DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1973/40

GRAVEL FOR RURAL ROADS - SEISMIC REFRACTION SURVEYS NEAR THARWA AND WILLIAMSDALE, A.C.T. 1972

by

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ILLUSTRATIONS

SUMMARY

A seismic refraction survey was conducted by the Bureau of Mineral Resources, Geology & Geophysics to determine the volume of gravel present at a number of sites near Tharwa and Williamsdale, ACT. The gravel is to be used in the construction and repair of rural roads in the Australian Capital Territory.

In three of the five areas examined, large quantities of gravel material of varying degrees of workability were revealed. The suitability of the material, with thickness ranging up to 15 metres, must be determined by further geological investigation.

1. INTRODUCTION

In June 1970, the Department of the Interior requested that the Bureau of Mineral Resources (BMR) undertake a search for sources of gravel for the construction and repair of rural roads in the ACT. The Engineering Geology section of BMR carried out a thorough search for suitable material (as specified by the Department of Works, Canberra) in suitable areas (as specified by the Department of the Interior). A number of sites in the Tharwa-Williamsdale area were located, and BMR carried out seismic refraction surveys in order to determine the extent and thickness of useful gravel material. The sites investigated are shown on Plate 1.

The field work was completed in April 1972 by a geophysical party from BMR's Engineering Geophysics group. The party consisted of I.D. Bishop and G.R. Pettifer (Geophysicists), and S. Hall (Shooter). Field hands were at times available from the Engineering Geology section. The positions of the seismic traverses are shown in Plates 2-5.

2. GEOLOGY

'Gravel' is used in this report in the engineering sense rather than the geological. It is defined as an unconsolidated, well-graded mixture of rock fragments, sand, and silt, in a feebly plastic soil binder. Gravel suitable for pavement was found to occur in two types of deposit:

(1) Material on slopes of hills which has undergone little or no transport since its formation by weathering of granitic rock. Such in situ slope deposits' were investigated at sites A, C, and D.

(2) Material which has been removed from its original place of formation and which now rests generally at the base of hills. Such 'slopewash deposits' were investigated at site B and at Williamsdale.

The predominant rock type in the Tharwa area is granite of the Murrumbidgee Batholith, with lenses of sediment and volcanic rock. The rocks of the Williamsdale area form part of the Middle Silurian Colinton Volcanics sequence; these also include welded tuffs and acid volcanics with lenses of sediments and limestone (Hansen, in prep. a, b).

3. METHOD AND EQUIPMENT

Standard BMR refraction seismic equipment consisting of a 24-channel SIE seismograph and 20-Hz TIC geophones was used for the survey. Geophones spacings of 3 m and 4 m were used depending on the dimensions of the area to be covered. Reciprocal geophones were used at distances between 40 m and 70 m beyond the ends of the spreads. Shots were fired from these points, and also at the ends and centres of the spreads. Interpretation was done by the time-intercept method (Dobrin, 1952) and the reciprocal method (Hawkins, 1961).

4. RESULTS

The seismic profiles from the five sites (4 in the Tharwa area, 1 near Williamsdale) exhibit few common properties. Bedrock velocities range from 3600 to 4700 m/s. In some cases there appears to be a sharp change from one velocity to a much higher velocity. However this is unlikely to be the true situation, as one or more relatively thin layer of intermediate velocity may be present. In these cases, the bedrock may be deeper than indicated on the profiles.

For deposits that have undergone little movement (A, C, and D) the seismic velocity is a reflection of their degree of weathering. This would also be true to a lesser extent for slope wash deposits. It is possible to interpret the velocities as follows:

300- 800 m/s	-	soil, clay, or completely weathered rock
800-1500 m/s	-	highly weathered rock
1500-2500 m/s	-	moderately weathered rock
2500-4000 m/s	-	slightly weathered rock
4000 m/s	-	unweathered rock

The seismic velocity also gives an indication of the rippability of the material. As the degree of consolidation, and thus seismic velocity, increases, the rock becomes less susceptible to ripping. Studies by the Caterpillar Tractor Company (1966), and local observations, indicate that rocks with velocities up to 2200 m/s may be ripped by heavy equipment, and that light blasting will considerably extend the rippable zones. Also, slope wash deposits may prove more easily rippable than in situ slope deposits with the same seismic velocity in situ slope deposits may contain bands more resistant to weathering, which may obstruct the movement of the blade.

The seismic results appear generally to agree with drill hole results within the limits of accuracy of the survey. In this type of work, error in depth estimation is usually considered to be less than 15 percent, although as mentioned the non-observation of an intermediate velocity layer may increase this error.

Considering each site independently, the results were as follows:

Area A (Traverses A and B, Plate 6)

The gravel of area A is an in situ deposit of highly coloured, well-graded, medium to coarse material.

Material of velocity 1700 m/s appears to overlie slightly weathered and unweathered rock on the slope, over a range of about 110 m along traverse A. The thickness of this gravel is about 5 m, while the width would seem to be less than 30 m since it is not evident on cross-traverse B. Below this the rock has a velocity in the region of 2800 m/s overlying a very irregular bedrock ranging in depth from about 5 to 15 metres.

Area B (Traverses C, D and E, Plate 7)

This is a granitic slopewash deposit of medium-grained grey gravel.

There appears to be a much greater thickness of low velocity material (1400 m/s) at this site. This material, which has a thickness of over 15 m in places, appears to have a lower velocity nearer to the present creek. This variation may be a reflection of the slopewash nature of the deposit. Bedrock has a velocity of 3600 m/s.

Area C (Traverses F and G, Plate 8)

The gravel here is an in situ deposit of coarse to medium, grey, well-graded material.

A layer of material of seismic velocity 900 m/s and thickness about 3 m overlies a large part of the area. This covers moderately weathered material with a bedrock (more regularly than in other areas) of high-velocity unweathered material.

Area D (Traverses H and I, Plate 9)

Hansen (in prep. a) suggests that this is a reasonably extensive in situ deposit of grey, coarse to medium, well-graded gravel. This is based on evidence from augering. However, there is no seismic evidence of a substantial layer of velocity less than 3000 m/s at this site. There is some evidence of a small area of low-velocity material (1500 m/s) near the intersection of the two traverses, and it may be this that the drill holes encountered. However, the author does not consider this to be representative of the whole area.

Williamsdale area (Traverses WA, WB and WC, Plate 10)

The gravel at this site is a generally fine-grained slopewash deposit. It shows frequent variation and increasing cementation with depth.

The seismic results do not define any zone of low-velocity material, although the geological report (Hansen, in prep. b) implies that up to 2.5 m of gravel exists. Calculations on a model of three layers of velocities 350, 1400, and 2500 m/s (gravel - 1400 m/s) indicate that any gravel layer less than 3 m thick could not be detected with confidence with the geophone spacings used in this survey.

However, the seismic results do indicate that such a layer may exist, although its thickness would be limited to 1.5-2 m over part of the area. The presence of this layer would mean that bedrock is generally about 0.5 m deeper than shown on the profiles.

5. CONCLUSIONS

The seismic results indicate that all these areas except Area D and the Williamsdale area contain extensive regions of low to moderate velocity material, the primary difference being the ease with which each can be worked.

6. REFERENCES

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DOBRIN, M.B., 1952 - INTRODUCTION TO GEOPHYSICAL PROSPECTING. New York, McGraw-Hill Inc.

HANSEN, R.J., (in prep. a) - Gravel for rural roads investigation, for the Naas Road, Tharwa Area, A.C.T. Bur. Miner. Resour. Aust. Rec.

HANSEN, R.J., (in prep. b) - Report on proposed gravel pit, Williamsdale A.C.T. Bur. Miner. Resour. Aust. Rec.

HAWKINS, L.V., 1961 - The reciprocal method of reoutine shallow seismic refraction investigations. Geophysics, 26(6), 806-819.

