DEPARTMENT OF MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1976/71

DEFENCE FORCE ACADEMY SITE, DUNTROON A.C.T.: INVESTIGATION OF THE SUBSURFACE, 1975

by

D.G. Bennett and G. Jacobson

Record 1976/71

DEFENCE FORCE ACADEMY SITE, DUNTROON A.C.T.: INVESTIGATION OF THE SUBSURFACE, 1975

by

D.G. Bennett and G. Jacobson

CONTENTS

SUMMARY

The Bureau of Mineral Resources, Geology and Geophysics investigated the subsurface of part of the proposed site of the Australian Defence Force Academy, Duntroon, A.C.T. The investigated area is underlain mainly by irregularly weathered dacite, with some colluvium at its eastern end. Depths of marginally rippable material range up to 12 m, but seismic surveys indicated two areas of hard rock close to the surface which are a constraint on planning the layout of buildings.

INTRODUCTION

At the request of the Department of Housing and Construction (DHC, now the Department of Construction), the Bureau of Mineral Resources, Geology and Geophysics (BMR) investigated the subsurface of part of the proposed site of the Australian Defence Force Academy, Duntroon, A.C.T. The site is bounded by Northcott Drive, Fairbairn Avenue, and General Bridges Drive (Plate 1).

A soils investigation of the entire site by DHC, and geological logging of trenches, indicated an area of hard rock close to the surface near General Bridges Drive in the southwest part of the site. A geophysical survey was undertaken in this area to investigate the extent of the rock, which may constrain the layout of buildings. Other objectives of the survey were to determine the approximate depths of rippable rock, and to establish depths to suitable foundation conditions for buildings. The survey was carried out in November 1975, and a total of 11 seismic spreads were shot over 726 m. The field party consisted of D.G. Bennett, D.H. Francis, and M.N. Preston-Stanley. F.J. Taylor and D.G. Bennett interpreted the seismic data.

GEOLOGY

The proposed Academy site is underlain by volcanic rocks, the Ainslie Volcanics, of Early Devonian age (Strusz & Henderson, 1971). Table 1 shows the rock conditions encountered in pits and trenches, and the depths of backhoe/bulldozer refusal.

In the steep southwest part of the site, hard dacite is close to the surface in places above 590 m. Dacite crops out adjacent to General Bridges Drive (Plate 1) and, the bulldozer trenches G8, C6/D6, and D8 indicated depths of 1.0-1.6 m to hard, slightly weathered, medium-grained dacite, which will have to be excavated by blasting. The seismic sections for this part of the site (Plate 2) indicate irregular weathering of the dacite, and a northeast-trending fault associated with zones of deep weathering.

TABLE 1

DEPTHS OF MACHINE REFUSAL

BACKHOE PIT		BULLDOZER TRENCH		
No.	Depth of Refusal (m)	No.	Depth of Refusal (m)	ROCK TYPE AND WEATHERING
1	1.1	J8	1.5	Moderately-slightly weathered ashstone
2	2.3			Moderately weathered ashstone
3	0.7	D8	1.6	Highly-moderately weathered, closely jointed dacite
4	2.6			Moderately weathered, quartz-veined rhyolite
5	3.0			Moderately weathered, quartz-veined dacite
6	2.0			Highly weathered dacite
7	2.0			Extremely weathered dacite
8	2.0			Moderately weathered dacite
9	1.5			Highly weathered rhyolite
		G8	1.0	Slightly weathered dacite
		C6/D6	1.2	Moderately-slightly weathered dacite

In the southeast part of the proposed Academy site, pits exposed deep, mainly clayey, colluvial soils overlying weathered dacite. Backhoe refusal was at depths of 2.0 m or more in the four pits (5, 6, 7, 8) excavated here, and the rock is probably rippable to about one metre below backhoe refusal.

In the northern part of the site, pits showed that clayey and sandy colluvial soils overlie weathered fine-grained volcanic rocks - rhyolite and ashstone. Depths of rippable material range from 1.5 m (bulldozer trench J8) to more than 2.6 m (Pit 4) and are irregular. Groundwater seepages were observed in the sandier soils, and might cause drainage problems in excavations.

THE SEISMIC SURVEY: METHODS AND EQUIPMENT

The seismic refraction method (Dobrin, 1952) was used to investigate the subsurface in the southwest part of the site. The locations of the four traverses are shown in Plate 1.

