DEPARTMENT OF NATIONAL RESOURCES

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD NO. 1977/1

KIEWA RIVER AND SNOWDONS AREA (MURRAY VALLEY) GEOPHYSICAL SURVEY FOR SAND AND GRAVEL, VICTORIA, 1976

by

G.R. Pettifer and E.J. Polak

(Appendix by M. Idnurm)

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CONTENTS

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SUMMARY

The Bureau of Mineral Resources, Geology and Geophysics is involved in a continuing geophysical study of the sand and gravel resources of the Albury-Wodonga area for the Albury-Wodonga Development Corporation.

A survey by magnetic profiling and resistivity traversing and depth probing of the lower Kiewa valley in the Baranduda area indicates a possible zone of sand and gravel from 300 to 600 m wide, following closely the existing channel of the Kiewa River. Weathered bedrock depths are interpreted as ranging from 6 to 15 m, with the alluvium thickening towards the Murray River/Kiewa River junction.

Investigation of a small area north of Snowdons Road, in the Murray valley 6 km east of Albury, suggests a generally high sand and gravel content over the area to a depth of 15 to 20 m. No clear sand channel pattern was found in this area.

1. INTRODUCTION

At the request of the Albury-Wodonga Development Corporation (AWDC) the Engineering Geophysics Group of the Bureau of Mineral Resources, Geology and Geophysics (BMR) conducted a geophysical survey in the Kiewa valley to investigate sand and gravel deposits. The survey was the third in a series of investigations for sand and gravel required in construction work in the Albury-Wodonga complex. Two previous surveys were made downstream from the Hume Highway causeway (Pettifer, Polak & Taylor, 1975; Ramsay, 1976).

The purpose of the survey was to determine the extent of the sand and gravel deposits in two areas of the lower Kiewa valley, and an area close to the Murray River referred to as Snowdons area (Plate 1) in this report. The survey was conducted from 2 February to 9 March 1976. Two geophysical methods were used: resistivity depth probing and traversing, and magnetic profiling. AWDC provided four field hands, office accommodation and generous help in running the party. As this is the third BMR survey for AWDC, the reader is referred to the two preceeding Records for details of the geophysical methods.

2. KIEWA VALLEY

2.1 General

Kiewa River forms the eastern boundary of the suburb of Baranduda (old name Middle Creek). AWDC proposed, at the time of the survey, that the larger part of the sand and gravel requirements of the suburb will come from the right bank of the Kiewa River, where the sand pits will be screened by large trees close to the river. For this reason most of the geophysics covers the right bank of the valley; only a few traverses were continued across the river to the left bank. To facilitate identification of traverses the lower part of the Kiewa River was subdivided into five working areas A to E, starting with section A at the confluence of the Kiewa and Murray Rivers. Six traverses were investigated in area C, one in area D, and thirteen in area E; no work was done in area A and B. The locations of these traverses are shown in Plate 2. Constant-spacing resistivity traversing and magnetic profiling were carried out on these traverses. Plate 3 shows the locations of the resistivity depth probes; nine depth probes were located in area C and eight in area E. Oriented samples from the quarry were cut from outcrops of bedrock (shown in Plate 4) for magnetic susceptibility and direction of magnetization measurements (see Appendix 1) in the laboratory at BMR.

Quarries along Pollards Road have been producing sand and gravel-mainly in the form of decomposed granitic rocks - for road base material. This material and alluvium from the Kiewa valley at the northern end of area E has a high mica and clay content and was found to be unsuitable for use in concrete (J. Aney, AWDC engineer, pers. comm.). This may apply to all the sand deposits in the Kiewa valley; if so, the geophysical methods used in this investigation have no way of distinguishing the presence of mica, which can be assessed only in follow-up drilling.

2.2 Geology

The geology of the area is shown on the Wangaratta 1:250 000 map sheet produced by the Geological Survey of Victoria. The map indicates that the area is covered by Quaternary alluvium of late Pleistocene to Recent age. Several outcrops of bedrock are indicated. The bedrock on the right bank has been mapped as gneiss, biotite gneiss, and gneissic granite of Silurian age. On the left bank of the river, Upper Ordovician granites and gneissic granodiorites have been mapped. As the area is covered by alluvium, no structural interpretation is shown on the map, but a fault nine kilometres south of the investigated area trends northwards in the general direction of the survey area. Thomas (1949) quoted by Beavis (1962) suggested that the lower Kiewa River may have developed on a major fault, so mylonite may underlie the alluvium of the valley floor. Beavis (1962) described a structure in the upper Kiewa area - the West Kiewa Thrust Zone - which is characterized by a shear zone occupied by mylonite more than 1½ km wide. Beavis does not consider the area of the present investigation; however the possibility of a northerly extension of the thrust zone into the survey area must be considered likely, especially as the lower Kiewa River valley follows a straight line, so dissimilar to the meandering nature of the neighbouring Mitta Mitta River valley (see map in Beavis, 1976).

The sand in the area is very fine grained. The shape of the lower Kiewa valley suggests that the flow of the river may have been obstructed in the past near the railway bridge. This suggests the possibility that the sand was deposited in a lake.

2.3 Results

The geophysical methods and the basis for interpretation were discussed in two previous Records of Albury-Wodonga surveys (Pettifer et al., 1975; Ramsay, 1976) and will not be repeated here. Table 1 lists the interpretations for the depth probes. Plate 4 shows the results of resistivity traversing in areas C, D and E. Plate 5 shows plots of the depth probes in area C and their interpretation. Plates 6 and 8 show the magnetic profiles in areas C and E respectively. Plate 7 shows plots of the depth probes and their interpretation in area E.

2.3.1 Areas C and D

Area C is enclosed by the Murray Valley Highway to the north and by the railway line to the south; in this area, six resistivity and magnetic profiles and nine depth probes were carried out. Area D extends southwards from the railway line, only one resistivity and magnetic profile was placed there for logistic reasons to complete the coverage of the southern end of area C.

