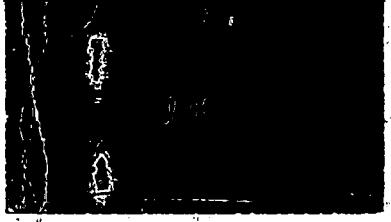
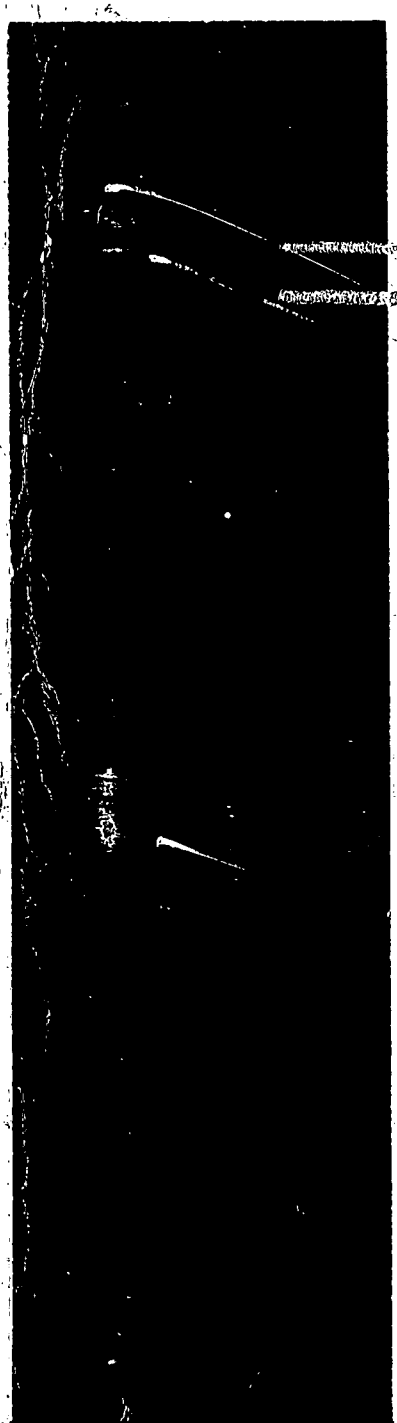
REPT.BK.NO. 73/30





SEISMIC REFRACTION SURVEY AT HINDMARSH VALLEY

R. G. NELSON

Department of Mines
South Australia —

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
EXPLORATION SERVICES DIVISION

SEISMIC REFRACTION SURVEY AT HINDMARSH VALLEY

by

R.G. NELSON
GEOPHYSICIST
EXPLORATION GEOPHYSICS SECTION

7th February, 1973 Rept.Bk.No. 73/30

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DEPARTMENT OF MINES
SOUTH AUSTRALIA

Rept.Bk.No. 73/30
G.S. No. 5036
D.M. No. ~~1043~~/72
1012

SEISMIC REFRACTION SURVEY AT HINDMARSH VALLEY

ABSTRACT

Seismic refraction traverses along the right abutment ridge of a proposed dam in Hindmarsh Valley were used to predict depth to Cambrian bedrock. The results indicated that the bedrock core of the abutment ridge falls in some places below the full storage level of the dam. A cable-tool hole, drilled at a critical site on the ridge, confirmed the result of the seismic traverse at this point.

INTRODUCTION

The site for the proposed dam lies on the Hindmarsh River and is about seven miles north of Victor Harbour. The Hindmarsh River drains part of the southern Mt. Lofty Ranges and flows into Encounter Bay at Victor Harbour.

Bedrock in the area consists of undifferentiated metasediments (mostly arkoses) of Cambrian age (Kanmantoo Group) which may achieve thicknesses in excess of 4500m. Glaciation during the Permian eroded wide valleys in the bedrock which were later filled with glacial and fluvioglacial deposits of silts and sands with some erratic boulders.

The dam site is situated in a deep steep-sided valley, which has been eroded by stream action into a scarp in the Cambrian bedrock (see Plan No. 73-39). The ridge which is to form part of

the right abutment of the dam is believed to consist of a core of Cambrian bedrock over which is draped a mantle of Permian glacial deposits.

