COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record No. 1969 / 146

Jervis Bay Reconnaissance Seismic Survey, ACT 1969

by

F. J. Taylor

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ILLUSTRATIONS

SUMMARY

A seismic refraction survey was carried out for the Australian Atomic Energy Commission at Jervis Bay, ACT during July and August 1969 to investigate two proposed sites for a nuclear power station. The two sites are Sandy Beach (JS1), and Murrays Beach (JS2) (Plate 1). Additional work was carried out in the vicinity of Lake Windermere for the Engineering Section of the Geological Branch of the Bureau of Mineral Resources. Although the location of the traverses around Lake Windermere has been included in Plate 1 the results and conclusions of this work will not be included in this report but will await further geophysical work before being incorporated in a separate report.

The bedrock at the two sites consists of Permian sandstone with a seismic velocity varying between 7000 and 15,000 ft/s. The overburden consists almost wholly of sand and weathered sandstone and attains a maximum thickness of 200 feet.

The ideal site for the nuclear power station is one where the upper limit of hard rock lies around 10 feet above sea level. An area of about 1000 feet square is required at this altitude. The upper limit of rock on the eastern end of site JS1 is around this required level but it is doubtful whether the area is large enough. A more promising area is the western side of site JS2 where the sand/weathered sandstone boundary appears to be around sea level and the area concerned is quite large.

1. INTRODUCTION

The Commonwealth Government in conjunction with the State Government of New South Wales wished to investigate the feasibility of building a power station on Commonwealth Territory at Jervis Bay. The foundations of the principal building housing the nuclear reactor must be on rock of suitable strength approximately 10 feet above sea level, the elevation being critical since an immense amount of sea water must be pumped through the plant in order to cool the reactor. It is proposed to channel the coolant sea water through a trench 3000 to 4000 feet in length excavated to 30 feet below sea level.

In response to a request from the Australian Atomic Energy Commission and the Electricity Commission of New South Wales a geophysical survey was conducted by the Geophysical Branch of BMR to determine the depth to fresh rock and the nature of the overburden. The survey was carried out during July and early August 1969, by a geophysical party comprising F.J. Taylor (party leader), P.C. Pollard (geophysicist), A.W. Schuett (Technical Assistant), D. Tarlinton (Technical Assistant) and T. Kimber (Drafting Officer). The supervising geophysicist was Dr E.J. Polak, who with R.J. Whiteley (geophysicist) assisted during the early part of the survey. Field assistants were provided by the Australian Atomic Energy Commission.

The terms "bedrock" and "overburden" as used in this report refer to the deepest refractor detected and the sand and weathered material above this refractor respectively.

2. GEOLOGY

The following geological summary was provided by M.J. Jackson of the Geological Branch of BMR. Plate 1 shows geology mapped by W.J. Perry and J.M. Dickins also of the Geological Branch. The Territory of Jervis Bay consists of gently-dipping, well jointed Permian sandstone (Jervis Bay Sandstone) overlain in places by unconsolidated Quaternary beach and dune sands, which contain lagoonal marsh deposits in some areas. The Jervis Bay Sandstone is generally a medium to coarse-grained, light-grey, massively-bedded sandstone, but silty layers and conglomeratic horizons occur at many levels in the succession. The fresh sandstone can be excavated only by heavy drilling and blasting, and it should provide strong fundations. Dolerite dykes and sills, weathered in places to pure kaolinitic clay, have intruded the sandstone in several localities. Ferruginous gravels occur on an irregular surface of sandstone in the north-west of the Territory.

The fine-grained Quaternary quartz sands range in colour from white to orange, and in thickness from a few feet to 200 feet. The deposition of these sands during the Quaternary Period was controlled largely by platforms and irregularities in the underlying sandstone. Hence, an evaluation of sand thicknesses and depths to bedrock requires extensive geophysical exploration.

3. METHODS AND EQUIPMENT

The depth to bedrock and the nature of the overburden were investigated using 24-channel SIE refraction equipment with TIC 20-Hz geophones. An oil filled bay cable with Hall-Seers MP-8E hydrophones were used for the water work. The well known and established "reciprocal geophone method" (Heiland, 1946) was used in conjunction with short weathering spreads (200 feet) to obtain all seismic data presented in this report. The normal geophone spread consisted of 23 geophones spaced 50 feet apart, and continuous coverages over all traverses were obtained using this spread. This spread gives depths to bedrock while the short weathering spreads placed every 1000 feet give information on the overburden.

The Electricity Commission of New South Wales contracted to have holes drilled on both sites using an auger drill and a diamond drill. Core samples taken from several diamond-drill holes were tested in the BMR laboratories and the specific gravity, seismic velocity (longitudinal waves), and compressive strength of several samples are shown in Table 1.

The seismic velocity was obtained using Cawkell ultrasonic equipment while the compressive strength was computed from an empirical formula relating seismic velocity to compressive strength (Wiebenga & Manganwidjoyo, 1960). This formula is valid for dry rocks with seismic velocities in excess of 6000 ft/s.

A total of 40,000 feet of traverses including 7000 feet of water traverses was completed on sites JS1 and JS2.

4. RESULTS

Plates 1, 2, and 3 show the location of the geophysical traverses while the seismic cross-sections are shown in Plates 4 to 10. The symbols used in these plates are explained in the legend attached to each plate. The elevation is expressed in feet and the point marked "0" represents mean high water at St Georges Basin.

Both sites have been interpreted as consisting essentially of four layers as outlined below:

(1) The first layer consists of dry to moist sand with a seismic velocity between 1000 to 2300 ft/s. The thickness of this sand varies between 3 and 100 feet.

(2) A second layer with a velocity between 3000 and 4000 ft/s is again interpreted as sand or clay but more compacted than that in the uppermost layer and possibly bonded by iron compounds.

(3) Those regions having velocities between 5000 and 9000 ft/s are interpreted as sandstone in various stages of weathering. Sandstone with velocities above 7500 ft/s, although weathered, would probably be quite suitable for fundations; it is probably the upper limit of velocities in sandstone that can be excavated without use of explosives.

(4) Finally the highest velocities measured, between 11,000 and 15,000 ft/s are interpreted as fresh sandstone. The depth to this region varies from 40 to 150 feet.

There are some variations from the four-layer structure outlined above. The velocity of 5000 ft/s measured along Traverses R and K on site JS1 is due to water-saturated sand. Both these traverses are close to the high water mark along Sandy Beach. Also the velocity of 4000 ft/s measured along Traverse J near spread 11 and spread 19 appears to be due to ferruginous sands situated within a few feet of the surface. It would appear that material of this nature is responsible for the shallowness of auger holes A5, A6, A7, and A8 on site JS2. That is to say although this material has rather a low velocity (4000 ft/s) it appears to be too hard for the auger drill. This idea tends to be confirmed by the measured velocity of a core from hole JS1/D3. A quite solid core from a depth of 25 feet gave a velocity of only 3280 ft/s, but the auger refused to drill at 23 feet at this same location. Hence poor correlation between auger holes and "seismic" depths need not mean that either one or the other is incorrect.

