COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1967/7

ASPEN ISLAND
SEISMIC REFRACTION SURVEY.

CANBERRA 1966

by

G. CIFALI

RECORD No. 1967/7

ASPEN ISLAND
SEISMIC REFRACTION SURVEY,

CANBERRA 1966

by

G. CIFALI

CONTENTS

ILLUSTRATIONS

SUMMARY

A refraction seismic survey was made on Aspen Island, Lake Burley Griffin, to study the foundation conditions for a carillon tower.

The bedrock, consisting of shale or clayey shale and silty mudstone is between 35 and 65 ft deep, sloping from north to south. The recorded seismic velocities indicate a relatively weak bedrock with a Young's modulus of about 9.9×10^5 lb/in^2.

1. INTRODUCTION

At the request of the Geological Branch of the Bureau of Mineral Resources (BMR), on behalf of the National Capital Development Commission, the Geophysical Branch of the BMR made a refraction seismic investigation on Aspen Island, an island artificially built up in Lake Burley Griffin, Canberra. The purpose of the investigation was to study the foundation conditions in relation to the planned construction of a carillon tower.

A drilling programme has been conducted on the island, and on the eastern shore of the mainland, by 'Ground Test Australia', a division of Frankipile Australia Pty Ltd.

The field work extended from 6th October to 10th October 1966. The geophysical party comprised L. Kevi (party leader), J. Milson, and G. Cifali (geophysicists).

2. METHOD AND EQUIPMENT

For a description of the seismic refraction method as used in engineering geophysics, reference is made to Heiland (1946, p.548) and Wiebenga and Polak (1962). The recorded longitudinal wave velocities indicate the quality of the formations: the higher the velocity, the stronger the formation. For the purpose of this Record the bedrock is defined as the deepest formation in which the highest seismic velocity was recorded.

The recording equipment was a Mid-Western 12-channel refraction seismograph and TIC geophones with natural frequency of 20 c/s.

The layout of the traverses and the location of the boreholes are shown in Plate 1. The geophone spacings were 40 ft and 15 ft on the normal geophone spreads and 10 ft on the weathering spread.

3. GEOLOGY

A summary of the geology of the area is given by Hawkins (1957).

Test bore logs obtained from 'Ground Test Australia' show the following general succession :

Soil
Sandy clay
Silty clay with or without sand or fine gravel
Silty sand with gravel
Large river gravel with occasional boulders, getting clayey with depth
Hard shaley clay
Shale soft to medium with visible fractured zones, starting from a depth of about 40 ft.

4. RESULTS

The profiles (Plate 2) show the depth to the bedrock, the velocity of compressional seismic waves in the bedrock, and the velocities in the overburden. A comparison with the bore logs indicates that the 5200-ft/s velocity corresponds to a river gravel, and the 7000 ft/s to shales and clayey shales.

The top of the7000-ft/s velocity layer deepens from north to south (see profiles in Plate 2 and contours in Plate 1).

Plate 2 also shows the available bore logs along Traverses A and B and the related seismic profiles. Comparing the results with the bore logs, the maximum error in bedrock depth determination is 12% at bore hole 11 (Station B3).

A 7000-ft/s velocity generally characterises a poor foundation rock, weathered and probably fractured. An approximate value of Young's modulus of a formation can be obtained from the recorded seismic velocity using the empirical formula (Wiebenga, 1957):

$$E = V^{2.34} \times 10^{-3}$$

where V = seismic velocity in ft/s
E = Young's modulus in lb/in^2

For a 7000 ft/s velocity, Young's modulus is estimated at about 0.7×10^{11} dynes/cm^2, or 9.9×10^5 lbs/in^2.

5. CONCLUSION

The comparison between bore logs and computed seismic depths to bedrock is acceptable. The bedrock is almost horizontal between B1 and B4; between B4 and B10 and between A3 and A11, it slopes in a south-easterly direction.

The approximate value of Young's modulus for the bedrock is 9.9×10^5 lb/in^2.

6. REFERENCES

HAWKINS, L. V. 1957 Seismic survey of the King's Avenue bridge site, Canberra, A.C.T. Bur. Min. Resour. Aust. Rec. 1957/32.

HEILAND, C. A. 1946 GEOPHYSICAL EXPLORATION New York, Prentice-Hall Inc.

