UR1981_06

1/12

1981/6. Fingal Tier seismic reflection traverses 1 and 2.

R.G. Richardson
D.E. Leaman

Abstract

Two seismic reflection traverses on Fingal Tier have shown that on a time-section, the dolerite cap is characterised by high amplitude arrivals from throughout its thickness, the Triassic coal measures by a largely featureless zone of low amplitude arrivals, and the underlying Permian sequence by an increase in amplitude and coherency. Deep shot holes and an adaption of CDP processing techniques are necessary before a detailed structural section can be prepared.

INTRODUCTION

The coalfield under Fingal Tier is representative of those Triassic coalfields of north-east Tasmania which lie under a thick dolerite cover. The area is exempt from the Mining Act and is the site of a drilling programme by this Department to outline the coal reserves under Fingal Tier. Geological mapping, drilling, gravity and magnetic techniques (Leaman and Richardson, 1980) have established that in addition to faulting, variations in dolerite thickness cause truncation of coal seams. As surface geological mapping shows little or no evidence of these problems, it was hoped that seismic reflection techniques could provide information on the dolerite structures.

Two traverses have been recorded and partially processed (fig. 1), but require further processing before maximum information is derived from the data. Control for Traverse 1 is provided by drill holes 16B and 24, which have collar elevations that differ by only four metres but with a dolerite thickness of 263 m and 389 m respectively. Traverse 2 crosses the Mitchell Fault from the west and continues east to a problem area for drilling. On both traverses the ground surface consists of massive dolerite or dolerite weathering products which made access preparation difficult.

The traverses were recorded using single 28 Hz geophones at 10 m intervals. Shot hole positions were 20 m apart with two charges fired at each position to produce a pseudo 16-channel recording. The Channel 1 to shot offset was 10 m for Traverse 1 and 20 m for Traverse 2. Air tracks were used to drill 70 mm diameter shot holes to a depth of three metres where the overburden thickness was less than two metres, or to six metres otherwise. The holes were loosely cased with PVC pipe, which was removed during loading of the holes, to allow pre-drilling of a complete traverse. A series of test shots showed that for charges of less than 70 g of gelignite the best stemming material was sand. The charge sizes used for Traverses 1 and 2 were 70 g and 35 g of gelignite respectively. To minimise ground-roll, recording was stopped whenever wind strengths were such as to require a larger charge to maintain an adequate signal to noise ratio.

Line preparation was done under contract by the Forestry Commission, at a rate of about one kilometre/week, and shot holes were drilled under contract by Wreckair Pty Ltd at about five holes/machine hour. Field recording and line marking were done with the assistance of B. Cox, L. Davis, A. Geddes, C. Harris, G. Humphries, J. Lister, J. Mackey, M. Triffett, and D. Wyatt. Data processing was performed by Geophysical Service International, Sydney.

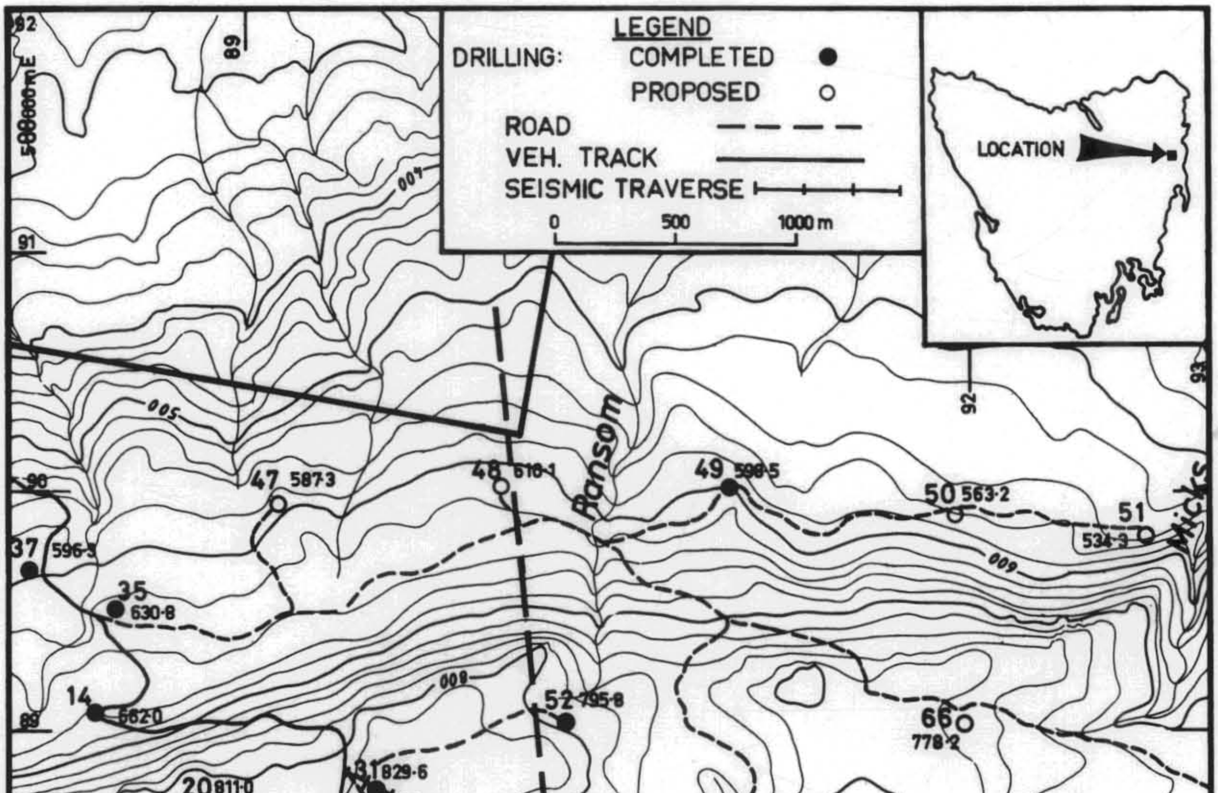


Figure 1. *Location of traverses, Fingal Tier. Reduced levels of boreholes (in metres) shown.*

5 cm

RESULTS

Traverse 1

Constant gain filter tests for this traverse (fig. 2) show numerous high amplitude arrivals in the first 150 msec of the record, followed by a rapid decrease in amplitudes. The absence of any probable reflected arrivals on these records prevents the choice of a pass-band on the grounds of reflection enhancement. Consequently a low-cut of 60 Hz was chosen to eliminate some of the ground-roll visible on the f-k noise analyses, and a high-cut of 200 Hz was selected as the maximum frequency likely in reflected arrivals from depths of 200 m or more.

