A field-data example of applying LITWEQ migration

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ABSTRACT

The LInearly Transformed Wave EQuation (LITWEQ) migration algorithm is applied to an Amoco field dataset taken from the Gulf of Mexico. The results show that the LITWEQ algorithm is more accurate in migrating large-angle events than the conventional finite-differencing migration algorithm.

INTRODUCTION

A new wavefield extrapolation method, called LITWEQ, was introduced by Li in 1984 (Li, 1984). The LITWEQ method represents and extrapolates wavefields in the characteristic coordinates of wave propagation. The principle behind this method and its high accuracy in extrapolating both small- and large-angle events were described in the previous SEP reports (SEP-41 and SEP-42).

In this paper the LITWEQ migration is applied to field data. The conventional 15-degree wave equation migration is also applied to the data. The geological structure under the line is a mushroom-shaped salt dome. The LITWEQ method better determines the boundary of the salt dome than the 15-degree wave equation method.

A field-data example of incorporating dipfilter into migration operator (Li, 1985) is also given in the paper.

FIELD DATA EXAMPLES OF THREE MIGRATION METHODS

The field dataset is a CDP stacked section, shown in Figure 1a, of a survey line in the Gulf of Mexico. The stack and the sediment interval velocity profile were provided by Samuel H. Gray of Amoco Production Company. The sample interval is 0.004 sec and the midpoint interval 82 ft. The geological structure under the line is a mushroom-shaped salt dome with surrounding sediments.

A velocity function for migrating the section is obtained by smoothing the Amoco's interval velocity profile. Due to both the memory and the speed limitations of VAX 11/780, the section is subsampled every 0.012 sec. Three migration methods are applied to the dataset using the same migration velocity function. These are the conventional 15-degree wave equation (Claerbout, 1985), LITWEQ without dipfiltering, and LITWEQ with dipfiltering (Li, 1985). The results are shown in Figures 1b, 1c and 1d, respectively.

The conventional 15-degree method tends to undermigrate and distort the dipping events. Migration using the LITWEQ method gives a better image of the salt dome. Because of the numerical dispersion effect and other artifacts of migration, the top parts of the migrated sections are noisy. The LITWEQ with dipfiltering algorithm is used to suppress those effects (Li, 1985). It can be seen from Figures 1c and 1d that the flat layers are more pronounced in the section migrated by LITWEQ with dipfiltering than they are in the section migrated by LITWEQ without the dipfiltering. The signal-to-noise ratio in the migrated section using LITWEQ with dipfiltering algorithm is higher than that of the LITWEQ without dipfiltering algorithm.

INTERMEDIATE RESULTS OF LITWEQ MIGRATION

To better understand the correspondence of events in migrated and stacked (unmigrated) sections, some intermediate results of the LITWEQ migration are shown in Figure 3. These results are obtained by slicing the (t', x', z') wavefield cube with certain surfaces. Figure 2 shows the intermediate data surfaces.

The successive pictures in Figure 3 show that the boundary of the mushroom-shaped salt dome is imaged as a result of the migration of the reflections and diffractions presented in Figure 1a, not as a result of migration artifacts. Another interesting phenomenon that can be observed from Figure 3 is that the vertical streaks, or d.c. components, on the final section are formed by migrating some water-bottom scattering waves with sediment velocities that are much higher than the water velocity. Low-pass filtering or dipfiltering should be able to suppress them.

CONCLUSION

The LITWEQ migration method improves the accuracy of handling both large- and small-angle events during wavefield extrapolation in the time and space domain. Implementing the algorithm with dipfiltering will suppress numerical artifacts. The LITWEQ method can be used to image large-angle reflectors, such as salt domes and thrust faults, when the velocities of the media are varying laterally.

ACKNOWLEDGMENTS

I thank Samuel H. Gray of Amoco for supplying the field dataset and other related information.

REFERENCES

Claerbout, J. F., 1985, Imaging the earth's interior: Blackwell Scientific Publications.

Li, Z., 1984, Wave field extrapolation by the linearly transformed wave equation operator: SEP-41, pp. 167-189.

Li, Z., 1985, Dip filtering and migration: SEP-42, pp. 375-381.

