COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1965/208

CAPITAL HILL TUNNEL GEOPHYSICAL SURVEY, CANBERRA, A. C. T. 1964

by

E.J. POLAK and M. WAINWRIGHT

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SUMMARY

Seismic refraction and resistivity surveys were made along the proposed tunnel line on Capital Hill, Canberra, A.C.T. to supply information on the thickness of the overburden and the character of the bedrock.

The results show that the depth to bedrock ranges between zero and 100 feet. There are three zones where the overburden is significantly thicker than the average, and these zones may represent faulted junctions. The limited resistivity data agree with the seismic information.

Seismic velocities in the unweathered bedrock range between 9000 and 10,000 ft/s. These low velocities indicate that the bedrock is jointed and probably weathered along the joints.

1. INTRODUCTION

The National Capital Development Commission is preparing plans for the construction of a road tunnel under Capital Hill, Canberra, A.C.T. To facilitate geological mapping of the tunnel line, the Geological Branch of the Bureau of Mineral Resources, Geology and Geophysics, in the capacity of adviser to the Commission, requested the Geophysical Branch to assist with the investigation. The main problems were to measure the depth to, and the character of, the bedrock.

The field work was done on the 22nd, 23rd, 26th, and 29th October 1964 by a geophysical party consisting of E.J. Polak (party leader) and M. Wainwright (geophysicist). Three field-hands were provided by the Geological Branch of the Bureau of Mineral Resources.

2. GEOLOGY

A detailed description of the geology of the Capital Hill area has been given by Opik (1958). A geological map of the area is shown in Plate 1.

The area of the proposed tunnel line is covered with soil, which overlies Black Mountain Sandstone, Camp Hill Sandstone, and State Circle Shale. Some outcrops of these rocks occur in the area.

Black Mountain Sandstone, probably of Lower Ordovician age, is very hard, fine-grained quartz-sandstone with a few beds of shale and is resistant to weathering. Camp Hill Sandstone, of Lower Silurian age, is very flaggy, calcareous quartz-sandstone and weathers easily. State Circle Shale, of Lower Silurian age, is non-calcareous sandy shale and black shale; it is moderately strong when fresh, but easily weathers into sandy clay.

3. METHODS AND EQUIPMENT

The seismic refraction method and resistivity constant-spacing traversing were used in the investigation.

A detailed description of the seismic method has been given by Hawkins and Stocklin (1956). The 'method of differences' was used for calculating the thickness of overburden (Heiland, 1946, p.548). The equipment used in the survey was a 24-channel refraction seismograph, manufactured by South-western Industrial Electronics Co., and geophones with a natural frequency of about 20 c/s, manufactured by Technical Instruments Co.

Resistivity constant-spacing traversing has been described by Jesson and Kevi (1963). The instrument used in the survey was a Telohmeter, a constant frequency (110 c/s), alternating current, resistivity meter.

4. RESULTS

The results of the survey are shown in Plate 1.

The overburden in the area was found to consist of two layers:

(a) An upper layer with a velocity of between 1000 and 1200 ft/s; this is probably a layer of soil.

(b) A lower layer with a velocity of between 3000 and 4000 ft/s; this is probably a layer of decomposed and weathered rock.

The bedrock consists of rock with seismic velocities between 9000 and 10,000 ft/s. These low velocities indicate that the bedrock is jointed and probably weathered along the joints.

There are three places along the traverse where the depth of weathered material is significantly greater than average:

1. Between seismic stations 200 and 300, where the weathered zone is up to 100 feet thick. This may represent the junction, possibly faulted, between Camp Hill Sandstone and Black Mountain Sandstone, of which the former weathers more rapidly than the latter.

2. Near seismic station 700, where the depth of weathered material increases to 50 feet. This probably represents a situation similar to the first one above.

3. Between seismic stations 1900 and 2000, where the weathered zone again increases to a thickness of about 50 feet. This may be correlated with the faulted junction between State Circle Shale and Black Mountain Sandstone.

Resistivity traversing, also shown in Plate 1, shows good correlation with the seismic cross-section. There is a minimum in the apparent resistivity between seismic stations 200 and 300, which agrees well with the first deep weathered zone as defined by seismic evidence. The next resistivity minimum, at station 700, may indicate a fault. To the west of station 700, the apparent resistivity rises to a maximum, which indicates the dry nature of the ground and the shallowness of the bedrock near the summit of the hill. Because of this, no resistivity measurements were made west of seismic station 1000.

