DEPARTMENT OF MINES

SOUTH AUSTRALIA

GEOLOGICAL SURVEY

GEOPHYSICS DIVISION

RESISTIVITY SURVEY NEAR STENHOUSE BAY, YORKE PENINSULA.

by

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GEOPHYSICAL SERVICES SECTION.

14th April, 1977.

Rept.Bk.No. 77/43
G.S. No. 5869
D.M. No. 672/75

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PLANS

DEPARTMENT OF MINES
SOUTH AUSTRALIA

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RESISTIVITY SURVEY NEAR STENHOUSE BAY, YORKE PENINSULA

ABSTRACT

53 vertical electrical soundings were conducted as an aid in finding a reliable supply of drinking water for proposed tourist developments near Stenhouse Bay.

Most of the area investigated was found to have very saline groundwater. Possible exceptions are a small area of 2 km^2 under a hill near Inneston and a larger area of about 40 km^2 situated several kilometres to the northeast of Marion Bay.

Drilling to obtain water samples is recommended in these locations.

INTRODUCTION

The region of Yorke Peninsula near Stenhouse Bay (see Fig. 1), which contains a large percentage of natural bushland and saltlakes, has been declared a National Parkland. The development of this area as a tourist resort is hampered by a lack of fresh groundwater.

Following a request by the Hydrogeological Section of the S.A. Department of Mines, the Geophysical Services Section undertook an electrical resistivity survey in selected parts of the region to assess the prospects for low salinity groundwater occurrences. The requirements were to locate and evaluate the thickness of zones of freshwater.

The ground surface varies from calcrete-covered aeolianite to claypans and saltlakes, some dry and some containing water with halite or gypsum. Most areas have a cover of thin sandy soil on sheet calcrete. Cliffs along the coast show the aeolianite to be, in the main, loosely consolidated between bands of sheet calcrete; the layers being typically aeolianite 4 m and calcrete 1 m thick. Some cliffs expose ten or more calcrete layers. Another feature is the frequent outcropping of igneous rocks close to sea-level along the coast, but no such outcrops could be seen inland.

A water sampling survey from all available bores and wells was conducted both prior to and concurrently with this survey by the Hydrogeological Section, and these data, together with further data from the Mines Department Bore Records, were used to correlate the resistivity results with water salinities.

SURVEY METHOD

The Schlumberger vertical electrical sounding system was used for all the resistivity probes. This system employs four steel electrodes placed symmetrically about a centre point and along a straight line such that the two inner electrodes are separated by not more than one-fifth of the separation of the two outer electrodes. A McPhar type P660 low frequency A.C. voltmeter was used with the inner pair of electrodes to measure the voltage produced at the centre of the spread by the current introduced into the ground by a Geoscience low-power transmitter (at 3 Hertz) at the outer electrodes. The power source consisted of a 12 volt lead-acid battery and a 400 Hertz inverter.

Distances were measured with cloth tape out to 100 m and pedometers or pacing from thereon.

SURVEY STATISTICS

The survey was conducted from a camp set up near Inneston from the 30th August, 1976 to the 10th September, 1976.

A total of 18.56 km of spread was covered at 53 sites along seven lines as shown in Fig. 1, with statistics as in Tables I and II. Rain prevented work for a few hours on several occasions and associated electrical leakage problems led to three spreads being repeated.

Sample field curves illustrating the type-curves encountered are shown in 12 drawings in the Appendix.

INTERPRETATION

The resistivity soundings were interpreted with the aid of logarithmic graphs assuming horizontal, homogenous layers. The resulting models listed in Table III were checked by computation of theoretical curves using a BASIC LANGUAGE programme which follows the method of Ghosh, 1971, as given by O'Neill, 1975.

Interpreted profiles along the survey lines are given in figures 2 and 3. Some adjustment has been made on the models for spreads situated where the horizontal layering assumption is obviously wrong.

Correlation with water bore data suggests that using the equation S = K/R where S = salinity in mg/l

K = 35 000 mg/l/ohm/m

and R = resistivity in ohm/m

provides a good first estimate of the relationship between resistivity and water salinity, i.e. porosity is reasonably constant.

The increase in salinity with depth in most parts of the local aquifer has led to shallow bores, designed to tap the upper less saline water, being drilled. If these bores are heavily pumped, the water obtained rapidly becomes too saline for use. Masking of the true electrical picture because of the limits of resolution of surface electrical depth probes is another problem that is exacerbated by the stratified salinity zones. These difficulties preclude more than a rough guide being obtainable from the above relationship, even without taking into account variable porosity and electrical equivalence (refer Kunetz, 1966).

Figure 1 is a contour map of subsurface resistivities and indicates an area of higher resistivity northeast of Marion Bay that should give a low salinity water supply. The low salinity water zones are replenished by only local rain infiltration and can quickly be exhausted, with possible salt water intrusion, if pumped at an average rate greater than rainfall intake. An example of dewatering which could lead to change in the salt water/fresh water interface is evident at spread E on line 5 (Fig. 2), which is close to an active pumping bore (number 685008002).

Annual rainfall averages near 500 mm but evaporation is close to 1 200 mm p.a. and hence rainfall intake to the aquifers will be small over most parts of the Peninsula.

RECOMMENDATIONS

It is recommended that the area 6 km northeast of Marion Bay be tested for a suitable water supply. A small supply might also be obtainable from under the hill 1 km west of Inneston.

Drilling sites cannot be established precisely from the regional survey data but detailed resistivity surveys in the low-salinity zones could be made to find the most suitable locations for test bores.

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14th April, 1977.
GP:ST

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REFERENCES

GHOSH, D.P., 1971: Inverse filter co-efficients for the computation of apparent resistivity standard curves for a horizontally stratified earth. Geophysical Prospecting, 19, pp. 769-775.

KUNETZ, G., 1966: Principles of Direct Current Resistivity Prospecting. Geoexploration Monograph Series 1, No. 1.

O'NEILL, D.J., 1975: Improved Linear filter co-efficients for apparent resistivity computations. Australian Society of Exploration Geophysicists Bulletin, 6, pp. 104-109.

SURVEY STATISTICS

TABLE I

Number of Spreads by Line

Line	Number of Spreads
1	6
2	6
3	3
4	7
5	6
6	17
7	6
X	1
Z	1
Total	53

TABLE II

Number of Spreads by electrode separation

Maximum Spread width (m)	Number of Spreads	Sub-total (km)
100	1	0.10
160	4	0.64
200	16	3.20
260	5	1.30
320	6	1.92
400	10	4.00
500	2	1.00
600	4	2.40
800	5	4.00
Total	53	18.56

TABLE III

Interpreted horizontal layer models for the Stenhouse Bay area sites tabled

Spread (m)	1A		1B		1C		1D		1E		1F	
Approx. elevation	15		18		22		25		28		27	
	thickness	resistivity	t	r	t	r	t	r	t	r	t	r
Layer 1	0.1	45	0.3	500	0.9	400	0.2	100	0.7	65	0.25	110
2	0.4	500	0.55	80	0.4	50	2	1500	0.8	100	0.5	300
3	1.0	100	4.8	500	3	300	4	94	2	350	1.6	90
4	1.2	400	37	130	38	130	20	55	4	60	15	400
5	2.7	100	13	50	6.5	50		4000	5	300	45	68
6	3.5	80	4	25		2000			24	60		1000
7	42	43		1000						1000		
8	24	21										
9		1000										
Depth to basement	75		60		49		26		36.5		62	

	2A		2B		2C		2D		2E		2F	
Approx. elevation	6		6		6		6		4		4	
	t	r	t	r	t	r	t	r	t	r	t	r
Layer 1	0.11	76	0.15	600	0.2	13	0.15	11	0.05	18	0.14	35
2	0.8	600	0.7	100	4.2	120	1.0	300	1.0	300	0.55	300
3	2.6	88	0.9	300	10	18	8	20	4	60	1.75	50
4	12	21	16	10	12	4.5	9	4.5	1.2	18	6	21
5	6	4.5	15	4.5	25	2	23	2	8	4.5	10	4.5
6	11	2	19	2	13	1		100	16	2	40	0.8
7		100	3	1		100			15	1		100
8				100						100		
Depth to basement	32.5		55		64		41		45		58	

	3A		3B		3C	
Approx. elevation	15		30		36	
	thickness	resistivity	t	r	t	r
Layer 1	0.11	70	4	46	0.33	230
2	1.5	700	3.3	300	0.66	22
3	10	100	40	34	3.9	80
4	40	42		500	3.6	340
5		500			20	30
6						500
Depth to basement	52		47		28.5	

	4A		4B		4C		4D		4E		4F		4G	
Approx. elevation	6		8		8		10		10		12		15	
	t	r	t	r	t	r	t	r	t	r	t	r	t	r
Layer 1	0.21	125	0.5	120	0.32	160	1.3	200	1.3	260	0.7	160	2.4	310
2	0.88	1250	0.65	400	3.8	1100	2.4	380	2.3	45	2.3	25	2.6	30
3	2.0	72	2.3	11	12	130	7.5	30	3.6	300	7	200	14	90
4	59	37	8	90	60	17	97	15.5	86	20	25	20	79?	20
5		200	40	20		200		200		150		120	15?	5
6				300										120
Depth to basement	71		51.5		76		108		93		35		113?	