The error in depth determination is considered to be less than 20 percent, while the error in the relative depth to bedrock from station to station is considerably less than this. A comparison of the depths obtained by drill holes and the seismic method can easily be made from Plates 4 to 10. Along Traverse J the correlation is quite good. It should be noted here that in the region between spread 15 and spread 11 on Traverse J although the section shows sand (1800 ft/s) all the way to bedrock it is certain that a thin layer of weathered material (about 7000 ft/s) will exist above the bedrock. It must also be remembered that the seismic survey was a reconnaissance survey and that information on the overburden is supplied only every 1000 feet. There is definitely a lack of weathering information along Traverse W at site JS2. Although two weathering spreads were placed along this traverse there appears to be no indication of material with a velocity between 3000 and 4000 ft/s. Traverse W is situated along a ridge, and it is possible that erosion has reduced the thickness of any such material, in which case its detection would become difficult.

5. CONCLUSIONS

The ideal site for the nuclear power station is one where the upper limit of hard rock lies around 10 feet above sea level. The area required at this altitude is approximately 1000 feet square. On site JS1 the eastern end is perhaps the only area approaching the above ideal conditions. Even so it is doubtful whether this area is large enough. On the western end, solid rock extends to as high as 50 feet above sea level and hence the excavation costs in the area may be prohibitive.

On site JS2 the area bounded by Traverses S, T, U, and V appears to be the most suitable area for a site. Along Traverse U the sand/weathered sandstone boundary appears to be around sea level. This boundary rises towards the east and attains a height of about 40 feet above sea level in the vicinity of Traverse V. Hence, providing the

material with velocity 3000 to 4000 ft/s is not too difficult to remove, and it should not be, the excavation costs for this site should not be prohibitive and the actual foundations will not require extensive pile-driving.

6. ACKNOWLEDGEMENTS

The members of the seismic party wish to acknowledge the co-operation given by the officers of the Electricity Commission of New South Wales, the Australian Atomic Energy Commission, and the Department of the Interior.

7. REFERENCES

HEILAND, C.A., 1946 - GEOPHYSICAL PROSPECTING, New York, Prentice Hall.

WIEBENGA, W.A. and MANGANWIDJOYO, A., 1960 - Some correlations between rock parameters derived from Wuerker's Annotated Tables. Trans. Amer. Inst. Engrs. 217.

APPENDIX A

(1) The zero elevation level used in this report is the mean high-water level of St Georges Basin, Jervis Bay, ACT. This datum is the standard datum adopted by the Department of the Interior for Jervis Bay, ACT.

(2) The position of the boat for every shot fired for the hydrophone work across Sandy Beach and Murrays Beach is given in BMR drawing No. I56/B5-6. The actual position of the No. 12 hydrophone is 100 feet closer to the shot.

(3) Survey plans as provided by the surveyer are recorded in BMR drawing No. I56/B5-15.

TABLE 1.

Physical properties of diamond-drill cores

Drill Hole	Depth, ft	Specific gravity	Seismic Velocity ft/s	Compressive strength x 1000 lb/in^2
JS1/D1	27.0 - 27.7	2.23	4,050	-
	36.6 - 37.1	2.35	8,850	16.93
	61.3 - 61.9	2.44	11,350	22.69
JS1/D3	24.3 - 24.7	2.27	3,280	-
	28.0 - 29.1	2.39	8,650	13.06
	52.3 - 53.2	2.41	9,960	19.44
JS1/D4	18.4 - 18.9	2.26	Sample broke under test	
	24.0 - 24.9	2.32	5,300	-
	75.2 - 75.9	2.45	10,600	18.38

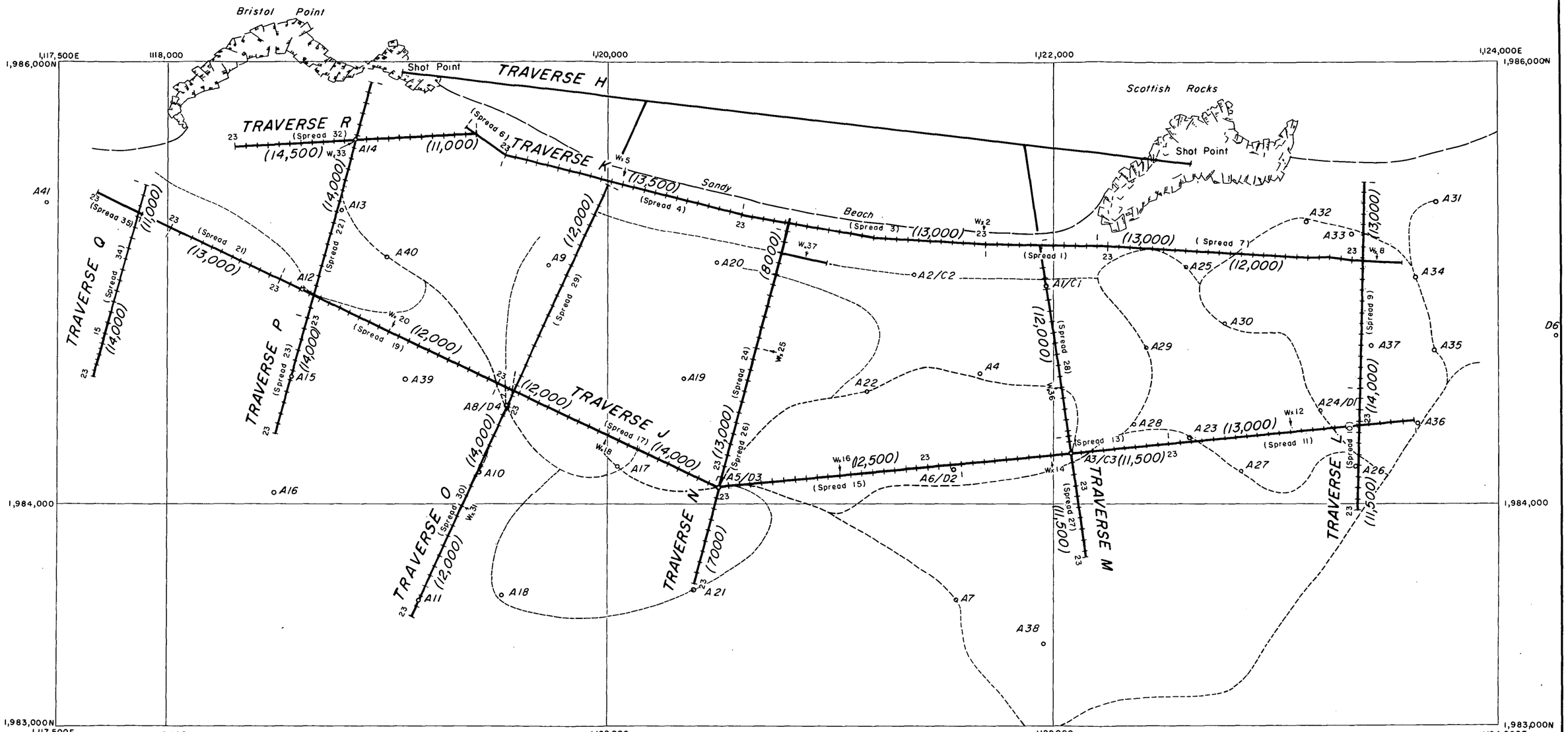
PLATE 1

Based on B.M.R. Geological Branch Drawing No. I56/A13/ACT-18-4

To Accompany Record No. 1969/146

I56/B5-3

PLATE 2



LEGEND

Rock
Track
Geophysical traverse
(Spread 1) 23 Positions of geophones
W1 18 Weathering spread
A3 Auger drill holes
C3 Cone penetration
D3 Diamond-drill hole
(12,000) Seismic velocity in ft/s in the bedrock

