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1980/50. Seismic reflection surveys, Clifton Beach, southern Tasmania

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Abstract

A series of reflection soundings and a reflection traverse with a velocity expander have been fired on the Clifton Beach tombolo in southern Tasmania. Results have confirmed the gravity implication of a deep Tertiary basin with very abrupt edges. At least 450 m of sediments with a velocity of 1400-1700 m/s is indicated.

INTRODUCTION

Previous geophysical work, gravity and seismic refraction, at the Clifton Beach tombolo [EN426404 to EN436410] has been summarised by Leaman (1974) and Leaman (1978). The latter reference (p. 12, 15; figs. 5, 6, 7) describes the preliminary use of the reflection method on the site. Initial reflection surveys were directed primarily at the specification of array and shot conditions in saturated Tertiary materials. The site was selected because the earlier work had suggested the presence of a deep basin, even though some results were conflicting. The refraction survey indicated a high velocity base at less than 80 m, while the gravity survey suggested a basin of more than 500 m depth. The test reflection soundings verified the gravity interpretation and the site was re-occupied to provide a complete profile, evaluate traverse techniques and train crews before applying the method to more normal and awkward situations inland.

RESULTS

Details of the initial reflection tests have been given in Leaman (1978) and are not repeated here. However Figures 1 and 2 reproduce the results of typical soundings and a quasi traverse. A number of reflectors are evident, with suggestions of stratigraphy and basement, even though small spreads and very small charges were used. The records shown in Figures 1 and 2 have been processed using the inbuilt filter facilities of the recording system.

The traverse coverage extended from EN425405 to EN439415 and covered only the western margin of the basin. A total of 42 shots were fired with a shot to Channel 1 offset of 20 m and an array spacing of 10 m. All shots were fired at one metre depth in saturated sand. The coverage was single fold. The shots were recorded using a DHR1632 8-channel system, arrays of 6 x 28 Hz geophones, a sample rate of 2000 per sec. and a low cut (60 Hz) input filter setting at a gain of 72dB. All processing has been done by Geophysical Services International (GSI), Sydney.

An example of field record analysis is shown in Figure 3 for shot point 29. The events at 550 and 600 ms are easily observed and have dominant frequencies between 64 and 192 Hz. Deeper events have arrivals in the range 32-128 Hz. Shallower reflections are more confused but have frequencies in the range 96-256 Hz. Based on such an analysis the following time-variant-filter (TVF) parameters were set (initially).

Low cut 100 Hz, 0-300 ms
64 Hz, 300-end
High cut 220 Hz, 0-350 ms
180 Hz, 350-end

Similarly, wave number noise analysis indicated a frequency pass band from 35 Hz to 270 Hz with a velocity line intersecting the positive and negative wave number axes at 117 Hz. This corresponds to velocity filtering (VEF) for exclusion of apparent velocities within the range -1.2 km/s to +1.2 km/s.

Examination of a brute stack with and without VEF suggested only minor differences. Coherency scaling, attempts to improve near-surface residuals (which are minor), and dip filtering have produced an improved section (fig. 4) in which the gross structure with much interval character, and some diffractions, may be discerned.

Figure 5 presents the processed form of a single expanded spread fired near the centre of the basin. Many reflectors are evident and a velocity analysis, covering the range 1000-2000 m/s, was undertaken. This demonstrated that a wide velocity range was applicable to the materials within the basin and may be summarised as follows:

0- 50 ms:	average velocity implied, 1500 m/s;	interval velocity 1500 m/s
50-100 ms:	average velocity implied, 1750 m/s;	interval velocity 1970 m/s
100-200 ms:	average velocity implied, 1550 m/s;	interval velocity 1320 m/s
200-300 ms:	average velocity implied, 1400 m/s;	interval velocity 1040 m/s
300-400 ms:	average velocity implied, 1500 m/s;	interval velocity 1770 m/s
400-550 ms:	average velocity implied, 1550 m/s;	interval velocity 1680 m/s
550-650 ms:	average velocity implied,>1750 m/s;	interval velocity >2590 m/s
650- ms:	uncertain	

Finally, Figure 6 presents a migrated stack incorporating velocity filtering, scaling with 200 ms gates, NMO statics, filters of 100-200 Hz 0-250 ms, 80-200 Hz for 250-300 ms, 64-180 Hz for 300 ms - ; 100 ms scaling gates. Migration using the indicated velocity profile has greatly improved the appearance of most of the section.