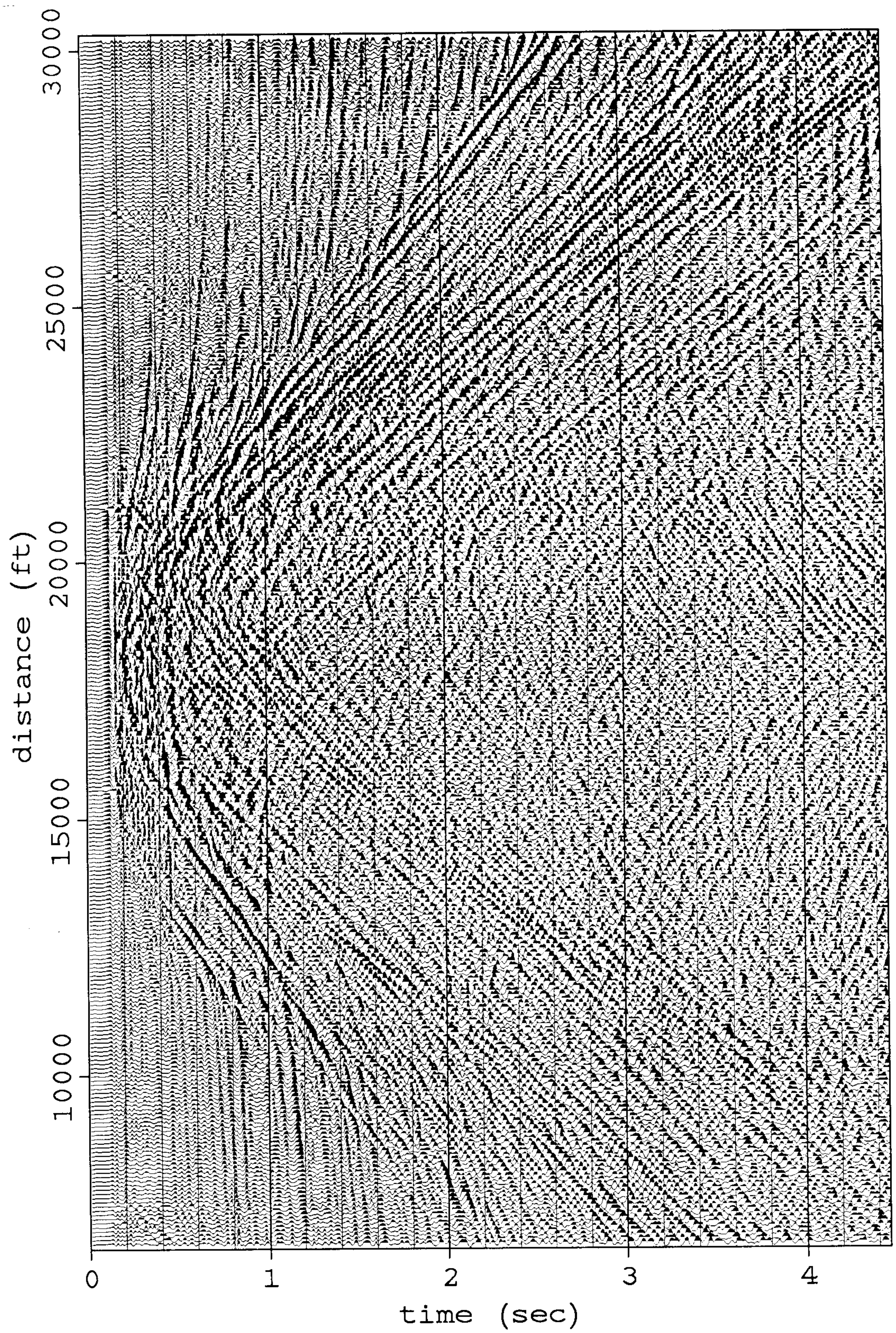

FIG. 1a. A stacked section of an Amoco's survey line in the Gulf of Mexico (provided by Samuel H. Gray of Amoco).

