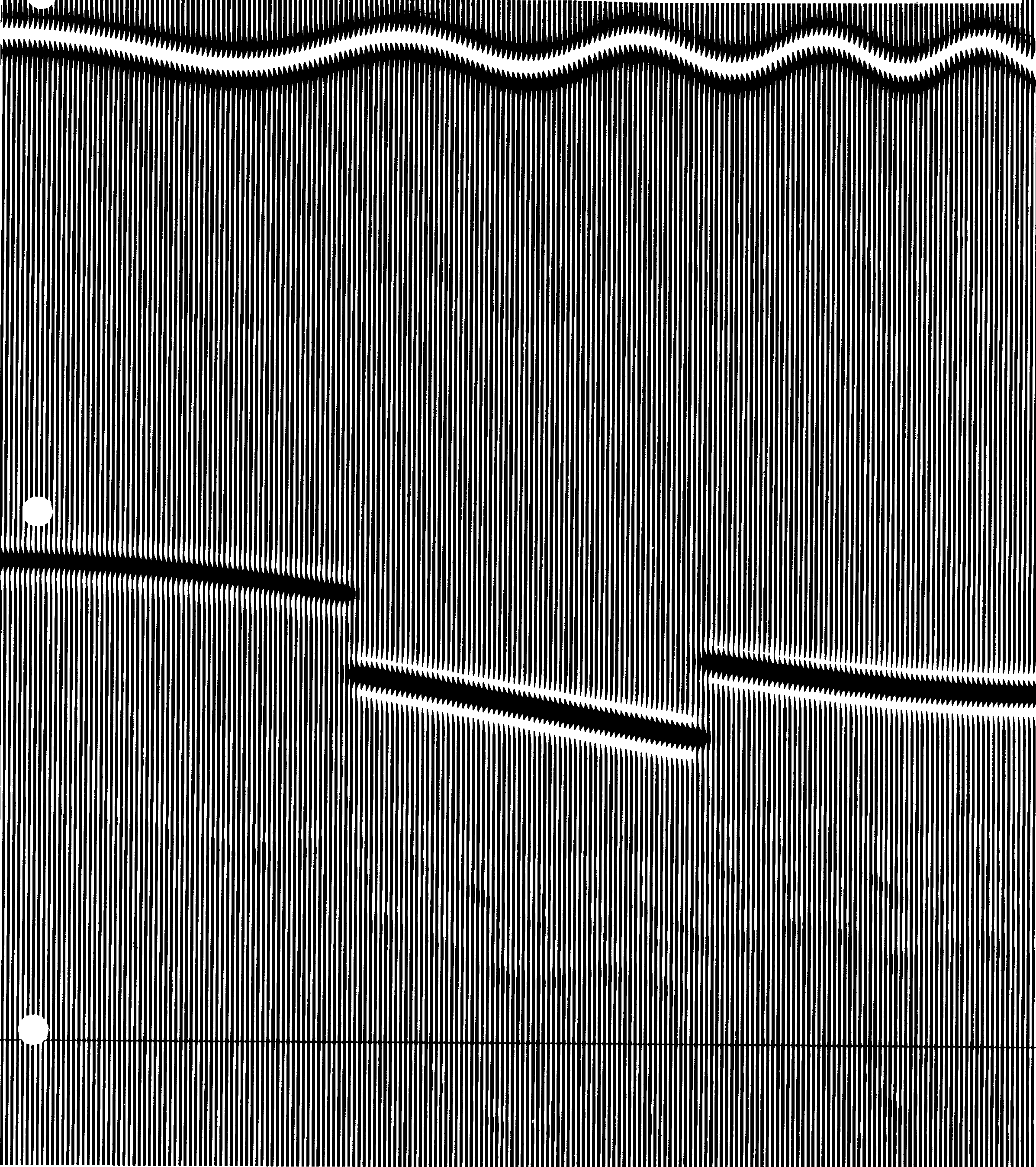

Figure 1.3 The third frame represents our attempt at trying to invert the reflection data of frame 2 to yield the original model. Essentially, the computer program that generated frame 2 can be run backwards. Our estimates of the reflectors are derived from the fundamental principle of reflector mapping: "reflectors exist at points in the ground where the first arrival of the downgoing wave is time coincident with an upcoming wave" (Claerbout, 1971). Thus, the inverse may be derived from the upcoming waves along the downgoing first arrival trajectory. This job, consisting of constructing the model, doing the forward calculation, and doing the inversion took 8 minutes on an IBM 360/67.