INTERPRETATION

The overall form of the basin and much internal structure is evident in Figure 4. The velocity analysis is not clear in the region 550-650 ms, but either event in the centre of the basin may represent 'basement'. As shown in Figures 4 and 6 the 550/650 ms "event" is made up of a train of high amplitude arrivals. It is possible that the basement lies within the train as suggested by the group character after migration (broken line, fig. 7). Figure 3 clearly shows the multiple reflector character at the base of the section, with events at 550 and 610 ms.

Migration has clarified many aspects of the section. At about 75 ms there is an abrupt change from current bedded structures to a layered structure. This corresponds to the higher velocity (>1970 m/s) unit and is consistent with the refraction data. The material may be a thin volcanic flow or cemented gravel whose 2400 m/s velocity terminated the refraction application. The bulk of the section, including the basal region (550-650 ms), shows normal sedimentary character. There is little evidence for other strong, continuous reflectors.

The velocities determined suggest a maximum sediment thickness of about 450 m to the first major event in the basal train near the centre of the basin (550 ms). The estimate could be increased by as much as 70 m if the true event is nearer 650 ms. Either estimate (450, 520 m) is consistent with the gravity result of 500+ m based on an average density of 1.97 t/m^3. Such a density would be compatible with the poorly consolidated materials implied by the average velocities. Interval velocities based on the average velocities observed suggest that the upper part of the section is dominated by sand (velocities 1300-1500 m/s), while the lower part is predominantly clay (v = 1650-1800 m/s). The central low velocity portion of the section may contain substantial amounts of organic matter, possibly in the form of lignite. It must be noted that the velocity determinations (average) have been made on unambiguous events in the record and the time bands ascribed may be a little coarse in some cases. For example, the high velocity band (nominally 50-100 ms) varies from about 60-90 ms across the body of the record, presuming the response character of units above and below is truly represented, in which case the interval velocity would be about 2200 m/s. A band narrowing of this type would increase the interval velocity. Similarly the low velocity band may be thicker than implied, in which case the interval velocity of the band would be greater and that of the interval below lowered.

A number of faults are suggested by disruption of reflectors (see figs. 4, 6). These possible structures, which affect both the edge and contents of the basin are shown in the interpretation summary (fig. 7).

CONCLUSIONS

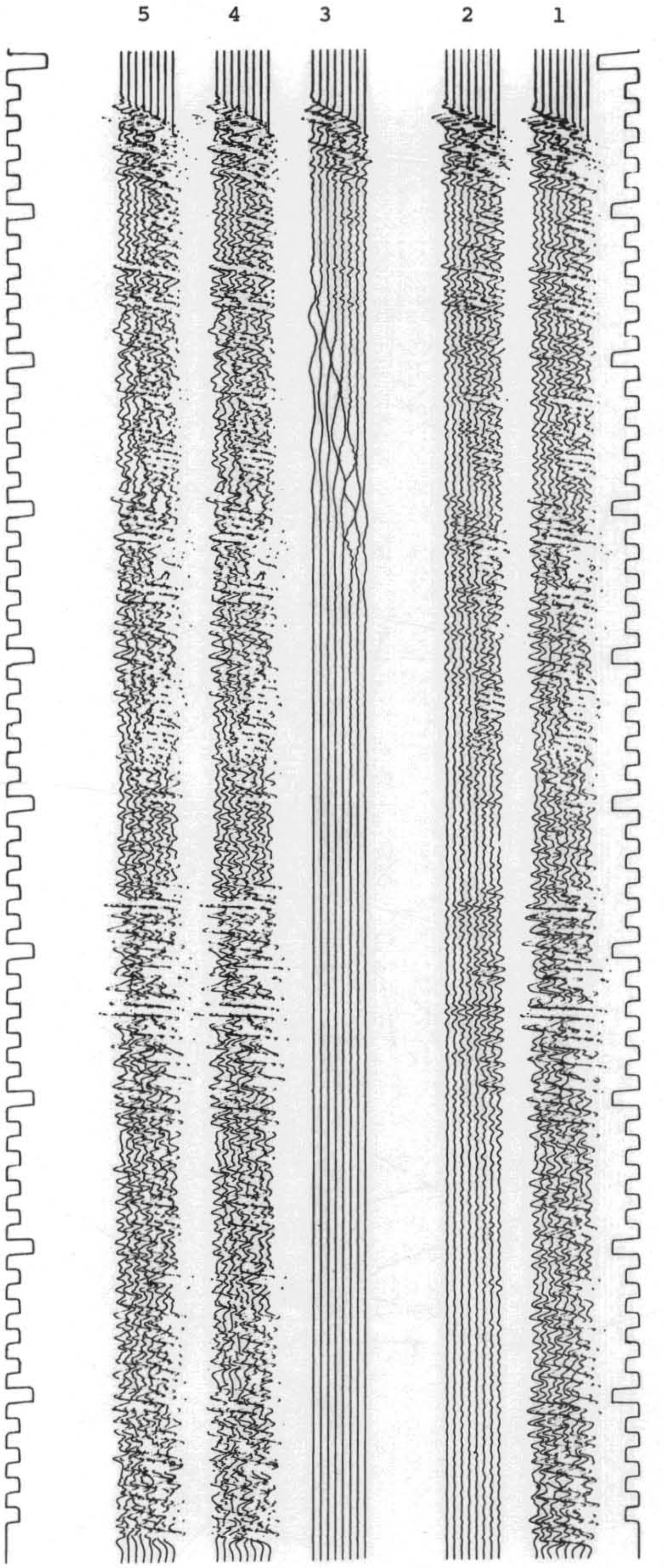
The reflection method offers an objective means of assessing the form and content of Tertiary basins even though basin edge interference effects may be serious. A multifold coverage need not improve the processed results, but high frequency geophones (28 or 40 Hz) and small shots are recommended. Shot holes should be deep enough to avoid surface variations.

