P-SV Studies in a Foothills Environment

Chakrit Sukaramongkol and Don C. Lawton

ABSTRACT

Preliminary synthetic seismic reflection data, both conventional P-P and converted P-SV, have been acquired from a numerical model of a thrust fault (Highwood structure) in Turner Valley southwest of Calgary. The model used in this experiment is based on the interpretation of a seismic line NCD-0007 by Mackay (1990).

The P-SV data were analysed and compared with the P-P data in terms of the feasibility of using P-SV data to assist in delineating complex subsurface geology in thrust belts. The preliminary results of this experiment show that P-SV data may be useful in elucidating the subsurface geology when integrated with the conventional P-P data. However, it is observed that P-SV data, when acquired over a near surface, high-velocity material, do not yield a clear image of the shallow part of the subsurface .

INTRODUCTION

Recently, shear wave techniques have begun to play an important role in hydrocarbon exploration. They can provide useful information about subsurface lithology and porosity of sedimentary rocks, when combined with conventional P wave data (Justice et al., 1987)

This current experiment uses the P-SV data in conjunction with conventional P-P data to delineate the geometry of a simulated thrust fault at Turner valley southwest of Calgary (Figure1). The major objectives of this study are to assess whether the converted mode (P-SV) seismic data can be used to elucidate the complex geological structure commonly found at the Rocky Mountain foothills, and to analyse the characteristics of reflection seismic data when near-surface high velocity material is present. The results of this study will also be useful in designing data acquisition and data processing parameters.

NUMERICAL MODEL

The modelling in this experiment was undertaken on the UNISEIS ray trace modelling package, based on the interpretation of a seismic line, NCD-0007, across Turner valley by Mackay (1990). The model consists of a thrusted portion of carbonate rocks of Mississippian age which overly Mesozoic rocks of the Alberta, Blairmore and Fernie groups (Figure 2) . It was designed to bring thrusted carbonate rocks close to the

