COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

RECORDS

1957, NO.24

SEISMIC SURVEY OF THE SOUTHERN ABUTMENT OF DAM SITE "A", UPPER COTTER RIVER, A.C.T.

by

L. V. HAWKINS.

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ABSTRACT

A seismic refraction survey of the southern abutment of Dam Site "A" on the Upper Cotter River A.C.T., was carried out to determine the depth to suitable foundation rock.

The seismic results show that deep excavations of the order of 60 feet would be necessary for the proposed dam foundation. The results, in conjunction with drilling results, indicate that the bedrock will probably be slightly weathered granite or partly weathered, silicified granite.

1. INTRODUCTION.

In response to a request from the Department of Works, Canberra, a seismic refraction survey of the southern abutment of Dam Site "A" on the Upper Cotter River, A.C.T., was carried out during May, 1956, by the Geophysical Section of the Bureau of Mineral Resources.

The proposed dam site is on the Upper Cotter River immediately below the junction with Bushrangers Creek (Plate 1).

The southern abutment of the proposed dam site consists of a narrow spur which trends approximately southerly to a small saddle and then south-easterly. The purpose of the seismic survey was to determine the depth and quality of the bedrock on the southern abutment of the dam site, that is, on the spur and saddle.

The geophysical party consisted of L.V. Hawkins, party leader, J.P. Pigott, field assistant, and three field hands supplied by the Department of Works, Canberra, A.C.T. W.A. Wiebenga, senior geophysicist, accompanied the party, which camped at the dam site during the survey.

The topographic survey of the geophysical traverses and stations was carried out by the Department of Works, Canberra.

It is desired to acknowledge the assistance given to the seismic party by officers of the Engineering Group of the Geological Section of the Bureau, and by the Department of Works, Canberra.

2. GEOLOGY.

The geology of the dam site has been described by Noakes (1946) and Perry (1953), and a geological sketch map is shown on Plate 1.

The most important structural feature in the area is the Cotter Fault, a near-vertical, major fault which has largely determined the course of the Cotter River for four miles south of Dam Site "A".

A general fault zone is probably associated with this fault and may include associated minor faulting. The zone is a few hundred feet wide. The western boundary is the faulted contact between the Tidbinbilla Quartzite and the Franklin Formation. The eastern side is assumed to be the contact with the Cow Flat Granite. A lens of silicified quartzite (part of the Tidbinbilla Quartzite) is included within the general fault zone and part of it forms the spur on the southern abutment of the proposed dam site. It is proposed to build the retaining wall of the dam along the quartzite lens, i.e. parallel to, and within, the general fault zone.

The lens of Tidbinbilla Quartzite has been fractured during faulting, subsequently cemented by silicification of the fault zone, and finally fractured and jointed. The quartzite outcrop is covered in places by soil and scree.

The Tidbinbilla Quartzite extends a considerable distance to the east of the fault zone.

The Cow Flat Granite forms an irregular lenticular intrusion into the Tidbinbilla Quartzite. Some brecciation and silicification of the granite has occurred at the contact

of the granite with the fault zone. The fault zone forms the western boundary of the granite at the surface. The quartzite/granite contact is parallel to, and just west of, traverse B, and the granite along the geophysical traverses is covered by very weathered granite and soil. Two drill holes started in the silicified quartzite in the fault zone intersect granite at fairly shallow depths.

Traverse D is located along the spur of quartzite, and traverses A and C extend eastwards from the quartzite within the general fault zone to the Cow Flat Granite; traverse B is located on the granite.

Perry (1953, Plate 1) shows the granite to the west of the quartzite spur as well as to the east, but this is not supported in a more recent geological map of the dam site by Burton, Foweraker and Noakes (1956).

As used in this report, the term "bedrock" refers to rock with a seismic velocity of 12,500 ft./sec. or greater; as there is a close relation between seismic velocity and elastic properties, the bedrock has a high Young's Modulus. The term "overburden" refers to the weathered rock, soil and scree, which overlies the bedrock. The overburden has an average seismic velocity between 4,500 and 2,100 ft./sec. and is considered unsuitable as foundation rock.

3. METHOD AND EQUIPMENT.

The seismic refraction "Method of Differences", which was used on this survey, has been described in detail in the report on the seismic investigation of Dam Site "B" (Hawkins and Stocklin, 1956). An explosive charge is used as a source of elastic waves which are refracted at elastic discontinuities. The travel times of the first arrival of the elastic waves from the shot point to a series of detectors (geophones) are recorded.

