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Marine Statics

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Abstract: Statics are in general a problem which is commonly encountered in land seismic because of weathering layers and the elevation of shots and receivers. In marine seismic, similar problems exist, though to a lesser extent, in areas where there are shallow anomalies which could be due to gas, soft weathering layers on the sea bottom, or coral reefs. Such irregular changes in very shallow lithology create seismic velocity and therefore introducing statics problems.

Examples of such problems are seen in several areas offshore Sarawak. The shallow anomalies differ in area and size and are rather irregular in shape.

To solve marine statics problems in 2D processing, the assumptions usually made are:-

(1) Feathering angle is negligible and therefore shot and receiver stations lie nearly in a straight line.

(2) The statics to be computed are surface consistent.

Our experience while processing data acquired in 1985 and some of the older vintages shows that remarkable improvements can be achieved on the stack sections with statics application. Application of statics gave an overall improvement in continuity of events resulting in better interpretable stacks.

INTRODUCTION

Static corrections are a well known step in land seismic processing to correct for the effect of time delay due to weathering layers and elevations. As a simple illustration, Fig.1A shows schematically a shotpoint fired at position S and the reflected signal being recorded by receivers R1, R2 and R6 at different elevations. In the absence of the weathering layers, i.e. by just measuring the travel time of the raypath below the datum plane, we would expect the reflected signal of a flat subsurface event A to appear in the shot record as a hyperbolic moveout event due to the shooting geometry. Normal moveout (NMO) correction can then be easily done to correct for such effect in later stage of processing. The variation in transit time through the weathering layers however, causes the reflected signal to appear scattered on the shot record as shown in Fig. 1B. The task of static corrections in processing is therefore to estimate from the data itself, the required time shifts to move the reflected events back along the hyperbolic curve so that they will line up horizontally after NMO correction. Common depth point (CDP) stacking after NMO correction would then enhance the events since they are stacked in phase.

STATICS CAUSED BY SHALLOW ANOMALIES

In marine seismic, similar phenomena could occur in areas where there are shallow anomalies caused by shallow gas, gas-filled mud columns on sea bottom or coral reefs. Such irregular changes in very shallow lithology cause time shifts on seismic records by either increasing (e.g. shallow reef) or decreasing (e.g. shallow gas) the seismic velocity. Examples of such phenomena are seen in some areas offshore Sarawak. The shallow anomalies, mainly

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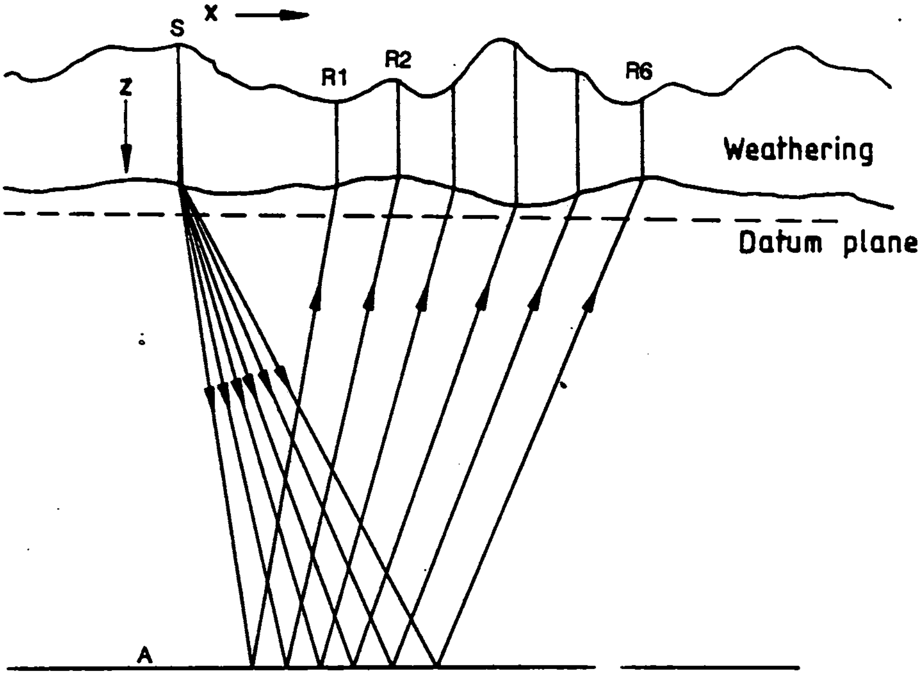

Fig. 1A. Schematic diagram showing reflection delays.

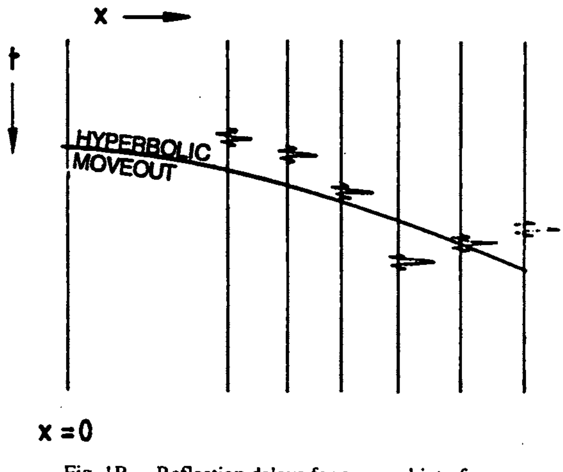

Fig. 1B. Reflection delays for a curved interface.

