Physical modelling of a 3D marine seismic survey

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ABSTRACT

We processed and analysed a pseudo-marine 3D seismic survey that was acquired over a physical model. Although the data contain much noise and the waveform is variable and complex, the target is imaged on offset gathers and limited offset stacks. The target is imaged best on north-south inlines (which are parallel to the transducer array) stacked with limited source-receiver scaled offsets of 300-900 m.

INTRODUCTION

The U. of C. physical modelling facility was used to collect a pseudo-marine 3D seismic survey. Details about the physical setup and acquisition are found in Wong et al. (2009). Distances and frequencies in this report are scaled by 1:10,000 and reported as equivalent real-world values. The target structure is two perpendicular anticlines composed of silicone rubber on top of an acrylic plate (Figure 1). From the time push-down underneath the anticline the velocity of the acrylic material is estimated to be 1000 m/s (Wong et al., 2009). The complete survey consists of 75 source lines from y=0 to y=3700 m in 50 m intervals (in world units), each with 32 shots from x= 0 to x=3100 m in 100 m intervals. The receivers comprise 32 lines from x=0 to x=3100 m in 100 m intervals with stations from y=50 to y=3600 m in 50 m intervals. The processed data consist of 32 north-south inlines at 50 m intervals and 73 east-west crosslines at 100 m intervals. The dominant frequency of the signal from the piezopin transducer is 100 Hz.

DATA PROCESSING

The data were assigned a 3D geometry and processed in ProMAX. The fold of the cdp bins is greatest along the x-axis of the C-D anticline (Figures 1 and 2). A typical shot gather (Figure 3a) shows a strong direct arrival and echo with linear moveout, which interferes with the signal at the farthest offsets. We attenuated this noise using air blast attenuation and muted some unwanted noise (Figure 3b). The waveform is complex and not consistent from trace to trace, as can be observed by the reflections below 1.3 s on this shot gather. We were unable to improve the quality of the signal.

Figure 4 shows inline four, over the western limb of the C-D anticline, sorted into source-receiver offsets of (a) 100 m, (b) 300 m, (c) 500 m, (d) 700 m and (e) 900 m. The imaging is best on the 500 m offset, where the top and base of the target are seen clearly at 1.33 s and 1.65 s, respectively. There is a velocity push-down underneath the anticline on the time domain images. The quality of the imaging is poor on the 100 m offsets, quite good on offsets of 300-700 m and deteriorates past offsets of 900 m.

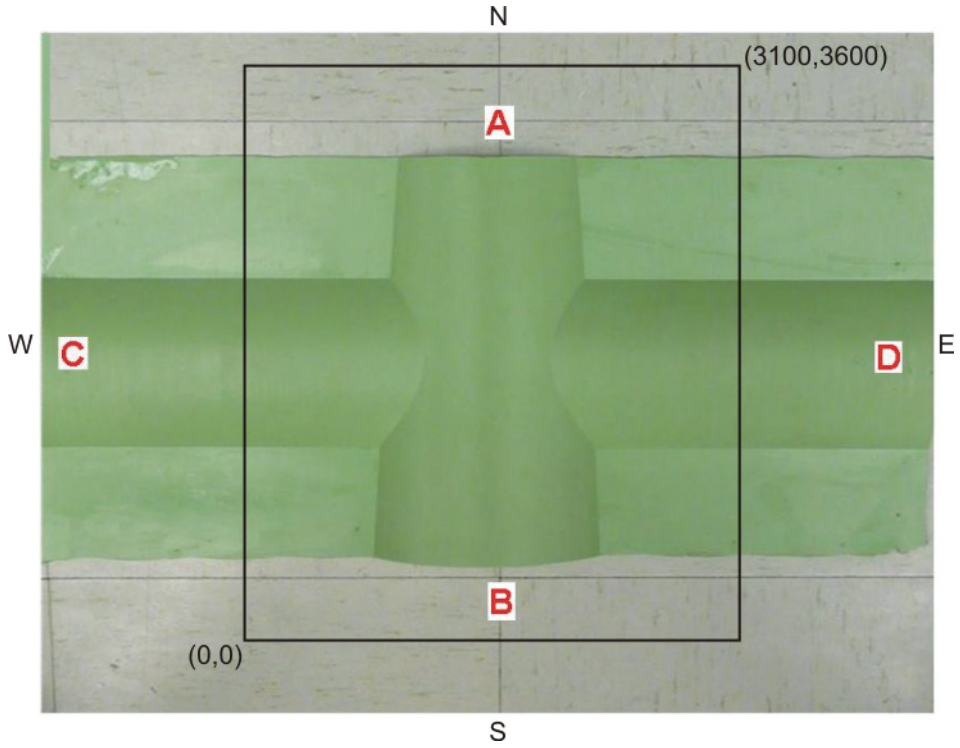

FIG. 1. A plan view photograph of the target, which has two perpendicular anticlines immersed in water at a depth equivalent to 800 m below the surface.