Co-ordinates are in feet and are based on the Australian National Grid Zone 8

True North

SITE JS I

TRAVERSE PLAN

FEET
400 200 0 400 800 1200

To Accompany Record No. 1969/146

I56/B5-4

PLATE 3

1,125,000E 1,126,000 1,128,000 1,130,000E

1,991,000N 1,990,000 1,988,000 1,987,000N

Shot Point

TRAVERSE X

Shot Point

Governor Head

Murrays Beach

A5 A6 A7 A8 A4 A3 A2 A1

(10,000) W+40 (Spread 39) (10,500)

(11,000) (Spread 38) (10,500) W+52 (Spread 51)

(11,000) (Spread 49) (Spread 53) (10,000) W+50

TRAVERSE U (12,000)

TRAVERSE V (11,000) W+46 (Spread 47)

TRAVERSE T (11,500) (Spread 41)

TRAVERSE S (10,500) (Spread 46) (12,500) (Spread 44)

TRAVERSE W (Spread 45) (11,500)

(13,500) W+43 (Spread 42)

23

FEET

400 200 0 400 800 1200

True North

LEGEND

Co-ordinates are in feet and are based on the Australian National Grid Zone 8

Rock
Track
Cliff

LEGEND

Geophysical traverse
1 (Spread 1) 23 Positions of geophones
W× 40 Weathering spread
○ A3 Auger drill hole

(12,000) Seismic velocity in ft/s in the bedrock

SITE JS 2
TRAVERSE PLAN

TO ACCOMPANY RECORD No. 1969/146 I56/B5-5

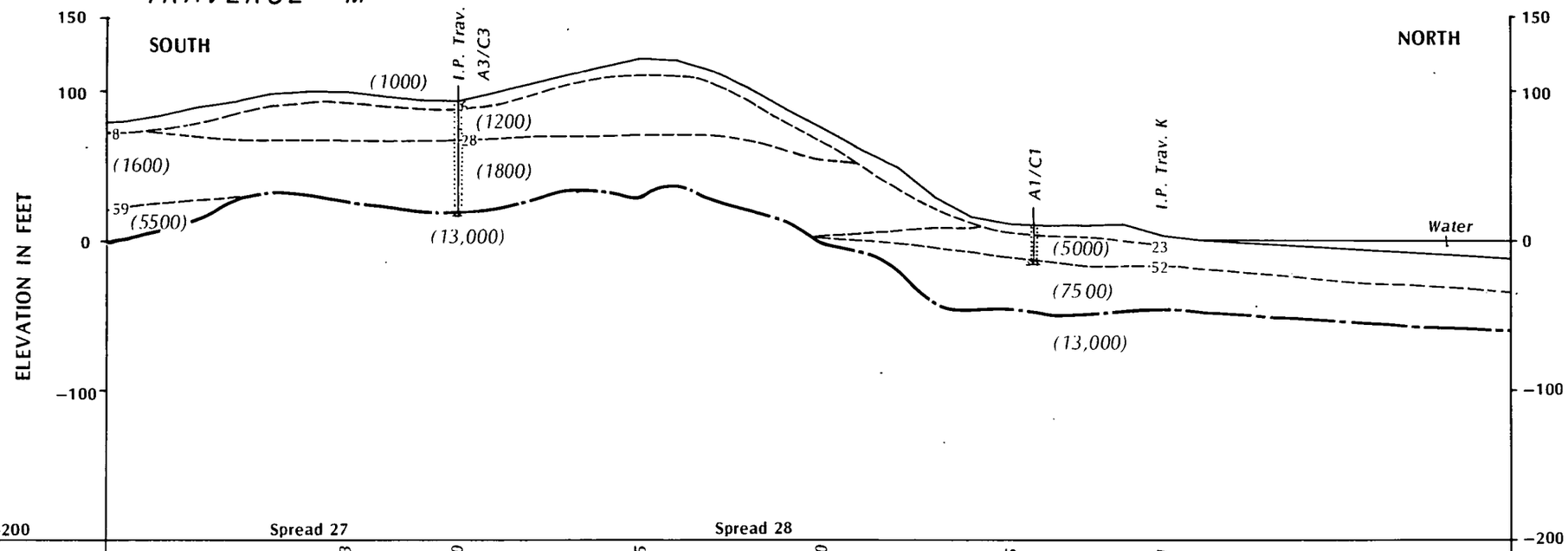
PLATE 4

TRAVERSES J, K and R
SEISMIC CROSS-SECTIONS

TO ACCOMPANY RECORD No. 1969/146

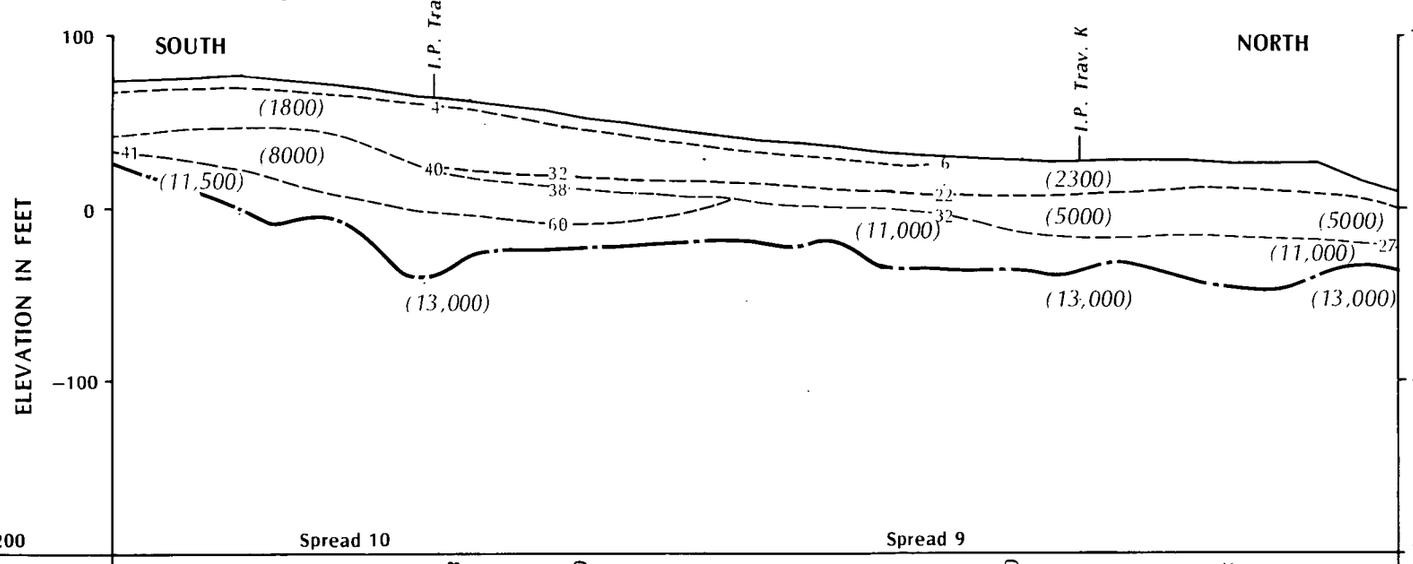
156/B5-8

TRAVERSE M



STATION NUMBER	22				14		23		6	20		2			15				10				5			1									
STATION ELEVATION (FEET)	80.0	84.5	89.2	93.5	97.7	99.6	99.3	96.4	94.2	94.1	98.7	105.0	111.5	117.0	121.8	121.0	112.2	99.6	86.8	74.8	62.5	49.3	29.7	15.7	11.5	10.1	10.3	9.8	2.8	SEA LEVEL				
DEPTH TO BEDROCK (FEET)	76	74	70	63	68	69	73	73	73		75	76	79	91	90	90	88	79	74	67	69	64	54	64	58	60		59	52						