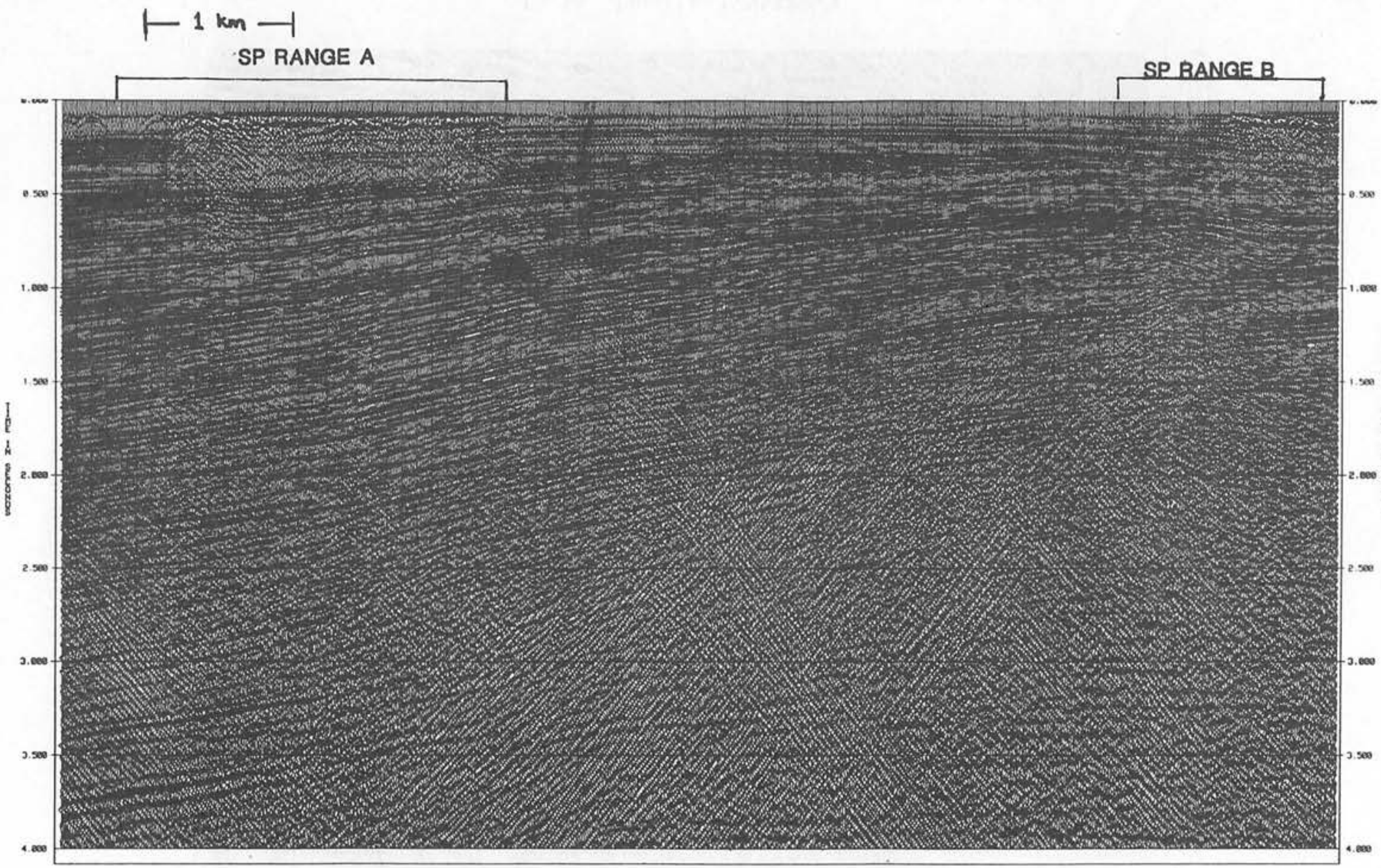

Fig. 2. Line 16 NMO/Stack

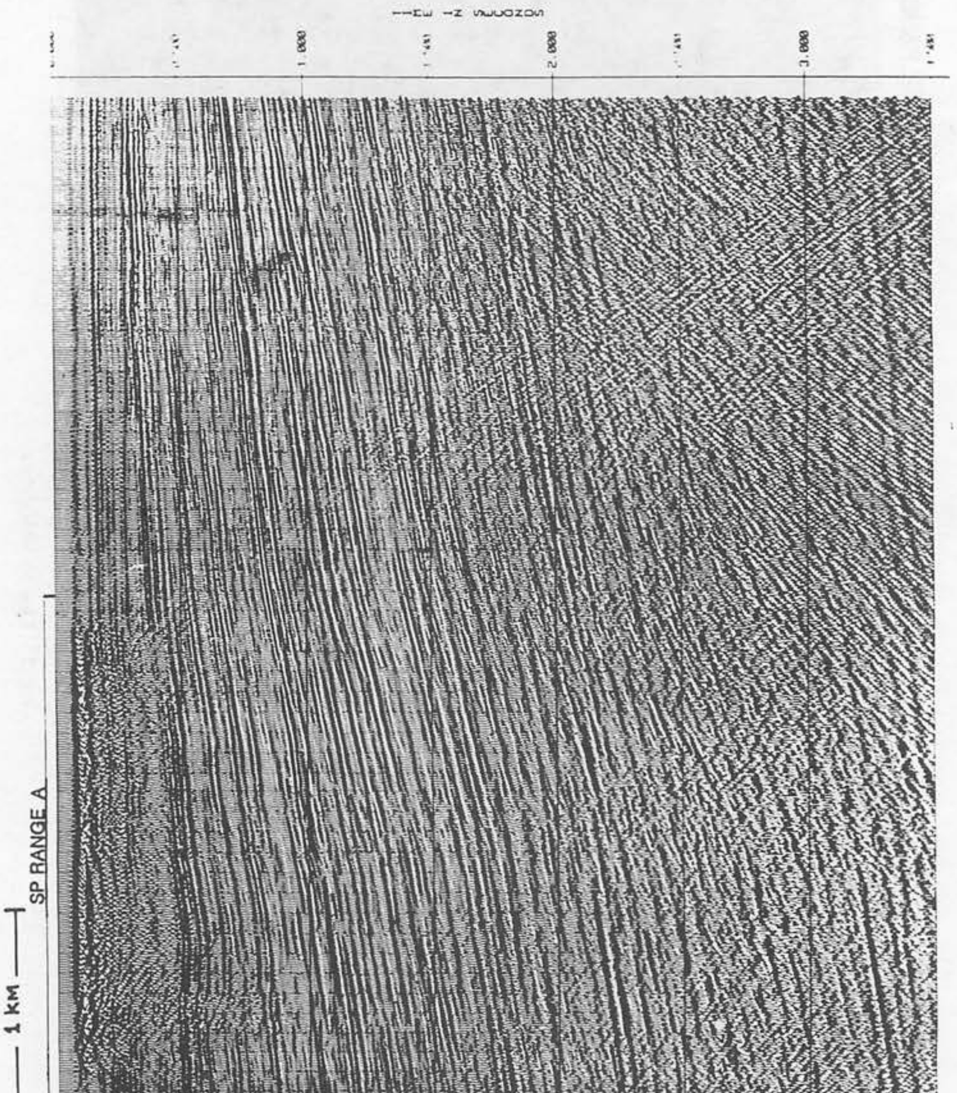

Fig. 3A. Part of Line 16 NMO/Stack

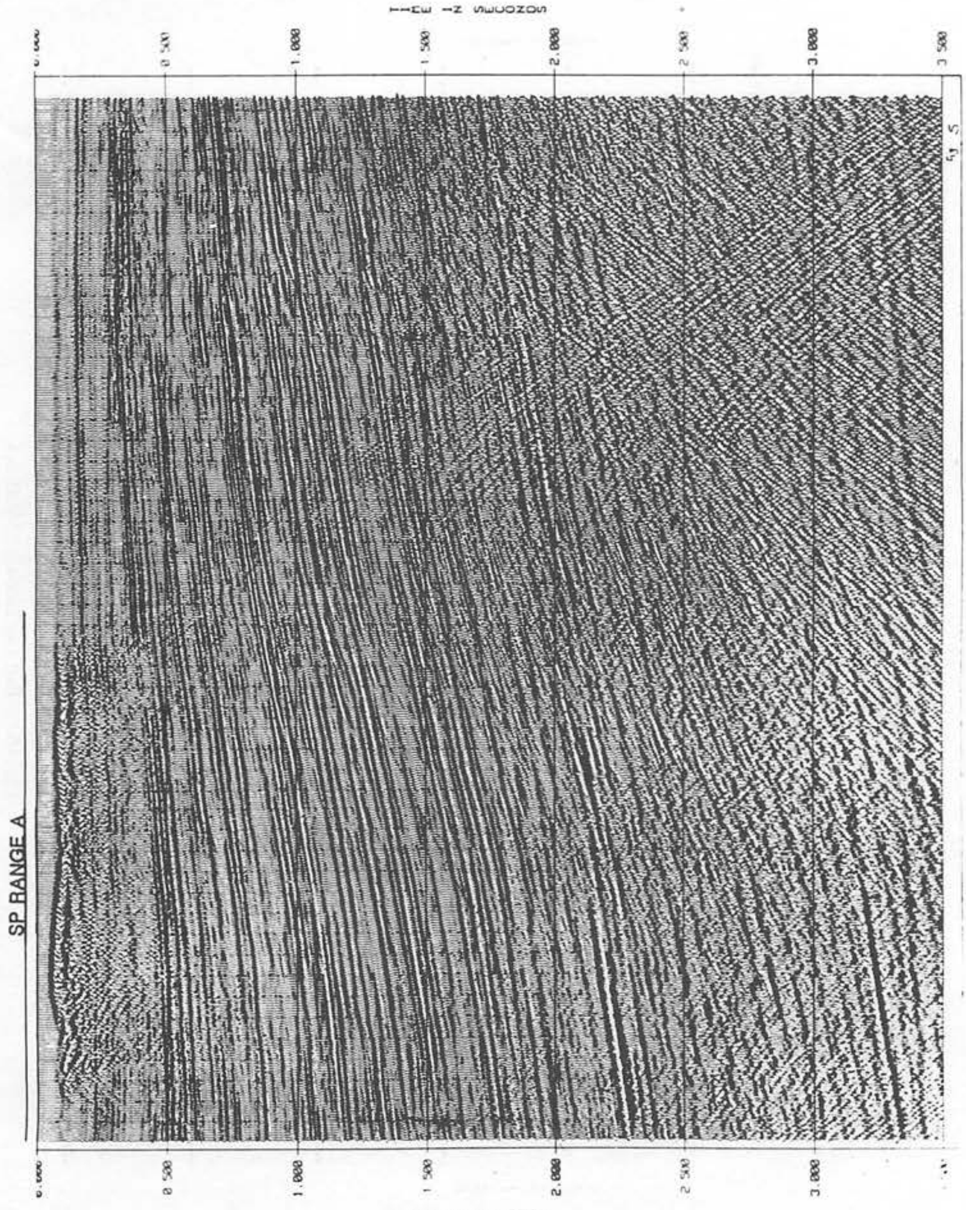

Fig. 3B. Part of Line 16 Stack with statics

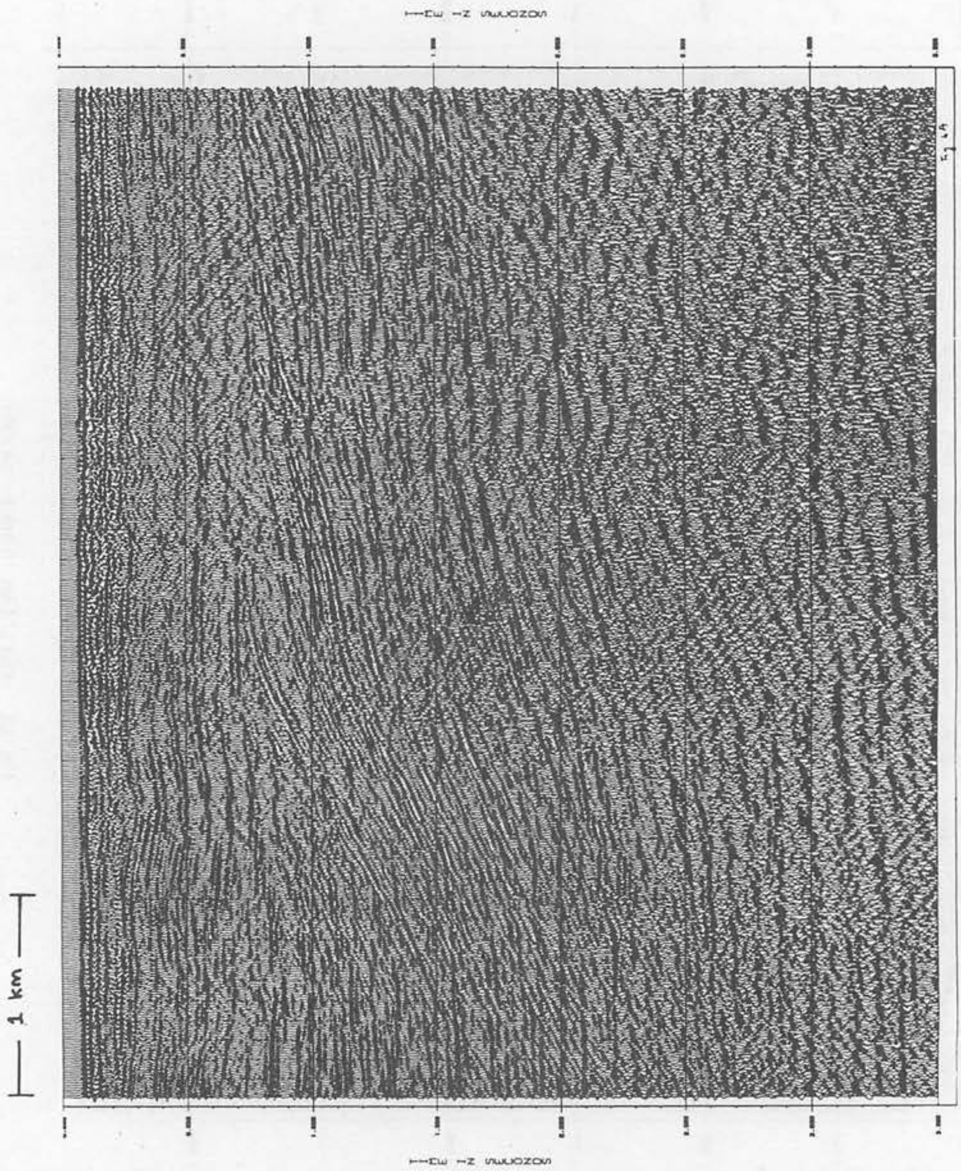

Fig. 4A. Part 1 of Line 01 NMO/Stack

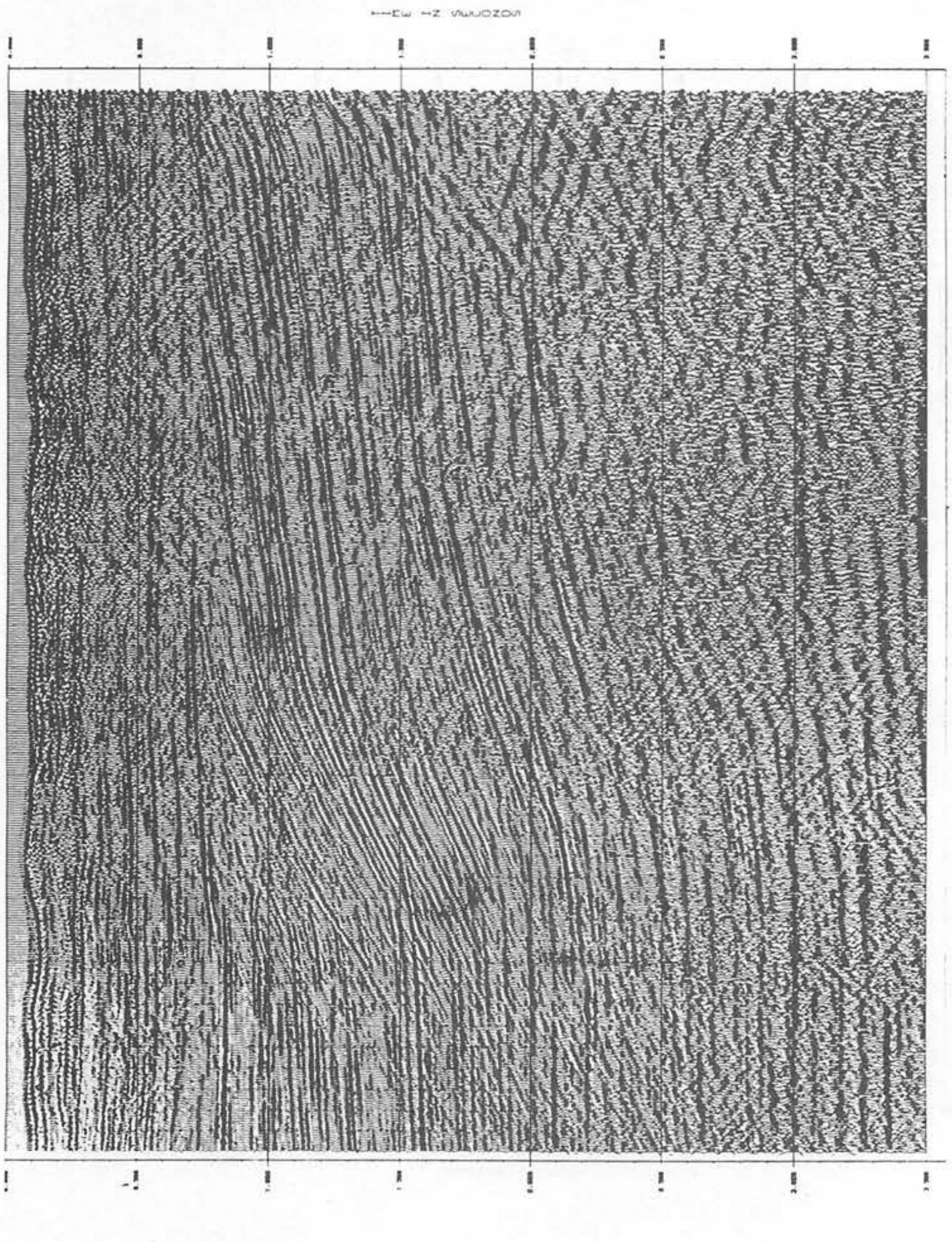

Fig. 4B. Part 1 of Line 01 Stack with statics

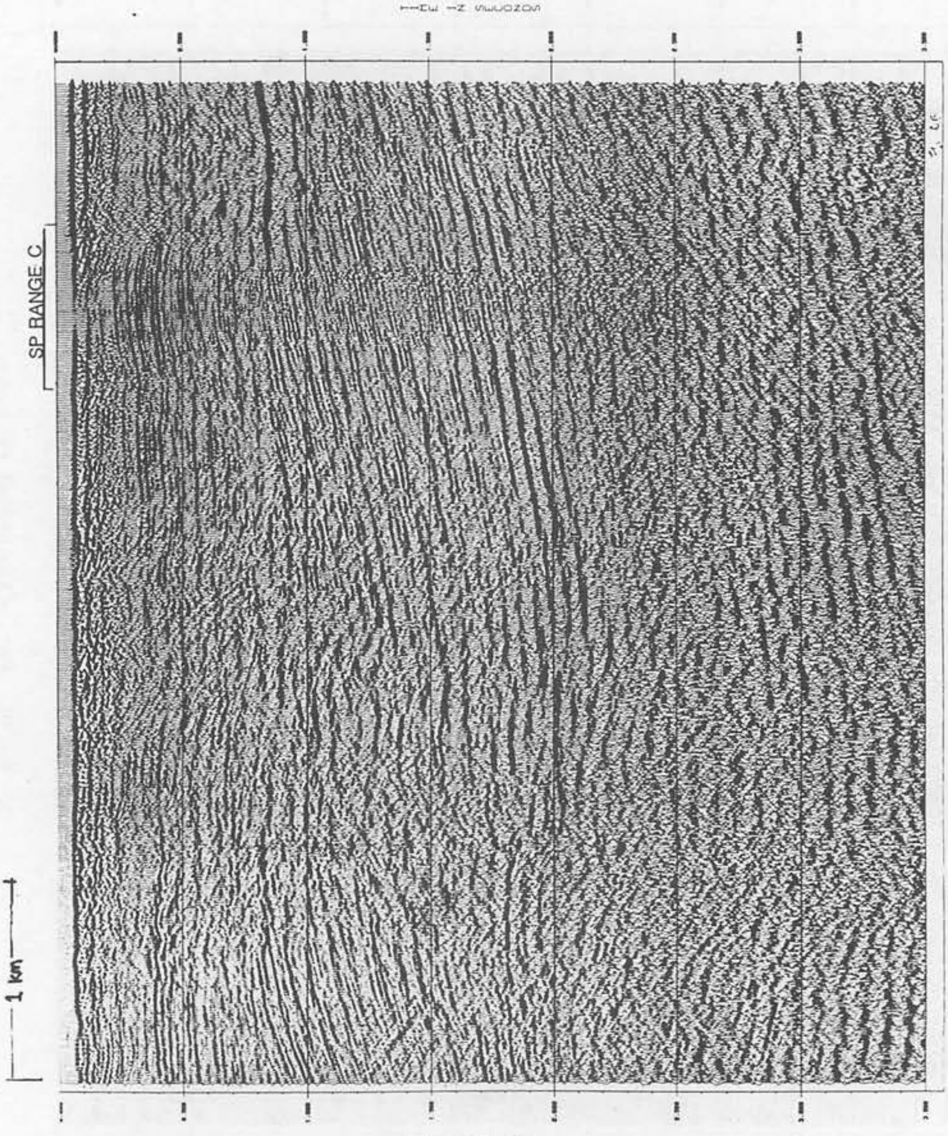

Fig. 5A. Part 2 of Line 01 NMO/Stack

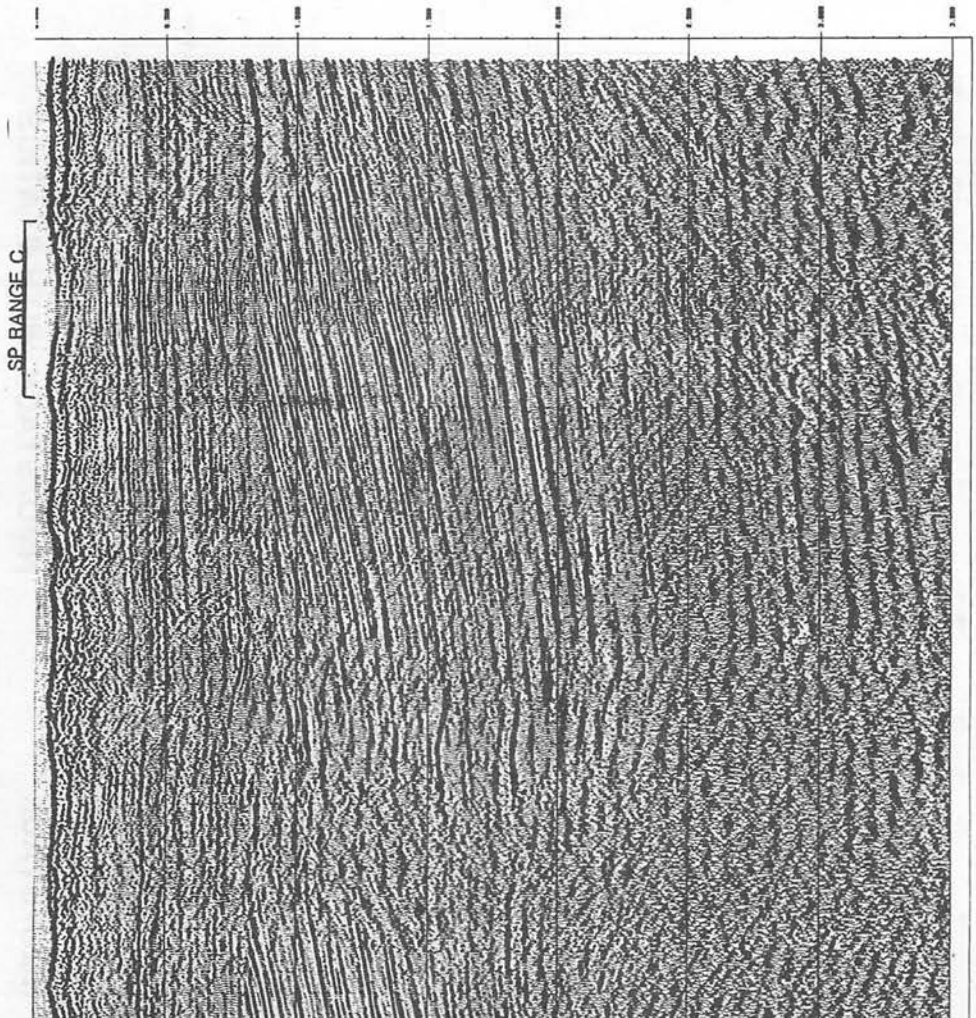

Fig. 5B. Part 2 of Line 01 Stack with statics

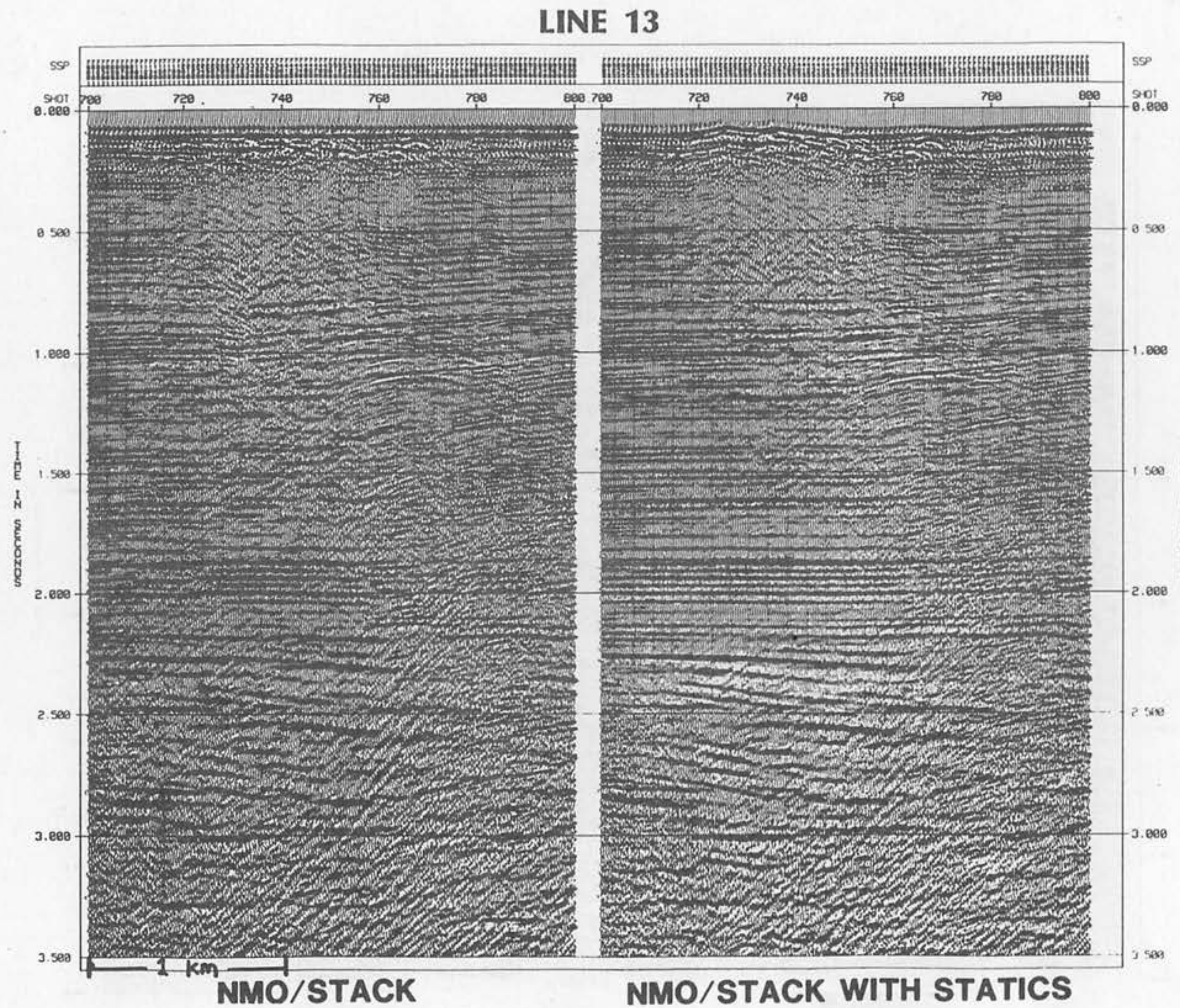