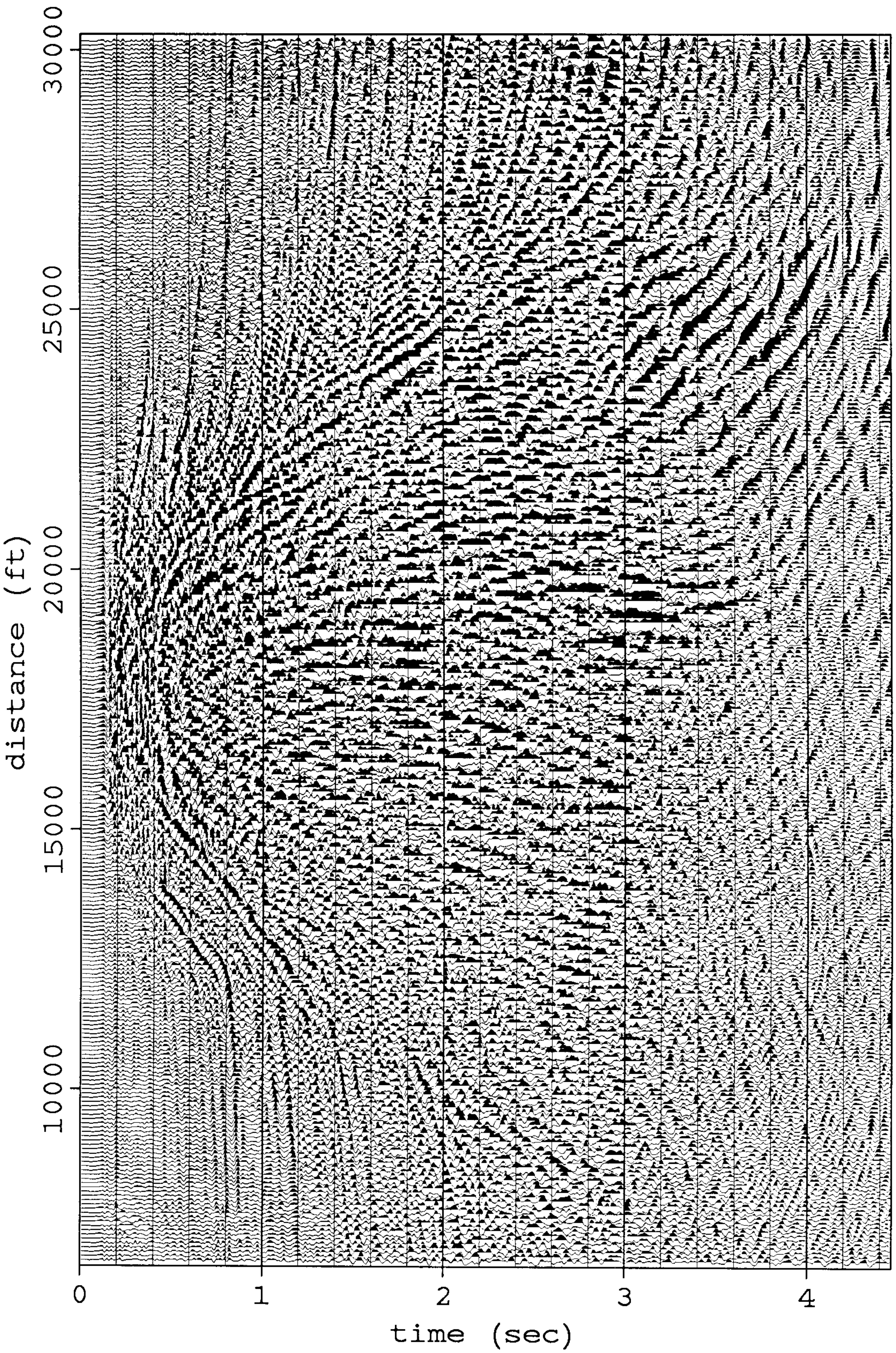

FIG. 1b. Migrated section using the conventional 15-degree wave equation.

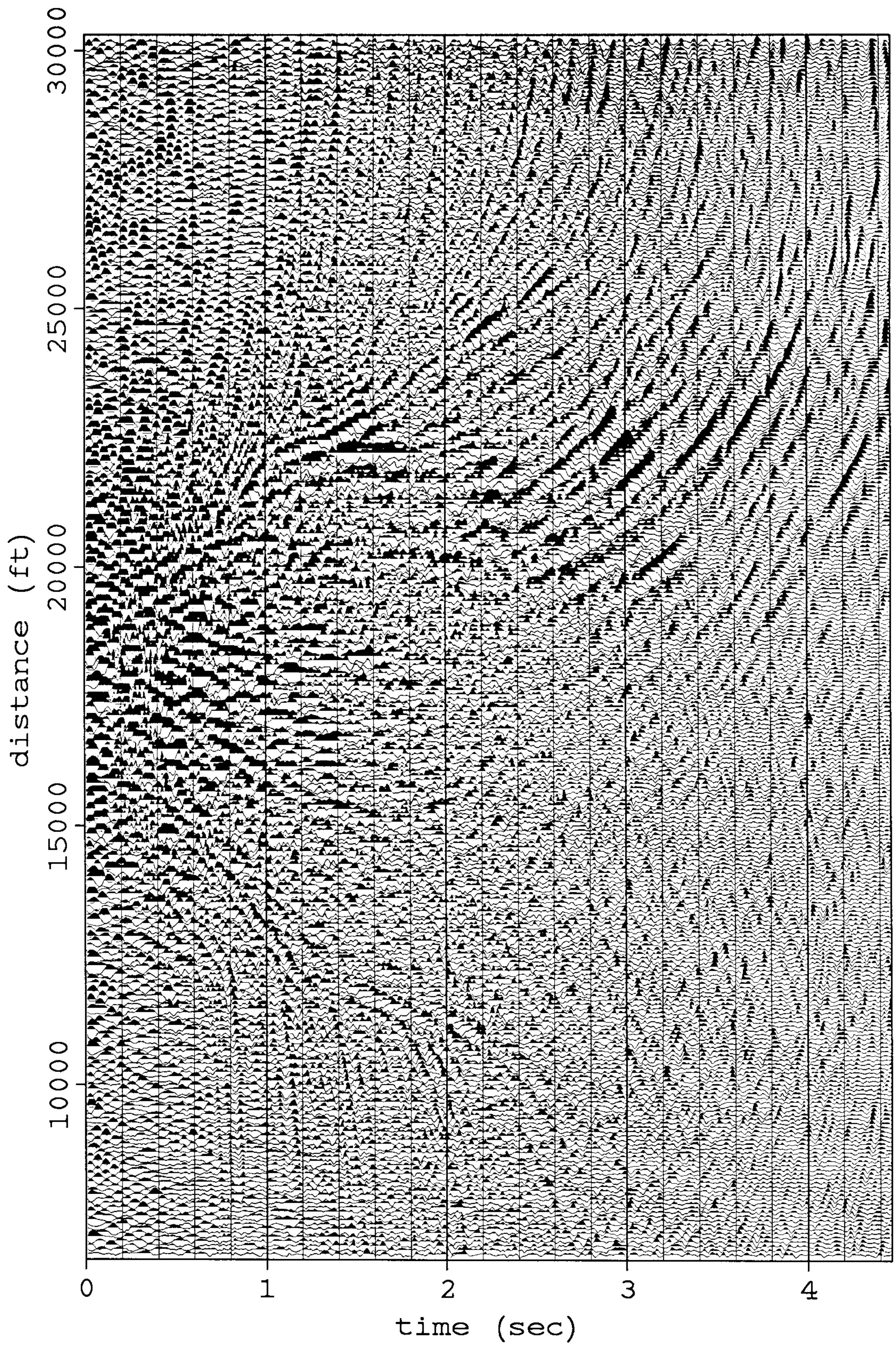

FIG. 1c. Migrated section using LITWEQ without dipfiltering.