TRAVERSE L



STATION NUMBER	23				15		9	23		1	20					15				10				5			1								
STATION ELEVATION (FEET)	74.4	74.9	76.3	76.9	74.9	71.6	68.8	65.5	63.4	60.5	56.6	52.9	49.6	45.8	43.3	40.4	38.1	35.1	33.6	31.6	29.9	28.8	28.3	28.5	28.7	28.2	27.4	27.6	27.6	16.7	10.2	2.4		
DEPTH TO BEDROCK (FEET)	46	55	65	75	81	76	79	98	102	87	81	75	70	63	61	56	60	53	63	65	65	63	64	60	61	67	72	72	74	55	44	35		

HORIZONTAL −200 100 0 200 400 600 FEET

VERTICAL 100 50 0 100 200 300

LEGEND

(13,000)	Seismic velocity in ft/s in the bedrock
59 — — —	Depth to formation with different seismic velocity.
I.P. Trav.	Traverse intersection point.
— · —	Unweathered bedrock boundary.
	Sand.
	Weathered sandstone.
A 3	Auger drill hole.
C 3	Cone penetration

TRAVERSES L and M

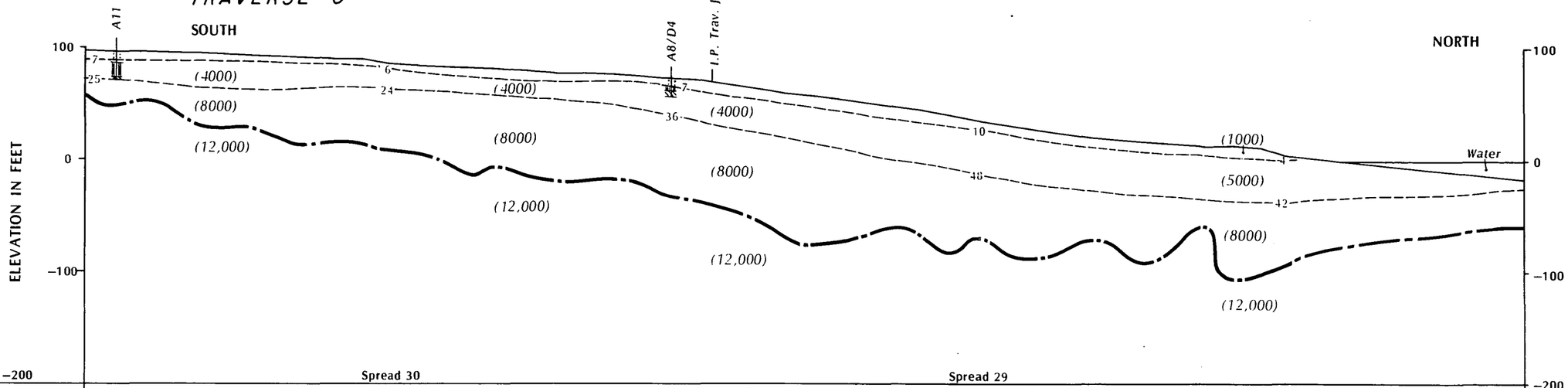
SEISMIC CROSS-SECTIONS

TO ACCOMPANY RECORD No. 1969/146

156/B5–9

PLATE 6

TRAVERSE O

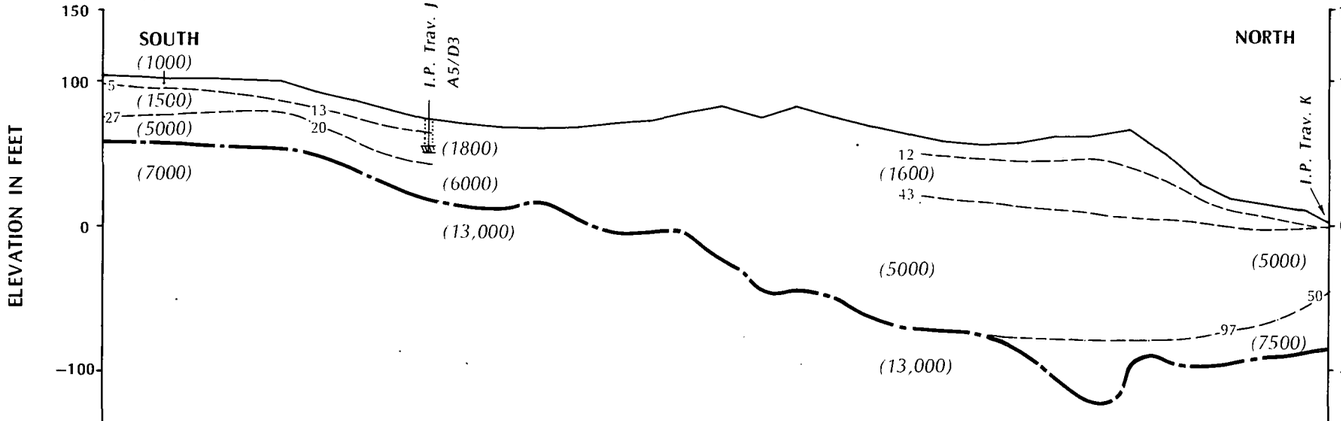


Datum −200

Spread 30 | Spread 29

STATION NUMBER	23			20				15				10				5				23		20				15				10					5				1								12	11	10	9	8	7	6	5	4	3	2	1
STATION ELEVATION (FEET)	96.6	96.4	96.4	95.8	95.0	94.2	93.3	91.9	90.6	89.4	90.1	86.4	85.1	84.1	83.3	82.3	80.1	77.6	77.3	75.9	74.8	72.0	68.9	65.2	60.6	57.7	54.8	51.7	47.7	44.5	40.4	35.5	31.0	27.8	24.5	21.3	18.3	15.8	14.5	11.6	12.9	10.8	5.5															
DEPTH TO BEDROCK (FEET)	40	51	45	48	64	68	63		78	76	74	79	79	85	97	88	96	96	97	95	97	106	107	115	116	124	134	128	120	108	113	124	103	116	116	105	90	102	108	93	71	120	114	99															

TRAVERSE N



Datum −200

Spread 26 | Spread 24

STATION NUMBER	23			20				15				10				5				23		20				15				10					5				1																														
STATION ELEVATION (FEET)	104.3	103.5	101.3	101.1	101.6	99.6	93.4	86.6	80.0	74.0	69.9	68.1	67.5	68.2	70.8	73.6	78.0	82.4	85.2	81.9	75.3	69.0	63.0	58.5	56.3	58.0	62.0	62.4	66.5	50.2	30.4	18.2	11.8	10.5																														
DEPTH TO BEDROCK (FEET)	45					46		49	58	53	55	56	52	66	76	76	85	109	120	128	122	130	132	130	128	143	170	186	156	142	132	120	108	89																														

LEGEND

(13,000)	Seismic velocity in ft/s in the bedrock
25 — — —	Depth to formation with different seismic velocity.
I.P. Trav.	Traverse intersection point.
—·—	Unweathered bedrock boundary.
	Sand
	Weathered sandstone
	Clay
A 3	Auger drill hole.
D 3	Diamond-drill hole.