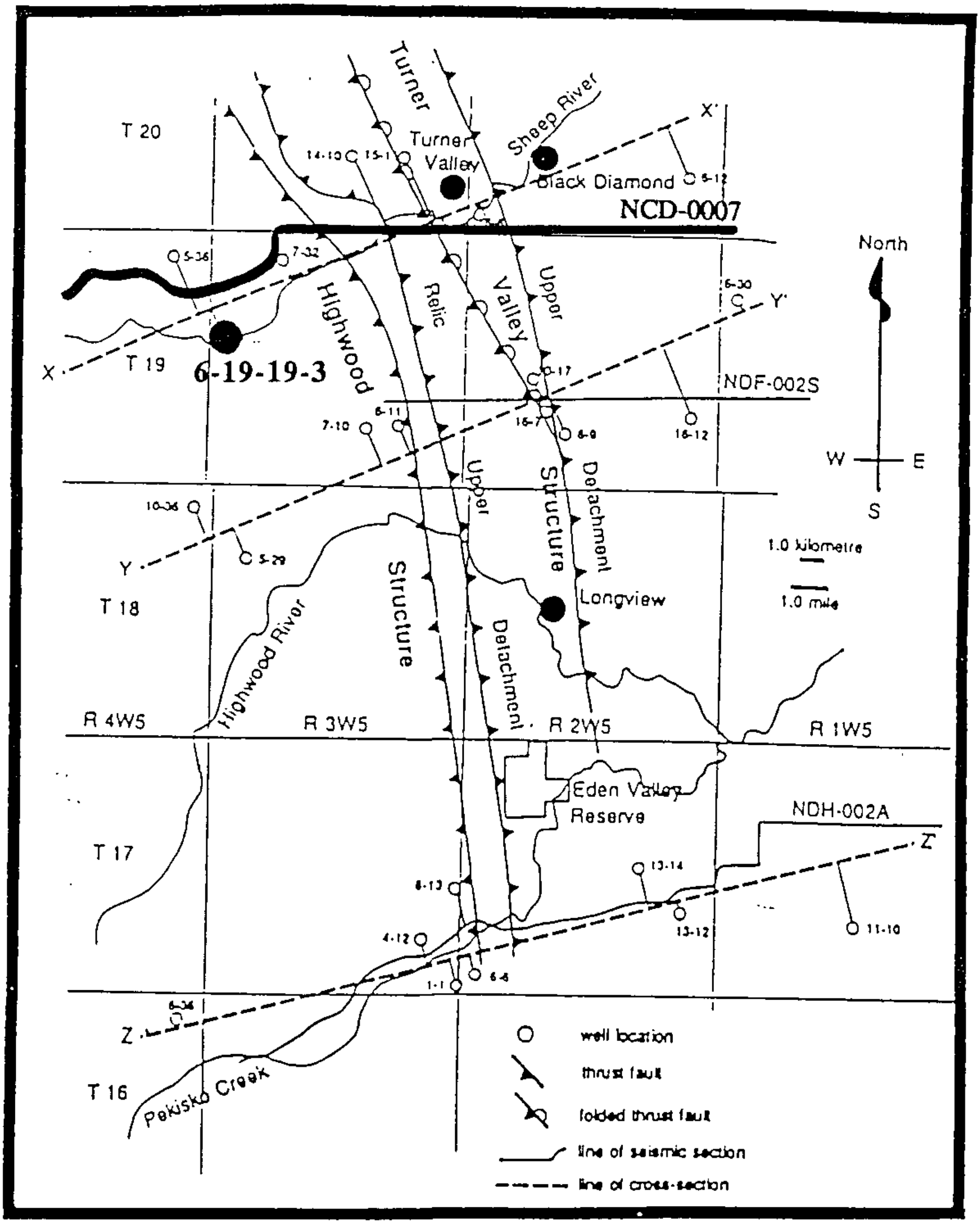
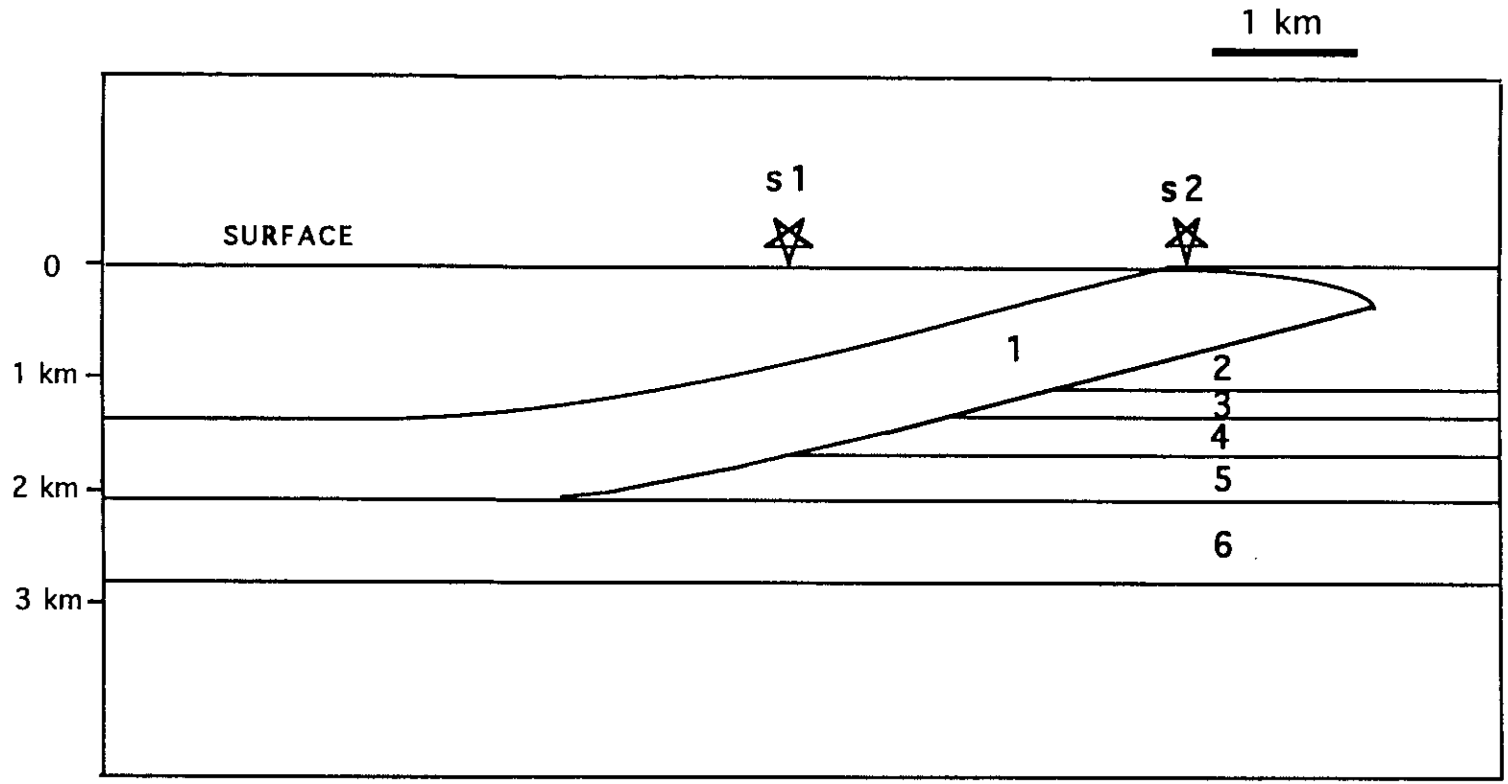