The aim of the seismic survey was to estimate the thickness of the Permian deposits over the bedrock core and to determine if at any point the depth to bedrock lies below the full storage level of the dam. Such a situation could lead to a short leakage route for water from the dam.

Methods Used

The locations of the seismic traverses are shown in Plan No. 73-39. The instrument used was a Texas Instrument Co. 7000B recording seismograph, which records information from twenty-four geophones. Standard seismic refraction geophones were used in in-line spreads with a spacing of 9.14m (30ft.) between geophones.

For each spread the following shots were fired:

(a) a centre shot, midway between geophones 12 and 13

(b) two shots at the end of the spreads, the end geophone in each case being displaced 4.57m (15ft.) down the line of geophones away from the shot.

In the case of the orthogonal spread at BB' (see Plan No. 73-40) two bracketing shots placed 30m from each end of the spread were also fired to give more information on the bedrock refractor. For all the other traverses the procedure was to move each spread a distance of one half-spread-length at a time so as to achieve a continuous split spread. The results of such an arrangement are then amenable to analysis by using either of the

methods of Hawkins (1961) or of Wyrobek (1956).

To obtain more information on near-surface layers a series of "weathering" spreads were shot employing in-line geophones with a spacing of 1.64m (5ft.). The locations of these are marked on the plan of the traverses (Plan no. 73-39).

The seismic explosive used was AN60 blasting gelignite, fired by means of a capacitance blaster and electrical detonators.

Results

Times to first breaks were obtained from the seismic records and plotted as time-distance graphs. The velocities and thicknesses of individual layers were then estimated from these. The reciprocal method reviewed by Hawkins (1961) was used to obtain further information on variations in bedrock relief and velocity.

Section AA' (see Plan No. 73-40)

This section shows a reasonably uniform surface layer (denoted by X) whose velocity varies from 370 m/s to 725 m/s and whose thickness varies from 0m to 5m. Underlying this is a layer (denoted by Y) with a velocity range of 1220 m/s to 1710 m/s. This layer overlies a high speed layer of 3720 m/s to 4270 m/s which is equated with bedrock. This last layer is denoted by Z.

Some variation in the velocity-layer distribution occurs beneath shotpoint 10 where a 2740 m/s layer appears above the high speed 3720 m/s refractor. This has been interpreted as a change in bedrock velocity, brought about either by lithological change or by deep physical or chemical weathering, and has been denoted by Z'.

Section BB' (see Plan No. 73-40)

This is the section produced from a spread orthogonal to traverse AA'. It shows a fairly uniform pattern throughout with layers X,Y and Z again being present.

Because the reciprocal analysis indicated that bedrock along this section might lie beneath the full storage level of the dam a cable-tool hole, CH1, was drilled at the intersection of sections BB' and AA'. The geological log of this is summarized briefly below, together with the seismic results.

Hindmarsh Dam Cable-Tool - Hole CH1

Geological log

From	To	Rock-type	Remarks
0m	4.2m	Sandy clay	Water cut 13.5m
4.2m	9.3m	Dense sand	rose to 10.68m
9.3m	17.10m	Sandy clay	Very small supply
17.10m	18.17m	Weathered quartzite	
18.17m	19m(EOH)	Hard quartzite (fresh)	

Seismic refraction results

Layer	Velocity	Thickness	Depth
X	725 m/s	5.10 m	0 m
Y	1710 m/s	13.46 m	5.10 m
Z	4270 m/s	-	18.56 m

Considering these results, it seems reasonable to equate layer X with the dry surface layers of sandy clay, layer Y with the sequence of dense sands and water-saturated sandy clays, and layer Z with the hard quartzite. Because of its thinness in relation to its depth, the weathered quartzite layer would be hard

to detect using seismic methods even if its velocity differed significantly from that of layer Y.

The results of the cable-tool hole have thus confirmed the seismic interpretation at this location.

Section CC' (see Plan No. 73-40)

This section intersects section AA' at shotpoint 10. The Z' layer encountered at shotpoint 10 persists throughout this section and appears to lie above the full storage level of the dam. Although its velocity is lower than that of layer Z it is nevertheless a relatively high velocity (greater than that of water): this is thought to indicate that, no matter what its nature, it is probably an impermeable layer which presents a barrier to leakage of water along this section.

