

1982/34. Reconnaissance seismic refraction survey of a proposed sewer line at Chigwell

R.C. Donaldson
D.A. Polya

Abstract

The Glenorchy City Council requested subsurface information on the nature of materials along the route of a proposed sewer line at Chigwell. A reconnaissance seismic refraction survey showed the proposed route to be largely underlain by a Triassic mudstone and sandstone sequence. Velocities of the order of 2000 - 2500 m/s were common at depths below 1 - 2 m; it is anticipated that these materials will require a combination of blasting and ripping for excavation to proceed to about six metres depth.

INTRODUCTION

The Glenorchy City Council requested the Department of Mines to advise on the nature of materials likely to be encountered during excavation for a proposed sewer line to be constructed adjacent to the railway line at Chigwell [EN206607].

A reconnaissance seismic refraction survey was undertaken in the vicinity of the railway cutting immediately south of Casuarina Crescent where information was required to a depth of at least six metres below the level of the existing railway lines.

Some 300 m of the proposed route was initially detailed for investigation, but due to time and cost restraints, only 200 m was finally investigated. Despite this, the survey was carried out over the deepest section of the route and the information obtained gives a good indication of conditions that may be expected to exist over the remaining 100 m or so.

GEOLOGY

The Hobart Sheet of the 1:50 000 Geological Atlas Series (Leaman, 1973) shows that the proposed route is underlain by a mudstone and sandstone sequence. These rocks are of Triassic age and are shown as dipping gently to the west.

Exposures in the railway cutting confirm the presence of these rocks in the area. However, the cutting has also exposed boulder clay deposits overlying the Triassic rocks. These deposits comprise poorly sorted rock fragments in a matrix of sandy clay (CH). Similar deposits have been noted along the foreshore at Casuarina Crescent, where the rock fragments are dominantly dolerite but include both Permian and Triassic sediments. These deposits are considered to be of Quaternary age (Donaldson, 1976).

SEISMIC REFRACTION SURVEY

Survey details

The survey consisted of six spreads using a twelve-channel Nimbus seismograph. Both hammer and electrical firing methods (seismic boosters with electric detonators) were employed. The spreads were fired from both ends and in the middle; some extension shots were also carried out. Geophone spacing was set at 2.5 m for all spreads.

