

1977/24. Foundation investigation for proposed Davey Street telephone exchange, Hobart.

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The site of the proposed new telephone exchange building [EN266515], by the existing Davey Street exchange was examined at the request of the Commonwealth Department of Construction, who requested technical assistance in carrying out a foundation investigation programme. The programme involved a single diamond drill hole to 20 m with a blow-out test on completion, and two test pits excavated by back-hoe to go to refusal, in order to obtain an indication of the degree of rippability of the rock.

It is understood that previous investigations involving drilling have been carried out. Nevertheless, the Department of Mines considered this work should be supplemented by a seismic refraction survey designed to provide a more comprehensive understanding of foundation conditions to the depth of proposed excavation.

GEOLOGY

The site consists of a variable thickness of surficial clay fill to a maximum of about 2 m overlying sandstone bedrock. The Triassic sandstone is variable both in the degree of weathering and frequency of jointing.

The bedrock is predominantly a fine medium-grained quartz sandstone frequently interbedded with a coarser sandstone. Both mica and feldspar (which comprise up to 10% of the rock) are common; mica is prevalent on bedding planes.

Test pits

The two test pits, sited about 30 m apart (fig. 1) highlighted the variable weathering of the bedrock and more importantly the degree of rippability.

Test Pit 2 encountered a slightly weathered competent sandstone below fill at 1.1 m. The back-hoe refused to excavate to a greater depth. A jackhammer successfully deepened a portion of the pit to 1.5 m. The bedrock at this location was closely jointed with defect spacings in the order of 100-200 mm. One major joint plane at 60°/140° (dip/dip azimuth) and several minor near-vertical joints with varying orientations were noted. All joints were tight.

The second test pit had one metre of clay fill overlying a moderately to highly weathered sandstone bedrock. The rock was completely stained with iron oxide and signs of physical disintegration were evident. The back-hoe easily excavated the pit to 1.5 m. The sandstone was partially friable, to the extent that a hand shovel could be used to deepen the test pit. The nature and orientation of defects were similar to that encountered in Test Pit 1. The minor joints were tight but the joint spacing was less (ranging between 20-60 mm). The major defect plane (65°/150°) had the same general orientation and spacing (c. 400 mm apart) as the counterpart in Test Pit 1. However, the joints were open and filled with up to 30 mm of brown to black sandy clay.

Both pits remained dry over the four day period they were left open.

Drilling

The core from the single diamond drill hole (total depth 17.75 m)