The high amplitudes in the early part of the records indicate that the dolerite is strongly fractured horizontally as well as vertically, and will have a very low transmission coefficient while producing high amplitude internal reflections and diffractions. Drilling has shown the dolerite to be fairly uniformly horizontally fractured except near feeders, where the amount of fracturing initially decreases with depth.

Stacked and single-fold sections were produced using the same assumed velocity distribution, but the theoretical factor of two increase in signal to noise ratio expected from 4-fold CDP stacking was not observed (fig. 3). This is because CDP stacking smears or splits arrivals unless the velocity distribution used is correct for each trace of that common depth point stack, particularly for high frequency data. For optimum CDP stacking in the Fingal Tier situation, a velocity-time function must be derived for each depth point prior to stacking and the cost of this in a commercial processing centre is prohibitive. Both stacked and single-fold velocity filtered sections (fig. 4) show only small areas of arrival alignment. No static corrections have been performed because of the minor and smooth nature of elevation variations.

Constant velocity gathers of an expanding spread at the centre of the traverse suggest an average velocity between 4000 m/sec and 4500 m/sec to a reflection time of approximately 100 msec, and an average velocity of slightly less than 4000 m/sec to a reflection time of 300 msec. The lack of any clear reflection from the base of the dolerite means that an accurate interval velocity for the material below the dolerite cannot be calculated, although the maximum possible value is 3500 m/sec.

Traverse 2

Although exhibiting high-amplitude signals in the first 100 msec, the constant gain filter tests for this traverse show a number of coherent arrivals (fig. 5). A pass-band between 60 Hz and 200 Hz provides the greatest enhancement of potential reflected arrivals.

Initially CDP stacked and near-trace single-fold sections were produced. The single-fold sections had a lower signal to noise ratio than the stacks, but showed essentially the same information. Some of the noise on the single-fold section appears to be source-related and affects only the near traces, so a single-fold section was produced using traces 7 to 10. This section has a signal to noise ratio similar to that of the stacked section and has greater arrival coherency (fig. 6), demonstrating the disadvantage of performing CDP stacking without an accurate velocity-time function.

Elevations along this traverse vary by 120 m with a number of abrupt height changes. Both single-fold and stacked sections were corrected to a uniform datum at 720 m, assuming a reduction velocity of 5500 m/sec. The resulting sections, however, show few coherent arrivals and will require velocity filtering before further processing or interpretation is possible.

Three expanding spreads provide an estimate of the velocity-reflection time function. The expander at Shot 24 shows an average velocity of approximately 5500 m/sec to 80 msec (220 m depth), and an average velocity of 4200 m/sec to 160 msec (340 m). The depth of dolerite in drill hole 31 is 302 m and the reflector at 80 msec probably lies within the dolerite. The expander at Shot 55 show an average velocity of 4000 + m/sec to 190 msec (400 m). The expander at Shot 84 shows average velocities of 4500 m/sec to 170 msec (380 m), 4000 m/sec to 230 msec (460 m), and 3600 m/sec to 320 msec (580 m).

INTERPRETATION

Traverse 1

The CDP stacked section (fig. 7) shows three distinct arrival zones. The first 100-150 msec of the section (Zone A) has large amplitude arrivals that are coherent over short intervals. Zone B, between Zone A and 300 msec, has much lower amplitudes and appears to have few coherent arrivals. Below 300 msec (Zone C) arrival amplitudes increase slightly and signal coherency increases significantly. The thickness of Zone A corresponds approximately to the dolerite thicknesses recorded from drill holes 16B and 24, and Zone C is at a depth similar to the upper part of the Permian sequence. Zone B represents the coal measures. The dolerite thins to the north with a decrease in thickness from 360 m near Shot 1, to 250 m near Shot 51. The upper Permian is at a depth of approximately 600 m.

Traverse 2

The single fold section (fig. 8) shows similar amplitude zoning to the section from Traverse 1. The bottom of Zone A varies from about 110 msec in the west (Shot 1) to 160 msec in the east. This corresponds to a thickness change from 300 m to 440 m, assuming that the zone is dolerite with an average velocity of 5500 m/sec. For an average velocity of 4000 m/sec to the top of Zone C, the depth to the upper Permian varies from a minimum of approximately 520 m near Shot 86 to approximately 600 m in the western end of the section. Once again the coal measures (Zone B) is a band of low amplitude arrivals with little coherency.

SUMMARY

The preliminary results from the two seismic reflection traverses on Fingal Tier show that the seismic reflection method is capable of indicating the base of the dolerite and the top of the Permian sequence. With improved stacking techniques and a suitable processing sequence, the definition of these two boundaries will be improved, and it is likely that features within the coal measures may be resolved. The use of deep shot holes in the dolerite is the only method of firing shots in this environment without generating large amplitude surface waves.

LEAMAN, D.E.; RICHARDSON, R.G. 1980. Gravity survey of the east coast coalfields. *Department of Mines, Tasmania*.

