SEISMIC SURVEY AND
PRELIMINARY INTERPRETATION
SQUID COVE LINE
CASTOR'S RIVER BLOCK

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SEISMIC INTERPRETATION, SQUID COVE LINE, CASTOR'S RIVER BLOCK

This line was shot across the regional trend to attempt to image the Acadian fold-and-thrust belt geometry in this area. Most of the section over the eastern part of the line is poorly imaged and is not interpreted. Because the Ten Mile Lake thrust crosses the seismic line at about SP 170, it is interpreted to sole and dip eastward at a shallow dip, although it cannot be clearly traced, and is a very tentative interpretation. This thrust as shown should carry a section of Labrador Group (at the surface) and PreCambrian basement over Cambro-Ordovician platform rocks, as the St. George Group outcrops to the west of the Ten Mile Thrust.

A possible intra-platform detachment is interpreted at around 1.5 seconds, and again dips gently eastward, indicating that it might be part of a west-vergent thrust system which resulted in repetition of the platform and rift sequence in this area. Below this boundary sedimentary rocks appear to be clearly imaged to a depth of 2.8 seconds (>6 km?). Two possibilities must be considered here: either (1) this section is indeed allochthonous lower Palezoic cover sequence, and the area has undergone much more structural repetition than previously interpreted, or (2) these are reflections in Precambrian metasediments which locally form part of the Grenville basement, in which case these lower reflectors would be mainly autochthonous, and unconformably underlying the upper section. The first interpretation is favoured, because large volumes of metasediments are not known regionally from the Grenville. Furthermore, even if such rocks were present, it would be fortuitous indeed if they were concordant in dip with the shallower platform sequence, as it appears on the profile.

Although the data quality of this line is disappointing, it has provided us with a tantalizing glimpse into the deep section, and has enabled us to identify acquisition problems and thereby focus our future exploration efforts.

INTRODUCTION

The- Applied Seismology Group at the Centre for Earth Resources Research (CERR) of Memorial University of Newfoundland has been involved in seismic studies of crustal and sedimentary structure in western Newfoundland fo- over a decade. Initially, this interest was focuseds through our NSERC Strategic Grant for studies in the Bay St. George basin and then through the Lithoprobe East funded vibroseis survey in the region In 1989. Since 1990, our interest has become centred on the sedimentary structure and tectonic history of the Humber zone. In 1994, we conducted a seismic study of the Carboniferous Deer Lake Basin. In 1995, CERR received a grant from Vinland Petroleum Inc. to assist in conducting further research into the tectonics of western Newfoundland, especially as related to the petroleum potential of the region. The overall focus of the research Is to study the allochthoneity of Lower Palaeozoic (and Grenville basement) thrust sheets in the Humber Zone. The interpretation of thrust stacks and westward directed thrusting in the Port Au Port region of the Humber Zone is now widely accepted. In the northern portion of the Humber Zone, the case for wide-spread allochthoneity is less well established. The initial study undertaken by CERR to investigate the tectonic setting of the region was a reconnaissance seismic profile along the Squid Cove access road near the community of Castor's River.

The seismic profile Is located along the Squid Cove Access Road and runs approximately 12 km from the Northern Peninsula highway more or less eastwards paralleling Castor's River. The west end of the line is about 100 m from tidewater and is sited on St. George's Group rocks. About 2 km from the highway, the profile crosses a major fault separating the St. George's group sediments from those of the Labrador Group. The remainder of the profile is on the Labrador Group rocks.

The primary objective of the profile is to determine whether there is evidence for large-scale west-directed thrusting, similar to that seen farther south in the Humber Zone, or whether the tectonic style is more compatible with a 'rooted' model.

ACQUISITION PARAMETERS

The data were recorded over the space of three days in October 1995 by CERR. The acquisition parameters were as follows:

Recording instrument: OYO DAS-1 24 bit
Geophones: Mark Products 14 Hz single phones
Pre-amp gain: 48 dB
Lo-cut filter: 3 Hz @ 6 dB/Oct.
Record length: 3072 ms
Sample rate: 1 ms
No. Of channels: 120 + 1 aux.
Nominal fold: 20
Groups: 1
Group interval: 20 m
Source: 0.5 kg UNIMAX explosive @ 3 m in a single hole
Shot interval: 60 m

The shot holes were drilled to a depth of 3 m with the shot pre-loaded at the bottom of the hole. Previous surveys in western Newfoundland had indicated that 0.5 kg would be sufficient, if well confined, for exploration to depths of 2 s. The resulting records show that the survey was generally undershot, with low signal-noise ratio throughout. It is significant to note though, the frequency content of the recorded signal is very high, with a median frequency in the range of 55 Hz to 70 Hz for most shots. This is probably due to the almost total confinement of the explosion for most shots as the shot hole was drilled into the very hard Labrador Group.

