COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1962/76

HUON RIVER/BLACKFISH CK DAM SITE GEOPHYSICAL SURVEYS, TASMANIA 1959-60

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SUMMARY

This Record describes seismic refraction and resistivity-traversing surveys carried out at the request of the Hydro-Electric Commission of Tasmania at a proposed dam site on the Huon River, up-stream from its junction with Blackfish Creek.

The purpose of the surveys was to determine the nature and thickness of the overburden and the nature of the bedrock. The overburden consists of scree material, sand, soil, clay, and weathered and recemented dolerite. In many places the seismic velocity in the weathered and especially the recemented dolerite indicates that these rocks are of sufficient strength for foundation purposes. Seismic results indicate that the overburden thickness ranges from 20 to 316 ft. Over most of the area, the estimated average overburden thickness is about 70 to 80 ft, although over about one sixth of the area the estimated overburden thickness ranges from 130 to 316 ft. The greatest thickness is indicated on the western bank. The bedrock consists mainly of unweathered dolerite, although the seismic velocities and drilling data indicate that the bedrock corresponds, in some instances, to partly-weathered or recemented dolerite.

It is estimated that the depth to bedrock has been calculated within 30 per cent.

1. INTRODUCTION

The Hydro-Electric Commission of Tasmania proposes to construct a dam on the Huon River up-stream from its junction with Blackfish Creek, approximately 4 miles up-stream from the village of Judbury (Plate 1). The approximate co-ordinates of Judbury are 482707 referring to sheet No. 6 of the Tasmanian State four-mile series.

In response to an application from the Commission, the Bureau of Mineral Resources, Geology and Geophysics carried out a geophysical survey to determine the nature of the overburden and bedrock and the depth to bedrock at the selected dam site. An earlier geophysical survey (Wiebenga and Polak, 1958) had been made near Frying Pan Creek which joins the Huon River about 1 mile up-stream from the Blackfish Creek/Huon River junction.

Seismic refraction and resistivity-traversing methods were applied. The resistivity work was done in the first week of March 1959 and the seismic work during April 1959. The geophysical party consisted of D.F. Dyson (party leader), P.E. Mann and B.J. Bamber (geophysicists), J. Croger (geophysical assistant).

After the preliminary examination of the results the Commission decided to increase the proposed height of the dam. Therefore a second survey was carried out by a geophysical party consisting of E.J. Polak (party leader), M.J.W. Duggin (geophysicist), and J.P. Pigott (geophysical assistant). The survey took place in June 1960. This Record describes both the 1959 and 1960 surveys.

The Commission provided field assistants and carried out topographical surveys along the traverses (see Plate 1).

2. GEOLOGY

The geology of the general area has been described by Wiebenga and Polak (1958).

The rock type in the area is dolerite, probably of Jurassic age (Ford, 1956). The dolerite crops out in several places near the water level. The remainder of the dam site area is covered with soil, sand, clay, scree material, and many dolerite 'floaters'. The area has been drilled, and drilling logs have been reproduced on Plates 4, 5, and 6.

As used in this report the term 'bedrock' refers to the deepest recorded seismic refractor. The term 'overburden' refers to soil, river sands, clay, scree material, and such dolerite as overlies the bedrock. In representing the drilling logs in this report, certain criteria have been adopted to classify the dolerite that overlies the bedrock. The drilling logs supplied by the Commission are reproduced in Table 1 (see Section 4 Results). From the description in the drilling logs, the following classifications have been made:

(a) Completely-weathered dolerite. Less than 90 per cent core recovery is the criterion used to distinguish completely weathered dolerite.

(b) Partly-weathered dolerite. This term refers to dolerite that has more than 90 per cent core recovery but in which joints have been described as clay filled, or weathered, or both.

(c) Recemented dolerite. This term refers to dolerite that has joints filled with calcite and clay minerals.

Dolerite that is described in category (b) and especially in category (c) commonly is suitable for dam foundations. The velocity of the seismic waves is a useful criterion for degree of rock-weathering. Rocks in which the velocity of the seismic waves is greater than 8000 ft/sec have been found in the past by Commission engineers to be sufficiently rigid to support certain types of engineering structures (Wiebenga and Polak, 1956). The depth to 'bedrock' generally refers to the depth to completely unweathered dolerite; this rock will in many cases have a greater rigidity than the minimum needed for dam foundation rock.

3. METHODS AND EQUIPMENT

Detailed descriptions of resistivity and seismic refraction methods were previously given by Polak and Moss (1959).

