WIDE LINE PROFILING IN OFFSHORE OPERATIONS

JACQUES MERLAND*

Introduction

The initial development of the Wide Line Profiling (WLP*) technique concerned exclusively land operations. However, the successful results obtained by the method when used in such various areas in Canada, U.S.A., Spain, Angola, Morocco, Libya, France, Tunisia . . . with such various sources as dynamite, Vibroseis**, Dinoseis***, underscored the need for an adaptation of the technique to marine surveys. This paper describes briefly some of the problems specific to offshore operations and the methods adapted for their solution.

WLP Basic Principles

Let us first review the basic principles of the WLP method. It consists (see Figure 1) of laying out either the source points or the geophone stations along several parallel lines instead of placing them on the same line as for conventional multiple coverage surveys.

For practical reasons, the number of parallel lines generally varies from three to five.

The interval between source points must provide for a sufficient stacking fold on each individual line. As a matter of fact, a poor signal to noise ratio on individual lines would not allow a proper determination of lateral dips.

For instance, a typical WLP survey will involve four parallel lines recorded in 600%, resulting in a total 2400% coverage along the Wide Line Profile.

Offshore Operations

In land operations, each source point or each geophone station can be placed in-

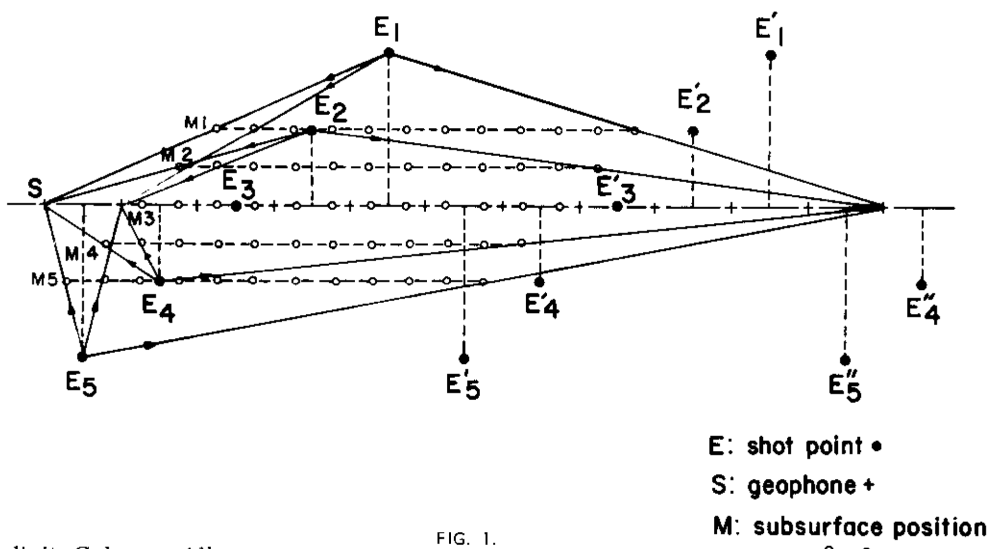

FIG. 1.

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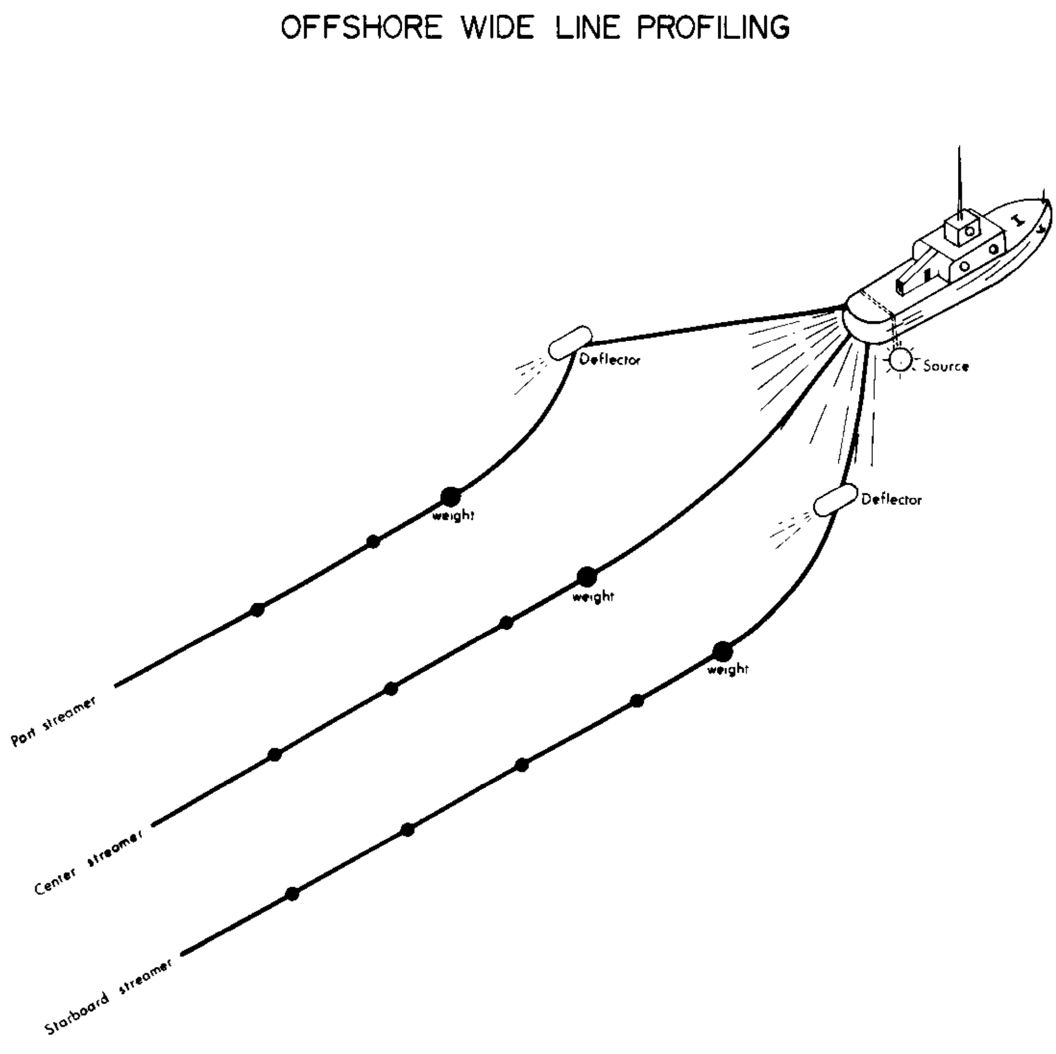
OFFSHORE WIDE LINE PROFILING
Deflector
Source
Deflector
weight
weight
weight
Port streamer
Center streamer
Starboard streamer

