DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD 1975/179

GEOLOGICAL AND GEOPHYSICAL INVESTIGATIONS AT EMU BANK, BELCONNEN TOWN CENTRE, A.C.T., 1975

by

G. BRISCOE & D.C. RAMSAY

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CONTENTS

SUMMARY

Subsurface investigations of a number of proposed building sites in the Belconnen Town Centre have located a wide (16–50 m) linear zone of weak and fractured rock. This feature, the Deakin Fault Zone, underlies a north-south trending ridge, Emu Bank, which has been designated for high-rise development.

Three of the four proposed building sites investigated lie adjacent to or across the fault zone, and relocation of some of them may have to be considered. Subsurface conditions in adjoining areas are not well known, and drilling is recommended. Seismic results indicate that the depths of weathering are not significantly shallower outside the fault zone, but higher velocities indicate that the rock will be stronger and probably less fractured.

INTRODUCTION

At the request of the National Capital Development Commission (NCDC), an investigation of several proposed building sites on Emu Bank within the Beloonnen town centre was undertaken in May 1975. The construction of four high-rise buildings is being considered for these sites as one of the major stages in the development of the town centre, which will be concentrated around the western and southern sides of Lake Ginninderra. Information about the subsurface conditions was required, to evaluate the proposed land allocation.

The investigation included five seismic traverses over a total distance of 1900 m, five diamond-drill holes to an average depth of 20 m, and surface mapping of cuts and excavations (Plate 1). Additional subsurface information has been obtained from Ground Test Pty Ltd (1975a, b), who recently completed site investigations for the proposed retail complex adjacent to Benjamin Way. Their investigations included 15 drill holes to an average depth of 8.4 m on a site east of Benjamin Way, and 28 drillholes on a site west of Benjamin Way.

PHYSIOGRAPHY

The town centre is being developed on gently undulating terrain which slopes down to the recently constructed Lake Ginninderra. Before this water feature was constructed, Ginninderra Creek followed a V-shaped course around more hilly ground to the north; the creek was entrenched up to 10 m in the surrounding land surface. Emu Bank is a north-south trending ridge near the southwestern extremity of the lake.

SEISMIC REFRACTION METHOD

The seismic refraction method utilizes the fact that elastic waves travel with different velocities through different rocks. At a boundary between rocks of different acoustic properties, some of the incident energy will be transmitted, some reflected, and some refracted. Geophones record the time of arrival of this energy back at the ground surface. From a graph of the time taken for the energy to reach each geophone versus distance of each geophone from the source of energy, the depths to subsurface layers and the velocity of propagation of seismic energy in these layers can be calculated (Dobrin, 1952). From this measured velocity, soils, weathered rock, and unweathered rock can be distinguished, but the rock type cannot be identified. Generally speaking, the higher the velocity, the fresher the rock will be. The accuracy of depth determinations is estimated to be ± 25 percent, with a best figure of about ± 10 percent in favourable conditions (Polak & Hawkins, 1956). Likewise, a change in bedrock velocity can only be located only to within two to three geophone spacings (8 to 12 m), depending mainly on the contrast between the velocities.

On this survey, depths to refracting layers were calculated from intercept times and a modification of the reciprocal method (Hawkins, 1961). Geophone spacings of 4 m were used throughout the survey and shots were fired in the centre of each spread, and at 2 m and generally 74 m beyond each end. The spreads were laid end on end along the traverse lines, except where obstructions prevented this. BMR's truck-mounted 24-channel SIE PSU-19 refraction equipment with 8Hz GSC-20D geophones was used.

SEISMIC RESULTS

The interpreted seismic cross-sections are shown in Plates 2 and 3. The seismic properties of the subsurface form a three-layer structure, with the degree of weathering decreasing with depth. The top layer, with a seismic velocity in the range 300-600 m/s is interpreted as surface soil and clay, completely weathered rock, and fill material. The intermediate layer, with velocity generally in the range 1500-2400 m/s is interpreted as highly to moderately weathered rock. Bedrock can generally be classified as having a velocity of either about 3400 m/s or about 4500 m/s. The higher velocity probably represents slightly weathered to fresh rock; the lower velocity might represent either a more jointed or fractured band of the same rock, or a different rock type with different weathering characteristics. It is impossible to distinguish between these two possibilities using the seismic information alone.

These two characteristic bedrock velocities are separated by a linear zone trending roughly N-S, displaying a very much reduced velocity; the intermediate layer also displays a reduced velocity in this zone. This reduction in seismic velocity indicates fractured or sheared rock and is interpreted as the Deakin Fault Zone, a major fault in the Canberra area. Another band of reduced seismic velocity (2600 m/s) was recorded at the western end of traverse 4. (It was also recorded on traverse 3 about 30 m west of chainage zero, but the recorded data was only suitable to calculate bedrock velocity). This could be another fault zone or a narrow band of different rock type, possibly a dyke.