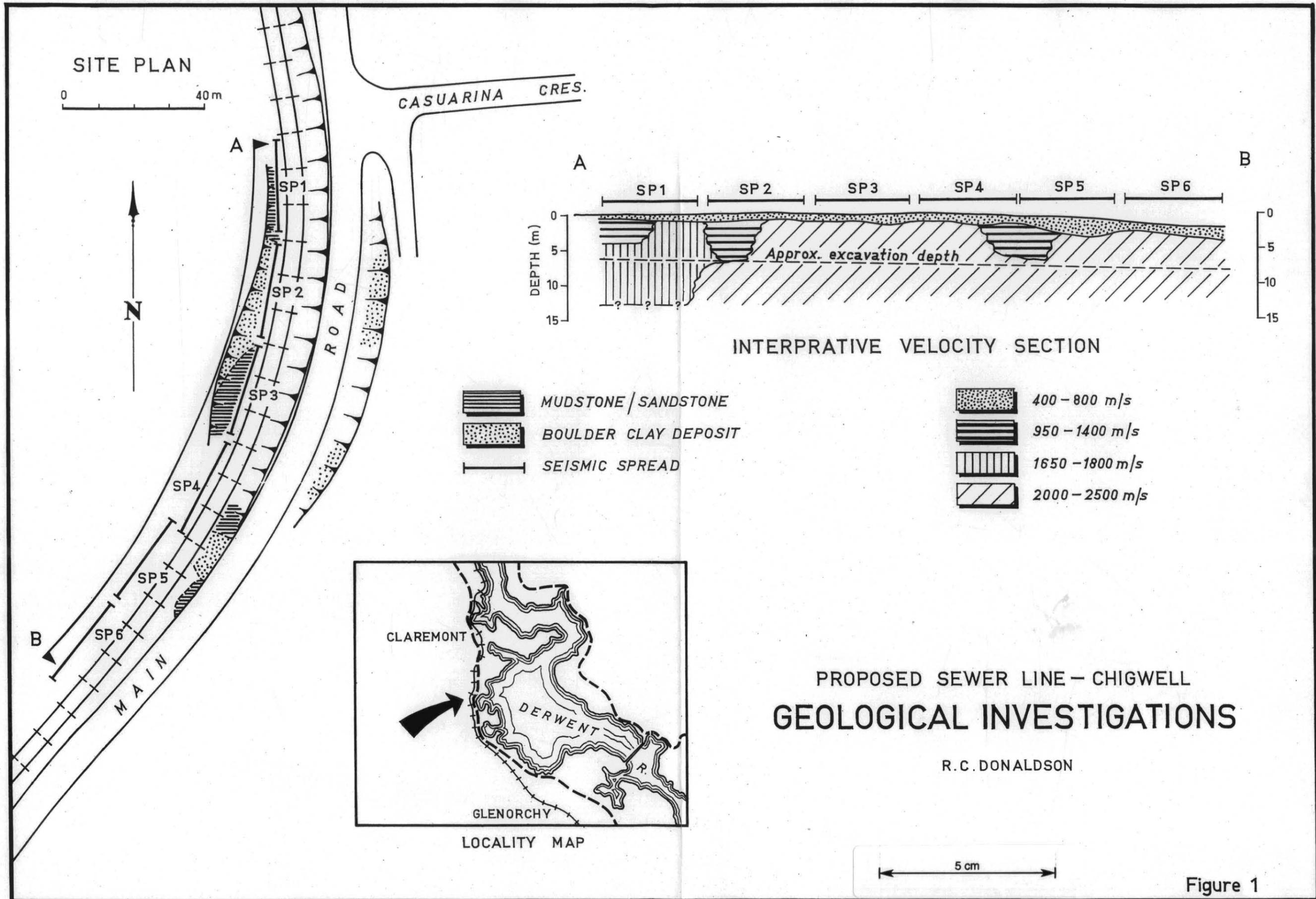


Figure 1

Survey constraints and limitations

The positioning of Spreads 1 - 3 was very limited; these spreads had to be confined to the base of the 7 m high cutting next to the railway tracks. Seismic spreads fired close to any abrupt topographical feature, whether at the base or at the top of a cutting, can distort seismic wave fronts and lead to spurious and misleading results.

Depth determinations of velocity layers were calculated using a combination of critical distance, reciprocal, and time-intercept methods. Where two or more depth determinations were calculated for a particular point using different methods, the average depth was taken. Thus depth determinations are to be regarded as approximate only. This applies especially to the thickness of the fastest velocity layer encountered in each spread. The method used assumes an unseen higher velocity which then gives a minimum thickness to the velocity layer.

Finally, the results should not be used for tendering purposes; the survey aims only to provide seismic velocities as a guide for the interpretation of the nature and type of the subsurface materials.

Interpretation of seismic velocities

The seismic velocities fall into four basic groupings, although not all are recognisable in each spread. For example, only two velocity layers were distinguished in Spreads 3 and 6, while three layers were present in the remaining spreads. The time-distance (velocity) plots range from the simple two layer symmetrical case to the asymmetrical, stepped, three layer case. A summary of the results of the seismic refraction survey is given in Table 1.

There appears to be a reasonable overall correlation between the materials exposed in the railway and road cuttings and the seismic results. The materials exposed in the cutting between Spreads 3 and 6 were mapped as Triassic sediments, with the exception of a small dolerite boulder clay deposit situated in the cutting to the east of the railway lines opposite the junction of Spreads 4 and 5. As indicated by the interpretive velocity section (fig. 1), a middle velocity layer (900 - 1400 m/s) was distinguished, coinciding with the boulder clay deposit.

The correlation of surface geology with results from Spreads 1 and 2 is not as distinct. Spread 2 was sited entirely on the boulder clay material with respect to material observed in the cutting (fig. 1). However, an intermediate velocity layer (1100 - 1300 m/s), similar to that attributed to the boulder clay deposit in Spreads 4 and 5, was present in the northern half of the spread only. This apparent anomaly could be accounted for if we take into consideration the nature and attitude of the interface between the boulder clay and the underlying Triassic sediments. The boulder clays are thought to represent valley fill material or similar, deposited on an irregular Triassic surface. The low angle interface between these two materials observed at the southern end of the cutting suggests that the boulder clay deposit would not be of significant thickness at this end of the spread.