Spread	5A		5B		5C		5D		5E		5F	
Approx. elevation	4		6		6		8		8		9	
	thickness	resistivity	t	r	t	r	t	r	t	r	t	r
Layer 1	1.25	4.2	0.71	60	0.32	98	1.1	110	17.5	270	0.31	220
2	1.25	10.5	0.96	6	1.3	470	2.1	11	19	23	1.0	4400
3	76	1.9	2.1	140	2.5	30	2.8	320		220	2.5	270
4	100	30	13	16	0.9	300	24	13			34	21
5		200	54	2	13	11	240?	30				200
6			30	30	32	2		1000				
7				200	60	30						
8						1000						
depth to basement	178		101		110		270?		36		38	

Spread	6A		6B		6C		6D		6E		6F	
Approx. elevation	4		4		4		15		8		18	
	thickness	resisitivity	t	r	t	r	t	r	t	r	t	r
Layer 1	0.125	26	1.2	14	0.5	47	0.3	500	0.8	115	0.9	230
2	1.7	65	2	3	0.65	235	0.9	100	0.8	220	0.45	35
3	4	3	20	0.9	2	2.6	4	25	10	25	12	150
4	35	1.35	10	12.5	20	1.3	2.3	133	25	12	15	19
5	10	12.5		1000	12	5	14	18	24	4	180?	64
6		1000			22	0.9	100	38		1000		1000
7						1000		1000				
depth to basement	51		33		57		121		61		208?	

Spread	6G		6H		6I		6J		6K		6L	
Approx. elevation	9		6		22		12		8		6	
	thickness	resistivity	t	r	t	r	t	r	t	r	t	r
Layer 1	0.7	27	2.1	96	2	90	0.185	120	0.23	21	0.21	72
2	3	40	2.0	500	20	220	0.5	50	4.4	110	3	110
3	7	90	1.0	90	32	130	7.5	78	4	23	5	21
4	48	2	41	1.5	15	3	5.8	250	18	4	31	2.4
5	30	30	40	30	40	30	46	4	40	30	30	30
6		1000		1000		1000	35	30		1000		1000
7								1000				
depth to basement	89		86		104		95		67		69	

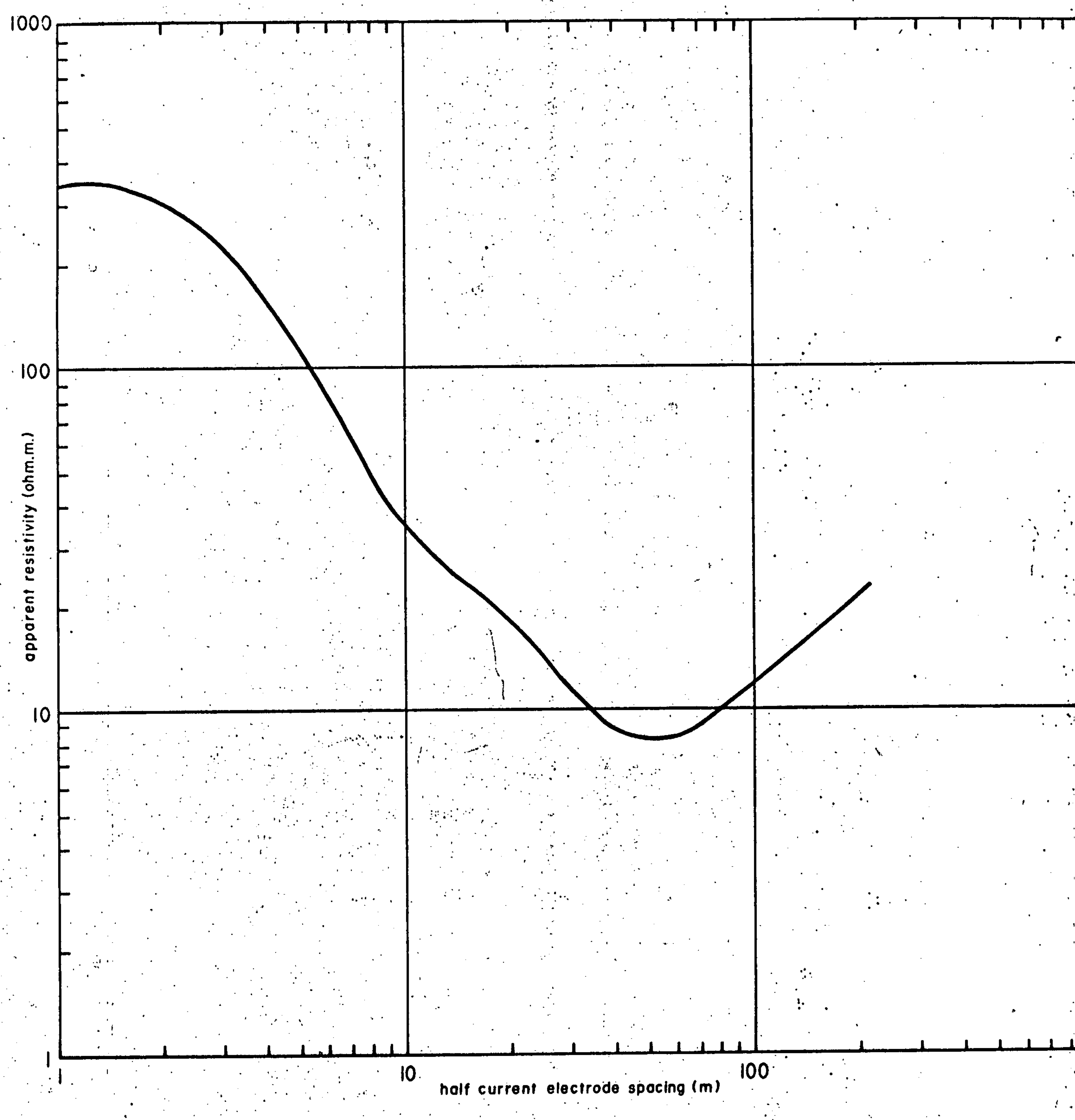
Spread	6M		6N		6O		6P		6Q	
Approx. elevation	6		6		6		6		4	
	t	r	t	r	t	r	t	r	t	r
Layer 1	0.2	140	0.25	78	0.77	52	0.2	10	0.45	37
2	0.25	55	0.35	390	1.9	20	0.55	250	1.44	14.8
3	0.8	30	1.8	38	26	2.2	4	14	12	3.1
4	3	10	65	1.95	20	30	13.2	2.3	30	100
5	35	4.6	35	30		1000	30	30	25	3.3
6		50		1000				1000		1000
Depth to basement	?		102		49		48		69	

Spread	7A		7B		7C		7D		7E		7F	
Approx. elevation	15		15		15		12		9		6	
	thickness	resistivity	t	r	t	r	t	r	t	r	t	r
Layer 1	0.24	360	0.64	85	0.35	100	0.2	80	0.4	14	0.2	4.2
2	0.36	79	2.8	43	0.3	20	1.8	13	1.6	35	0.94	20
3	1.6	36	15	9	2	115	5	10	5.5	10	1.2	70
4	8.6	20	20	180	3	80	4.5	20	4	70	6.6	5.8
5	45	13	24	12	19	7	26	2.5	15	3	53	0.8
6		1000		1000		1000		1000		1000		1000
Depth to basement	56		62		25		38		26		62	

Spread	X		Z	
Approx. elevation	45		30	
	t	r	t	r
Layer 1	0.72	75	0.4	125
2	10.8	30	0.8	12.5
3	7	155	2.5	180
4		80	8.4	48
5			40	86
6			61	9
7			60	100
8				4
Depth to basement	?		?	

APPENDIX

Showing typical Schlumberger resistivity depth sounding curves obtained from spreads 2A, 2F, 5B, 6B, 6C, 6F, 6I, 6M, 6Q, X, 7A and 7E.