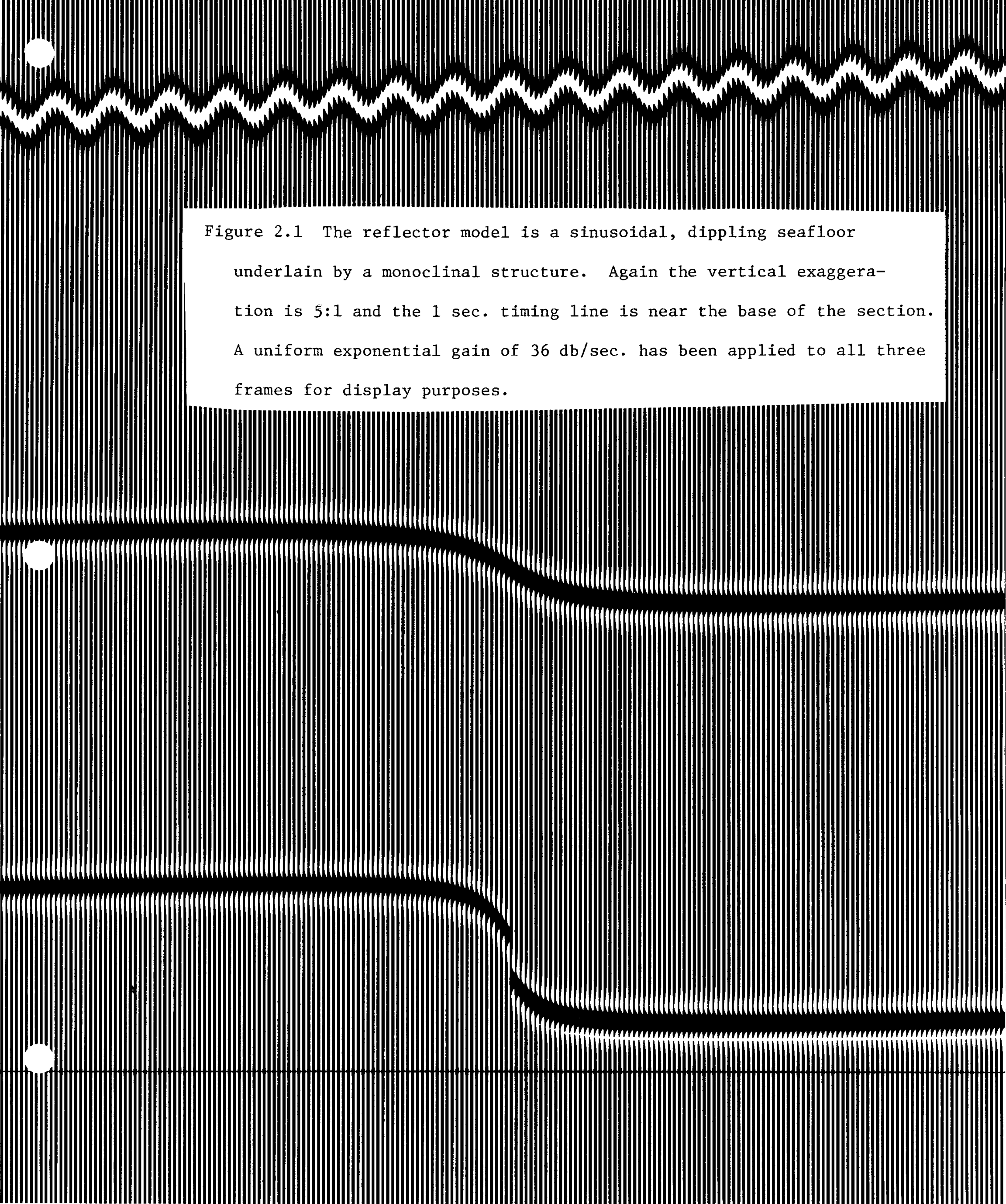

Figure 2.1 The reflector model is a sinusoidal, dippling seafloor underlain by a monoclinal structure. Again the vertical exaggeration is 5:1 and the 1 sec. timing line is near the base of the section. A uniform exponential gain of 36 db/sec. has been applied to all three frames for display purposes.

Figure 2.2 The second frame is the resulting reflection seismograms as computed from the model of frame 1. Note that the diffractions on the seafloor primary and multiples increase with increasing water depth. The second seafloor multiple is barely visible with the gain chosen. The structure peglegs again exhibit the long path diffraction phenomenon. The scattering off the fault zone is less apparent than in figure 1 due to the geometry of the fault. Note the structure-structure arrival in the lower left corners of the frame of the first monocline.