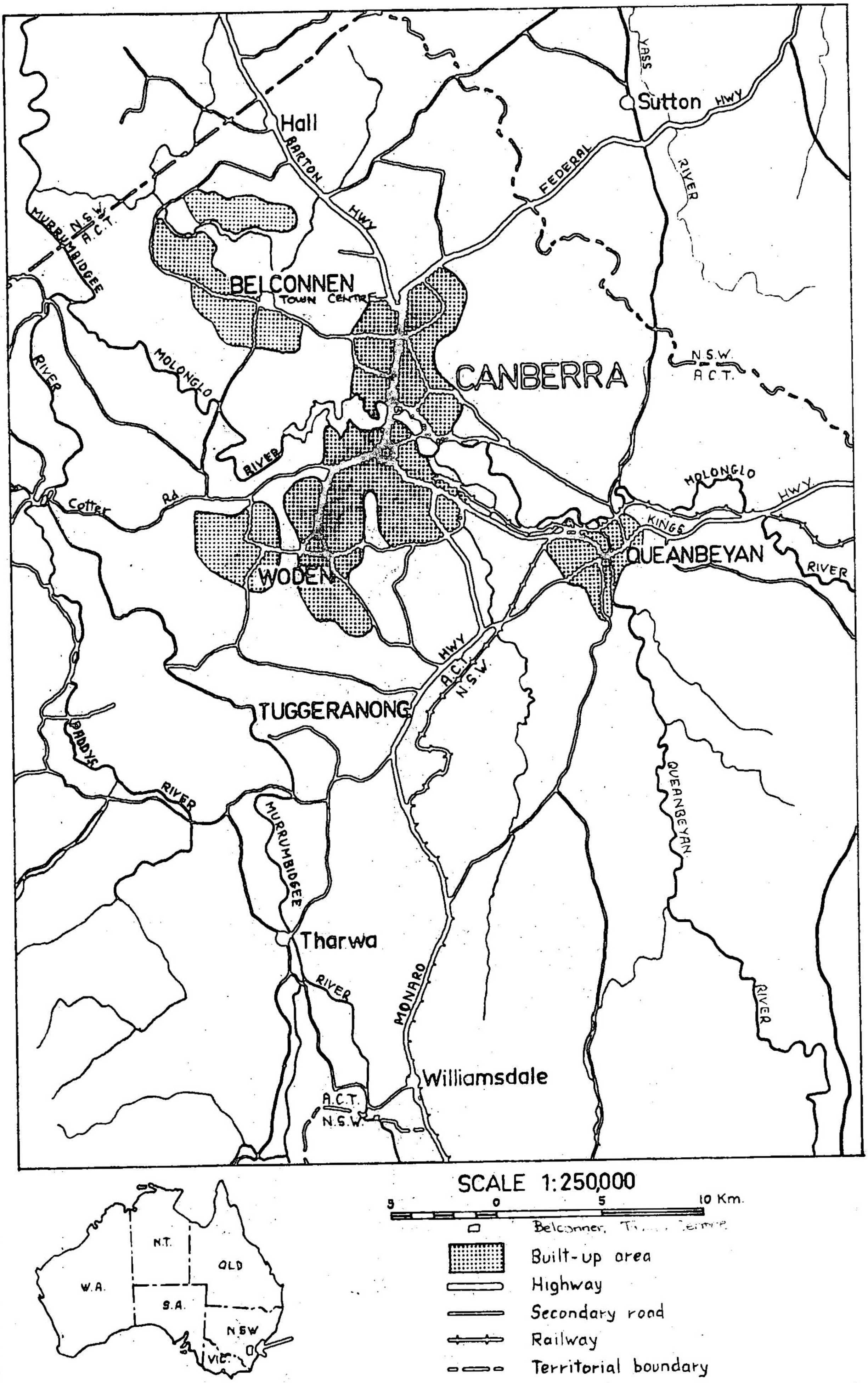

Fig.1 Location map

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I55/A16/1403

Traverse 4, which continued farther east than the other traverses, shows that the lower-velocity bedrock to the east of the fault did not continue beyond chainage 350 m, where the average velocity increased to 4600 m/s. Thus there appears to be a band of low-velocity bedrock (3400 m/s) (about 150 m wide at the location of Traverse 4) extending eastward from the Deakin Fault Zone and wedged between bedrock of a higher seismic velocity (4600 m/s). At the eastern end of the traverse there is another zone of reduced velocity which probably represents another fault.

Traverse 5, aligned N-S, is in or close to the Deakin Fault Zone. Bedrock velocity recorded in this direction is slightly higher than in the E-W direction because seismic energy is propagated at a higher speed along a line of fractures than across one. There is a reasonable correlation of depths to subsurface layers between this traverse and the E-W traverses.

Generally speaking, consolidated material with a seismic velocity greater than 1500 m/s will require some degree of prior blasting before it can be removed, whereas material with a seismic velocity less than 1500 m/s can be removed with conventional heavy machinery (Caterpillar Tractor Company, 1966). Thus any excavations extending into the intermediate layer will probably require blasting, except in the fault zone where the reduced seismic velocity indicates fractured rock, which should be more easily removed.

GEOLOGICAL INTERPRETATION

The investigation area is underlain by porphyritic acid to intermediate igneous rocks. Examination of excavations and drill cores indicates that a number of different igneous lithologies are present. Plate 1 summarizes the geology in the investigated area, and Figure 2 is an interpretative section east-west across the Deakin Fault Zone.

West of the Deakin Fault Zone

To the west of the Deakin Fault Zone, the most abundant rock type is a coarse-grained acid igneous rock. When fresh it is grey-green and porphyritic, with phenocrysts of quartz, plagioclase, and biotite in a finer-grained groundmass. Fine, disseminated pyrite is a common accessory, and thin quartz veins (less than 5 mm) and epidote-sericite veins are also abundant. Alteration of the plagioclase and ferromagnesian minerals increases towards the fault.

Adjacent to the fault zone, the rock is closely fractured, and contains narrow (up to 4 cm), subhorizontal zones of weak, highly to extremely weathered rock and clay. Near the fault zone the rock is closely jointed with tight, discontinuous joints; further away from this zone, joints are open, continuous and widely spaced (average 0.3 to 1.0 m), and are coated with clay, limonite, hematite, and chlorite.

The seismic results indicate that strong, fresh to slightly weathered rock is found at depths of 9 to 19 m, with depths increasing slightly towards the fault.

A low-velocity (2600 m/s) zone striking NW-SE was intersected by traverses 3 and 4 of the seismic survey (Plates 1, 2, and 3) in this western area. Drilling by Ground Test Pty Ltd (1975a; Drillhole 9) intersected a weathered andesite, very close to this weak zone. A summary of the Ground Test Pty Ltd drill logs is given in Figure 3. The core sample was highly to moderately weathered andesite at 7.9 m; it was closely jointed, and consisted of a clay-rich fine-grained groundmass with altered ferromagnesian phenocrysts. The low-velocity zone might be either a small fault, or a dyke of deeply weathered rock.

The Deakin Fault Zone

The Emu Bank ridge is the surface expression of the Deakin Fault Zone. Within this zone of lower-velocity material (1900-2800 m/s), very closely fractured and jointed partly silicified igneous rock with massive quartz veins is present. Table 1 summarizes the fault zone features based on the seismic results.