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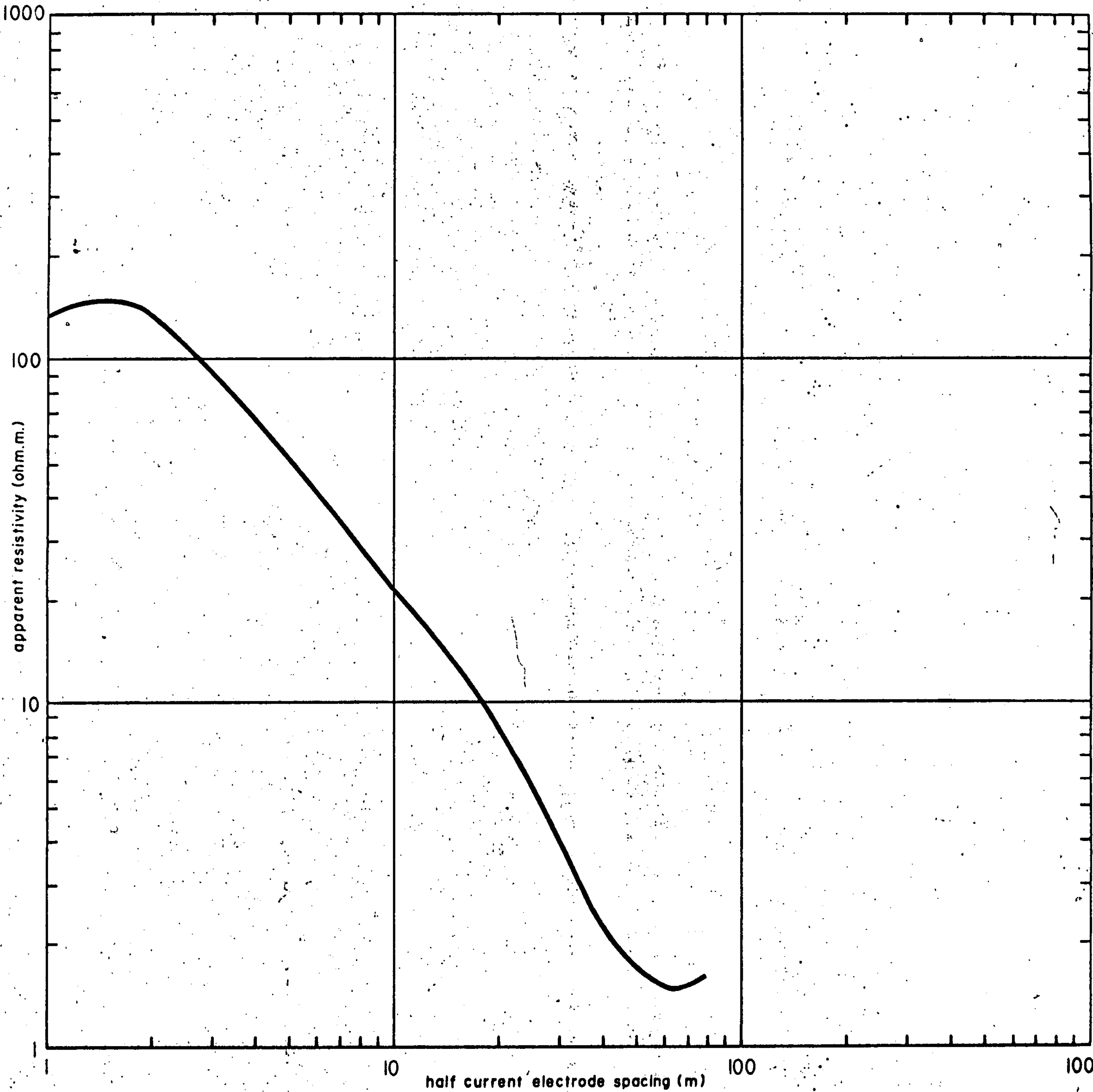
STENHOUSE BAY RESISTIVITY SURVEY
SCHLUMBERGER VERTICAL ELECTRICAL SOUNDINGS
SPREAD 2A



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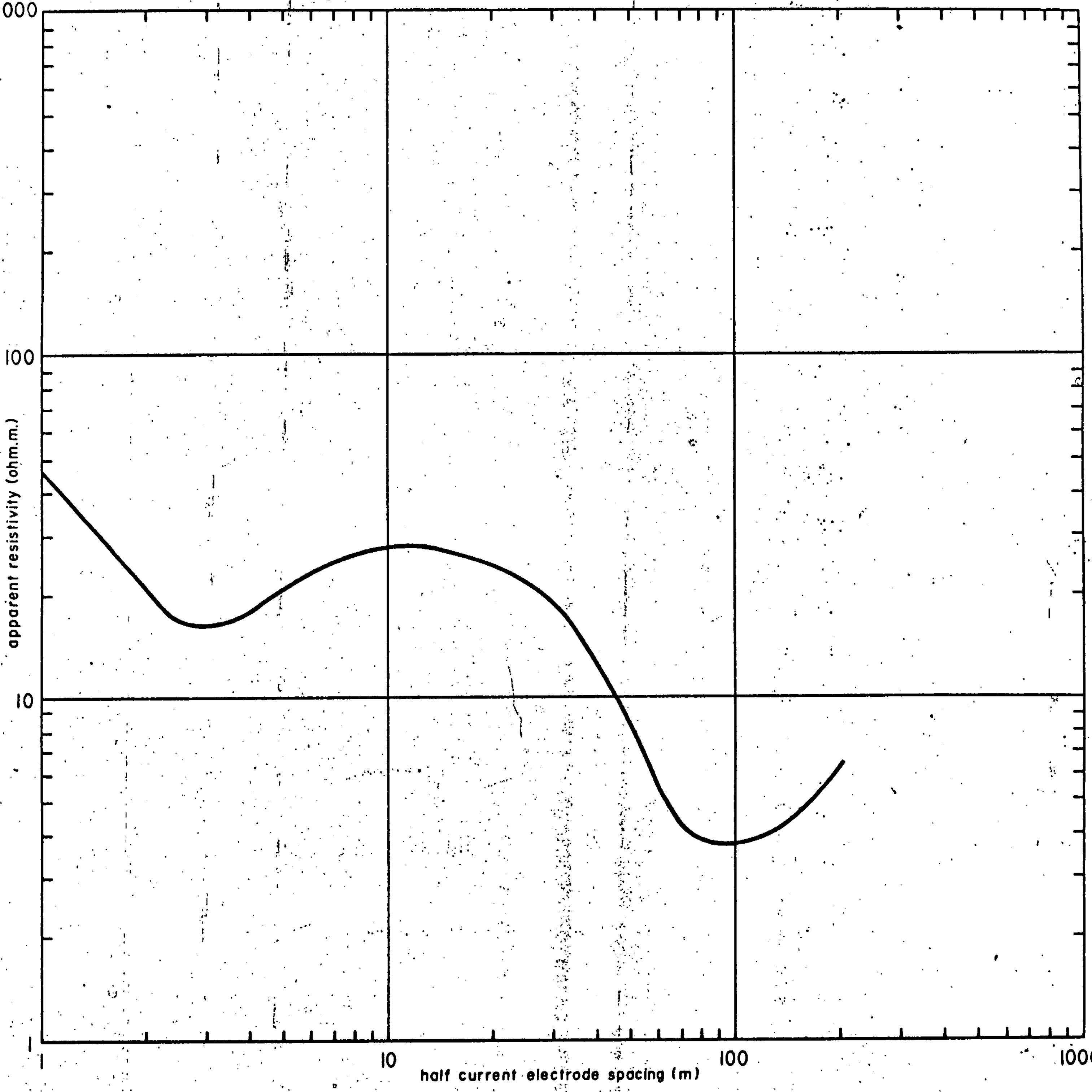
STENHOUSE BAY RESISTIVITY SURVEY

SCHLUMBERGER VERTICAL ELECTRICAL SOUNDINGS

SPREAD 2F



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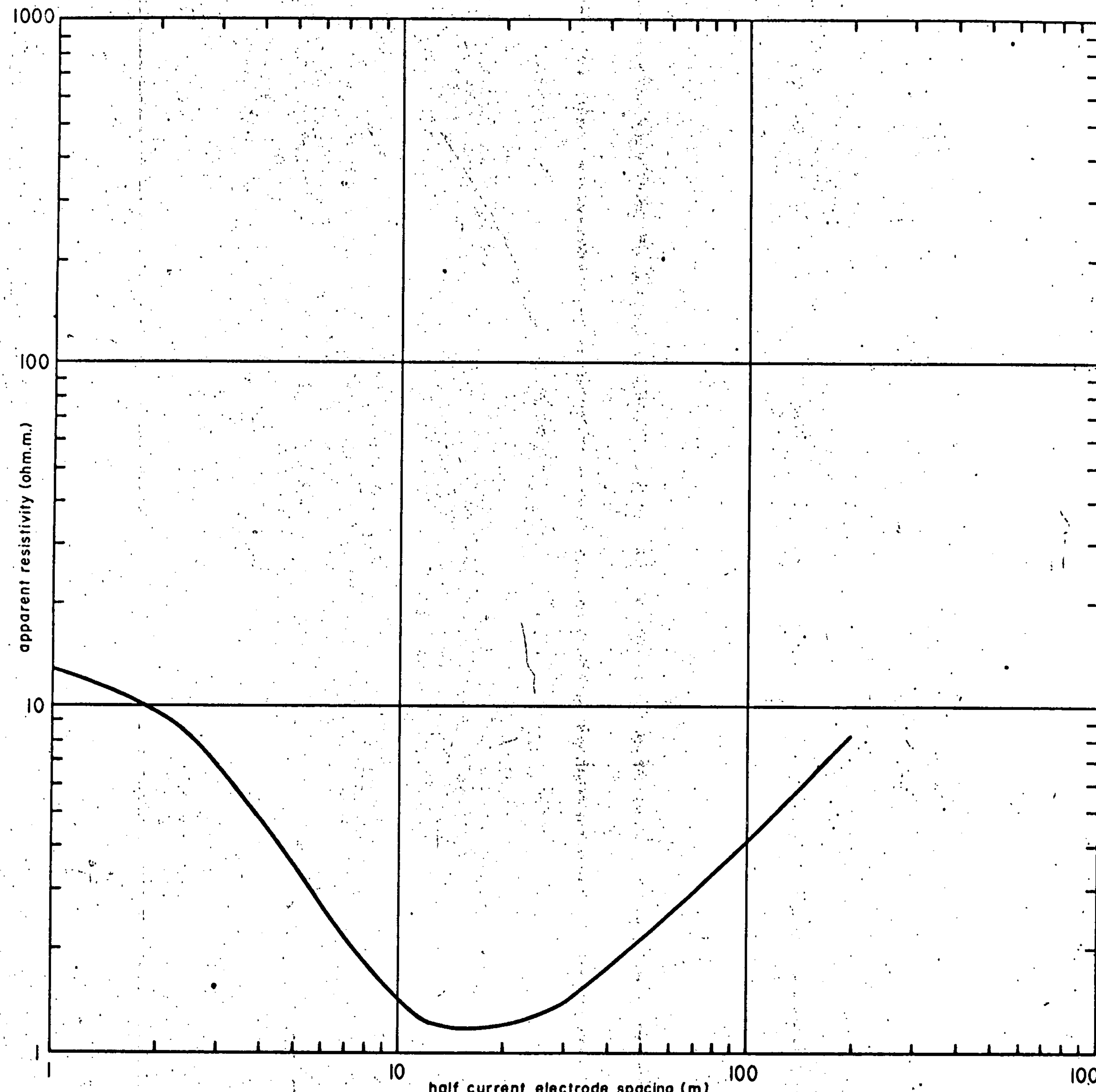
STENHOUSE BAY RESISTIVITY SURVEY
SCHLUMBERGER VERTICAL ELECTRICAL SOUNDINGS
SPREAD 5B