Section DD' (see Plan No. 73-40)

This ties in with section CC' at shotpoint 13 and exhibits results similar to those of section CC'. The Z velocity layer is, however, absent except at shotpoint 13.

The Z' layer lies in general above the full storage level of the dam except under shotpoint 12 which is in any case outside the critical area of the abutment.

Conclusions

The results of the seismic refraction survey have been used to estimate depth to the bedrock core of the right abutment ridge of the proposed dam. Along most of the ridge this core seems to lie above the full storage level of the dam. However, there is a bedrock depression which occurs near the intersection of sections AA' and BB', at a particularly narrow section of the

ridge. This has been confirmed by drilling. It could present a possible leakage path for water from the dam.

A major change in bedrock type seems to occur along traverses CC' and DD' either as a result of weathering or of lithological variation. However, the magnitude of the seismic velocity indicates that it will still act as a barrier to leakage of water.

R.G. Nelson

RGN:AM
7.2.73

R.G. NELSON
GEOPHYSICIST
EXPLORATION GEOPHYSICS SECTION

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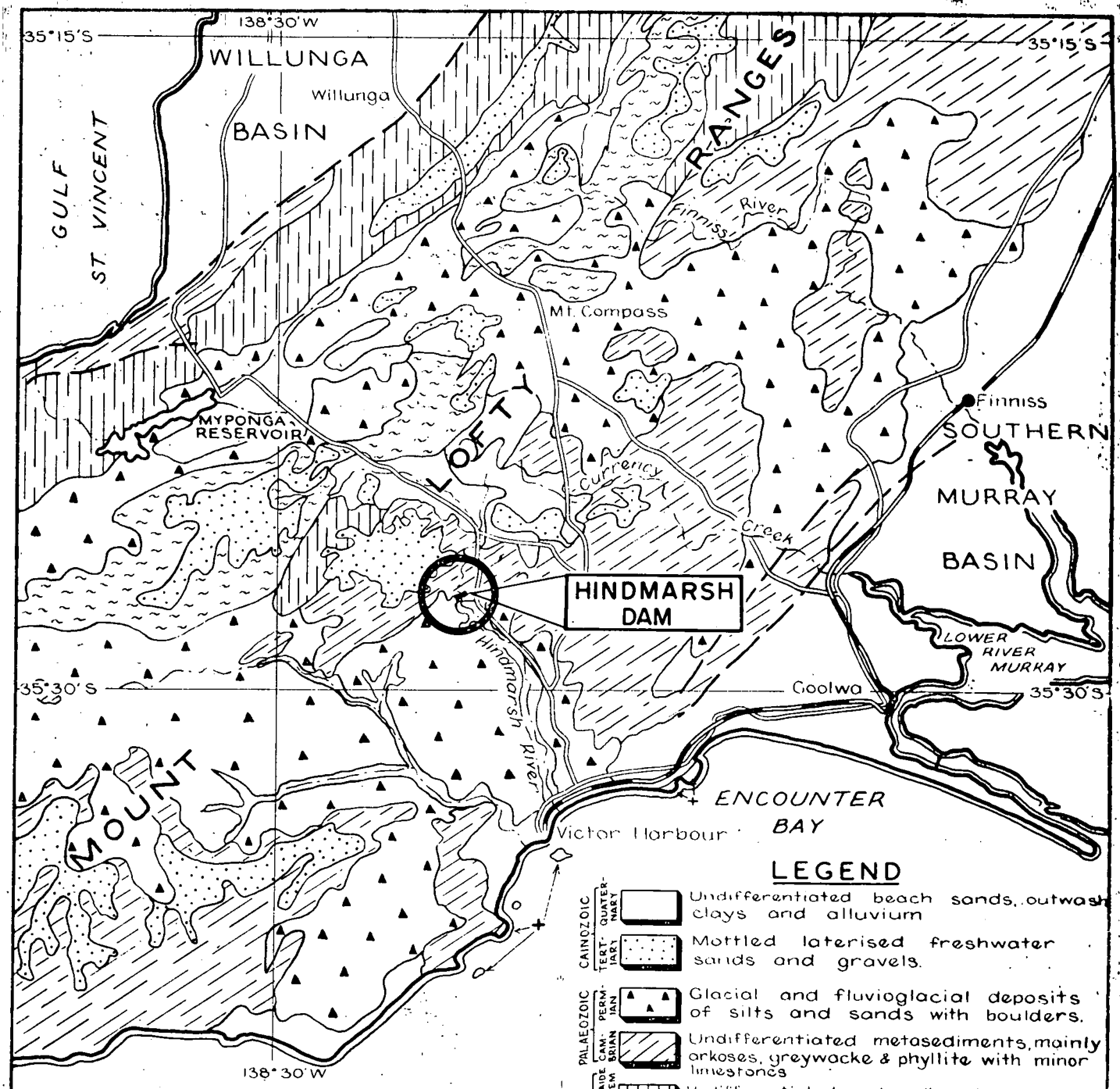
Hawkins, L.V., 1961. The reciprocal method of routine shallow seismic refraction investigations. Geophysics, 26: 806-819.