The total length of resistivity traverses surveyed was 20,500 ft. The traverses were surveyed twice, using 100-ft and 50-ft electrode spacings. A Tellohm geophysical meter manufactured by Nash and Thomson was used.

The equipment used on the seismic survey was an SIE 12-channel refraction seismograph (Type PRO 11-6), with TIC geophones of natural frequency about 20 c/s. The total length of seismic traverses surveyed was 32,000 ft.

4. RESULTS

Seismic

Identification of rock types in terms of seismic velocities. The drilling logs have been reproduced on Plates 4, 5, and 6; Table 1 compares the drilling logs with the seismic results.

TABLE 1

No.	Drilling location	Geological log	Depth (ft)	Seismic Results Velocity (ft/sec)	Depth (ft)
214	60'E of C39	Completely-weathered dolerite	0 - 8	1000	0 - 4
	inclined	Weathered dolerite	8 - 20	6000	4 - 27
	44°N	Less-weathered dolerite	20 -	18,000	27 -
		Total depth drilled 55 ft			
205	40'E of C28	Partly-weathered dolerite	0 -	1000	0 - 3
	Vertical	Total depth drilled 56 ft		6000	3 - 49
				18,000	49
203	40'W of C25	Weathered dolerite	0 - 10	1000	0 - 4
	Inclined 48°	Recemented dolerite	10 -	6000	4 - 30
	N	Total depth drilled 281 ft		17,000	30 -
206	15'W of D24	Completely-weathered dolerite	0 - 3	1000	0 - 4
	Vertical	Recemented dolerite	3 -	2,200	4 - 20
				17,000	20 - 39
		Total depth drilled 50 ft		20,000	39
213	130'W of	Weathered dolerite	0 -	1000	0 - 3
	G25			2000	3 - 73
	Vertical	Total depth drilled 121 ft		5800	73 - 130
				12,000	130-
212	J26	Decomposed dolerite	0 - 5	1000	0 - 4
		Weathered dolerite	5 - 70	1600	4 - 65
		Unweathered dolerite	70 -	8000	65 - 141
		Total depth drilled 80 ft		14,000	141
210	J21-J22	Very-weathered dolerite	0 - 74	1600	0 - 50
	Vertical	Partly-weathered dolerite	74 - 102	7000	50 - 91
		Recemented dolerite		15,000	91-
		Total depth drilled 149 ft			
202	20'S of	Very-weathered dolerite	0 - 5	1000	0 - 2
	J13-J14	Weathered dolerite	5 - 29	5000	2 - 15
	Vertical	Recemented dolerite	29 - 69	11,000	15 - 63
		Unweathered dolerite	69 -	20,000	63 -
		Total depth drilled 76 ft			
211	J8 - J9	Partly-weathered dolerite	0 - 37	1000	0 - 2
	Inclined			5000	2 - 25
	45°W	Less-weathered dolerite	37 -	12,000	25 - 80
		Total depth drilled 229 ft		20,000	80 -
209	40'S of J2	Completely-weathered dolerite	0 - 16	1000	0 - 6
	Vertical	Weathered dolerite	16 - 53	6000	6 - 42
		Unweathered dolerite	53 -	12,000	42 -
		Total depth drilled 72 ft			

Notes to Table 1

(a) depths in drill holes 203, 211, and 214 have been corrected to vertical. Total depth drilled is measured along the axis of the hole.

(b) Information relating to inclined drill holes 201, 204, 207, and 208 has been omitted from the table as these holes are located on positions of vertical holes.

(c) Drill hole 206 on Traverse D is located between two weathering spreads that show markedly different seismic velocities in the overburden. Thus the interpolation given above is somewhat doubtful. A similar state of affairs exists near drill holes 210 and 212 on Traverse J.

Table 2, which summarises the identification of rock types, is based on Table 1.

TABLE 2

Rock type	Seismic velocity (ft/sec)	Estimated value for Young's modulus (lb/in^2)
Soil, sand, scree material, clay	800 - 1000	
Completely-weathered dolerite	1600 - 6000	
Partly-weathered dolerite	6000 - 12,000	$0.7 - 3.7 \times 10^6$
Recemented dolerite	7000 - 17,000	$1.0 - 8.1 \times 10^6$
Unweathered dolerite	17,000 - 21,000	$8.1 - 13.0 \times 10^6$

The values of Young's modulus shown in Table 2 have been calculated from an empirical formula, based on data collected by Birch, Schairer and Spicer (1950), between the Young's modulus and the seismic longitudinal velocity. The values of Young's modulus may be considered to have a maximum possible error of 30 per cent.