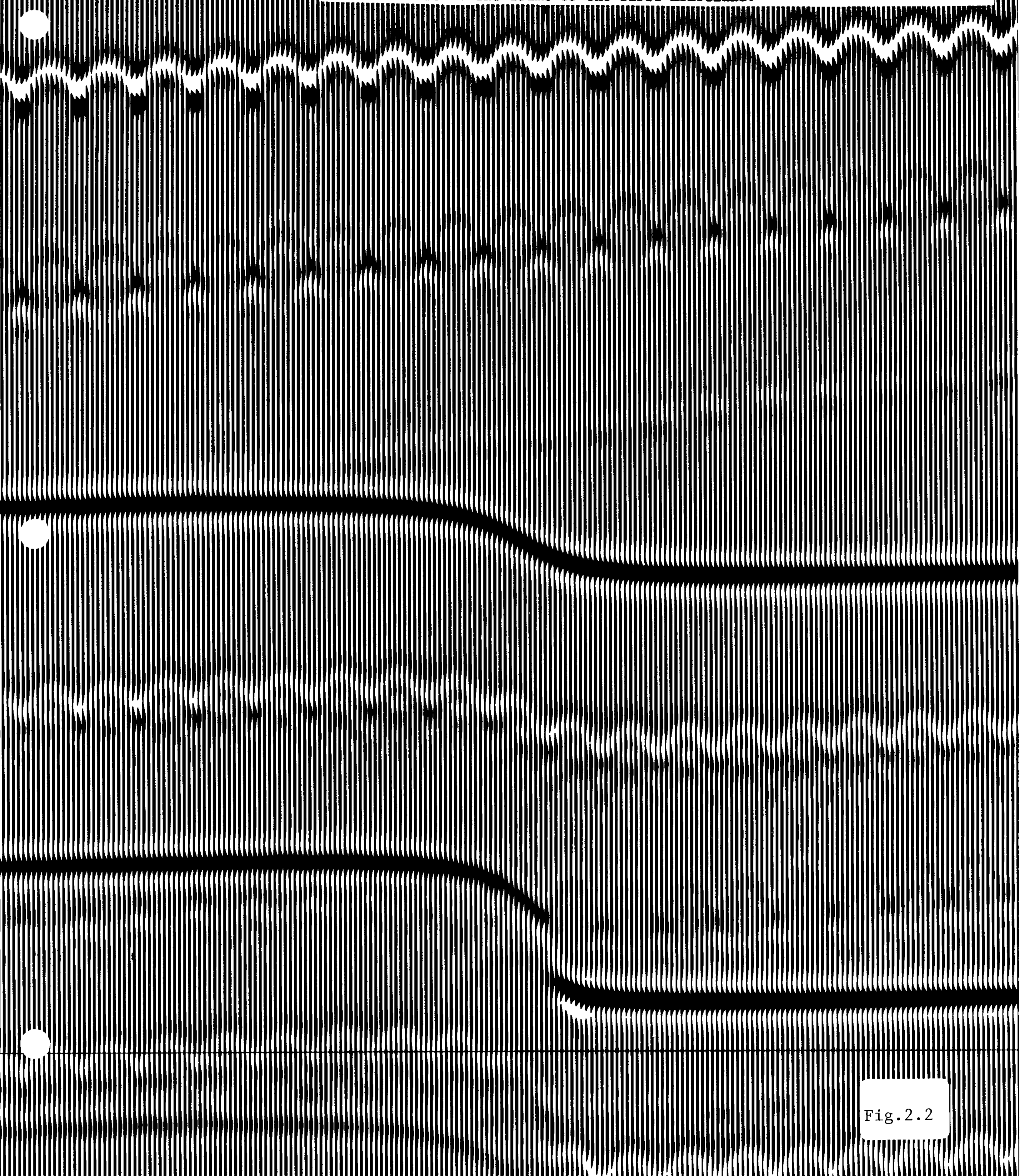

Fig.2.2

Figure 2.3 The third frame is the reconstruction of the reflector model using the data of frame 2 as a boundary condition.