Wyrobek, S.M., 1956. Application of delay & intercept times in the interpretation of multilayer refraction time-distance curves. Geophysical Prospecting, 4:112-130.



Geology from Barker, 1:250000 Geological Atlas Series.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

Compiled:

Drn. D.J.M. | Ckd.

HINDMARSH DAM

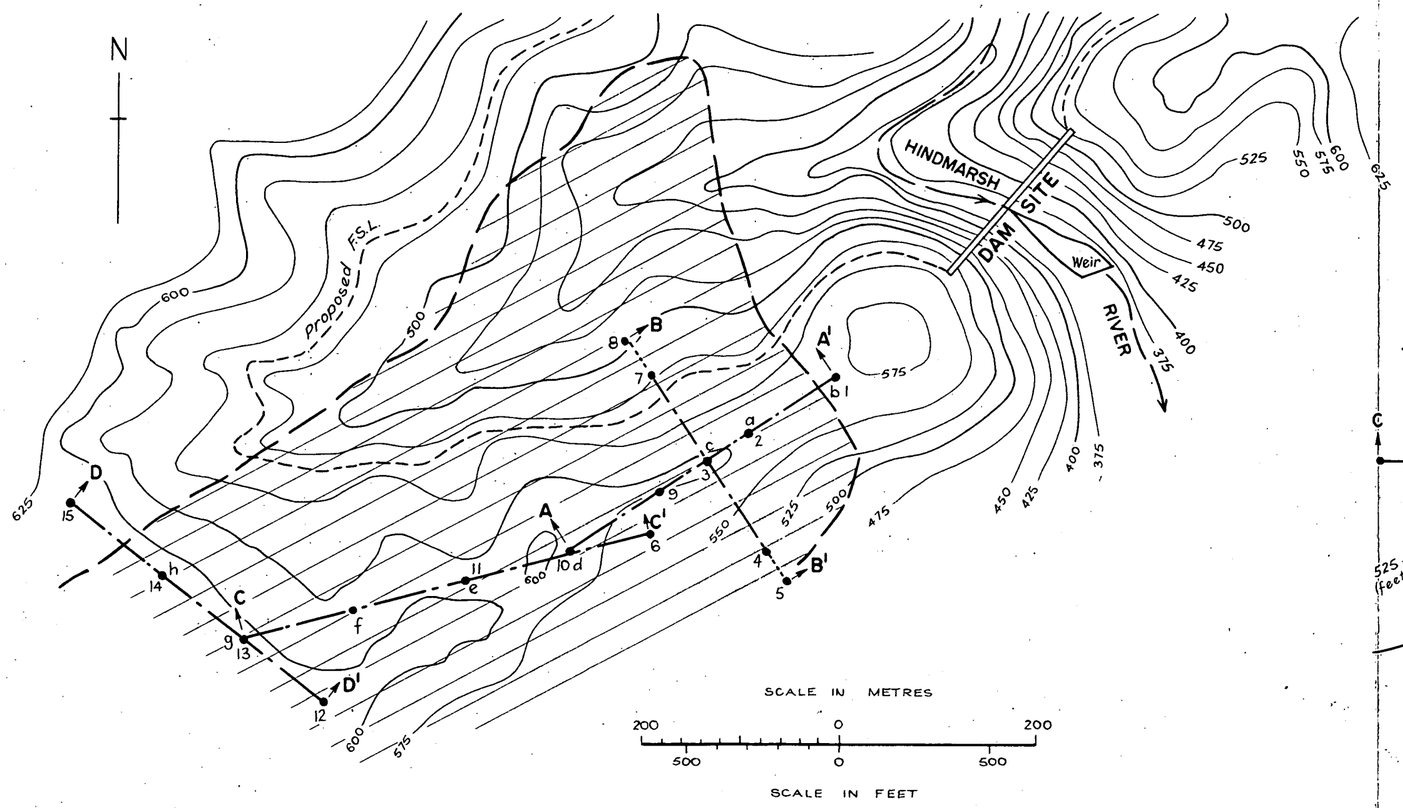
LOCALITY AND GENERALIZED REGIONAL GEOLOGY