5. CONCLUSIONS

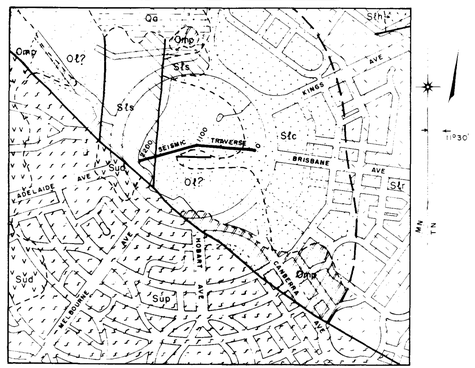
The thickness of the overburden is up to 100 feet at one place and up to 50 feet at two other places along the seismic traverse. These places may indicate increased weathering owing to the softer nature of material overlying the Black Mountain Sandstone or may represent faulted junctions. Resistivity traversing, limited to the eastern side of Capital Hill, agrees well with seismic and geological evidence.

6. REFERENCES

HAWKINS, L.V., and STOCKLIN, A. 1956 Seismic survey of the eastern abutment of Dam Site B, Upper Cotter River, A.C.T. Bur.Min.Resour.Aust.Rec. 1956/124 (unpubl.)

HEILAND, C.A.	1946	GEOPHYSICAL EXPLORATION New York, Prentice-Hall, Inc.
JESSON, E.E. and KEVI, L.	1963	Canberra National Library Site resistivity survey 1962. Bur.Min.Resour.Aust.Rec. 1963/119.
" OPIK, A.A.	1958	The geology of the Canberra City district. Bur.Min.Resour.Aust.Bull. 32.

LOCALITY AND GEOLOGICAL MAP



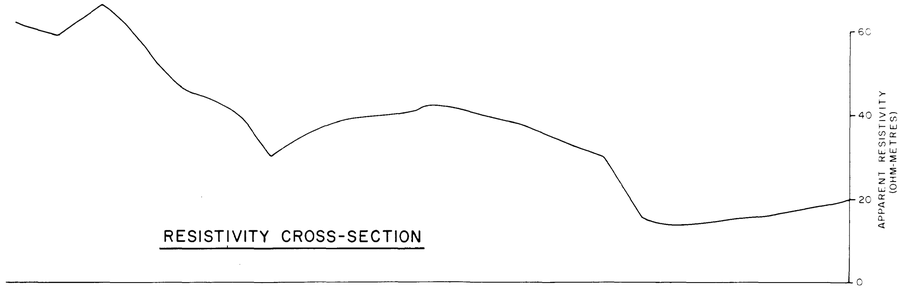
LEGEND

Qa	Undifferentiated	RECENT TO PLEISTOCENE
Sup	Mt Painter Porphyry	UPPER & LOWER SILURIAN
Sud	Deakin Volcanics	
Sth	City Hill Shale	
Str	Riverside Formation	
Sts	State Circle Shale	
Stc	Camp Hill Sandstone	
Omp	Pittman Formation	ORDOVICIAN
Ot?	Black Mt Sandstone	

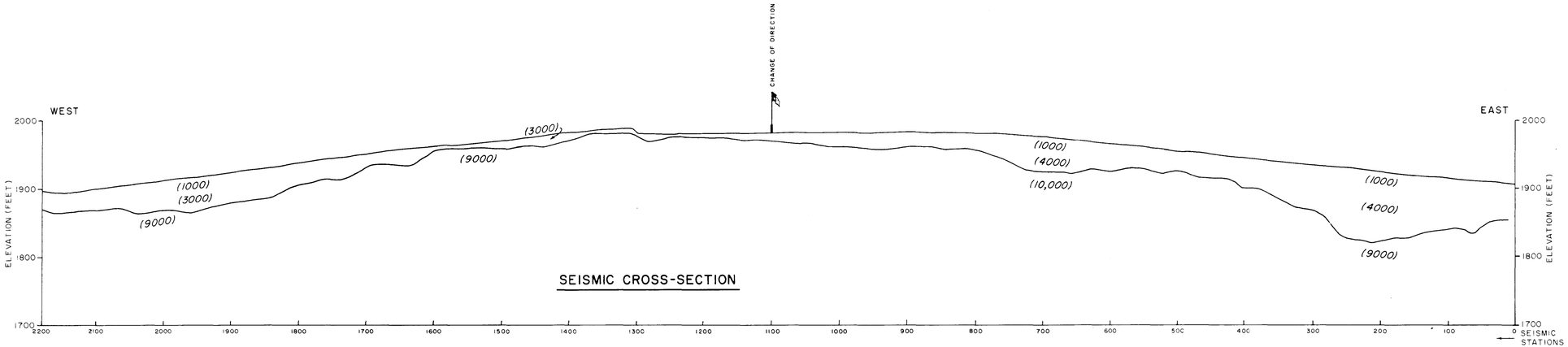
Fault – position accurate

Fault – position approximate

Geology after A A BPIK (1958)



RESISTIVITY CROSS-SECTION



SEISMIC CROSS-SECTION

LEGEND

(3000) Seismic velocity (ft/s) in formation

(Vertical scales as shown)

GEOPHYSICAL SURVEY, CANBERRA, A.C.T., 1964

CAPITAL HILL TUNNEL

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