HORIZONTAL 200 100 0 200 400 FEET

VERTICAL 100 50 0 100 200

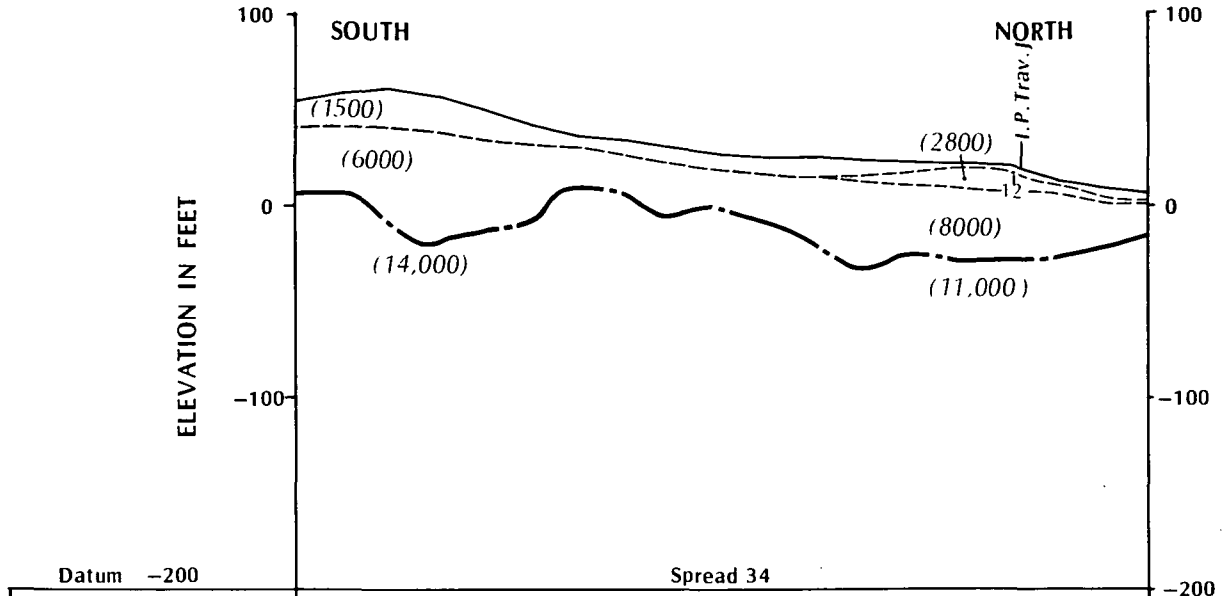
TRAVERSES N and O

SEISMIC CROSS-SECTIONS

TO ACCOMPANY RECORD No. 1969/146

156/B5–10

TRAVERSE Q

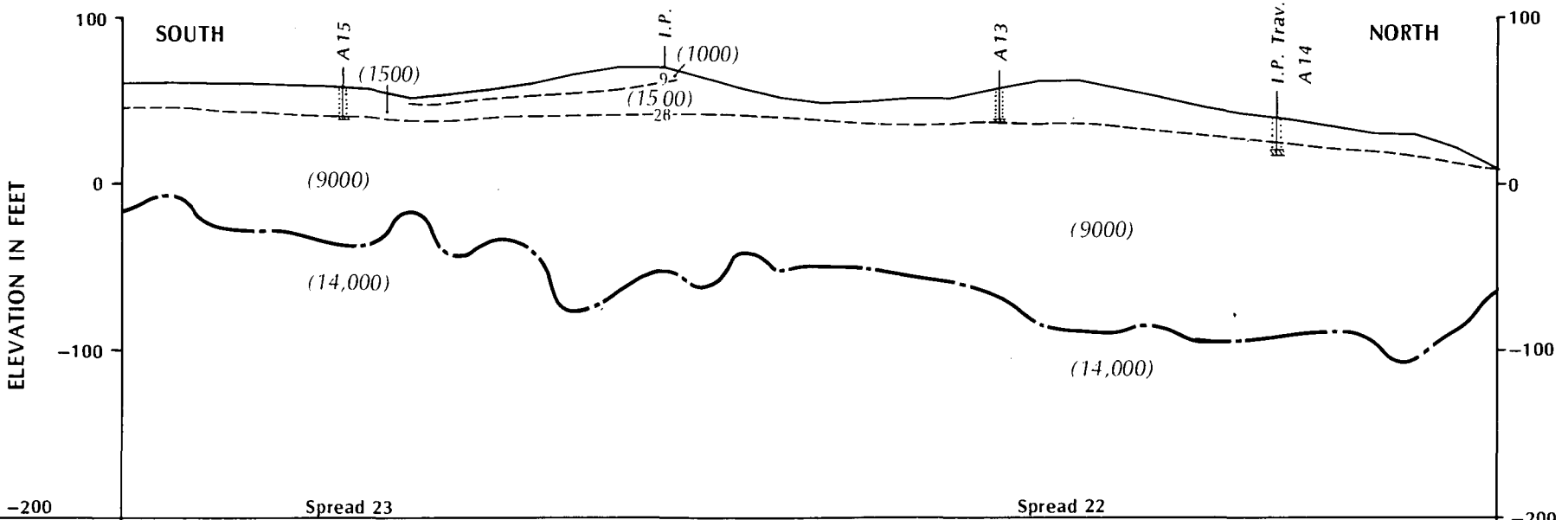


STATION NUMBER	23		19		15				10					5								1
STATION ELEVATION (FEET)	53.8	58.0	61.2	57.7	50.3	42.2	36.3	33.7	30.3	25.8	25.4	24.8	23.8	23.0	23.2	22.3	13.6	9.1	6.8			
DEPTH TO BEDROCK (FEET)	48	51	67	75	64	53	26	26	35	27	35	41	56	48	50	48	38		22			

LEGEND

(13,000)	Seismic velocity in ft/s in the bedrock.
52 — — —	Depth to formation with different seismic velocity.
I.P. Trav.	Traverse intersection point
— · —	Unweathered bedrock boundary.
	Sand.
	Weathered sandstone.
A 3	Auger drill hole.
C 3	Cone penetration.
D 3	

TRAVERSE P



STATION NUMBER	23				15			7			1	23			20				15				10					5					1		
STATION ELEVATION (FEET)	61.5	60.8	61.1	61.1	60.4	59.4	56.5	53.4	55.0	58.0	62.2	67.0	72.1	71.8	64.9	57.8	52.7	52.2	51.0	53.6	52.6	58.3	62.9	62.9	58.3	53.0	47.5	43.5	39.6	35.6	32.4	31.5	23.1	9.4
DEPTH TO BEDROCK (FEET)	76	66	83	87	86	92	93	67	97	90	100	142	136	121	125	97	102	96	100	107	110	130	148	150	145	136	141	136	130	126	121	138	112	73