FIG. 2.

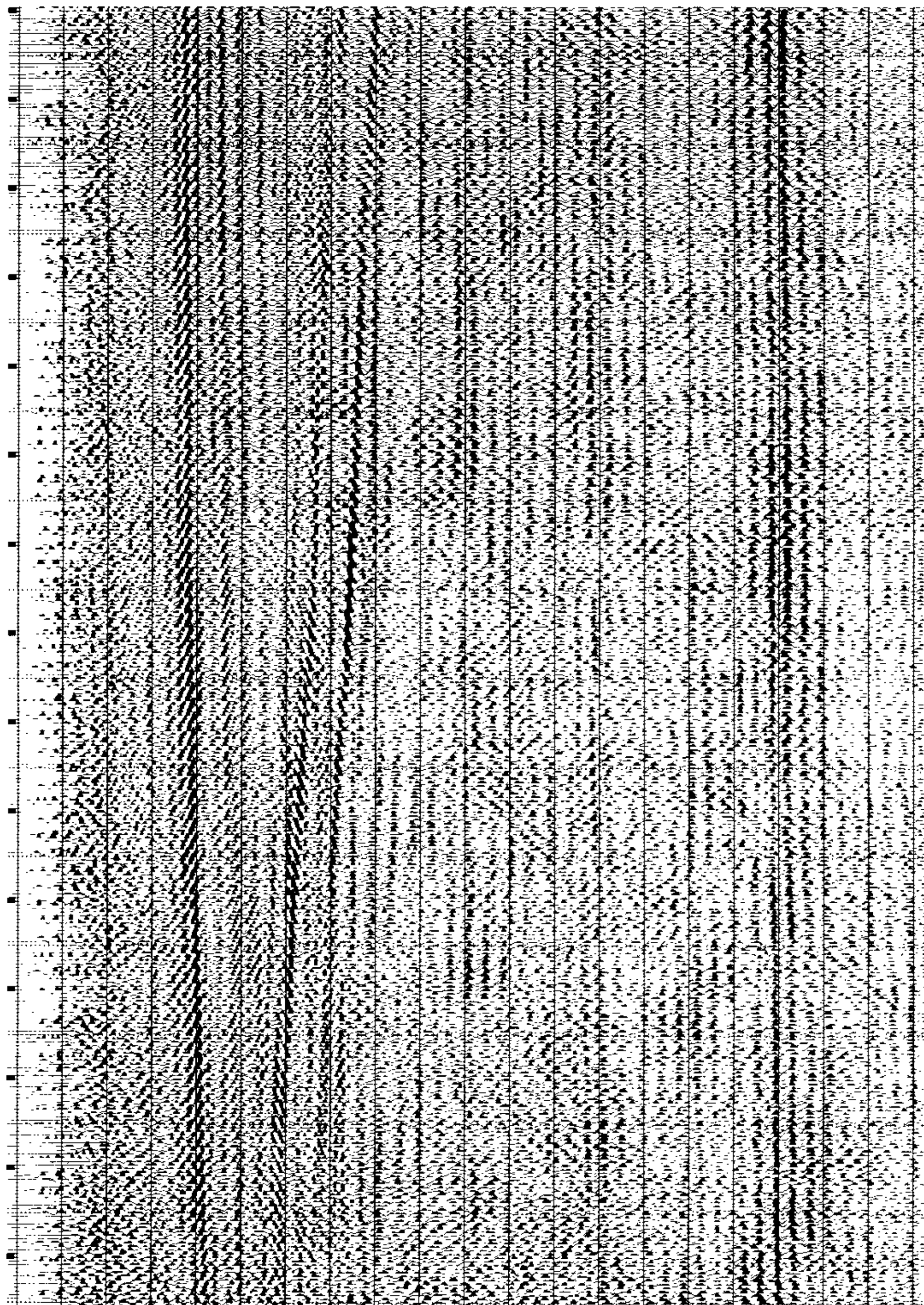

FIG. 3.

dividually at a desired location. In offshore operations, on the other hand, the boat, the source, and the recording cable (streamer), form an ensemble within which the relative position of the various elements cannot change.