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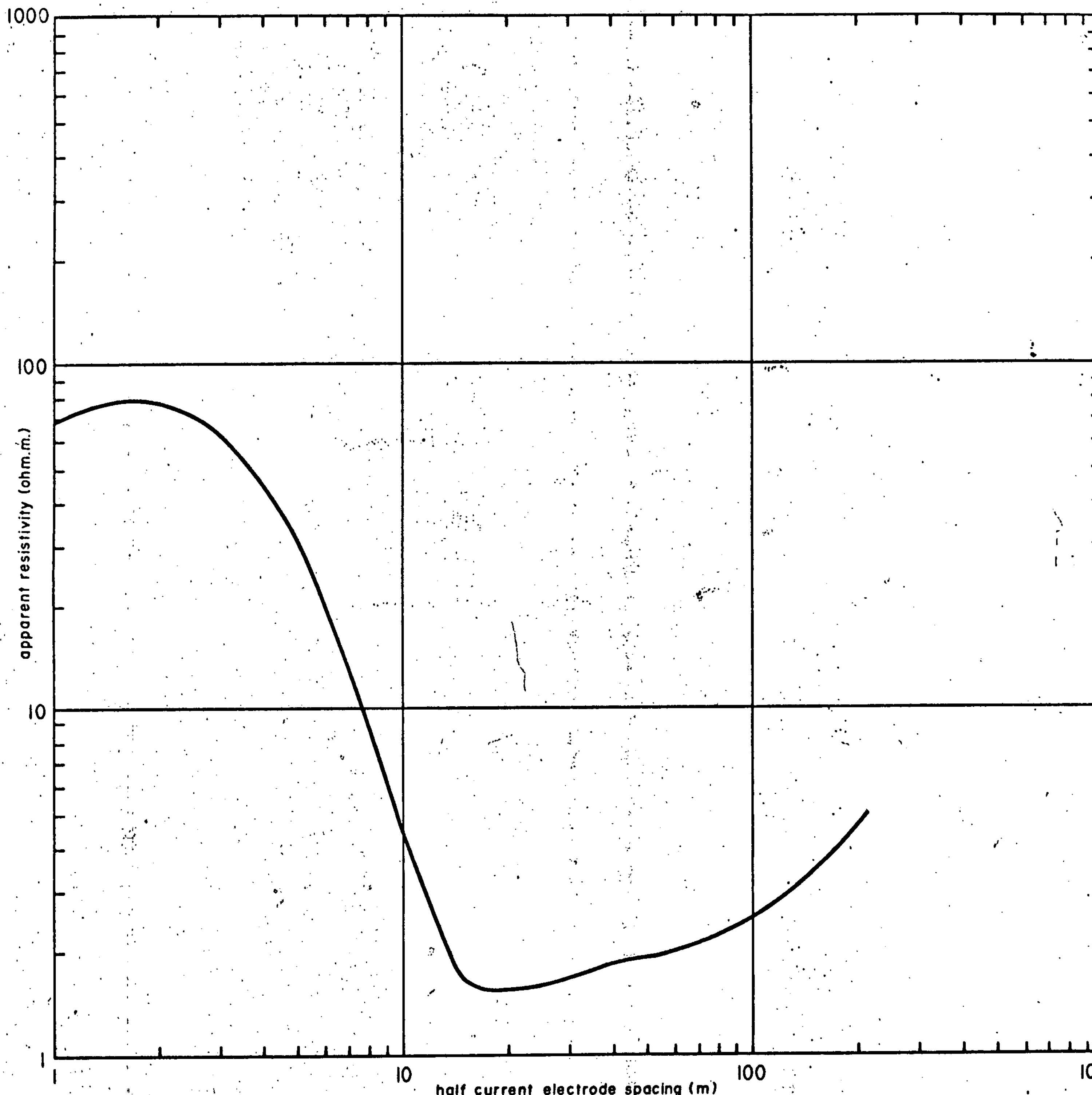
STENHOUSE BAY RESISTIVITY SURVEY

SCHLUMBERGER VERTICAL ELECTRICAL SOUNDINGS

SPREAD 6B



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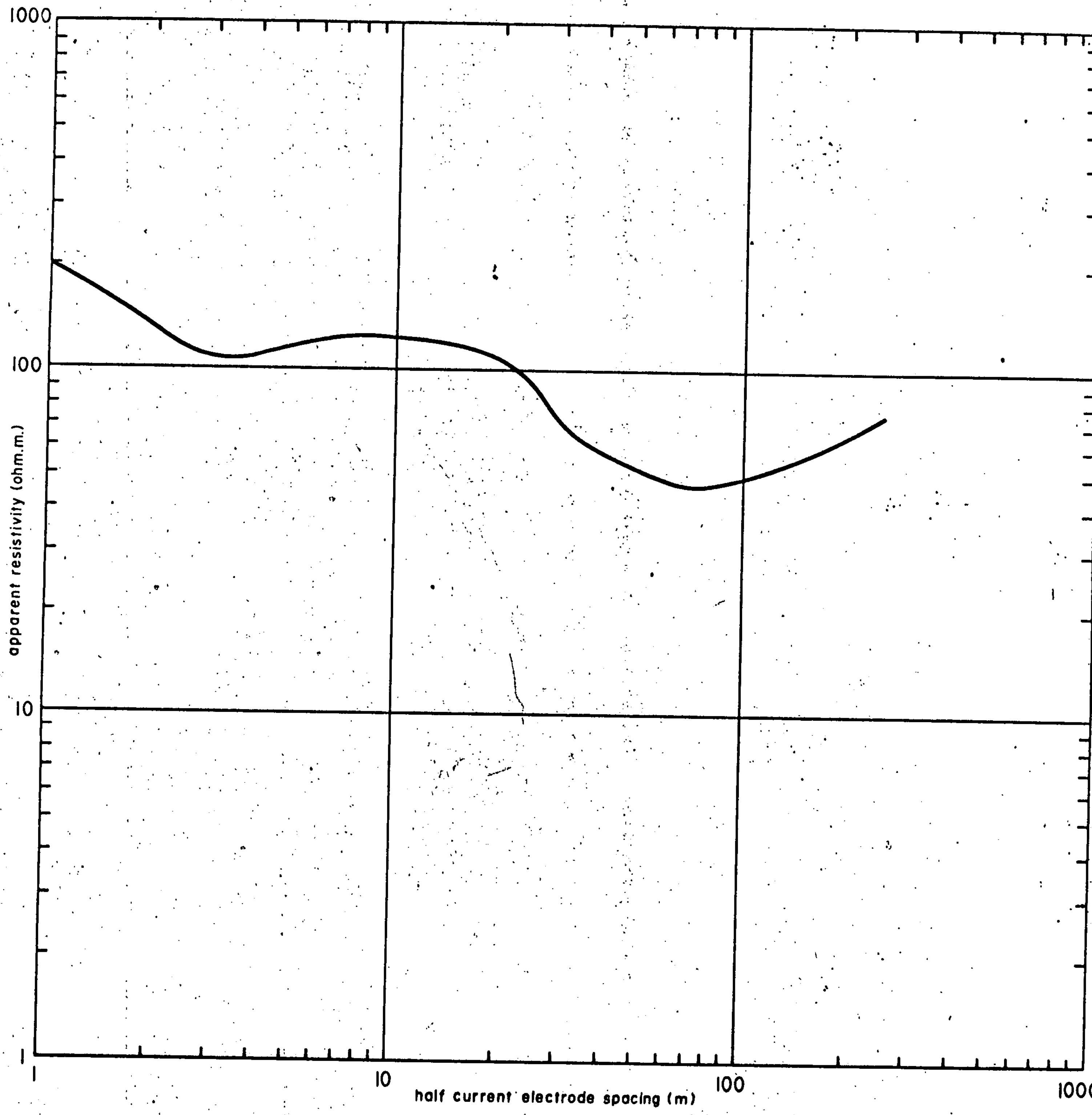
STENHOUSE BAY RESISTIVITY SURVEY