With the exception of Spread 1, the fastest refractor distinguished in each case had velocities of the order of 2000 - 2500 m/s, which is considered to represent the Triassic mudstone-sandstone sequence. However, velocities of 1650 - 1800 m/s were the fastest recorded in Spread 1. The materials in the cutting show this spread to be underlain by Triassic sediments (fig. 1). It is suggested that these lower velocities merely

Table 1. RESULTS OF SEISMIC REFRACTION SURVEY

Spread No.	Velocity (m/s)	Layer thickness (m)	Velocity plot characteristics	Comparison of velocity refractors	Geological interpretation
1	450 - 830 1350 - 1400 1650 - 1800	0.5 - 1 3 - 4 8 - 11	Symmetrical	V ₂ layer absent at south	Topsoil unconsolidated material EW-HW mudstone/sandstone? HW-SW mudstone/sandstone
2	400 - 550 1100 - 1300 2000 - 2500	0.5 - 1 5 - 7 -	Asymmetrical and stepped	V ₂ layer absent at south V ₃ layer stepped, velocity segments from 1900 - 3300	Topsoil Boulder clay deposit SW-FR mudstone/sandstone
3	500 - 700 2200 - 2500	1 - 2 7 - 8	Symmetrical	Good correlation in V ₂ layer	Topsoil SW-FR mudstone/sandstone
4	625 950 - 1250 2000 - 2500	0.5 - 1 3 - 4 8 - 10	Asymmetrical	V ₂ layer absent at north V ₃ segments from 1700 - 2700 m/s; velocities faster from south to north	Topsoil Boulder clay deposit SW-FR mudstone/sandstone
5	400 - 600 900 - 1400 2000 - 2500	1.0 - 2.5 3.5 - 4.0 -	Asymmetrical	V ₂ layer absent at south V ₃ segments from 1850 - 3000 m/s; velocities faster from south to north	Topsoil Boulder clay deposits SW-FR mudstone/sandstone
6	500 - 600 2000 - 2500	1 - 2 8 - 10	Asymmetrical and stepped	V ₂ layer stepped, segments from 1500 - 3500; velocities faster from south to north	Topsoil SW-FR mudstone/sandstone

EW - extremely weathered
 HW - highly weathered
 SW - slightly weathered
 FR - fresh

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show that the rock is in a more weathered state and/or has open jointing.

Finally, the asymmetry of the plots and corresponding apparent velocity ranges within a single refractor in Spreads 3 - 6 suggests that the sediments have a shallow apparent dip to the south-west.

Excavation conditions

The ease with which rock materials can be excavated can be related to seismic velocity, which is in effect a composite measure of the degree of weathering and fracturing of a rock mass. In practice, rippability also relies on the orientation of discontinuities relative to the face of excavation. A rippability chart based on the capabilities of a D9 bulldozer is shown in Figure 2. It is anticipated that under favourable conditions, the upper limit of rippability for the rock to be encountered in the construction of the sewer line will be of the order of 2000 - 2200 m/s.

Material representing the top or surface layer (400 - 800 m/s) can be readily removed by light machinery with little difficulty.

The second (950 - 1400 m/s) velocity layer should also be excavated without requiring ripping. The material should be dry, that is, the water table should not be encountered. Where this velocity layer represents the dolerite boulder clay deposit, large single boulders of two metres or more in diameter may be encountered.

Excavation of the 1650 - 1800 m/s material present in Spread 1 will almost certainly require some ripping or similar form of mechanical loosening (jackhammer) prior to excavation.

In the highest velocity layer (2000 - 2500 m/s) the rock condition is likely to vary between a slightly weathered state as indicated by the lower end of the velocity range to a largely fresh, hard, tightly jointed rock. This material will require both blasting and ripping. Ultimately, the frequency and attitude of discontinuities will determine the amount of rippable material.

CONCLUSIONS

The proposed route is largely underlain by a mudstone and sandstone sequence of rocks assigned to the Triassic age.

On the present information, it is anticipated that the majority of the route will require a combination of ripping and blasting for excavation below about one or two metres. However this will depend to a large degree on the orientation and frequency of discontinuities in the rock mass.

