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DEPARTMENT OF MINES
SOUTH AUSTRALIA

SEISMIC INVESTIGATIONS YANKALILLA RIVER PUMPED STORAGE SCHEME

by

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Geophysicists

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ABSTRACT

A seismic refraction survey was made to determine depth to bedrock along three traverse lines on portions of the rim of a proposed reservoir for the Yankalilla River Pumped Storage Scheme in order to detect possible leakage paths through the reservoir rim. The survey is thought to have determined with reasonable accuracy the depth to bedrock along two of the traverses and to have given some indication of bedrock conditions along the third.

A programme of drilling and velocity survey is recommended if further information is required on the third traverse.

INTRODUCTION

During September and October 1959, a refraction seismic survey was made at Normanville, about 60 miles south of Adelaide in South Australia by the Geophysical Section of the South Australian Department of Mines. This survey was undertaken as part of the investigations being made by the Department of Mines into the water tightness of a proposed reservoir for the Yankalilla River Pumped Storage Scheme. Three line refraction surveys were made along traverse lines 8200, 2800 and 3000 feet in length which were located on ridges forming portion of the rim of the reservoir storage, through which leakage of the impounded water could occur.

Seismic refractors were detected with varying velocities from 3000 to 7500 feet per second and another deep refractor with velocity 12000 to 15000 feet per second was also found. This deep refractor is considered to be the bedrock in the area.

PREVIOUS INVESTIGATIONS

The area forms the subject of Department of Mines

Report No. 206/59 "Preliminary Geological Report on a Dam and Reservoir Site on the Yankalilla River for a Pumped Storage Electricity Generation Scheme" by W. Johnson (1959) and of No. 206/59 "Progress Report on Damsite Investigations - Normanville Pumped Storage Scheme" by M. N. Hiern (1959). No previous geophysical investigations have been made.

GEOLOGY

The proposed reservoir site is situated on the shore of Gulf St. Vincent 2 miles south of Normanville where the Yankalilla River emerges through the coastal scarp in a steep-sided V shaped gorge. This scarp is formed of hard metamorphic rocks of Archaean age and these rocks extend inland and form a large proportion of the reservoir rim. The remainder of the reservoir rim is formed of unconsolidated glacial and fluvio glacial sands and clays of Permian age. It was over the outcrops of these sands and clays that the seismic traverses were run in an endeavour to determine the depth to Precambrain bedrock and so detect possible leakage paths through the reservoir rim in the Permian beds.

FIELD METHODS

Traverse lines were located along the rim of the reservoir for a total distance of 14000 feet between outcrops of the Precambrian bedrock. One traverse was located on the northern ridge with length 8200 feet, one on the southern ridge with length 2800 feet, and one on the southern ridge at the upper damsite with a length 3000 feet. The lines were surveyed and levelled by officers of the Electricity Trust of South Australia, pegs for geophone stations being located every 50 feet along the line. Shotholes located every 500 feet were drilled to a depth of 20 feet where possible, using, for the earlier work a landrover mounted Proline rotary posthole digger which was found to be very slow and subject to breakdowns, and for the final shotholes a truckmounted Mayhew 1000 rotary shothole drill which was far more efficient. A twelve channel Century portable refraction seismic recorder (on loan from the Bureau of Mineral Resources) was used to record the results. From each shotpoint short spreads were laid out adjacent to the shotpoint with detectors spaced 12½, 25, 37½, 50, 75, 100, 125, 150, 175, 200, 250 and 300 feet from the shotpoint and small charges of a few ounces of Geophex located at the surface were exploded.

The detector spread was then shifted further from the shotpoint and using 50 feet separation of the detectors, larger charges of Geophex (from 5 to 15 lbs) were exploded in the drilled shotholes.

Further spreads located at greater distances from the shotpoint were then recorded until the seismic wave refracted from the bedrock was detected (where possible).

INTERPRETATION

Graphs were drawn of the refraction times (corrected to surface-to-surface times) against distance for each shotpoint. The corrections to the surface were made using the velocities in shallow section indicated by the short spreads near the shotpoints.

For the traverse on the northern ridge simplified time-distance curves were drawn for a series of three flat-lying beds and the depths of the refractors computed from these curves.