SCHLUMBERGER VERTICAL ELECTRICAL SOUNDINGS

SPREAD 6C



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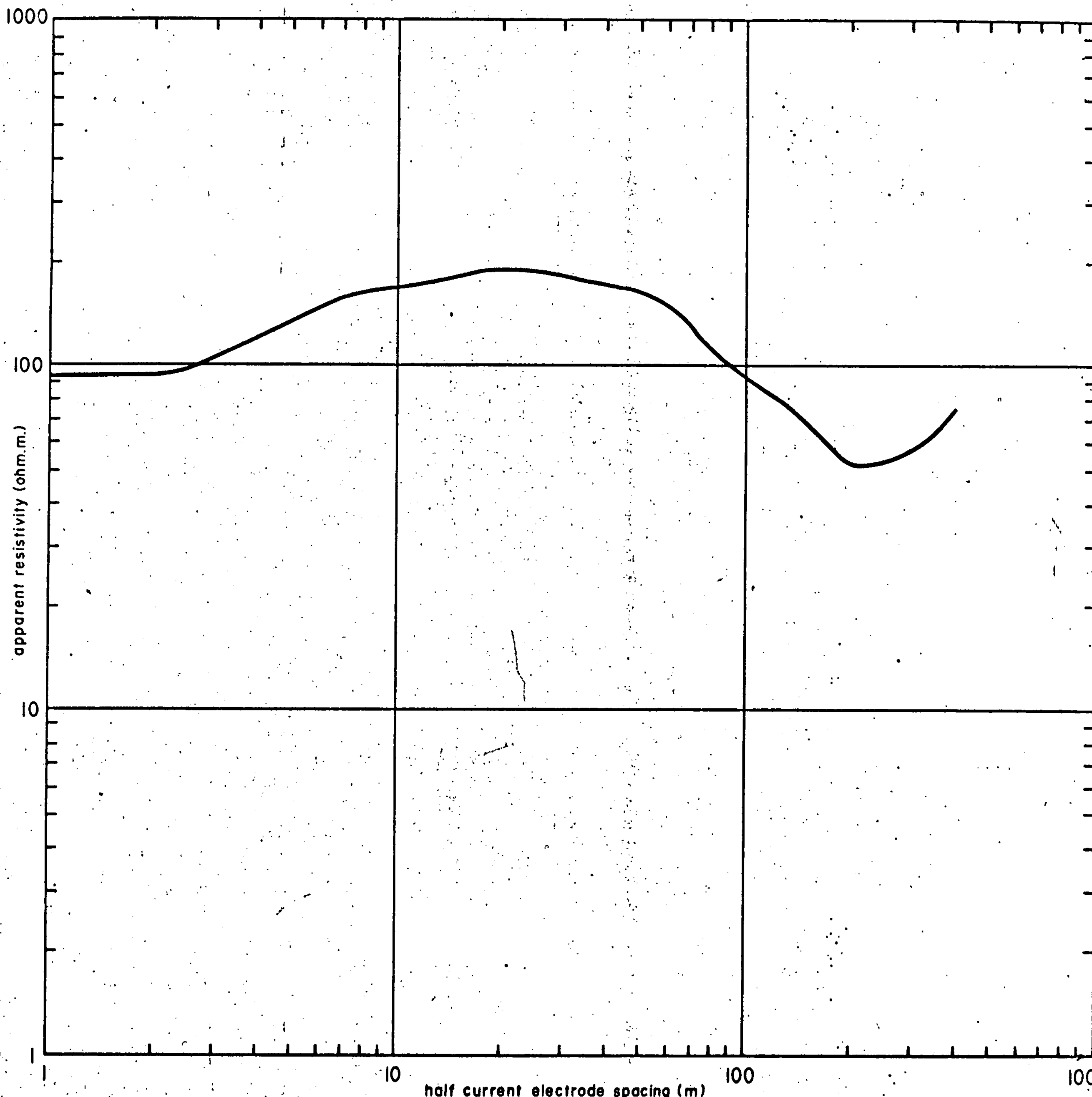
STENHOUSE BAY RESISTIVITY SURVEY

SCHLUMBERGER VERTICAL ELECTRICAL SOUNDINGS

SPREAD 6F



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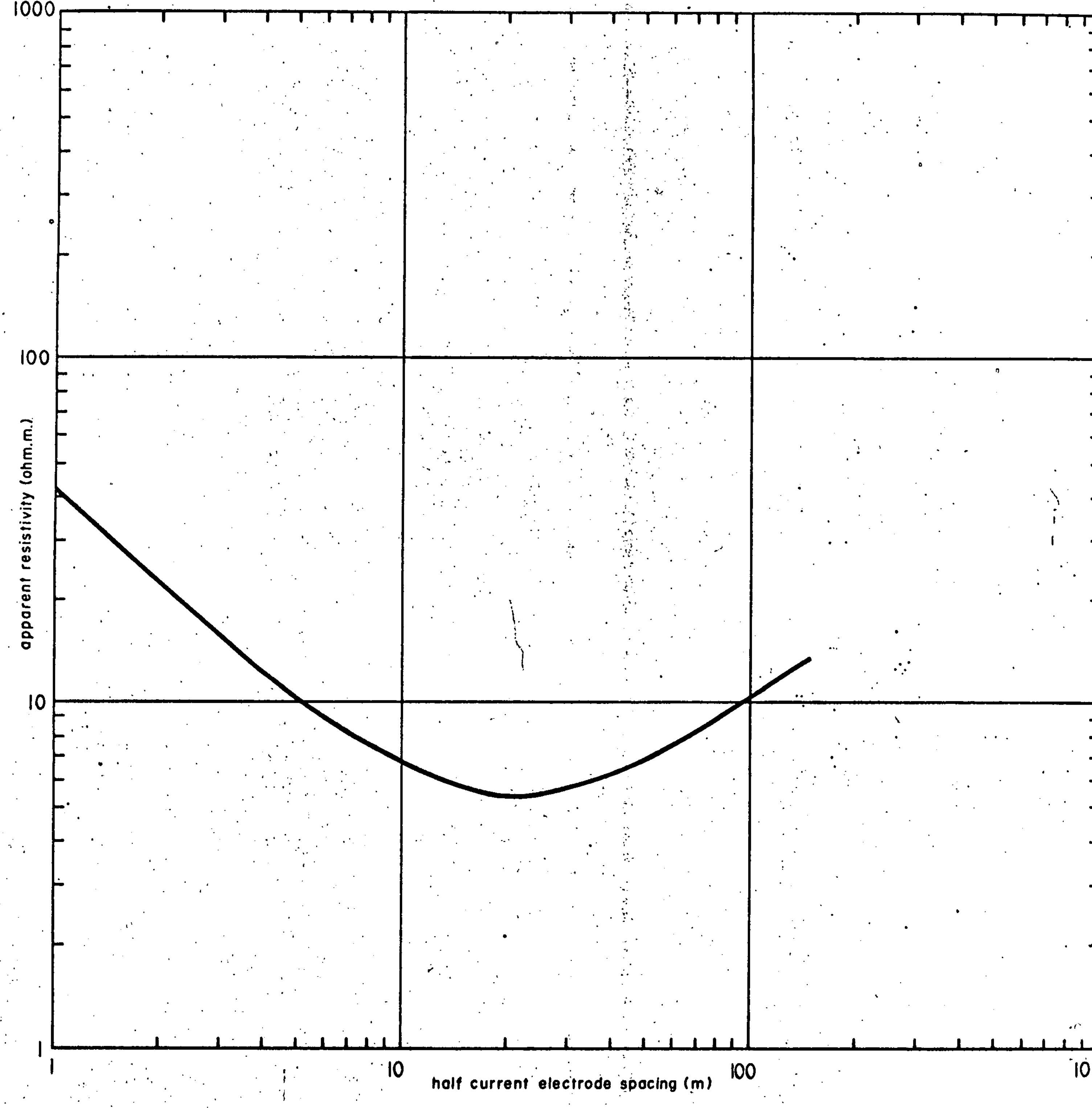
STENHOUSE BAY RESISTIVITY SURVEY

