

1984/83. A refraction seismic survey of land at Sophie Place, West Launceston.

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#### Abstract

Two refraction seismic spreads were fired on a large block off Sophie Place, West Launceston. Dolerite appears to crop out near the block but no near-surface dolerite velocity occurs in the seismic survey. The velocities recorded in the two spreads indicate that a considerable depth of Tertiary sediments and deeply weathered dolerite underlie the block. As the upper layer of the Tertiary sediments is likely to be clay, slope failure is a potential problem. Further subsurface work of four to six backhoe holes is recommended.

#### INTRODUCTION

The Department of Mines was requested by Mr G. Charnley to investigate the foundation conditions likely to be encountered on Blocks 1 and 9 at Sophie Place, West Launceston [EQ106114]. Mr Charnley plans to build a series of two to three-storied town houses in blocks of four on this large area. The units will be at varying levels following the contours around the slope and overlooking the First Basin of the Cataract Gorge of the South Esk River. In order to obtain council approval for this project, a subsurface investigation would be required. From an earlier inspection of the site, P.C. Stevenson, in a letter of 19 October, recommended a reconnaissance refraction seismic survey, probably followed by some backhoe trenching.

#### LOCATION

The two blocks combined cover an area of 0.6 Ha and face in a north and north-westerly direction. The blocks are enclosed by established houses facing the surrounding streets. The area is reached by a narrow right-of-way off Sophie Place (fig. 1).

The slope is uniformly steep, being  $15^\circ$  along the NE boundary flattening to  $13^\circ$  at the south-western end of the block. The slope is on the south-eastern headwater area of a small narrow valley that runs down to the First Basin.

#### GEOLOGY

No definite outcrops were present on the block but some large blocks of near-outcrop dolerite were present on the north-east boundary and right-of-way area. The soils were brown organic silts (CH) with scattered dolerite boulders on the surface.

Sophie Place has been mapped (Longman *et al.*, 1964) as on the dolerite/sediment boundary, with most of the block appearing to be underlain by the Launceston Beds of Tertiary age. These sediments were considered to have been deposited in one of the minor sedimentary basins of the Tamar Trough (Longman, 1966).

Given the steepness of the block and likelihood that the sediments overlying the dolerite could be clay, a seismic survey followed by trenching was recommended. The depth to 'bedrock' required by the owner (in this case presumably dolerite) could also be established.