For the traverses on the southern ridge and at the upper damsite, the refractors were located and their velocities were determined from the apparent velocities recorded and the intercept times computed at each shotpoint. From these results a theoretical section was constructed for each traverse line and time-distance curves were drawn for these sections. These theoretical time-distance curves were then adjusted to the observed time-distance curves until a satisfactory fit was obtained.

The results are presented in the form of sections showing the positions of the refractors, and time versus distance graphs showing the theoretical time distance curves (shown as lines), and the corrected first arrival times from the records (shown as points.)

The traverse line on the northern ridge indicates shallow bedrock along the first leg of the traverse (A B). The second leg B C is over bedrock outcrop. The third leg CD shows the bedrock to be deepening to the south until at a point 2000 feet from C it lies at a depth of 200 feet from the surface. From here the bedrock rises until at D it is about 110 feet deep and on the fourth leg DE it rises to a point 300 feet from D where it lies 50 feet from the surface and then deepens again further south until at a point 800 feet from D it lies about 150 feet from the surface. From here it rises to the surface at E. The fifth leg of the traverse EF is over bedrock. The sixth leg of the traverse FG shows a deep narrow valley filled with unconsolidated sediment close to F. 300 feet from F bedrock lies at 180 feet while 700 feet from F it has risen to 70 feet from the surface and then rises gradually to the surface at G. The velocity of the bedrock on the legs AB and FG is about 12000 feet per second and of the overlying sediments 3000 to 4000 feet per second. There is a shallow surface low velocity layer (usually from 4 to 10 feet in thickness) with velocity 1000 feet per second. On the legs CDE this low velocity layer is also present but the velocity of the bedrock is 15000 feet per second and the overlying sediments have velocity 6500 feet per second. It is considered that the high bedrock velocity indicates that the bedrock in this area consists of granite while at the ends of the traverse it consists of metamorphosed rocks.

The traverse line on the southern ridge indicates fairly shallow bedrock (up to 100 feet) throughout. Bedrock velocity varies from 12000 feet per second to 15000 feet per second. It is considered that the higher velocity is possibly again indicative of the presence of granite. The overlying sediments have velocity 5000 feet per second and the surface layer with velocity 1000 feet per second is again present.

The upper damsite traverse indicates more complex subsurface conditions. Three refractors were located. The surface low velocity layer of velocity, 1000 feet per second, is underlain by sediments of velocity 5000 feet per second. These are underlain by sediments of velocity 7500 feet per second which are underlain by bedrock of velocity 13000 feet per second. The bedrock on the first leg of the traverse (AB) dips to the south from A (where bedrock is shallow) to B where it lies approximately 220 feet from the surface. The second leg of the traverse BC crosses a deep valley filled with sediment and bedrock, dips to about 480 feet from the surface. On the third leg of the traverse CD bedrock rises from C (where it lies about 450 feet from the surface) to the surface at D.

The accuracy of the indicated depths to bedrock is very different for the three traverses. On the traverse on the northern ridge the seismic conditions are simple and the agreement between the values obtained from the seismic survey and the results of drilling is good. Similarly on the southern ridge the conditions are simple, so for these two traverse lines the survey is considered to be reasonably accurate. For the traverse at the upper damsite the survey presents a picture which is complex and does not appear very convincing. The result here should be considered rather unreliable until confirmed by drilling. In particular, it seems possible that the layer of velocity 7500 feet per second is merely a lens of high velocity material and in this case the depth indicated by the survey will be grossly in error. The records obtained on this traverse are not very good and the depth to bedrock is too large to be determined accurately by the method and equipment used.

CONCLUSIONS

It is considered that the seismic refraction survey has determined with reasonable accuracy the depth to bedrock along two of the traverses made and has given some indication of bedrock conditions along the third. If more accurate determination of depth to bedrock is required on the third traverse (at the upper damsite) a percussion drill hole should be drilled to bedrock at the deepest point indicated by the seismic survey. A velocity survey made in this hole would give data on which to base a more accurate interpretation of the results obtained by this survey.

