DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1973/65

HIGH-RESOLUTION SEISMIC PROFILING SURVEY OF PORT PHILLIP BAY NEAR THE CITY OF MORDIALLOC, VICTORIA 1972

by

B.H. Dolan

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ILLUSTRATIONS

1. INTRODUCTION

The Melbourne and Metropolitan Board of Works (MMBW) is investigating a suggestion that the beach from Mentone to Parkdale be reclaimed by dredging sand from offshore. As a first step in the investigation the Board's engineers and geologists considered that geophysical profiling of the bay bottom should be carried out.

The area selected for this survey was 3 km long parallel to the City of Mordialloc shoreline and between 0.3 km and 0.5 km offshore.

MMBW requested assistance from the Bureau of Mineral Resources, Geology and Geophysics (BMR). As a result a party from BMR made a seismic profiling survey in the area in October 1972.

The party consisted of B.H. Dolan (geophysicist and party leader), B. Devenish (geophysicist and electronics adviser), P. Mooney (technical officer) and S. Hall (field assistant). A modified 'Sparker' system, a modified 'Boomer' system, and a Raytheon 3.5 kHz Profiling system were used. Bottom sampling was done with a scoop loaned by the Marine Geology group of BMR.

The boat Investigator and supporting staff, were supplied by the MMBW. Surveyors and shore control were also provided by MMBW.

2. GEOLOGY

The geology of the area is described by Kenley (1967). Tertiary sand and sandstone crop out in the nearby area. These form prominent cliffs, e.g. Red Bluff and Rickett Point.

Some borehole data near the survey area (Plates 2, 3) were obtained by Esso-BHP during the geological investigation for a pipeline. The boreholes were drilled to a maximum depth of about 6 m. The sediment recovered ranged from fine sandy silt to gravel. Friable sandstone from within this depth was recovered from boreholes Nos. 19, 23, and 24.

3. METHODS AND EQUIPMENT

Three seismic profiling systems were employed. They are termed 'Sparker', 'Sonar Boomer' and 'Ringer'.

The principles of operation of each are basically the same. A pressure pulse is introduced into the water by a transducer towed from the boat. This pulse is transmitted through the water at a known velocity

1.5 km/s. At the bottom some energy is reflected back to the boat and some is transmitted through the sediment. Further reflections will be at the boundaries between media of differing acoustic impedance, e.g. between sediment and rock (Sargent, 1969; Taylor Smith & Li, 1966).

The reflections are received by a pressure-sensitive transducer. The signal is then frequency filtered, amplified, and recorded on an electrosensitive paper recorder. The time between the transmission and reception of the pulse is recorded graphically. The pulses are transmitted regularly at intervals of 0.6 seconds. Reflections from a continuous horizon are then recorded continuously on chart paper and a profile of that horizon is drawn.

The Sparker employs an electric discharge in the water to produce the pressure pulse. This pulse is due to the sudden production of gases around the electrode in the water.

The Boomer consists of an insulated flat, heavy-guage copper coil with an aluminium disc held against it by a spring. Again it is activated by an electric discharge, but in this case the discharge is via the coil. The aluminium disc is repelled suddenly by the magnetic fields, resulting from induced eddy currents in the aluminium disc.

In both the above systems the electric discharge comes from a bank of large capacitors charged to 4 kV, with a stored energy of 0.4 kJ. The time for discharge is less than 1 ms and the discharge is triggered by the recorder. Both systems are capable of deep penetration (to about 100 m) in unconsolidated sediments and can penetrate, to a lesser extent, some sedimentary rock.

The Pinger used on this survey consisted of a Raytheon 3.5-kHz PTR-105A transceiver with a Massa TR-75A piezo-electric transducer. The PTR produces a 3.5 kHz signal for a period of 1-2 ms. This is triggered by the recorder and excites the transducer, which introduces a 3.5-kHz acoustic signal into the water. The reflections are received by the same transducer, converted to electric signals and are then received by the PTR transceiver, which is designed to pass only 3.5-kHz signals. This reduces recorded noise level.

The Pinger used has a much lower peak pressure output than the Sparker (0.01-0.02 bar at 1 m compared with 0.8 bar at 1 m). It is designed for higher resolution between layers of unconsolidated sediment, but its depth of penetration is much lower.

The horizontal scale used for the profiles and the position of traverses is the same (4800:1). The vertical scale is derived from the time for reflections to be received using a velocity for sound in sea water of 1.5 km/s. This gives a vertical exaggeration of about 16:1.