Depth to bedrock Plates 4, 5, and 6 show the bedrock cross-sections calculated from seismic data. On the eastern bank, the seismic work indicates that the overburden thickness on Traverses A and B is fairly uniform. The overburden thins out toward the southern end of Traverse C, which is near and approximately parallel to the river.

On the western bank, the seismic work indicates a belt of thick overburden stretching across Traverses E, F, and G (Plate 5) and Traverses I and J (Plate 6). In this region the calculated overburden thickness reaches a value of 316 ft at station F17. The cross-sections on Plate 5 suggest that this bedrock depression may extend to Traverse D between D14 and D12. A study of the cross-sections along Traverses E, F, and G, shows that the bedrock depression is marked by localised lower seismic velocities in the bedrock. This suggests that the feature represents a fault or shear zone in which weathering has penetrated along the fractures to a considerable depth.

The drilling data presented in Table 1 suggest that the depth to bedrock obtained from seismic data is accurate within 30 per cent.

Resistivity

Apparent-resistivity contour maps over the damsite area are reproduced on Plates 2 and 3, for electrode spacings of 100 ft and 50 ft respectively.

On the eastern bank the values of the apparent resistivity (100 ft electrode spacing) rise very steeply to a peak of the order of 10^4 ohm-metres between C26 and C34 (Plate 2). A similar but smaller feature occurs between B10 and B16. A comparison is made on Plates 4 and 5 between the bedrock cross-sections calculated from seismic data with the apparent-resistivity profiles. The very high values of apparent resistivity on the eastern bank occur in a region where the indicated overburden thickness is uniformly small (about 30 ft) between stations C29 and C36.

On the western bank the apparent resistivity is generally low (200 to 600 ohm-metres); the seismic work indicates a large thickness of 'overburden' on this bank. The measured apparent-resistivity (100-ft electrode spacing) reaches a maximum on Traverse F between F14 and F8 (see Plate 5). This rise to a maximum is also well-marked in apparent resistivities using 50-ft electrode spacing. Seismic work indicates that the bedrock rises steeply towards the surface from F17 to F10; however, the overburden thickness is still too great for bedrock to affect the resistivity measured with 100-ft electrode spacing. This rise to a peak value in the apparent resistivity probably corresponds to the presence of partly weathered or recemented dolerite near the surface. This may correspond to the material with velocity of 8000 ft/sec found at a depth of 51 ft near station F14.

5. CONCLUSIONS

The geophysical survey provided information on the depth to bedrock at the dam site. The 'overburden', i.e. all the material above the deepest recorded refractor, consists of soil, sand, clay, scree material, completely and partly-weathered dolerite, and recemented jointed or fractured dolerite; its maximum thickness estimated by the seismic work in the area is 316 ft at Station F17.

On the western bank there is a very great thickness of 'overburden'; seismic work indicates that, in an area of about 500 ft by 1000 ft, the 'overburden' thickness ranges from 130 ft to 316 ft. Over the remainder of the area surveyed, the seismic estimates of 'overburden' thickness range between 20 ft and 130 ft, with the average thickness between 70 ft and 80 ft. On the eastern bank, the great thickness of 'overburden' indicated by seismic work is probably associated with a fractured or sheared zone.

The resistivity work was useful on the eastern bank where high values of apparent resistivity were recorded toward the up-stream end of Traverse C. This supports the seismic results which indicate a thinning of 'overburden' in this region. The resistivity work on the eastern bank is probably no guide to basement conditions because the depth to bedrock is mostly in excess of 100 ft.

In using these results to assist in the selection of a dam site it is stressed that the 'overburden' probably includes rocks suitable for foundations. For example it includes dolerite that is only partly-weathered, and dolerite which, although sheared or fractured, is largely recemented with calcite. Such dolerite commonly is sufficiently rigid to support certain types of engineering structures. Dolerite in which the velocity of the seismic waves exceeds 8000 ft/sec is generally sufficiently rigid for foundations of certain types of dams.