HORIZONTAL 200 100 0 200 400 600 FEET

VERTICAL 100 50 0 100 200 300

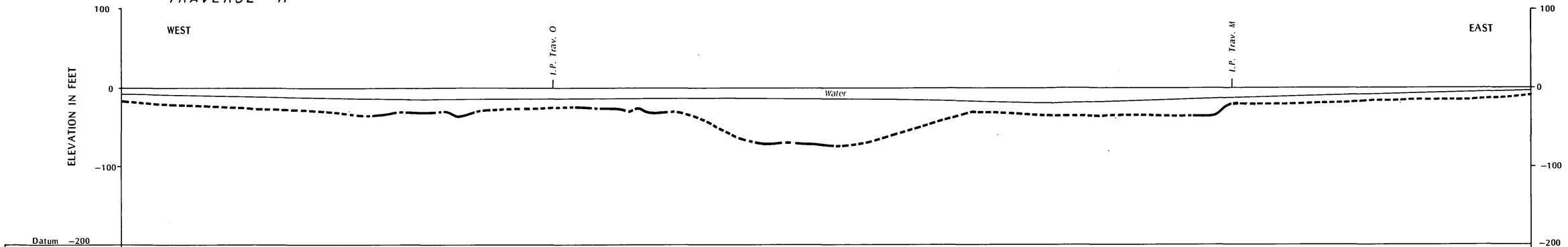
TRAVERSES P and Q

SEISMIC CROSS-SECTIONS

TO ACCOMPANY RECORD No. 1969/146

156/B5-11

TRAVERSE H



STATION NUMBER	100	200	300	400	500	620	645	670	695	720	745	770	795	820	845	870	895	1000	1100	1170	1195	1220	1245	1270	1295	1320	1345	1370	1395	1500	1620	1645	1670	1695	1720	1745	1770	1795	1820	1900	2000	2100	2170	2200	2300	2400	2500	2600	2720	2745	2770	2795	2900	3000	3100	3200	3300	3400	3500	3568
STATION ELEVATION (FEET)	SEA LEVEL																																																															
DEPTH TO BEDROCK (FEET)						35	35	35	32	30	30	32	32	30	32	37	32			25	27	27	27	27	30	27	32	32	32			70	72	70	70	72	72	72	75	75				22								37	33	35	25								

LEGEND

I.P. Trav. Traverse intersection point

Unweathered bedrock boundary

Sea depth from charts

TRAVERSE H

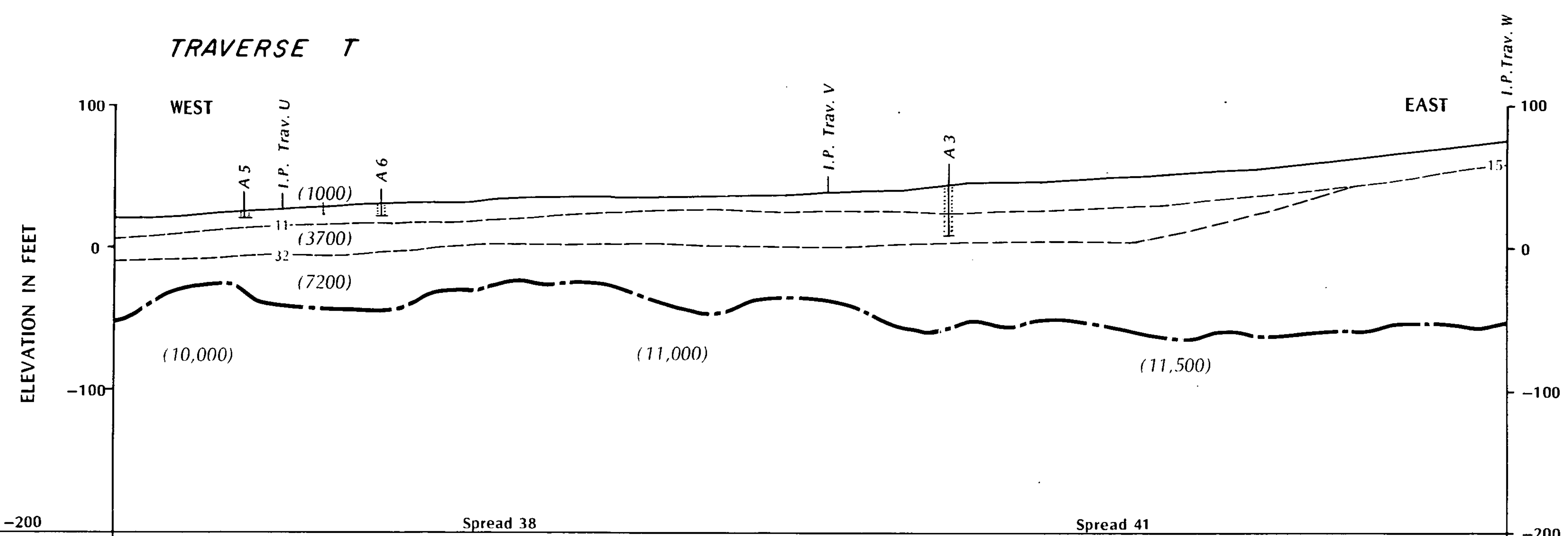
SEISMIC CROSS-SECTION

HORIZONTAL 200 100 0 200 400 600 FEET

VERTICAL 100 50 0 100 200 300

TO ACCOMPANY RECORD No. 1969/146

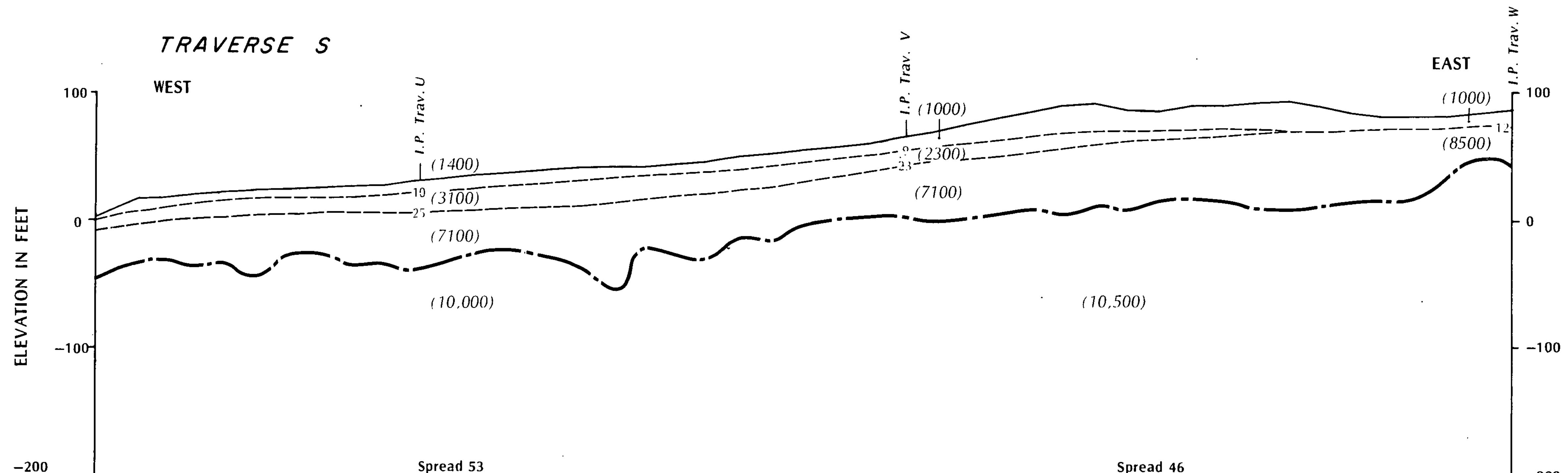
TRAVERSE T



Datum −200

Spread 38 Station Number	Spread 41 Station Number	Station Elevation (Feet)	Depth to Bedrock (Feet)
1		20.7	71
		21.2	56
		22.4	50
		24.5	48
5		26.2	62
		27.6	68
		28.8	71
		30.0	73
		30.8	75
10		31.7	61
		33.0	61
		34.2	57
		35.0	59
		35.7	58
15		36.1	60
		35.8	70
		36.3	77
	1	36.6	80
		36.9	71
20		37.7	71
		39.0	73
	5	40.8	84
23		41.2	95
		43.4	101
		46.0	96
		47.1	101
	10	47.5	96
		48.5	99
		50.6	106
		51.2	112
		52.9	115
	15	54.7	112
		56.4	115
		58.8	119
		61.5	118
		64.6	121
	20	67.6	118
		70.3	122
		72.7	126
	23	76.0	128