From the observed travel times, the depth to bedrock may be computed. Also, by removing the effect of the irregular thickness and velocity of the overburden (Hawkins and Stocklin, 1956), the velocity of the elastic waves in the bedrock may be reliably estimated.

Seismic velocity logs of two drill holes were taken by detonating small charges down the drill holes. The information on overburden velocities so obtained increased the accuracy of the seismic results.

Geophone station intervals of 40 feet and 10 feet were used.

A "Century Geophysical Corporation" 12-channel, portable refraction seismograph was used with "T.I.C." geophones of frequency 20 cycles per second.

4. RESULTS.

The locations of the four seismic traverses are shown on Plate 1; the depth to bedrock, the velocity of the seismic waves in the bedrock, and the average velocities through the overburden, are shown on Plate 2.

Traverse D is located on the quartzite spur. The depths to bedrock computed from the seismic results range between 34 feet at station D3 and 83 feet at station D11, the average

depth being 66 feet. The log of diamond drill hole No.11, near station D8, shows a depth of 76 to 82 feet, to weathered granite with quartz veins, below weathered quartzite. The seismic determinations at D8 show a depth of 77 feet to bedrock of 13,500 ft./sec. velocity. This would indicate that the 13,500 ft./sec. velocity corresponds to weathered granite with quartz veins at the quartzite/granite contact. However, unweathered, slightly jointed quartzite could have the same velocity.

Between stations D3 and D7, the bedrock velocity is 18,000 ft./sec. and may indicate either unweathered granite, or quartzite with joints cemented by quartz. The overburden along traverse D has an average velocity of 4,500 ft./sec. and consists of brecciated and weathered quartzite.

Traverse C is located across the quartzite spur and extends eastwards over the area of granite outcrop. The average depth to bedrock is 52 feet, ranging from 60 to 70 feet over the quartzite spur to 32 feet at station C13. An inclined diamond drill hole, D.D.H.9, shows weathered,silicified granite,underneath weathered, silicified quartzite and quartzite breccia, at a depth of 55 feet below the surface at a point about 36 feet downhill from station C7. The seismic determination at C7 is 62 feet to bedrock of velocity 14,000 ft./sec., which is therefore assumed to be partly weathered, silicified granite. The average velocity in the overburden along traverse C ranges from 4,300 ft./sec. in the jointed and weathered quartzite over the quartzite spur to 3,000 ft./sec. in the very weathered granite near station C13.

Traverse B is located on weathered granite to the east of the spur and is approximately parallel to traverse D. The depth to bedrock of 14,000 ft./sec. velocity ranges from 25 feet at station B3 to 49 feet at B8, the average depth being 40 feet. A layer with a velocity of 19,000 ft./sec. was recorded from below the 14,000 ft./sec. material, and appears to represent unweathered granite underlying partly weathered granite. The partly weathered granite thins out towards the northern end of the traverse. The average velocity through the overburden along traverse B ranges from 2,700 ft./sec. in very weathered granite on the saddle of the ridge, to 3,700 ft./sec. near traverse C. The latter velocity may indicate very weathered granite and scree.

Traverse A trends south-easterly through the saddle of the ridge. Between A6 and A15 the depth to bedrock of 12,500 ft./sec. velocity ranges from 48 to 69 feet, the average depth being 59 feet. This velocity of 12,500 ft./sec. represents partly weathered granite. The average velocity through the overburden along traverse A, near the quartzite outcrop at station A5, is 4,000 ft./sec., and represents jointed and weathered quartzite. The 2,100 to 2,700 ft./sec. velocity on the saddle represents very weathered granite.

There is some evidence of a thin layer of fairly weathered granite of 9,000 ft./sec. velocity on top of the partly weathered granite of 14,000 ft./sec. velocity east of traverse B.

The thickness of this"layer" could not be accurately estimated, but may be of the order of 10 feet.

Table 1 shows a comparison between the results obtained from the seismic determinations and those from three diamond drill holes located near the seismic traverses.

TABLE 1.

