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1986/15. Seismic refraction survey at the site of a proposed submarine facility, Margate

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Abstract

A seismic refraction survey conducted at the site of a proposed submarine facility, Margate, indicates that a 34-62 m thickness of Tertiary age sediments overlie basement rocks. The Tertiary sediments are unlikely to provide adequate end bearing capacity for heavily loaded piles but will develop significant frictional resistance to suitably designed driven piles. End bearing capacity will be obtained by piles driven to the basement rocks.

INTRODUCTION

At the request of Gutteridge, Haskins and Davey Pty Ltd a seismic refraction survey was undertaken in North West Bay, Margate, in an attempt to provide some design constraints for a possible submarine facility. The survey comprised four over-water seismic traverses and a single land traverse. Difficulties were encountered in maintaining the over-water traverses in position due to longshore currents, winds and poor anchorage of the hydrophone cable. As a consequence, the reliability of all but one of the over-water traverses is low.

GEOLOGY

The geology of the site has been reviewed by Paterson and Underwood (1984). In summary, the area is covered by Tertiary sediments which were deposited on a basement of either Permian sandstone and siltstone or Jurassic dolerite. Tertiary basalt may or may not be present at the proposed site.

SEISMIC REFRACTION SURVEY

The approximate locations of the seismic traverses are shown on Figure 1. Table 1 provides a summary of the results. A more detailed analysis has been possible for traverses 1 and 5.

The on-land survey (traverse 5) revealed an upper layer of 500 m/s material which is interpreted as moist loamy silty topsoils or clayey topsoils. It is calculated to range in thickness between 2.6 and 4.4 m. The material is expected to have low unconfined compressive strengths (in the range 50-150 kPa). The underlying layer velocity of 1680 m/s is interpreted to represent wet sandy clayey materials. These might be expected to have unconfined compressive strengths in the range 200-400 kPa. The main refractor recorded a velocity of 3200 m/s when fired from an extended offshore shot and 4860 m/s when fired from an extended on-land shot. This is interpreted as a down-dip/up-dip couplet with true velocity of 3860 m/s. This velocity may represent a variety of materials *e.g.* jointed slightly weathered to fresh dolerite, basalt or Permian rocks. With respect to driven piles, the engineering behaviour of these materials will be similar *i.e.* they all will provide adequate resistance to end bearing piles. The materials are expected to have medium to very high strength with equivalent unconfined compressive strength in the range 7-70 MPa.

Definitive calculations on the thickness of the 1680 m/s layer and thus the depth of the main refractor are not possible as neither a critical distance inflexion nor a reciprocal shot-to-shot travel time was recorded. However, some estimates are possible. For these it was necessary to correct

the travel times for a difference in elevation due to the extended offshore shot being some seven metres lower than the on-land extended shot. The estimate of the shot-to-shot reciprocal travel time has a variation of ±11 millisecs which is equivalent to ±10.25 m thickness of 1680 m/s material. A horizontal earth has been assumed. The resultant profile is presented at Figure 2.

Traverse 1 is the most reliable of the over-water traverses. The first layer recorded a velocity of 1630 m/s. This velocity is a composite between that of water (velocity of 1540 m/s usually adopted) and sandy clayey sediments. No distinction between the two has been attempted. The main refractor recorded velocities of 3650, 5000, 6000 and 6430 m/s. A layer velocity of 5000 m/s is adopted. This is interpreted as either fresh dolerite, basalt or Permian rocks. The material will provide adequate end bearing for driven piles. The calculated depth to the main refractor ranges between 34.5 and 48.3 m for the close-in shots and 43.1 and 56.9 m ±8.6 m for the extended shots. The resultant profile is presented as Figure 2.

CONCLUSIONS

The seismic refraction survey indicates that a considerable thickness of between 34-62 m of Tertiary sediments may overlie slightly weathered to fresh basement rocks at the site of a proposed submarine facility, Margate. The sediments are not likely to be a suitable founding material for end bearing piles. Significant frictional resistances to suitably designed driven piles should be developed within the sediments. The basement rocks should provide adequate end bearing resitance to driven piles.

The seismic survey results do not support the hypothesis that basalt flows detected further up the valley extend down to the proposed site.

Silcrete, 'greybilly' were not indicated by the seismic survey. This is not surprising as they usually occur as discontinuous masses which by their nature are unlikely to be detected by the seismic technique.

The depths given in this report may, due to refinement of interpretation, vary from those given verbally to Gutteridge, Haskins and Davey Pty Ltd on 16 January 1986.

RECOMMENDATIONS

The material interpreted as Tertiary sediments has similar velocity whether detected on land or offshore. The gross engineering properties of these materials detected at an on-land site should be applicable to an over-water site. It is therefore recommended that:

(1) A series of quasi-static electrical cone friction sleeve continuous recording penetrometer holes be undertaken. Such holes will in effect be miniature piles and the recordings will provide parameters directly relevant to the selection of friction and end bearing parameter for driven piles within the Tertiary sediments.