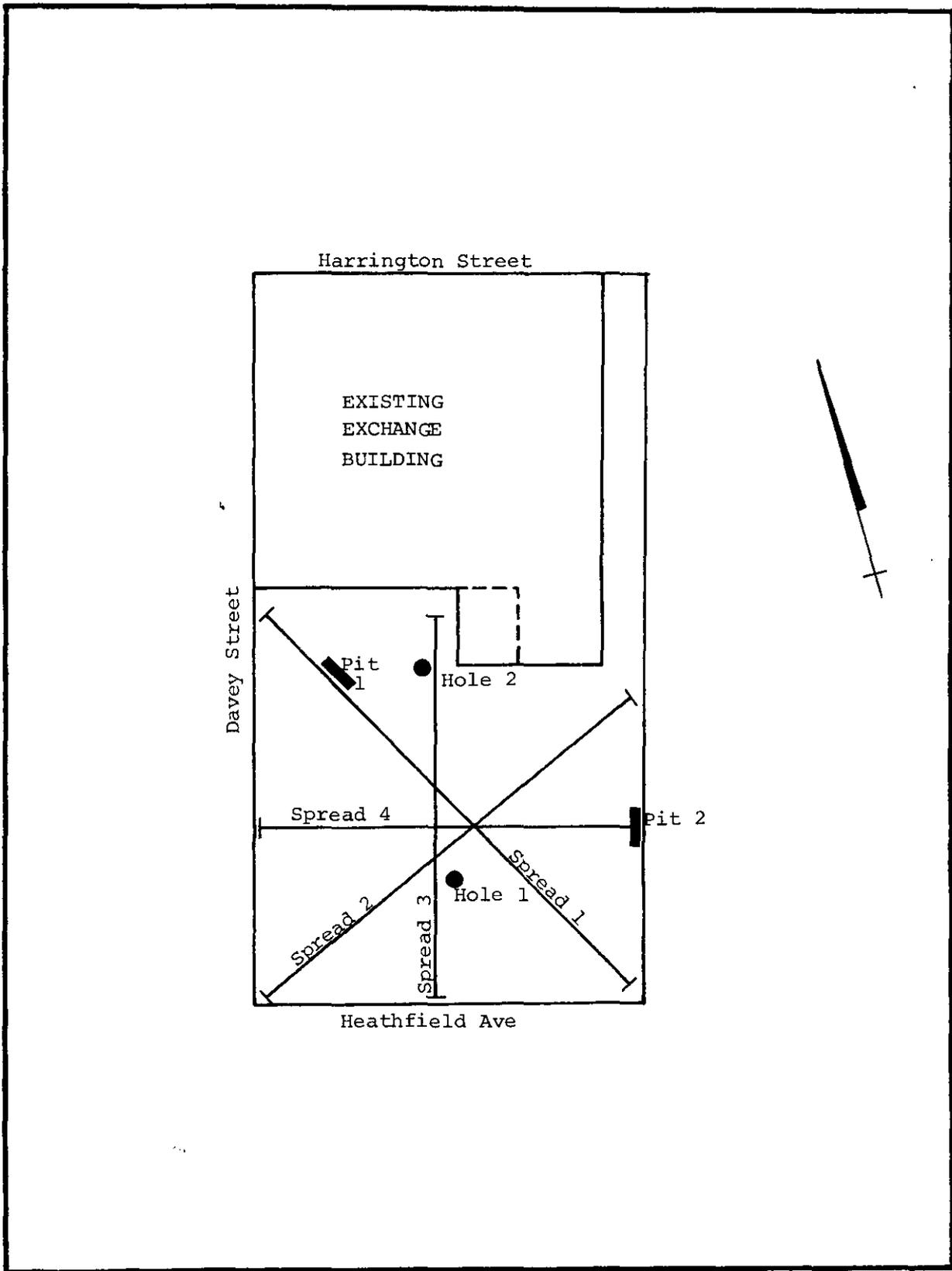


Figure 1. Drill hole, test pit, and seismic spread locations.

revealed an essentially slightly weathered sandstone profile to 12.9 m (table 2). The rock above this level, with the exception of a moderately weathered zone between 2.5-4.8 m, exhibited iron oxide staining along all joint surfaces and adjacent zones, but discolouration of the bulk of the rock was minimal. The sandstone below this depth was typically moderately to highly weathered with iron oxide staining extending throughout the rock. Signs of physical disintegration were also evident. Two clay seams, each about 50 cm thick were intersected at 5.45 m and 13.6 m respectively.

Core dip angles range between 20-25°, but the direction of dip of the sequence is unknown. The Triassic sandstone is generally closely jointed but includes fractured zones (defect spacings 60 mm or less) and zones where the jointing is moderately wide (defect spacings 200-600 mm). Infillings along joint planes were absent. Many of the joints encountered were either sub-horizontal (70-85°) or sub-vertical (0-15°) to the core axis. Joints intersecting the core at 30-50° were not uncommon.

Blow-out tests

A blow-out test was carried out at the completion of the coring of Hole 1. Water continued to be expelled for the duration of the test (approx. 15 minutes). It is difficult to correctly gauge the quantity of water being expelled from a blow-out test, but it was estimated to be about 910-1360 l/h (200-300 gal/h). The water level rose rapidly from 6.8 m and virtually stabilised at 2.65 m after one hour.

A second hole was drilled and intersected water at about 3 m. A relatively static water level of 1.85 m was reached after 10 minutes. Only minor fluctuations were recorded over the following week.

SEISMIC REFRACTION SURVEY

Four spreads were fired (fig. 1). The siting of the spreads and the positioning of the shot-firing points was governed by the presence of existing buildings and services, particularly the coaxial cable situated just inside the Davey Street boundary of the site.

The interpretation of the seismic results is shown in Table 1. The velocity curves were typically asymmetrical, very stepped and inverted, making interpretation difficult.

Three velocity layers were found at the site.

- (1) A surface layer ($V_0 = 400-700$ m/s).
- (2) A lower layer ($V_1 = 1000-1700$ m/s) with frequent steps up to an apparent velocity of 3500 m/s.
- (3) A bottom layer with $V_2 = 2000-2500$ m/s (Spreads 3 and 4 only).

The slower surface layer was interpreted as clay fill with a variable thickness (up to about 2 m). The absence of this slower V_0 layer in some of the results is because the shot depth equalled the fill depth.