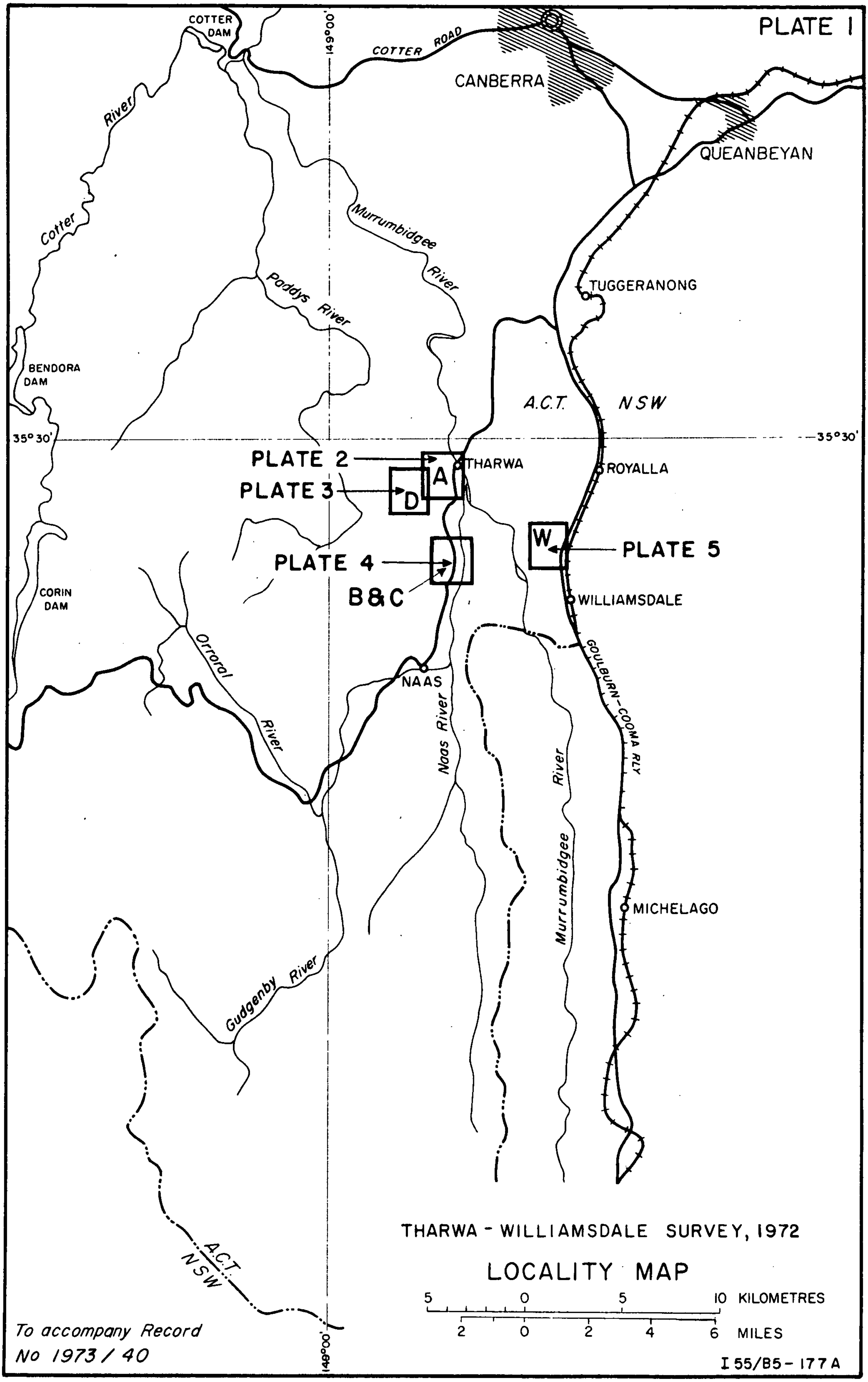
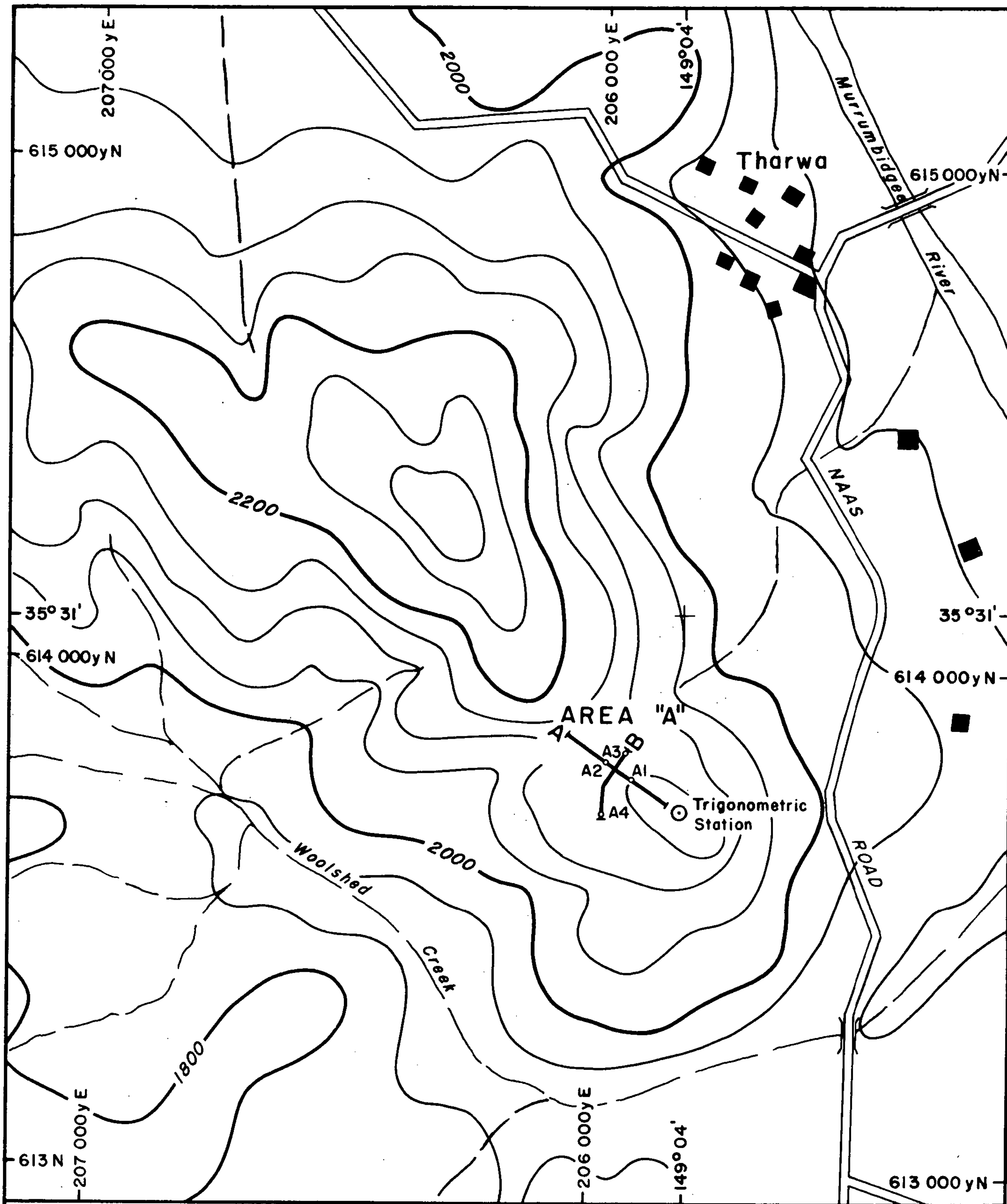


PLATE 1
COTTER DAM
COTTER ROAD
149°00'
CANBERRA
QUEANBEYAN
Cotter River
Murrumbidgee River
Paddys River
TUGGERANONG
BENDORA DAM
A.C.T.
NSW
35°30'
35°30'
PLATE 2
PLATE 3
A
D
THARWA
ROYALLA
W
PLATE 5
PLATE 4
B&C
WILLIAMSDALE
CORIN DAM
Orroral River
NAAS
Naas River
GOULBURN-COOMA RLY
Murrumbidgee River
MICHELAGO
Gudgenby River
A.C.T.
NSW
THARWA - WILLIAMSDALE SURVEY, 1972
LOCALITY MAP
5 0 5 10 KILOMETRES
2 0 2 4 6 MILES
To accompany Record No 1973/40
149°00'
I 55/B5 - 177 A