REFERENCES

LEAMAN, D.E. 1974. Geophysical survey, Pipeclay Lagoon, South Arm. *Tech. Rep.Dep.Mines Tasm.* 17:110-112.

LEAMAN, D.E. 1978. Use of the reflection method in Tasmania. Part 1: Equipment, techniques and problems. *Geophys.spec.Rep.Dep.Mines Tasm.* 7.

[11 December 1980]



a = 5, S = 25, g<1,
SR = 2000

1. IF = LL; 6 detonator stack; PBF = LM + HH + AGC + PGC (=36dB)

2. IF = LL; 6 detonator stack; PBF = LM + AGC

3. IF = O; Gain test. 60-72dB

4. IF = O: 3 detonator stack; PBF = LM + AGC + 36dB

5. IF = O: 3 detonator stack; PBF = LM + AGC + 36dB

Figure 1. *Reflection sounding, Clifton Beach (centre)*

5 cm

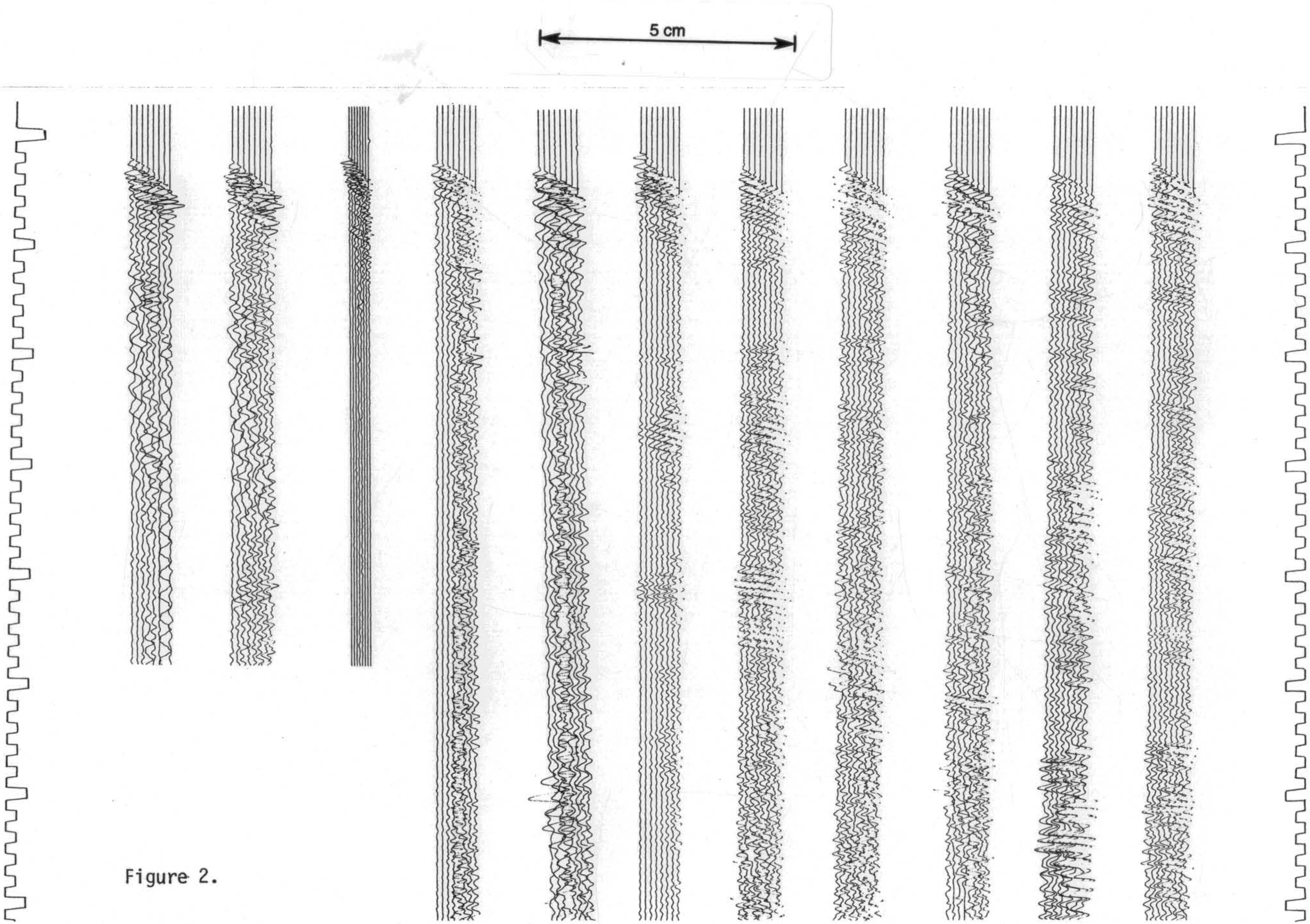
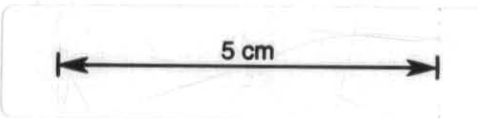