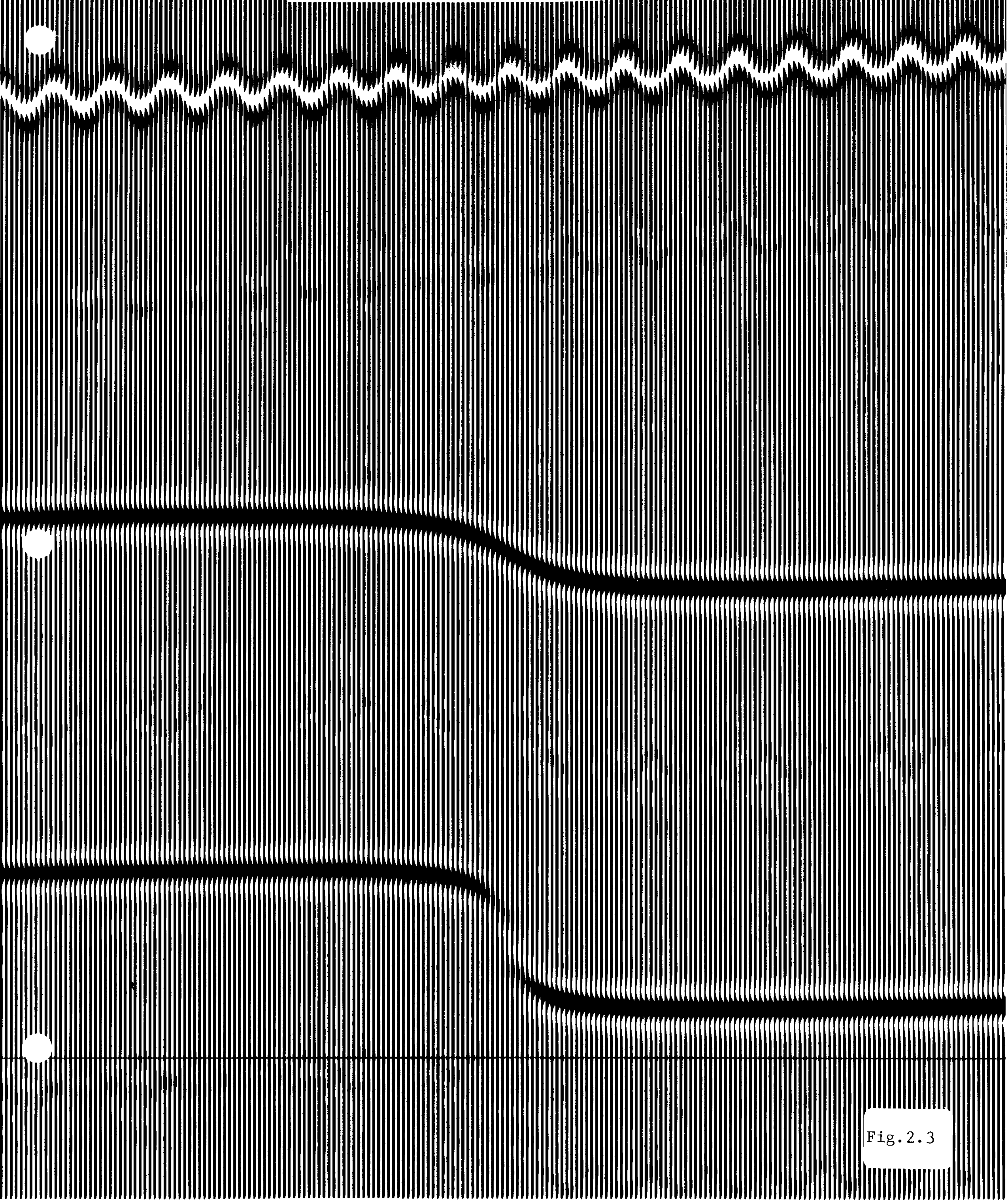

Fig.2.3

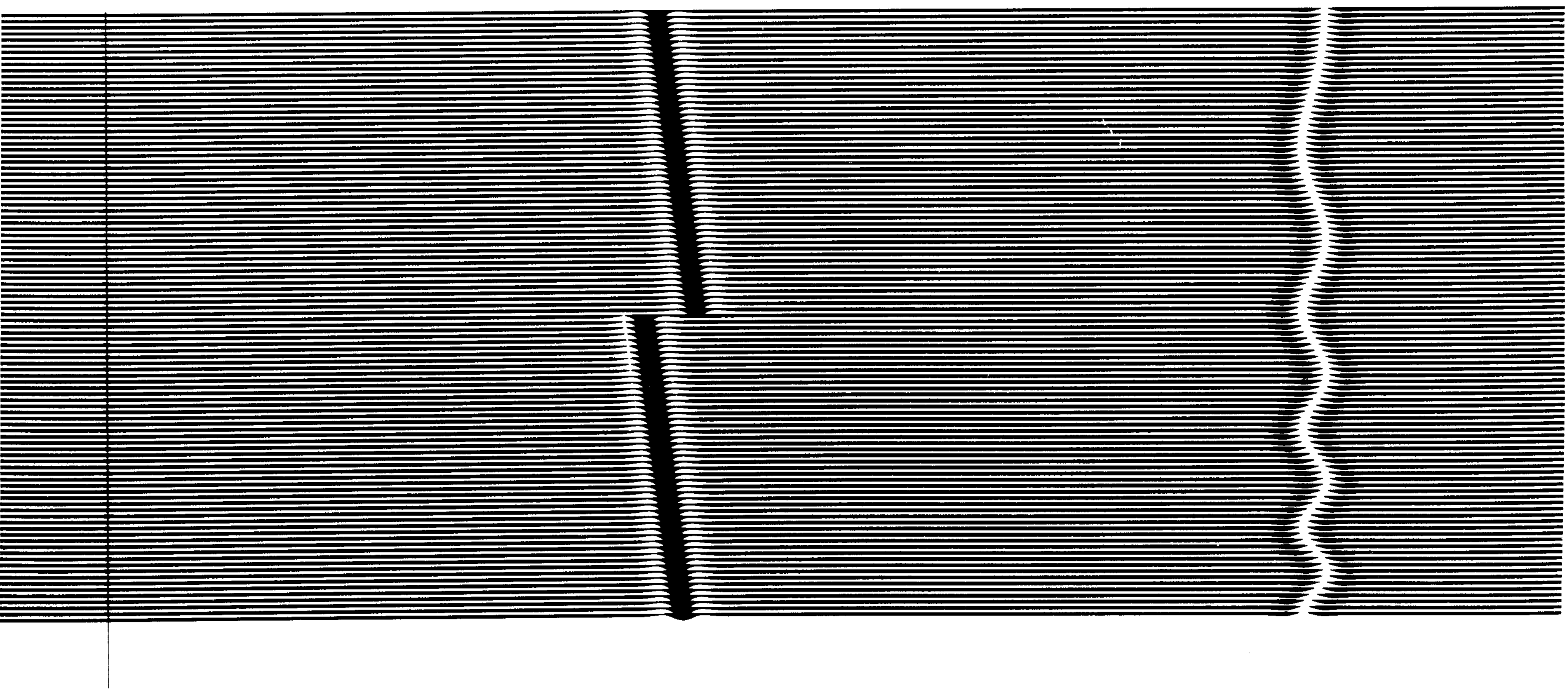

Figure 3.1 This model is similar to that of figure 1 with