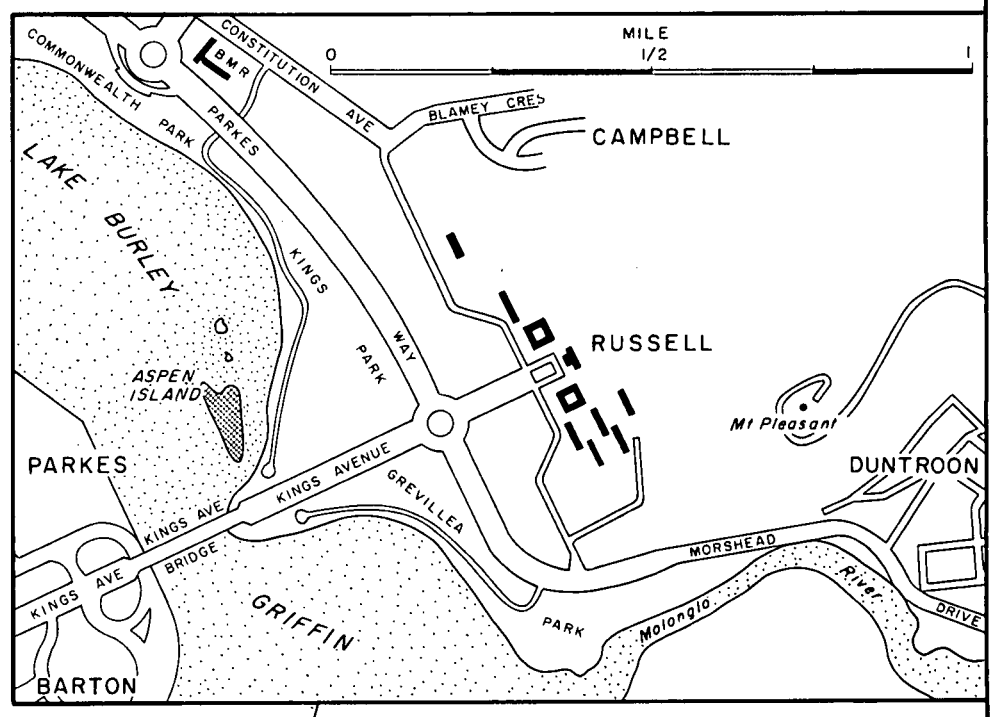
WIEBENGA, W. A., and POLAK, E. J. 1962 Rabaul geothermal investigation, New Britain 1960. Bur. Min. Resour. Aust. Rec. 1962/9

WIEBENGA, W. A. 1957 Exploration geophysics applied to the dolerites of Tasmania. Dolerite Symposium, Geol. Dept. Univ. of Tasmania, July 1957.

7000 N — 39,000 E

40,000 E — 7000 N

LOCALITY MAP



LAKE BURLEY GRIFFIN

ASPEN ISLAND

KINGS PARK

14 13 12 11 10 9 8 7 6 5 4 3 2 1

A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 W12 W1

B1 B2 B3 B4 B5 B6 B7 B8 B10 B11

TRAVERSE A

TRAVERSE B

TRAV. W

1785 1790 1795 1830 1835 1775 1780 1770

11° 20'

T.N.

M.N.

6000 N — 39,000E

6000N — 40,000E

LEGEND

A2 A3 A4 — Seismic traverse with geophone positions

⊙10 — Bore hole 10

1830 — Elevation contour (interval 5 ft)

1780 — Bedrock contour (interval 5 ft)

Normal lake level : R L 1825 ft

ASPEN ISLAND A.C.T.

SEISMIC REFRACTION SURVEY 1966

FEET

100 0 100 200 300

PLATE 1

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

I 55/B 5-44

TO ACCOMPANY RECORD No. 1967/7

PLATE 2


TRAVERSE A
NORTH
SOUTH
ELEVATION IN FEET
SP
A1
A2
A3
A4
A5
BH 7
A6
A7
BH 6
A8
A9
I.PI Trav. B
A10
A11
(1500)
(5200)
(7000)
(1000)
(1600)
DECOMPOSED SHALE AND CLAY
BROKEN, DECOMPOSED, WEATHERED SILTY MUDSTONE AND SANDSTONE WITH SOME SHALE
FIRM DECOMPOSED MUDSTONE
SHALE AND SILTY MUDSTONE (WEATHERED)
TRAVERSE B
NORTH-WEST
SOUTH-EAST
B1
B2
BH 11
B3
B4
B5
BH 10
B6
B7
B8
I.PI Trav. A
B9
B10
B11
LOAMY FILLING
BROWN DRY CLAY
BLACK CLAY
DARK BROWN CLAY
COARSE SAND WITH RIVER GRAVEL
BROWN AND RED BROWN SHALES AND CLAYEY SHALES
DARK BROWN WITH FINE GRAVEL
BLACK BROWN WITH TRACES OF GRAVEL
SANDY CLAY
RED COARSE SAND, SMALL GRAVEL
LARGE GRAVEL
SOFT BLUE SHALES
LEGEND
SP Shot point
Geophone position on seismic traverse
(7000) Seismic velocity (ft/s) in formation
BH 6 Bore hole location
I.PI Traverse intersection point
Bedrock (highest velocity layer)
LOAMY FILLING
CLAY
SANDY CLAY
SAND
GRAVEL
LARGE GRAVEL
SHALE
MUDSTONE
FEET

SEISMIC PROFILES AND BORE LOGS

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

I 55/B5-45

TO ACCOMPANY RECORD No. 1967/7