Figure 2.

a = 5, S = 25, g<0.5

1. IF = LL, G = 72dB, one detonator, PBF = LM + HH + AGC + 24dB
2. IF = LL, G = 72dB, three detonator stack, PBF = LM + HH + AGC + 36dB
3. IF = LL, G = 72dB, one detonator, PBF = 0, (reduced trace spacing)
4. IF = LL, G = 60-72dB, four detonator stack, PBF = LH + HH + AGC + 18dB
5. IF = LL, G = 60-72dB, four detonator stack, PBF = LM + HH + AGC + 18dB
6. IF = LL, G = 60-72dB, two detonator stack, PBF = LH + HH + AGC + 18dB
7. IF = LL, G = 60-72dB, four detonator stack, PBF = LH + HH + AGC + 36dB
8. IF = LL, G = 48-60dB, four detonator stack, PBF = LM + HH + AGC + 18dB
9. IF = LL, G = 60-72dB, two detonator stack, PBF = LM + HH + AGC + 18dB
10. IF = LL, G = 60-72dB, one detonator, PBF = LM + HM + AGC + 36dB
11. IF = LL, G = 60-72dB, two detonator stack, PBF = LH + HH + AGC + 18dB

Figure 2. *Reflection traverse, Clifton Beach*



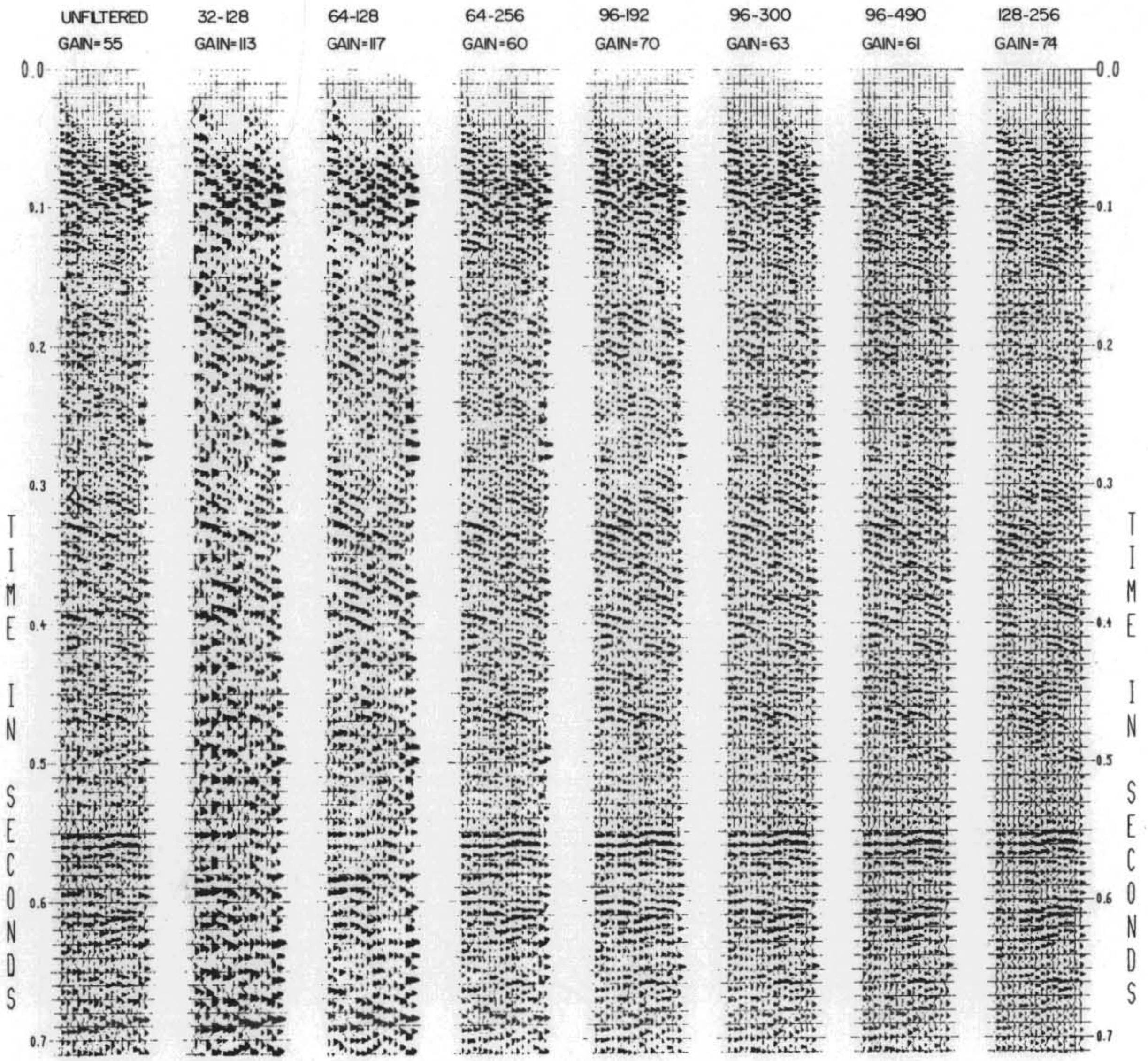


Figure 3. *Field record analysis, SP 29*

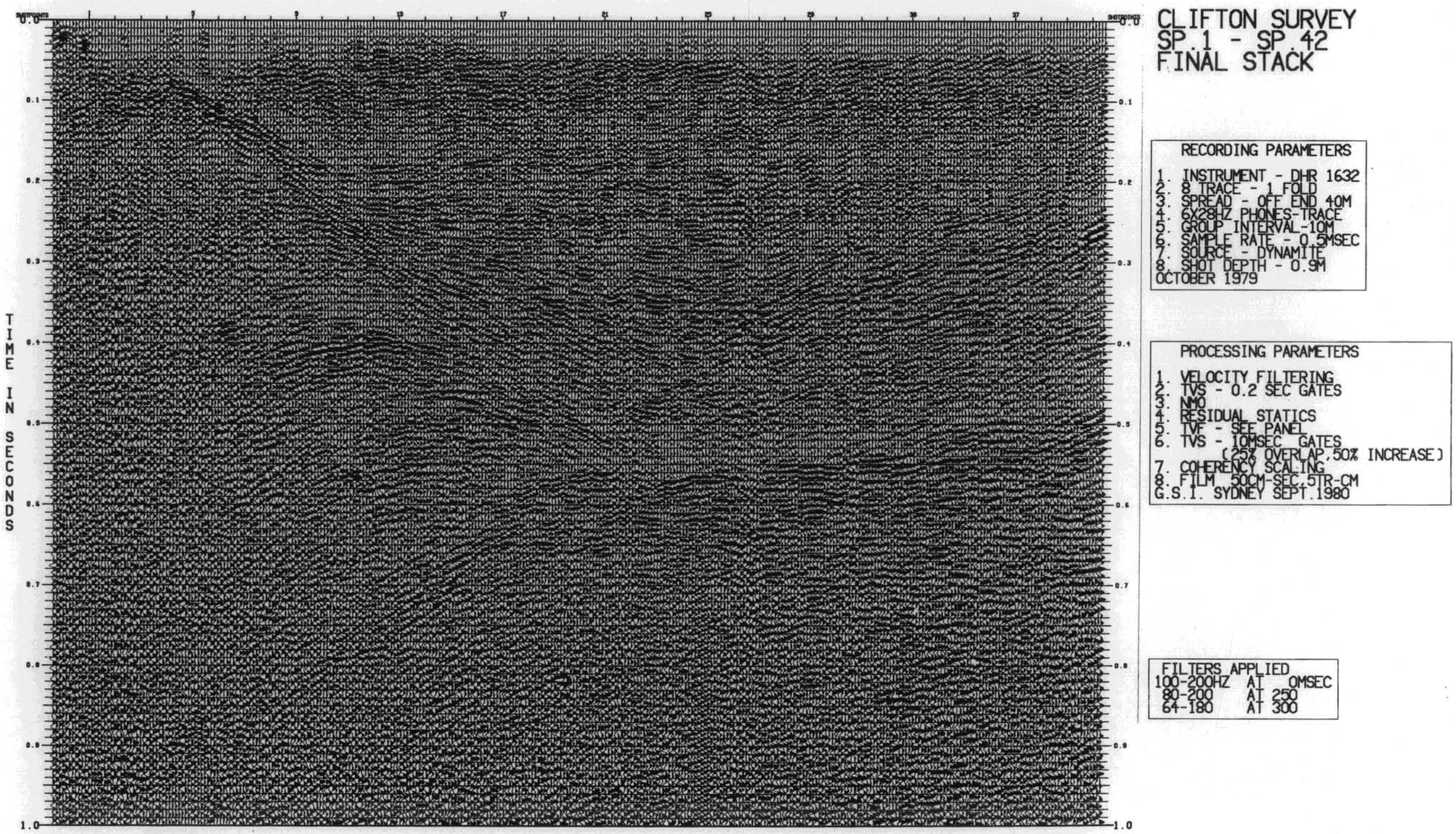
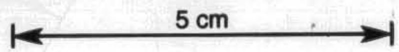