[16 February 1981]

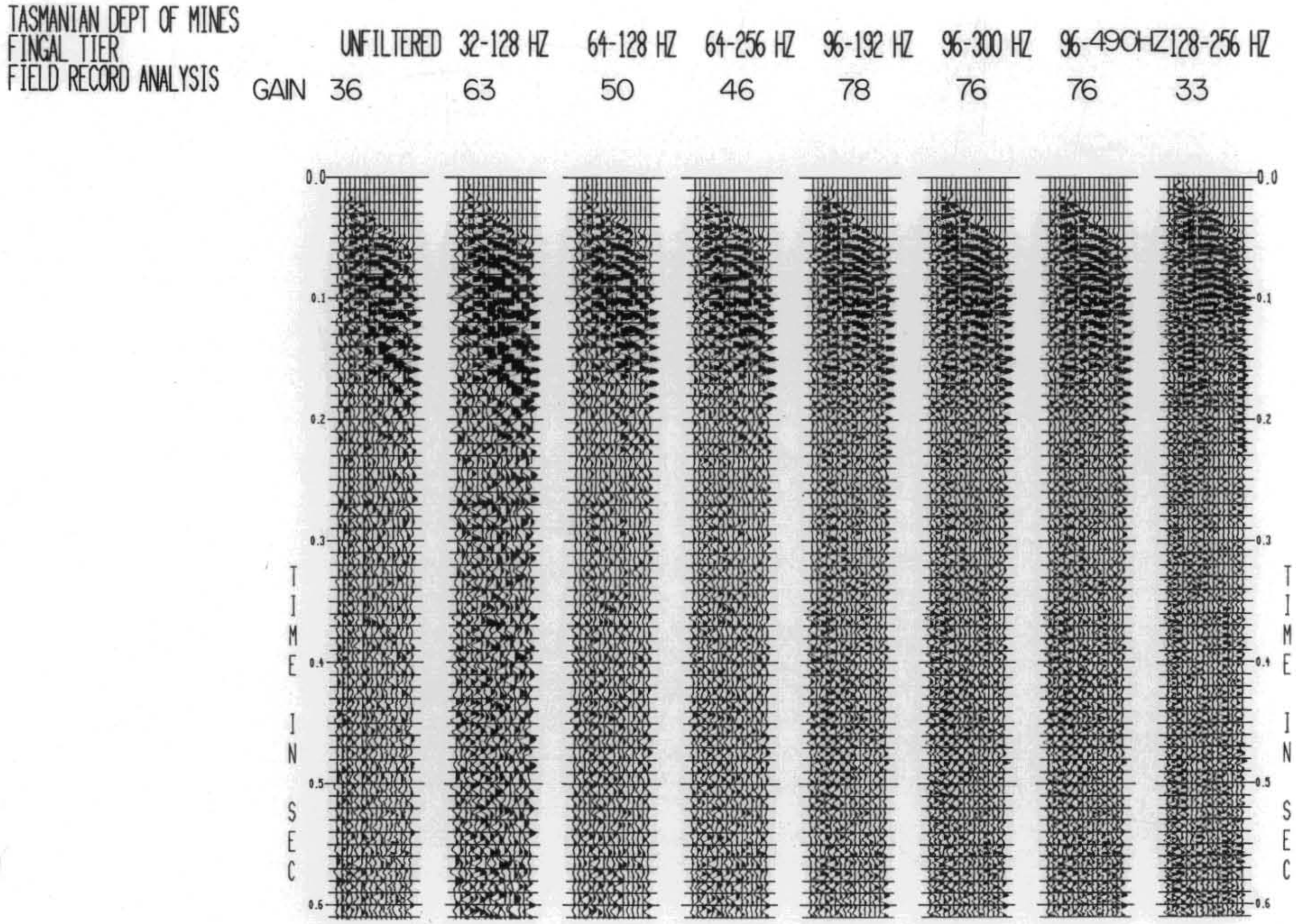
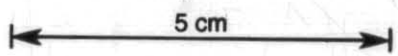