Drill hole B1 is located on traverse 1 within the fault zone, and drill holes B2 and B3 are very close to the main zone of faulting. Table 2 summarizes the rock conditions in the drill holes, and detailed drill logs are contained in the Appendix.

Within the investigation area the Deakin Fault occupies a curved zone 16 to 50 m wide which strikes 170° in the south (Section 54) and 130° in the north (through Section 55).

The rock conditions and depths of weathering in most of drill hole B1 are considered to be representative of the fault zone. The low-velocity layer (1400-1600 m/s) from 12 to 20 m below the surface consists of very closely fractured quartz and silicified volcanic rock with weak zones of highly to extremely weathered rock and clay; fault breccia and slickensides are common.

Fig. 2 Section XX' across the deakin fault zone

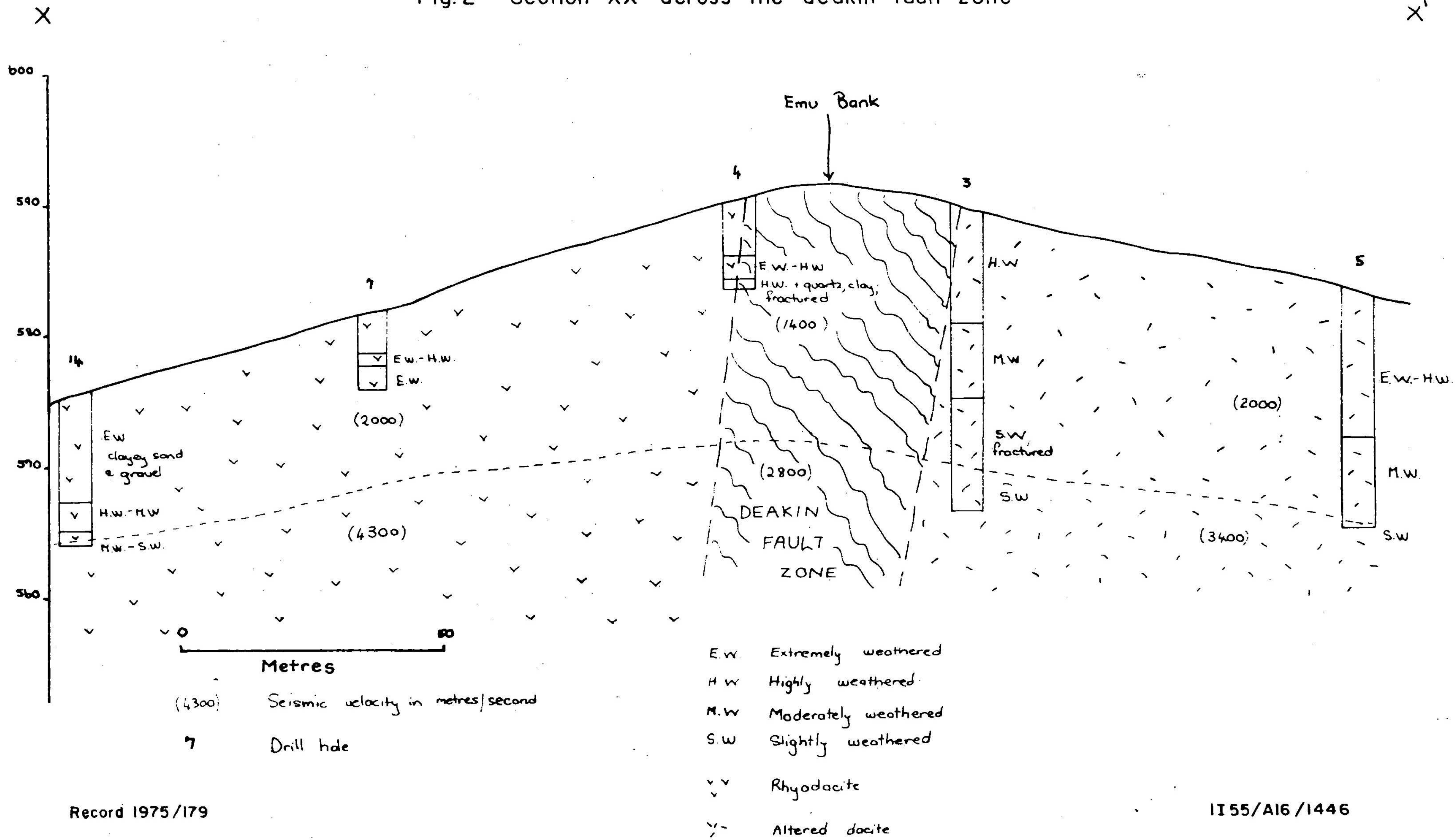

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TABLE 1: SUMMARY OF FAULT ZONE FEATURES (based on seismic results)

Traverse	Width	Depth to moderately weathered rock	Velocity of deepest refractor (m/s)
T1	16–32 m	15–17 m	2800
T2	50 m	20 m	1900–2800
T3	24+m	15 m	2300
T4	24+m	16 m	2800

TABLE 2: SUMMARY OF ROCK CONDITIONS (based on drill logs)

Drill hole no.	Depth to moderately weathered rock	Rock description
B1	18 m	Fault zone material: fractured and jointed quartz, silicified rock, and breccia; extremely weathered zones with clay and gravel
B2	17 m	Grey-green rhyodacite: fractured, closely jointed, sheared, moderately strong
B3	10 m	Grey-green and fawn porphyritic volcanics: fractured, brecciated, silicified, quartz-veined, closely jointed
B4	10 m	Porphyritic rhyodacite: grey-green, strong, closely jointed
B5	15 m	Grey-green volcanics: closely fractured and jointed, sheared, with clay and gravel bands

At greater depths the rock is moderately to slightly weathered (velocities of 1900–2800 m/s), and closely fractured with open joints coated with clay, chlorite, and iron oxides. Zones of extremely weathered rock and clay are common and average 20 cm in width.

Adjacent to the fault, abundant quartz veins and closely fractured and jointed rock are considered to be evidence of shearing. The depth to moderately weathered rock varies from 10 to 18 m, which is only slightly shallower than in the fault zones; however, the rock is stronger and less fractured.

