Seismic refraction survey, Randalls Bay - Garden Island: Feasibility study, submarine gravel deposits.

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Abstract

A seismic refraction survey undertaken for feasibility purposes in the Huon River has indicated that a large scale survey is possible with the equipment available and that gravel deposits may persist well offshore. Velocities typical of saturated onshore gravels (∿2000 m/s) have been found. A limited test drilling programme is suggested to verify the pilot interpretation and control any future extension of this survey.

INTRODUCTION

Accessible gravel deposits of good quality are relatively rare in southern Tasmania. The best known and most fully utilised are along the shores of the estuary of the Huon River. The largest known deposits are on the south end of Port Cygnet north of Beaupré Point and west of Randalls Bay. Each deposit is discrete and most are small. As these deposits have been worked for several years, reserves are now low and as a result the Department of Main Roads requested a seismic survey in the estuary to locate further deposits.

Reason for a feasibility study

Seismic methods offer the simplest and cheapest means of evaluating bedrock, covering materials and cover thickness in an aqueous situation. Drilling is far more direct and positive in terms of gravel location, quality and thickness, but is far more expensive and the problem of where to test drill becomes crucial.

Unfortunately, there are some problems with marine refraction surveys, both technical and interpretive. The technical problems relate to efficient positioning of the boats, cable and shots, the manoeuvring of the cable, the means of shot firing and overall safety. The interpretive problems relate to recognition of low velocity silts which may confuse depth estimates and recognition of velocities appropriate to the target, in this case gravel.

A feasibility study in the open conditions of the Huon River was thus proposed to sort out the practical problems of large scale surveys and to determine whether any distinctive velocities might relate directly to gravel deposits. A set of test holes could then be suggested which would verify the interpretation and permit expansion of the survey from a pilot to production coverage if results were positive. In this way, the entire estuary could be examined with some firm control and the best deposits pinpointed for further drilling.

SURVEY

The area south of Randalls Bay and west of Garden Island was selected for this pilot study as it is easily accessible and adjacent to one of the major onshore deposits.

A total of 52 spreads were fired across the area indicated in Figures 1 and 2. Most spreads were fired with twelve channel equipment and a hydrophone spacing of 15 m, although some eight channel 5 m spreads were fired (inshore, Randalls Bay). Detonators were used as energy sources throughout.

Only two long spreads were fired onshore on Randalls Bay. Of the spreads using hydrophones, eleven were anchored and reciprocally fired. The remainder of the spreads were streamed and fired single ended. All shots were radio fired, eliminating lengthy shot cabling and all positions were fixed by transit sightings.

It was found that the most efficient technique was to trail the cable and firing boat, to fix the shot distance and to maintain steerage so as to avoid large catenaries of the cable. Using the radio techniques and small charges, it was found possible to fire up to twelve spreads per hour as against 2 - 4 per day anchored. Many problems were experienced before all equipment operated in the conditions without interference effects.

The results of the survey are summarised in Figure 1 where the second layer velocity is indicated. In general, the following velocities were found:

Onshore:	1500 - 1700 m/s	saturated sand, possibly gravel
	1700 - 2200 m/s	sand/gravel
	3000+ m/s	sandstone
Offshore	1500 m/s	water
	1600 - 2400 m/s	sand-gravel-weathered rock
	3000 - 4000 m/s	sandstone, weathered dolerite
	5000+ m/s	dolerite, up dip effects

INTERPRETATION

It will be apparent from the above velocities that there is considerable overlap and interpretation of the velocities. Consideration of the distribution of sandstone and dolerite in the region and the recorded velocities suggests that a sedimentary bedrock forms the largest part of the area. Higher velocities in the west (4000 - 5000 m/s) could be related to marked shallowing (up dip) of the river bed. The critical part of the velocity table is the velocity range 1600 - 2400 m/s. Values of 1600 - 1900 m/s are typical of saturated sand, clay and poor gravel, while values of 1800 - 2200 m/s are typical of more massive gravel. However values in excess of 2000 m/s can also represent weathered rock. The time distance curves reveal a patchy occurrence of this intermediate velocity range and while it may reflect random scouring of the bedrock, it more probably represents gravel. This interpretation is indicated in Figure 2.

Figure 1 also presents some estimates of the thickness of this material. In many cases the thickness appears to be less than 2 - 3 m and has been left unmarked. However for the spreads fired well into the estuary west of Garden Island, no reliable estimate can be given but thickness possibly exceeds 20 m.

An approximate bathymetric survey was also undertaken and the results matched against the interpreted thickness of the first layer which had been presumed to be water. In nearly every case the interpretation overestimated the thickness by about one third, which indicates that a silt layer of lower velocity is hidden in the results. The silt appears to vary in thickness from less than one metre to more than 10 m. A zone of very thick silt is indicated on Figure 2.