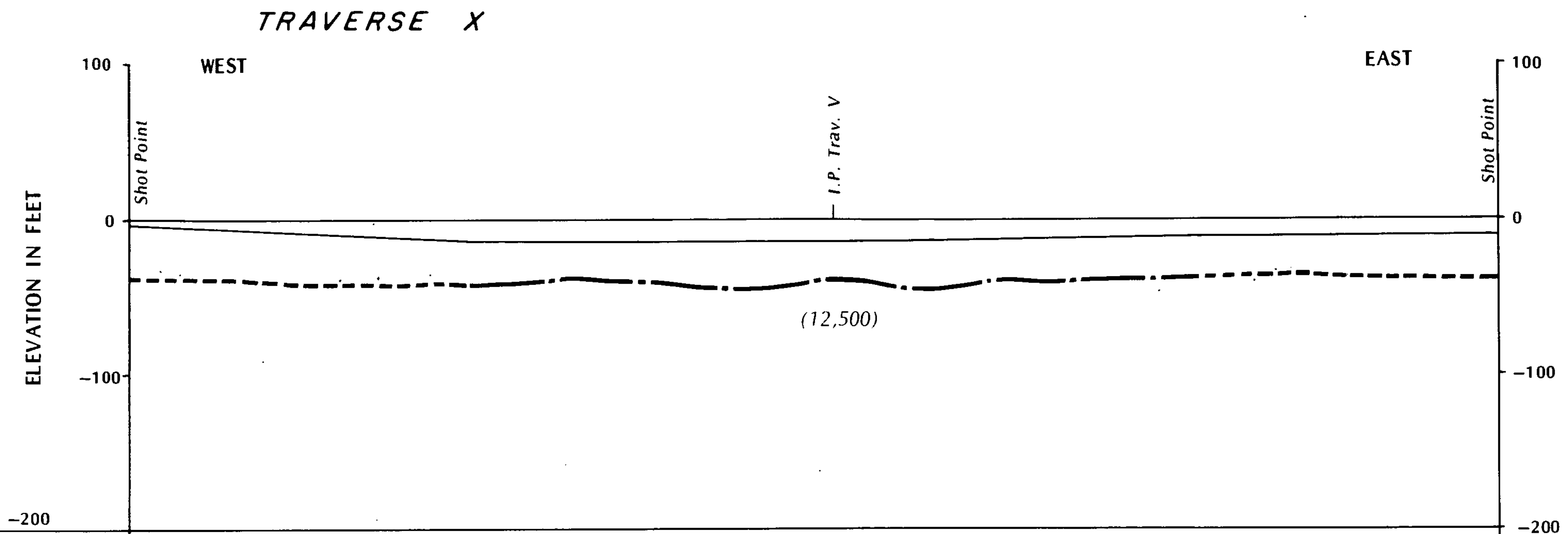
TRAVERSE S



Datum −200

Spread 53 Station Number	Spread 46 Station Number	Station Elevation (Feet)	Depth to Bedrock (Feet)
1		3.0	46
		13.7	46
		17.6	48
		20.0	57
5		23.0	55
		23.7	67
		25.1	52
		26.2	52
		26.9	63
10		28.4	61
		31.6	70
		33.7	65
		35.8	59
		38.4	61
15		40.4	68
		42.3	78
		42.9	97
		42.6	62
		44.7	71
20		47.4	78
		51.0	62
		53.7	68
23	1	55.8	57
		58.0	57
		61.6	57
		66.0	61
	5	69.7	70
		75.6	72
		80.0	76
		85.4	76
		90.7	85
	10	92.3	80
		87.3	78
		85.8	69
		89.9	73
		90.5	75
	15	93.2	83
		94.4	84
		90.9	81
		85.6	69
		82.7	66
	20	82.0	64
		82.4	44
		83.8	35
	23	86.6	44

TRAVERSE X



Datum −200

Station Number	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300
Station Elevation (Feet)	SEA LEVEL													
Depth to Bedrock (Feet)						40	40	42	45	40	45	40	40	37

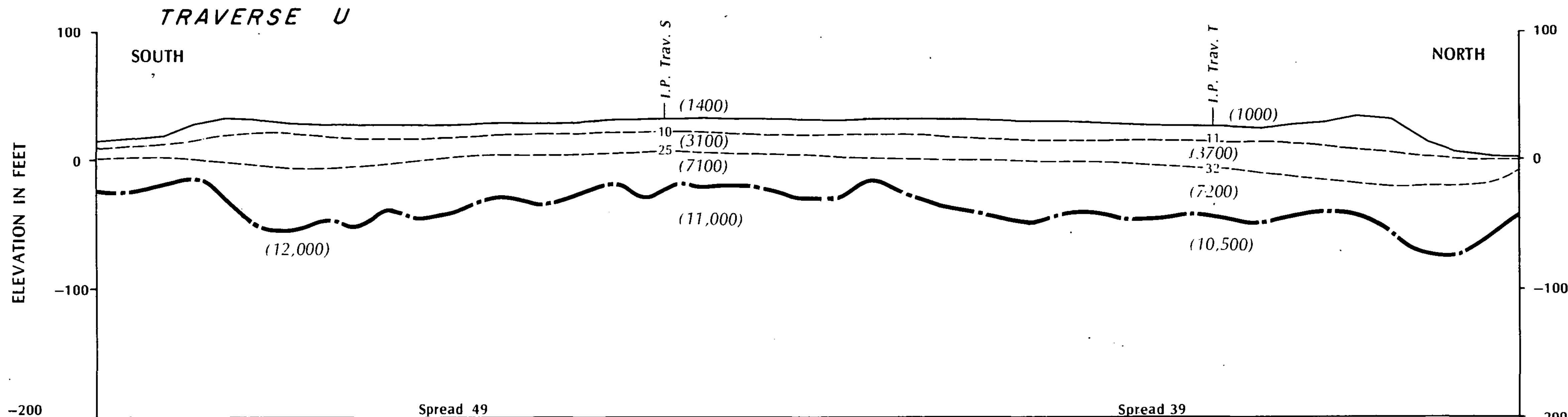
LEGEND

(12,500)	Seismic velocity in ft/s in the bedrock.
52 — — —	Depth to formation with different seismic velocity.
I.P. Trav.	Traverse intersection point.
▬ · ▬	Unweathered bedrock boundary.
(symbol)	Sand.
A 3	Auger drill hole.