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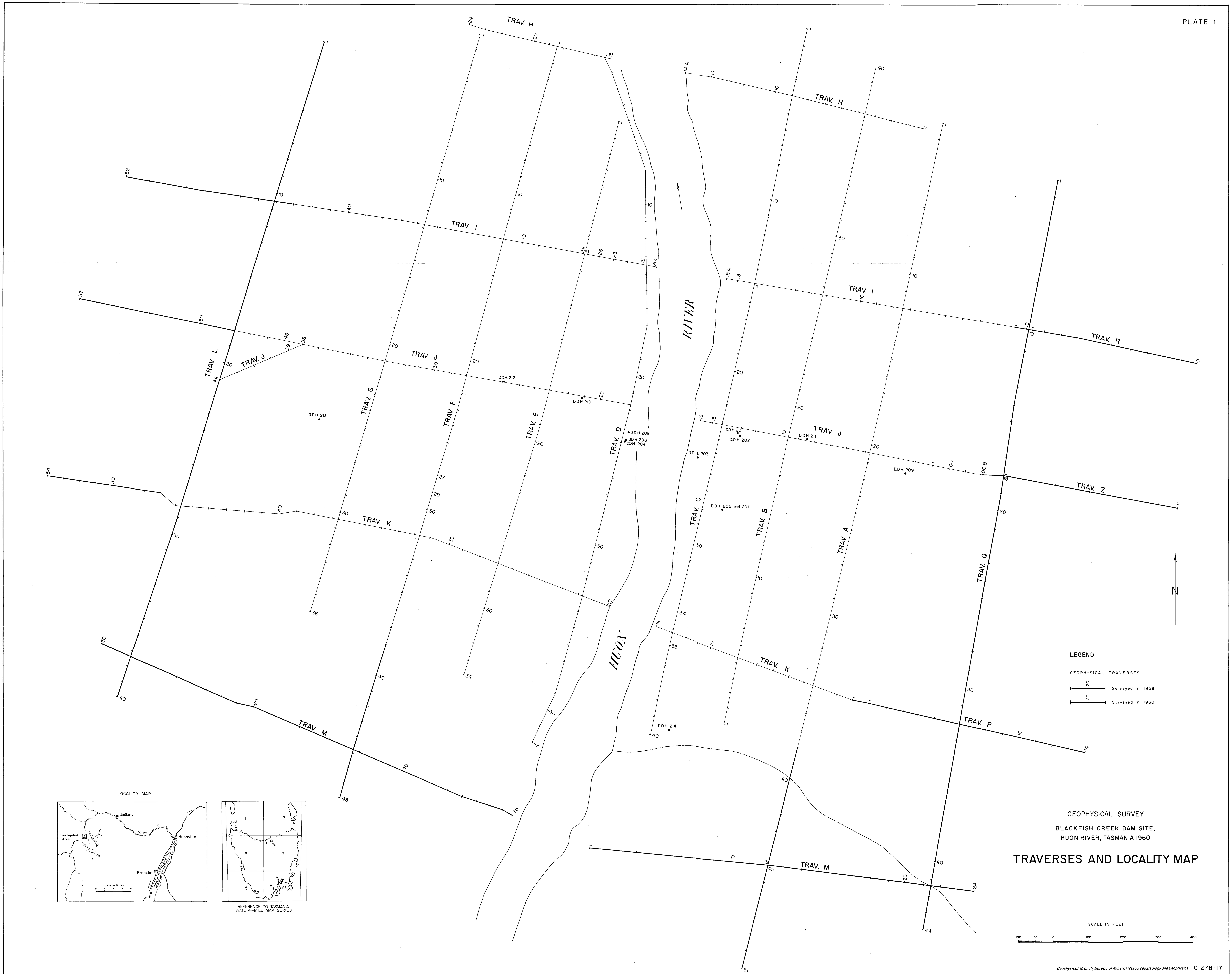


GEOPHYSICAL SURVEY

BLACKFISH CREEK DAM SITE,
HUON RIVER, TASMANIA 1960

TRAVERSES AND LOCALITY MAP

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G 278-17

TO ACCOMPANY RECORD No. 1962/76

PLATE 2

LEGEND

CONTOURS IN OHM/METRES

DRILL HOLE

BENCH MARK WITH LEVEL

GEOPHYSICAL TRAVERSE

GEOPHYSICAL INVESTIGATION AT BLACKFISH CREEK,
HUON RIVER DAMSITE, TASMANIA

APPARENT-RESISTIVITY CONTOURS

ELECTRODE SPACING 100 FEET

SCALE IN FEET

100 0 100 200 300

CONTOUR INTERVAL AS SHOWN

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G278-12

TO ACCOMPANY RECORD No 1962/76

PLATE 3

LEGEND

1000 — 800 — CONTOURS (IN OHM-METRE)