Each spread consisted of 23 geophones placed in a straight line, with the 24th geophone used as a reciprocal. For the centre-line traverse a 3-m geophone spacing was used; for each of the cross-traverses 3-m and 4-m spacings were used to give a complete coverage. Five shots were fired for each spread, one in the centre of the spread, one at half a geophone spacing from each end, and one at a distance of 35 to 40 m from each end.

The equipment used was a 24-channel SIE PSU-19 refraction seismograph with 8 Hz GSC-20D geophones. Interpretation was based on the reciprocal method (Hawkins, 1961).

SEISMIC VELOCITIES AND EXCAVATION CONDITIONS

Seismic velocities are roughly related to excavation conditions (Caterpillar Tractor Co., 1966). Table 2 shows an approximate relationship between seismic velocity and rippability in the Canberra district.

TABLE 2

SEISMIC VELOCITIES AND EXCAVATION CONDITIONS

SEISMIC VELOCITY (m/s)	EXCAVATION CONDITIONS	GEOLOGY
Less than 1000	Rippable	Soil; completely to highly weathered rock.
1100-1500	Marginal - rip or blast	Highly-moderately weathered rock; possibly corestones of fresher rock
Greater than 1600	Blasting	Moderately-slightly weathered rock; fresh rock

RESULTS OF THE SEISMIC SURVEY

The seismic sections are shown on Plate 2.

Traverse 1 (centreline): This traverse shows a thin surface layer, generally less than 1 m, of soil with a seismic velocity of 300 m/s. At the intersection point with traverse 4 this layer thickens in a pocket to a depth of 2.5 m.

The underlying layer varies considerably in depth and seismic velocity: under the western end of the traverse its seismic velocity is between 1200 and 1650 m/s, which may represent rippable material; between chainages 105 and 140, hard rock with a seismic velocity between 1600 and 2300 m/s will have to be blasted for excavations; east of this the second layer thins gradually, but its seismic velocity indicates that it should be rippable.

The bedrock velocity also varies. Up to chainage 230 the bedrock has two main velocities: one about 5000 m/s, the other between 3400 and 3700 m/s. At chainage 230, the seismic velocity changes abruptly from 3700 m/s on the west to 1800 m/s on the east. The velocity of 1800 m/s represents moderately weathered rock, possibly in a fault zone.

Traverse 2 (cross): The surface layer of soil (300-450 m/s) is generally a metre or less over most of the traverse, but thickens to 2.5 m at chainage 50, near where a fault has been indicated (Plate 2). On the southern side of this fault a second layer with velocity of 600-900 m/s (highly weathered rock) extends to a depth of 5-6 m. A layer with similar velocities was not detected on the northern side. Underlying this layer is moderately weathered rock with a velocity between 1650 and 1800 m/s. The bedrock on the northern side of the fault has a velocity of 4800 m/s, and was detected at a depth of 10 m. On the southern side, the bottom refractor has a velocity of 3200 m/s, and its average depth is 22 m.

Traverse 3 (cross): This traverse is similar to cross-traverse 2. A thin surface layer of soil thickens near the fault. The second layer of highly weathered rock appears to be continuous. It has a velocity of 950 m/s near the fault and increases to 1100 m/s farther away. This material should be rippable; its thickness varies from about 7 m at the northern end to about 4 m near the southern end. On the southern side of the fault a third zone of higher velocity, 1700-2000 m/s, overlies the bedrock. At the northern end of the traverse, bedrock velocity was 4500 m/s at an average depth of 7-8 m. Near the fault this velocity decreased to 3400 m/s, and at the southern end the velocity was 2700 m/s, indicating a zone of deep weathering.

Traverse 4 (cross): This cross-traverse follows a similar pattern to the other two, with a fault indicated near the intersection of the centreline traverse. A thin layer of soil thickens slightly at the intersection point with traverse 1. Below it, highly weathered rock or indurated colluvium up to 5 m deep has a seismic velocity of 800 m/s, and extends roughly from chainage 30 to 110; it should be easily ripped. Underlying these layers, the weathered rock has a velocity of 1500-1600 m/s south of chainage 112; north of chainage 112, a seismic velocity of 2250 m/s indicates an area of hard rock. At the southern end, hard fresh bedrock was not reached and the refracting layer has a velocity of 2400 m/s at a depth of 17 to 21 m below the surface. At the northern end, a bedrock velocity of 4800 m/s was detected at a depth of about 10-12 m; bedrock appears to shallow to 5 m at the far northern end.

CONCLUSIONS

1. In the southwest part of the Academy site, seismic sections and pits indicate irregularly weathered dacite with possibly some colluvium up to 4 m deep downslope. Depths of rippable material vary, and may be up to 12 m in places.