Fig. 6. Line 13 - Comparison of stacks with and without statics

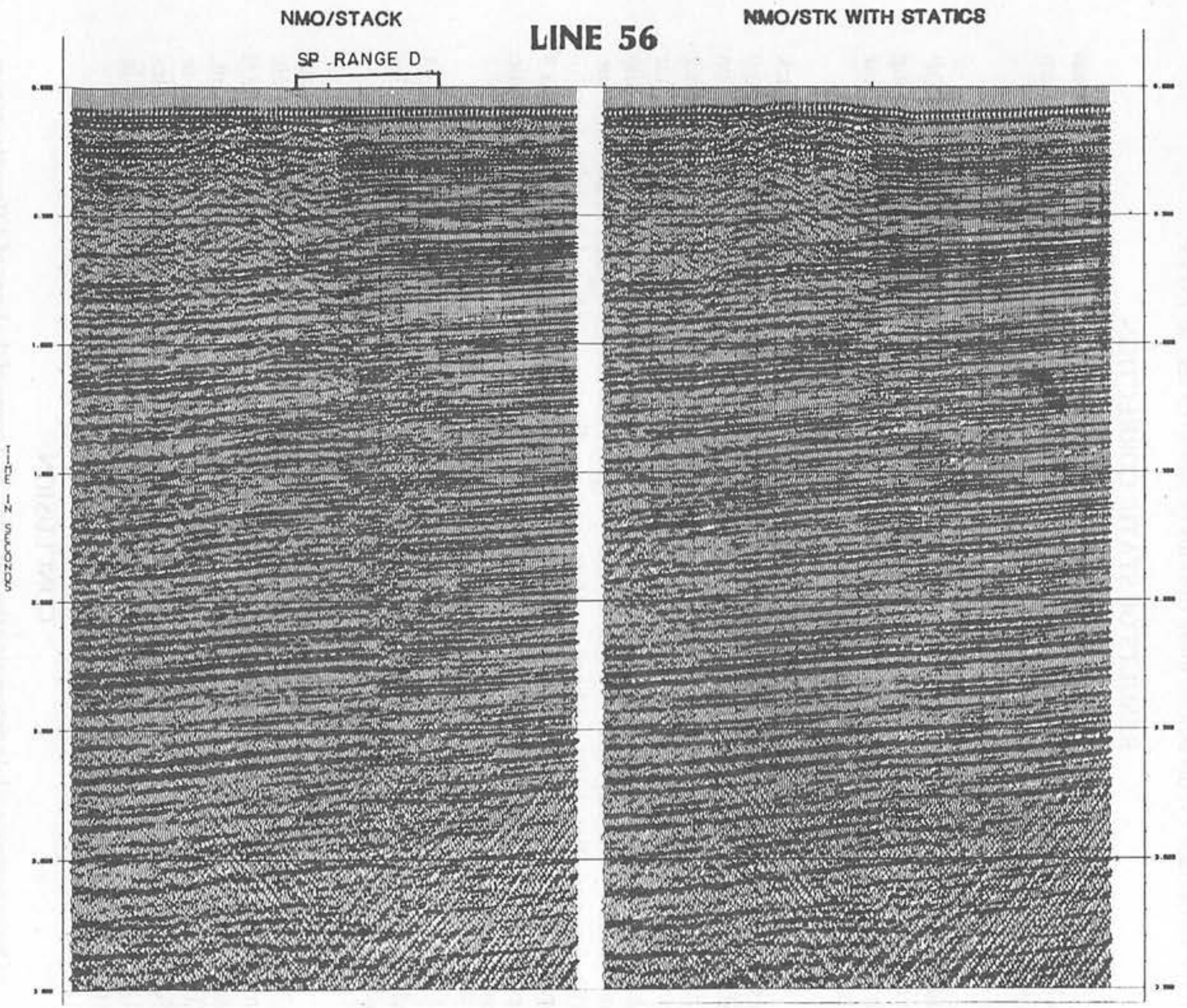

Fig. 7. Line 56 - Big feathering angle – Comparison of stacks with and without statics

due to shallow gas, differ in area size and are rather irregular in shape. A seismic line in these areas could sometimes encounter a few patches of such anomalies. Fig. 2 shows part of the stack of Line 16 which has shotpoint ranges A and B affected by shallow gas. In shotpoint (SP) range A, the shallow gas which slows down seismic velocity causes a sag or time delay in the subsurface events below, more obvious between 0.5 sec. to 1.0 sec.