East of the Deakin Fault

An accurate description of the lithology to the east of the Deakin Fault is not possible owing to poor-quality cores from drill hole B5. The rock is a sheared, porphyritic altered dacite with little or no quartz. When slightly weathered, the rock is pale grey-green to fawn with a fine-grained groundmass and larger (1–2 mm) feldspar and altered ferromagnesian phenocrysts. Accessory pyrite is also present.

The seismic velocity of the deepest refractor (3400 m/s) is lower than that to the west of the fault, and is attributed to closer fracturing, jointing, and the presence of wide clay zones. The core from drill hole B5 is very closely fractured with wide zones of clay and extremely weathered rock; as it is close to the contact with the adamellite, it may have intersected sheared rock near the contact; however, seismic traverse 4 (Plate 3) does not indicate any zone of weakness at the contact with the adamellite.

The area to the east of Emu Bank Road and across the southern extension of the lake is underlain by adamellite, a very coarse-grained, porphyritic acid intrusive rock which contains large (up to 2 cm) phenocrysts of plagioclase and quartz in a coarse-grained groundmass. Biotite is commonly altered to chlorite, and garnet and magnetite are present as accessories. Strong, slightly weathered to fresh rock (seismic velocity 4600 m/s) occurs below 8 to 12 m. On the eastern extremity of the mapped area a fault zone was detected by seismic traverse 4; this had been mapped previously by G.A.M. Henderson (pers. comm.) as a normal fault dipping to the east.

Seismicity

The Deakin Fault is a major structural feature of the Canberra area. It is a normal fault dipping steeply to the west, with downthrow to the west (Wilson, 1966). Displacement movement along the fault probably occurred during the Palaeozoic (over 200 million years ago), and further movement is considered unlikely. The fault zone remains as a line of weakness, but recorded seismic data for the Canberra region does not indicate that the fault is active, and the seismic risk is considered negligible, as it is for the rest of Canberra. It should be emphasized that buildings located on faults are not necessarily more susceptible to damage than buildings a few kilometres away.

FOUNDATION AND EXCAVATION CONDITIONS

It should be emphasized that only one hole has been drilled on each building site; as rock conditions are likely to vary over short distances in such an area, one hole is not representative of a site. Marked differences in rock conditions and the bearing capacities of rocks within and adjacent to the fault zone are to be expected, and detailed site investigations will be required for the design of foundations. For high-rise development it may be preferable to relocate some buildings in order to avoid the problems of differential settlement and deep excavation, both of which are likely to increase the cost of foundations. The depth to moderately or slightly weathered rock within the fault zone does not vary greatly from that of the adjacent rocks, but there is a marked increase in the intensity of shearing, and consequently a decrease in rock strength.

Of the sites investigated, site D appears to have been least affected by the adjacent fault zone. Slightly to moderately weathered rock is present at depths of 11–16 m; the rock is closely jointed in places (average spacing 10 cm), with tight, discontinuous joints dipping at 30–60°.

The other sites are less favourable; parts of buildings A, B, and C will probably be located on the Deakin Fault Zone. It is difficult to predict the excavation and foundation conditions on these sites but differential settlement might be a problem. The seismic results indicate a low-velocity zone (1900 m/s) at site B, but it is not possible to locate this zone with sufficient accuracy from seismic information alone. An accurate location and description of the low-velocity zone will be necessary for foundation design of the building.

Building site A is on the eastern margin of the fault zone. The nearby drill hole, B1, passed out of the sheared material at a depth of about 12 m, and that would suggest that the fault dips to the west. The rock should be readily excavated by mechanical methods, but the walls of the excavation may be unstable owing to very closely spaced open joints coated