Additionally, the penetrometer holes may reveal the existence of 'greybilly' masses as these are likely to be massive and resist further penetration.

(2) As it is unlikely that the penetrometer holes will reach the basement rocks, a single on-land borehole should be bored to

Table 1. SUMMARY OF SEISMIC REFRACTION SURVEY RESULTS - SUBMARINE FACILITY, MARGATE

Traverse number	Velocity (m/s)	Interface depth (m)	Comments
1	V_1 1630 V_2 5000	48.3-56.9 offshore 34.5-41.3 onshore	
2	V_1 1750 V_2 5000	50.3-62.5 offshore, 38.1 onshore	poor hydrophone alignment, some variation in V_1
3	V_1 1620 V_2 5000	35.7-39.3 offshore 46.4 onshore	poor hydrophone alignment, possible but poorly represented intermediate velocity (2000 m/s) layer
4	V_1 1670 V_2 7500	51.8 upstream 46.6-53.8 downstream	poor recording of V_2, possible steps in basement level at about mid traverse (near previous shots)
5	V_O 500 V_1 1680 V_2 3860	V_O/V_1 2.6-4.4 V_1/V_2 36.3-56.6 near shoreline, 41.6-62.2 inland	

Note 1. Except for traverses 1 and 5, critical distance calculations only.

Note 2. V_O = 500 m/s probably silty/loamy or clayey topsoils
V_1 = 1620-1750 m/s composite between water (upper limit of 1580 m/s) and Tertiary sediments
V_2 = 3860-7500 m/s slightly weathered to fresh bedrock

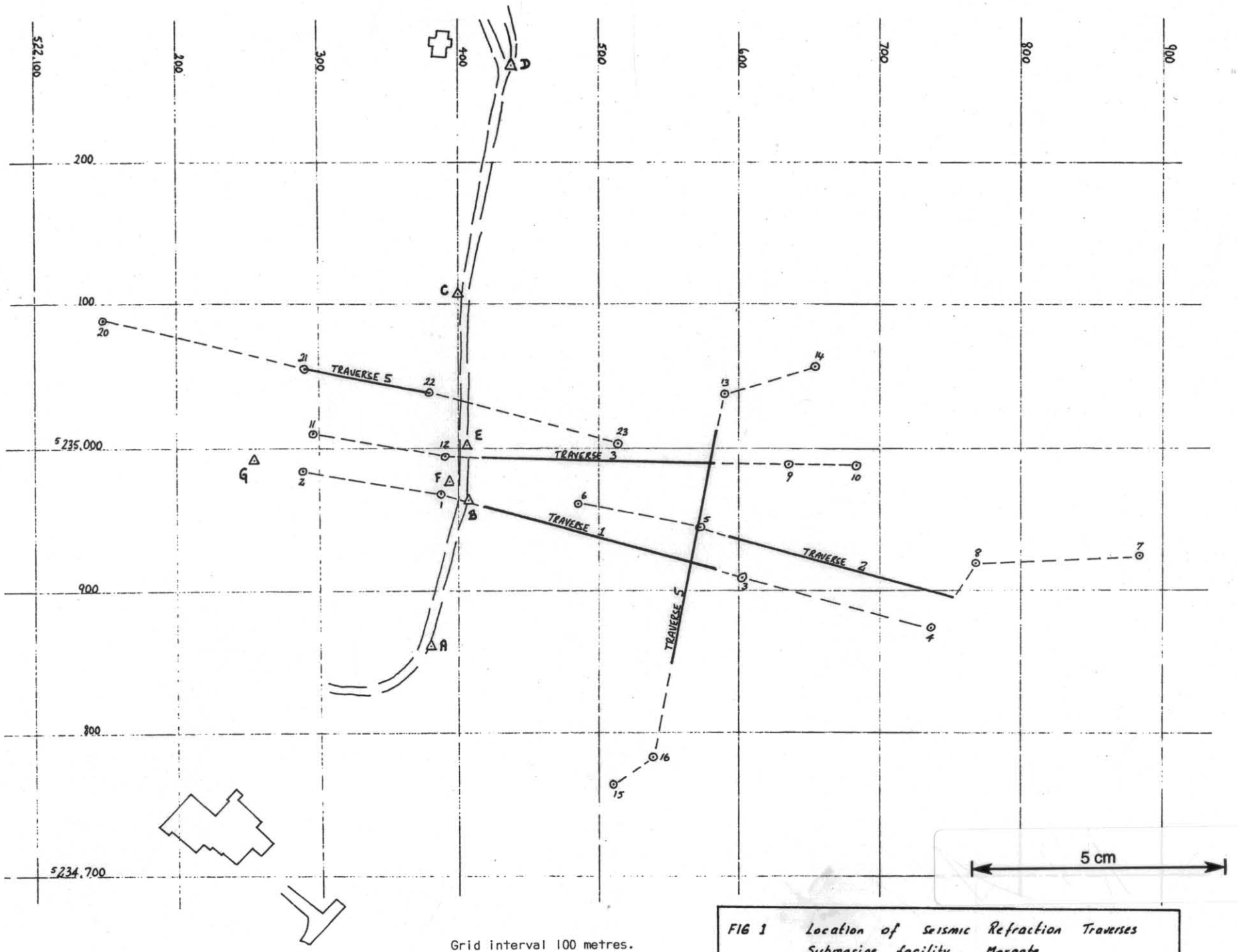
prove the bedrock level. This borehole may be tested and sampled as required.