SCHLUMBERGER VERTICAL ELECTRICAL SOUNDINGS

SPREAD 61



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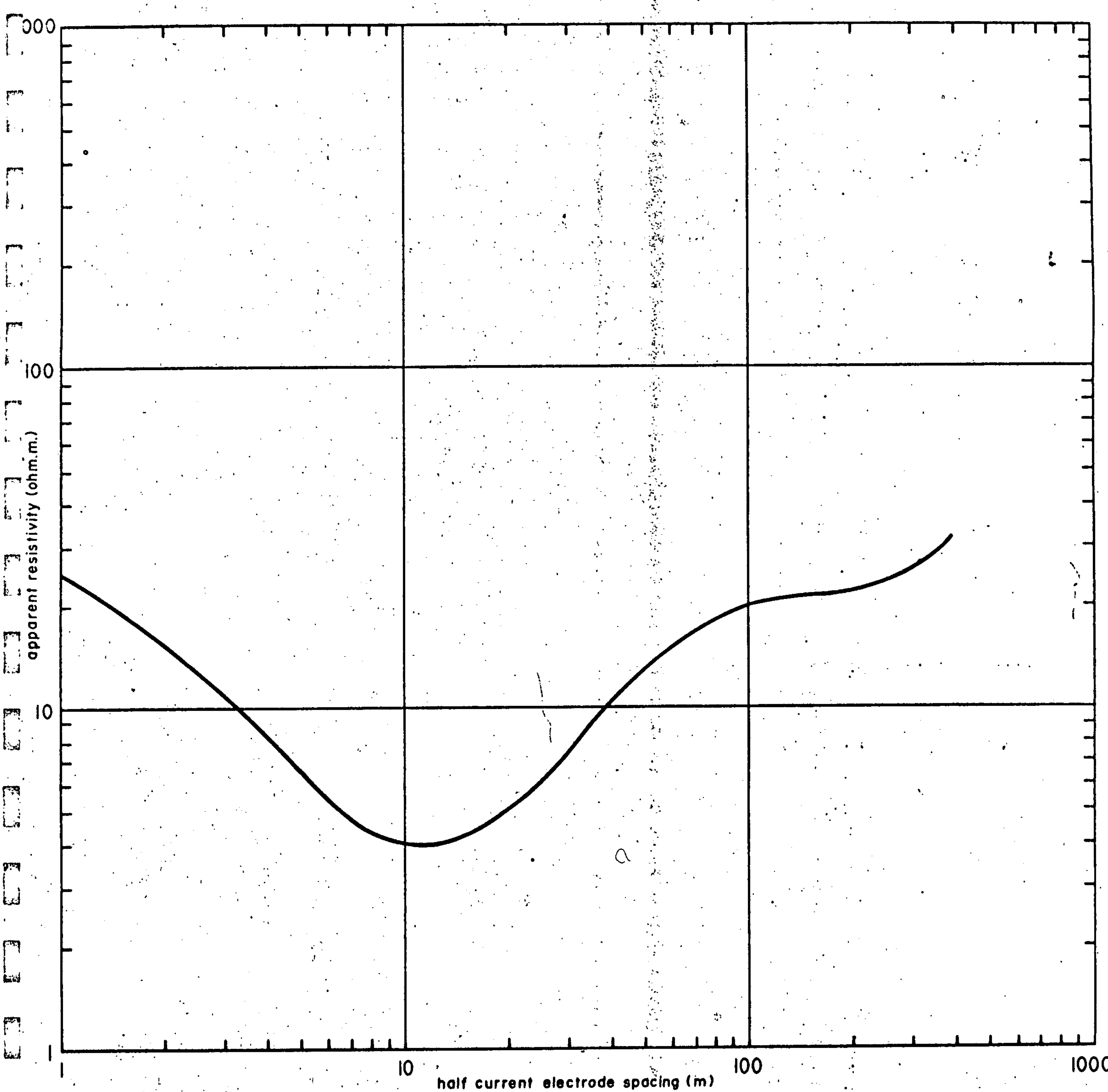
STENHOUSE BAY RESISTIVITY SURVEY

SCHLUMBERGER VERTICAL ELECTRICAL SOUNDINGS

SPREAD 6M



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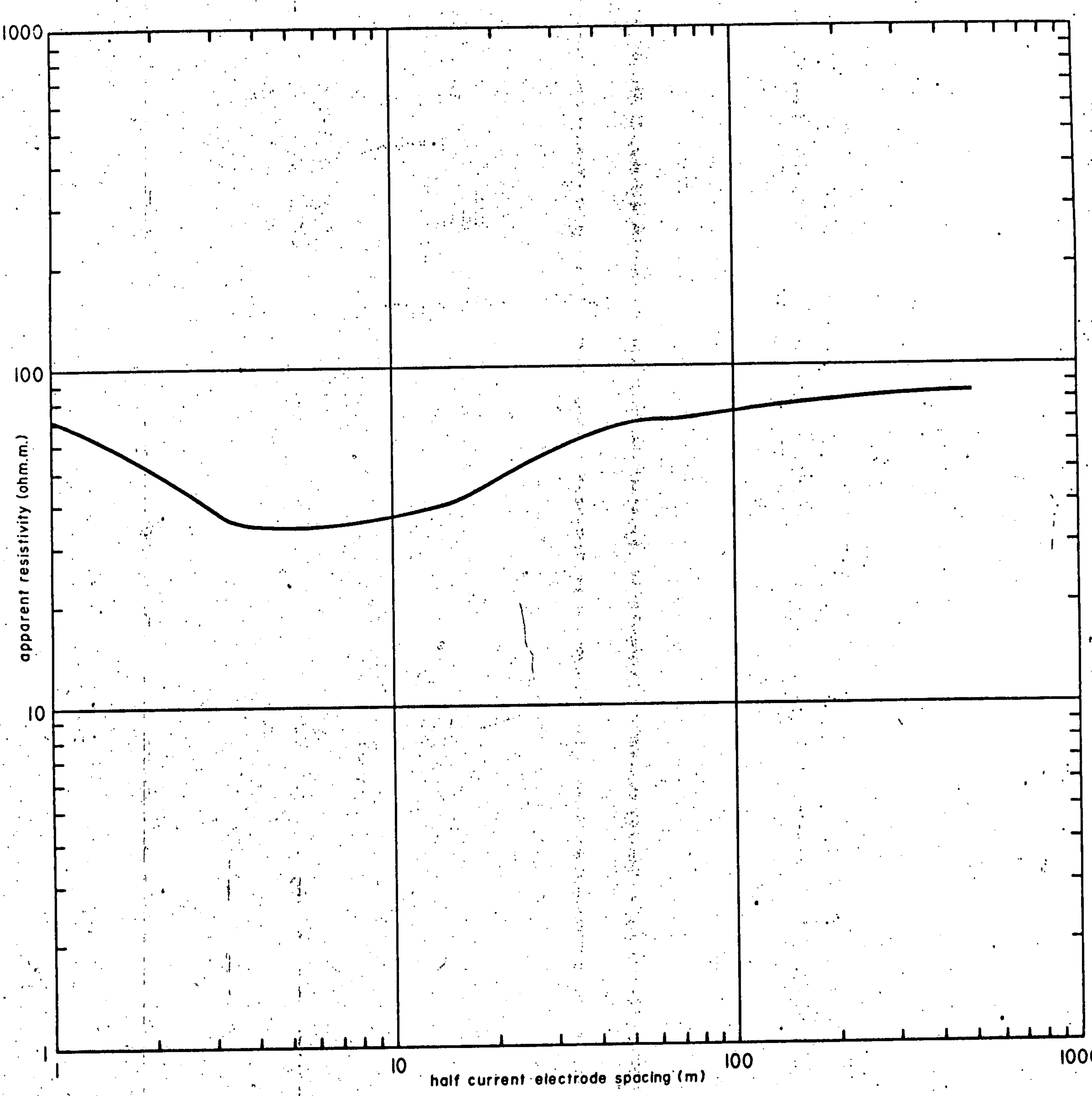
STENHOUSE BAY RESISTIVITY SURVEY

SCHLUMBERGER VERTICAL ELECTRICAL SOUNDINGS

SPREAD 6Q



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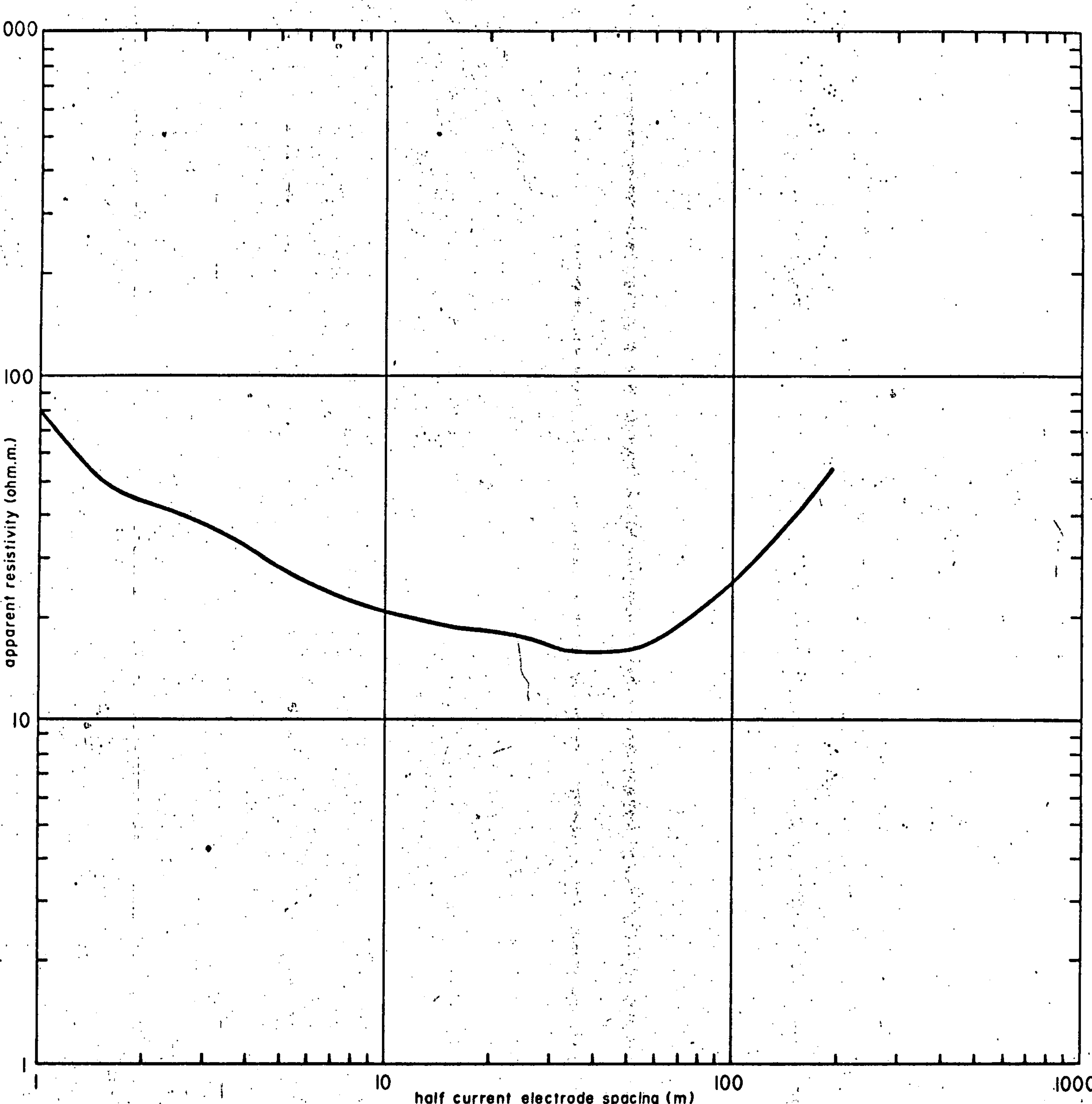
STENHOUSE BAY RESISTIVITY SURVEY