slightly more topography on the seafloor. Again the vertical exaggeration is 5: 1 and an exponential gain of 42 db/sec. has been applied prior to display on all three frames.

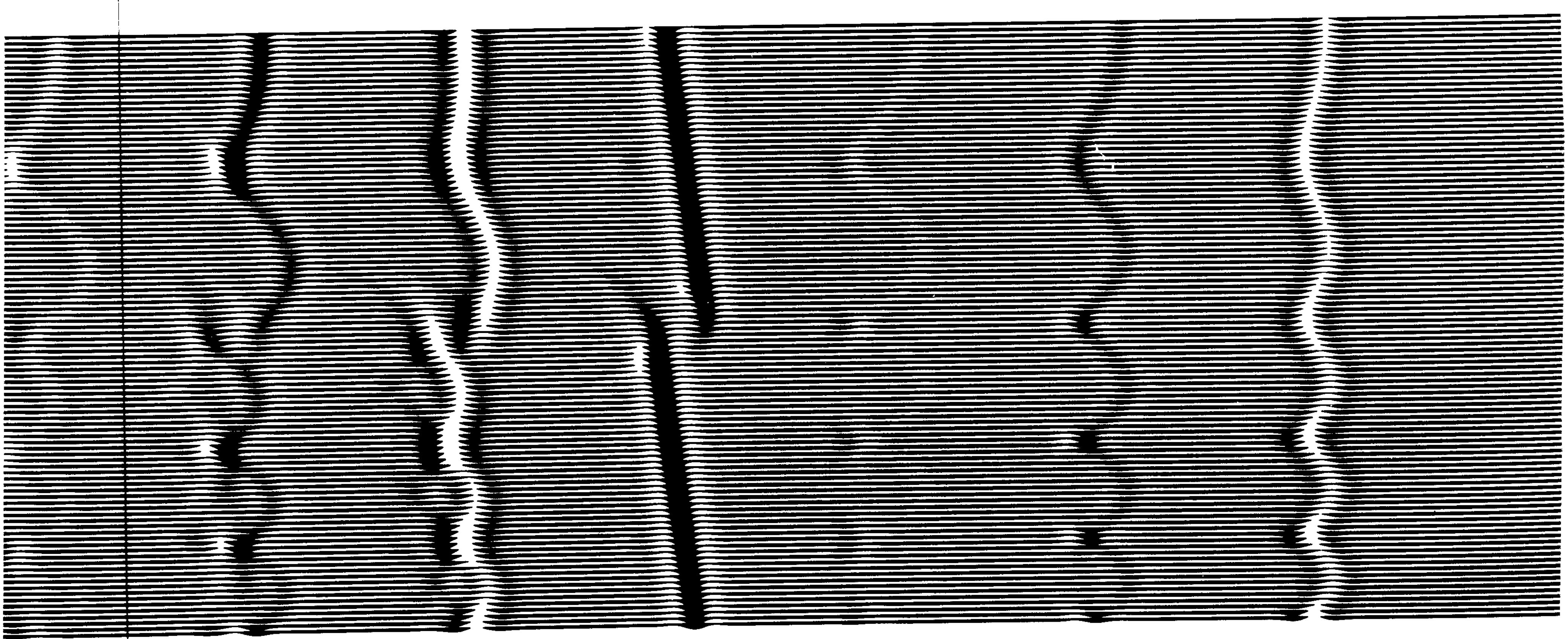

Figure 3.2 Frame 2 is the synthetic seismograms resulting from the model in frame 1.

