TR18_103-105

15. River Derwent seismic and magnetic survey. Site of proposed Bedlam Walls bridge.

D.E. Leaman

A preliminary foundation investigation commenced by Maunsell and Partners has comprised a seismic refraction survey along the centre line of the proposed bridge from Bedlam Walls to Rock Cod/Woodman Point. This survey by the consulting engineers and its geophysical consultant was of limited value due to the technical limitations of the procedure used (single hydrophone, bottom based, low energy sources, line control and absolute position control of hydrophone) in relation to the very complex geology. The survey produced results which were largely uninterpretible and only the most qualitative outline of bedrock geology and seismic velocity was produced. In addition, as the survey was restricted to a single line and correlated only to geology at the shore at either end the problems of lateral structural and rock unit variations could not be assessed (see below).

As the data obtained from the original survey appeared inadequate, and considering the need for careful drill site location, a further survey was undertaken using multi-channel, near-surface hydrophone equipment and large explosive sources. The survey was not restricted to the centre line due to the need to:

(1) observe the range of seismic velocity variations,
(2) relate all local geologic units to sections of the bedrock (especially the Selfs Point basalt),
(3) obtain more seismic velocity data,
(4) obtain the structural overview with respect to the present channel and older channels,
(5) obtain more depth data (indeed to positively identify the bedrock at the deepest point if possible),
(6) verify the nature of the river silt (suspected as being peculiar in the Maunsell Report).

The refraction survey was supported by a magnetic survey in order to resolve problems related to the basalt since the seismic velocity overlaps suspected were likely to produce problems of interpretation.

THE GEOLOGICAL PROBLEM

The Derwent River flows through a narrow gorge at Bedlam Walls with Permian siltstone to the east and Triassic sandstone, intruded by dolerite, to the west. Weathered Tertiary basalt is exposed to the south at Selfs Point. At least two faults are present; one major (NNW-SSE) just west of the face of Bedlam Walls and one minor (NE-SW) through Shag Bay.

The basalt at Selfs Point is a capping on Tertiary sediments which fill the main Tertiary channel of the Derwent from Cornelian Bay through New Town and Moonah to Elwick Bay. Thus in the first instance the presence of a major Tertiary channel at Bedlam Walls was not to be expected although a more recent feature may be present. Tertiary sediments were presumed absent.

The following information was desired:

(1) The actual position of the Triassic/Permian boundary fault or accessory faults.
(2) Whether a slab of Tertiary sediment overlain by basalt was present in New Town Bay and if so how far north it extended.
(3) The thickness of Recent-Pleistocene river silts.

(4) The quality of bedrock across the river.
(5) The limits of the basalt.

These problems could not be resolved by survey of a single line. The centre line survey of the consulting engineers resulted in a river section not unlike that deduced from the present survey and shown in Figure 20. It revealed a gentle slope from the west side with an escarpment and loss of information on the west-centre of the river. The interpreted escarpment may be composed of a series of smaller features in which case considerable fracturing would be expected. On the eastern side a broad bedrock swell was interpreted with a sharp scarp step up to the walls. Due to single end firing the interpretation could not be properly resolved as dip components of the seismic velocities were particularly large and refractor sections were not overlapped.

SURVEY, RESULTS AND DISCUSSION

Seismic surveys of any type are difficult to manage in this region due to problems with currents, winds, confined spaces, varied geology and abrupt surface and concealed escarpments. The magnetic survey could also be affected by the range of composition and depth to the basalt present. In short, a very difficult problem for which absolute answers were unlikely.

The seismic survey was undertaken using a 12 hydrophone cable (15 m separation) and up to 300 m shot extension. The whole cable system was towed about in the river and shots were fired wherever conditions permitted. Spread positions were restricted by the manageability of up to 480 m of cable. Shots were fired at depths of 10-12 m generally and hydrophones were suspended at 1.5 m. Due to manoeuvring difficulties reverse firings were not possible and thus the data obtained from each spread is of limited reliability. However, by firing 18 spreads in a limited area with various orientations, reasonably reliable estimates of seismic velocities and depths are possible.

The magnetic survey was undertaken using a McPhar fluxgate magnetometer with a sensitivity of better than 10 nT/division. Broad anomalous features up to 600 nT were recorded. A continuous recording was made along all traverses.