Table 1. Interpreted Resistivities and Depths

Depth Probe No. / Resistivity (R) ohm-m / Depth (h) m	Top Layer R_1	h_1	Second Layer R_2	h_2	Third Layer R_3	h_3	Fourth Layer R_4	h_4	Fifth Layer R_5	h_5	Sixth Layer R_6	h_6	Seventh Layer R_7	h_7	Eighth Layer R_8	h_8	Remarks
DC1	60	1.20	195	11.7	90	85	810										
DC2	200	0.42	5000	0.84	200	12	90	120	2000								
DC3	188	0.72	76	1.33	22	2.46	210	15	85	141	958						
DC4	236	2.83	129	6.43	334	17	156	106	591								
DC5	360	1.5	200	3.5	762	12.9	178	23	30.6	42	378	100	1368				
DC6	375	0.39	983	1.42	406	4.03	878	11	173	13	108	30	221	47	95	109	Layer 9 1358 -
DC7	51	0.44	83	1.63	70	4.49	163	16	76.8	78	322	-					Layer 9
DC8	172	0.58	371	4.64	752	8.17	302	12	70	16	28	19	148	55	116	176	9904 -
DC9	141	0.46	62	0.60	36	2.00	128	11	91.7	13	114	56	61	127	356	158	2225 -
DE1	123	1.57	310	1.78	750	129	5000	-									
DE2	1408	0.41	4444	2.05	1091	5.90	593	15	420	36	530	60	905	115	2403	-	
DE3	254	0.47	352	2.03	267	3.30	903	12	266	66	2442	-					
DE4	250	1.0	800	7.0	200	31	2800	-									
DE5	56	0.86	482	6.43	229	52	1347	144	2441	-							
DE6	81	0.85	330	4.93	734	12	305	92	1122	155	20773	-					
DE7	84	0.50	22	1.40	80	3.93	650	12	260	106	17135	-					
DE8	864	0.91	294	1.35	29	1.51	4.56	2.74	53	30	820	58	1553	-			
Snowdons No. 1	40	0.56	12	0.70	7.72	1.66	196	6.70	98.3	20	43.5	77	542	-			Layer 9
" " 2	905	0.36	3262	2.20	698	3.10	186	4.70	382	15	21.7	17	113	69	51.0	102	280 140 Layer 10 3507
" " 3	480	0.39	964	1.15	323	5.52	1016	9.66	209	19	11.4	27	232	84	4695	124	Layer 9 7609

Magnetic profiling (Plate 6) suggests the Kiewa valley occupies a low-intensity magnetic lineation bounded by two magnetic highs. This lineation may be the result of faulting or deeper weathering within the valley. If it is due to faulting, it may be related to a northerly extension of the West Kiewa Thrust Zone (section 2.2; Beavis, 1962). The elongated depression is filled with river alluvium over which the river is meandering at present.

Magnetic profile MCX located along the valley indicates much lower magnetic level in the downstream direction. This may be due to either the thickening of alluvium in this direction, or the thickening of weathered bedrock, while the thickness of alluvium remains constant.

Magnetic profiles MC1 and MD1 indicate an uplift in the magnetic anomaly in the centre of the valley. This may be due to a fault or a dyke.

Plate 4 shows the resistivity-traversing profiles, with a = 10 m spacing. As in previous surveys the amplitude of the curve indicates, for high resistance, either a higher content of sand and gravel in the bed or a thinner layer of soil and clay overlying the sand bed, and, conversely, a low resistance indicates a higher content of clay. The resistance traverse RD1 indicates a high-resistivity section extending 350 m east of the present channel of the river.

Plate 3 shows the locations of the resistivity depth probes, and the interpreted sections for probes C1 to C7 and results of C8 and C9. The principal feature of all the depth probes is a lower-resistivity layer, 30-150 ohm-m (typically 80-100 ohm-m), below a depth between 10 and 17 m. At greater depths (typically 100 to 140 m), the resistivity increases to larger values (greater than 600 ohm-m, typically of the order of 1000 ohm-m). Similar results are noticeable in area E and Snowdons area depth probes. This effect is interpreted to be due to weathered bedrock overlying fresher bedrock. The lower resistivity of the weathered bedrock is due to the presence of clay released in the weathering process. The depth of weathering (100-140 m), although large, is of the order, observed elsewhere in the Albury-Wodonga area (Pettifer et al., 1975).

The thickness of alluvium then, is, at least 10 m over most of the area. The resistivities of the layers overlying weathered bedrock are higher in depth probes DC5, DC6, and DC8 (350-800 ohm-m) then the values of 60-150 ohm-m west of the river in DC7 and the values of 120-300 ohm-m (typically 200 ohm-m) in DC1 to DC4 and DC9.

On the basis of these results and the traversing profiles, a zone 350 m wide of relatively clean sand and gravel is interpreted near DC5, DC6, and DC8. Areas of high clay content are indicated west of the Kiewa River (DC7) and at DC9. DC1 to DC4 results suggest finer sand or clay/sand-gravel mixtures east of the main sand/gravel channels. Soil and overburden thicknesses vary from less than one (DC8) to four metres (DC6) over the area.

2.3.2 Area E

Area E extends from an E-W line crossing the quarry off Pollards Road to a line through the diary off Mahers Road. The valley here widens, but several outcrops of bedrock within the valley indicate that the thickness of alluvium is less than in area C.

In this area 9 constant-spacing resistivity traverses, 13 magnetic traverses, and 8 resistivity depth probes were surveyed.