PLATE 2



Seismic traverse layout

∘A1 Auger hole

AREA 'A', TRAVERSES A and B

100 0 100 200 300 400 500 METRES

Contour interval 50 feet

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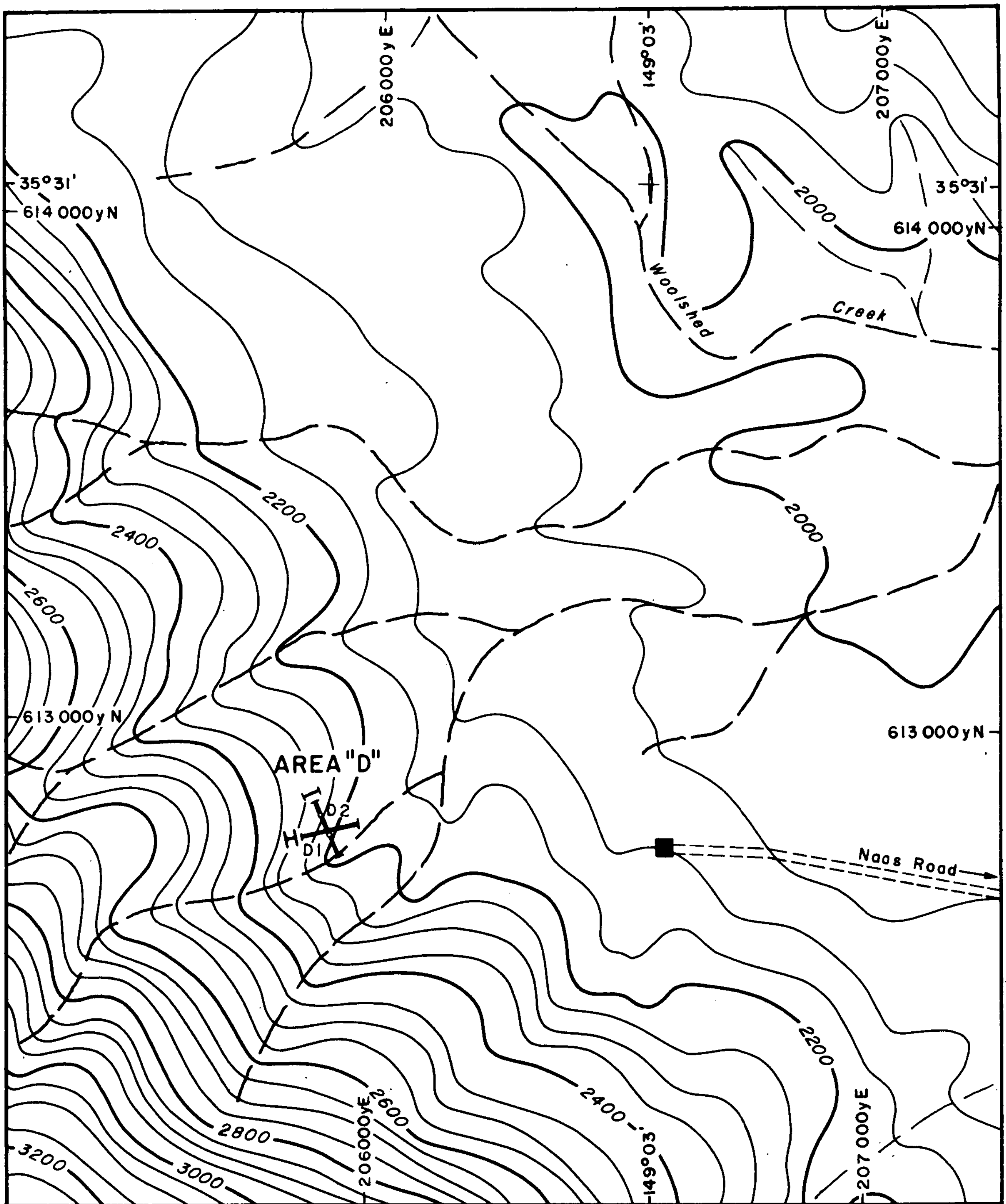
I 55/B5-178A