FIG.1 Map showing locations of Turner Valley and seismic line, NCD-0007. The location of well 6-19-19-3 is also indicated (after Mackay, 1990).



1,6	MISSISSIPPIAN CARBONATES
2	WAPIABI
3	CARDIUM
4	BLACKSTONE
5	BLAIRMORE
s1	SHOT POINT 1
s2	SHOT POINT 2

FIG. 2 A thrust fault model (Highwood Structure) at Turner Valley

surface in order to examine the characteristics of the reflection data acquired over near-surface high velocity material.

The physical parameters, summarized in Table1 were obtained from well 6-19-19-3W5M and from data provided by Miller and Stewart (1990). In this current experiment, four shot records were collected over two selected portions of the model, i.e. near the crest of the thrusted rocks and near the intermediate portion of the model (Figure 2). At each shot location, 240 traces of both P-P and P-SV data were obtained using a simulated explosive source and a split spread geometry with 20 m. group intervals.

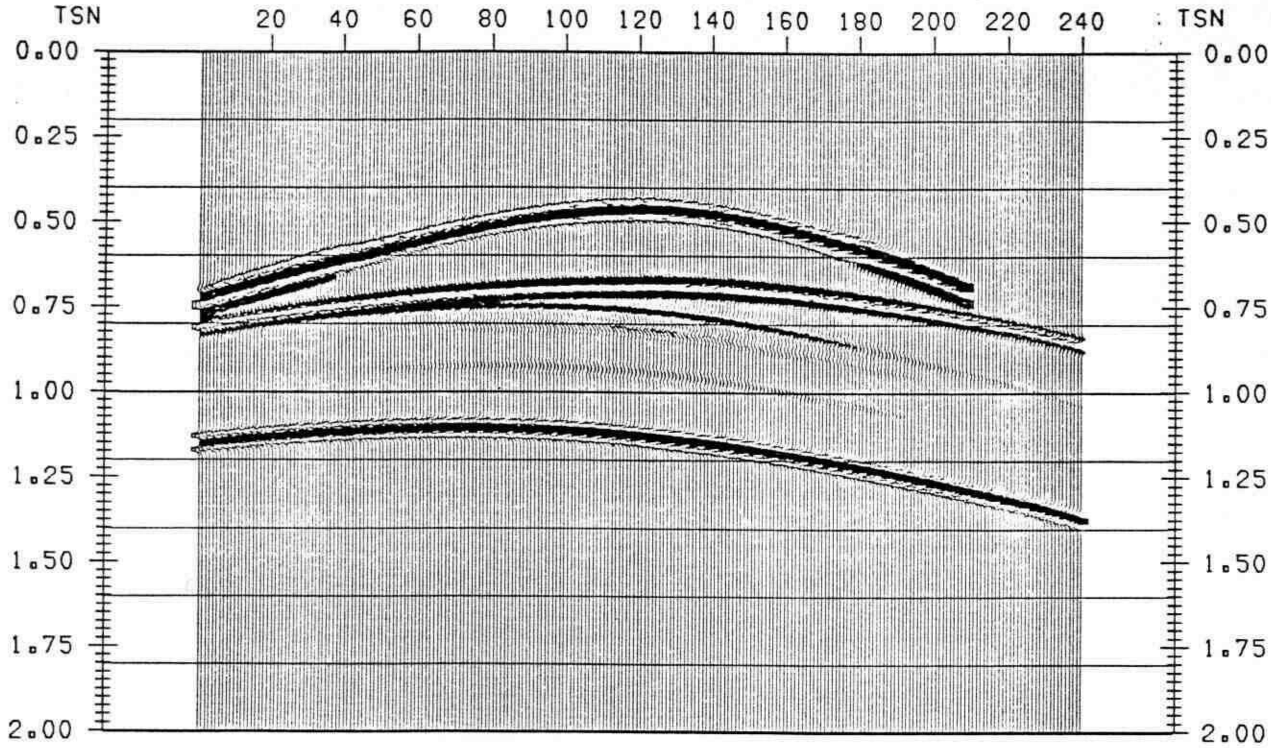
TABLE 1. Physical parameters of the model