Plate 2 shows the locations of magnetic profiles and Plate 8 magnetic anomalies. Magnetic measurements were taken on the right bank of the river only. Magnetic anomalies suggest a similar structure to that in area C. In five profiles (ME8, ME9, ME10, ME12, and ME13) the eastern edge of the valley is clearly defined. The higher magnetic anomalies near the river in profiles ME6 and ME11 suggest a local shallowing of the bedrock under the alluvium. A similar rise in bedrock is evident in profile ME13, in which a sharp increase in magnetic intensity near the bridge may be correlated with an outcrop of granitic rock downstream of the bridge. No magnetic data is available on the left bank of the Kiewa River in area E; however the distance between outcrops on either side of the valley suggests that the valley was once much wider in area E than it is now in area C. Investigations should be made to determine whether areas D and E were once covered by a Pleistocene lake which was drained when an outlet near MC1 was established. If a lake existed it would affect the probable distribution of sand, gravel, and fine sediments.

Plate 3 (inset) shows the interpretation of the depth probes in area E, and Plate 7 shows DE1 to DE5 were located east of the Kiewa River in a high-resistivity zone, which traversing profiles suggest is generally 500-600 m wide and extends close to the present course of the Kiewa River. Three of the four short profiles west of the river suggest the resistivity high extends no more than about 350 m west of the present river course.

Probe DE1 shows no significant weathering, and the high resistivity (750 ohm-m) below 3-4 m may represent slightly weathered bedrock, since DE1 is only 200 m west of a granite outcrop. DE2 to DE5 show the alluvium thins southwards, from greater than 10 m at DE2 to about 6 m at DE5. The weathered bedrock layer in area E is generally of higher resistivity (200-700 ohm-m) and thinner (40 to 100 m) than weathered bedrock in area C and D (section 2.3.1); this indicates that the rock type beneath area C is different from the granites outcropping in area E. DE8 is on outcrop and indicates fresh bedrock at about 60 m.

Depth probes DE1 to DE5, which were all located within the high-resistivity zone located by traversing, show interpreted resistivities of 300 to 1000 ohm-m for the layer interpreted as alluvium overlying weathered bedrock. This indicates good supplies of sand and gravel in this zone. Soil and overburden thicknesses are generally less than 1 m.

The resistivity-probing results provide no evidence for or against the existence of a Pleistocene lake in area E. No definite low-resistivity clay layers were detected above weathered bedrock. The area between areas D and E is the more likely location for thicker deposits of clay if such a lake existed, and as this area was not covered by resistivity depth probes, no conclusions can be drawn from the probing results.

2.4 Conclusions and recommendations

In the Kiewa Valley two main areas C and E were investigated in detail by resistivity traversing and depth probing and magnetics. The interpretations of the depth probes on which the evaluation of the sand/gravel resources are based are subject to the normal limitations of errors in interpretation of depths and resistivity. Ramsay (1976) outlines some of these limitations in the report of the 1975 Wodonga sand and gravel investigation.

The sand and gravel of the Kiewa valley may contain appreciable quantities of mica, unlike the sands of the Murray floodplain at Wodonga, which will render the Kiewa sand unsuitable for use in concrete. The geophysical methods used in this investigation cannot determine mica content and are sensitive mainly to porosity and clay content. Mica content must be assessed in follow-up drilling.

With these considerations in mind the following conclusions can be made.

- In area C a channel of sand and gravel about 350 m wide extends north from the railway viaduct on the eastern bank of the Kiewa River. Soil and overburden thickness appears to be less than 1 m in this channel. On the west bank of the Kiewa River, soil thickness increases to 4 m. East of the channel of sand and gravel the alluvium consists of finer sands or sand/clay mixtures. Weathered bedrock depths vary from 10 to 15 m over area C.

- In area E, a high resistivity zone 500 to 600 m wide following the present course of the Kiewa River is interpreted as a channel of sand and gravel overlying weathered bedrock. Overburden thickness is less than 1 m. The high-resistivity zone is mostly on the eastern bank of the Kiewa River, though in places - particularly at the southern end of area E - extends up to 350 m west of the river. East of the channel, sand is covered by up to 4 m of low-resistivity clay and fine sands. Alluvium thickness varies from 6 to 10 m, being thinner in the south of area E.

- Magnetic data shows the Kiewa valley as a linear magnetic low reflecting either deeper weathering or a possible northeast extension of the West Kiewa Thrust Zone.

- It is recommended that in the course of drilling to investigate the results of the geophysical survey, effort be made to establish the existence or otherwise of a Pleistocene lake in areas D to E.

3. SNOWDONS AREA

3.1 General

Three resistivity depth probes and five resistivity traverses were carried out in Snowdons area in a semicircular area bounded by Snowdons Road and the Murray River (see Plates 9 and 10). The area is within the Murray River plain and from airphoto-interpretation is crossed by a series of crescent-shaped sand ridges and channels.

3.2 Results

The resistance traversing profiles shown in Plate 9 shows the variability of the resistivity over the area. No clear pattern of sand channels is obvious; this may be due in part to inadequate coverage of the area by traverses. The depth probes, DS1 to DS3 (locations, Plate 10; interpretation and field curve, Plate 11, Table 1, show that the alluvium has high sand/gravel contents (resistivities 300-1000 ohm-m) above 10 metres. The overburden thickness is generally less than 1.5 metres. DS1 and DS2 were located on resistivity highs, and indicate clean sand and gravel. In DS3, finer sands and clay/sand mixtures are suggested by the results.

Resistivity decreases markedly at depths of between 15 and 20 m. The low resistivities may represent weathered bedrock or the presence of clay, on some depth probes the high-resistivity fresh bedrock is also shown.

3.3 Conclusions and recommendations

The limited coverage suggests the Snowdons area of the Murray River valley is generally very sandy. Two areas of good clean sand have been indicated near DS1 and DS2. Sediments may contain more clay in the southeast of the area, near DS3. Drilling of this area is recommended in more detail than is provided by the geophysical coverage.