Seismic traverse layout

∘D1 Auger hole

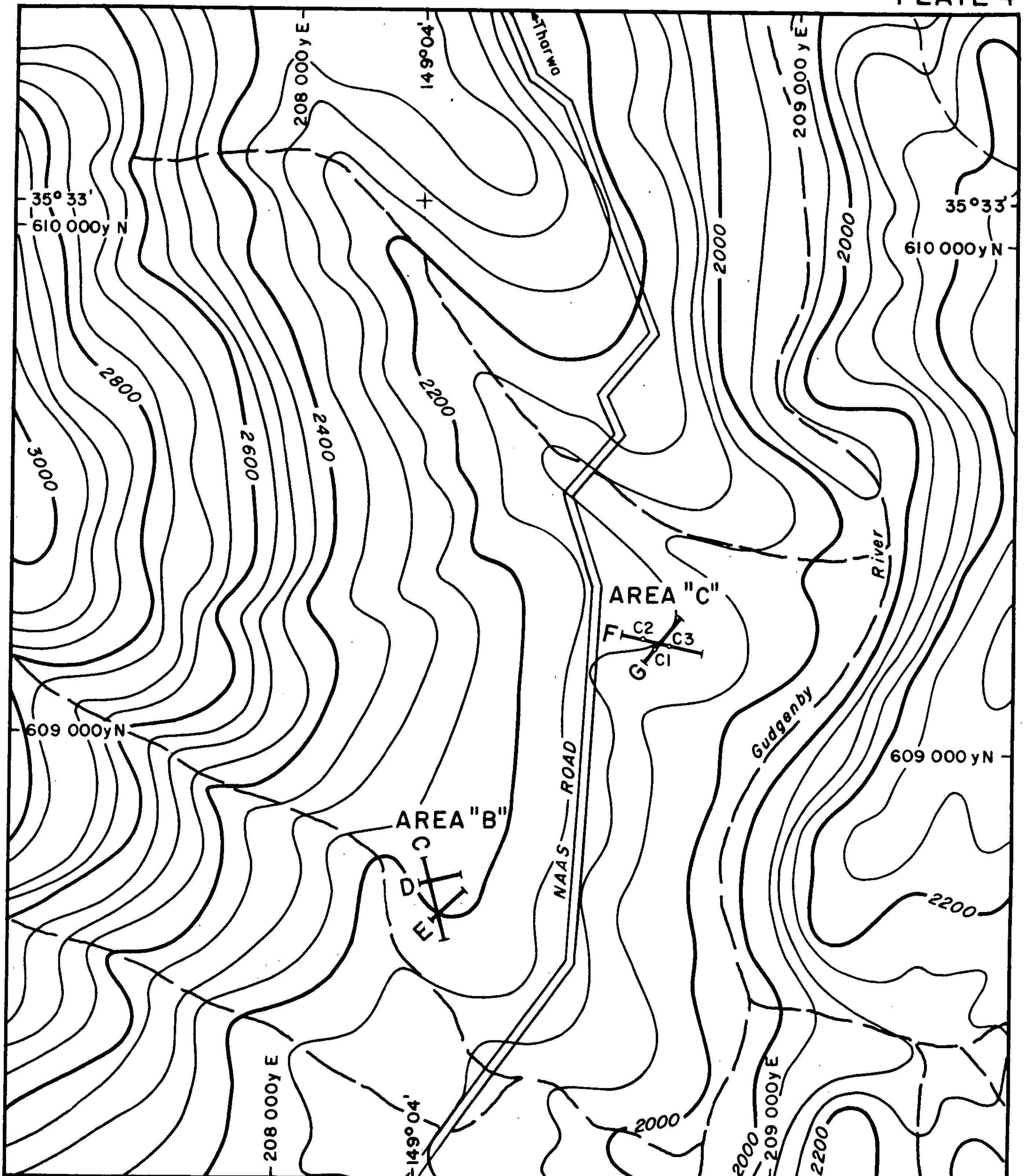
AREA 'D', TRAVERSES H and I

100 0 100 200 300 400 500 METRES

Contour interval 50 feet

To accompany Record No. 1973/40

I55/B5-180A



Seismic traverse layout

∘ C1 Auger hole

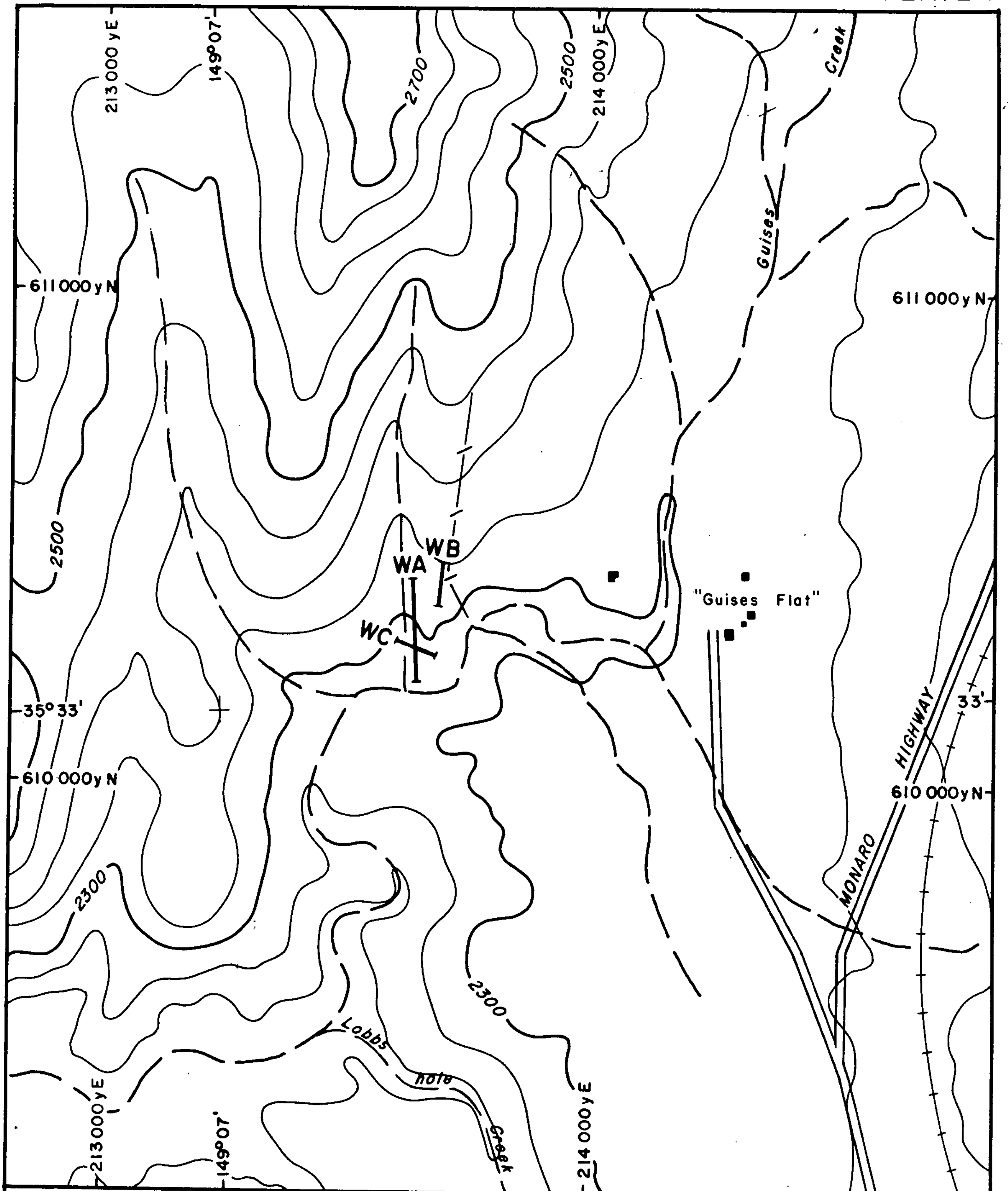
AREA 'B' and 'C', TRAVERSES C, D, E, F, and G