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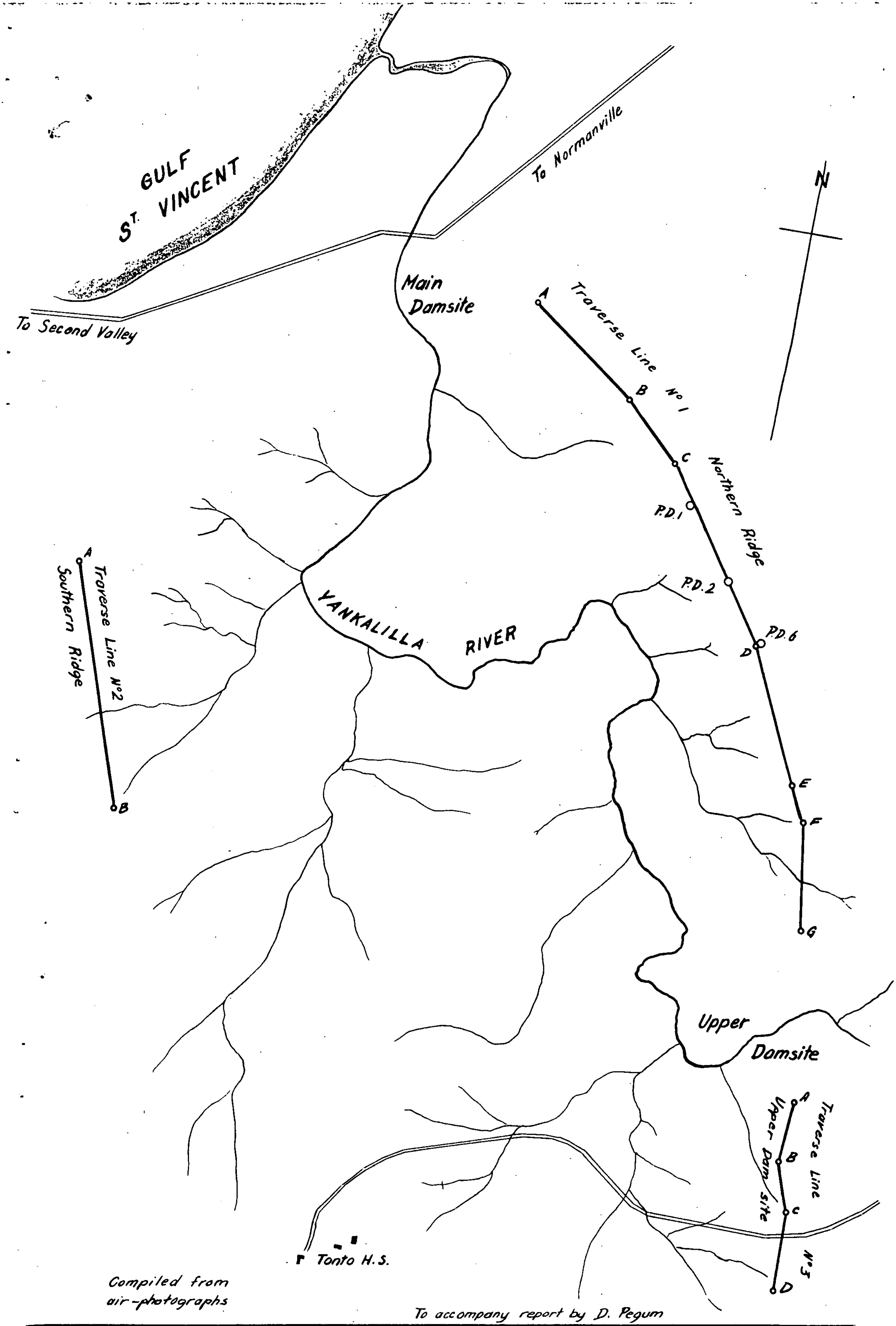

Compiled from air-photographs

To accompany report by D. Pegum

S.A. DEPARTMENT OF MINES					
Approved	Passed	Drn.	YANKALILLA RIVER PUMPED STORAGE SCHEME	D.M.	Scale 22 chs to 1 in approx.
		Tcd. G.S.		Req.	S 2293
		Ckd. R.R.	Location of Seismic Traverses and Percussion Drill Holes		Hc 7
Director		Exd.			Date 9-11-59