Therefore, two basic approaches of offshore WLP recording lie either in the use of several sources and one streamer, or one source and several streamers.

The different sources in the first case or the different streamers in the second case, must be located at various lateral distances from the boat.

This in itself does not constitute too difficult a problem. Mine sweeping operations or drag net fishing have perfected the design of paravanes or deflectors which maintain towed objects at a considerable lateral offset from the boats.

Using several sources would be an attractive solution, were it not for the fact that practically all existing high energy offshore sources would lose most of their power at several hundred feet from the boat.

This situation may change in the future, and various experiments with new shooting techniques have shown some promise in that direction.

However, for the time being, the other alternative (a single source and several streamers) has proven easier to implement. Figure 2 shows a typical WLP offshore operation, with three streamers and a single source. This technique has been used for various surveys during the past two years, including several projects recorded offshore Canada in 1973.

Data Processing

Although one may process WLP data in a conventional manner and obtain consequently a conventional stack section, there are better ways of extracting the information gathered by the method. As a matter of fact ,one of the main advantages of this technique is that it preserves the lateral dip as well as the longitudinal dip of recorded events.

Figure 3 demonstrates this possibility. It shows groups of traces gathered by lateral

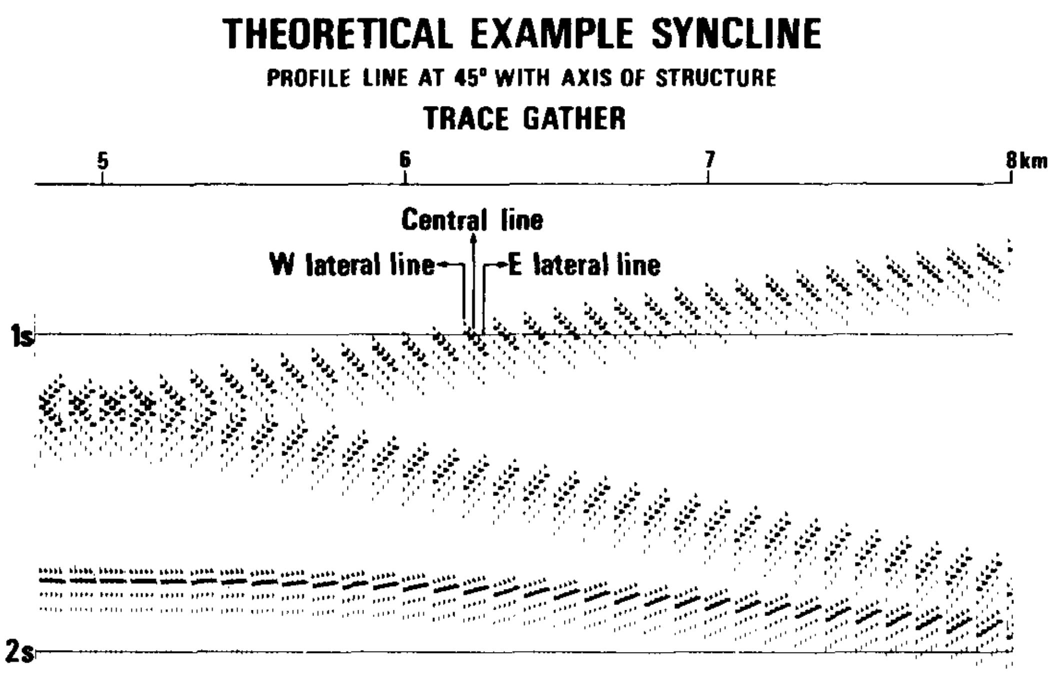

FIG. 4

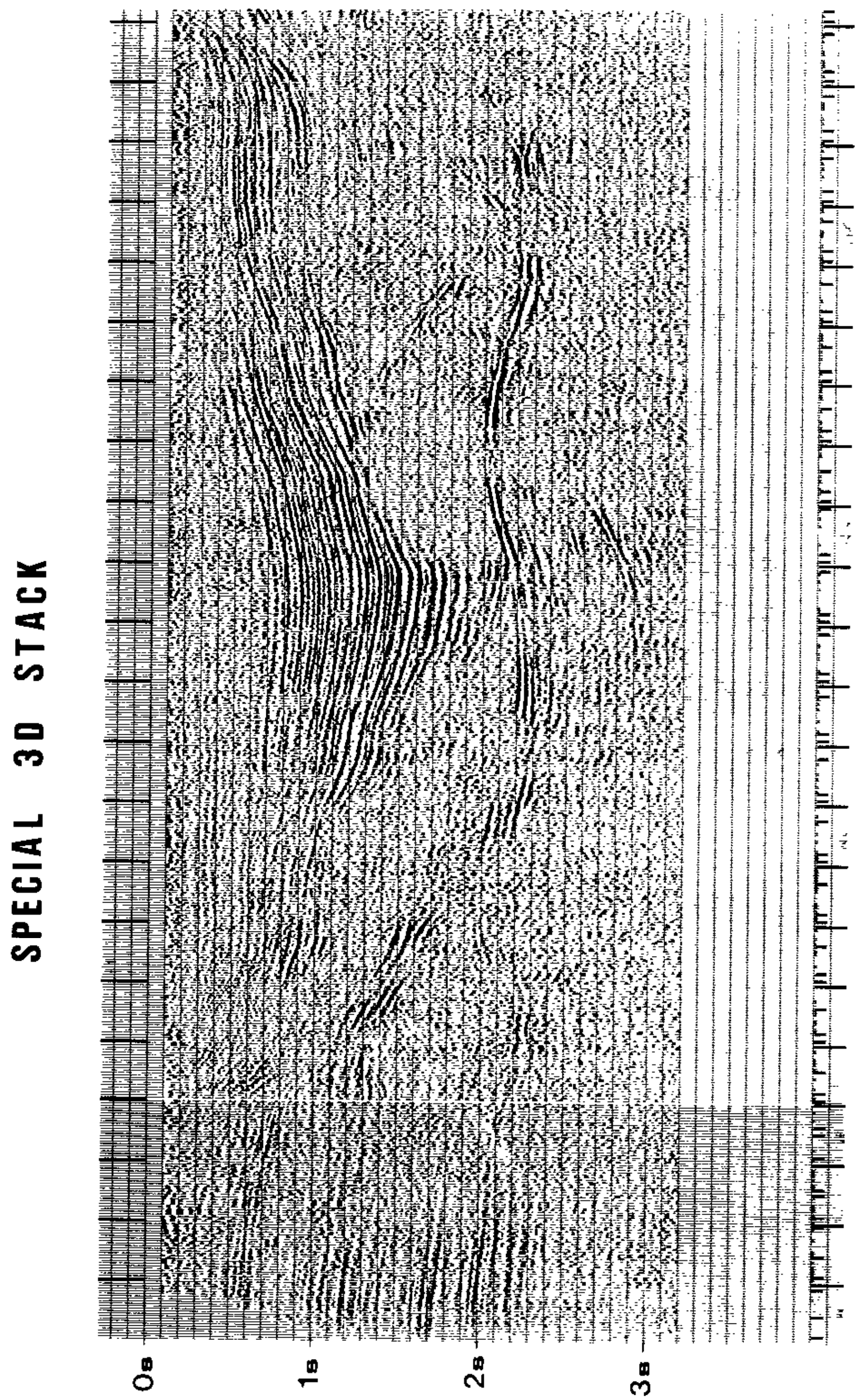

FIG. 5.

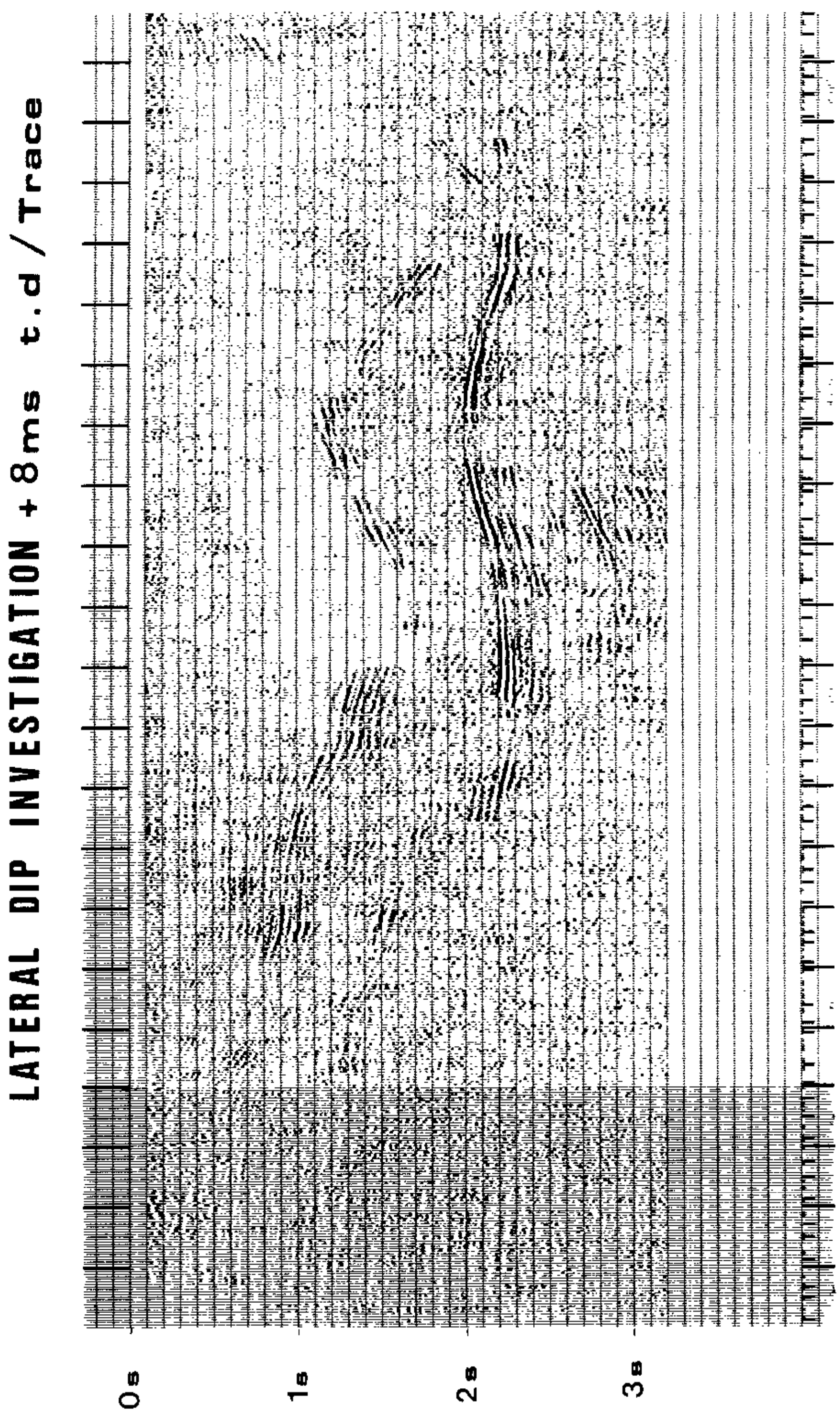

FIG. 6.