Diamond Drill Hole	Direction	Vertical Depth to Granite	Distance from Geophysical Station	Seismic depth determinations	Seismic Velocity of Bedrock (ft./sec.)
D.D.H. 9	Depressed at 61°, N75°E.	55'	36' downhill from C7	62' at C7	14,000
D.D.H.10	Vertical	Still in quartzite at 68½'	13' from D6	65' at D6	19,000
D.D.H.11	Vertical	76'-82'	3' from D8	77' at D8	13,500

The seismic velocity logs of D.D.H.10 and D.D.H.11 are shown in Table 2.

TABLE 2.

D.D.H.10			D.D.H.11		
Depth (ft.)	Rock	Velocity (ft./sec.)	Depth (ft.)	Rock	Velocity (ft./sec.)
0-10	Partly weathered unsilicified quartzite.	2,200±	0-20	Very weathered unsilicified quartzite breccia.	3,300±
10-30	Partly weathered quartzite and quartzite breccia.	4,000	20-40	Weathered quartzite breccia, unsilicified.	5,000
30-50	Slightly weathered silicified quartzite and breccia.	13,000	40-70	"	5,000
50-70	"	13,000	70-96	Weathered silicified quartzite to 76', then weathered, silicified granite.	17,000±

The velocity determinations in Table 2 are approximate only, as measurements were taken over only a short distance. The differences in the velocity in the quartzite are due to differences in the degree of weathering and silicification. The quartzite in D.D.H.11 has a velocity of 5,000 ft./sec. and is weathered but not silicified; D.D.H.10 shows slightly weathered silicified quartzite with a velocity of 13,000 ft./sec. The latter velocity shows that part of the bedrock recorded on traverse D may be slightly weathered silicified quartzite and not granite.

The results may be considered to have a maximum error of ± 15 per cent.

5. CONCLUSIONS.

The seismic results show that the depth to rock suitable for the foundation of a dam, is of the order of 60 to 70 feet over the quartzite spur. The bedrock recorded by the seismic method appears, from the geology and drilling results, to be slightly weathered granite or partly weathered silicified granite, but could be slightly weathered quartzite over a part of the quartzite spur.

The average velocity in the weathered and jointed quartzite overburden on the spur, which is shown as 4,500 ft./sec. on traverse D (Plate 2) indicates that the quartzite is unsuitable for the foundation rock of a dam; the recommendation of Perry (1953, p.4) that, with grouting, this rock would give suitable foundations, is not supported.

The depth to partly weathered granite (12,500 ft./sec. velocity) over the saddle is of the order of 60 feet. The overburden of weathered granite has a low velocity of 2,100 to 2,700 ft./sec.

6. REFERENCES.

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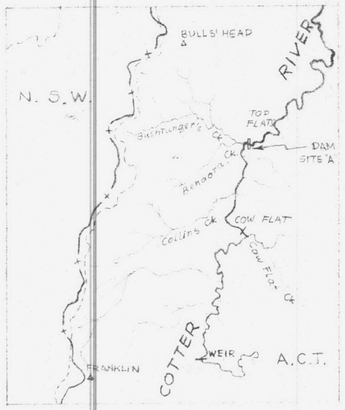
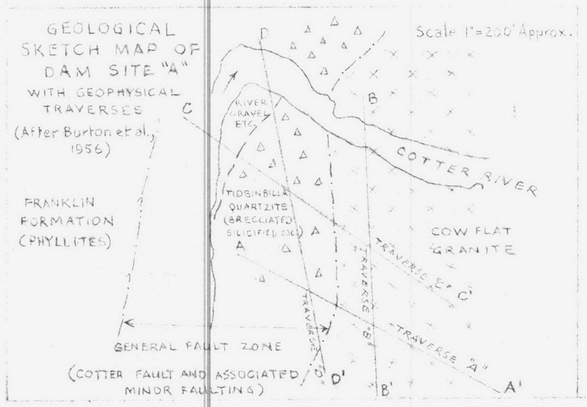
Perry, W.J., 1953 - "Geological Survey of the Upper Cotter Dam Sites A and B. A.C.T." Bur.Min.Resour.Aust., Records 1953, No.18.