No extended interpretation has been, or should be, made of the results due to the difficulties of the area and the various technical limitations of the survey. Figure 20 shows approximate contours on bedrock as interpreted using simple methods. Some additional spot depths and velocities are also shown. The suspected basalt boundary deduced from the magnetic data is indicated. As the figure shows, the knoll suspected in the Maunsell survey on the eastern side of the river is confirmed and the shape and position reasonably described. All depths shown are from the surface. Seismic velocities are variable due to dip components and the extreme values recorded in the Maunsell survey are accounted for since the centre line is almost perpendicular to all slopes. The more oblique, random spreads used here have proved much more helpful. It was also found that many first arrivals were of low energy and that they might have been missed entirely using the low energy sources of the previous survey.

Triassic rocks usually have velocities in the range 2000-3500 m/s (slightly weathered/fractured-fresh, massive) and few values fall in this range. The Triassic rocks exposed near Woodman Point are only considered to extend about 250 m into the river. The interpreted structure is shown in the small sketch on Figure 20 and the distortion of contours, increase in depth, increase in seismic velocities, escarpment indicated in Maunsell survey and alignment of these features with the Shag Bay Fault is the basis for the fault extension and termination of the Triassic sandstone series.

Only spreads fired in the western limits of New Town Bay, outside the area shown on the figure, revealed seismic velocities which could definitely be related to Tertiary sediments (1600-1700 m/s) and dolerite. Although the possibility of hidden layers cannot be excluded it does appear that Tertiary sediments are unlikely to occur east of Selfs Point and Rock Cod Point.

Basalt usually has seismic velocities in the range 3000-7000 m/s and it will be noted that many velocities within this range have been recorded. Unfortunately the Permian siltstone produces velocities in the range 3000-5000 m/s and thus there is much uncertainty in direct interpretation of the velocities. Where the seismic velocity exceeds 5000 m/s (absolute maximum for siltstone) and is unrelated to up dip records then basalt is definitely indicated. Indeed velocities in excess of 4500 m/s probably represent basalt. However many velocities are in the range 2250-4000 m/s and could represent either material. The qualitative interpretation of the magnetic survey is indicated in Figure 20 and provides a separation of basalt and siltstone. In the deep channel the records imply no, or little, basalt but this cannot be positively established.

It appears that patches of basalt are present as far north as the proposed centre line and that the principal bedrock of the area is siltstone. The whole system has been deeply scoured and filled by more than 100 m of silt. The filling silt has been interpreted using a velocity about that of water (1500 m/s). The report by Maunsell and Partners did suggest that the silt velocity might be lower than this but there is no evidence for this on the basis of the present survey. The author cannot conceive a water-saturated silt having a lower velocity than water. The interpreted depths, presented both as contours and spot values would be affected by errors in the velocity assumption mentioned above. However, these figures should be regarded as estimates only since the survey conditions did not allow reverse firing.

The curious knoll near Bedlam Walls appears to be partly of basalt and the nick near the wall face was to be expected as the expression of the Bedlam Walls Fault.

CONCLUSION

A complex, recent geological history is implied for the Derwent River and apart from a more detailed magnetic survey in the region of the knoll and centre line no further geophysical work could be recommended at this stage.

It should also be noted that any interpretation at this stage must be relatively qualitative and should be used only as a control for a drilling programme.

Should further seismic work be found necessary it should be of reflection type rather than refraction; the latter not being wholly suitable to this problem.

[11 December 1973]