4. REFERENCES

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APPENDIX 1

REMANENCES AND SUSCEPTIBILITIES OF ALBURY-WODONGA GRANITES

by

M. Idnurm

Sample	Specimen	Remanence* intensity mA/metre	Decl.	Incl.	Mag. susc.** SI units
1	1	0.6	205	4	<100
	2	1.2	233	-8	<100
	3	0.9	210	10	<100
	4	1.4	214	8	<100
2	1	0.6	157	-13	<100
	2	1.4	179	-29	<100
	3	0.6	197	-27	<100
3	1	3.1	163	-76	130
	2	1.8	121	-62	180
	3	2.9	201	-70	130
	4	1.4	133	-63	140
4	1	1.3	79	-58	<100
	2	0.8	216	-38	<100
	3	0.8	116	-42	<100
5	1	58	265	-7	1400
	2	38	279	-8	1600
	3	29	298	+14	530

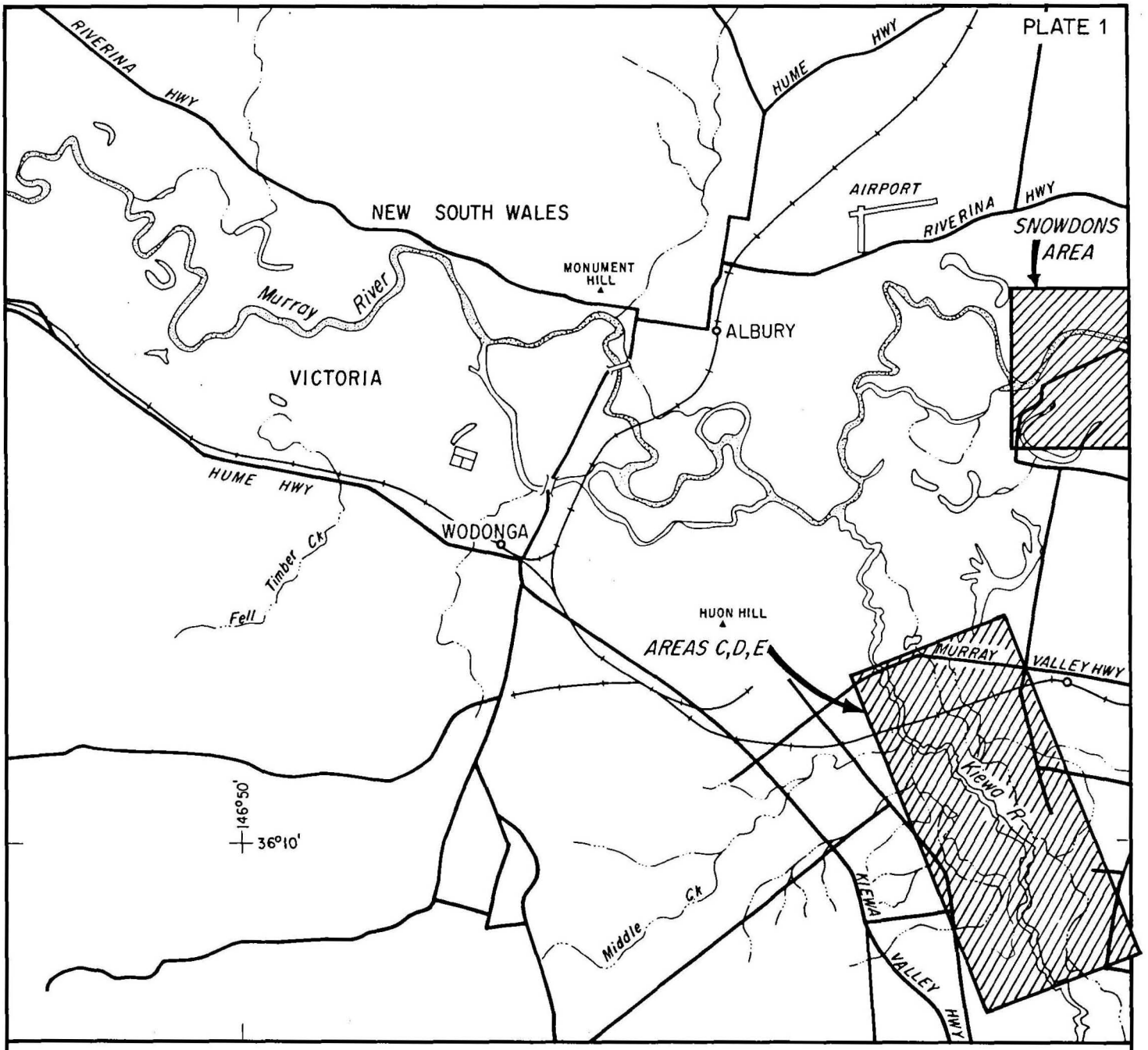
* $1 mA/m = 10^{-6}$ emu/cm

** Mag. susc. (SI) = 4π Mag. susc. (cgs)

Notes

1. The declination and inclination values have been corrected for strike and dip of samples.

2. Sample 4 was impregnated with polycote by the CSIRO Division of Soils, before measurement, to strengthen the sample.



LEGEND

- Road
- Railway
- River or stream
- Survey area

LOCATION MAP

Record No. 1977/1

J55/B5-146A

OUTCROP

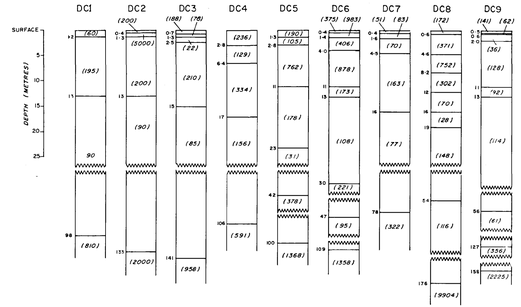
ME 13 MAGNETIC PROFILE

0 100 200 300 400 500 METRES

LOCATIONS OF MAGNETIC TRAVERSES,
AREAS C,D AND E,KIEWA RIVER VALLEY

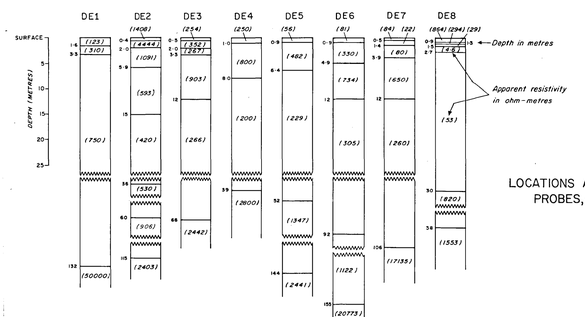
Record No.1977/1

J55/B5-153



RESISTIVITY DEPTH PROBE INTERPRETATIONS

(Note: Depths below 25m are not to scale)