TRAVERSES S, T and X

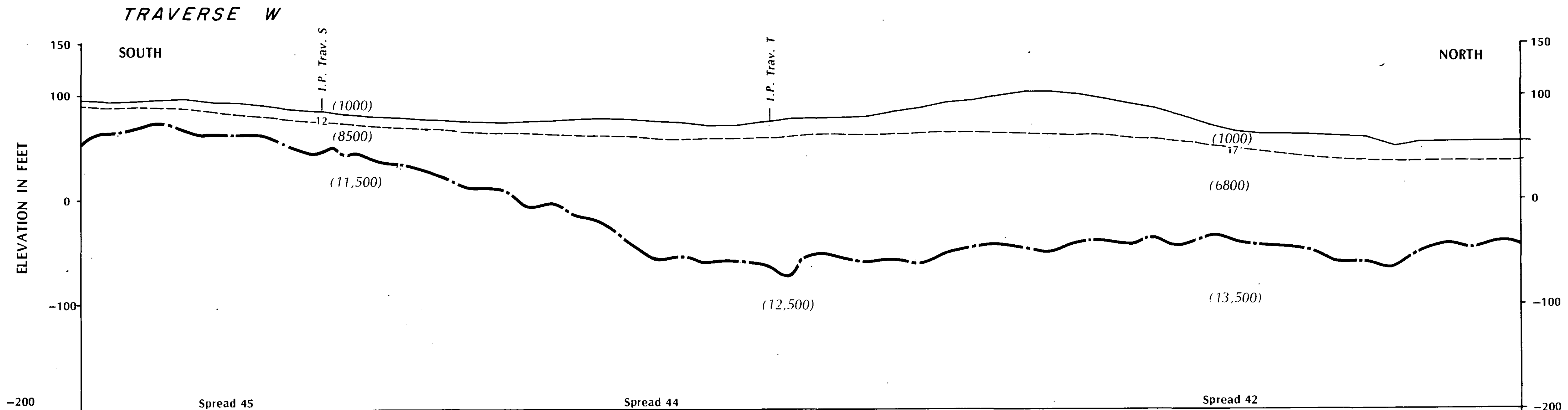
SEISMIC CROSS-SECTIONS

HORIZONTAL 200 100 0 200 400 600 FEET
VERTICAL 100 50 0 100 200 300



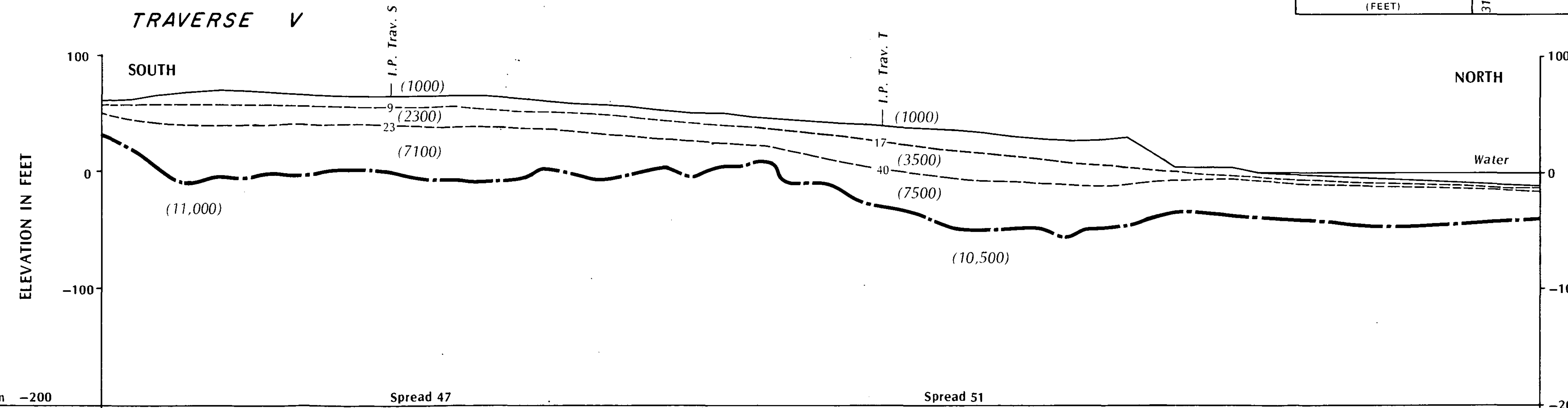
Traverse U (Datum −200)

	Values
Spread	49 · 39
STATION NUMBER	Spread 49: 23, 20, 15, 10, 5, 1 · Spread 39: 23, 20, 15, 10, 5, 1
STATION ELEVATION (FEET)	14.8 16.6 19.7 28.4 32.9 32.3 29.2 27.8 28.5 28.4 28.2 28.2 29.1 28.8 28.9 29.9 31.1 31.2 32.0 32.9 32.3 32.3 31.3 30.8 32.1 32.5 32.5 32.0 31.4 30.4 29.8 29.1 28.9 27.7 27.7 26.1 25.6 27.9 30.5 33.8 32.0 15.0 6.6 3.0 2.8
DEPTH TO BEDROCK (FEET)	39 41 37 43 64 84 84 74 80 66 74 68 60 58 63 55 49 61 50 54 52 54 61 60 47 58 66 71 76 79 71 69 74 70 68 71 76 71 71 77 84 90 80 59 43



Traverse W (Datum −200)

	Values
Spread	45 · 44 · 42
STATION NUMBER	Spread 45: 23, 19, 13, 7, 1 · Spread 44: 23, 20, 15, 10, 5, 1 · Spread 42: 23, 20, 15, 10, 5, 1
STATION ELEVATION (FEET)	96.2 95.2 95.9 96.9 9.8 95.3 94.3 91.3 88.7 86.6 83.5 82.2 80.1 78.3 77.0 76.3 74.8 75.3 75.9 77.3 77.7 77.7 76.6 74.7 72.5 72.0 74.7 77.9 79.4 79.0 80.1 83.8 88.7 93.7 96.1 100.0 103.8 104.3 102.4 97.0 91.9 87.0 79.8 71.6 65.9 63.6 62.8 62.3 61.5 60.7 51.7 55.2 55.1 55.7 56.4 56.7
DEPTH TO BEDROCK (FEET)	40 31 29 27 25 21 19 24 27 32 31 29 29 27 27 29 34 41 37 31 38 35 40 45 46 55 63 63 81 78 93 100 117 130 127 130 129 136 149 128 132 139 140 148 143 140 142 149 153 142 135 133 122 124 106 104 106 108 112 120 120 114 103 97 101 95 97



Traverse V (Datum −200)

	Values
Spread	47 · 51
STATION NUMBER	Spread 47: 23, 20, 15, 10, 5, 1 · Spread 51: 23, 21, 17, 15, 14, 12, 10, 9, 5
STATION ELEVATION (FEET)	61.2 62.6 66.2 69.0 69.7 68.9 67.8 66.4 65.5 65.1 65.0 65.2 66.0 66.4 64.5 61.8 59.6 57.8 65.0 53.6 51.3 50.8 48.1 46.1 44.2 42.5 40.7 38.1 36.6 35.8 33.8 30.1 27.8 26.9 28.1 29.8 16.8 5.0 3.0 0 SEA LEVEL
DEPTH TO BEDROCK (FEET)	29 41 64 78 74 74 68 68 62 62 65 72 72 74 70 58 58 65 59 49 55 48 43 37 41 56 53 52 56 66 70 74 85 84 80 76 83 76 78 78 74 64 50 20 45 40

LEGEND

(12,000)	Seismic velocity in ft/s in the bedrock
10 — — —	Depth to formation with different seismic velocity.
I.P. Trav.	Traverse intersection point.
—·—·—	Unweathered bedrock boundary.

TRAVERSES U, V and W
SEISMIC CROSS-SECTIONS

HORIZONTAL 200 100 0 200 400 600 FEET
VERTICAL 100 50 0 100 200 300