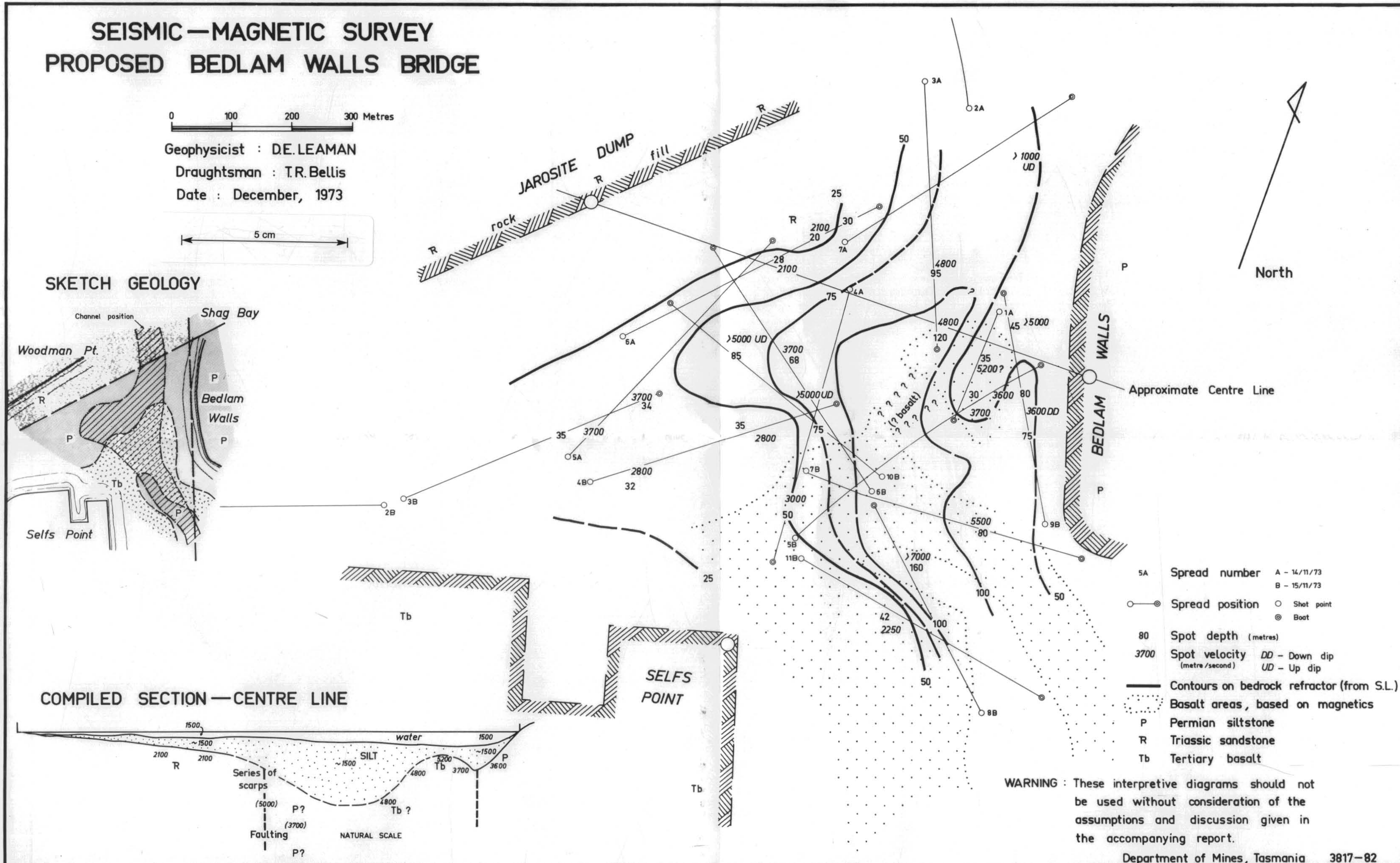
SEISMIC—MAGNETIC SURVEY
PROPOSED BEDLAM WALLS BRIDGE
0 100 200 300 Metres
Geophysicist : D.E. LEAMAN
Draughtsman : T.R. Bellis
Date : December, 1973
5 cm
SKETCH GEOLOGY
Channel position
Shag Bay
Woodman Pt.
Bedlam Walls
Selfs Point
JAROSITE DUMP
rock
fill
North
BEDLAM WALLS
Approximate Centre Line
SELFS POINT
COMPILED SECTION—CENTRE LINE
water
SILT
Series of scarps
Faulting
NATURAL SCALE
5A Spread number A - 14/11/73 B - 15/11/73
Spread position ○ Shot point ◎ Boat
80 Spot depth (metres)
3700 Spot velocity (metre/second) DD - Down dip UD - Up dip
Contours on bedrock refractor (from S.L.)
Basalt areas, based on magnetics
P Permian siltstone
R Triassic sandstone
Tb Tertiary basalt
WARNING : These interpretive diagrams should not be used without consideration of the assumptions and discussion given in the accompanying report.
Department of Mines, Tasmania 3817—82

Figure 20.