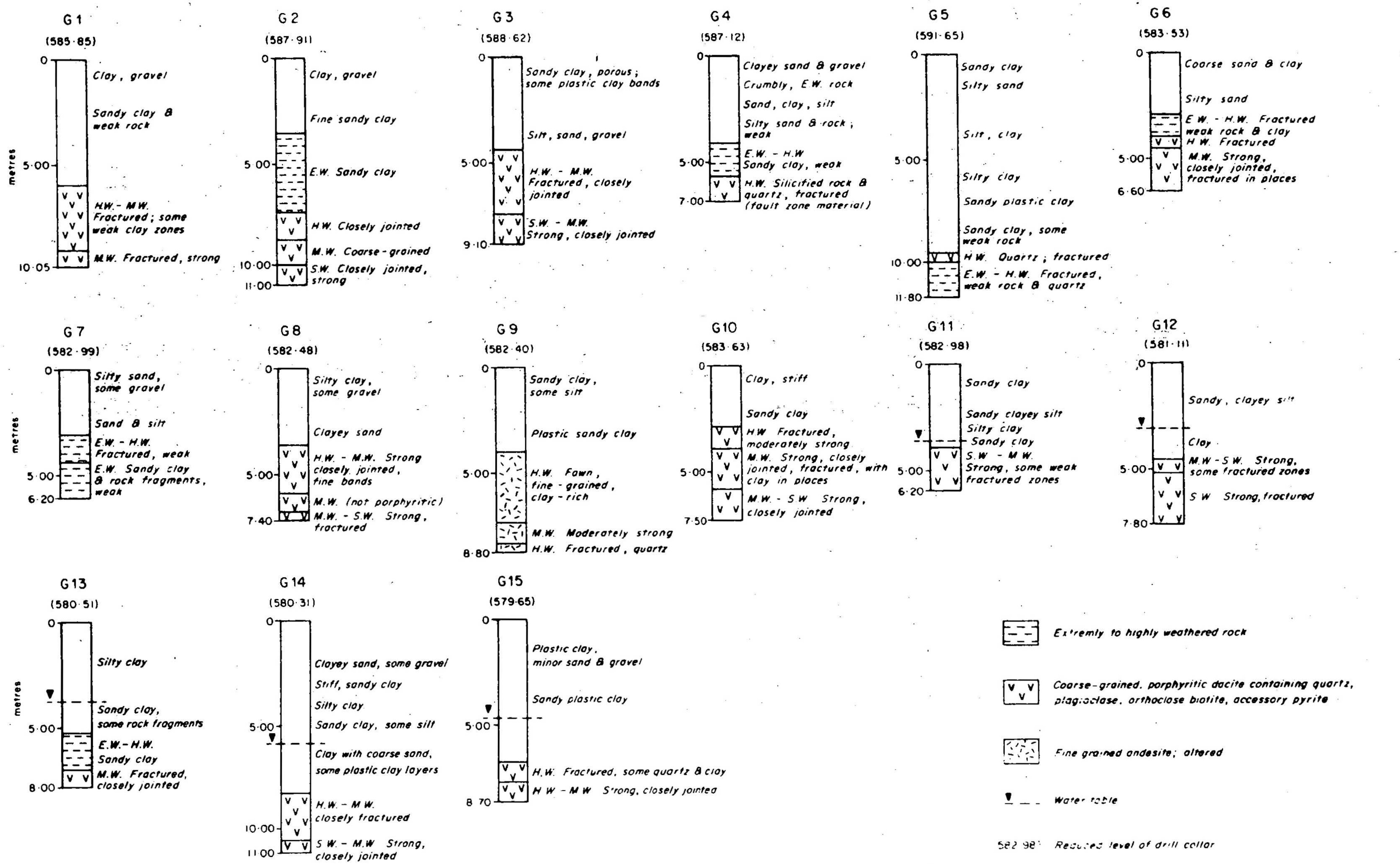

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Fig. 3 Logs of ground test drill holes

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with clay and chlorite.

Ground Test Pty Ltd (1975b) reviewed the available drilling information from the 4 sites, and their comments are summarized as follows:

1. The information available is insufficient for detailed design of the buildings.
2. If the design is conventional then is should be feasible to found the buildings on shallow footings or piers at relatively shallow depth.
3. There is a possibility of differential settlement if major discontinuities occur within the site, and if the building design has high unit loadings.

Groundwater conditions at these building sites are unknown. The Ground Test Pty Ltd results show that the water-table lies between 3 and 6 m from the surface adjacent to Benjamin Way, which overlies a former drainage channel. On Emu Bank the water-table is expected to be deeper, and no problems with groundwater inflow are anticipated.

CONCLUSIONS

The following conclusions on the geological conditions at these sites are relevant to the planning of this area.

1. A wide (16-50 m) fault zone of weaker material (seismic velocities 1900-2800 m/s) strikes NW-SE and passes through, or close to the building sites. This zone, the Deakin Fault Zone, is an ancient structural feature, and is not considered to be seismically active.
2. Weathering conditions do not vary greatly from within the fault zone to the adjacent rocks, but the degree of fracturing is greater in the fault zone and lower velocities were recorded there.
3. Moderately to slightly weathered rock (seismic velocities greater than 2500 m/s) occurs throughout the area at depths of 10 to 18 m, and is capable of supporting multistorey buildings on end-bearing piles.
4. A building site that is partly on the fault zone may require raft or piled foundations in order to reduce differential settlement.
5. The location and composition of a weak zone (seismic velocity 1900 m/s) near site B will require investigation to assess its influence on foundation design.

6. Mechanical excavation of the highly sheared and fractured rock of the intermediate-velocity layer will be easily achieved, but steep rock slopes may be unstable owing to the close irregular fracturing and abundant weak zones.

REFERENCES

CATERPILLAR TRACTOR COMPANY, 1966 - HANDBOOK OF RIPPING: A GUIDE TO GREATER PROFITS. Peoria, Illinois, Caterpillar Tractor Company.

DOBRIN, M.B., 1952 - INTRODUCTION TO GEOPHYSICAL PROSPECTING. New York, McGraw-Hill Inc.

GROUND TEST PTY LTD., 1975a - Report on foundation conditions, Belconnen town core, April 17, 1975, Sydney, Ground Test Pty Ltd.

GROUND TEST PTY LTD., 1975b - Report on sub-surface investigation, Belconnen town centre, August 7, 1975. Sydney, Ground Test Pty Ltd.

HAWKINS, L.V., 1961 - The reciprocal method of routine shallow seismic refraction investigations. Geophysics, 26(6), 806-19

POLAK, E.J., & HAWKINS, L.V., 1956 - Seismic refraction survey of the Dawson River dam site, Queensland. Bur. Miner. Resour. Aust. Rec. 1956/108 (unpubl.).

WILSON, E.G., 1966 - Preliminary geological investigation of Belconnen areas 5, 6, 7, 8 and 9, Australian Capital Territory. Bur. Miner. Resour. Aust. Rec. 1966/67 (unpubl.).

APPENDIX

LOGS OF DIAMOND-DRILL HOLES

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: BELCONNEN TOWN CENTRE
LOCATION: Section 55 (north of block 1)
ANGLE FROM HORIZONTAL (θ): 90° DIRECTION:
COORDINATES: 077479 (1:50,000) R.L. OF COLLAR:

HOLE NO. 1
SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
	No Core				1						
Clay	Clay with qtz. silicified volcanics.								FAULT ZONE		
E.W. Volcanics. Quartz.	Fractured qtz. E.W. volcanic fragments in orange-yellow sandy clay. Qtz. tough. Some Fe staining.			100 95	2 3 4				(clay mostly washed out in this lift.)		
	No Core								Rock roller used - qtz. chips recovered		
H.W. Volcanics	Fault breccia of quartz recemented by quartz; in places tough. Fractured zones with quartz, grit, clay. Fe clay-rich seams developed on E.W. volcanics. Silty clay seam at 7.4-7.5m, medium plasticity, grit + rock core to 20cm long same clay seams - frac. zones. Sandy clay + H.W. vols. (c. grained feldspars altered)		V		4.57 5 6 7 7.31 8 8.51 9 9.62 10 11 11.52 12 13 13.41				Clay seam 5.4-5.6m. Clay on joints.		
Clay	Sandy clay with rock fragments: qtz. (3-4cm)				14						
S.W. Volcanics	Fine grained, black. Fractured: strongly silic.		V								
Clay	Sandy clay with rock fragments - coarse quartz sand.				15 16 17.06 17						
E.W. Rhyodacite clay	Sandy clay with angular rock fragments. (1-5cm)				17.98 18						
S.W. - M.W. Rhyodacite	Brecciated rhyodacite recemented with qtz. E.W. Volcanics with clay, sand.		V		18.48 19.02 19 19.73 20				Vein quartz, closely fractured		

Drill type: Mayhew 1000
Feed: Mechanical Pull Down
Core barrel type: Triefus
Driller: L. Keast
Commenced: May '75
Completed: May '75
Logged by: G. Briscoe
Vertical scale: 1:100
Checked by:

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blocked in.
Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.
Defect Frequency — Number of natural defects (shears, joints, fractures) per 25cm of core occurring at specified intercept angle range.
Water Level Measurements — ▼ Level when hole in progress at specified depth
▽ Level in completed hole on specified date.