The lower layer (V_1) is variable due to the irregularity of the fast refractor steps and the curve reversals. The stepping effect suggests a layered situation with an alternating sequence of weathered and fresh sandstone. This lower V_1 layer should be largely rippable but may require minor use of explosives where the fresher sandstone layers are either massively bedded or insufficiently fractured.

The bottom velocity layer (V_2) can only be interpreted as a correlative

Table 1. SEISMIC REFRACTION RESULTS, DAVEY STREET TELEPHONE EXCHANGE

Spread	Direction	Spread length (m)	Geophone interval (m)	Velocity layers (m/s)	Shape and character of Time/Distance plot	Comparison of velocity refractors	Geological interpretation
1	N-S	46	3.5	<p>SP North V_0 - absent V_1 = 1000-1700 with steps to 3500.</p> <p>SP South V_0 - absent V_1 = 1000-1500 with steps to 3500.</p>	Poor symmetry. Curve very stepped with marked inversion between geophones 6-7 SP north.	<p>V_0 absent at north end. First geophone not recording hence V_0 layer possibly not shown.</p>	<p>V_0 - fill. V_1 - weathered sandstone. Steps represent very hard layers of fresh sandstone. The velocity reversal may represent a perched water table situation.</p>
2	E-W	39	3.0	<p>SP East V_0 - absent V_1 = 1000-1500 with steps to 3000.</p> <p>SP West V_0 = 700 V_1 = 1000-1500 with steps to 3000.</p>	Asymmetrical and stepped with curve reversal between geophones 6-7 SP west.	<p>V_0 layer not seen at eastern end as first two geophones not recording.</p>	<p>V_0 - fill. V_1 - weathered Triassic sandstone alternating with fresh hard sandstone layers.</p>
3	NE-SW	33	2.5	<p>SP North-east V_0 - absent V_1 = 1250-1400? with steps to 2500. V_2 = 2500</p> <p>SP South-west V_0 - absent V_1 = 1250 with steps to 2500. V_2 = 2500</p>	Very stepped and irregular with inversion between geophones 6-7 SP NE	<p>V_0 absent at both ends. Repetition of V_1 and V_2 layers from each shot point. V_2 doubtful as a correlative layer and is possibly the effect of pronounced stepping in the V_1 layer.</p>	<p>V_1 - weathered sandstone. V_2 - fresh hard sandstone. Stepping effect suggests an alternating sequence of weathered and fresh rock.</p>
4	NW-SE	26 33.5 (extended shot SE)	2.0	<p>SP North-west V_0 = 400 V_1 = 1000 V_2 = 2000</p> <p>SP South-east V_0 = 400 V_1 = 1000 V_2 = 2000</p> <p>SP SE (extended) V_2 = 2000</p>	Symmetrical and stepped with curve inversion in centre of spread	<p>V_0 seen at both ends. V_1 appears below surface layer V_0 at both ends also. V_2 layer is shown quite strongly in extended shot and in SP NW.</p>	<p>V_0 - fill. V_1 - weathered Triassic sandstone. V_2 - fresh hard sandstone. Bedrock occurs as alternating zones of fresh and weathered sandstone.</p>

24-4

layer on Spreads 3 and 4 where it tends to persist over three or more geophone intervals. It is thought to represent a fresh competent sandstone. Velocities of the order of 2000-2500 m/s are approaching the upper limit of rippability. It is likely that some explosives may be required if a machine cannot utilise to advantage the bedding and jointing discontinuities of the rock mass.

CONCLUSIONS

The bedrock at the proposed new telephone exchange site is Triassic sandstone. The sequence dips at 20-25° in an unknown direction. The rocks are generally closely jointed, and fractured zones are likely. The weathering pattern is likely to be variable in depth and extent as a result of the probable perched water table situation within the bedrock. Consideration must be given in the design to the anomalous situation of increased weathering with depth and an appreciable groundwater flow.

Provision should be made to control the expected continual inflow of groundwater during excavation and a suitable means of keeping the basement areas free of water throughout the life of the building.

It is envisaged that the majority of the rock encountered during excavation will be rippable with a large machine, but some use of explosives may be required.

[29 June 1977]

Table 2. LOG OF DIAMOND DRILL HOLE 1.