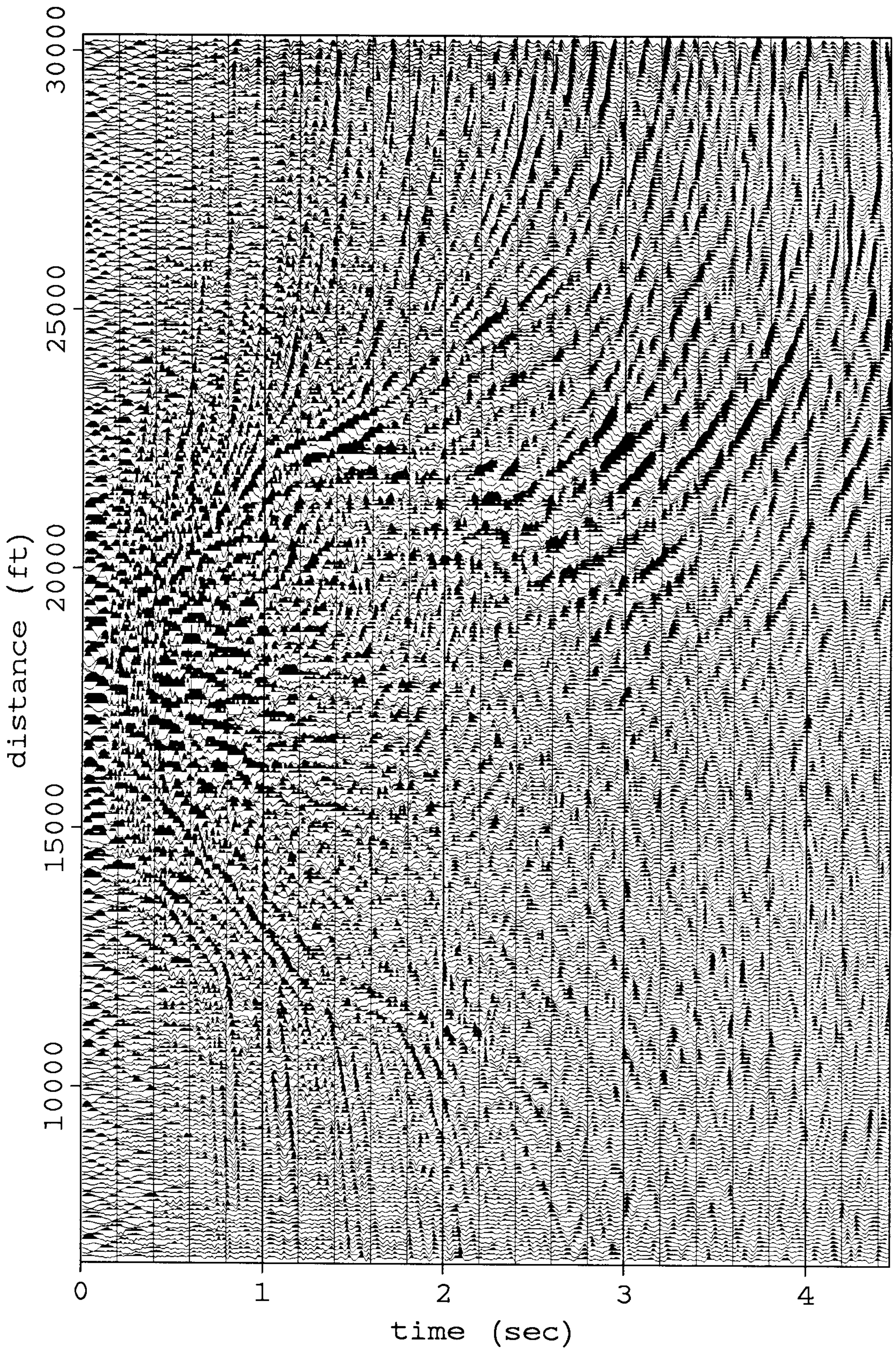

FIG. 1d. Migrated section using LITWEQ with dipfiltering.