Scale: 1:250000

Date: 5 FEB. 1973

Drg. No. S10128 Hc9

300-6.72 C5552



LEGEND

PERMIAN Sands, sandy clays, with boulders

CAMBRIAN Micaceous sandstones and arkose quartzite in places

C — 2 — C' Seismic refraction traverse CC', with shotpoint No. 2

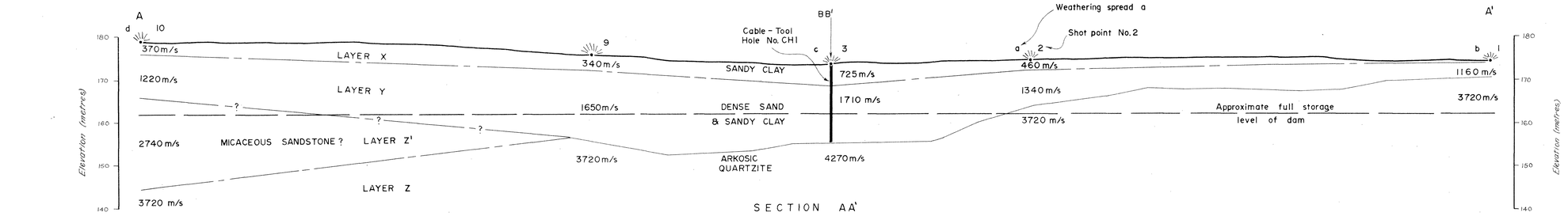
a Weathering spread No. a

525 (Feet) Contour – All contours are taken from E.&W.S. plan No. 5482.

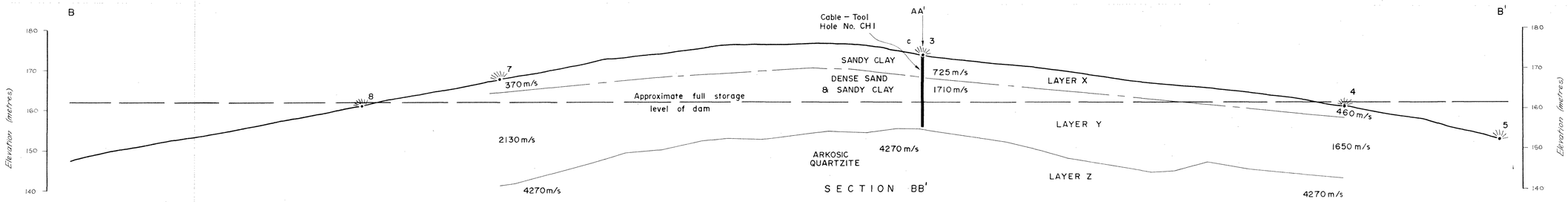
Geological boundary

EXPLORATION GEOPHYSICS SECTION	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: 400 FT. = 1 INCH. (1:4800)
Compiled: R. Nelson	HINDMARSH DAM	Date: 1 FEB. 1973
Drn. AJM Ckd.	LOCATION OF SEISMIC REFRACTION TRAVERSES.	Drg. No. 73-39 Hc9