The Department of Main Roads has a suitable quasi-static trailer-mounted penetrometer and should be approached to undertake the penetrometer soundings. The Department of Mines drillers have now recommenced work after their vacation period and could be made available if desired.

REFERENCE

PATERSON, S.J.; UNDERWOOD, R. 1984. *A submarine facility in Tasmania. Geological site notes.* Government of Tasmania : Hobart. [part of Tasmanian Government's submission for a submarine facility in Tasmania, July 1984].

[21 January 1986]



Grid interval 100 metres.

FIG 1 Location of Seismic Refraction Traverses Submarine facility, Margate

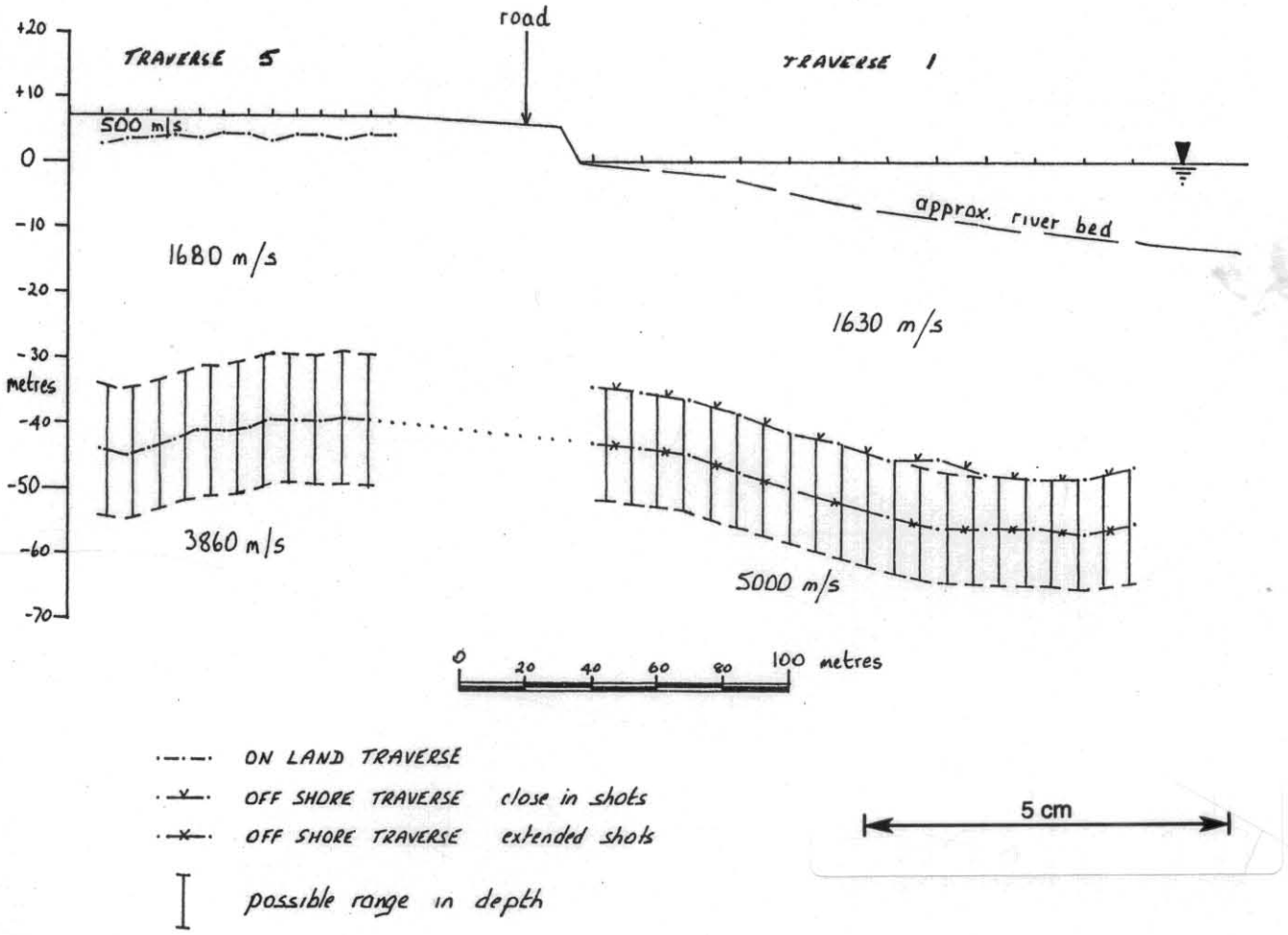


Figure 2. *Interpreted seismic subsurface profile, submarine facility Margate.*