SCHLUMBERGER VERTICAL ELECTRICAL SOUNDINGS

SPREAD X



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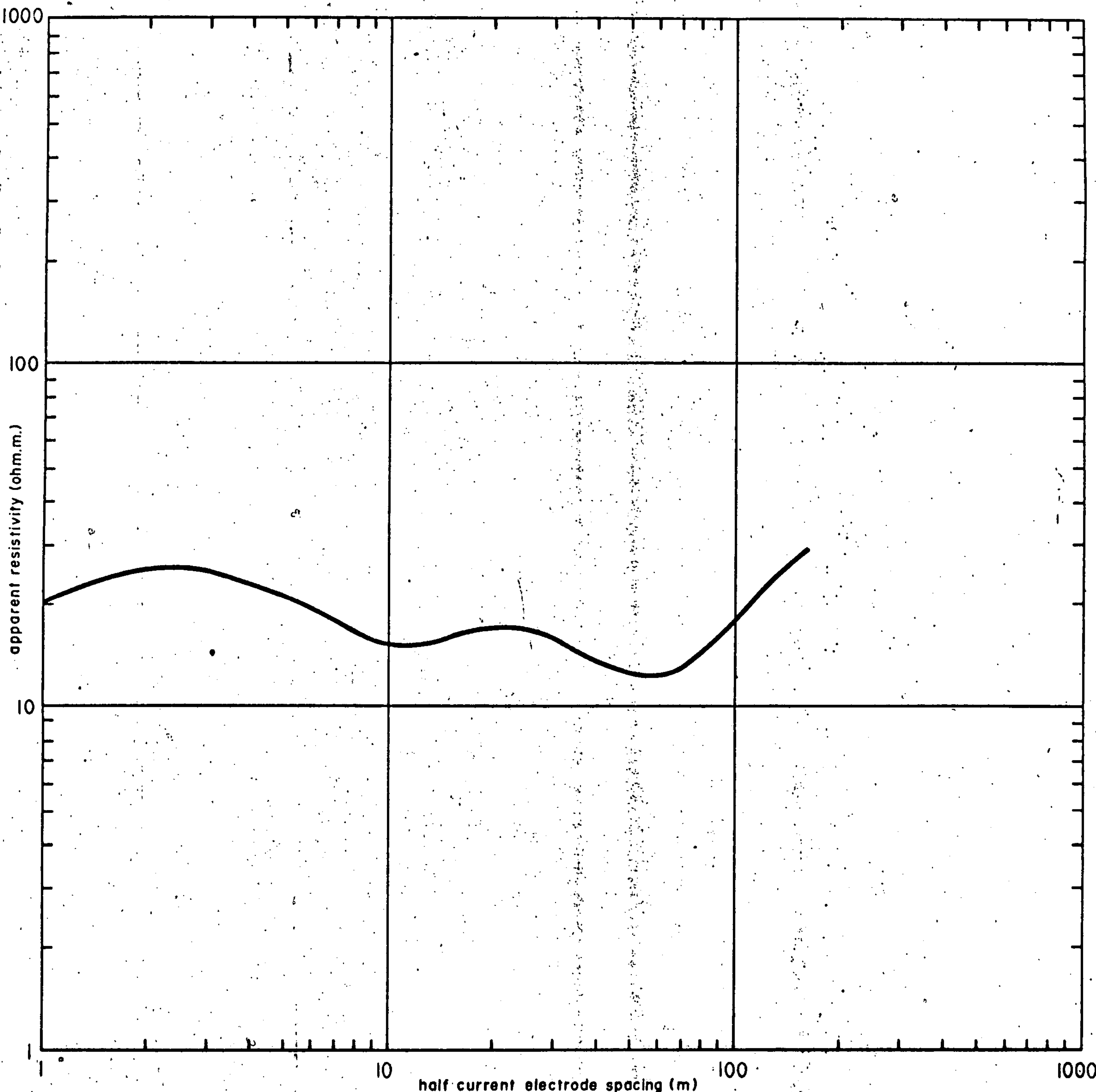
SOUTH AUSTRALIA-DEPARTMENT OF MINES

STENHOUSE BAY RESISTIVITY SURVEY

SCHLUMBERGER VERTICAL ELECTRICAL SOUNDINGS

SPREAD 7A



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STENHOUSE BAY RESISTIVITY SURVEY