LOCATIONS AND INTERPRETATIONS OF DEPTH PROBES, AREAS C AND E KIEWA RIVER

Record No. 1977/1

J55/B5-150

OUTCROP

RESISTANCE PROFILE

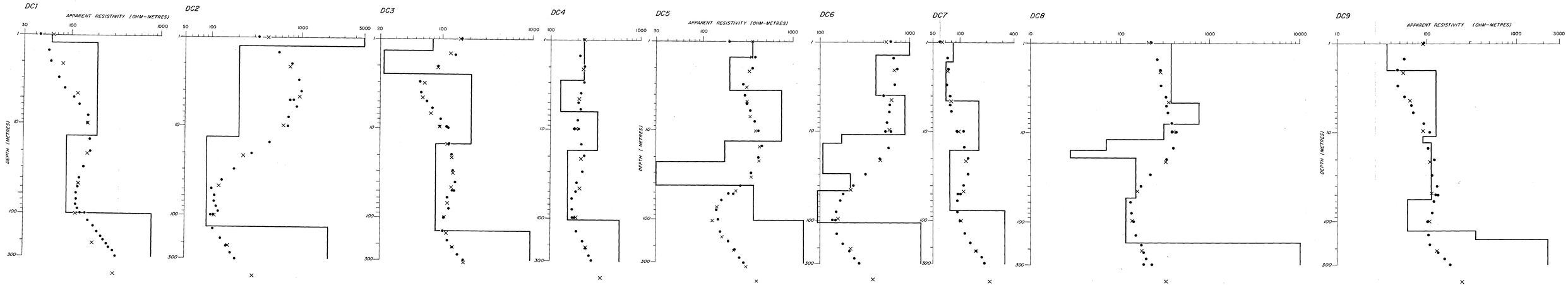
30 20 10 0
OHMS

0 100 200 300 400 500 METRES

RESISTANCE PROFILES, AREAS C,D AND E,
KIEWA RIVER VALLEY

Record No 1977/1

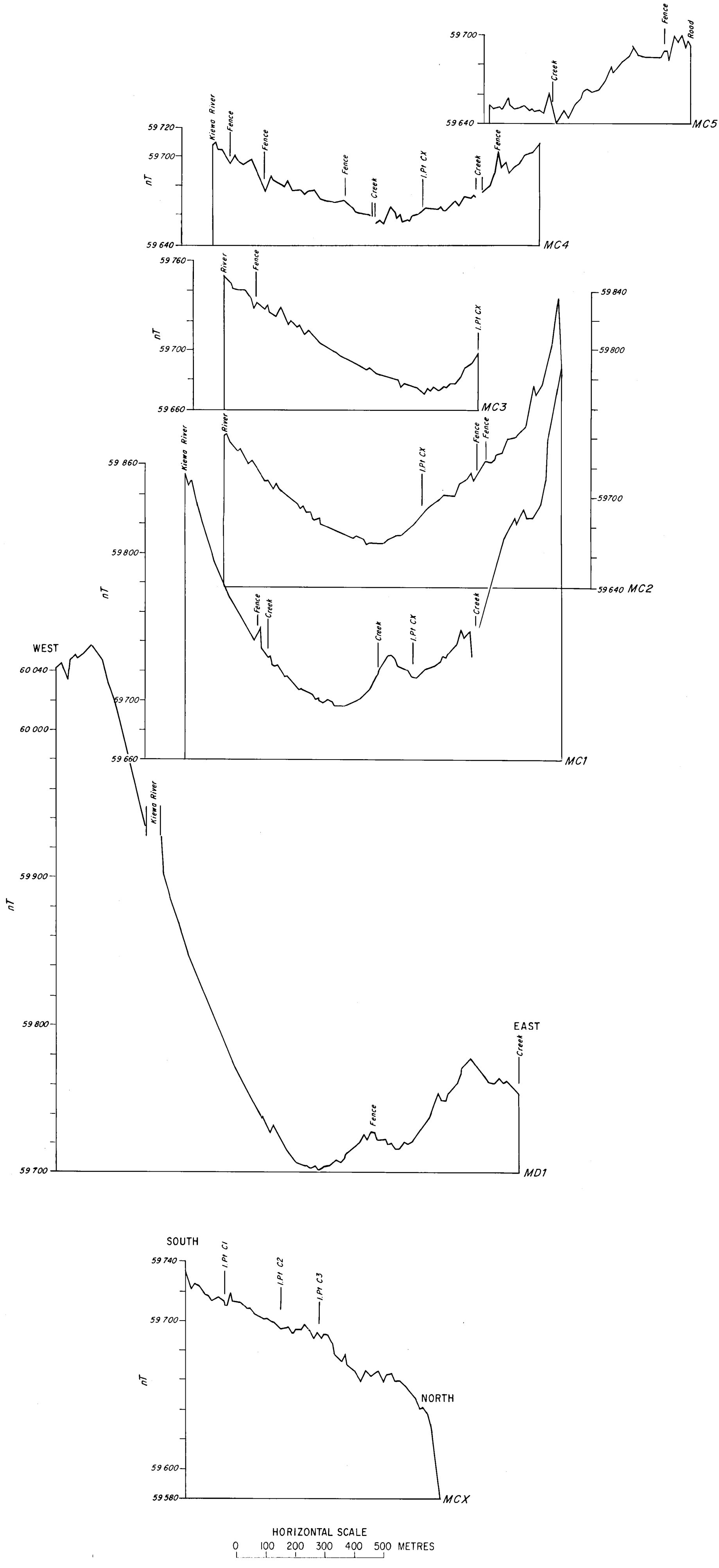
J55/B5-149



RESISTIVITY DEPTH PROBES, AREA C, KIEWA RIVER VALLEY