LOCALITY MAP

SCALE : 0 1 2 3 4 MILES

NOTE : ▯ AREA INVESTIGATED



GEOPHYSICIST :

L. V. Hawkins.

LEGEND

TOPOGRAPHICAL CONTOUR

RIVER

TRAVERSES AND GEOPHYSICAL STATIONS

DIAMOND DRILL HOLE ⊙ DDH 4

SEISMIC VELOCITY IN FEET PER SECOND (14000)

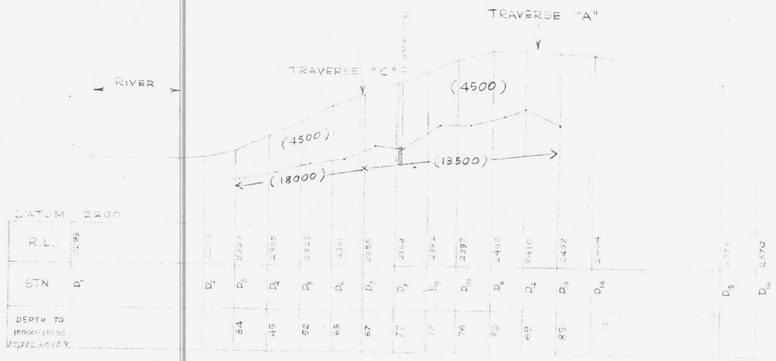
SEISMIC REFRACTION SURVEY OF THE UPPER COTTER DAM SITE "A", CANBERRA, A.C.T.

LOCALITY MAP AND SEISMIC TRAVERSES

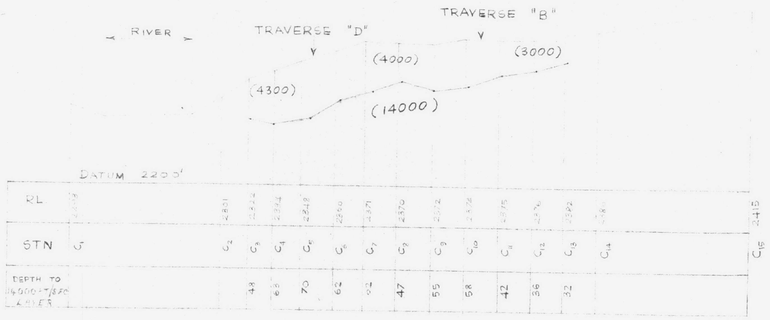
SCALE : 0 100 200 300 400 ft

BUREAU OF MINERAL RESOURCES, GEOPHYSICAL SECTION

G2603



TRAVERSE "D"



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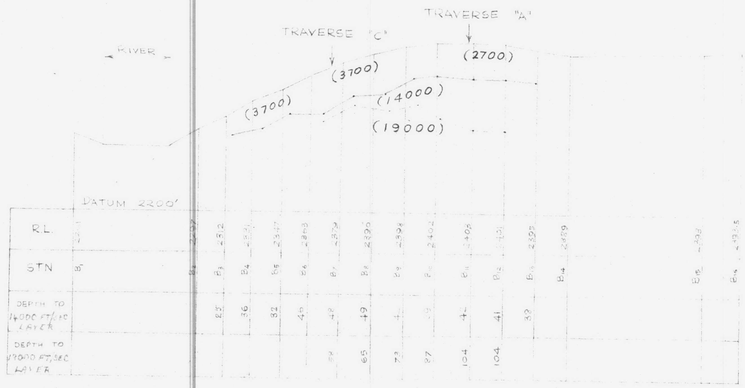
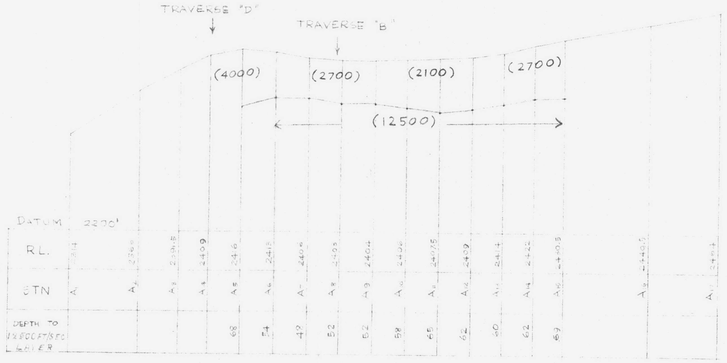


TRAVERSE "B"



TRAVERSE "A"

GEOPHYSICIST:

L. V. Hawkins

LEGEND

(19000) SEISMIC VELOCITY IN FEET PER SECOND

SEISMIC REFRACTION SURVEY OF THE UPPER COTTER DAM SITE "A", CANBERRA, A.C.T.

VERTICAL SECTIONS SHOWING UNWEATHERED ROCK PROFILES

SCALE : 0 100 200 300 400 ft

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