Thus two distinct sections have been recorded;

1) water-silt-bedrock (usually sandstone)

2) water-silt-sand/gravel (variable ratio)-bedrock (usually sandstone).

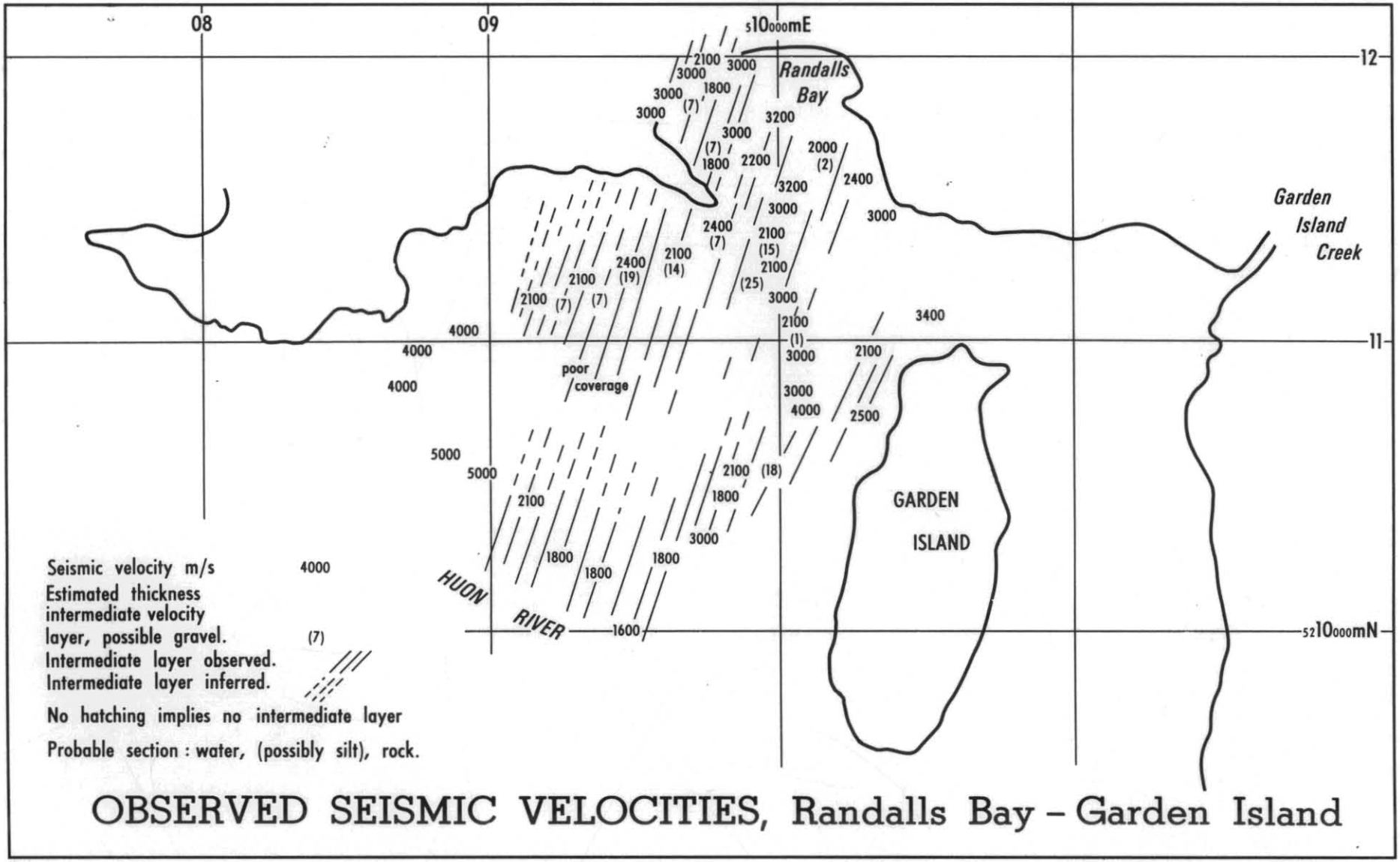
CONCLUSIONS AND RECOMMENDATIONS

The technical problems related to a refraction survey in a major expanse of water have been overcome and a capacity of up to 80 spreads per day established, given good weather and no breakdowns.

Some of the interpretive difficulties have also been separated. Low velocity silt is present but the actual velocity can only be estimated without control drilling to fix a section. The velocity range noted for onshore gravel / sand deposits has been noted in the estuary and it seems likely that significant deposits are present. If the velocity-gravel nexus can be proven by test drilling, then the refraction method will provide a simple means of exploring the estuary.