PROCESSING STREAM

The processing stream follows a fairly conventional flow, but with special emphasis placed on refraction statics and spectral broadening. With the low signal-to-noise ratio, conventional deconvolution methods did not perform well. The best spectral whitening was achieved by spectral balancing over at least two octaves. This was quite successful as the spectral content of the signal was reasonably rich and the median frequency was quite high.

The low signal-to-noise ratio leads to difficulty in semblance analysis for stacking velocities. This is a problem that we frequently encounter In the deep crustal (e.g. Lithoprobe) data and the most effective means of deriving stacking velocities is through the use of a series of constant velocity stacks. Large portions of the data were constant velocity stacked. The information form the constant velocity stacks was integrated with the near-surface velocities from the refraction statics analysis and with conventional velocity spectra from semblance analysis. This was used to form a composite velocity function for stacking. The whole process was iterated several times to 'fine tune' the velocities.

The processing steps are as follows:

1. Bulk shift correction for cap delay

2. Interactive trace editing and first break picking

3. Crooked line geometry analysis and trace binning (bins 10 m X 150 m)

4. De-spiking algorithm

5. Gain correction for geometrical spreading using regional velocity function

6. Surface consistent refraction statics analysis (pseudo-datum 165m amsl)

7. Notch filter 56 Hz - 64 Hz attenuated

8. Spectral balancing: frequency 25 Hz to 100 Hz, 15 Hz windows, 350 ms AGC

9. CMP sort - nominal fold 20

10. Constant velocity stack analysis (3500 m/s to 6500 m/s 100 m/s increment)

11. Iterative surface consistent residual statics: max. shift 10 ms

12. NMO application: mute at 50% stretch

13. AGC 400 ms window

14. Stack

15. Coherency filtering

16. Bandpass filter: Butterworth 26 Hz to 30 Hz and 70 Hz to 85 Hz.

17. AGC prior to plot - 400 ms window

PRELIMINARY INTERPRETATION AND RECOMMENDATIONS

The final stocked data after coherency filtering show weak, sub-horizontal reflections from less than 1.0 s to greater than 2.5 s. At a mean velocity of 5000 m/s, these correspond to depths from approximately 2 km to greater than 6 km. The reflectors are especially well imaged at the west end of the line and are generally clipping at low dips to the east. The near surface structure is not as well imaged, though there are some reflectors at the west end that are shallow and tend to dip in a westerly direction. The other significant seismic information is that the stacking velocities (and those from the refraction statics analysis) are very high at the surface - reaching 5000 m/s at less than 0.5 s TWT. Furthermore, the interval velocities show maxima near 0.5 s with generally lower interval velocities at greater depths.

The first conclusion that can be drawn from the data is that this appears to be a region of overthrusting at relatively shallow angles. There is considerable evidence to argue against a 'rooted' nature for the Long

Range. The number of thrust surfaces that are imaged, especially in the west of the profile, suggests an overall tectonic setting not dissimilar from that seen on the Port au Port peninsula. It is likely that the decrease in interval velocity that is inferred from the stacking velocity results from thrust emplacement of high velocity Lower Palaeozoic sediments (Labrador Group) and, possibly, Precambrian Grenville basement over lower velocity sediments that are themselves allochthons in lower thrust slices and/or parauthochthonous shelf sequences on the ancient margin of Laurentia.

While the data have low signal-to-noise ratio and the reflections are weak, there is clear evidence that this is a thrust setting with westward directed thrusting during the closure of Iapetus Ocean that has emplaced high grade sediments and (possibly) basement allochthons over Mid-Ordovician carbonates.

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Obtain a copy of Shot Point Location map/Squid Cove Prospect & Seismic Line SC01-95 Stack (pdf - 17kb)