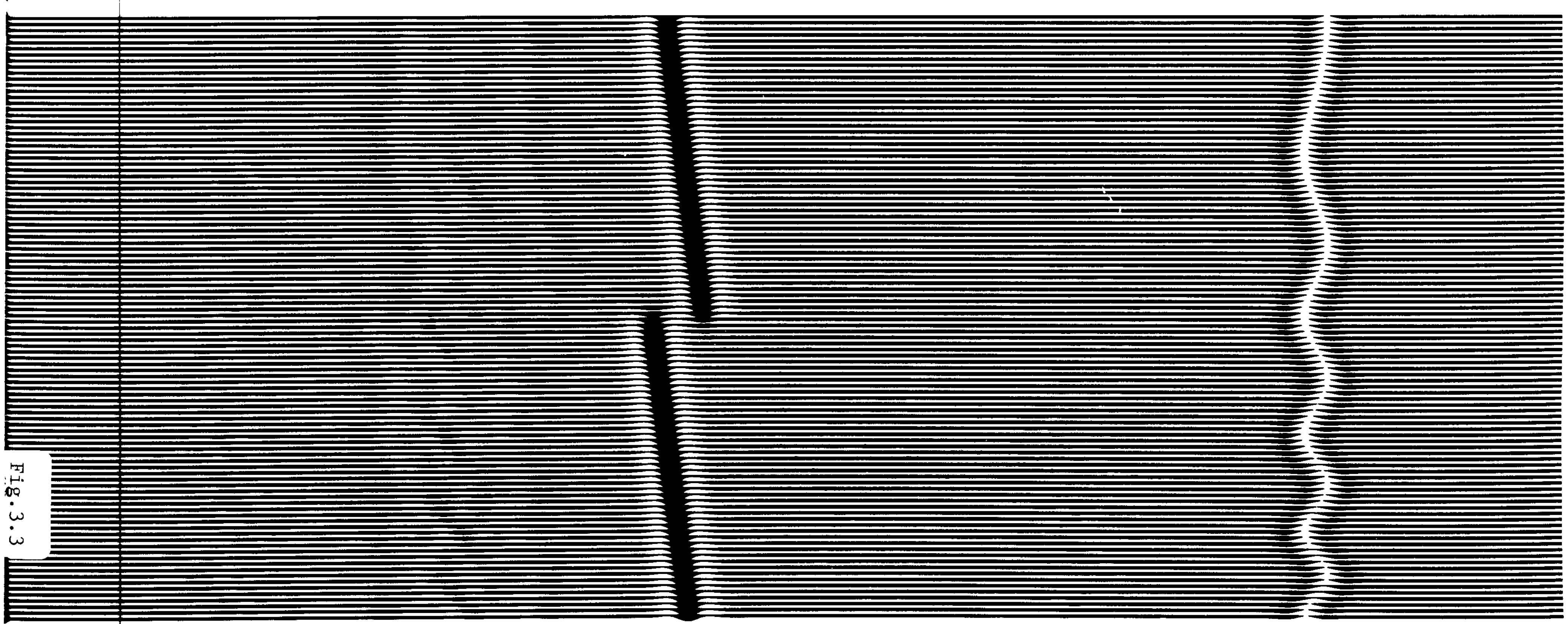

Figure 3.3 Using the data of fig. 3.2 we attempted to reconstruct the model of fig. 3.1 by running the forward algorithm in reverse. The estimates of the reflectors were derived using the fundamental principle of reflector mapping. Note that the quality of reconstruction is dependent on the dip of the reflectors.