Record No 1977/1

J55/85-158

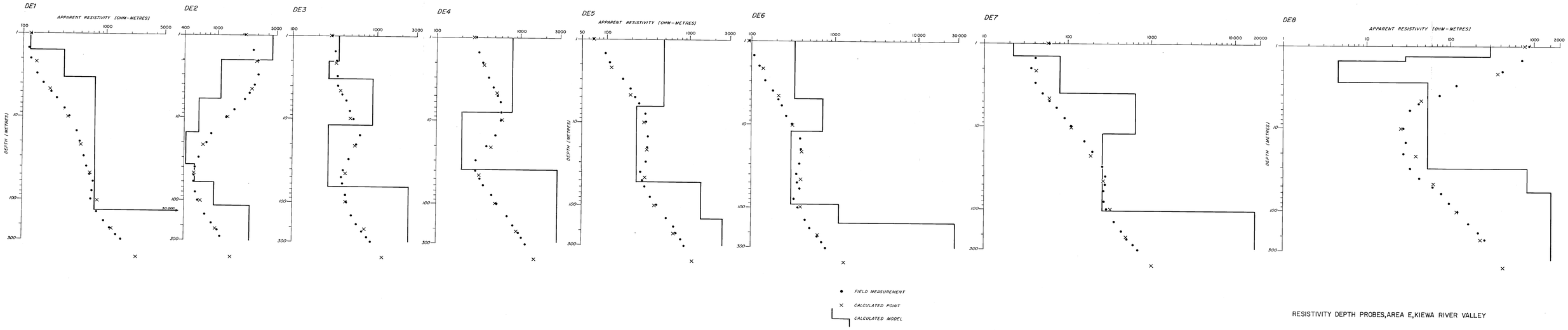


MAGNETIC PROFILES, AREA C AND D KIEWA RIVER VALLEY

Record No 1977/1

J55/B5-151

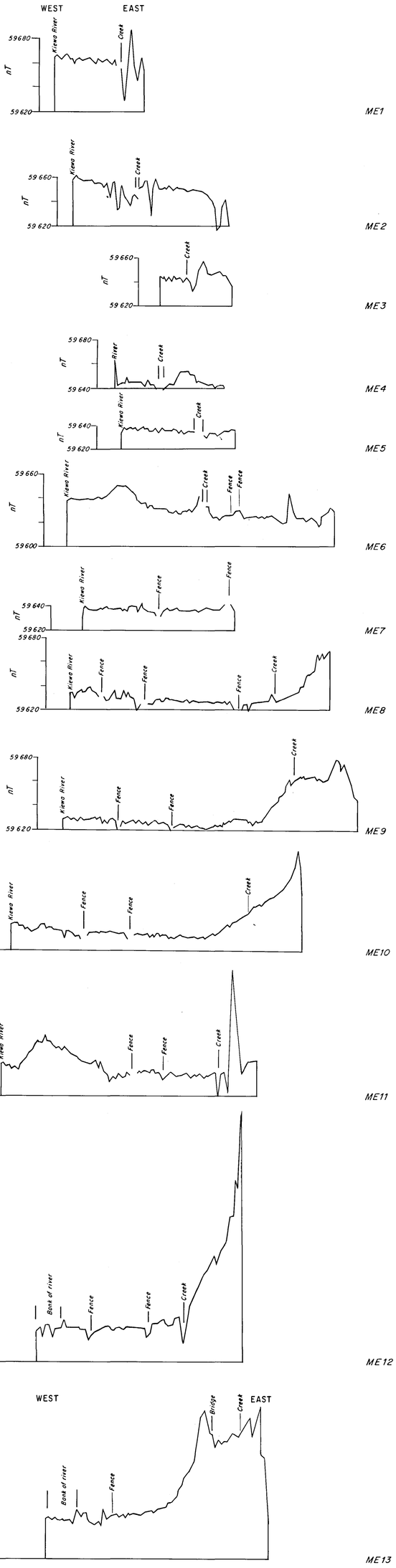
PLATE 6



RESISTIVITY DEPTH PROBES, AREA E, KIEWA RIVER VALLEY

Record No 1977/1

J55/85-159



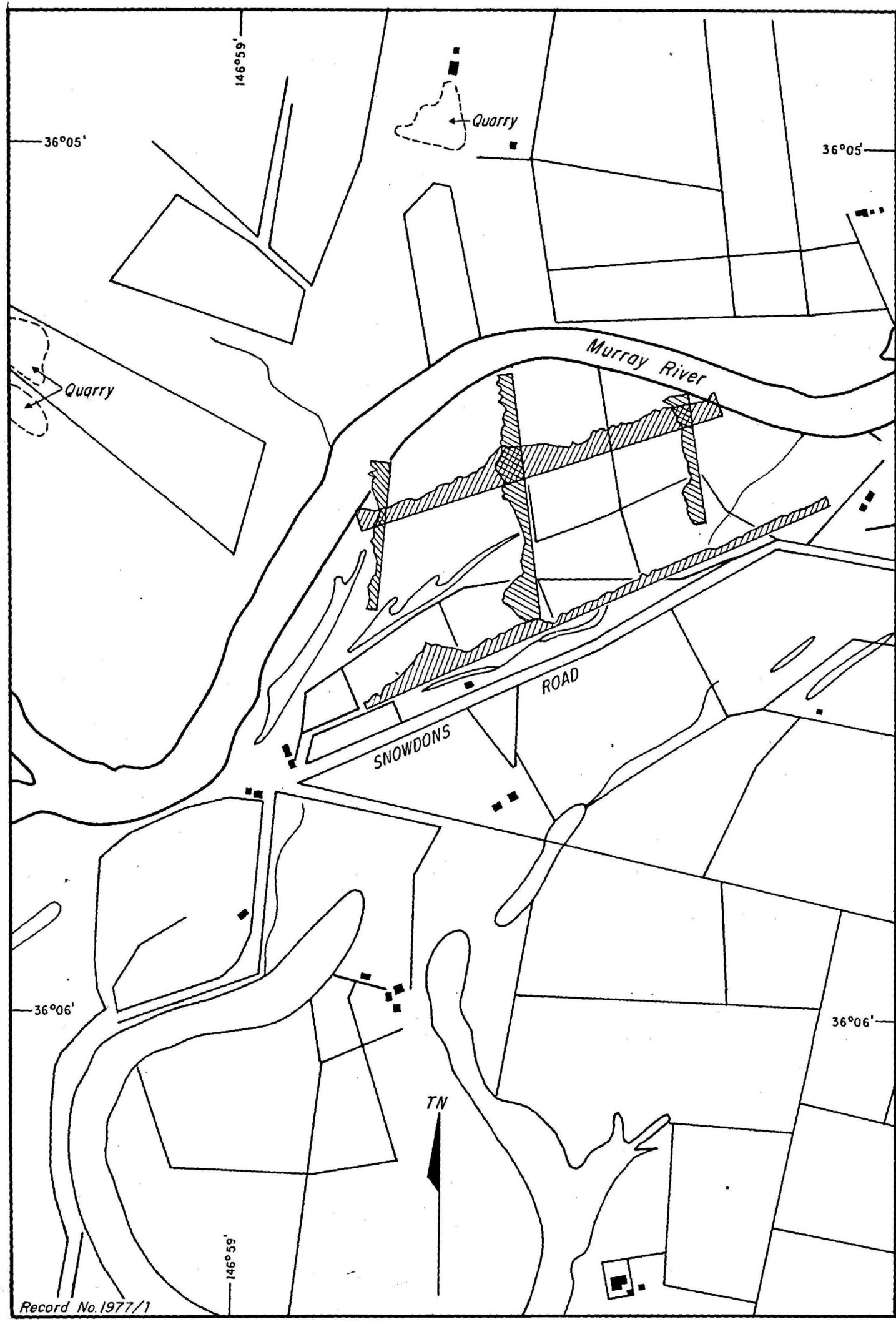
MAGNETIC PROFILES, AREA E, KIEWA RIVER VALLEY