D.H.212 DRILL HOLE

B.M.3059 448.02' BENCH MARK WITH LEVEL

H24 GEOPHYSICAL TRAVERSE

GEOPHYSICAL INVESTIGATION AT BLACKFISH CREEK,
HUON RIVER DAMSITE, TASMANIA

APPARENT-RESISTIVITY CONTOURS

ELECTRODE SPACING 50 FEET

SCALE IN FEET

100 0 100 200 300

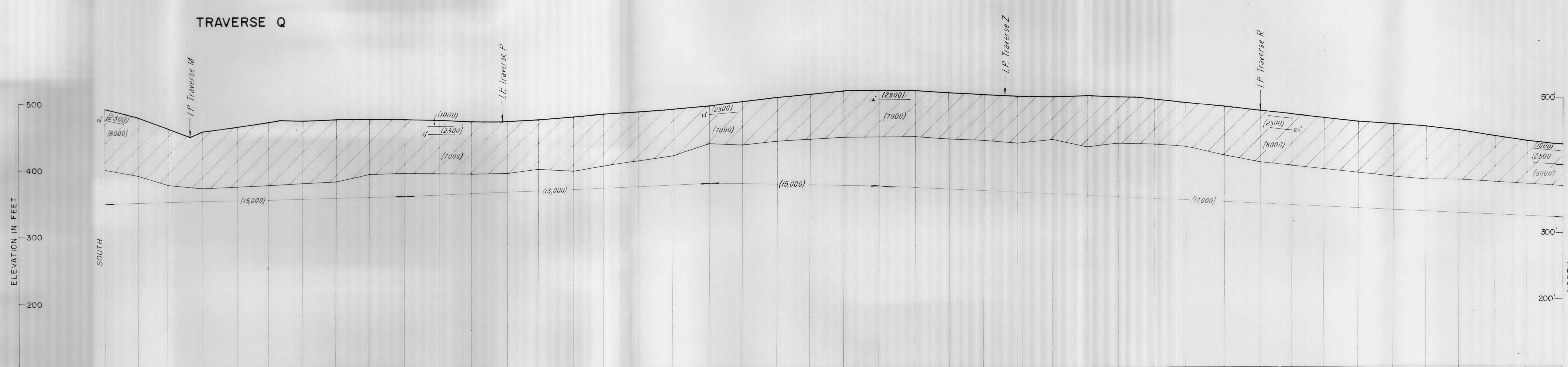
CONTOUR INTERVAL AS SHOWN

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G278-13

TO ACCOMPANY RECORD No 1962/76

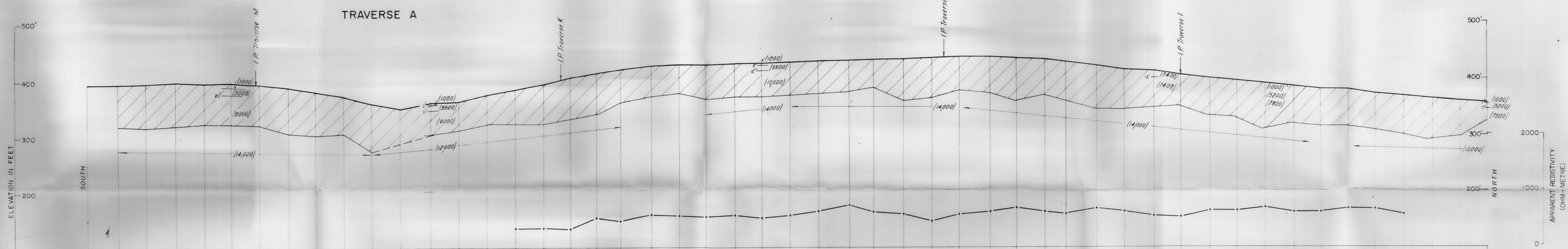
PLATE 4

TRAVERSE Q



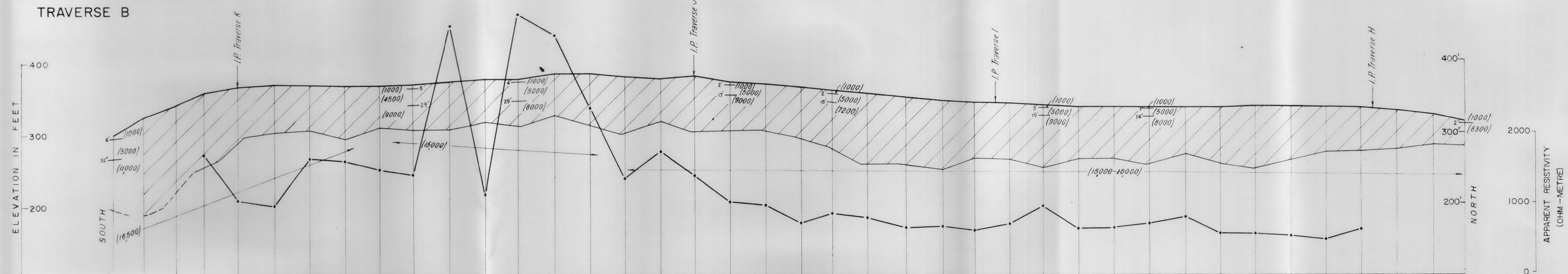
Station No.	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	Q18 & W54	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Surface Level	499.8	476.5	460.0	453.6	462.5	466.2	470.9	472.7	473.6	473.4	470.3	468.4	469.4	471.2	474.5	479.9	483.4	487.4	491.0	497.3	504.2	509.9	513.9	514.4	513.6	510.1	507.7	504.9	503.5	504.8	502.7	499.9	494.8	486.6	482.9	477.4	472.1	467.2	462.7	456.4	452.6	444.0	437.4	431.2
Depth to Bedrock	99	87	85	88		93	93	95	84	81	78	77	77	74	83	77		66	58	66	68	68	69	68	68	70	70	70	65	77	71	68	68	74	80	77	75	77	80	88	70	67	67	68

TRAVERSE A



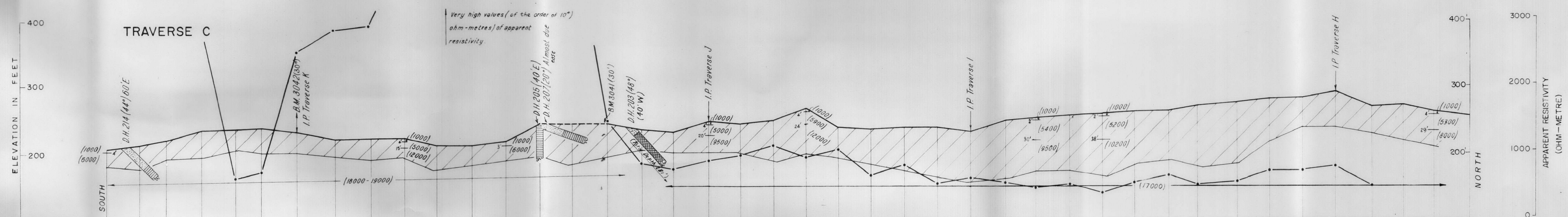
Station No.	51	50	49	48	47	46	A45 & M12	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Surface Level	391.6	393.7	395.5	396.2	395.4	395.6	393.5	386.2	378.3	370.5	358.1	348.0	359	360	372	381	390	401	410	417	422	426	426	428	428	430	432	433	435	435	438	440	440	438	436	431	425	418	418	407	402	398	393	388	384	380	375	371	367	364	360
