COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1962/171

COTTER DAM SITE 'E', SEISMIC REFRACTION SURVEY, A.C.T., 1961

by

W.A. Wiebenga, E.J. Polak & M. Kirton

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ILLUSTRATIONS

SUMMARY

This Record describes a seismic survey of damsite E on the Cotter River, A.C.T., made at the request of the Geological Branch of the Bureau of Mineral Resources. Along the main axis of the damsite, the bedrock is deeper than 50 ft over the greater part. The seismic velocities within the bedrock suggest that this site is not suitable for a concrete arch dam.

1. INTRODUCTION

An additional storage dam will be needed within 10 years to supply Canberra with sufficient water. The Commonwealth Department of Works has been investigating various possible sites for such a dam, and has asked the Bureau of Mineral Resources for advice on these. The Geological Branch of the Bureau recommended a geophysical survey at the Cotter Dam Site E to test foundations, with special reference to rock quality. This survey was made by the Geophysical Branch in 1961.

The approximate co-ordinates of the centre of the proposed damsite axis are 855113 on the Bimberi sheet (eastern half) of the Australian 1-mile series.

The field work was done between 16th and 19th September 1961 by a geophysical party, consisting of M. Kirton (party leader) and J.P. Pigott and C.J. Braybrook, geophysical assistants. The seismic computations were done by W.A. Wiebenga and E.J. Polak.

The equipment consisted of an SIE 12-channel refraction seismograph with TIC geophones (natural frequency about 20 c/s) and two three-component Hall-Sears geophones to record longitudinal and transverse waves.

The topographical survey of the traverses was done with compass and tape by officers of the Geological Branch.

For a description of the seismic method, reference is made to Heiland (1946) and Stam (1962).

2. GEOLOGY

The geological information was supplied by the Geological Branch, Bureau of Mineral Resources (1961, unpublished).

The rocks at the dam site are steeply-dipping quartzite, quartz sandstone, greywacke, siltstone, shale, and slate. They are thoroughly indurated and extensively, but evenly, silicified.

The sediments are strongly folded; it is not clear at present in which direction the folds plunge.

Some faulting has been recognised and other faulting is suspected. On the west valley slope, the Cotter Fault trace is about 350 ft. above creek level.

An unconformity occurs at about 150 ft above river level on the east side of the river valley. The condition of the underlying rock at the unconformity is not known.

The arenaceous rocks are jointed, but at depth, the joints should generally be closed. At the surface many of the argillaceous and fine-grained arenaceous rocks part along joints, cleavage, and bedding.

3. RESULTS

Plate 1 shows a sketch plan with some geological information and the approximate position of the traverses. Plate 2 shows the seismic cross-sections along Traverses A, B, and C with the measured seismic velocities. The term bedrock refers to the deepest seismic refractor indicated; the layers above the bedrock are called overburden.

Longitudinal seismic velocities give a fair indication of rock strength, the higher the velocity, the stronger the rock. Table 1 shows the probable interpretation of the longitudinal seismic velocities in geological terms, using the available geological information.

TABLE 1

Longitudinal seismic velocity (ft/sec)	Rock Type
1000	Soil
2000 to 2300	Scree, eluvium, colluvium, alluvium, not water saturated; very weathered rock.
6000 to 9000	Weathered, fractured bedrock.
10,000 to 11,500	Moderately weathered bedrock, fractured.

Table 2 shows the location along the traverses, the longitudinal seismic velocity in bedrock, Poisson's ratio, Young's modulus, and compressive strength. Poisson's ratio and Young's modulus are computed from transverse and longitudinal wave velocities, assuming a specific gravity of 2.55 for bedrock. Young's modulus determined dynamically is about 10 to 20 percent higher than corresponding values determined by static methods.

The compressive strength is obtained from correlations by Judd and Huber (1961). The values for compressive strength should be considered as maximum values.

TABLE 2

Location	Poisson's ratio	Longitudinal seismic velocity (ft/sec)	Young's modulus ($lb/in.^2$)	Compressive strength (lb/in^2)
A100 to A600	0.30	9500	2.3×10^6	22×10^3
A600 to A1100	0.26	11,500	3.6×10^6	27×10^3
A1200 to A1700	0.34	10,000	2.2×10^6	24×10^3
B80 to B200	0.34	11,000	2.7×10^6	26×10^3
Overburden	-	6000	-	10×10^3
Overburden	-	8000	-	14×10^3

The depth to bedrock is about 10 ft near the river (A1200 and Traverse C) but exceeds 75 ft between A1350 and A1550. The bedrock profile and the lower seismic velocities within the bedrock between A1350 and A1550 suggest the presence of a shear zone or fault zone.