RECOMMENDATIONS

A trial excavation is recommended using a traxcavator or similar machinery to test the results of the survey and to determine first hand, the capability of the machinery with respect to velocity ranges.

The trial excavation should be dug in the vicinity of Spreads 5 or 6 and examined geologically in order to check the above conclusions.

ROCK TYPES

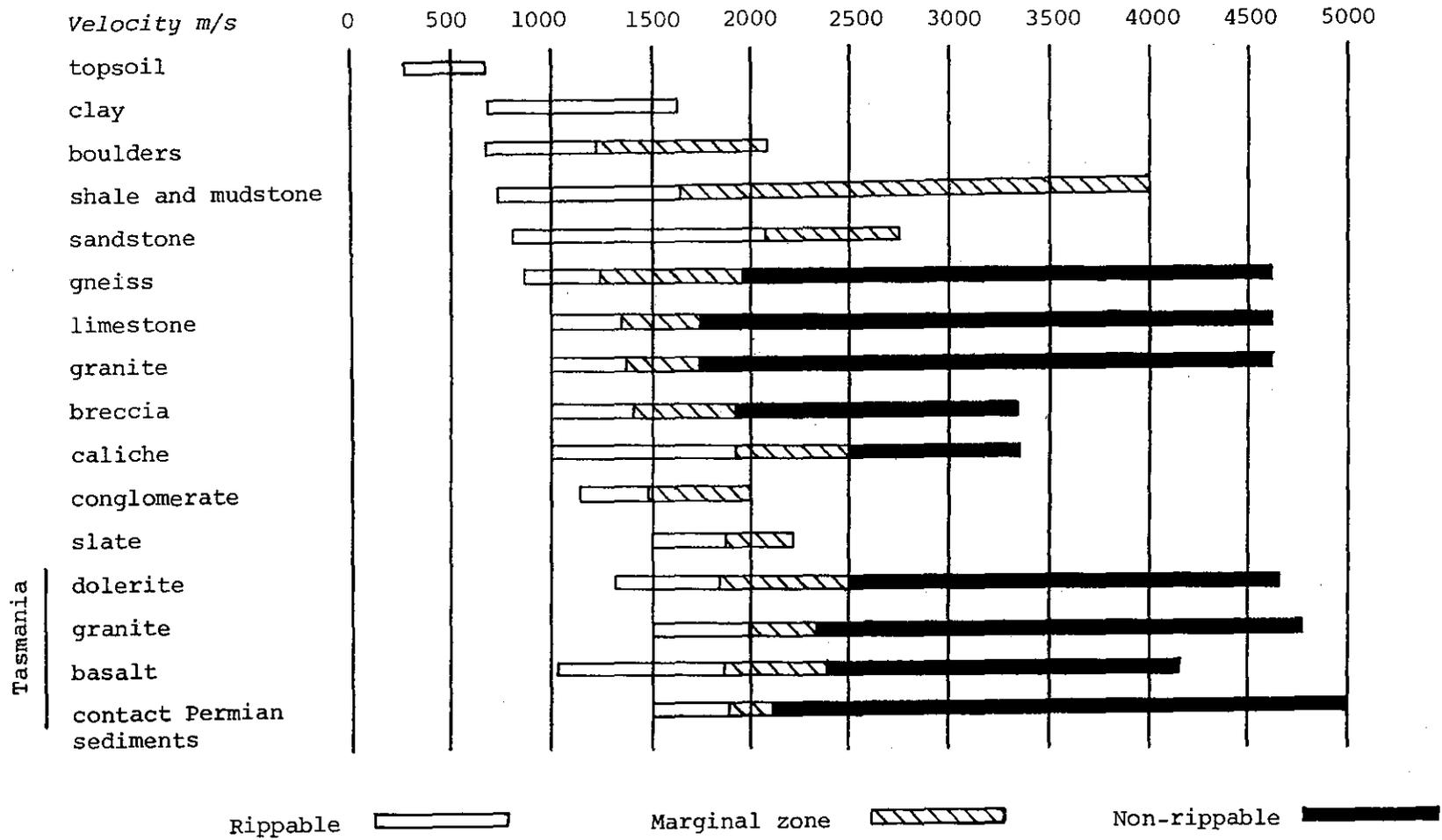


Figure 2. Guide to rippability (adapted from Soil Test Inc.)

5 cm

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