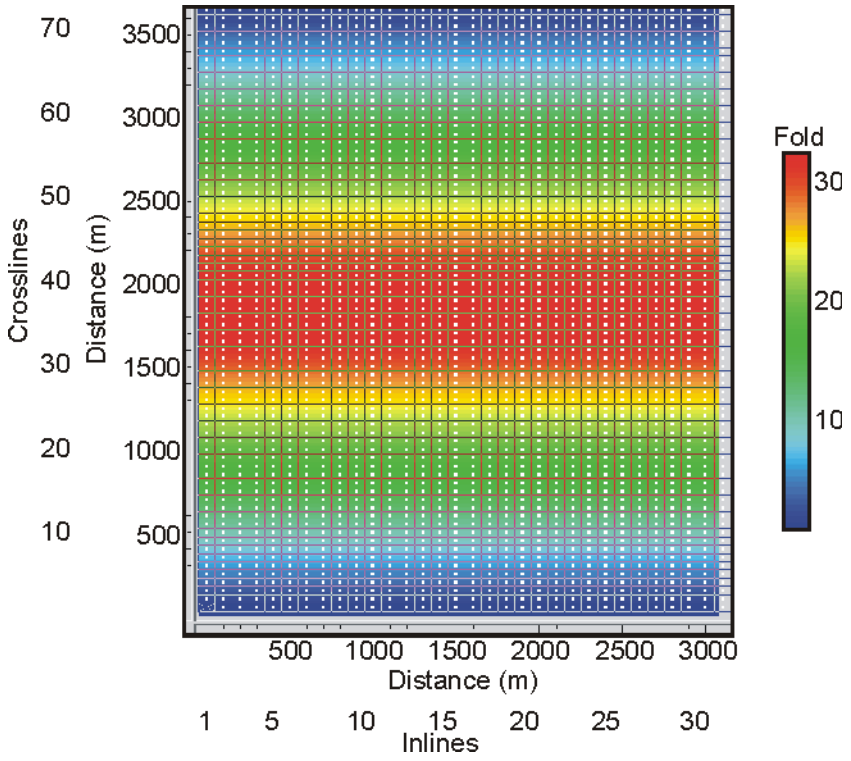

FIG. 2. Fold of the marine 3D survey.

We stacked the data using a constant water velocity of 1450 m/s and limited the offsets to 300-900 m. Past these offsets the data deteriorate and detract from the quality of the stack. Figure 5 shows inlines 4 and 28, which are north-south lines over the limbs of the C-D anticline. The crest of the anticline is imaged at 1.3 s and a clear velocity push-down is seen below it. The imaging is better on the north-south inlines, which are parallel to the transducer array, than on the east-west crosslines. The images on migrated lines are poor so they are not included here.

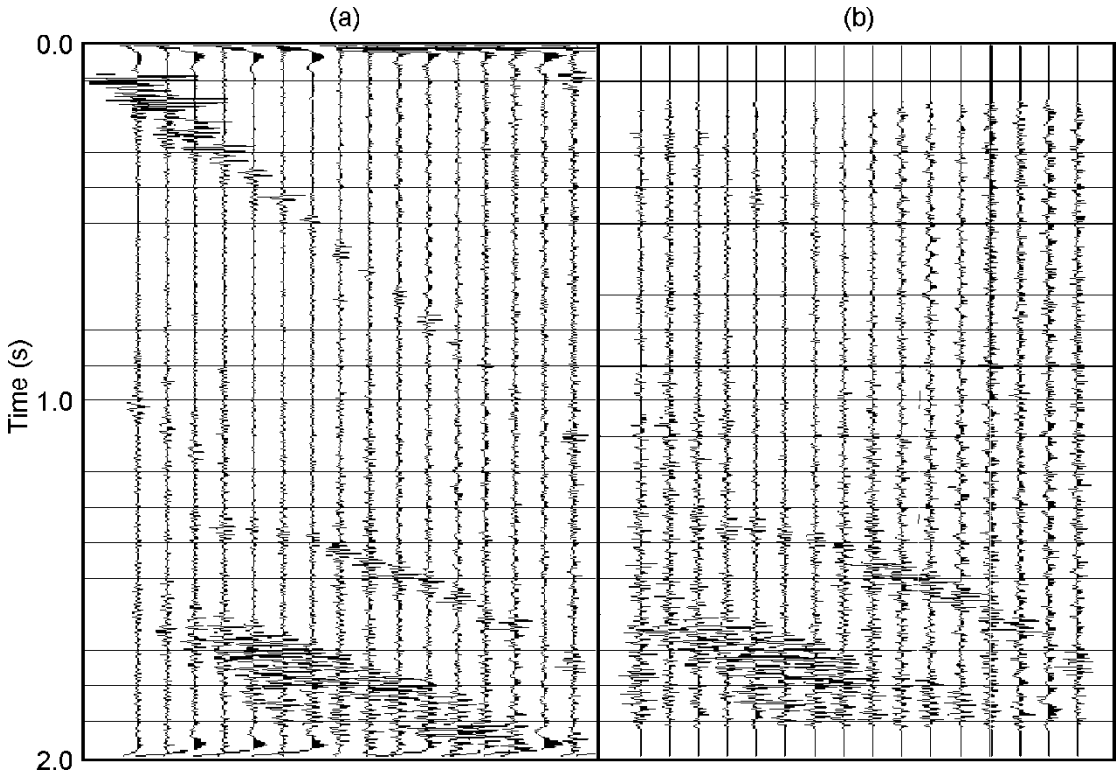

FIG. 3. A shot gather (a) before and (b) after attenuation of the linear noise and muting of some events. Reflections from the top and base of the model can be seen below 1.3 s.