Figure 4. *Final section*



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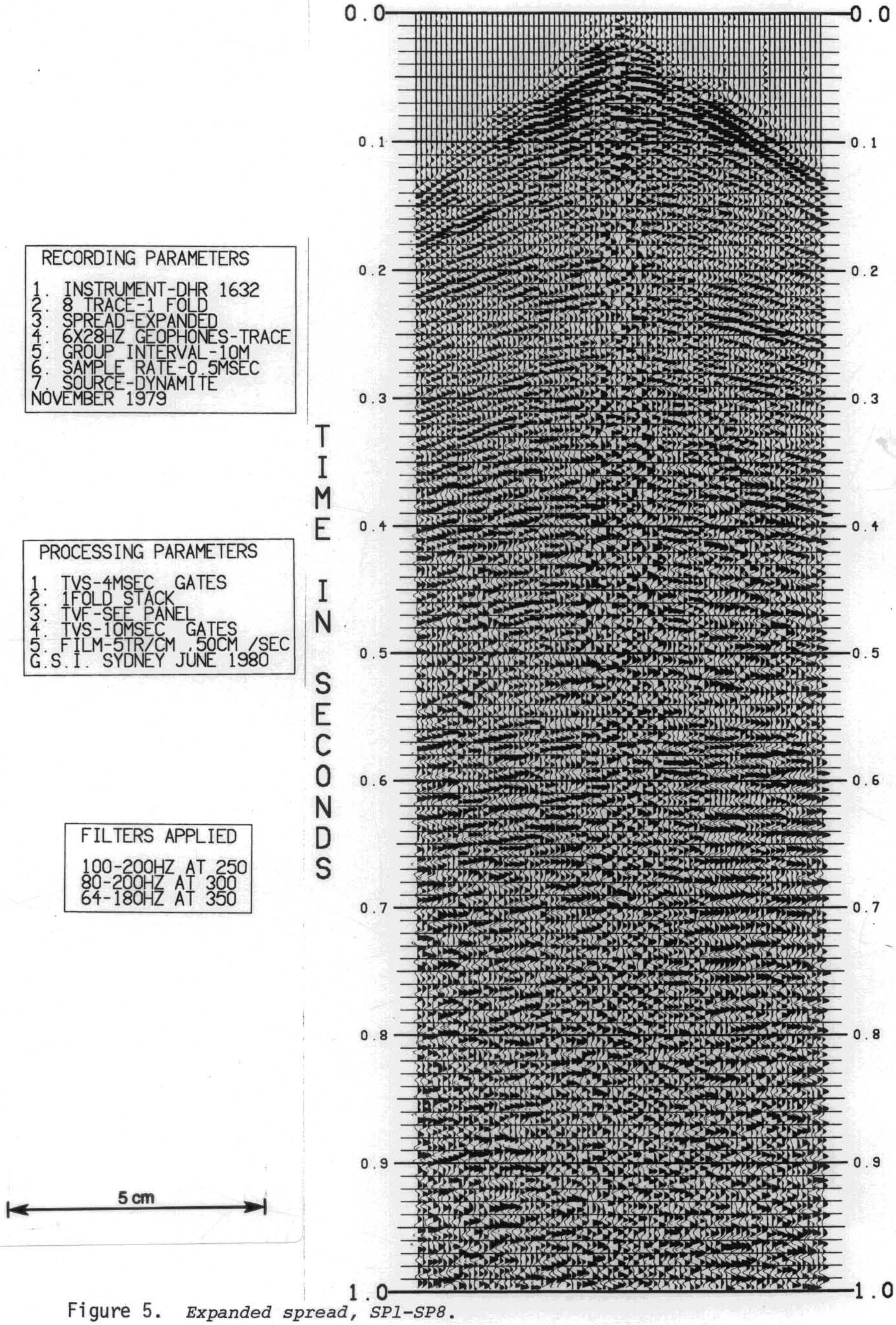