100 0 100 200 300 400 500 METRES

Contour interval 50 feet

To accompany Record No. 1973 / 40

I55/B5-179A



Seismic traverse layout

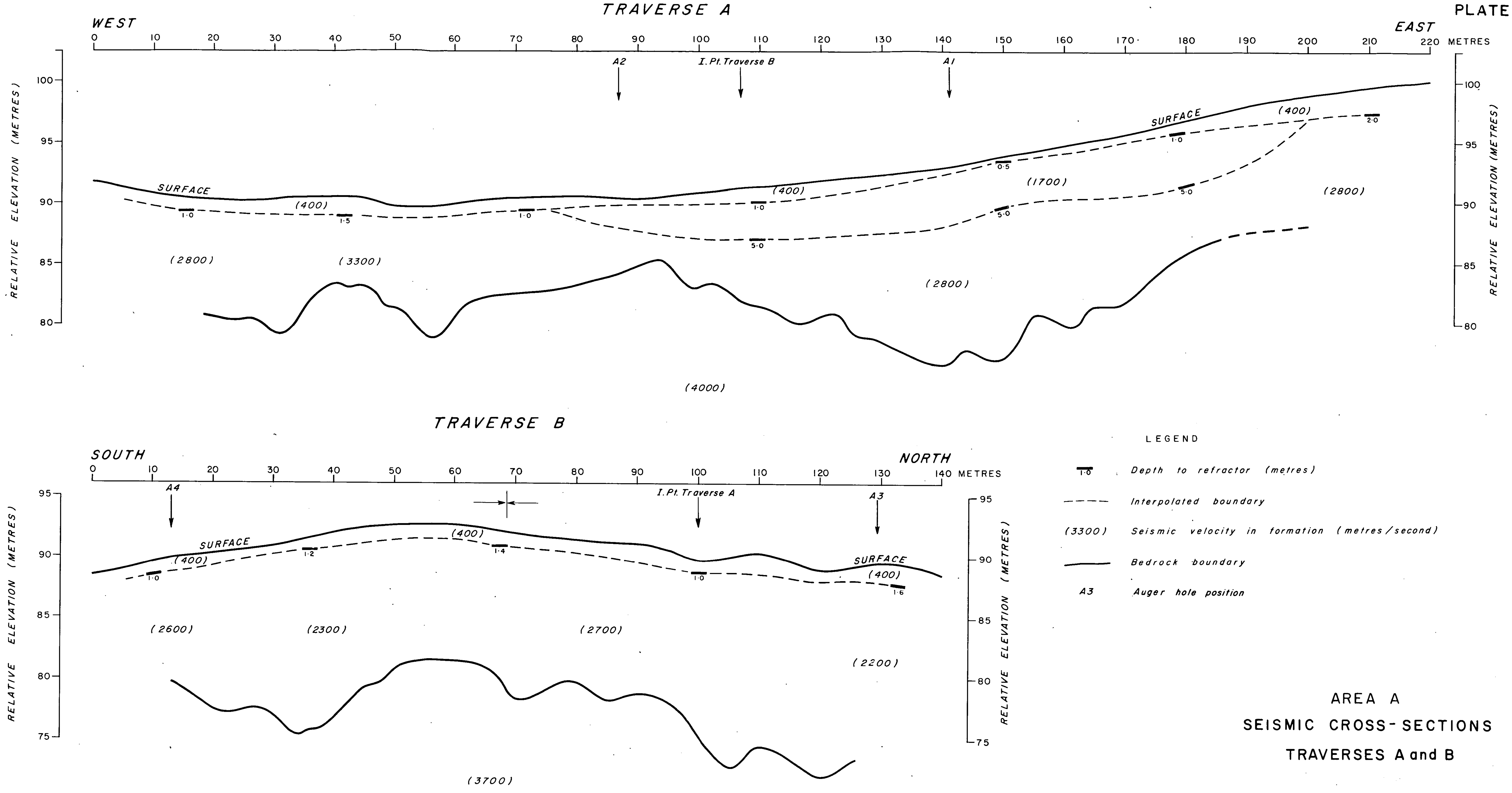
WILLIAMSDALE AREA, TRAVERSES WA, WB, WC

100 0 100 200 300 400 500 METRES

To accompany Record No. 1973/40

I55/B5-181A

PLATE 6



AREA A
SEISMIC CROSS-SECTIONS
TRAVERSES A and B

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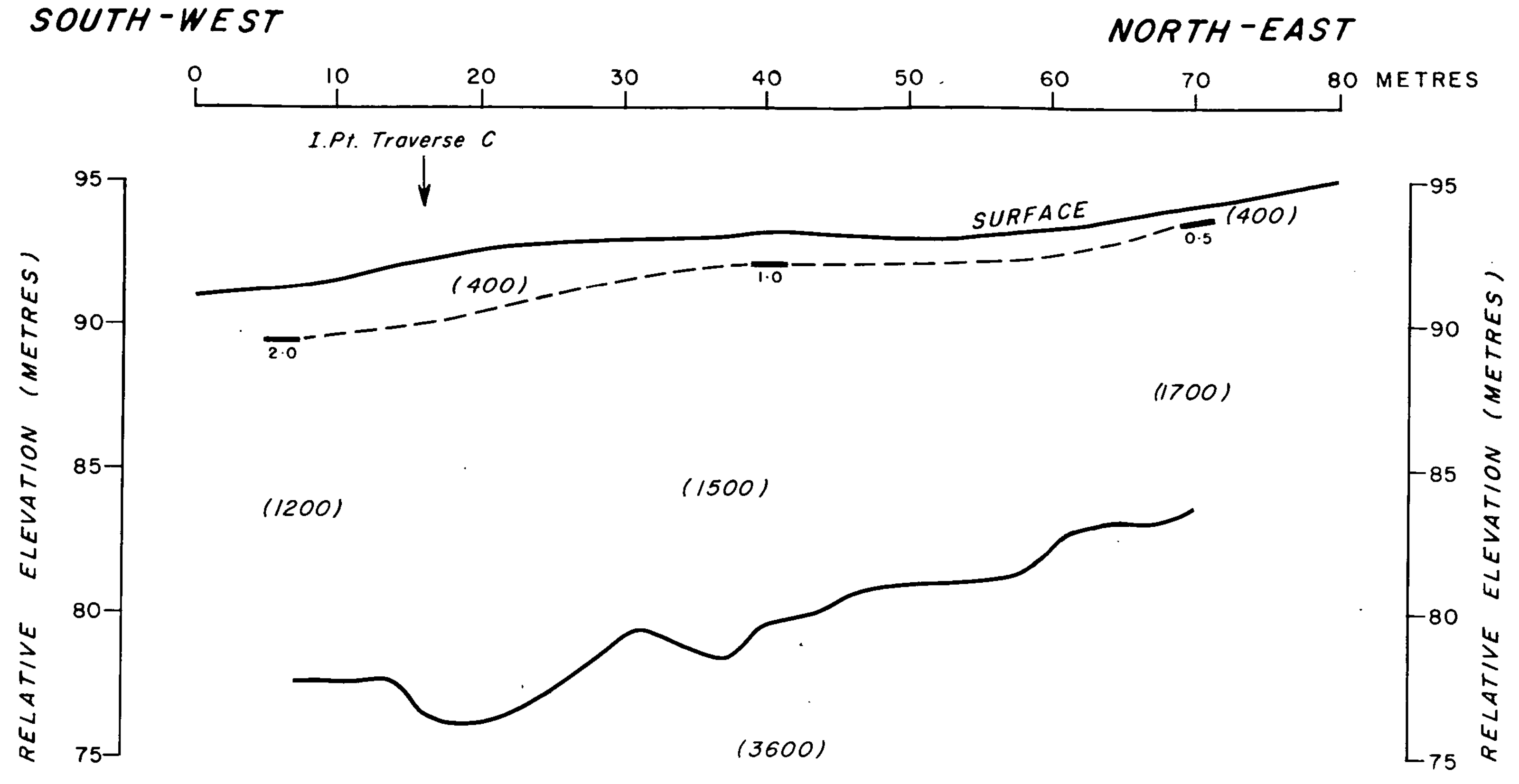
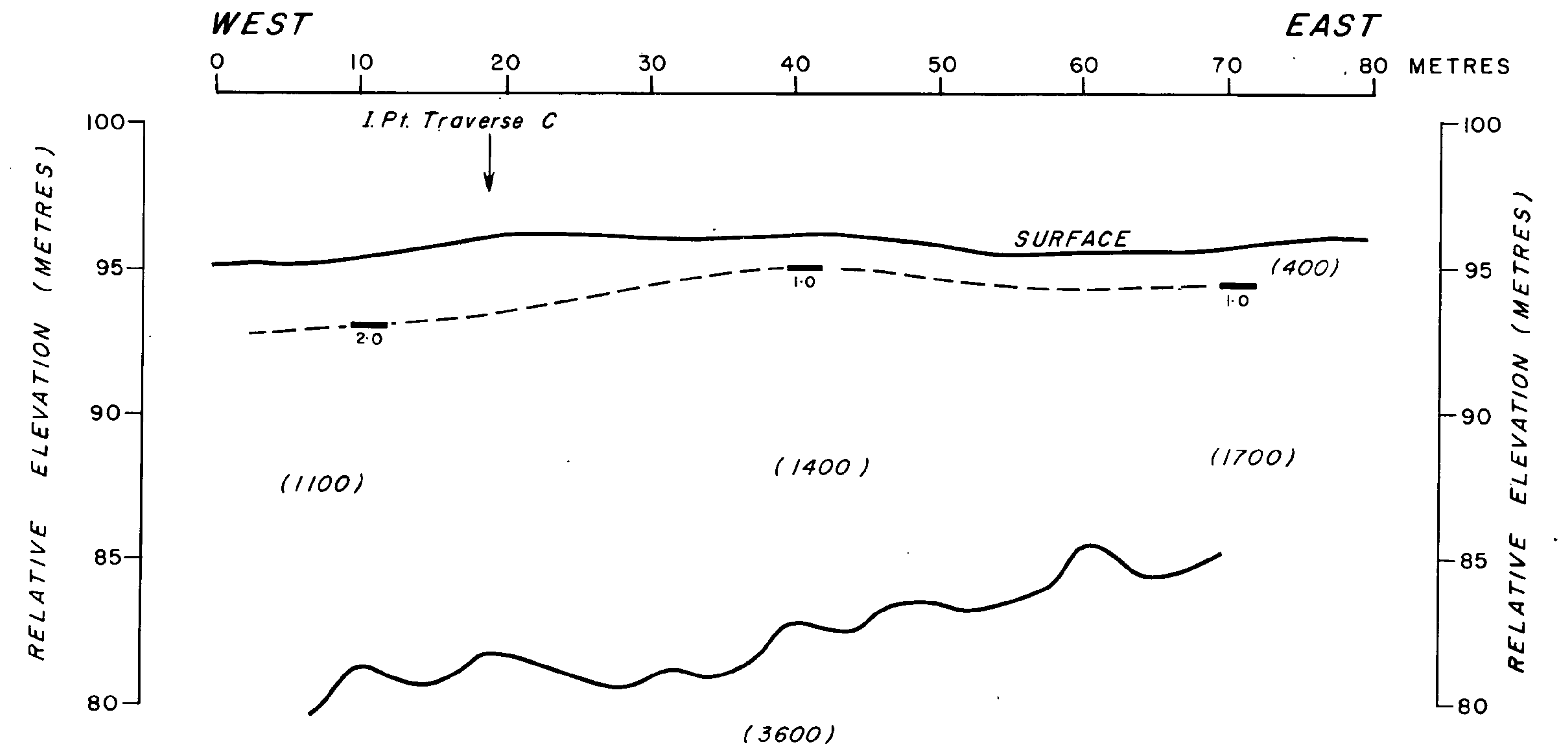
I55/B5-164