Figure 2. *Filter tests, Traverse 1*



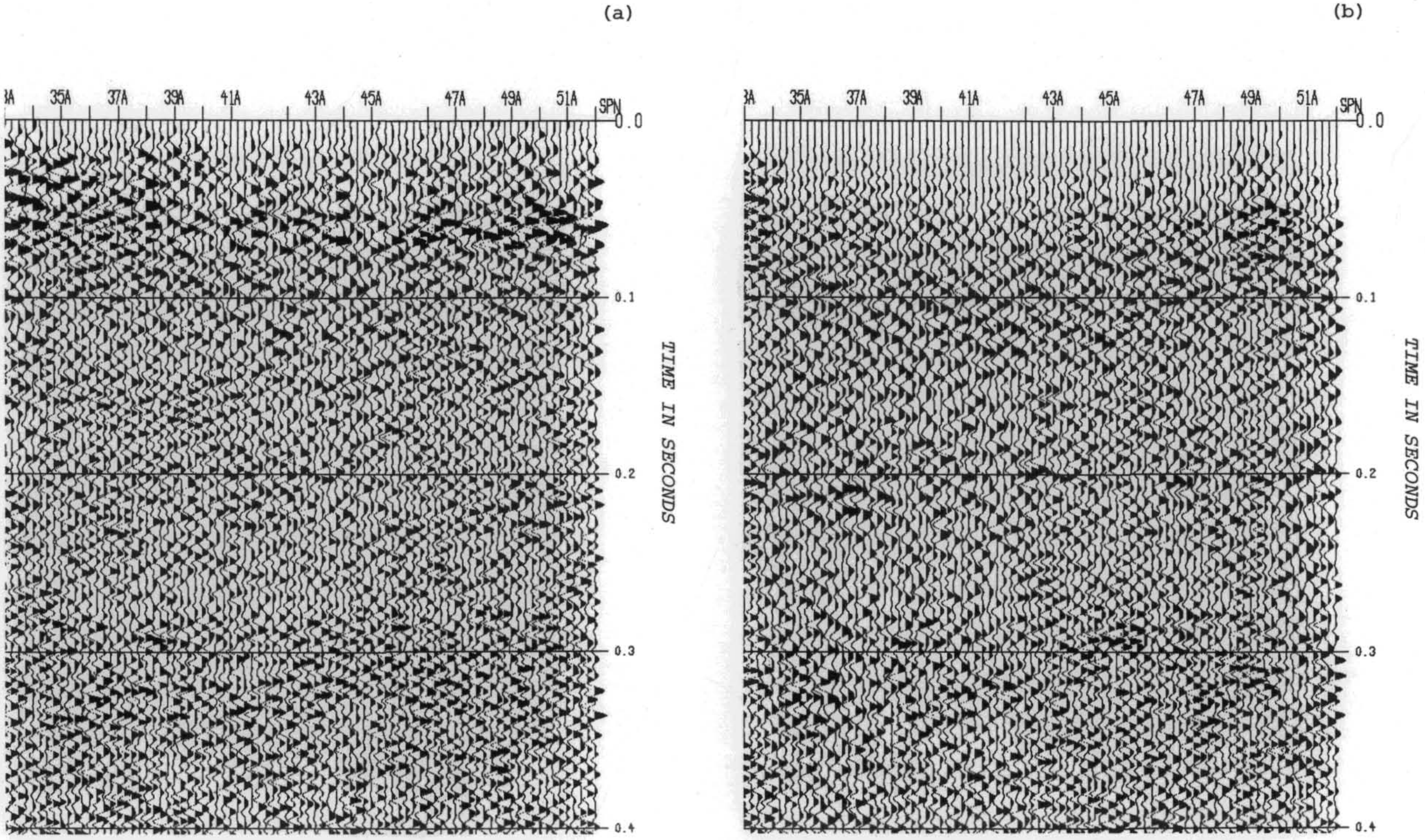


Figure 3. *Traverse 1, stack (a) and near trace gather (b), no velocity filtering*