The locations of inclined drill holes P1, P1B, P3, P4, and P5 are shown on Plates 1 and 2. An accurate comparison between the seismic work and the geological logs of these drill holes is not possible except for drill hole P3; drill holes P4 and P5 are located too far from the seismic traverses and P1 and P1B are in a zone where insufficient seismic information was obtained. However, the following general comments are of interest:

Drill hole P3. Seismic work indicates that the vertical depth to the 8000-ft/sec layer is about 18 ft, and the vertical depth to the 10,500-ft/sec layer is about 40 ft. The geological log lists soil, sandy clay, and greywacke weathered to a light brown colour (corresponding to the seismic velocity 2300 ft/sec) to a vertical depth of 18 ft, then fine to medium-grained, weathered quartz sandstone (corresponding to a seismic velocity 8000 ft/sec) to a vertical depth of about 33 ft, and moderately weathered greywacke and sandstone deeper than 33 ft (corresponding to seismic velocity 10,500 ft/sec).

Drill hole P1. To a vertical depth of seven feet, the 2200-ft/sec layer corresponds with alluvium, clayey sand, sandy clay and silt, and sand and pebbles. Below seven-feet depth the 6000 to 8000-ft/sec layer corresponds with gravel and fine-grained quartz greywacke.

4. CONCLUSIONS

On most of the west bank the bedrock ranges between 50 and 70 ft in depth; on the east bank a zone in which depths exceed 70 ft is located between A1350 and A1600.

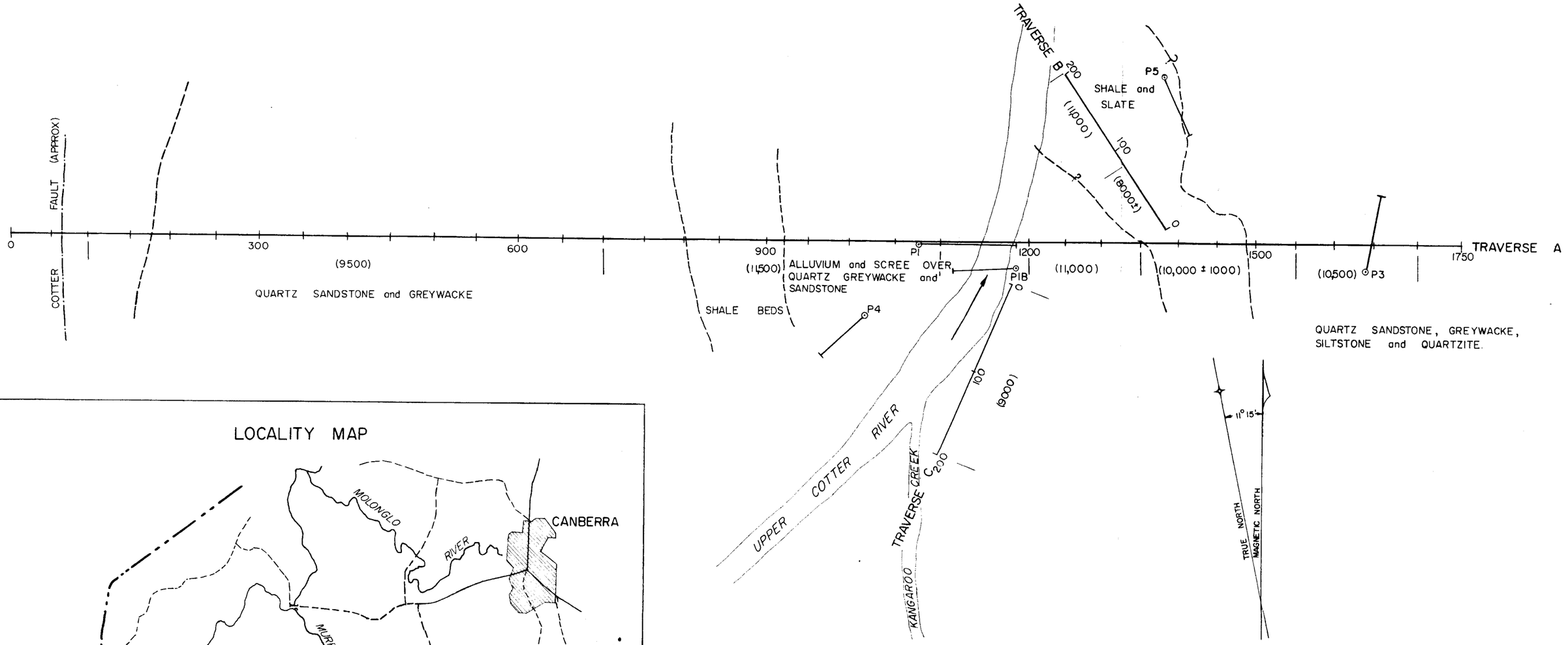
The seismic velocities within the bedrock do not suggest the presence of a good foundation rock that would be suitable for a concrete arch dam.