Formations	Vp(m/s)	Vs(m/s)	Density (g/ cm^3)
Mississippian carbonates	5500	2894	2.80
Wapiabi	3884	2044	2.55
Cardium	4300	2529	2.65
Blackstone	4000	2139	2.60
Blairmore	4200	2545	2.65

RESULTS AND FUTURE WORK

The synthetic seismograms obtained from this experiment are shown in Figure 3 and Figure 4. These preliminary results have demonstrated that in general, the converted mode (P-SV) data give a similar image of subsurface geometry when compared to that of the conventional P-P data. This means that a better understanding of the subsurface geometry of the thrust faults in the foothills can be obtained if both P-P and P-SV data are available. However, it is noticed that both P-P and P-SV data when acquired over near-surface high velocity material (i.e., the Mississippian carbonates in this case), do not exhibit clear images of the shallow portion of the model that is, for the P-P case, the reflection strength of the top Mississippian carbonates is rather weak (Figure 4 A) and only a small portion of the top Mississippian carbonates is displayed in the P-SV section (Figure 4 B). It is expected that increasing the fold in acquiring the data will enhance imaging of the shallow part of the seismic section. This can be best achieved with smaller group and shot intervals.

It is proposed to acquire more numerical seismic data from this model in order to both increase the fold and to gain information covering the major portions of the thrust fault model. The data will then be analysed and processed with particular attention to