Depth to Bedrock		71	78	75	74	71	69	78	75	60	48			50	48	60	69		71	59	57	53	62	60	81	58	59	56	52	74	71	60	63	77	64		77	71	68	57	67	66	81	65	65	64	64	67	75	58	

TRAVERSE B



Station No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Surface Level	296	321	338	355	365	367	367	368	366	368	371	374	373	381	381	376	378	372	369	368	361	356	351	340	343	339	337	336	333	332	332	331	331	333	333	338	331	327	321	312
Depth to Bedrock		150	90	94	74	69	64	75	81	78	66	62	65	59	75	83	81	92	70	65	72	78	99	93	99	77	79	92	76	74	80	67	79	91		83	64	158	45	

TRAVERSE C



Station No.	40	39	38	37	36	35	K13	34	33	32	31	30	29	28		26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	H9	4	3	2	1
Surface Level	220	227	234	239	240	242	237	226	226	228	216	216	221	248		248	239	234	251	248	251	270	243	239	242	241	234	252	256	259	262	264	266	273	278	283	285	294	268	274	265	257
Depth to Bedrock	27	37	29	41	28	38	32	28	34	32	37	32	31	49	64		30	34	48	46	65	69	48	53		74	76	88	84	83	96	79	73	93	93	67	46	52	40			

LEGEND

- Constant spacing Resistivity profile (100 ft spacing)
- (9000) Seismic Velocity in ft/sec
- 20' Depth to different velocity layers in feet
- Overburden
- Drillhole Sections
  - Completely weathered Dolerite
  - Weathered Dolerite
  - Recemented Dolerite