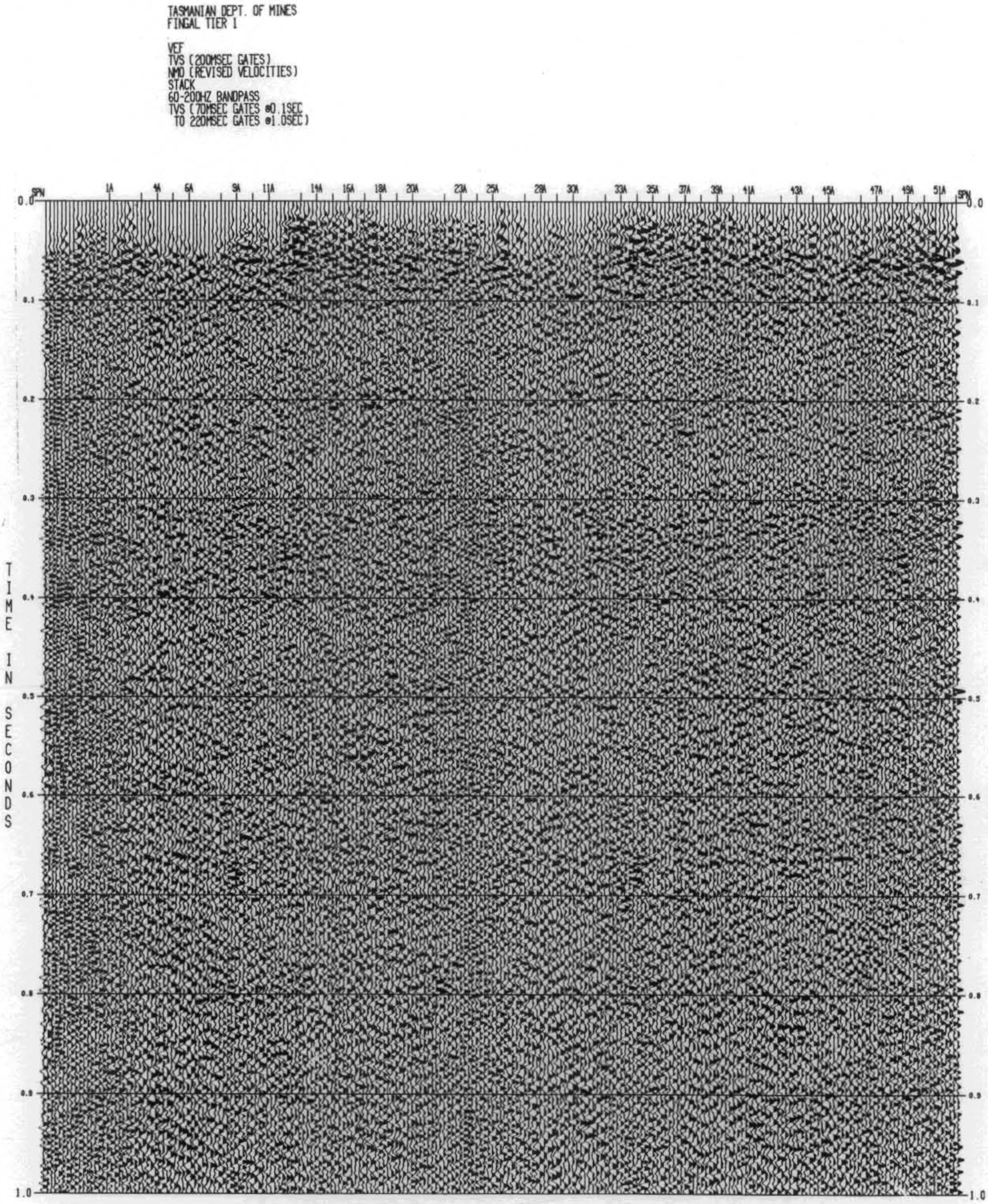


Figure 4(a). *Traverse 1, stack, velocity filtered*

5 cm

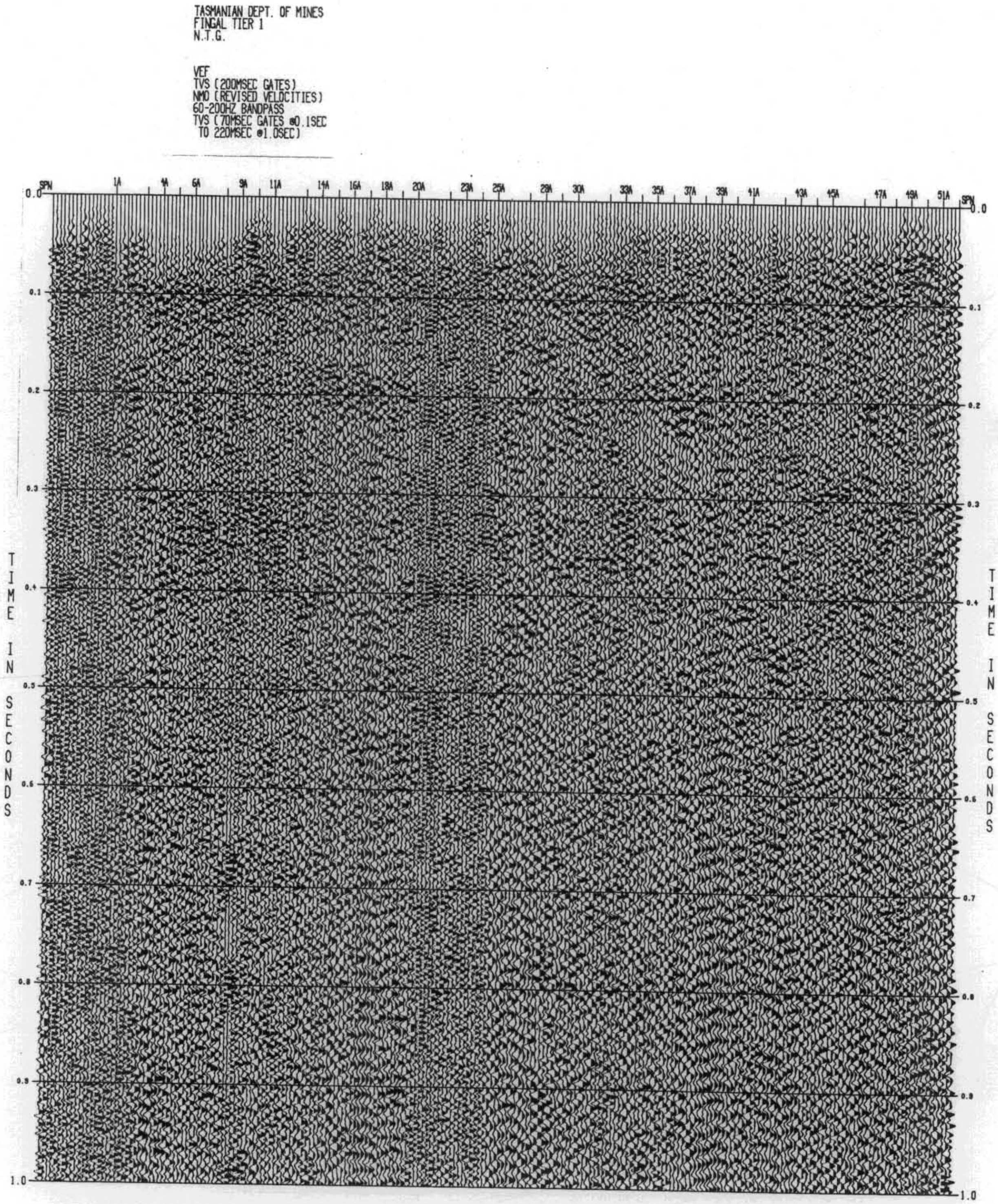


Figure 4(b). *Traverse 1, near trace gather, velocity filtered*