Figure 5. *Expanded spread, SP1-SP8.*

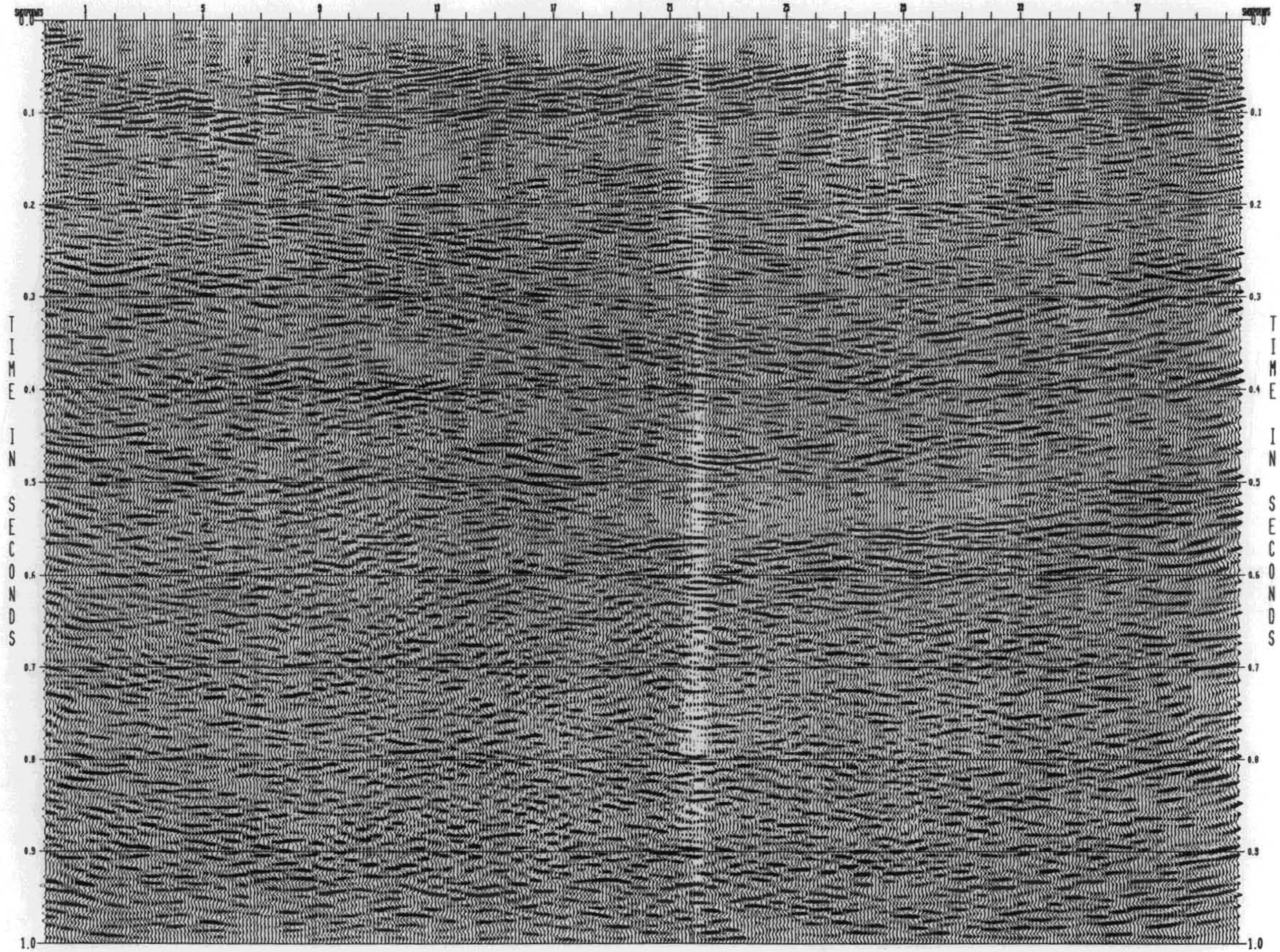

Figure 6. *Migration section*