E.W. Extremely weathered
H.W. Highly weathered
M.W. Moderately weathered
S.W. Slightly weathered

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blocked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: BELCONNEN TOWN CENTRE
LOCATION:
ANGLE FROM HORIZONTAL (θ):
DIRECTION:
COORDINATES:
R.L. OF COLLAR: 590.0 m

HOLE NO. 1
SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle 0 30 60 80 90	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
S.W. – M.W. Rhyodacite	Brecciated rhyodacite. As above.		V V		20.95						
	No core				21 21.56						
S.W. – M.W. Rhyodacite	Green-grey & purple: coarse grained: moderately strong		V V		22 22.47				Smooth shear planes with chlorite.		
M.W. – E.W. Rhyodacite	Rock fragments; sandy clay.		V		22.96				Less alteration on shears.		
M.W. Rhyodacite	Recemented volcanics + qtz. Fract. in places with sandy clay + rock Frag. core → to 10cm.		V V		23 24				Smooth joint planes; closely jointed.		
	End of hole 24.07m										

Drill type
Feed
Core barrel type

Driller
Commenced
Completed
Logged by
Vertical scale

Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blocked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth.
▽ Level in completed hole on specified date.

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: BELCONNEN TOWN CENTRE
LOCATION: Section 51 (eastern side)
ANGLE FROM HORIZONTAL (θ): 90°
DIRECTION:
COORDINATES: 078477 (1:50,000)
R.L. OF COLLAR: 590.5 m

HOLE NO. 2
SHEET 1 OF 2

Rock Type and Degree of Weathering	Description (Lithology, colour, strength, etc.)	Lift and % core recovery	Depth (m)	Structures (Joints, veins, seams, faults, etc.)
	No core		1 – 1.52	
	Sandy clay - qtz → 5mm			
E.W. Rhyodacite	Buff coloured, fine grained groundmass - coarse: qtz - 5mm weak - frac.		2	
	No core			
H.W. Rhyodacite	Buff coloured, fractured, weak.	70	3 – 4 – 4.57	Joints steeply dipping. Fe & clay on joints.
	No core		5 – 7 – 7.53	
H.W. Rhyodacite	As above - less fractured.		8	
E.W. Rhyodacite	Buff. Weak.		9	
	Sandy clay. Angular rock frag.		9.64	
E.W. Rhyodacite	Buff sandy clay with coarse quartz. (2mm → 1cm) Weak.		10 – 10.96	
E.W. – H.W. Rhyodacite	Buff coloured: coarse grained with E.W. bands of clay + coarse sand. Weak.		11 – 13	Fe on joints. (2mm wide)
	No core		14	
	Sandy clay			
H.W. Rhyodacite	Buff. Moderately strong.		15	Closely jointed. Fe + clay on joints.
E.W. – H.W. Rhyodacite	Clay with coarse qtz. bands Buff with green (epidote) patches.	40	16	Quartz veins with Fe staining. Chlorite on jts.
M.W. – S.W. Rhyodacite	Grey-green, coarse grained fractured + quartz (to 5mm). Feldspar (altered to epidote). Ferromagnesians (altered to chlorite) + pyrite. Strong.		17 – 20	joints & shear planes 45° → 60°. Joints with clay, chlorite. Closely jointed. Shearing.

Columns on form (not otherwise filled): Casing; Graphic Log; Fracture Log (0 6 12 18+); RQD; Defect Frequency – Intercept Angle (0 30 60 80 90); Water Level; Water Pressure Test Losses (Lugeons) *

Drill type: Mayhew 1000
Feed: Mechanical Pull Down
Core barrel type: Triefus
Driller: L. Keast
Commenced: May '75
Completed: May '75
Logged by:
Vertical scale: 1:100
Checked by:

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blocked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

E.W. Extremely weathered
H.W. Highly weathered

Water Pressure Tests

* Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blocked in strips.

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT BELCONNEN TOWN CENTRE
LOCATION
ANGLE FROM HORIZONTAL (θ) 90° DIRECTION
COORDINATES R.L. OF COLLAR

HOLE NO 2

SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
S.W. Rhyodacite	As above.		V V		20·77						
	End of hole 20·77m				21						
					22						
					23						
					24						

Drill type
Feed
Core barrel type
Driller
Commenced
Completed
Logged by
Vertical scale
Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blocked in

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▽ Level when hole in progress at specified depth
▽ Level in completed hole on specified date

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blocked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: Belconnen Town Centre
LOCATION: Section 55 Southern Side (in block 2)
ANGLE FROM HORIZONTAL (θ): 90° DIRECTION:
COORDINATES: 078478 (1:50,000) R.L. OF COLLAR: 590.0 m