PLATE 7

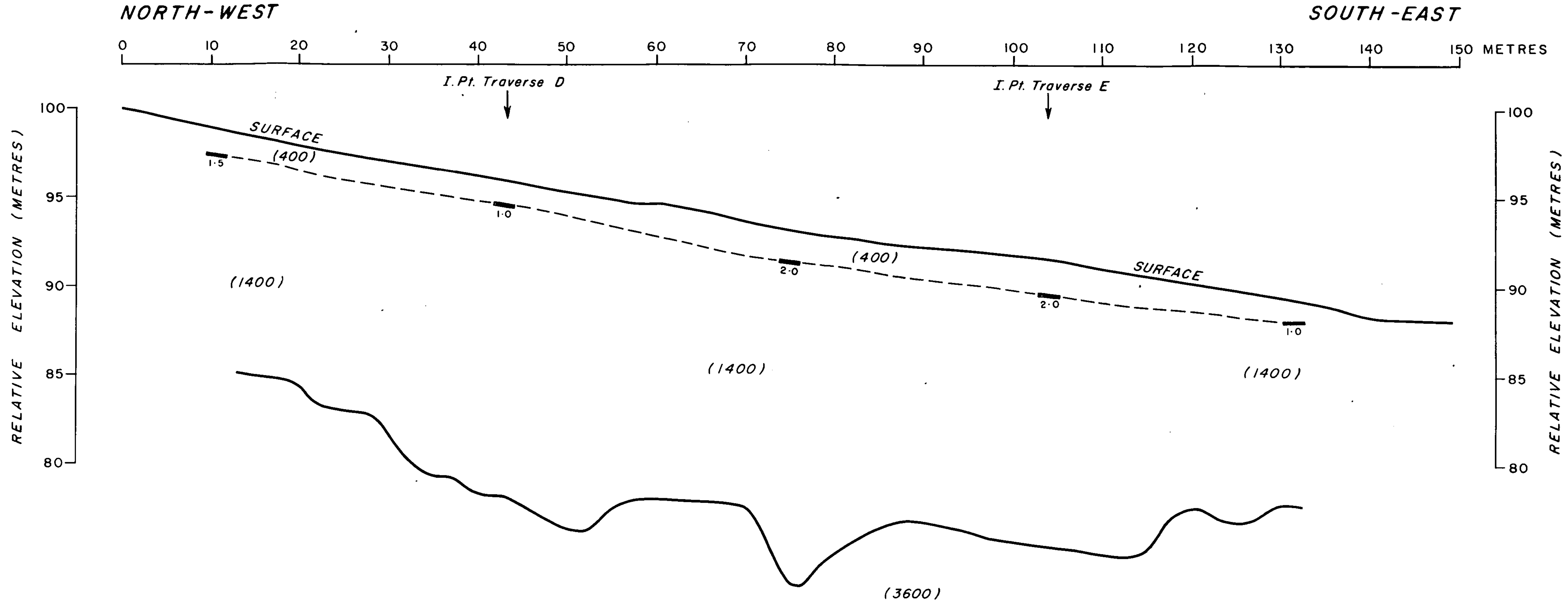
TRAVERSE E



TRAVERSE D



TRAVERSE C



LEGEND

- 1·5 — Depth to refractor (metres)
- – – – Interpolated boundary
- (1400) Seismic velocity in formation (metres/second)
- ——— Bedrock boundary

AREA B

SEISMIC CROSS-SECTIONS

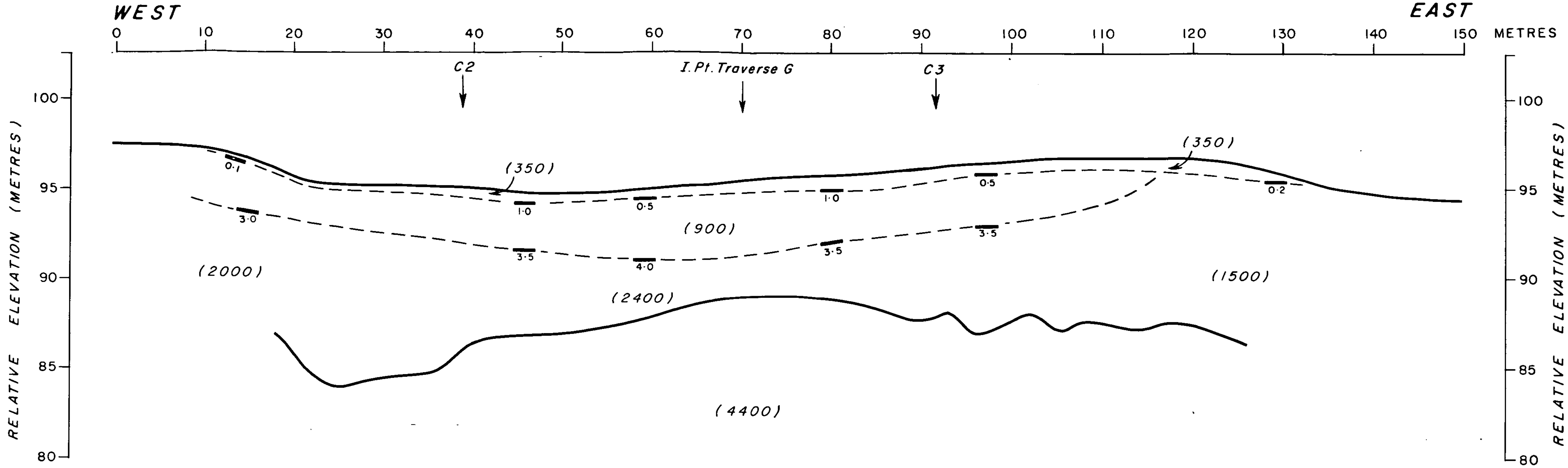
TRAVERSES E, D and C

To accompany Record No. 1973 / 40

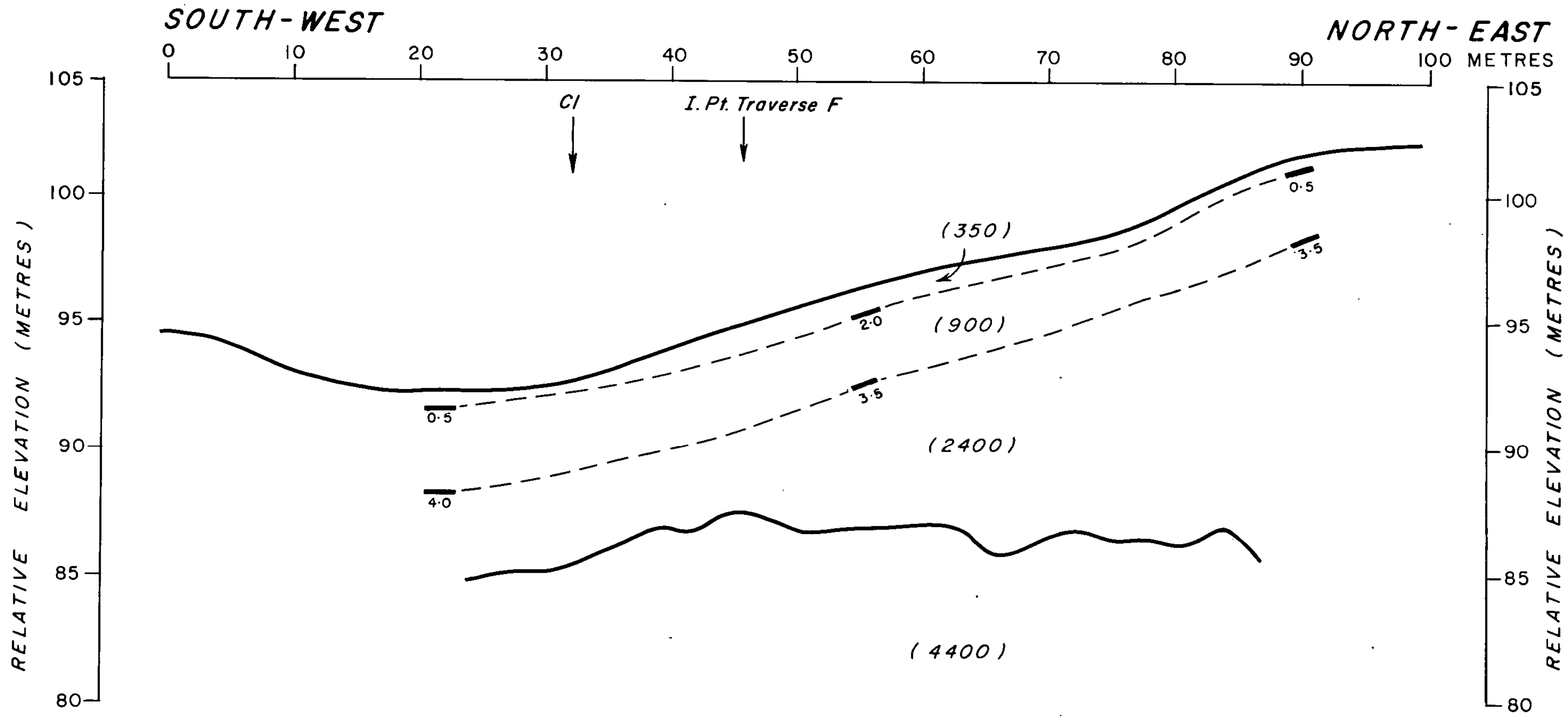
I55/B5-165

PLATE 8

TRAVERSE F



TRAVERSE G



LEGEND

3·0 Depth to refractor (metres)