A velocity of 1.5 km/s would be within 5 percent of the actual value for water in the area, but would be low for the velocity in the sediments (Taylor, Smith & Li, loc cit.; Shumway, 1960). Sediment with a mean grain diameter of 0.25 mm can have a velocity of about 1.8 km/s, and coarser sediments would have even higher velocities. The depths given in the interpretation are therefore minimum depths.

The position fixing was done by MMBW Surveyors, from a number of theolodite stations established around the survey area. These are marked in Plates 2 and 3. Fixes were obtained generally at 2-minute intervals. These fixes were synchronized by radio with event marks on the seismic records.

4. RESULTS

The location of the survey area is shown in Plate 1. The positions of the Sparker traverses, Boomer traverses, bottom samples and Esso-BHP's boreholes are shown in Plates 2 and 3. A sample record and interpretation is shown in Plate 4. The seismic cross-sections are shown in Plates 5 and 6. Pinger records are not shown because they lacked useful information.

Two types of reflections can be identified on the records. Firstly a series of strong, continuous, almost parallel reflections from an average depth about 8 metres below bottom. This series can be identified over most of the survey area. Secondly there is a series of weaker, discontinuous reflections between the strong reflections and bottom. (Plates 4 to 6).

It is considered that the strong reflections arise from sandstone layers and that the weaker reflections arise from boundaries between sediment of different compositon and in some places possibly from layers of friable sandstone.

The weak reflections indicate that there is only a small difference in the acoustic impedance of adjacent layers of sediment. This means that the contrast in grainsize across the boundary is not very marked (Taylor Smith & Li, loc cit.).

The results of Esso-BHP drilling near the area show that mostly sand with some silt, clay, and gravel occur to a depth of about 4.5 m. These boreholes yielded sediments similar to the bottom samples obtained in the survey area (Table 1), which were analysed by J. Marshall of the Marine Geology Group of BMR.

On some traverses the Boomer records show the deeper reflections more clearly. This is because the reflections from the overlying boundaries are weaker and these reflections and their associated energy do not interfere with the deeper reflections. Generally, however, the Sparker records show the shallower reflections more clearly, but there is no obvious reason why this is so.

The Pinger yielded little useful data, for several reasons. Firstly the attenuation through the sandy, silty, sediment at this frequency was too great for the Pinger to record the deeper reflections. Secondly it was relatively low power output. Thirdly the lack of distinct sediment layers resulted in poor, inconsistent reflections from the overlying sediment. The attenuation in such sediment could be of the order of 2 dB/m at about 3 kHz (McCann & McCann, 1969).

It is considered that a more powerful Pinger system with a larger transducer, or an array of transducers, may have recorded the bedrock surface. Such a system would be lighter than the Sparker or Boomer and more convenient to operate from a small vessel.

A possible filled-in channel is indicated on traverses 'B' and 'C' between Boomer fixes B2 and B3 and next to Boomer fix C6.

The strong reflections deepen towards the northwestern end of the survey area.

TABLE 1

DESCRIPTION OF BOTTOM SAMPLES OBTAINED DURING THE MORDIALLOC BEACH MARINE SURVEY

by J. Marshall (BMR)

Sample No.	Description
5/10/72 1	Gravelly sand mainly well sorted coarse sand size quartz with minor abraded shell material and possibly some silt.
5/10/72 2	Fine to medium sand mainly quartz with minor comminuted shell fragments. Possibly some silt.

Sample No.	Description
5/10/72 3	Gravelly sand with quartz grains of granule to coarse-sand size and rock fragments, together with a fair proportion of coarse abraded shell material, and some silt.
5/10/72 4	Coarse quartz sand with minor abraded shell material and some silt.
5/10/72 5	Gravelly sand with quartz grains of granule and coarse sand size and rock fragments together with comminuted shell fragments (minor). Some fine sand to silt-size material is also present.
5/10/72 6	Silty sand consisting mainly of fine to medium quartz sand with larger abraded shell fragments and grey-brown silt.
5/10/72 7	Silty sand with quartz grains of medium to coarse sand size and shell fragments with minor grey-brown silt (and/or clay). Black staining due to decay of organic material.
5/10/72 8	Medium to coarse quartz sand with some abraded shell material and silt. Black staining due to organic decay.
5/10/72 9	Silty sand with fine to medium sand-size quartz and minor finely abraded shell material, together with grey-brown silt.
5/10/72 10	Silty sand with fine to medium quartz sand with a fair proportion of grey coloured silt (and/or clay).