5 cm

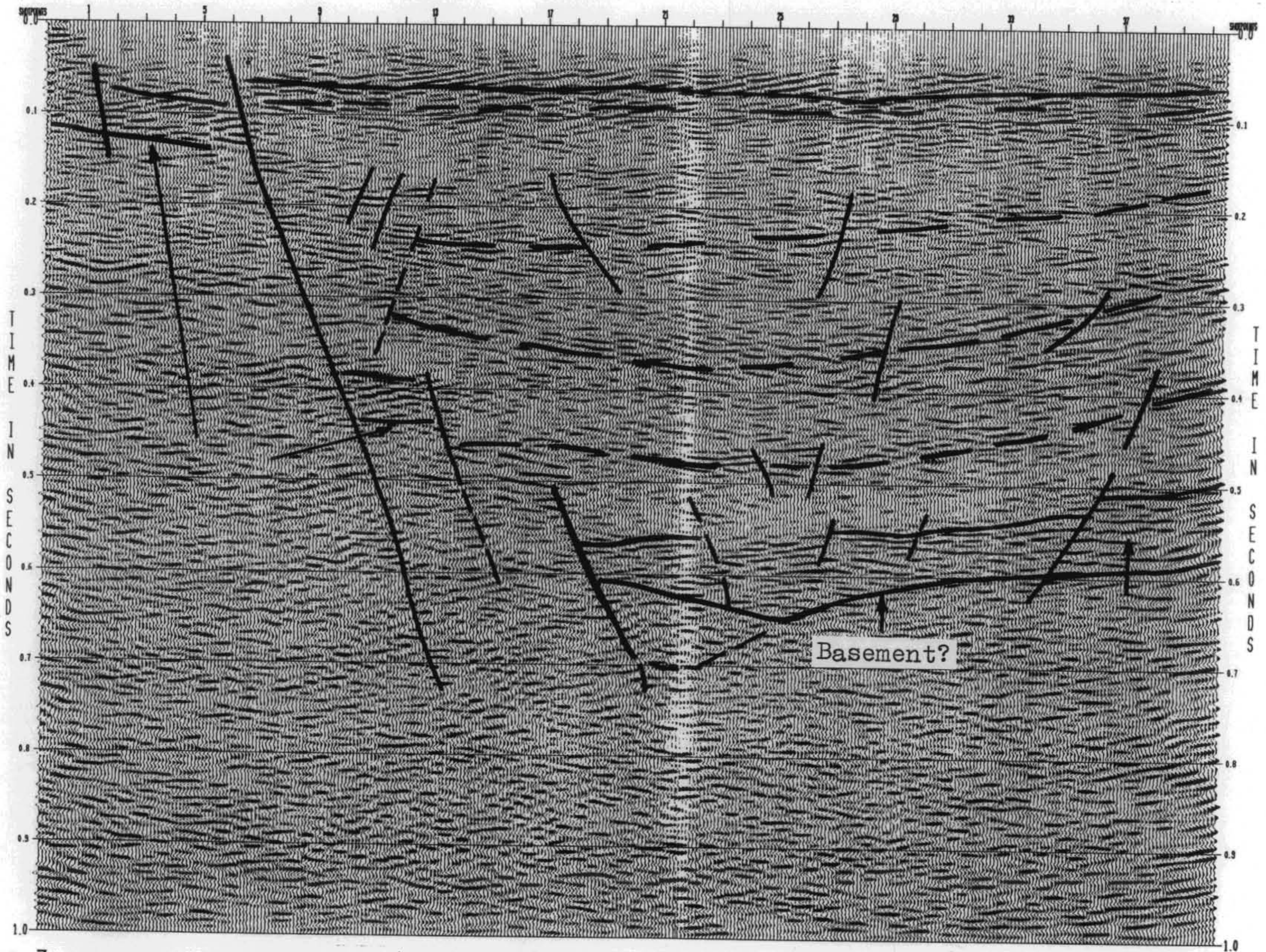

Figure 7. *Possible interpretation, Clifton section*