Interpolated boundary

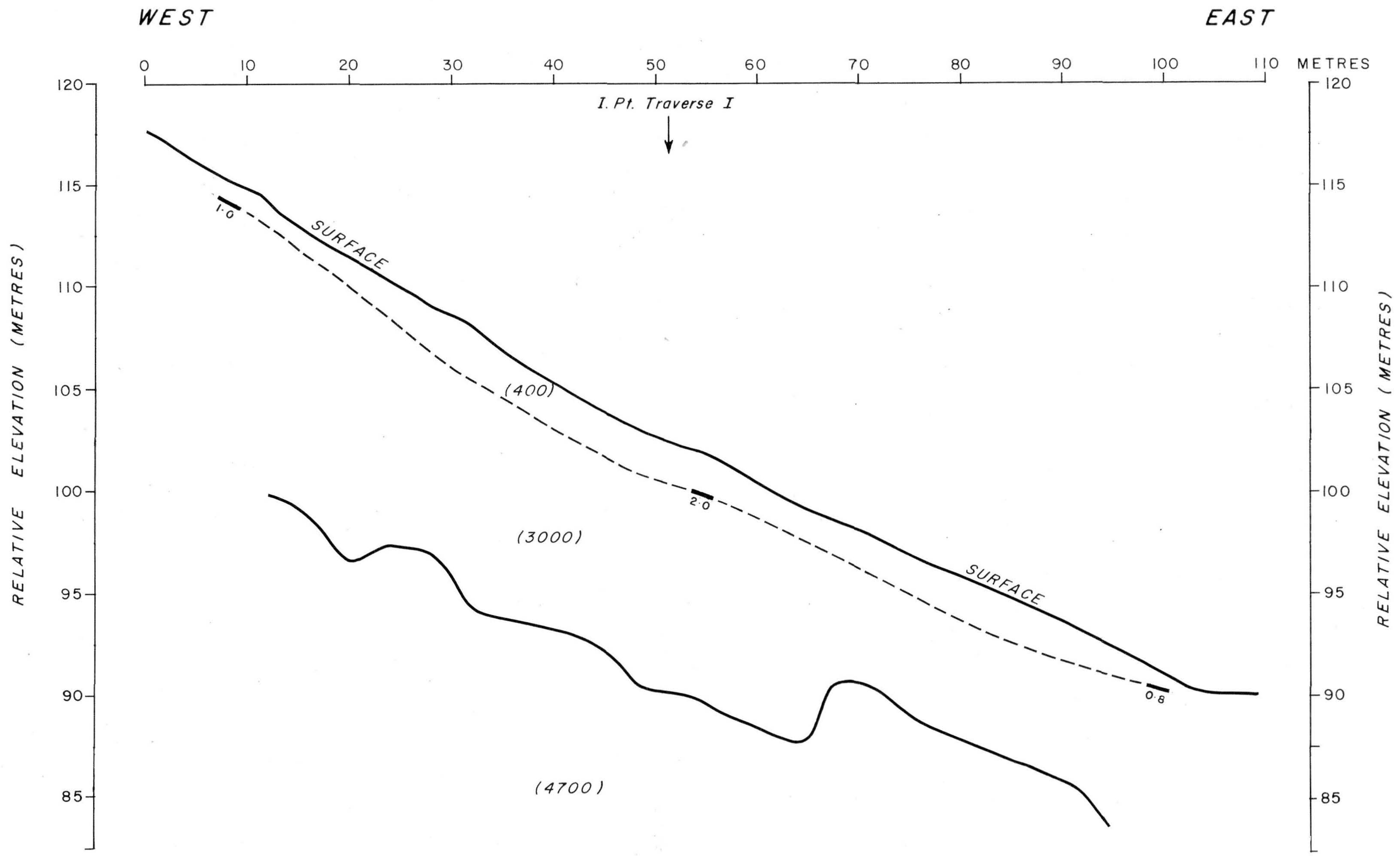
(2400) Seismic velocity in formation (metres/s)

Bedrock boundary

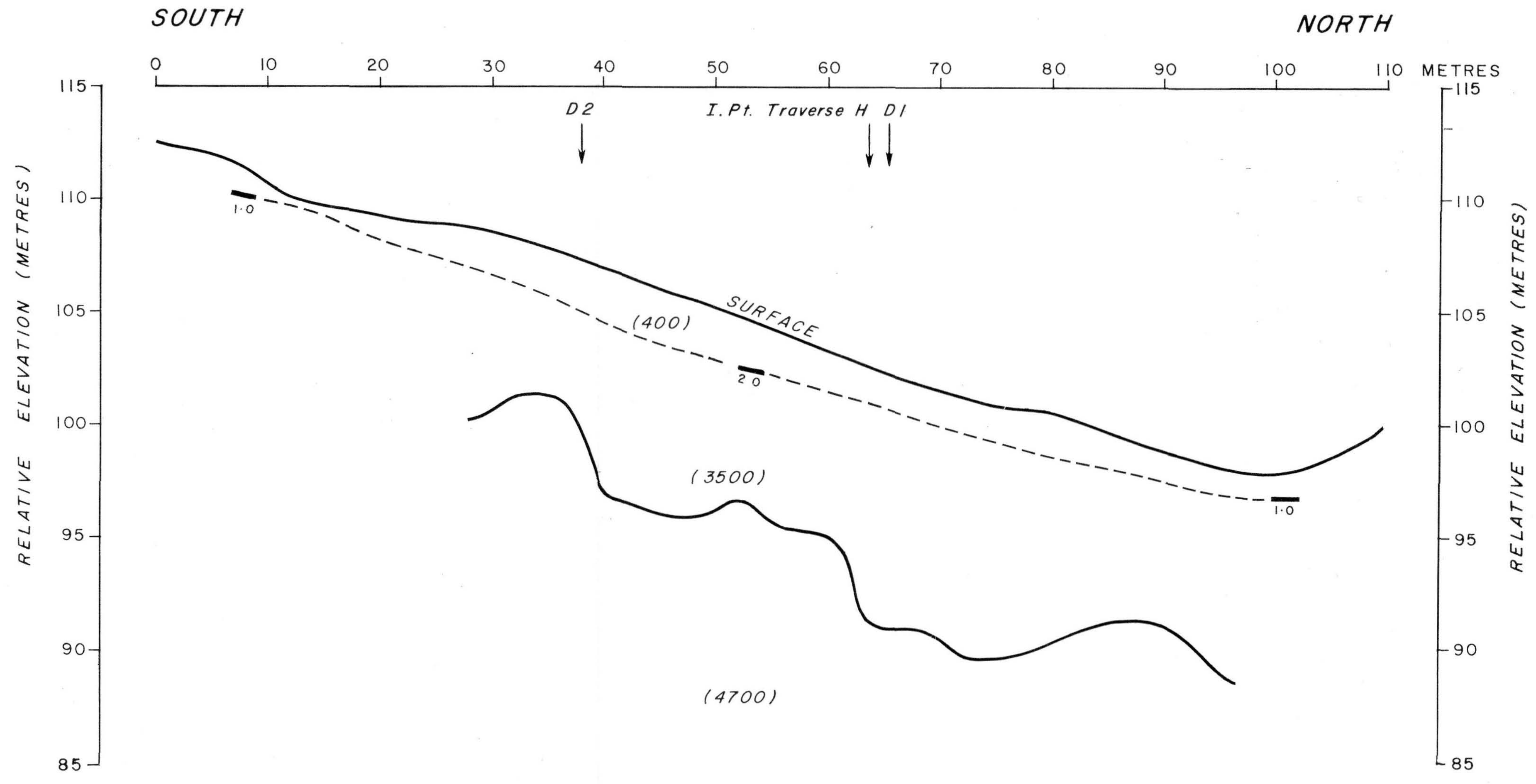
C2 Auger hole position

AREA C
SEISMIC CROSS-SECTIONS
TRAVERSES F and G

TRAVERSE H



TRAVERSE I



LEGEND

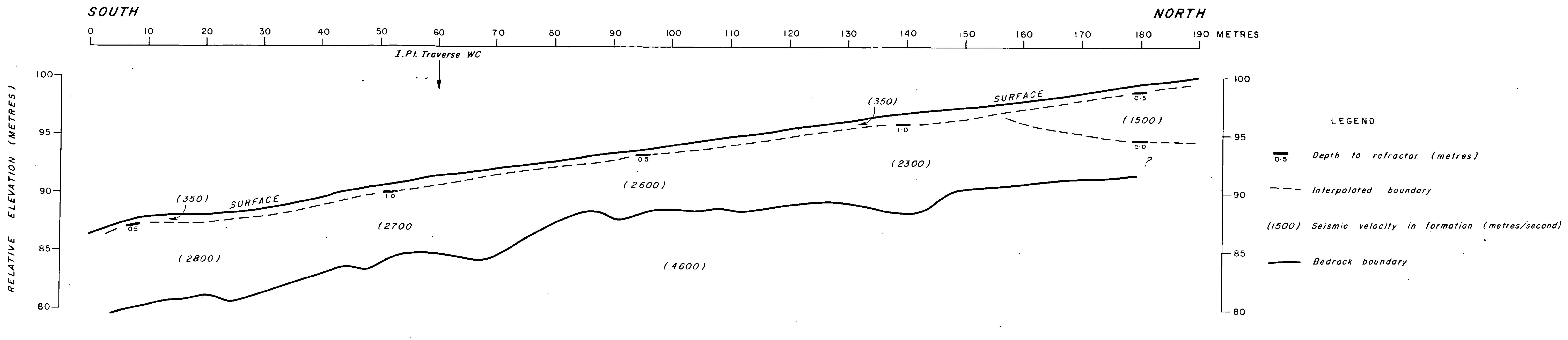
1·0	Depth to refractor (metres)
– – –	Interpolated boundary
(3000)	Seismic velocity in formation (metres/second)
⁓	Bedrock boundary
D2	Auger hole position