RESULTS OF STATIC CORRECTION

About 580 km of 2D marine seismic lines shot by Sarawak Shell in 1985 were over areas where there are statics problems. The time shifting technique mentioned earlier was then applied to improve the continuity of seismic events.

One of the assumptions usually made while applying this method is that the statics or time shifts to be computed are surface consistent. This means that from the shot or CDP records, a static value could be derived statistically for every shot and receiver station along the seismic line. This assumption is valid in our case since the statics are caused by near surface anomalies.

Fig. 3A is an enlarged display of SP range A of Line 16 while Fig. 3B is the same stack section with statics applied. It is obvious that after statics application, all the events below SP range A show better continuity. A more remarkable improvement could also be seen on Line 01 in the same area. Fig. 4A shows the stack section of part 1 of Line 01, the dipping events between 1.0 to 2.0 sec. look rather discontinuous and smeared because of statics. After static correction, the dipping events are clear and where they terminate at around 0.7 sec., the unconformity is much better defined. Similarly Fig. 5A and 5B show part 2 of the same line 01 before and after statics application. Here again the dipping events and the unconformity are better defined after statics application. There is a pull-up effect at SP range C around 0.3 sec. due to rather localised high velocity interval, this effect has also been removed by static correction.

Fig. 6 shows that the same method of static correction is successfully applied in Line 13 which is in another area about 500 miles away. Here the cause of the statics problem is similar to the examples given earlier.

Fig. 7 shows line 56 in the same area. The average feathering angle for this line is about 17 degree because of the local tidal conditions with respect to the direction of shooting. Static shifts are clearly seen on SP range D. After static corrections the events between 1.5 to 3.0 sec. are more continuous but events between 0.5 to 1.0 sec. do not show any improvement. The explanation is that with big feathering angles, the receiver positions no longer lie in or close to a straight line and therefore the static shifts become unpredictable. This also deviates significantly from the basic assumption that the line of traverse and the data recorded lie in a two dimensional plane.

CONCLUSION

Our experience while processing the 1985 data and some of the lines of different vintages shows that remarkable improvement can be achieved on the stack sections with statics application provided the feathering angles are insignificant. Application of statics have an overall improvement in continuity of events resulting in better interpretable stacks.

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