TRAVERSES Q, A, B, and C
SEISMIC CROSS-SECTIONS, RESISTIVITY PROFILES,
AND DRILLING INFORMATION

SCALE IN FEET

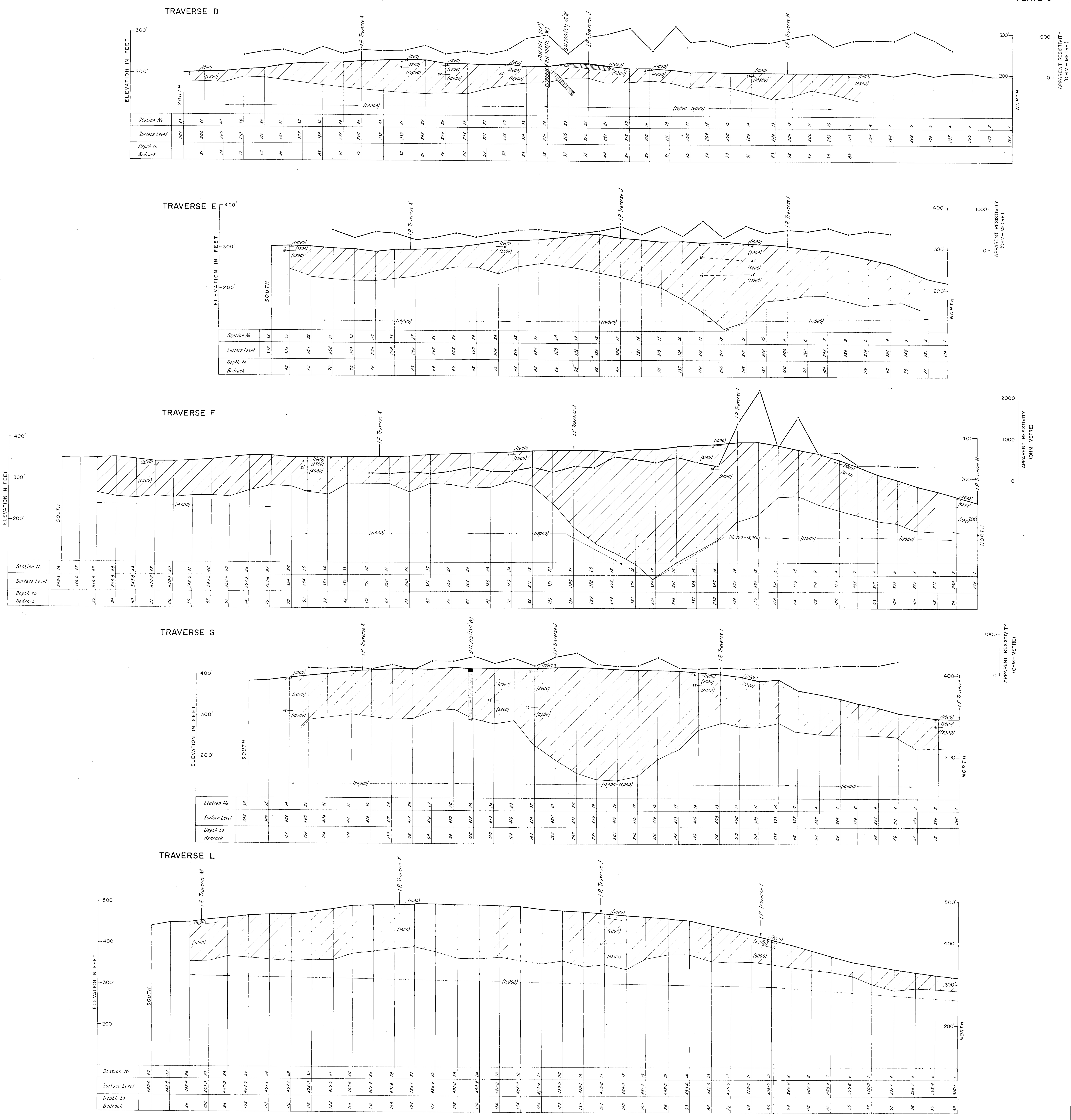
100 50 0 100 200 300

BLACKFISH CREEK TASMANIA 1960

G278-18

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics

TO ACCOMPANY RECORD No. 1962/76



LEGEND

- Constant spacing Resistivity profile (100ft spacing)
- (2000) Seismic velocity in ft/sec
- 20' Depth to different velocity layers in feet
- Overburden

Drillhole Sections

- Completely weathered Dolerite
- Weathered Dolerite
- Recemented Dolerite
- Fresh Dolerite