5. CONCLUSIONS

Reflections which are considered to originate from the sandstone bedrock were recorded over the survey area. The maximum depth below bottom to top of these reflections is about 12 m. The overlying material is considered to be mostly sand with various amounts of gravel, silt, and clay and some decomposed sandstone.

6. RECOMMENDATIONS

It is recommended that drilling on the traverse lines be used to correlate the seismic reflectors with sediment boundaries and rocks surfaces. Three locations are suggested:

(i) Near Boomer fix E4 where the deep reflector is strong and very regular and the shallower reflectors are weak.

(ii) Near Boomer Fix C6 where a possible channel is indicated.

(iii) Near Boomer fix A3 where the reflectors are very irregular a dip more steeply.

7. REFERENCES

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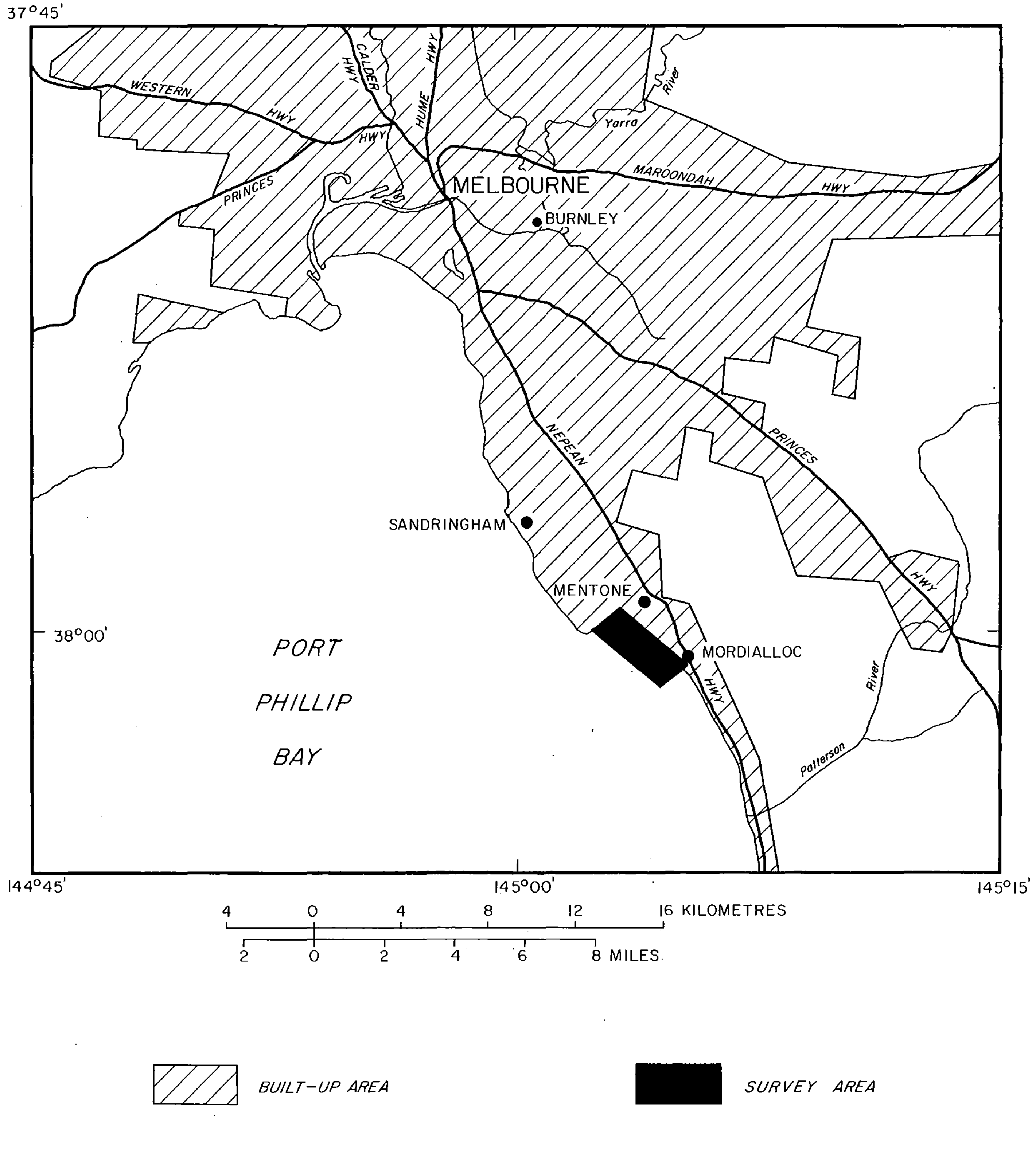
PLATE 1