Depth (m)	Description
0-1.5	Pre-collar - clay fill.
1.5-2.5	1.5 m: Commence coring. <i>SANDSTONE</i> : Predominantly medium- to fine-grained quartz sandstone with up to 10% mica and feldspar content. A coarse-grained sandstone is frequently interbedded with the medium-fine grained sandstone. Quartz grains are sub-angular to sub-rounded. Bedding core angles vary between 20-25°, but direction unknown. Slight weathering is evident on joint surfaces; the degree and depth of Fe-oxide staining is variable. The rock is moderately widely jointed with angles of 20° and 70° to core axis being noted.
2.5-4.8	<i>SANDSTONE</i> : Moderately weathered, very closely jointed to highly fractured. Fe-oxide staining extends throughout the whole rock. Defect spacing is 60 mm or less. Jointing generally vertical to sub-vertical and sub-horizontal.
4.8-5.45	<i>SANDSTONE</i> : Fine- to medium-grained quartz sandstone intercalated with a coarser sandstone. Rock is slightly weathered and very closely jointed. Staining beyond joint surfaces is minimal. Joints essentially sub-vertical (0-15°), sub-horizontal (70-85°) and 30-40° to core axis.
5.45-5.50	<i>CLAY</i> : Fawn gritty soft clay with fragments of extremely weathered sandstone dispersed throughout.
5.5-7.8	<i>SANDSTONE</i> : Slightly weathered and closely to very closely jointed.
7.8-12.9	<i>SANDSTONE</i> : Slightly weathered to fresh. Defects are dominantly sub-horizontal to core axis and generally moderately widely spaced (200-600 mm). Jointing tends to be very close at 9.2-9.3 m and 12.3-12.4 m in particular. Slight Fe-oxide staining on joint surfaces although bulk of rock unaffected by weathering.
12.9-14.6	<i>SANDSTONE</i> : Moderately to highly weathered and closely jointed. Abrupt colour change to Fe-oxide brown. Joint planes either sub-horizontal or between 50-70° to core axis. <i>CLAY</i> seam at 13.6 m: 50 cm of fawn soft gritty clay followed by 150 cm of very closely jointed extremely weathered sandstone.
14.6-14.9	<i>SANDSTONE</i> : Moderately-highly weathered as above but fractured.
14.9-16.6	<i>SANDSTONE</i> : Moderately weathered bedrock exhibiting moderately widely spaced horizontal joints.
16.6-17.75	<i>SANDSTONE</i> : Moderately-highly weathered. Defect spacings generally at right angles to core axis with a frequency spacing of 20 mm or less.
	Hole terminated at 17.75 m.

N.B. Individual core run depths were not kept at time of drilling. The calculated depths in the above log are based on an 80% average core recovery. There are therefore only approximate.

Driller: H. Stacpoole.



Plate 1. *Test pit 1 showing slightly weathered, closely jointed sandstone [CN5148].*



Plate 2. *Detail of jointing in Test Pit 1 [CN5144].*



Plate 3. *Test Pit 2 showing the moderately weathered nature of the bedrock. The pen points to a major joint plane infilled with clay [CN5146].*



Plate 4. Core from Hole 1,
1.5-5.5 m [CN5051].

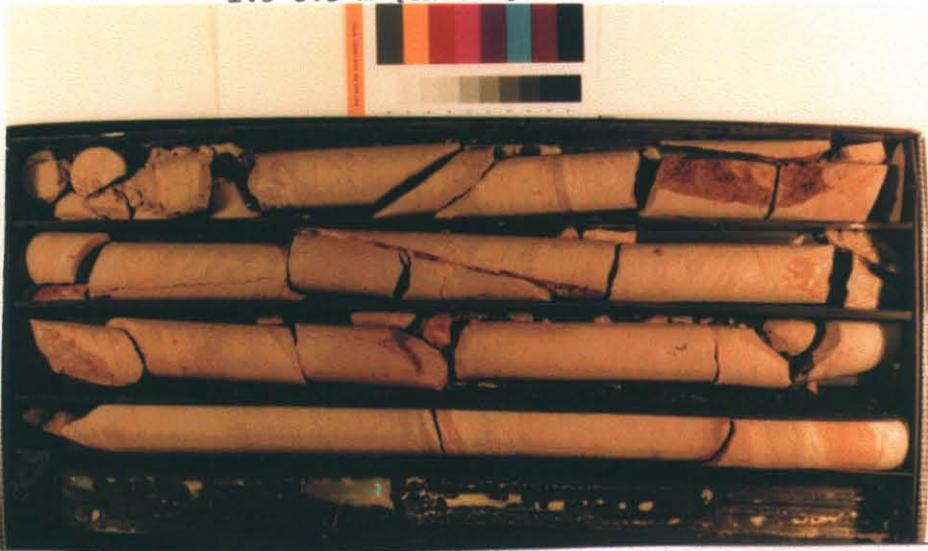


Plate 5. Core from Hole 1,
5.5-8.75 m [CN5052].