In this type of terrain the accuracy of depth determinations of seismic discontinuities is probably not better than 25% of the depth.

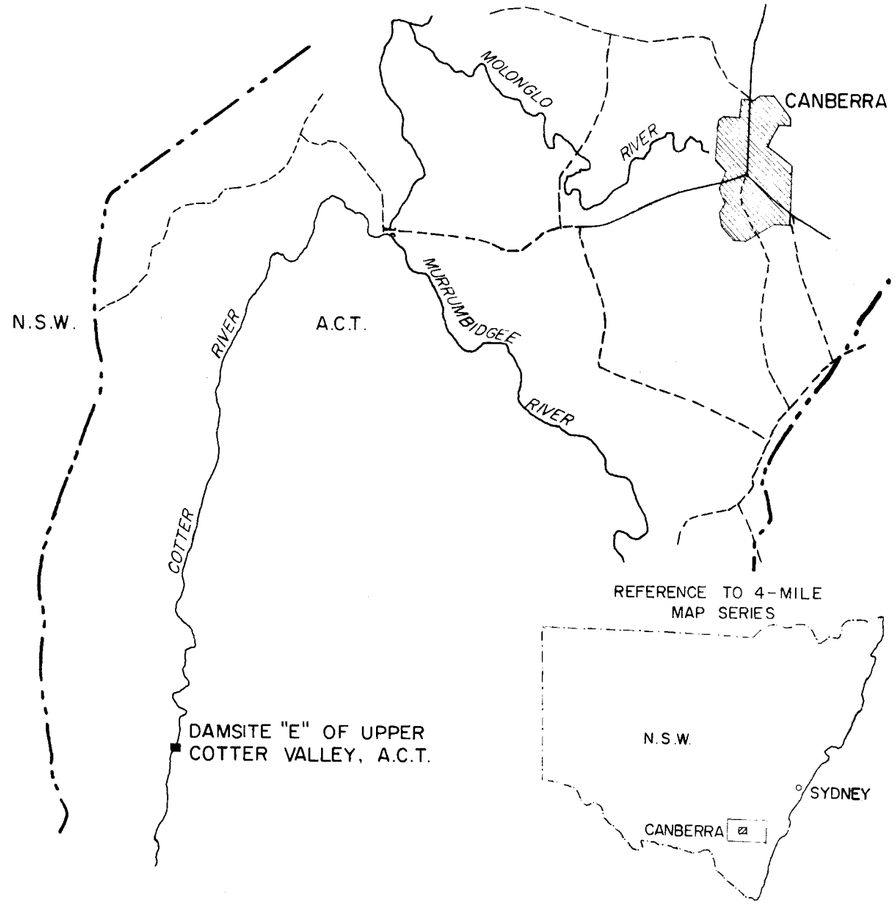
5. REFERENCES

GEOLOGICAL BRANCH, BUREAU OF MINERAL RESOURCES	1961	Upper Cotter Dam Site 'E', summary of conclusions, May 1961 (unpublished).
HEILAND, C.A.	1946	GEOPHYSICAL EXPLORATION. New York, Prentice-Hall Inc. p.548.
JUDD, W.R., and HUBER, C.	1961	INTERNATIONAL SYMPOSIUM ON MINING RESEARCH. Correlation of rock properties by statistical methods. Pergamon Press Ltd. Oxford, (2), p.621.
STAM, J.C.	1962	Modern developments in shallow seismic refraction techniques. Geophysics, 27 (2), p. 198-212.