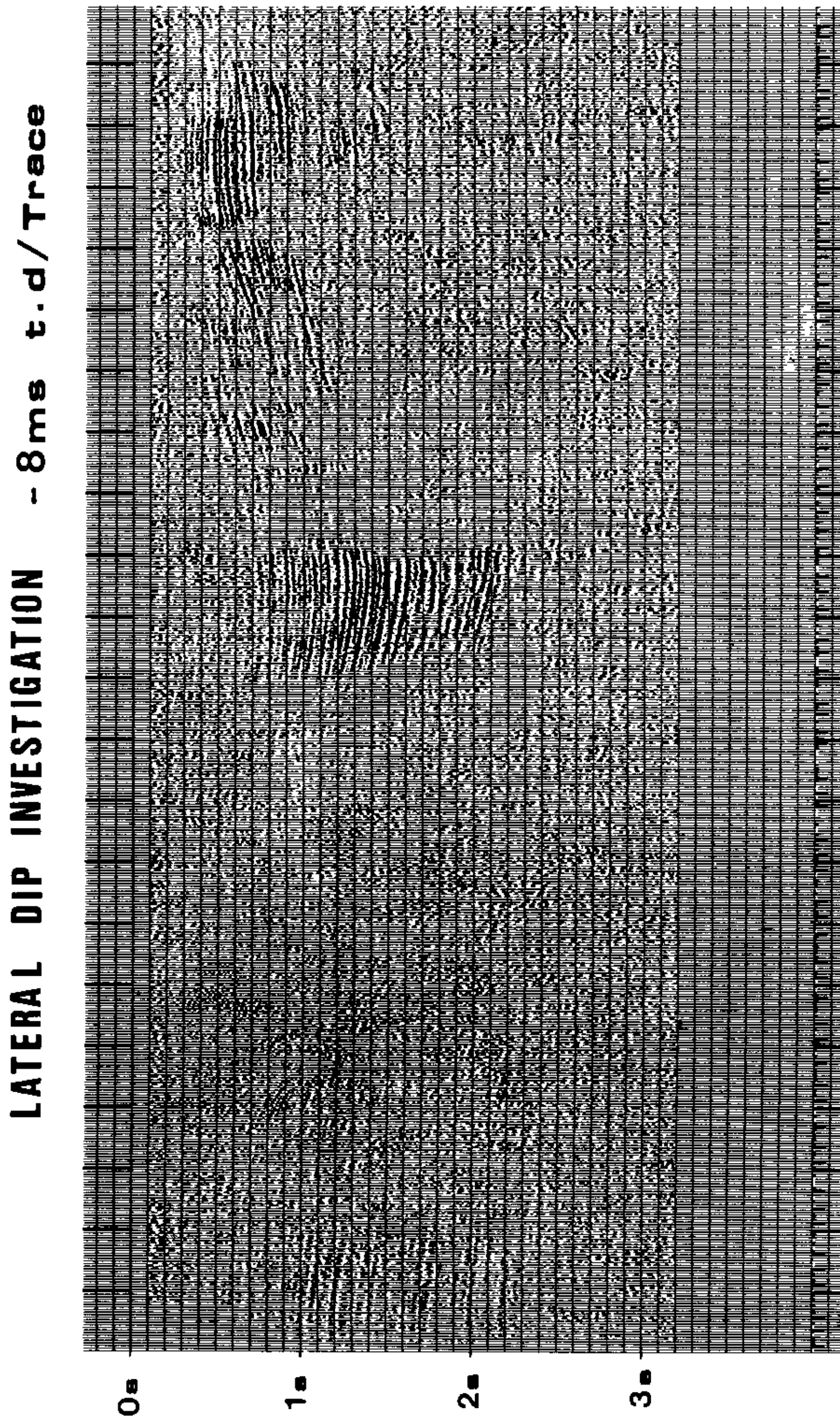

FIG. 7.