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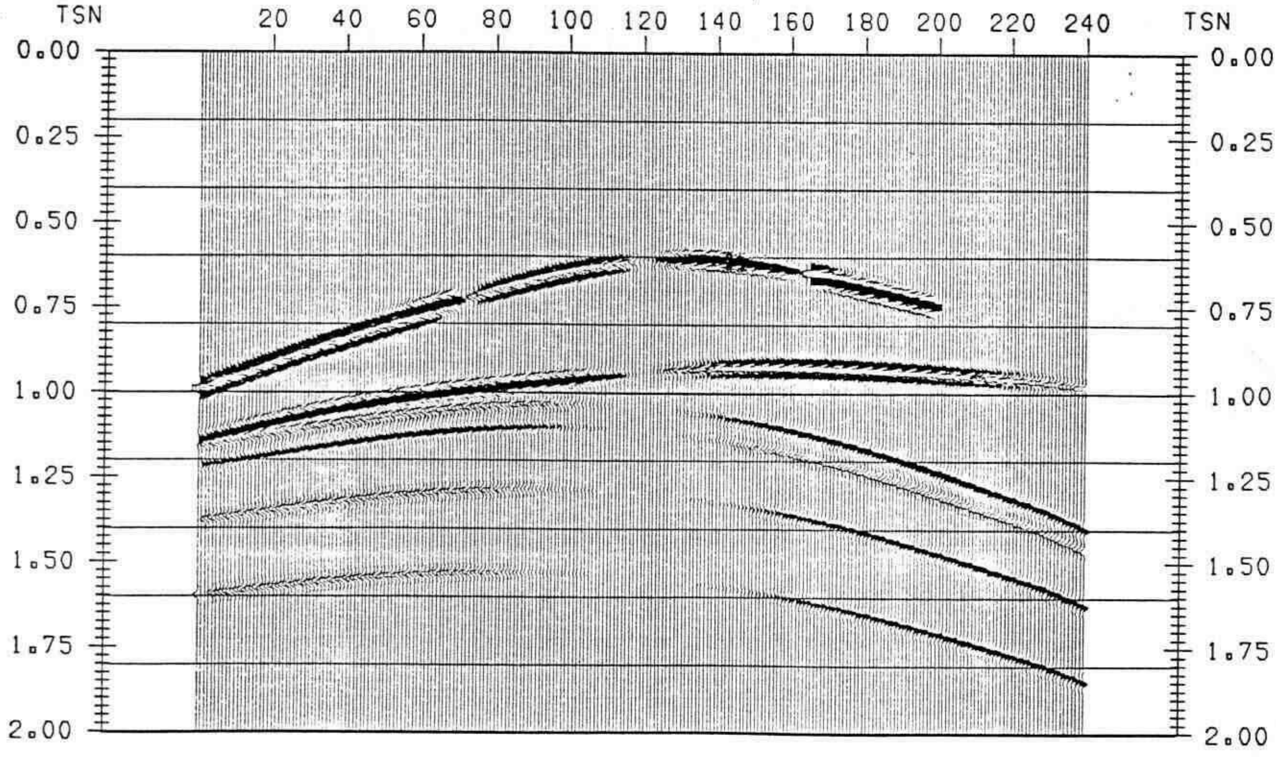
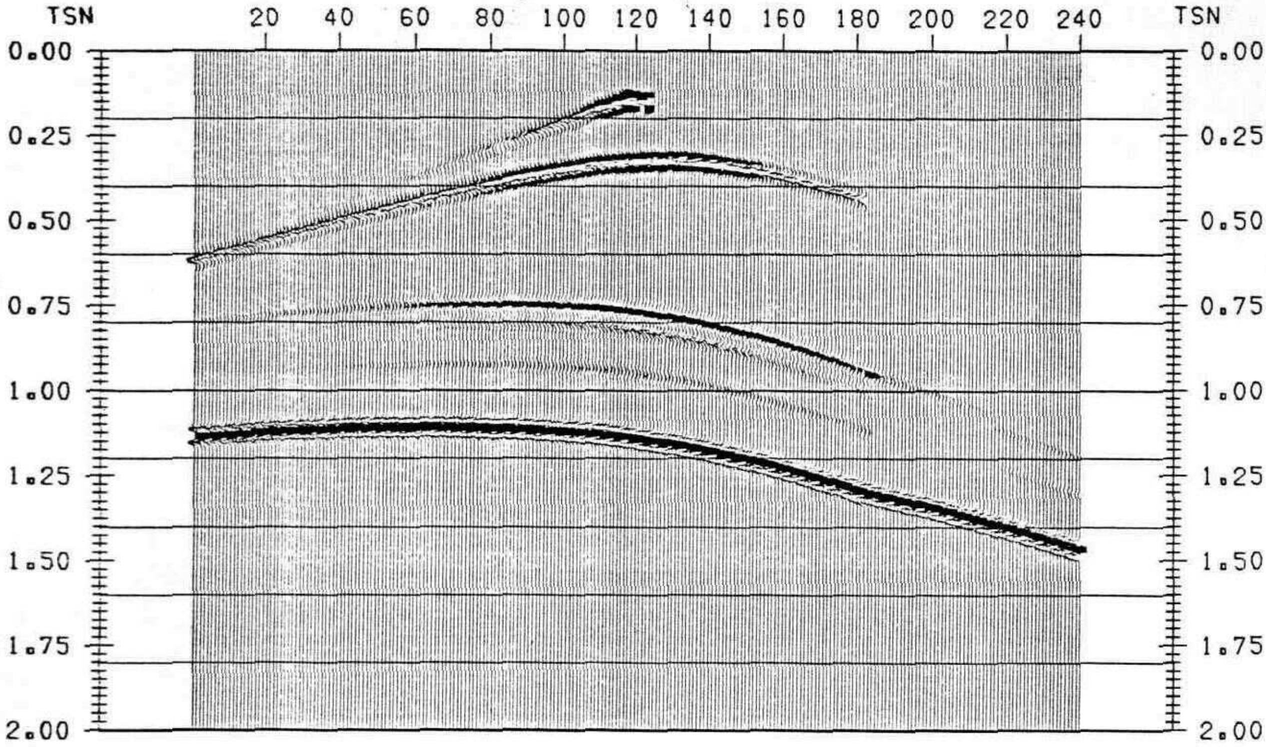