Four test holes are suggested (fig. 2) which should establish the viability of the method and control any extension of this survey in future.

[30 October 1978]



OBSERVED SEISMIC VELOCITIES, Randalls Bay – Garden Island

Figure 1

5 cm

4/5

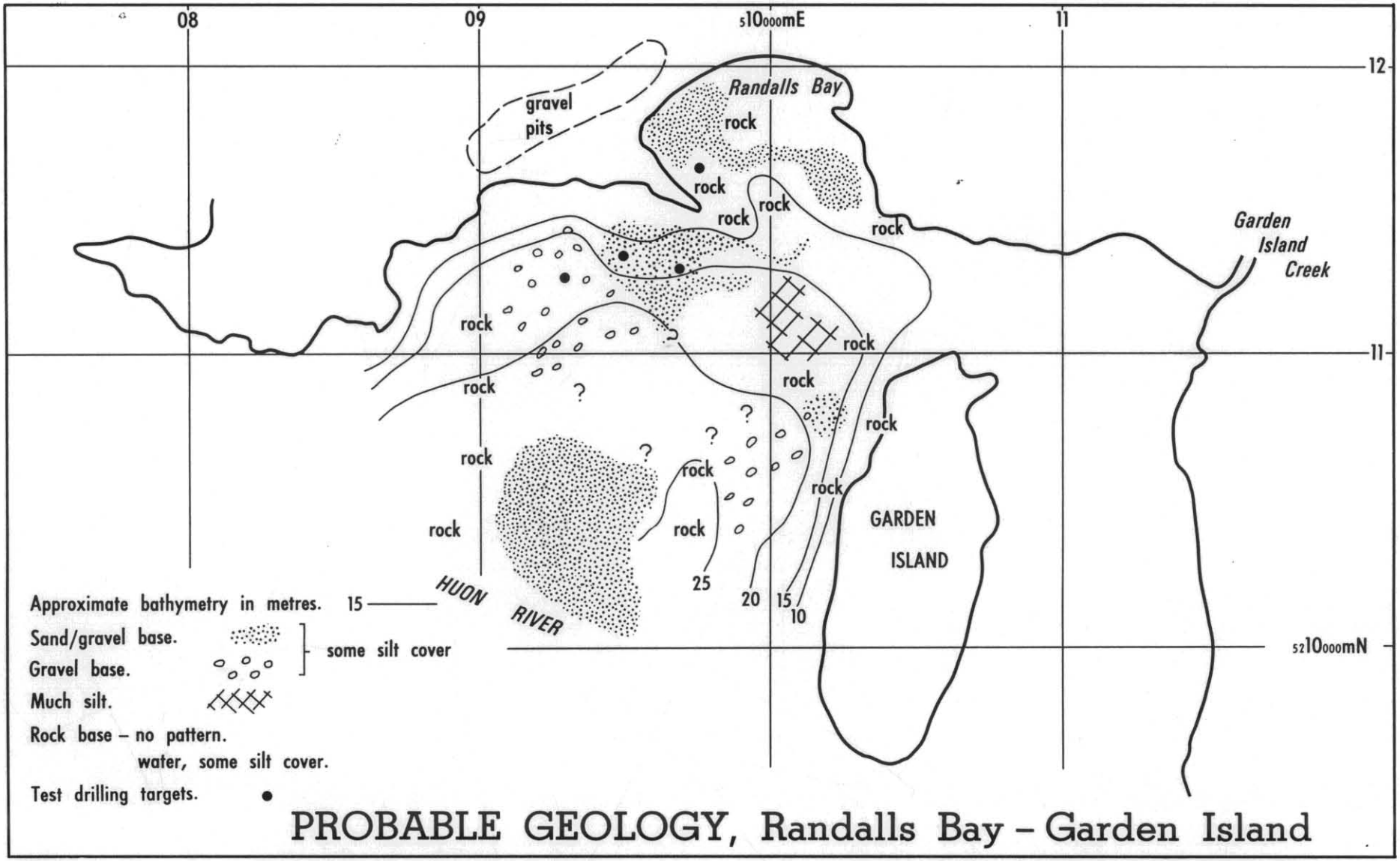

08
09
510000mE
11
12
11
52 10000mN
Randalls Bay
gravel pits
Garden Island Creek
GARDEN ISLAND
HUON RIVER
rock
?
25
20
15
10
Approximate bathymetry in metres. 15
Sand/gravel base.
Gravel base.
some silt cover
Much silt.
Rock base – no pattern.
water, some silt cover.
Test drilling targets.
PROBABLE GEOLOGY, Randalls Bay – Garden Island

Figure 2

5 cm