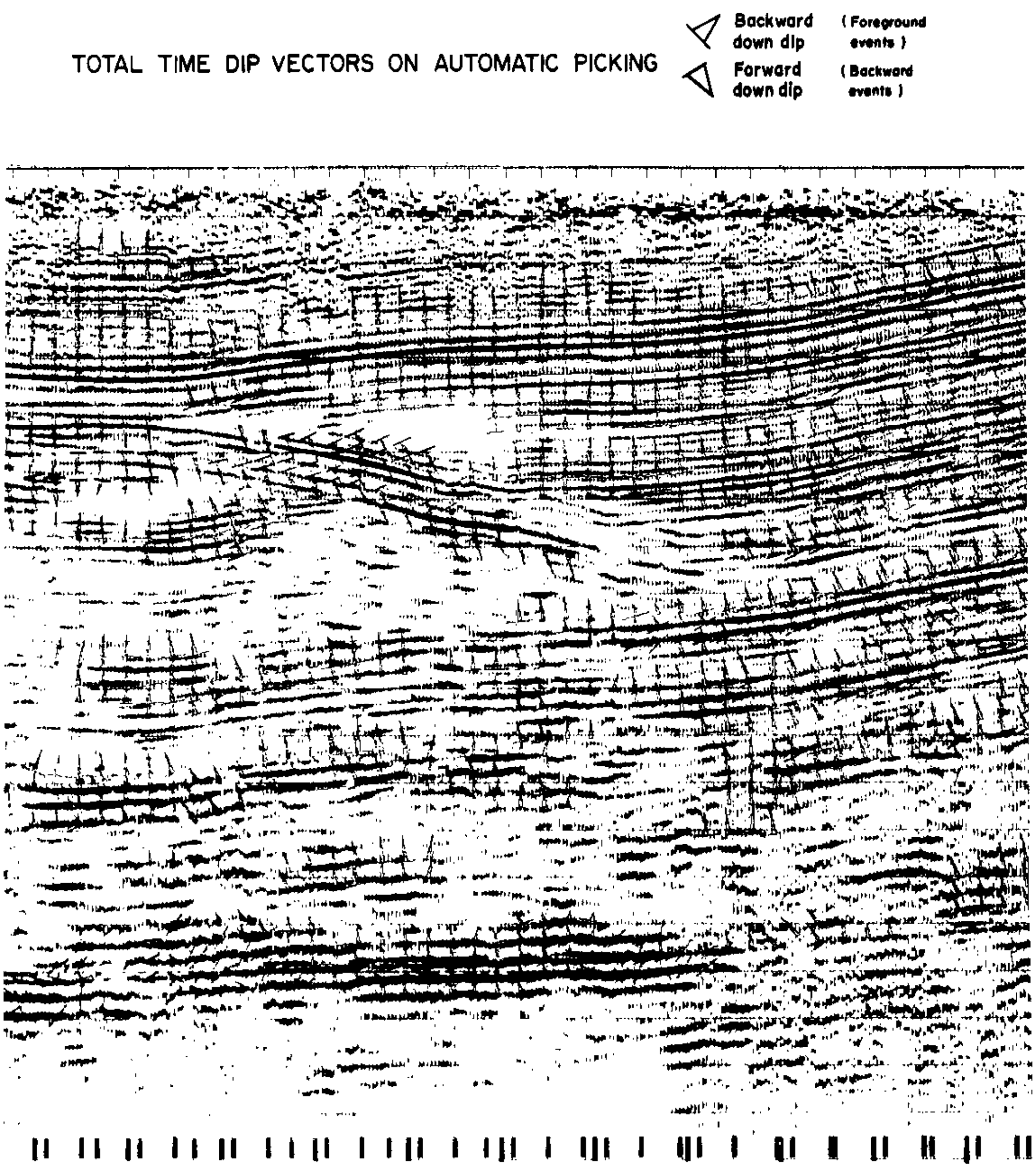
TOTAL TIME DIP VECTORS ON AUTOMATIC PICKING
Backward down dip
(Foreground events)
Forward down dip
(Backward events)