2. The locations of two areas of hard rock close to the surface have been indicated by the seismic results: between chainages 105 and 140 in the centreline traverse 1, and at the northern end of traverse 4. In these areas, rock at a depth of about one metre will require blasting.

3. A fault zone about 10 m wide trends northeast-southwest, nearly parallel to the centreline traverse. The rock immediately southeast of the fault is deeply weathered with seismic velocities of 1500-2000 m/s to depths of up to 22 m.

4. Pits have indicated generally deeper soils in the northern and eastern parts of the Academy site; these areas have not been investigated by seismic survey, but depths of weathering are expected to be greater than those in the southwest part of the site.

REFERENCES

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

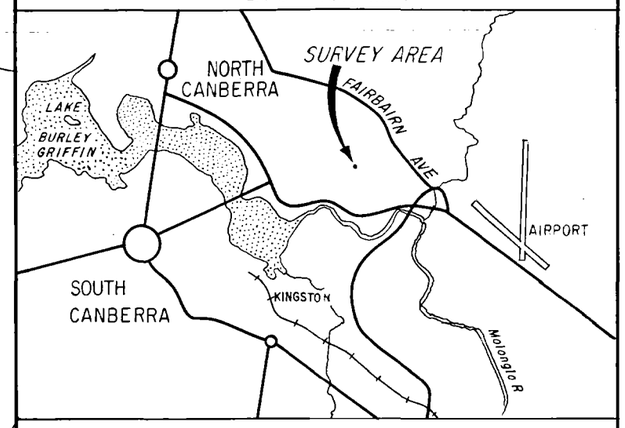
DOBRIN, M.B., 1952 - INTRODUCTION TO GEOPHYSICAL PROSPECTING. New York, McGraw-Hill Inc.

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

STRUSZ, D.L., & HENDERSON, G.A.M., 1971 - Canberra, A.C.T. - 1:50 000 geological map and explanatory notes. Bur. Miner. Resour. Aust. explan. Notes.