HOLE NO. 3 SHEET 1 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
	No Core				1, 1.8						
H.W. – M.W. Volcanics	Fractured weak fawn fine grained with altered feldspars and ferromagnesions Qtz. phenocrysts.		V V V V		2, 2.8, 3, 3.35				Fe on joints; closely jointed; open joints; qtz. veins with clay to 2cm wide.		
H.W. – M.W. Volcanics	As above with fawn & pink variable colours. Core size 2-8cm. H.W.–E.W. with clay, rock fragments. 8.15 – 8.55m.		V V V V V V V V		4.65, 5, 5.85, 6, 6.35, 7, 7.25, 8, 8.9, 9				Closely fractured. 4.2 – 4.3 m. Clay seam 6.15–6.35m. Fractured 7.15–7.45m. Clay seam. 8.15m. Clay on joints. Clay & Fe on joints. Clay seam 9.20m		
M.W. Volcanics	Recemented and silicified acid volcanics, fawn & pink; variable colour; strong. Core size to 35cm, av. size 10cm.		V V V V V V V		10, 10.05, 11, 11.45, 11.85, 12, 13, 13.75, 14				Closely jointed. Quartz veins. Joints generally discontinuous; tight. Qtz. veins 12.30–13.80 limonite, Fe on joints; clay on some.		
S.W. Volcanics	Fractured, grey, fine grained groundmass with larger ferro-magnesions. (altered to chlorite) –pyrite		V V V		15, 16, 17				Quartz veins; clay on joint planes. Open joints closely jointed.		
S.W. – M.W. Volcanics	Closely fractured, E.W. in places with grey sandy clay & rock frag.		V V		17.65, 18						
S.W. Volcanics	Grey green. Strong		V						Qtz. veins.		
S.W. Volcanics	closely fractured grey green with larger qtz., ferro-magnesions, pyrite.		V V		19, 19.30				Chlorite on joints. Qtz. veins: fine pyrite veins. Discontinuous open joints.		

Drill type: Mayhew 1000
Feed: Mechanical Pulldown
Core barrel type: Triefus
Driller: L. Keast
Commenced: May '75
Completed: May '75
Logged by: G. Briscoe
Vertical scale: 1:100
Checked by:

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blocked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25cm of core occurring at specified intercept angle range.

Water Level Measurements — ▽ Level when hole in progress at specified depth; ▼ Level in completed hole on specified date

E.W. Extremely weathered
H.W. Highly weathered
M.W. Moderately weathered
S.W. Slightly weathered

Water Pressure Tests

* Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.

Core Photograph Negative No.

Depth (m)	Black & White	Colour

[illegible] 1975/176

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: BELCONNEN TOWN CENTRE
LOCATION:
ANGLE FROM HORIZONTAL (θ): 90°
DIRECTION:
COORDINATES: 078478 (1:50,000)
R.L. OF COLLAR: 590.0m
HOLE NO. 3
SHEET 2 OF 2

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log (0 6 12 18+)	RQD	Defect Frequency Intercept Angle (0 30 60 80 90)	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
S.W. Volcanics	Fine grained; darker grey green patches. 21.2-21.35m Fawn feldspar-qtz. vein 20.3m		V V V V		21				Mottled red in places. Very fractured 21.70-21.84m		
S.W. Volcanics	Fawn groundmass with epidote patches. Ferromagnesians, pyrite		V V		22 23				Very fractured (1-2cm) 22.50 - 23.22 closely jointed, qtz. veins.		
	End of hole 23.22m				24						

Drill type
Feed
Core barrel type
Driller
Commenced
Completed
Logged by
Vertical scale
Checked by

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in

Bedding and Joint Planes → Angles are measured relative to a plane normal to the core axis

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: BELCONNEN TOWN CENTRE
LOCATION: Section 54 (eastern side)
ANGLE FROM HORIZONTAL (θ): 90°
DIRECTION:
COORDINATES: 1:50,000 078 476
R.L. OF COLLAR: 590·90 m
HOLE NO: 4
SHEET 1 OF 1

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Casing	Graphic Log	Lift and % core recovery	Depth and size of Core	Fracture Log	RQD	Defect Frequency Intercept Angle 0 30 60 80 90	Structures Joints, veins, seams, faults, etc	Water Level	Water Pressure Test Losses (Lugeons) *
	No core				1						
E.W. Rhyodacite	Brown-yellow sandy clay with coarse quartz + some mica, rock fragments; weak.			60	2						
	No core				3						
E.W.–H.W. Rhyodacite	Fawn, coarse grained, fractured, weak. E.W. zones of sandy clay, quartz + rock fragments.		V V V V	100	4, 5, 5·75, 6				Fractured zone 4·4–4·9m. Fe and chlorite on joints.		
H.W. Rhyodacite	Fawn with patches of green chlorite alteration. Mod. Str.			100	6·65						
H.W. Rhyodacite	As above with E.W. zones of clay, rock fragments, quartz.		V	90	7·05, 7				Clay, Fe on joints, open joints, qtz. veins. Fractured 6·65–6·75m.		
H.W.–E.W. Rhyodacite	Fractured with weaker clay and rock fragments seams, weak (crumbles in hand).		V V V V	100	8·01, 8, 9, 9·20				Fe, clay, chlorite on joints.		
M.W.–H.W. Rhyodacite	Coarse grained with chlorite patches; strong.		V	100	10				Closely jointed; open joints with Fe; qtz. veins.		
M.W. Rhyodacite	Grey green + chlorite + coarse qtz. Strong.								Closely jointed, joints discontinuous. Tight, Fe.		
M.W–S.W. Rhyodacite	Less alteration to chlorite, pale fawn-grey to green, coarse to medium grained. Strong. E.W. seams with clay + rock fragments.		V V V V	100, 100	11, 11·95, 12, 12·40, 13				Joints less Fe stained + tighter, more continuous. Chlorite on joints, stringers, thin qtz. veins. Closely jt. (2cm). Slickensides.		
S.W. Rhyodacite	Fawn with quartz (to 5mm). White feldspar (some altering to epidote /albite). Ferromagnesians → chlorite. Strong, core pieces 5–20cm. More weathered - 14·2m		V V V V V V	100, 100, 100	13·80, 14, 14·90, 15, 15·50, 16, 17, 17·3				Tight joints with chlorite. Fe, clay, slickensides. Thin quartz veins. Joints dip 30°–60° to core.		
	End of hole 17·30m.				18, 19						

Drill type: Mayhew 1000
Feed: Mechanical Pull Down
Core barrel type: Triefus

Driller: L. Keast
Commenced: May '75
Completed: May '75
Logged by: P. Rosengren
Vertical scale: 1:100
Checked by: G. Briscoe

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in.