5 cm

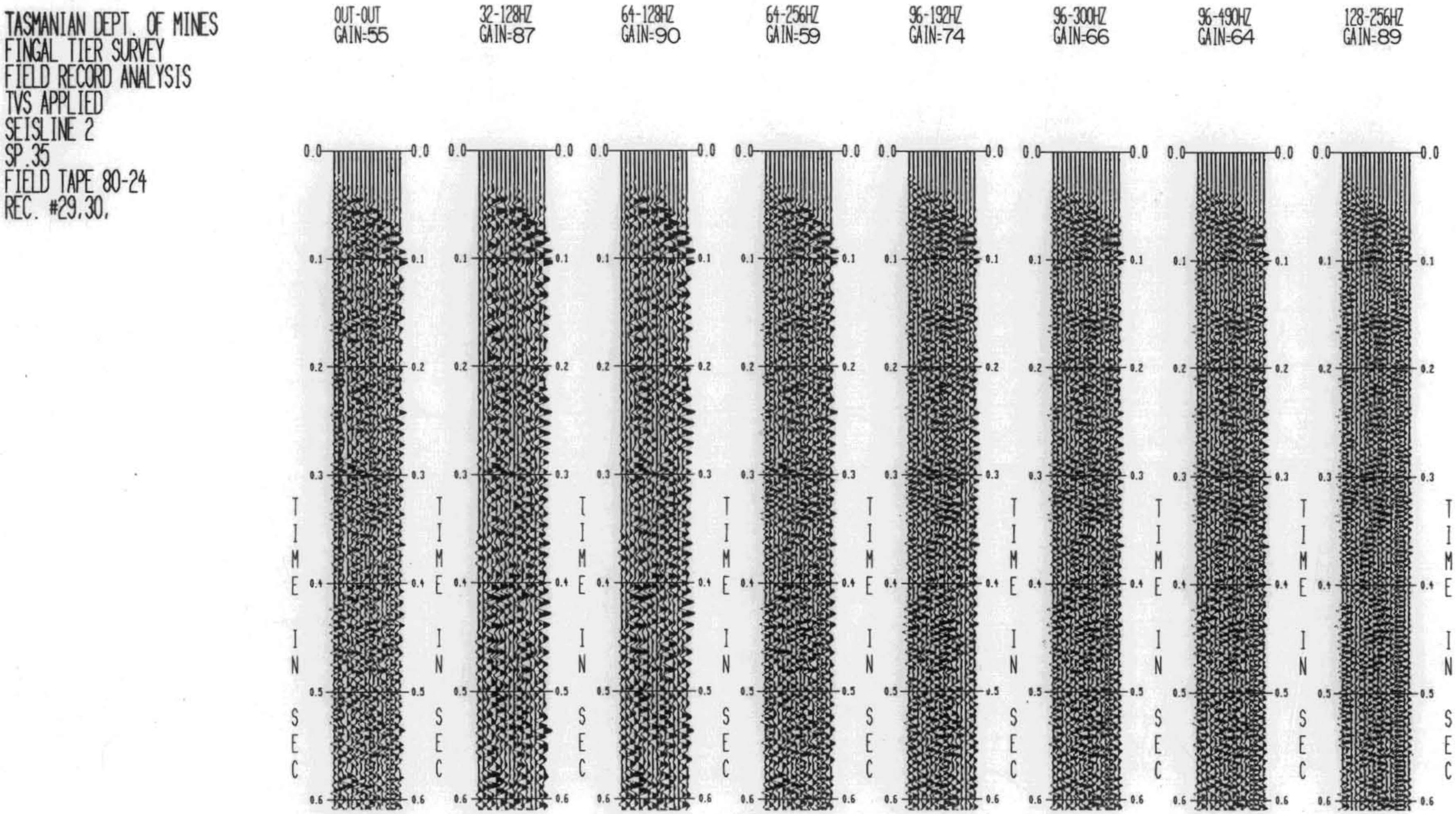


Figure 5. *Filter tests, Traverse 2*

5 cm

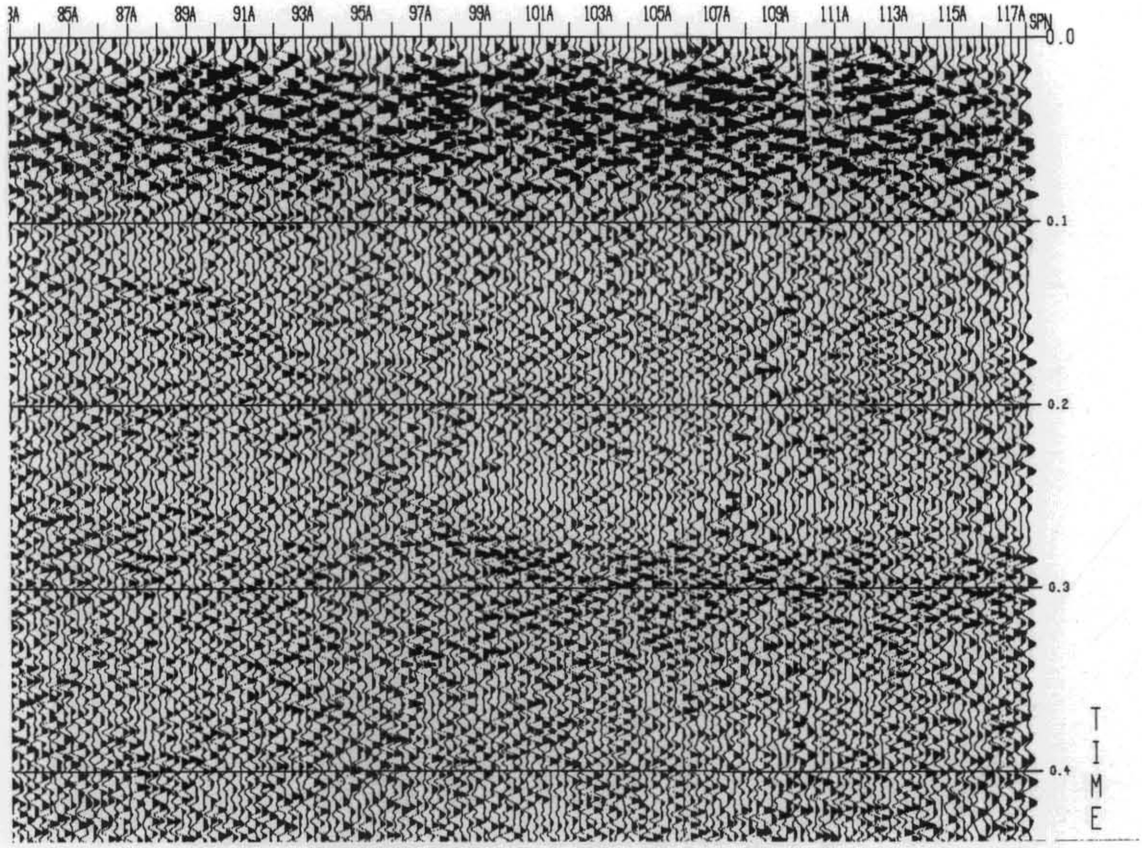


Figure 6(a). *Traverse 2, stack, velocity filtered*