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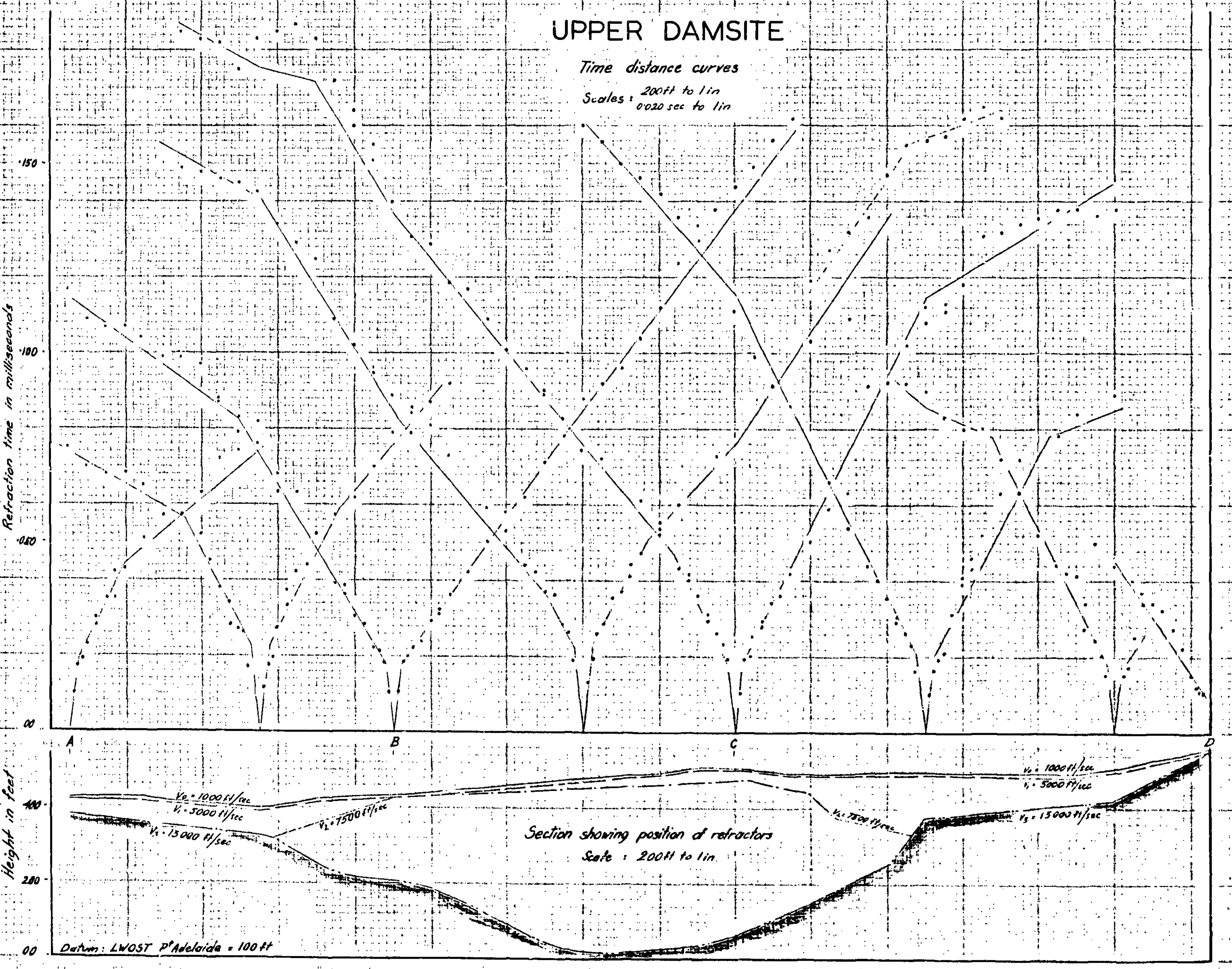