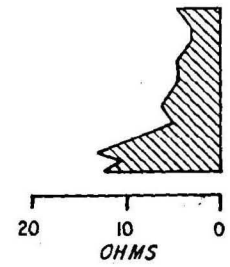
Record No 1977/1

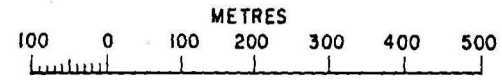
J55/B5-152

PLATE 8

PLATE 9



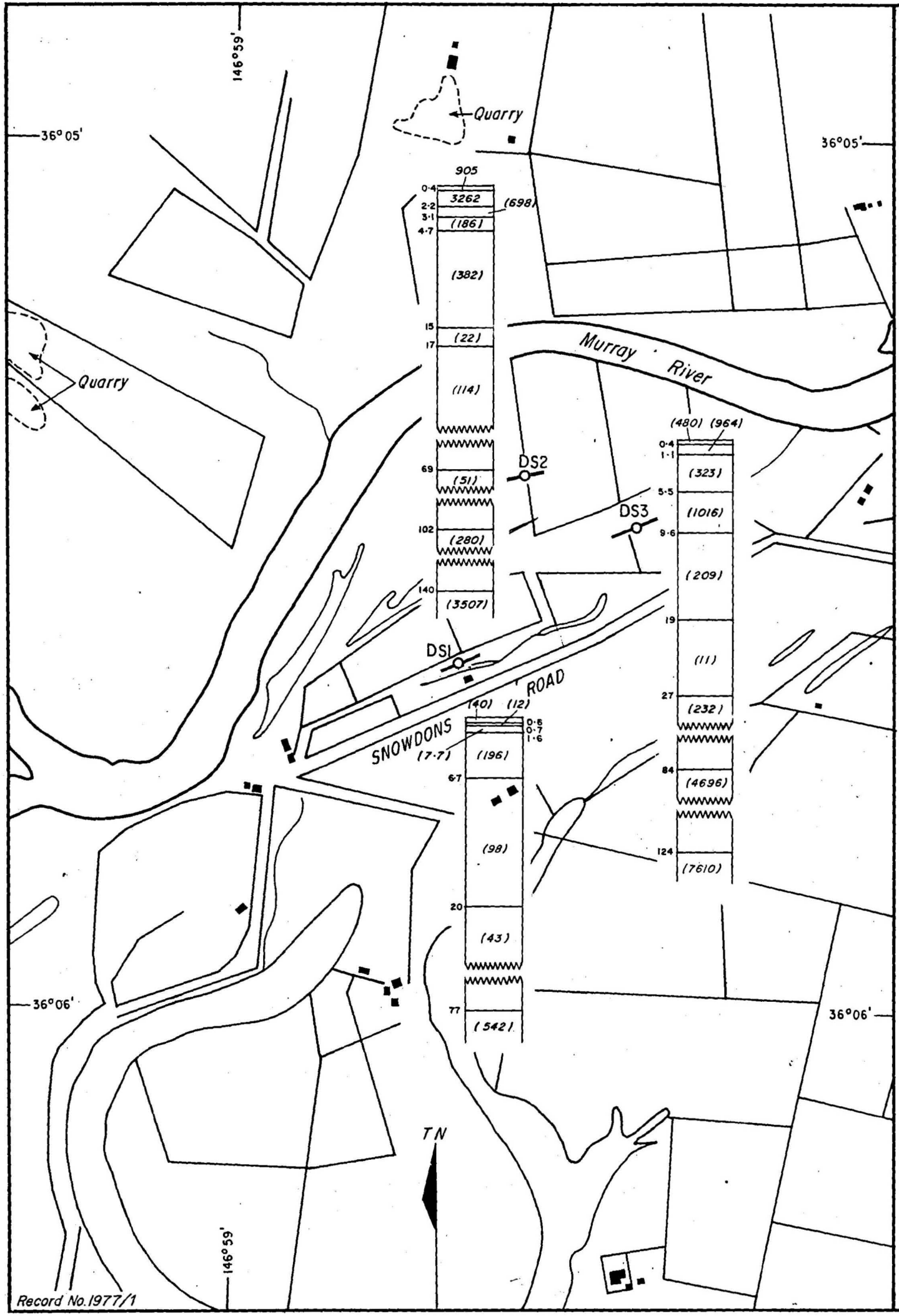




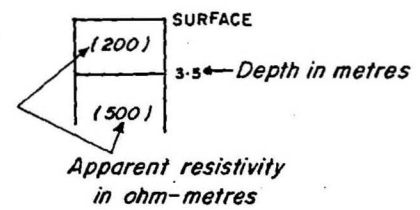
RESISTANCE PROFILES, SNOWDONS AREA, KIEWA RIVER VALLEY

J55/B5-147

PLATE 10