LOCALITY MAP

To accompany Record No. 1973/65

J55/B5-89A

PLATE 2

BEAUMARIS BAY
BEACH ROAD
MENTONE PARADE
CHARMAN ROAD
SEA PARADE
MARINA ROAD
MUNDY STREET
PLUMMER ROAD
STREET
KITCHENER
MARIGOLD ROAD
ANTHES STREET
BIRDWOOD STREET
PARKERS STREET
HERBERT STREET
Mc INDOE PARADE
RENNISON STREET
BAY STREET
HIGH STREET
CENTREWAY
WELLS ROAD
Terminal point
NEF 1
NEF 2
NEF 3
LOCATION OF SPARKER TRAVERSE
100 0 100 200 300 400 METRES
200 0 200 400 600 800 1000 1200 FEET
⊕ ESSO - B.H.P Bore holes
To accompany Record No. 1973/65
J55/B5-91

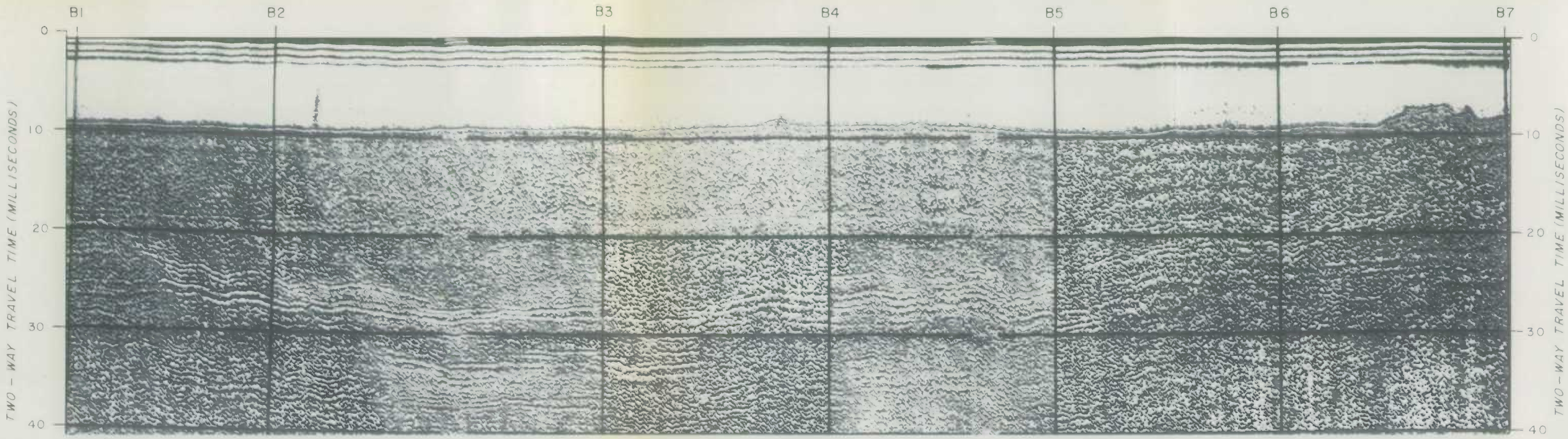
LOCATION OF BOOMER TRAVERSE

To accompany Record No. 1973/65

J55/B5-93

PLATE 4

RECORD



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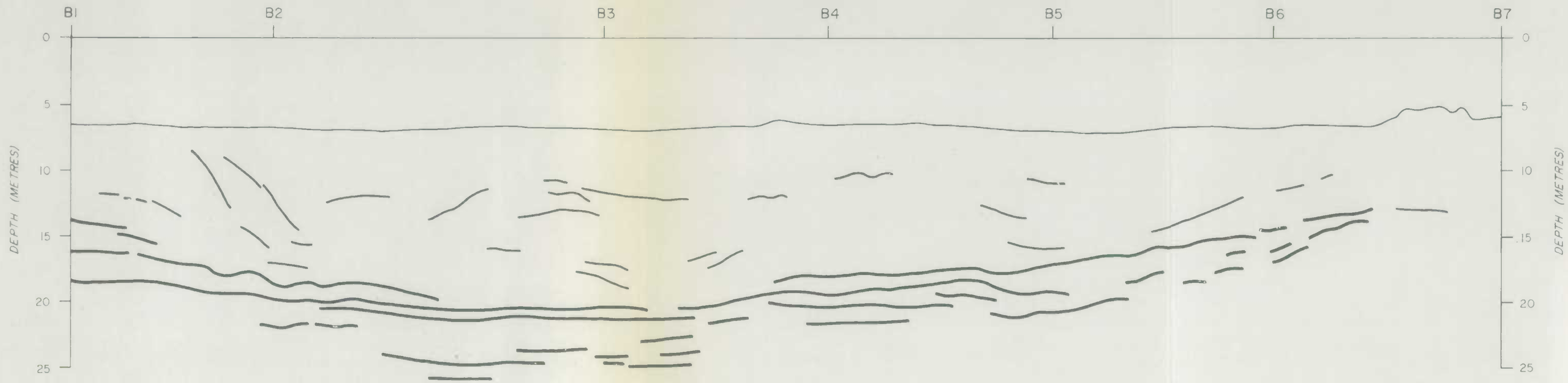

BOOMER RECORD B

100 50 0 100 200 300 METRES

(APPROXIMATE ONLY)

B 5 *Traverse fix number*

Strong Sub-bottom reflections

Bottom reflections

Weak Sub-bottom reflections

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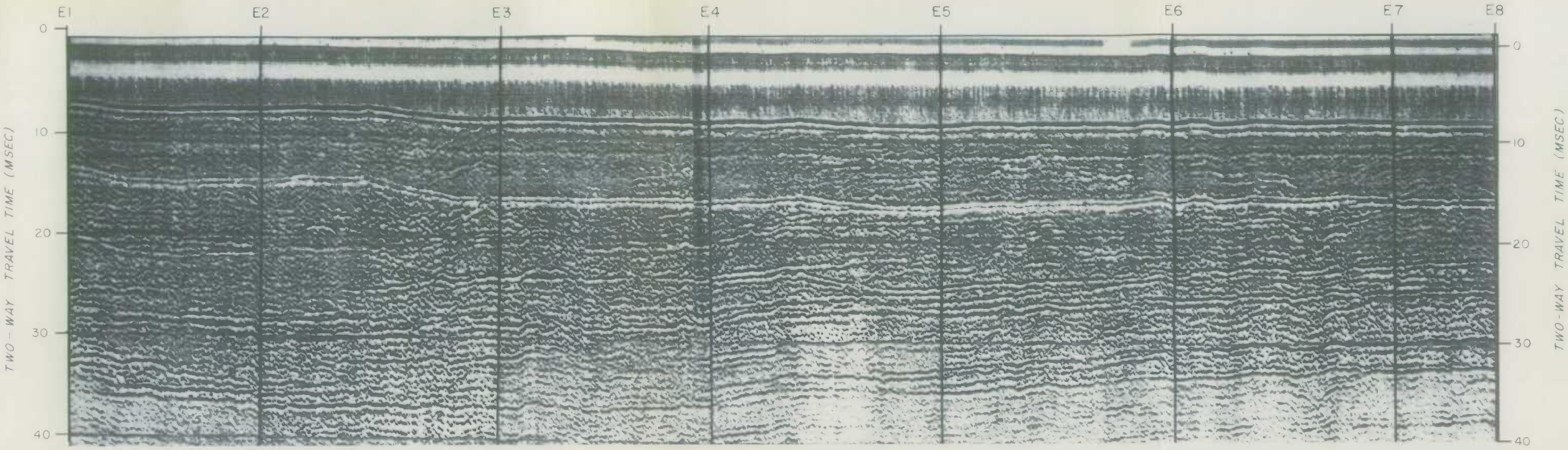
PLATE 5