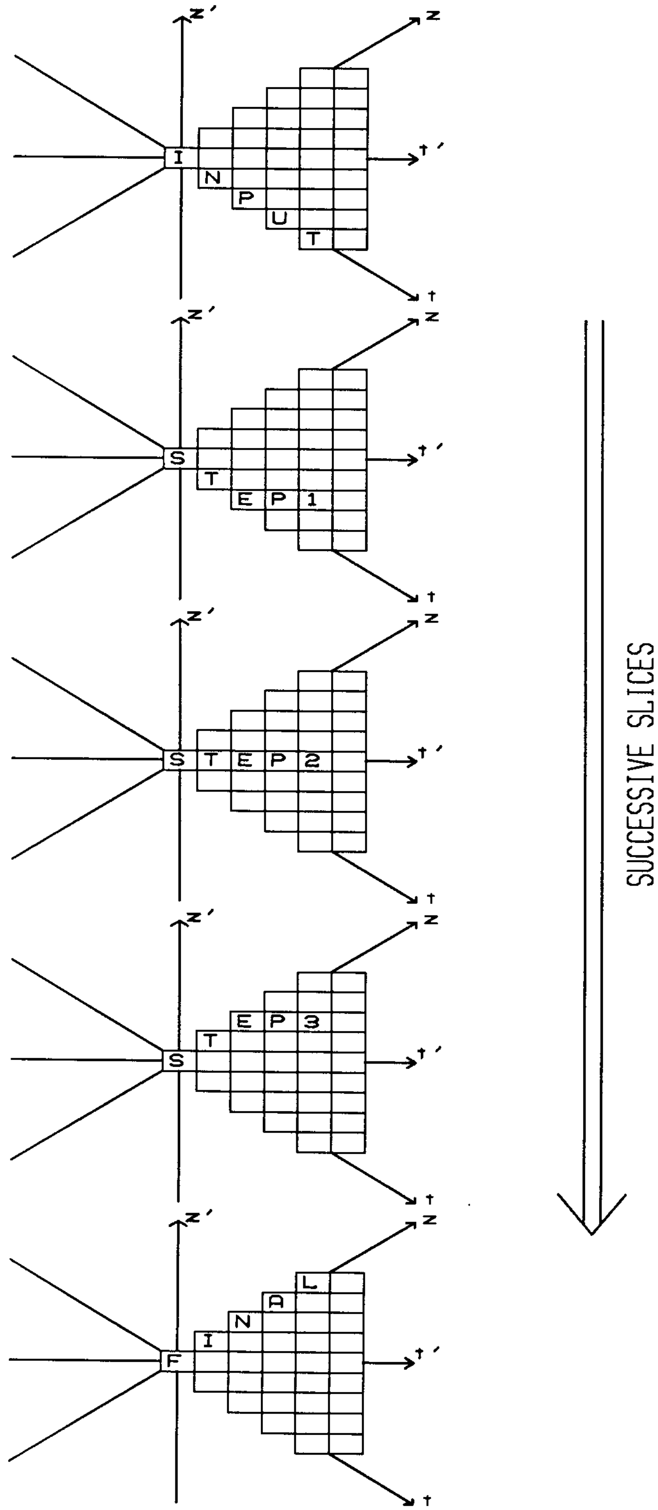

FIG. 2. Intermediate data surfaces of the LITWEQ migration. The third axis, x' , is perpendicular to the (t' ,z') plane. The intermediate results are taken from the labeled boxes on the (t' ,z') plane, as shown by the successive pictures above.

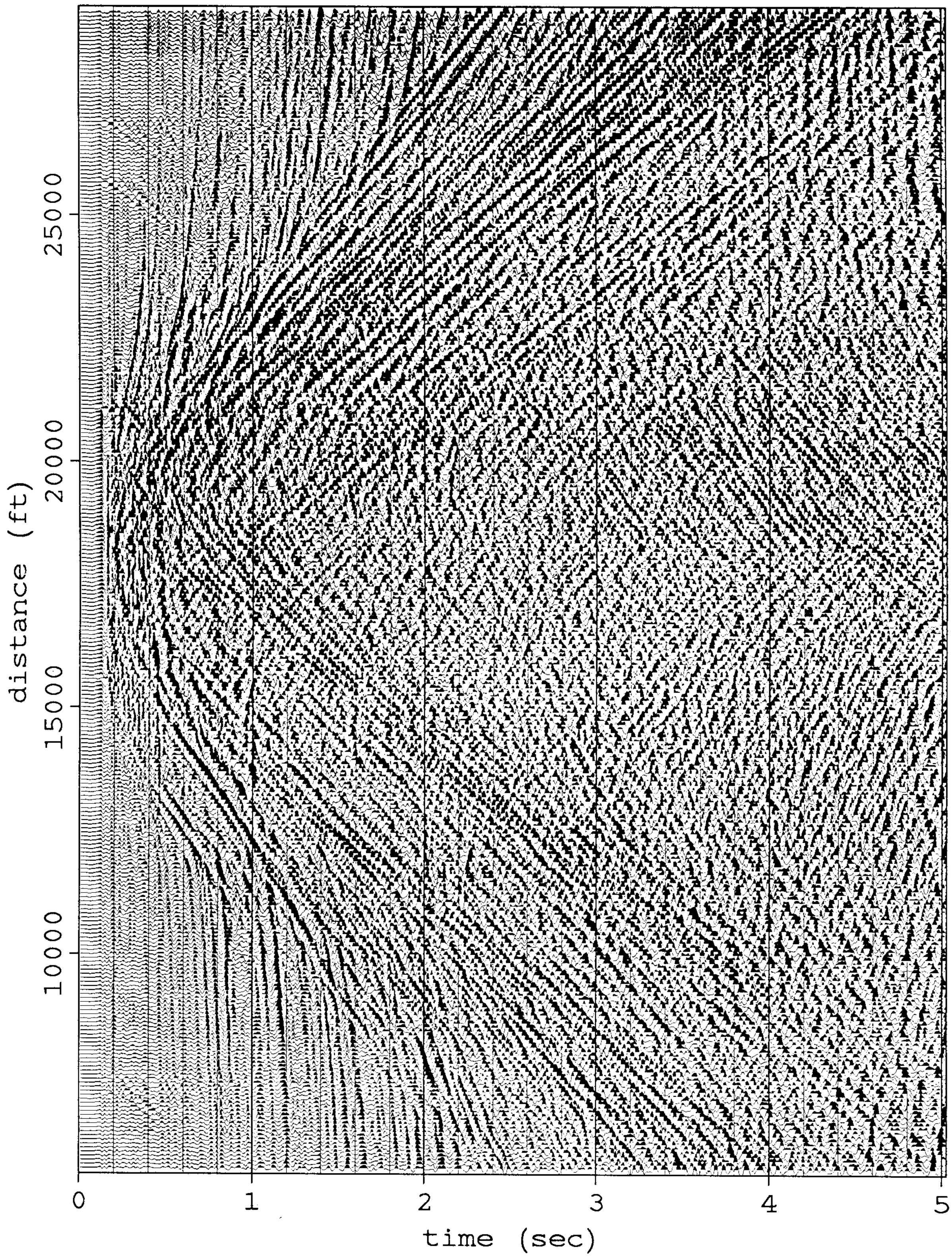

FIG. 3a. The stacked-section input of the LITWEQ migration.