DEPTH PROBE INTERPRETATION



DS2 — RESISTIVITY DEPTH PROBE

METRES

0 100 200 300 400 500

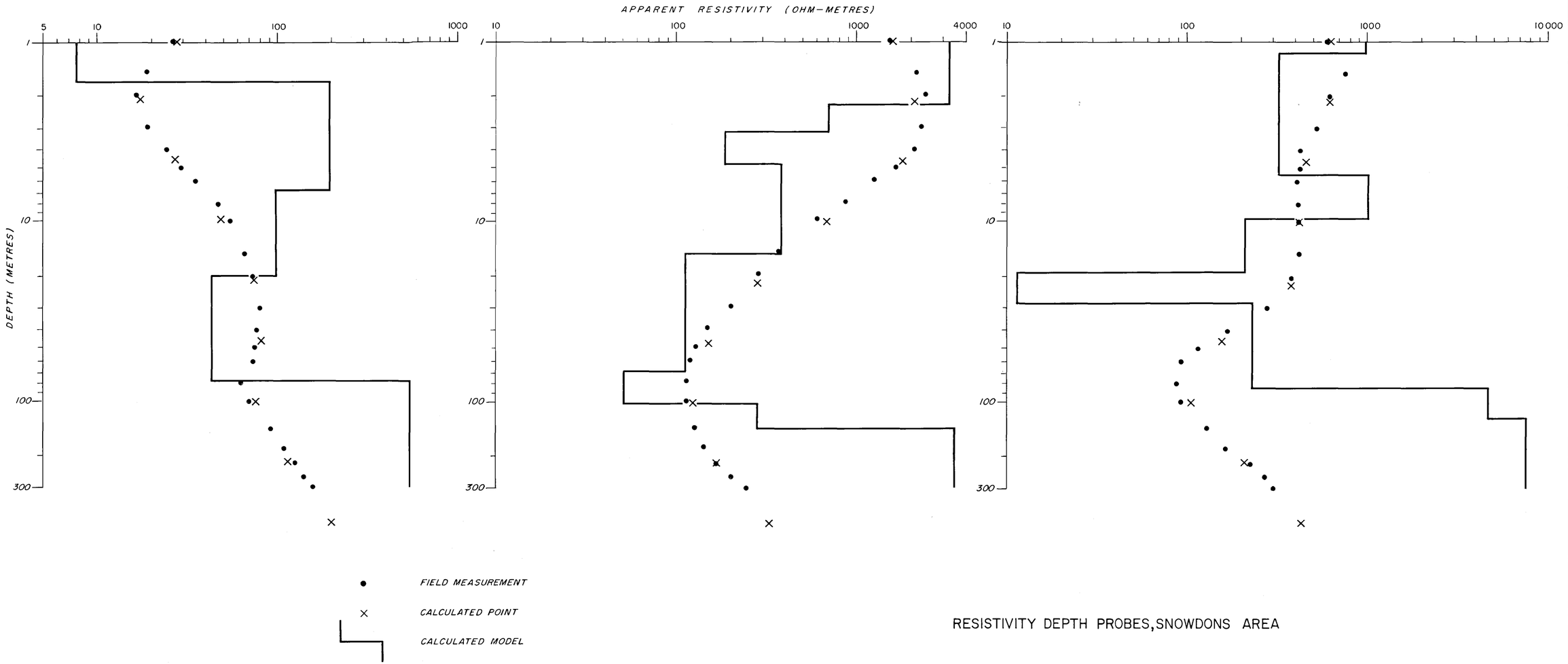
LOCATIONS AND INTERPRETATIONS OF DEPTH PROBES, SNOWDONS AREA

J55/B5-148

SNOWDONS No. 1

SNOWDONS No. 2

SNOWDONS No. 3



RESISTIVITY DEPTH PROBES, SNOWDONS AREA

Record No 1977/1