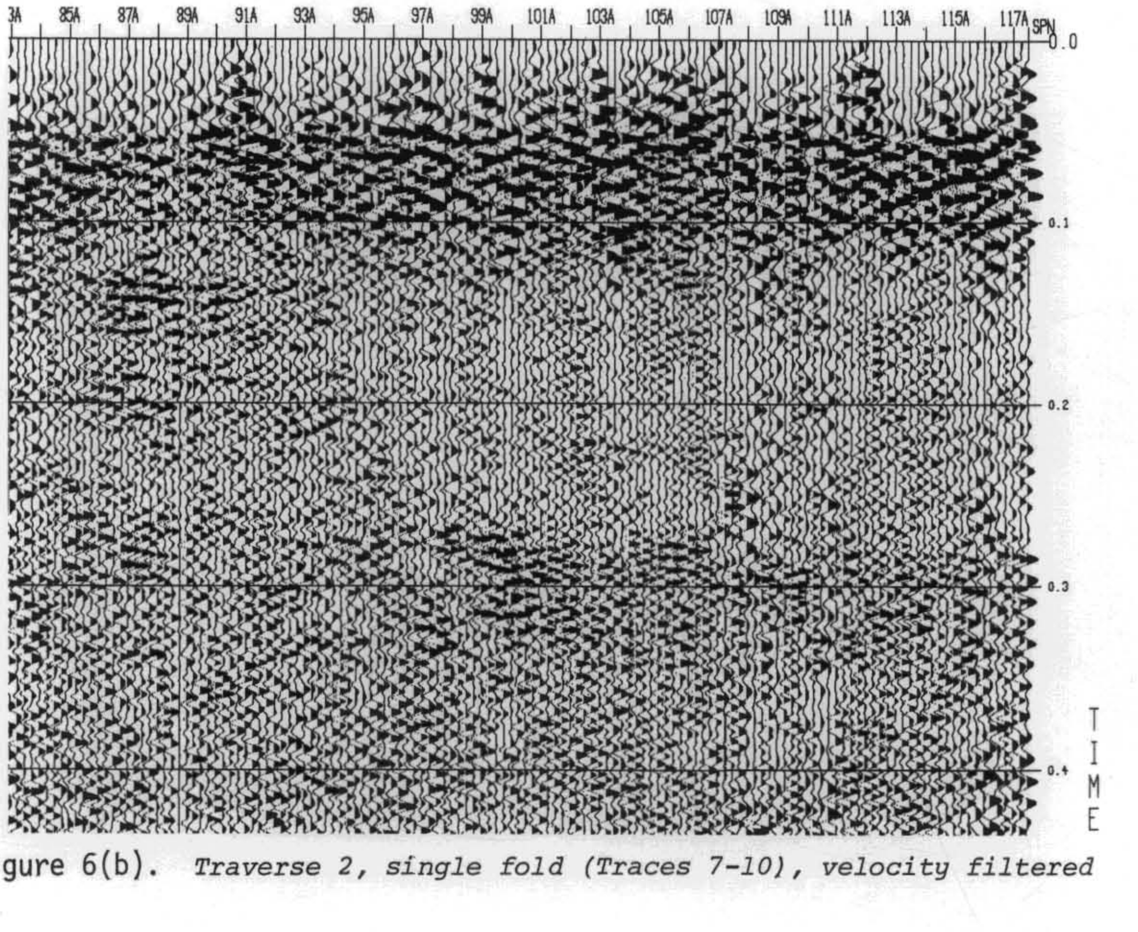


Figure 6(b). *Traverse 2, single fold (Traces 7-10), velocity filtered*

5 cm

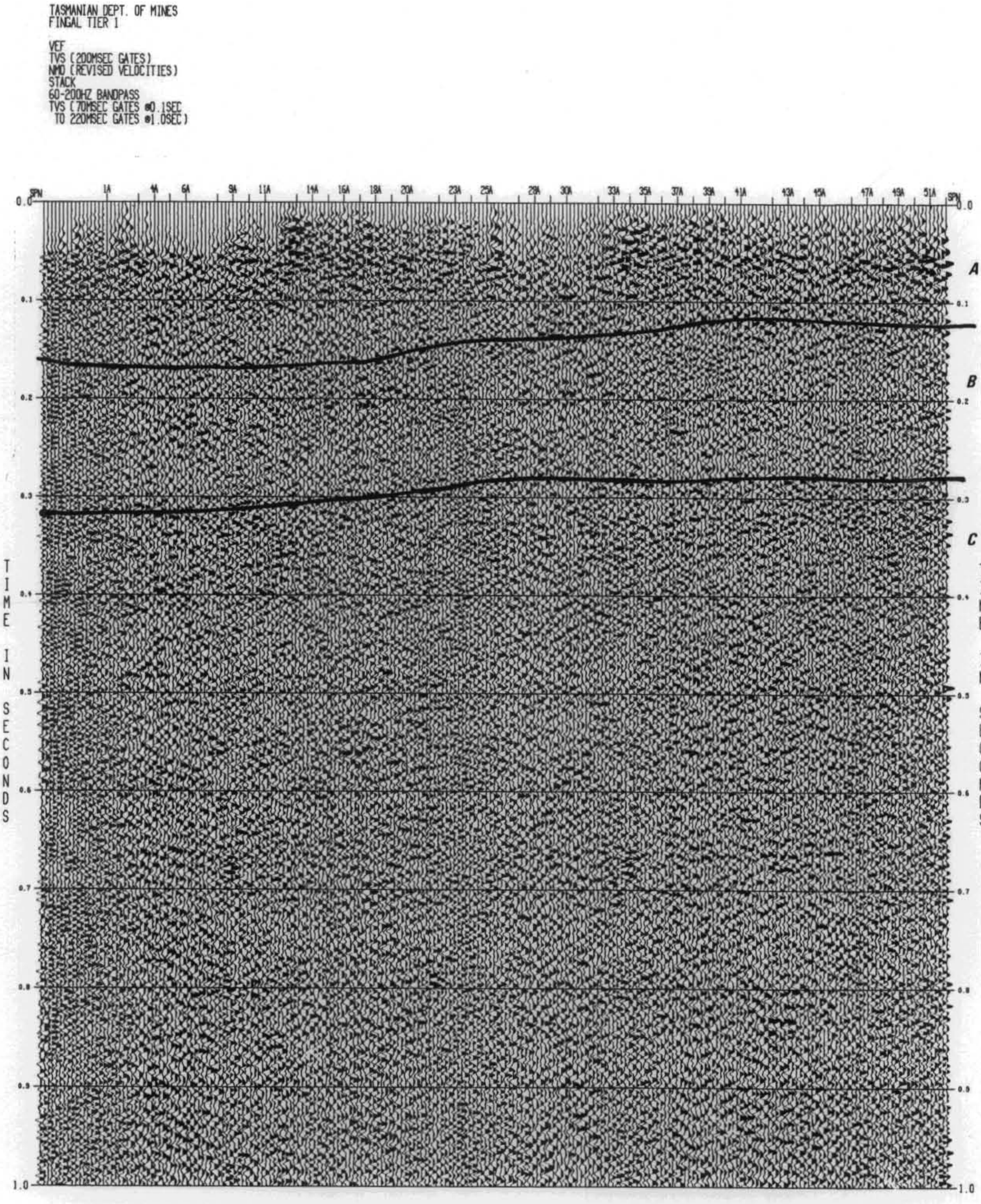
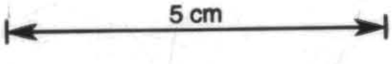