RECORD



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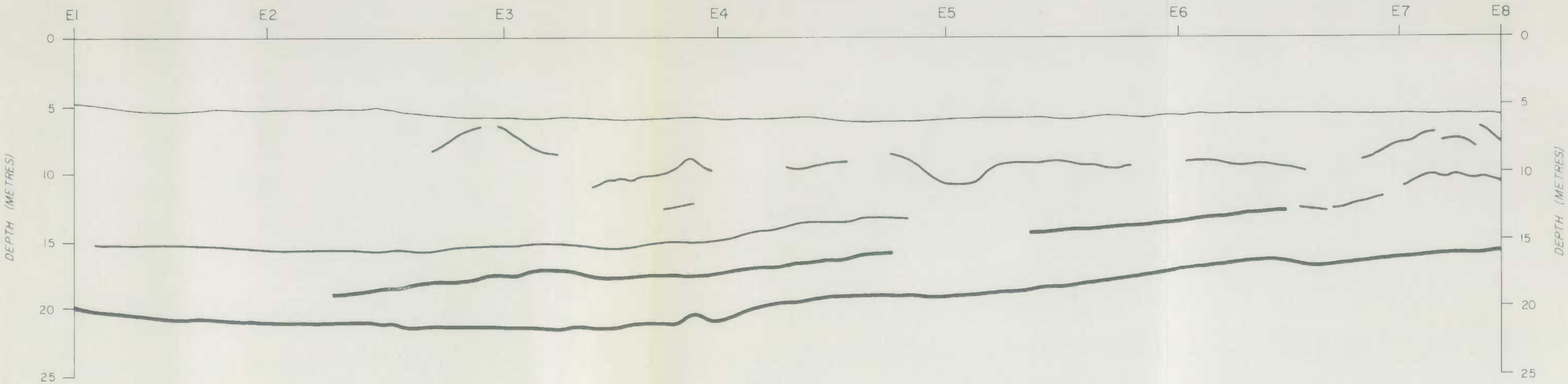


SPARKER RECORD E

100 50 0 100 200 300 METRES

(APPROXIMATE ONLY)

E6 *Traverse fix number*

Strong Sub-bottom reflections

Bottom reflections

Weak Sub-bottom reflections

To accompany Record No. 1973/65

J55/B5-94

SPARKER CROSS-SECTIONS

100 0 100 200 300 400 METRES

200 0 400 800 1200 FEET

F5 *Traverse fix numbers*

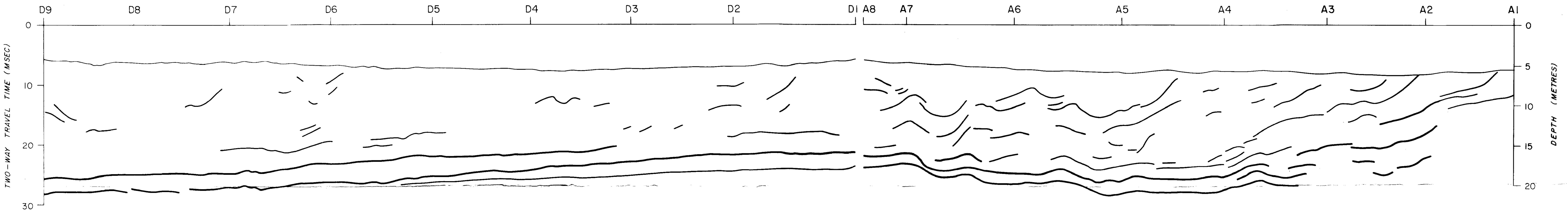
Strong Sub-Bottom Reflections

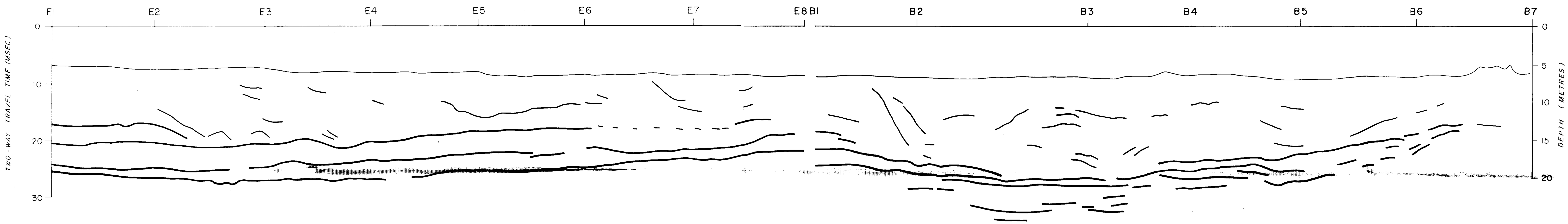
Bottom Reflections

Weak Sub-Bottom Reflections

To accompany Record No. 1973/65

J55/B5-92





BOOMER CROSS-SECTIONS

100 0 100 200 300 400 METRES
200 0 400 800 1200 FEET

F5 *Traverse fix numbers*

Strong Sub-Bottom Reflections

Bottom Reflections

Weak Sub-Bottom Reflections