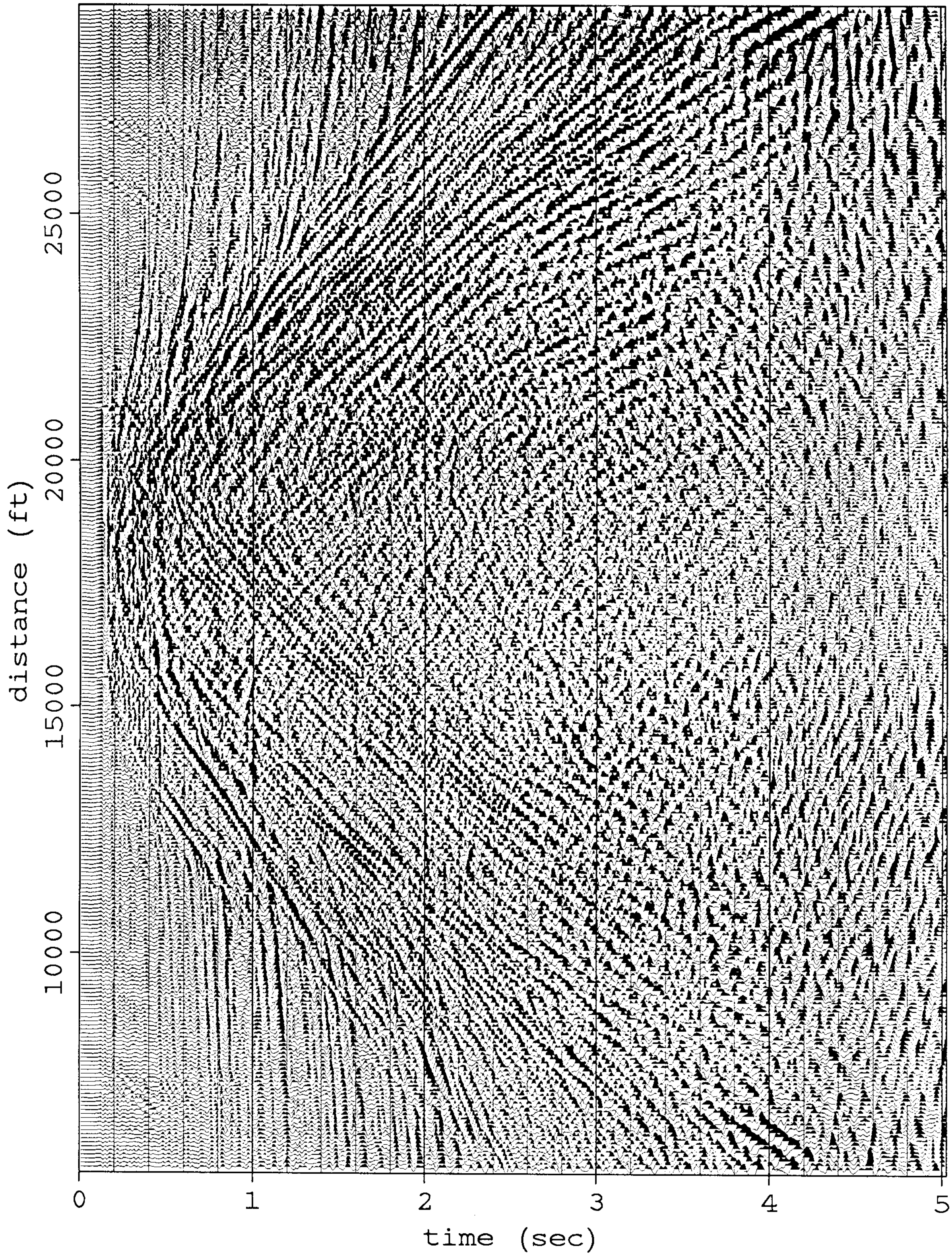

FIG. 3b. Intermediate step 1 of the LITWEQ migration. The dipping events begin to migrate upwards.