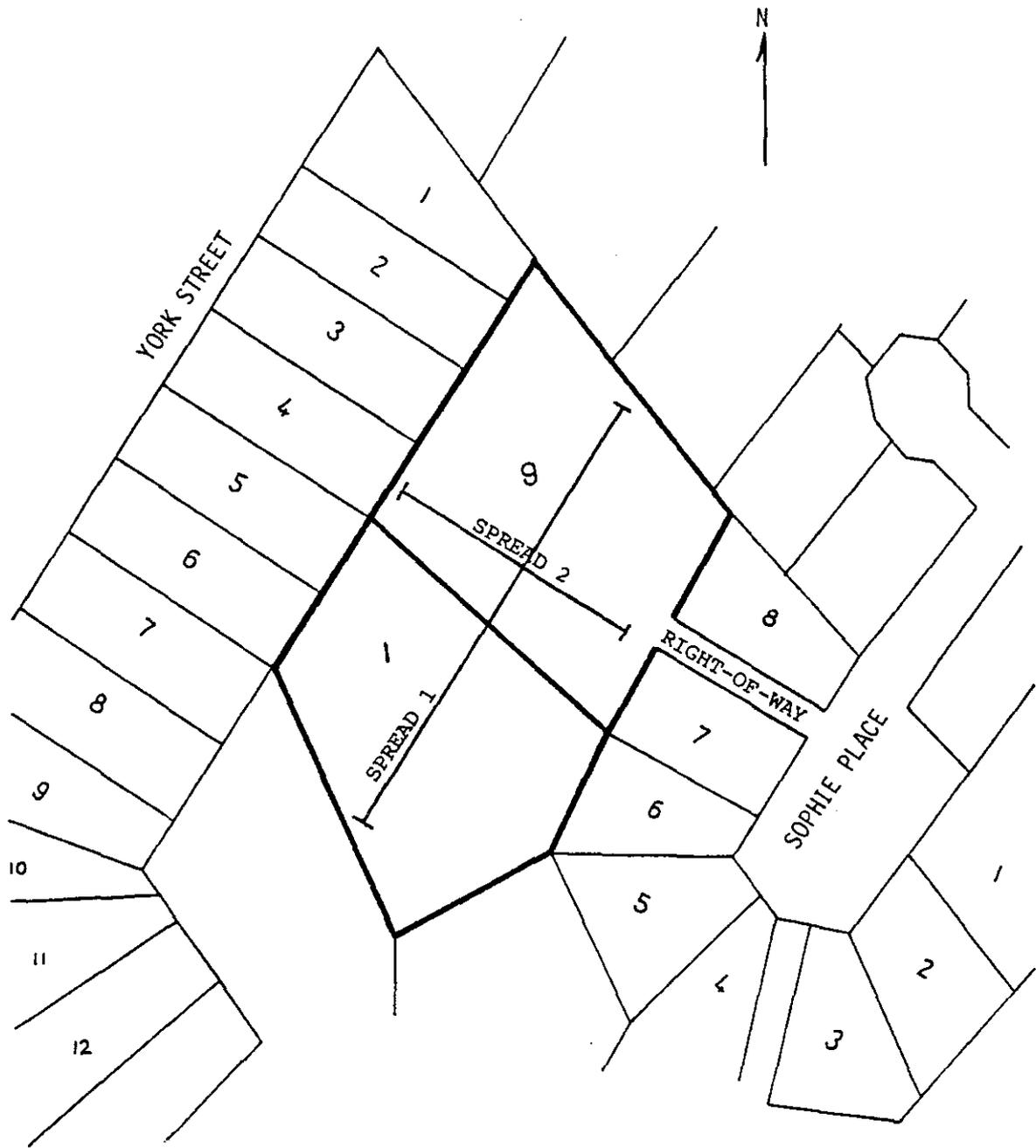


Figure 1. Location of seismic spreads on Lots 1 and 9, Sophie Place.

SEISMIC SURVEY

Results

The refraction seismic survey was undertaken on 21 November using a Geometrics Nimbus ES 120 seismograph with 12 channels and gelignite for an energy input. Because of the close vicinity of the surrounding houses and an energy-absorbing surface layer, repetitive shot firing had to be used. This combined with thunderstorms and long wet grass causing shorting on the geophone contacts made for poor records and loss of time. Only two spreads were completed in the allocated time.

In the 135 m long NE-SW spread (Spread 1), three consistent velocity layers were present, with a surface velocity layer ( $V_0$ ) of 500-800 m/sec, an intermediate layer ( $V_1$ ) of 1100-1300 m/sec and a third high velocity layer ( $V_2$ ) of 2400-2900 m/sec. The thickness of the surface layer is calculated to be 5-9 m with the intermediate layer 11-14 m thick. The total depth to the high velocity layer rock or 'bedrock' is estimated to be 16-23 metres.

In the short 65 m Spread 2 down the slope the lower velocity layers were less distinct because of stepping. Three layers were present with a surface layer velocity, similar to the first spread, of 500-800 m/sec. The intermediate layer velocity was 1000 m/sec, while the third layer velocities covered a wide range because of stepping from 1400-2400 m/sec, with the consistent velocity appearing to be 1600 m/sec. Because of the surface slope and stepping the depth calculations on this spread are less reliable. The surface layer is 1.5-2.8 m calculated thickness and the intermediate layer 7.0-8.0 m thick. No consistent high velocity layer was reached in this spread as appears in Spread 1.

It was not possible to obtain greater depth penetration on this spread as the shot points were close to the block boundary, and extended shot points would have been outside the property's boundary.

*Geological interpretation*

The surface layer of both spreads is thought to be a thin soil with possibly talus deposits of clay and dolerite boulders, underlain by clay of the Launceston Beds. In Spread 1 the intermediate velocity layer of 1100-1300 m/sec is probably a combination of soft mudstone and sandstone of the Launceston Beds and deeply weathered dolerite. The high velocity third layer of Spread 1 (2400-2900 m/sec) is unweathered dolerite or bedrock.