FIG. 8

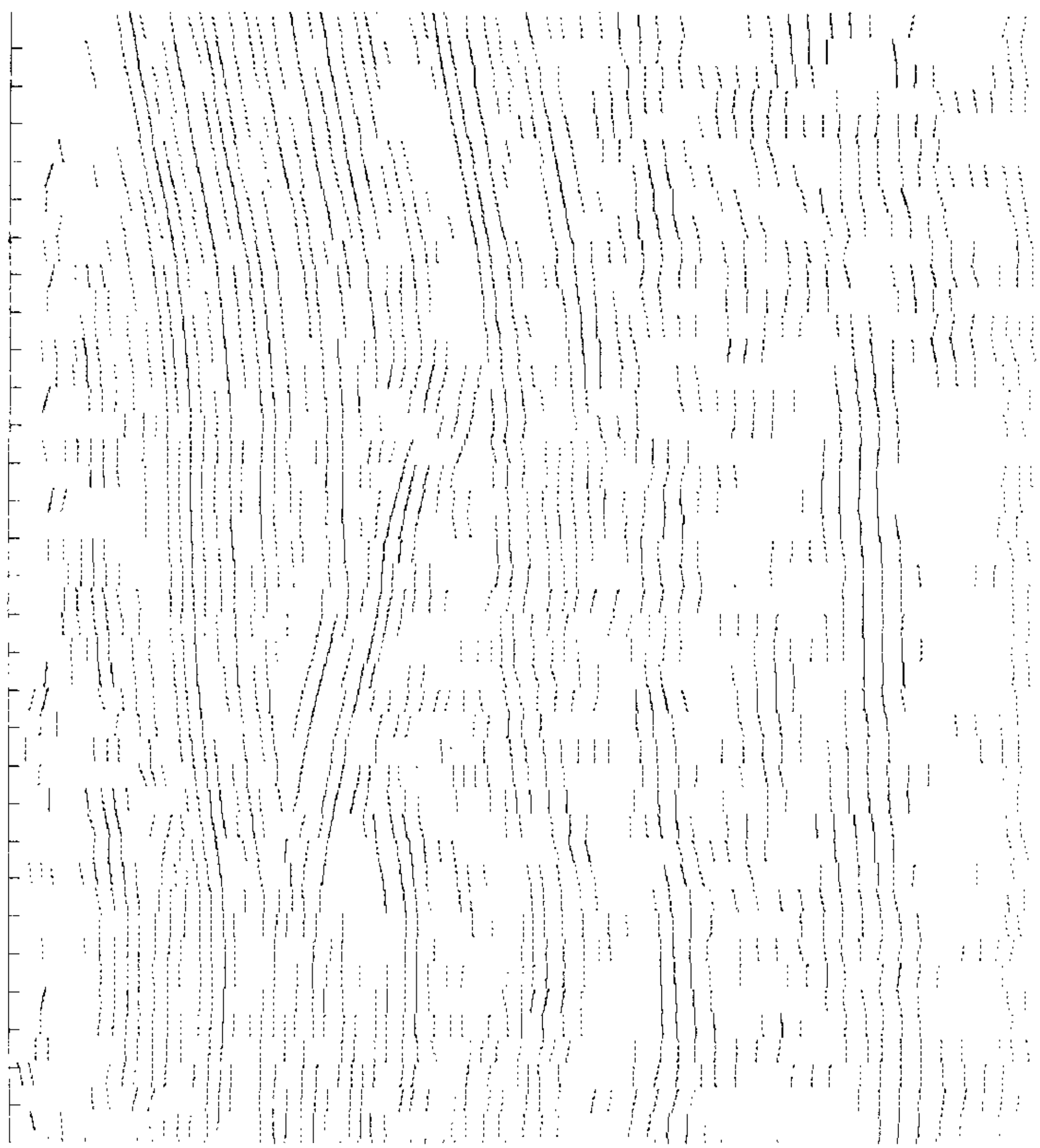

FIG. 9.

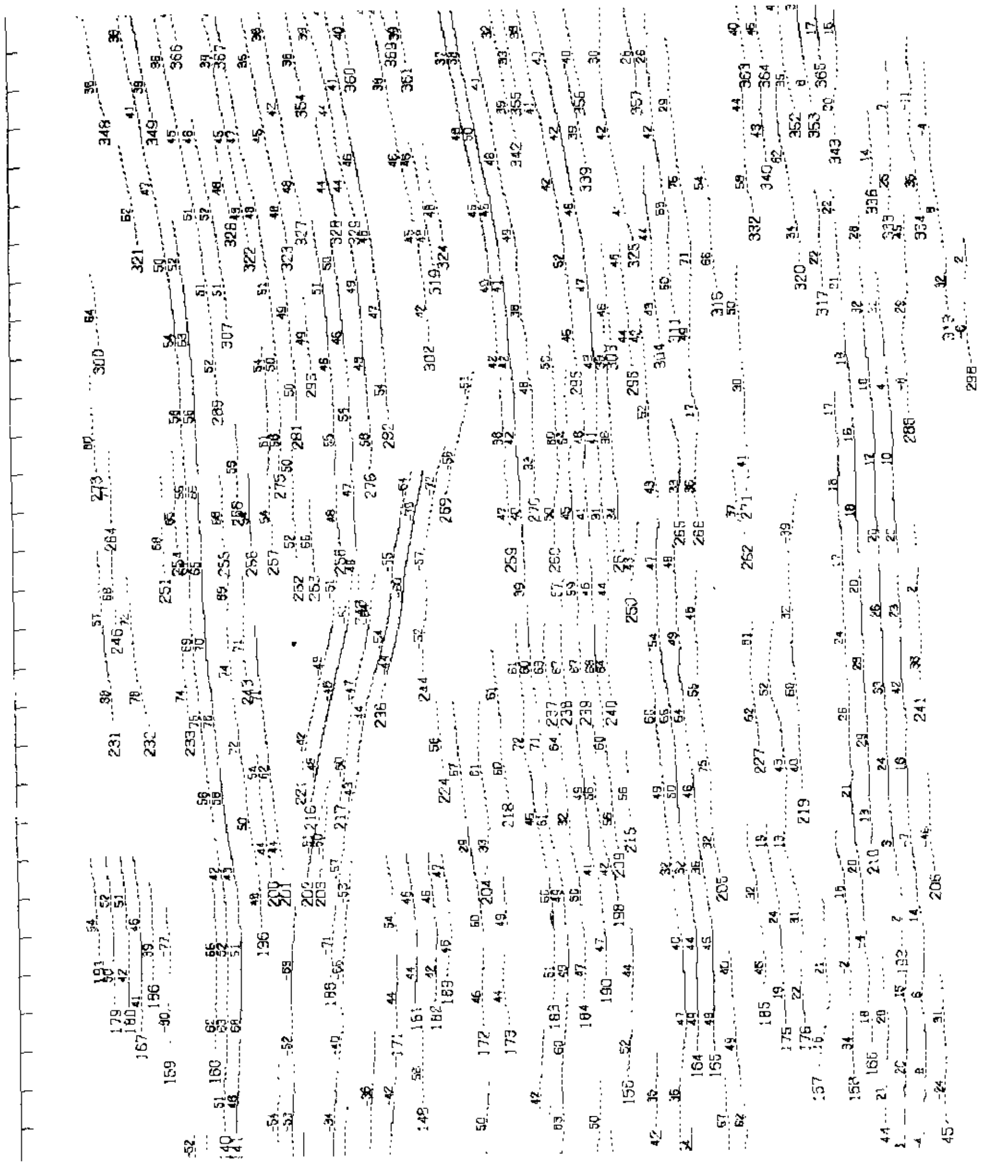

FIG. 10.

offset inside each group, or, in other words, a series of short transverse sections perpendicular to the main direction of the line.