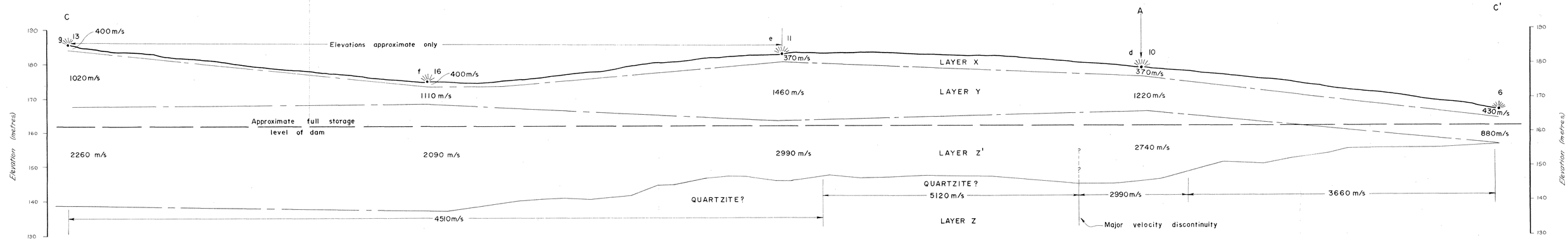
1M–2,70 A1811



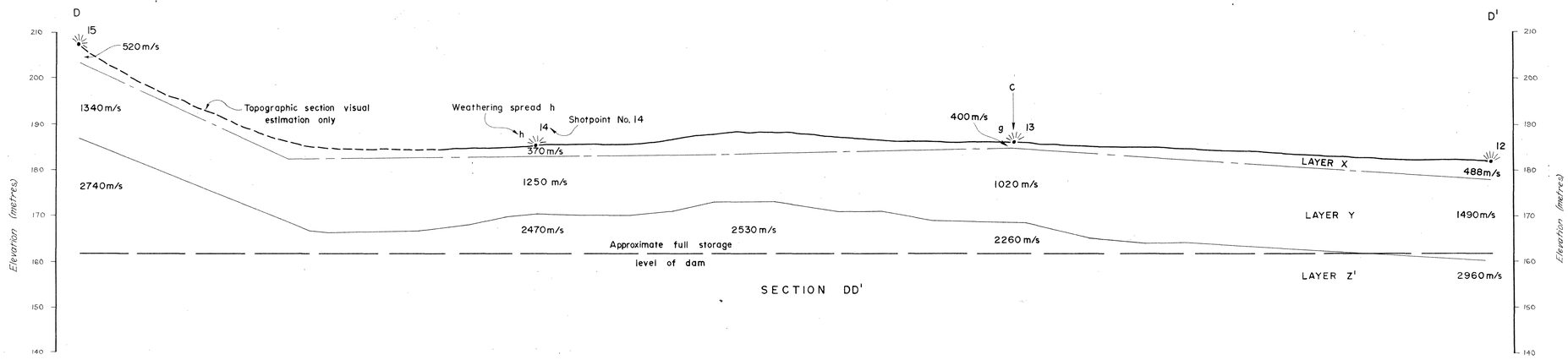
SECTION AA'



SECTION BB'



SECTION CC'



SECTION DD'

SCALE IN METRES
10 0 10 20 30 40 50
50 0 50 100 150
SCALE IN FEET

Vertical Scale = Horizontal Scale

Note: Topographic sections measured using Tape and Abney Level (unclosed).

R.L. estimated from E.&W.S. Plan No. 54 82

DEPARTMENT OF MINES — SOUTH AUSTRALIA

HINDMARSH DAM
RIGHT ABUTMENT RIDGE
SEISMIC REFRACTION TRAVERSE

EXPLORATION GEOPHYSICS SECTION		Drn. A.K.	SCALE: 1:500 (1cm = 5 metres)
		Tcd. G.W.	73 - 83
		Ckd.	
Director of Mines		Exd.	DATE: 5 JUNE 1973