SUMMARY

The pseudo-marine 3D seismic survey acquired over a physical model contains a lot of noise, the waveform is varied and complex and the dominant frequency is 100 Hz. Some of the noise was attenuated by filtering. The quality of the imaging varies with offset, with offsets of 500 m providing the best offset gather images. The best images of the target are seen on stacked offsets of 300-900 m on the north-south inlines, which are parallel to the transducer array. Offset gathers and stacked data show the crest of the anticline and associated velocity pull-down.

ACKNOWLEDGEMENTS

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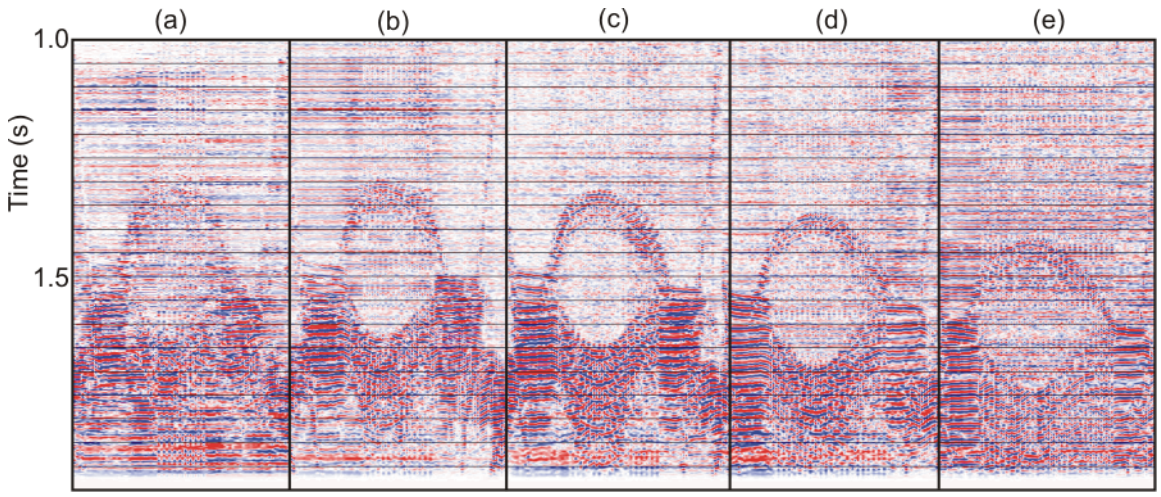

FIG. 4. Source-receiver offset gathers of north-south inline 4 over the C limb of the C-D anticline (Figure 1). The offsets are (a) 100 m, (b) 300 m, (c) 500 m, (d) 700 m and (e) 900 m.

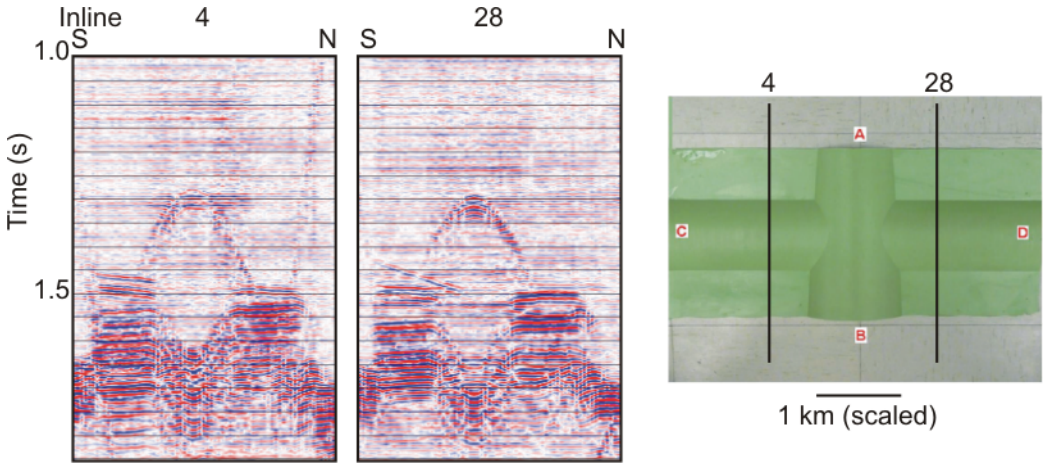

FIG. 5. North-south inlines 4 and 28 which cross the west and east limbs, respectively, of the C-D anticline. Offsets of 300-900 m were included in these stacks.

REFERENCES

Wong, J., R. Maier, E. Gallant and D. Lawton, 2009, Physical modeling of a 3D marine seismic survey: CREWES Research Report, Vol. 21.