TRAVERSES D, E, F, G, and L

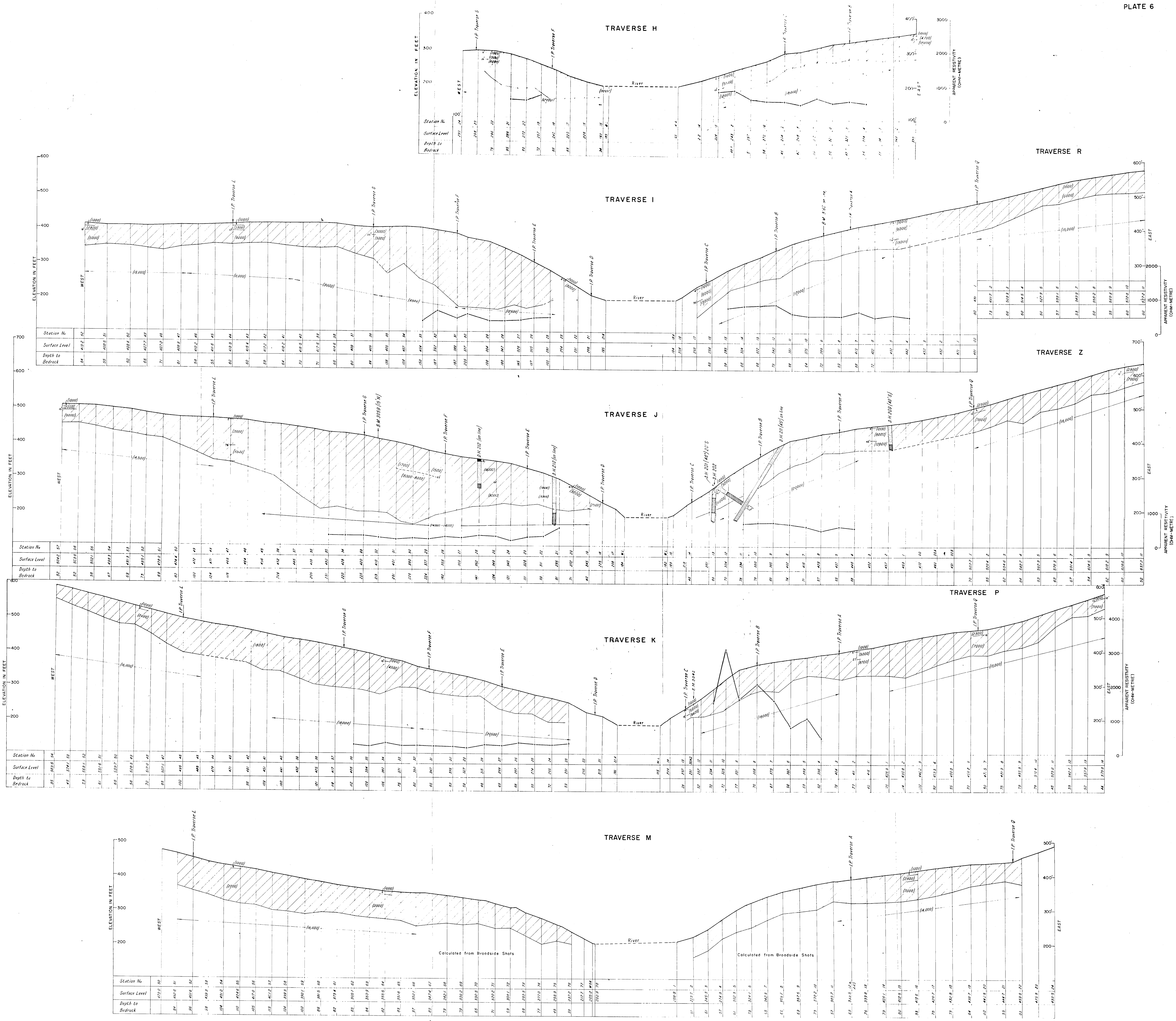
SEISMIC CROSS—SECTIONS, RESISTIVITY PROFILES, AND DRILLING INFORMATION

SCALE IN FEET

100 50 0 100 200 300 400 500

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G278-19

TO ACCOMPANY RECORD No 1972/76



LEGEND

- Constant spacing Resistivity profile (100ft spacing)
- (2000) Seismic velocity in ft/sec
- 0' Depth to different velocity layers in feet
- Overburden

Drillhole Sections

- Completely weathered Dolerite
- Weathered Dolerite
- Recemented Dolerite
- Fresh Dolerite

TRAVERSES H, I, J, K, and M

SEISMIC CROSS-SECTIONS, RESISTIVITY PROFILES, AND DRILLING INFORMATION

SCALE IN FEET

100 50 0 100 200 300 400 500