B

FIG.3 Comparison between P-P gather (A) and P-SV gather (B) from shot point 1.



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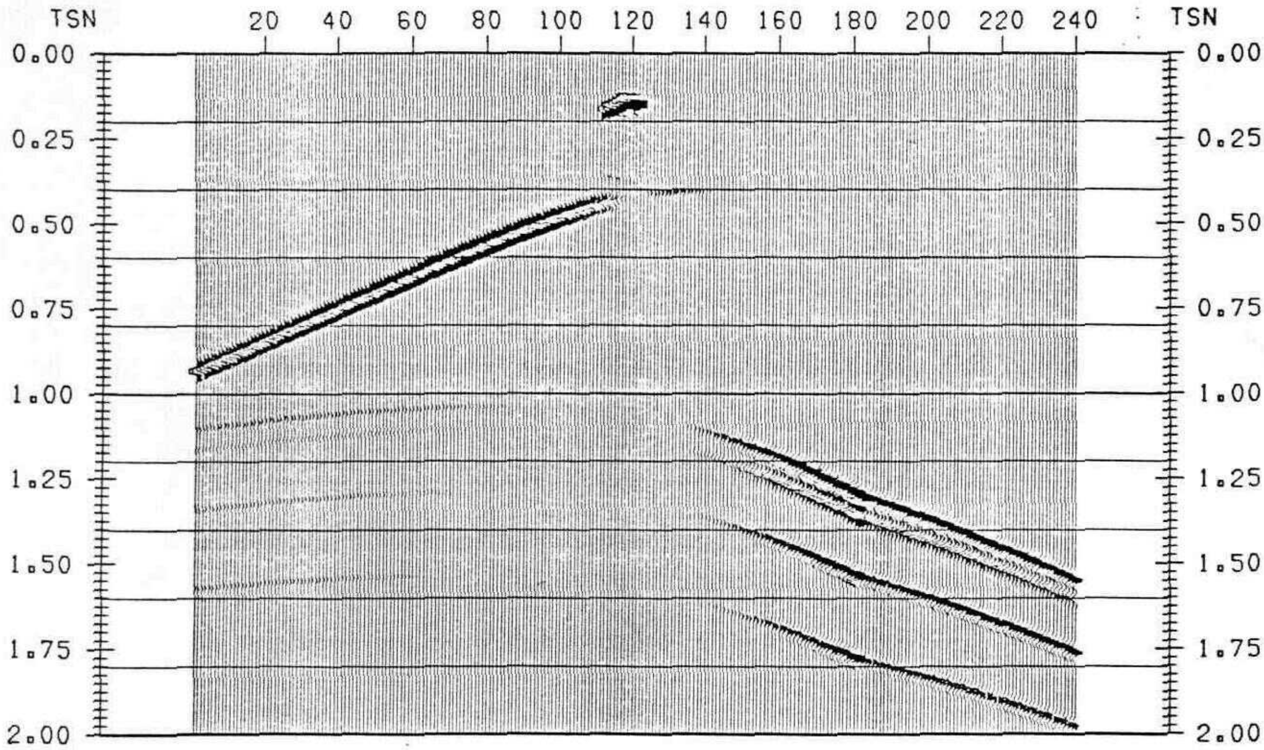

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FIG.4 Comparison between P-P gather (A) and P-SV gather (B) from shot point 2.

enhance the image of the shallow geometry of the thrust fault. It is anticipated that a physical model, based on the geometry of the cross section in Figure 2, will also be constructed over the next year and allow collection of physical-model seismic data to contrast and compare with numerically modelled data.

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