AREA D

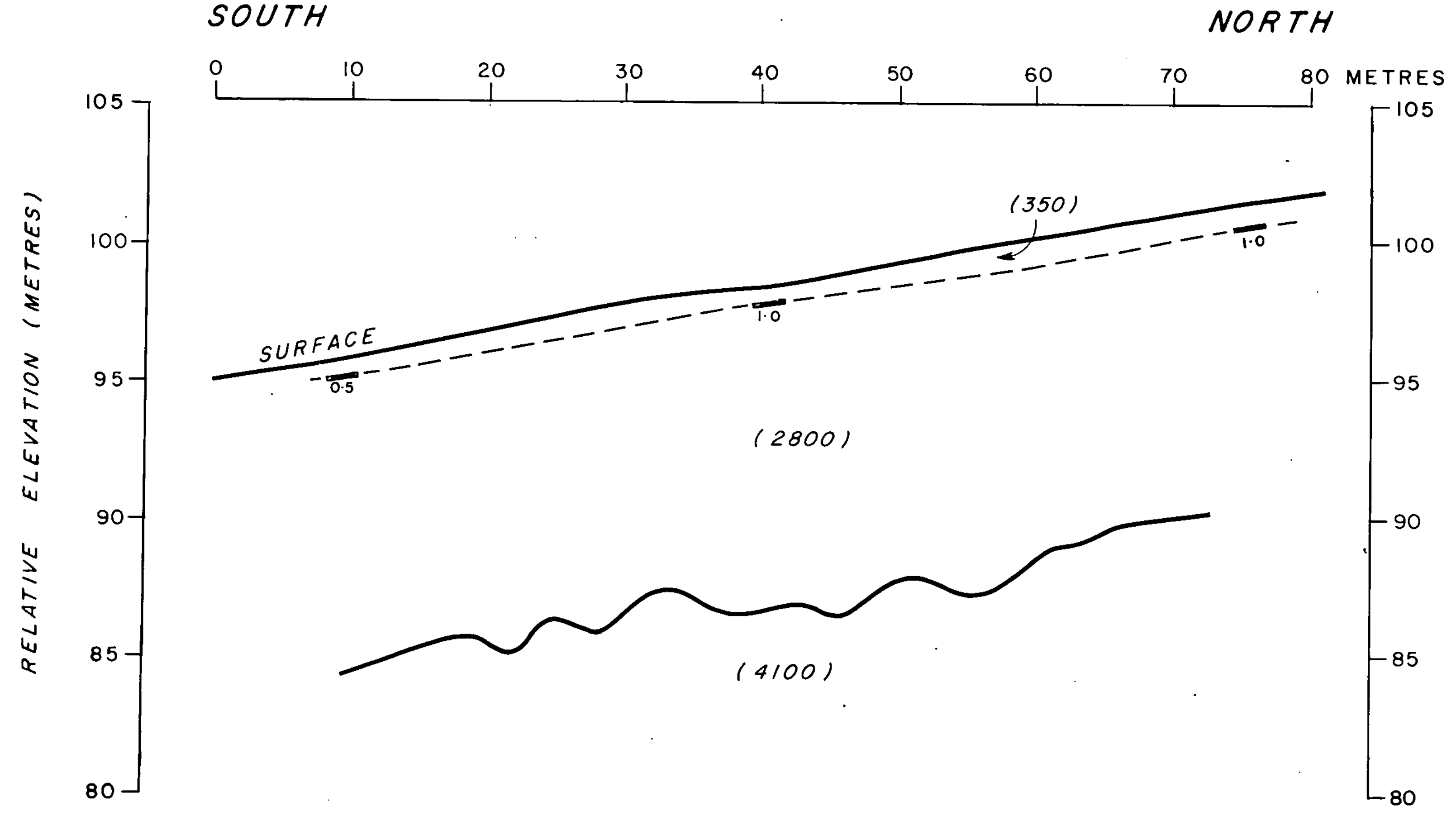
SEISMIC CROSS-SECTIONS

TRAVERSES H and I

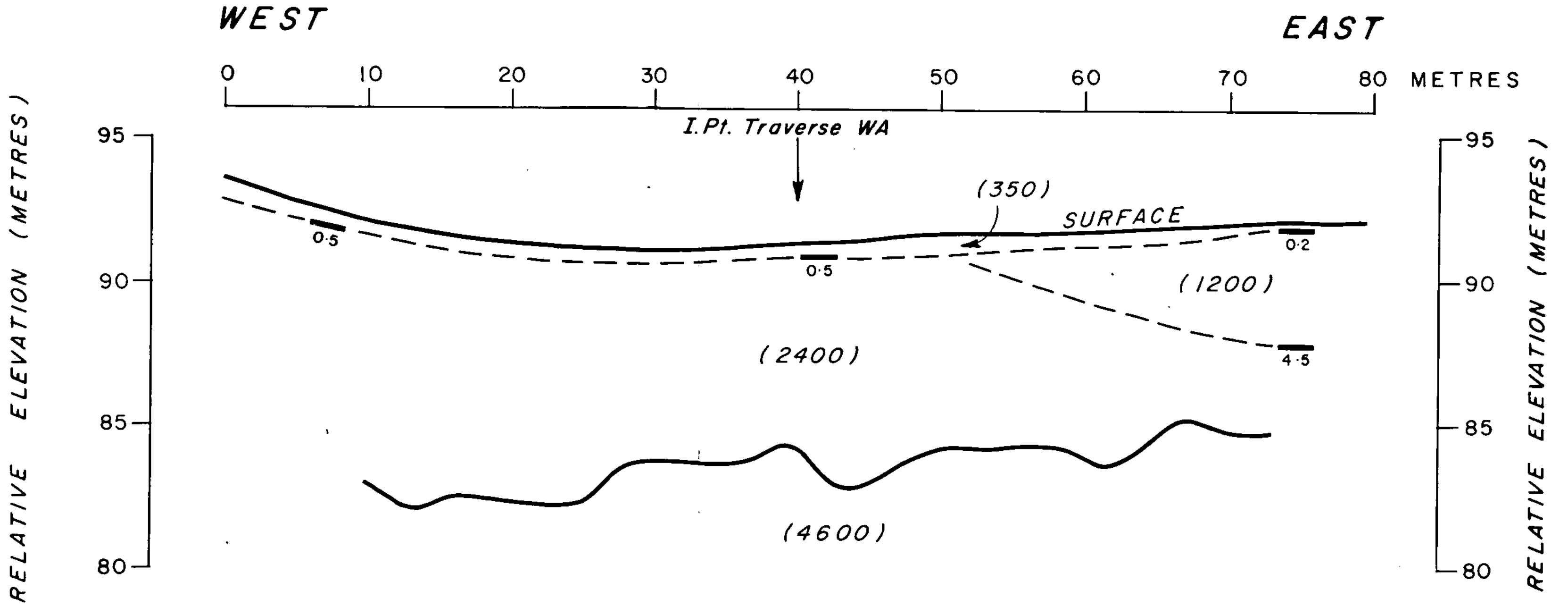
TRAVERSE WA



TRAVERSE WB



TRAVERSE WC



WILLIAMSDALE AREA, AREA W
SEISMIC CROSS-SECTIONS
TRAVERSES WA, WB, and WC.