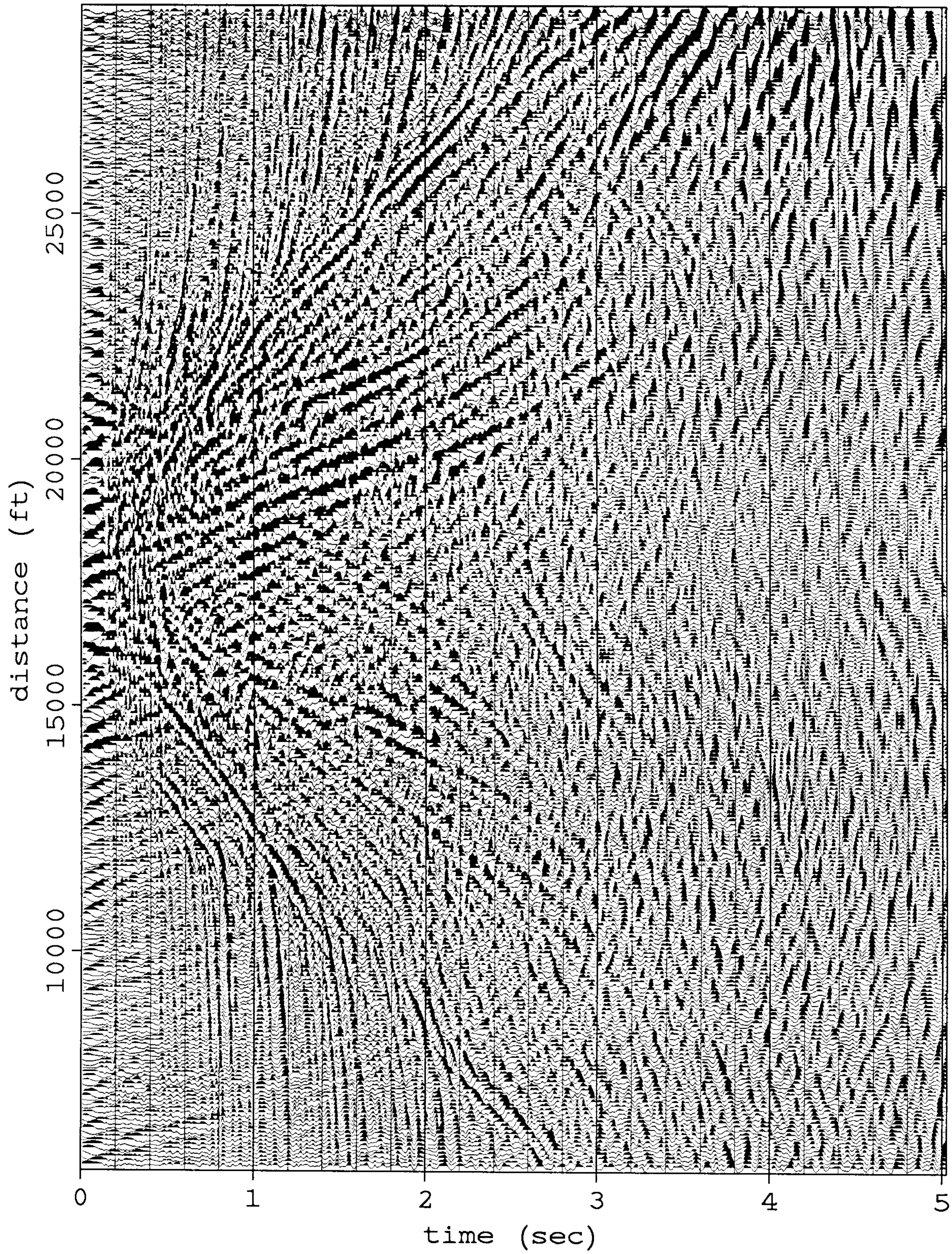

FIG. 3c. Intermediate step 2 of the LITWEQ migration. The dipping reflections from the salt-dome boundary are migrated further upwards. Some water-bottom scattering events from the top of the salt dome migrate to the center of the salt dome.