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis.

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25 cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

E.W. Extremely weathered
H.W. Highly weathered
M.W. Moderately weathered
S.W. Slightly weathered

Water Pressure Tests

** Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blacked in strips.*

Core Photograph Negative No.

Depth (m)	Black & White	Colour

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: Belconnen Town Centre
LOCATION:
ANGLE FROM HORIZONTAL (θ): 90° DIRECTION: –
COORDINATES: R.L. OF COLLAR:
HOLE NO 5
SHEET 1 OF 1

Rock Type and Degree of Weathering	Description Lithology, colour, strength, etc	Depth (m)	Structures Joints, veins, seams, faults, etc
	No Core	0 – 1.3	
Clay; H.W.-M.W. Volcanics	Fractured rock frag. in grey plastic clay; khaki-orange mottled sandy clay.	1.3 – 2.8 (1.6)	
	No core	2.8 – 3	
H.W.-M.W. Volcanics	Fractured fawn to grey-green rock in clay (av. size 2cm). Fine gravel bands and stiff clay seams.	3 – 6.45 (3.45, 4.75)	Closely fractured 3.45-3.85m. Fe, clay on open joints; closely jointed.
H.W. Volcanics	Very closely fractured and jointed; weak. Clay and fine gravel bands.	6.45 – 8.9	Haematite + limonite, clay on joints.
	No core	8.9 – 9.1	
H.W.-E.W. Volcanics	Yellow-white clay + rock; weak	9.1 – 9.3	
	No Core	9.3 – 10.7	
H.W. Volcanics	closely fract. rock with clay + fine gravel.	10.7 – 10.9	
H.W. Volcanics	Fractured, grey, fine-grained with clay + gravel bands.	10.9 – 15 (12.3, 13.45)	Limonite, clay on joints; closely jointed. Slickensides.
M.W.-S.W. Volcanics	Fine grained, grey-green with ferro-magnesians + feldspar phenocrysts. Thin clay + gravel bands. E.W.-H.W. 18.10-18.20+m.	15 – 18.20 (15.8, 16.6)	Closely jointed and fractured. Generally tight, discontinuous jts. Continuous jts have clay + limonite. Chlorite on some jts; breaks easily along these.
	End of hole 18.20m.		

Column headings also on form (not filled): Casing; Graphic Log; Lift and % core recovery; Fracture Log (0 6 12 18+); RQD; Defect Frequency – Intercept Angle (0 30 60 80 90); Water Level; Water Pressure Test Losses (Lugeons) *

Drill type: Mayhew 1000
Feed: Mechanical Pull Down
Core barrel type: Triefus
Driller: L. Keast
Commenced: June '75
Completed: June '75
Logged by: G. Briscoe
Vertical scale: 1:100
Checked by:

Notes

Fracture Log — Number of fractures per 25 cm of core. Zones of core loss blacked in

Bedding and Joint Planes — Angles are measured relative to a plane normal to the core axis

Defect Frequency — Number of natural defects (shears, joints, fractures) per 25cm of core occurring at specified intercept angle range.

Water Level Measurements — ▼ Level when hole in progress at specified depth. ▽ Level in completed hole on specified date.

E.W. Extremely weathered
H.W. Highly weathered
M.W. Moderately weathered
S.W. Slightly weathered

Water Pressure Tests

* Values in lugeons should be read in conjunction with computation sheets. Test sections are indicated by blocked in strips.

Core Photograph Negative No

Depth (m) | Black & White | Colour


PLATE 1
BELCONNEN TOWN CENTRE
GEOLOGICAL AND GEOPHYSICAL
INVESTIGATION, 1975
N
Rhyodacite
Altered dacite
Adamellite
Fill or modified surface
Fault zone
Fault, position accurate
Fault, position approximate
Dyke
Dyke position inferred
Contour interval 2·5m
0 10 20 30 40 50 metres
Ground Test drillhole
BMR drillhole
Seismic traverse and number
Seismic velocity of deepest refractor in metres/sec.
Cross section
Geological boundary
Building site
Road cut
Gully
E.W. Extremely weathered
H.W. Highly weathered
M.W. Moderately weathered
H.W. 3m+ Depth to highly weathered rock
LAKE
GINNINDERRA
Lake Wall
DEAKIN FAULT ZONE
CHANDLER
EMU BANK STREET
BENJAMIN WAY
EMU BANK ROAD
CAMERON AVENUE
TRAVERSE 1
TRAVERSE 2
TRAVERSE 3
TRAVERSE 4
TRAVERSE 5
A
B
C
D
55
56
54
53
49
205300
205400
205500
205600
205700
205800
205900
608900
608800
608700
608600
608500

I55/A16/1445


PLATE 2
SEISMIC CROSS-SECTIONS, TRAVERSES 1,2,&3
(3400) Seismic velocity in formation (metres/second)
Interpolated formation boundary
Interpolated bedrock boundary
Seismic discontinuity
10 5 0 10 20 30 40 metres
WEST TRAVERSE 1
EAST
SURFACE
FILL MATERIAL
(300)
(400)
(500)
(1400)
(2000)
(2800)
(3300)
(4300)
I.P.1 Trav 5
ELEVATION (metres)
CHAINAGE IN METRES
WEST TRAVERSE 2
EAST
SURFACE
(500)
(600)
(1000)
(1600)
(1900)
(2000)
(2200)
(2300)
(2800)
(3400)
(4600)
WEST TRAVERSE 3
EAST
SURFACE
PARTLY FILL MATERIAL
(300)
(400)
(500)
(600)
(1500)
(1600)
(2100)
(2200)
(2300)
(3400)
(4200)
(4500)
Record No.1975/179
I55/B5-277

SEISMIC CROSS-SECTIONS, TRAVERSES 4 & 5
(3400) Seismic velocity in formation (metres/seconds)
Interpolated formation boundary
Interpolated bedrock boundary
Seismic discontinuity
40 metres
WEST TRAVERSE 4
EAST
SURFACE
CHAINAGE IN METRES
ELEVATION (metres)
SOUTH TRAVERSE 5
NORTH
Record No 1975/179