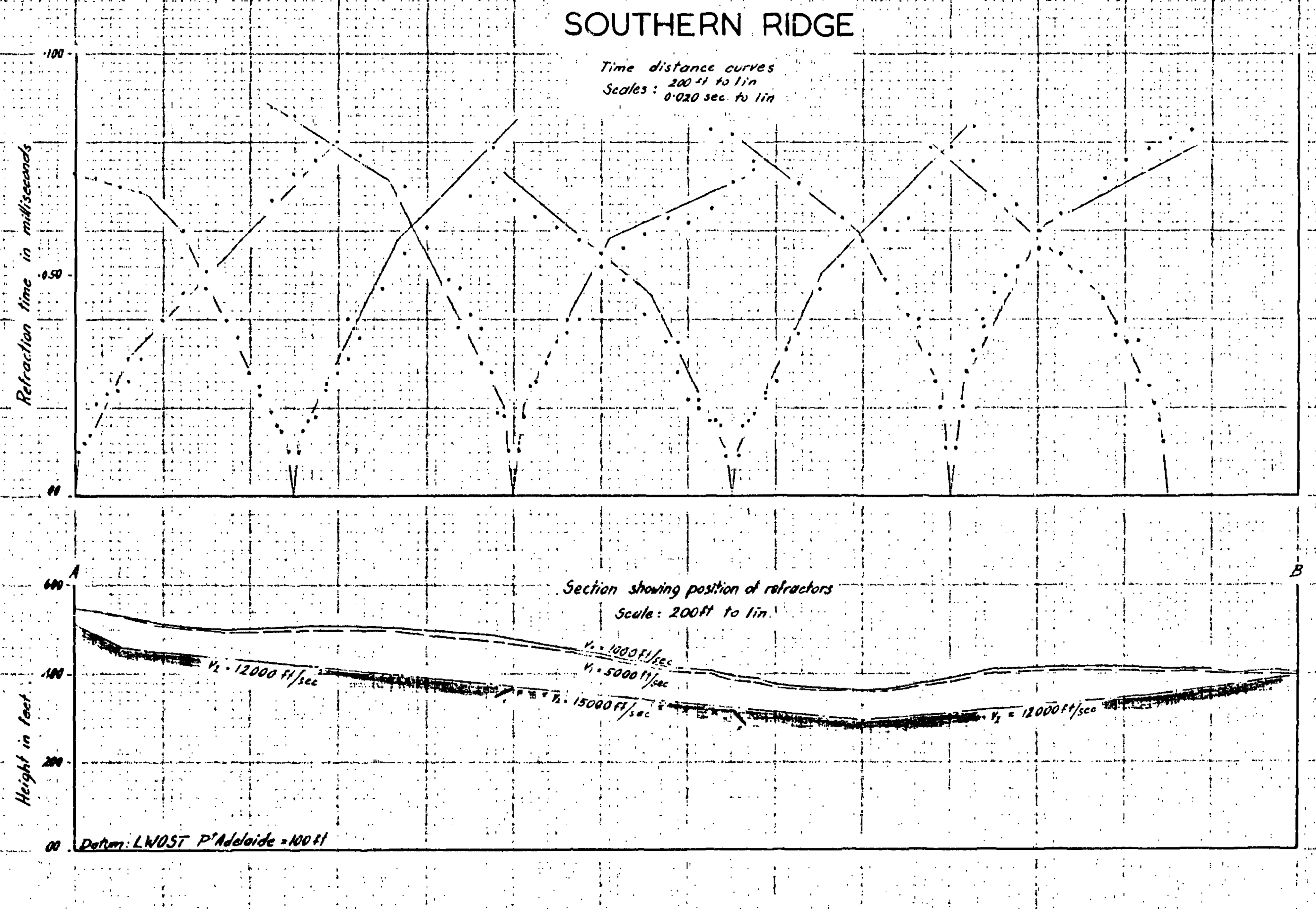

To accompany report by D. Pegum.

S.A. DEPARTMENT OF MINES				
YANKALILLA RIVER PUMPED STORAGE SCHEME SEISMIC TRAVERSES				
Drn		Passed	Scales: As shown	L 59·180
Tcd	G.S.			
Chd	R.R.	Approved	Date : 9-11-59	Hc 7
Exd				