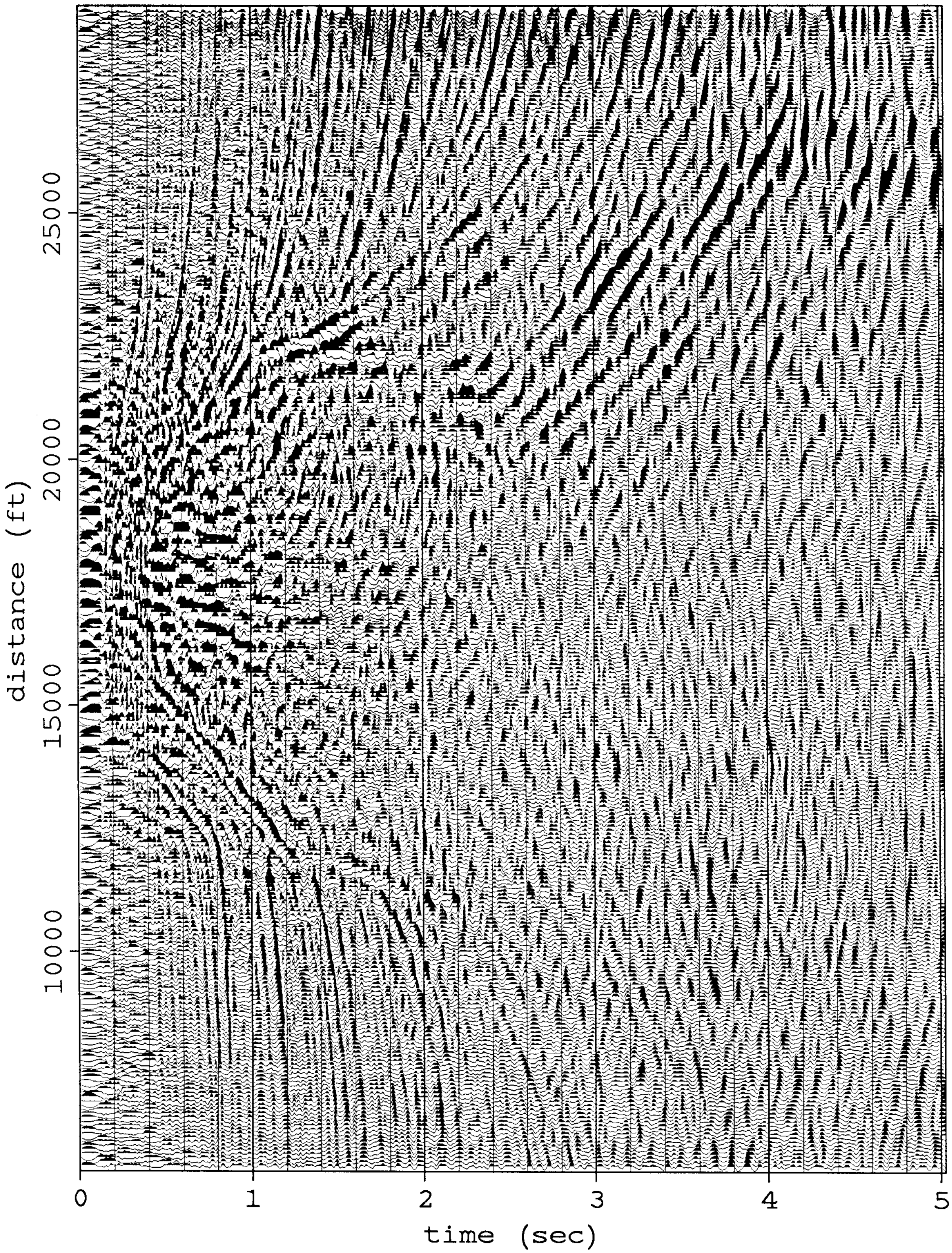

FIG. 3d. Intermediate step 3 of the LITWEQ migration. The salt-dome boundary starts to appear. The vertical streaks near the top of the salt dome are the water-bottom scattering events migrated with sediment velocities.

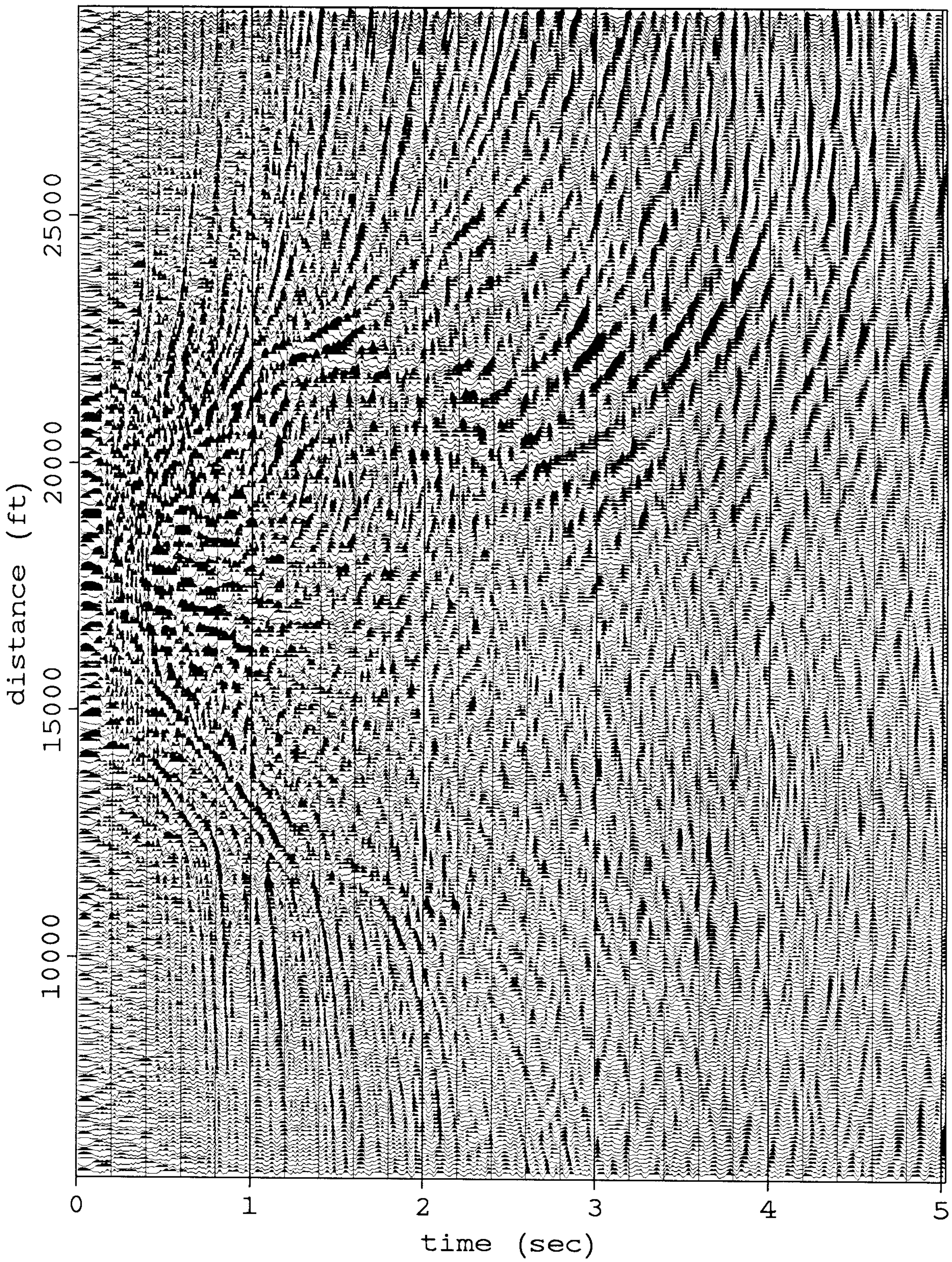

FIG. 3e. Final image of the geological structure of the salt dome

H a n a u m a
Convex responsibility assignment

joe	acceptance test.
rick	forefront exploration
paul	power and disk partitioning
chuck	hardware configuration -- ethernet
marta	sell RP07, TU78, and eventually AP
biondo	terminal lines and modems
jon	finance and license
stew	software consultant
li	
dan	
pete	
clem	
bill	alumnus