PLATE 1



LOCALITY MAP



LEGEND

(12,000) SEISMIC VELOCITY IN DEEPEST REFRACTOR, (FT/SEC)

SEISMIC STATION

P4 INCLINED DRILL HOLE No. 4

FAULT, (FROM GEOLOGICAL REPORT)

APPROXIMATE GEOLOGICAL BOUNDARY (FROM GEOLOGICAL REPORT)

LOCALITY MAP, LAYOUT OF SEISMIC TRAVERSES, & GEOLOGY
DAMSITE E, UPPER COTTER VALLEY, A.C.T.
SEISMIC REFRACTION SURVEY 1961

SCALE IN FEET

100 0 100 200 300

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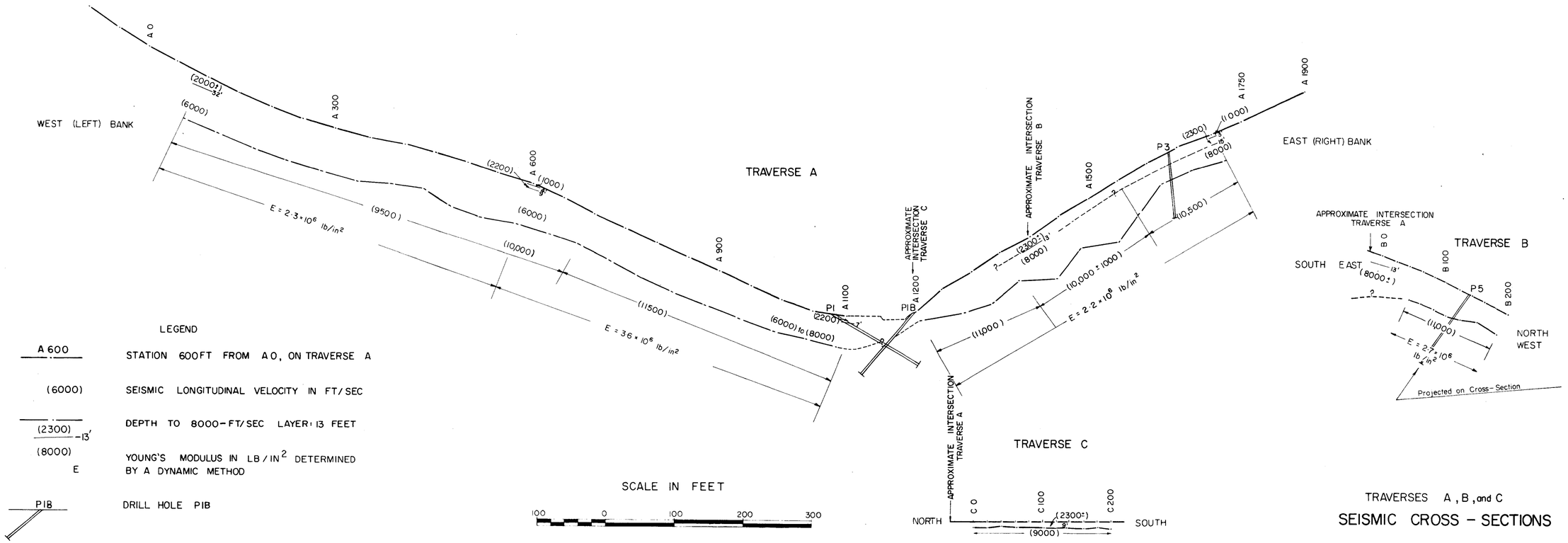

LEGEND

A 600	STATION 600 FT FROM A 0, ON TRAVERSE A
(6000)	SEISMIC LONGITUDINAL VELOCITY IN FT/SEC
(2300) / (8000) — 13'	DEPTH TO 8000-FT/SEC LAYER: 13 FEET
E	YOUNG'S MODULUS IN LB/IN^2 DETERMINED BY A DYNAMIC METHOD
P1B	DRILL HOLE P1B

SCALE IN FEET

100 0 100 200 300

TRAVERSES A, B, and C

SEISMIC CROSS - SECTIONS

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