Plate 6. Core from Hole 1,
8.75-12.75 m [CN5053].

5 cm

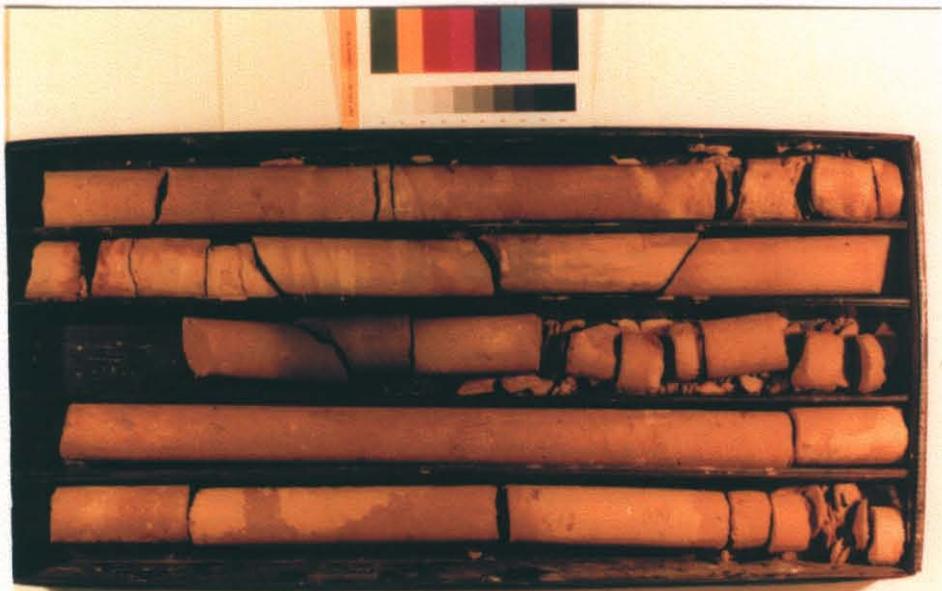


Plate 7. Core from Hole 1,
12.75-16.75 m [CN5054].

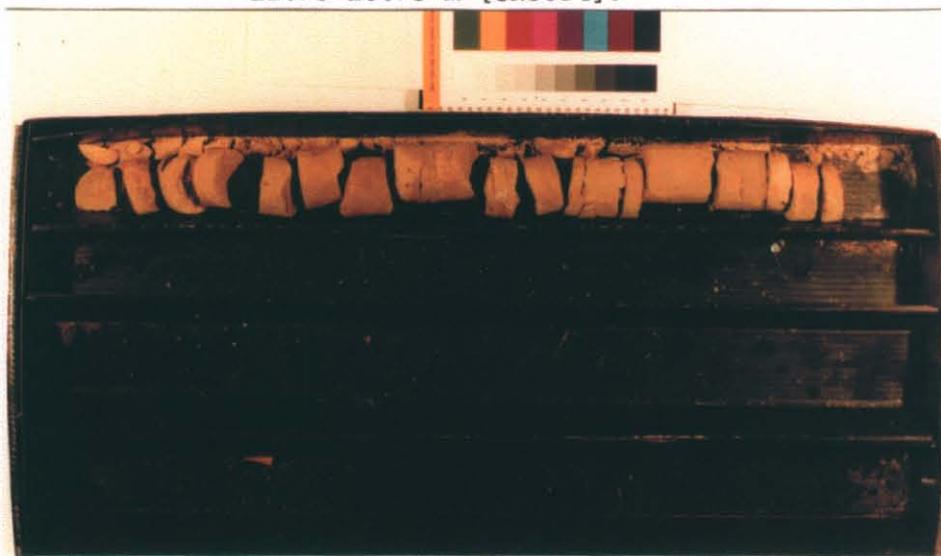


Plate 8. Core from Hole 1,
16.75-17.75 m [CN5055].