Let us note that each trace is a stack trace, obtained by conventional CDP stack along each elementary line of the Wide Line.

The direction and the magnitude of the lateral dip of various events are clearly apparent. For instance, an event located at about 0.8 seconds exhibits a lateral dip of about 8 ms/trace toward the right, while an event occurring at 1.2 seconds shows a lateral dip of approximately 6 ms/trace to the left. A deeper event, recorded at 3.2 seconds has no appreciable lateral dip.

It is interesting to compare the above figure with a synthetic model (Figure 4) which simulates how the transverse sections would appear when recording a Wide Line across a syncline.

The similarity between the two sections is quite remarkable; this means that the upper events on the actual data could correspond to several reflections generated by a single syncline shaped horizon and recorded from different directions.

Another presentation consists of sorting the data by lateral dip and displaying them on separate sections. Figures 5, 6, and 7, illustrate this approach: Figure 5 shows a total stack incorporating all lateral dips, while Figures 6 and 7 represent only the events with lateral dips respectively equal to +8 ms. and —8 ms (by convention, we assign the plus sign to the events which originate from the foreground of the line, and the minus sign to the events which originate from the background. The terms foreground and background are relative to a person looking at a vertical cross section of the line).

Colour sections offer the possibility of displaying lateral dip information on a single document, by controlling the colour of each event through the value of its lateral dip.

The interpretation of WLP results can go further. As a matter of fact, we have access to the lateral and longitudinal dips and therefore we can obtain the direction and the magnitude of the total dip. This may be achieved through a computer program which measures the coherency of the data versus various longitudinal and lateral

PICKING AND TIME CONTOUR MAPS

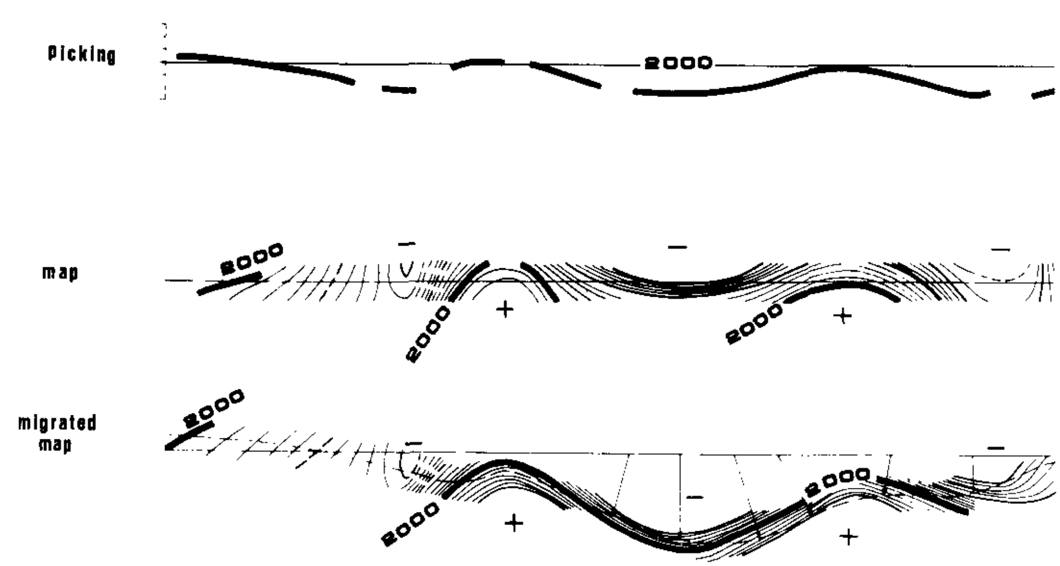

FIG. 11.

F

dips, and retains only those events which exhibit a coherency factor above a desired threshold.

Figure 8 shows the output of such a program, with the vectors representing the total dips superimposed on the WLP section. We usually use a colour display for that presentation.

If we display only the longitudinal components of the selected events, we obtain an automatic picking of the section (Figure 9).

So far, we have considered each event as independent of the others. Now, we may try to correlate separate events in order to obtain continuous horizons. A program will sort the events retained during the previous pass and will associate those which differ in time, longitudinal dip, lateral dip by less than a given value. The program will then assign a unique file number to each set of events (Figure 10). These file numbers allow the interpreter to communicate more easily with the computer. We may request the display of specific horizons, as well as their time contours, or their migrated time contours (Figure 11).

Conclusion

The extension of the Wide Line Profiling method to offshore operations has made it possible to obtain useful 3D information in marine surveys. The use of three parallel streamers gives satisfactory results provided that proper precautions be taken both at the recording and at the processing stages. It even brought up some improvement of the basic data quality in certain areas because of the effectiveness of the array on lateral noise.

By supplying the interpreters with a continuous knowledge of the direction and magnitude of the dip of reflected events, the WLP technique can contribute to a more accurate interpretation of marine projects, either at the reconnaissance stage or in detailed surveys.