PLATE I

LOCATION MAP



NORTHCOTT DRIVE

FAULT

FAULT

FAIRBAIRN AVENUE

620

610

600

590

580

572

QUARTZ

Pit 4

Pit 9

DEEP SOILS (>1·5m) OVERLYING RHYOLITE/ASHSTONE

Pit 1
Trench J8

Pit 2

Pit 7

DEEP SOILS (>2m) OVERLYING DACITE

SHALLOW SOILS (<1·5m) OVERLYING DACITE

Pit 6

Trench G8

POSSIBLE FAULT

Pit 5

Pit 8

TRAVERSE 1

TRAVERSE 4

TRAVERSE 3

TRAVERSE 2

Trench C6/D6

Pit 3
Trench D8

DRIVE

Dacite outcrop

BRIDGES

GENERAL

LEGEND

- ROAD
- TRACK
- 580 ELEVATION CONTOUR (2m interval)
- SEISMIC TRAVERSE
- GEOLOGICAL BOUNDARY

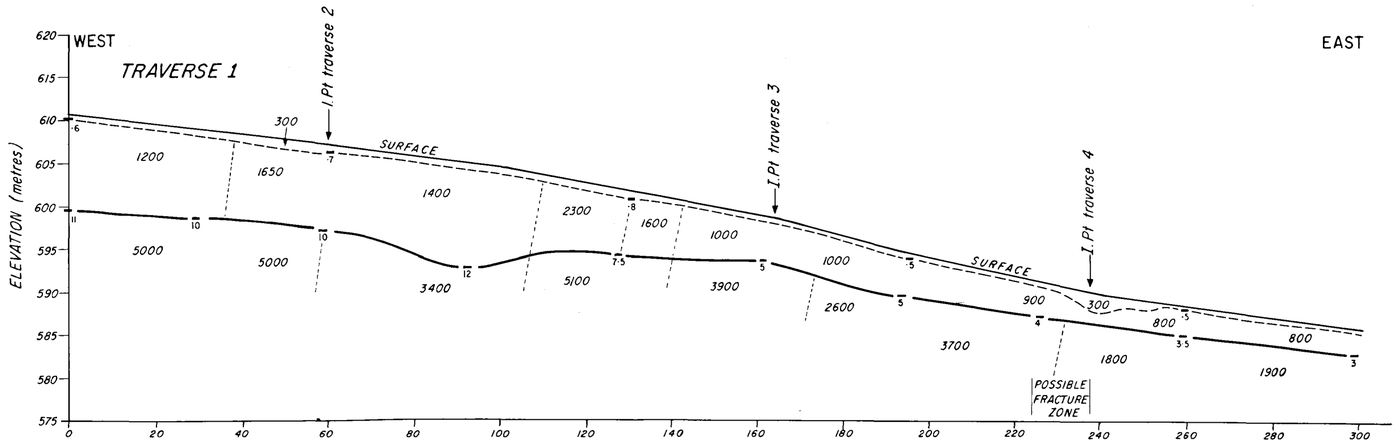
N

METRES
50 0 50 100

AUSTRALIAN DEFENCE FORCE ACADEMY SITE, LOCATIONS OF SEISMIC TRAVERSES

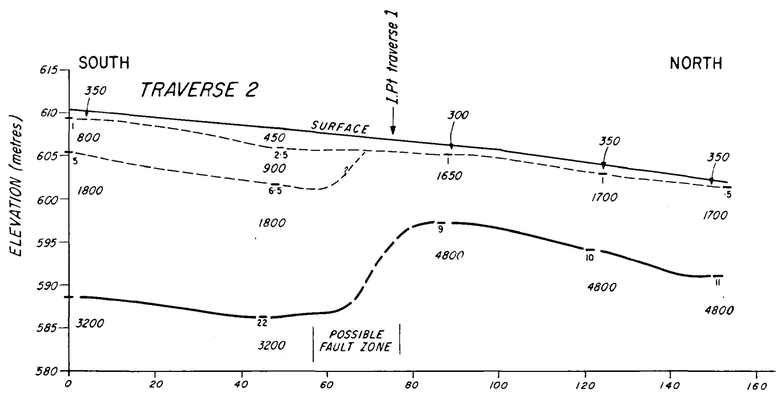
Record No. 1976/71

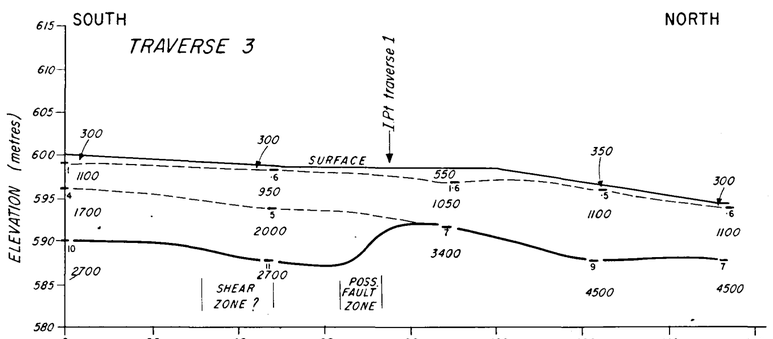
I55/B5-299

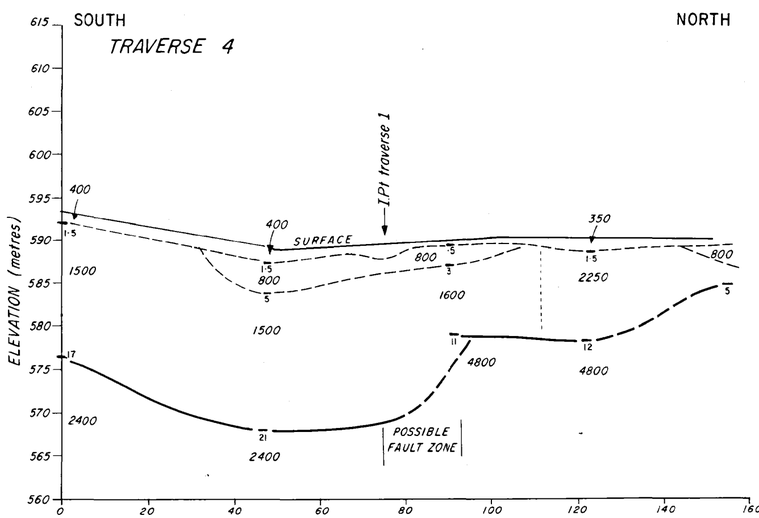


LEGEND

3·5	Depth to refractor (metres)
3700	Seismic velocity in formation (metres/second)
----------	Interpolated boundary of intermediate refractor
————	Bedrock boundary







HORIZONTAL SCALE

50 0 50 100 METRES

AUSTRALIAN DEFENCE FORCE ACADEMY
SEISMIC CROSS-SECTIONS

Record No. 1976/71

I55/B5-305