In Spread 2 the unweathered dolerite interface is thought not to have been reached, as shown by the shallow depth of 9-11 m for the  $V_1/V_2$  interface compared with the estimated depth of the unweathered dolerite interface of 16-23 m in Spread 1. The high velocity of 2200-2400 m/sec was only seen in one step of three geophones in the middle of the spread when fired up-slope in Spread 2. It was not a consistent velocity as in Spread 1.

The intermediate velocity has been split into two layers (Tertiary sediments and weathered dolerite) in Spread 2. This is a somewhat arbitrary division in the velocity plots and rarely does a geological interface coincide with a seismic interface.

CONCLUSIONS

- (1) Though the seismic records are of a poor quality, no high velocity rock such as unweathered dolerite occurs close to the surface on this block. What appears to be dolerite outcropping near the north-east boundary of the block near the high section of Sophie Place is probably only large boulders underlain by soft sediments.
- (2) The unweathered dolerite or bedrock is overlain by two layers of softer rock which are considered to be Tertiary age sediments and deeply weathered dolerite. These layers have a combined estimated thickness of 16-23 m, far too deep for any conventional foundations for the proposed structures.
- (3) In the middle and lower sections of the block where the surface seismic layer thickness may be as great as nine metres, there is a strong possibility of clay of the Launceston Beds occurring. Such clay is likely to be highly plastic, expansive and prone to slope failure. No sign of any downslope movement was seen on the block but with concentrated development as planned this risk cannot be ignored.
- (4) The high energy absorption that occurred from the seismic shooting would appear to indicate that a clay layer is close to the ground surface.

RECOMMENDATIONS

- (1) The seismic results need confirmation by subsurface investigation on this block.
- (2) The first stage of this investigation should be four, or possibly six, backhoe holes dug to the machine's maximum depth.
- (3) If the backhoe cannot penetrate because of large boulders, auger and possibly some diamond drilling will be required.
- (4) If any suspect clay is exposed in either the trenches or drill holes, the clay should be tested for Atterberg limits, composition, linear shrinkage and by slow shear-box.

REFERENCES

LONGMAN, M.J.; MATTHEWS, W.L.; ROWE, S.M. 1964. Geological atlas one mile series. K/55-7-39. Launceston. *Department of Mines, Tasmania.*

LONGMAN, M.J. 1966. Geological atlas one mile series. K/55-7-39. Launceston. *Explan.Rep.geol.Surv.Tasm.*

[4 December 1984]

Table 1. RESULTS OF REFRACTION SEISMIC SURVEY, SOPHIE PLACE

Spread no. and location	Direction & length of spread (m)	Geophone spacing (m)	Shot Point distances (m)	Velocity layers (m/sec)	Thickness (Z <sub>0</sub> ) of layers & total depth (m)	Symmetry of velocity plots	Amount of stepping	Geological interpretation of velocity layers	Reliability
1 Across middle of block	NE - SW 130	10	10 NW - SE & mid shot point	V <sub>0</sub> 500-800 (calc. 500) V <sub>1</sub> 1100-1300 (calc. 1200) V <sub>2</sub> 2400-2900 (calc. 2500)	Z <sub>0</sub> = 5 - 9 Z <sub>1</sub> = 11 - 14 TD = 16 - 23	Assymetrical thicker surface layer SW end. Slope on V <sub>1</sub> /V <sub>2</sub> interface.	Minor	V <sub>0</sub> - dolerite talus and clay V <sub>1</sub> - soft sandstone, mudstone and weathered dolerite V <sub>2</sub> - unweathered dolerite	Spread fired on same level. Records poor due to heavy rain etc. but thought to be reliable.
2 Down the slope of the block	NW - SE 65	5	5 NW & SE	V <sub>0</sub> 500-800 (calc. 500) V <sub>1</sub> 1000 V <sub>2</sub> 1400-2400 (calc. 1600)	Z <sub>0</sub> = 1.5 - 2.8 Z <sub>1</sub> = 7.0 - 8.0 TD = 9 - 11	Symmetrical	Stepped	V <sub>0</sub> - dolerite talus with clay V <sub>1</sub> - soft sandstone and mudstone V <sub>2</sub> - weathered dolerite	Steep surface slope and stepping make depth calculations unreliable.

calc. = calculated velocity used to estimate depth

TD = total depth to V<sub>1</sub>/V<sub>2</sub> interface.

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