Figure 7. *Interpretation, Traverse 1*



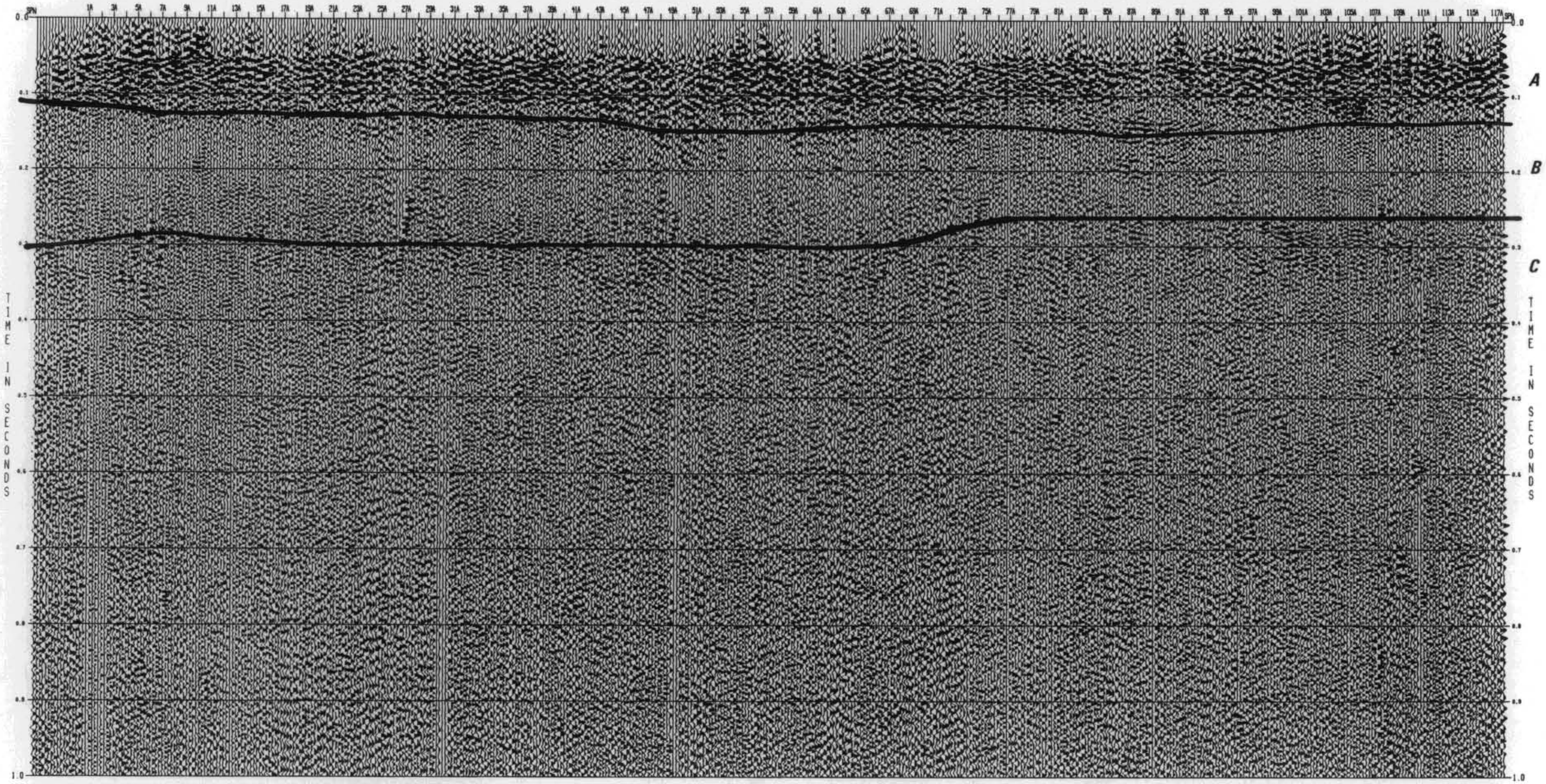


Figure 8. *Interpretation, Traverse 2*