SCHLUMBERGER VERTICAL ELECTRICAL SOUNDINGS

SPREAD 7E

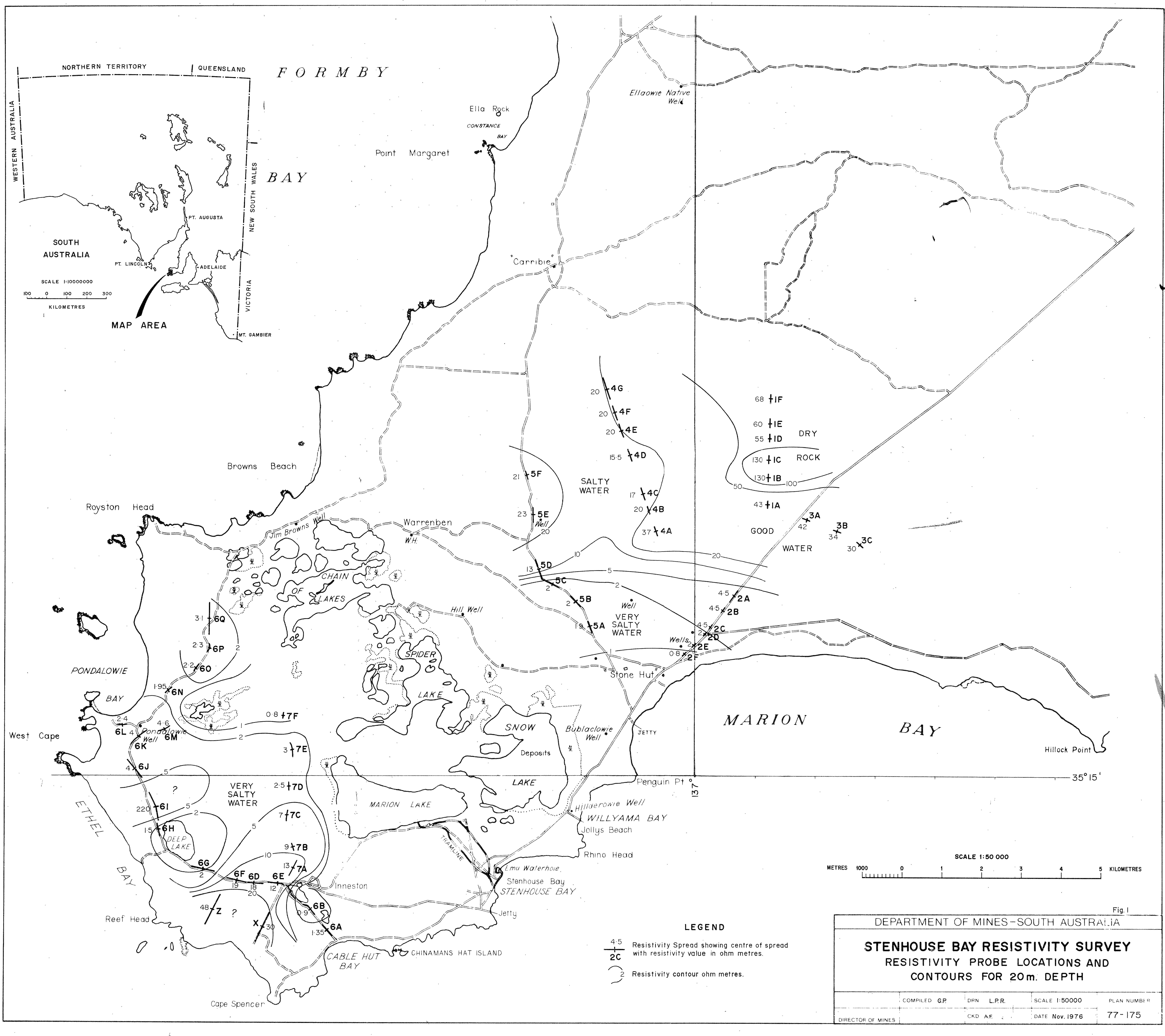


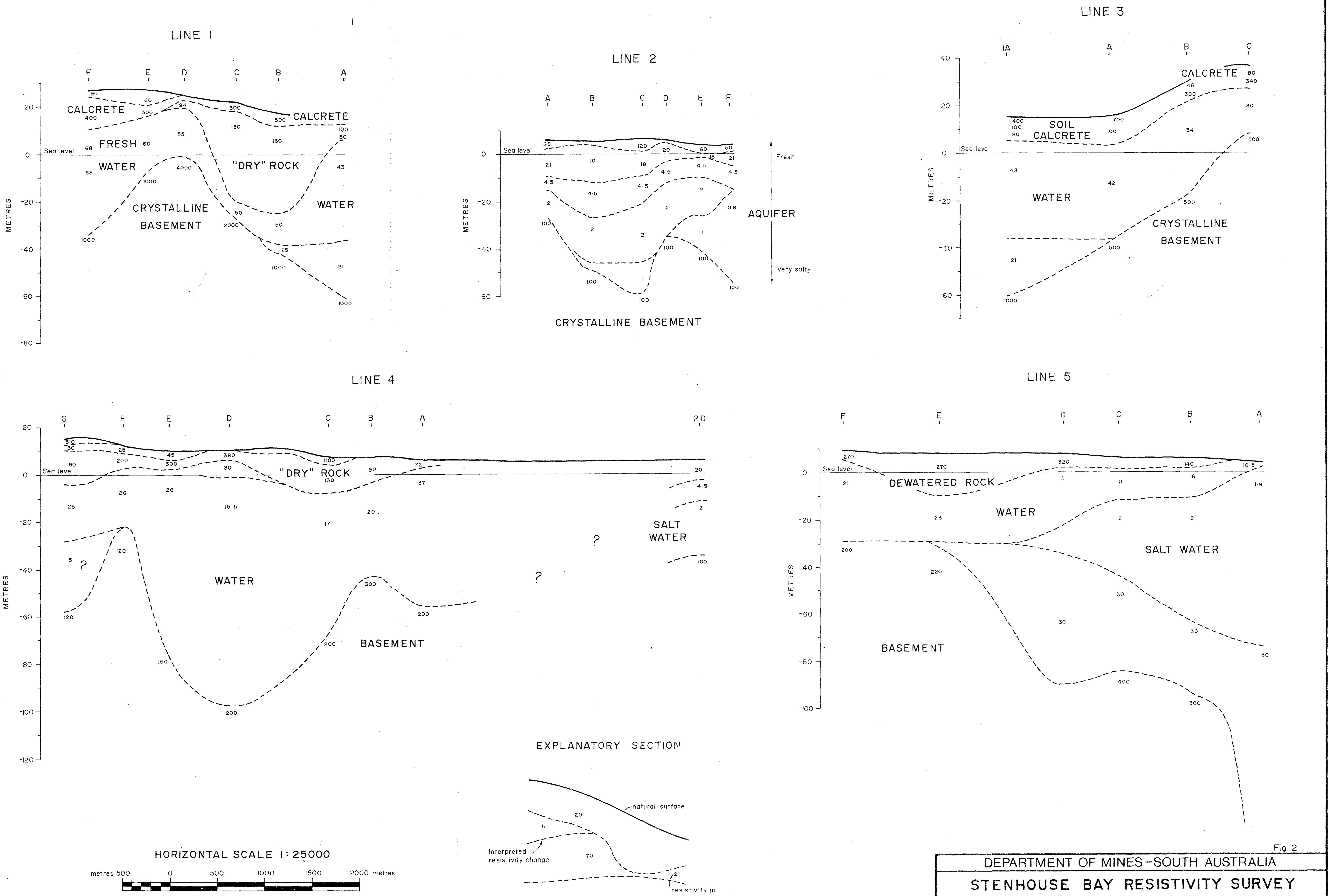
Fig. I

DEPARTMENT OF MINES–SOUTH AUSTRALIA

STENHOUSE BAY RESISTIVITY SURVEY

RESISTIVITY PROBE LOCATIONS AND CONTOURS FOR 20m. DEPTH

COMPILED G.P.	DRN L.P.R.	SCALE 1:50000	PLAN NUMBER
DIRECTOR OF MINES	CKD A.F.	DATE Nov. 1976	77-175



DEPARTMENT OF MINES–SOUTH AUSTRALIA

STENHOUSE BAY RESISTIVITY SURVEY

INTERPRETED SECTION

LINES 1, 2, 3, 4, 5

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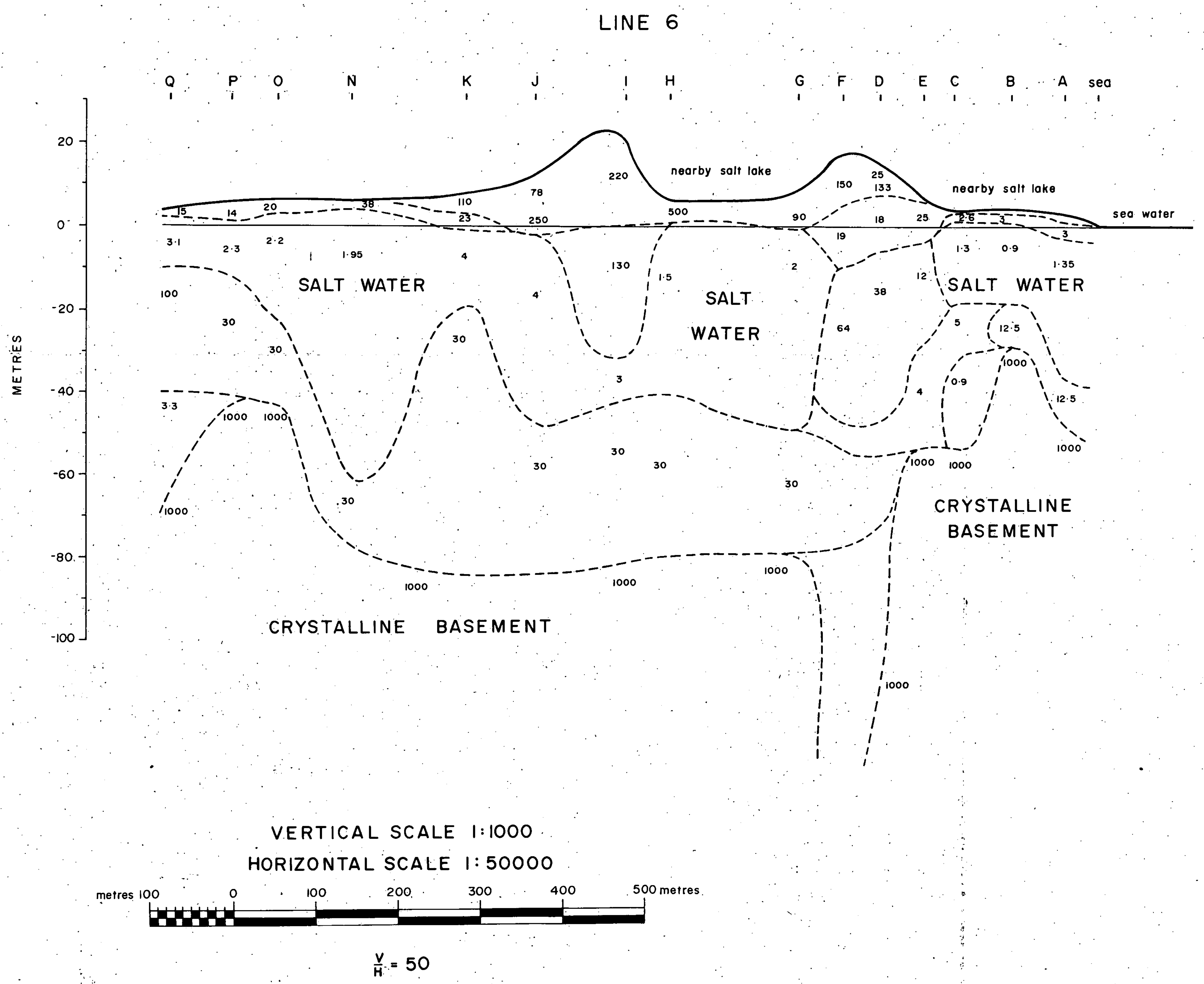
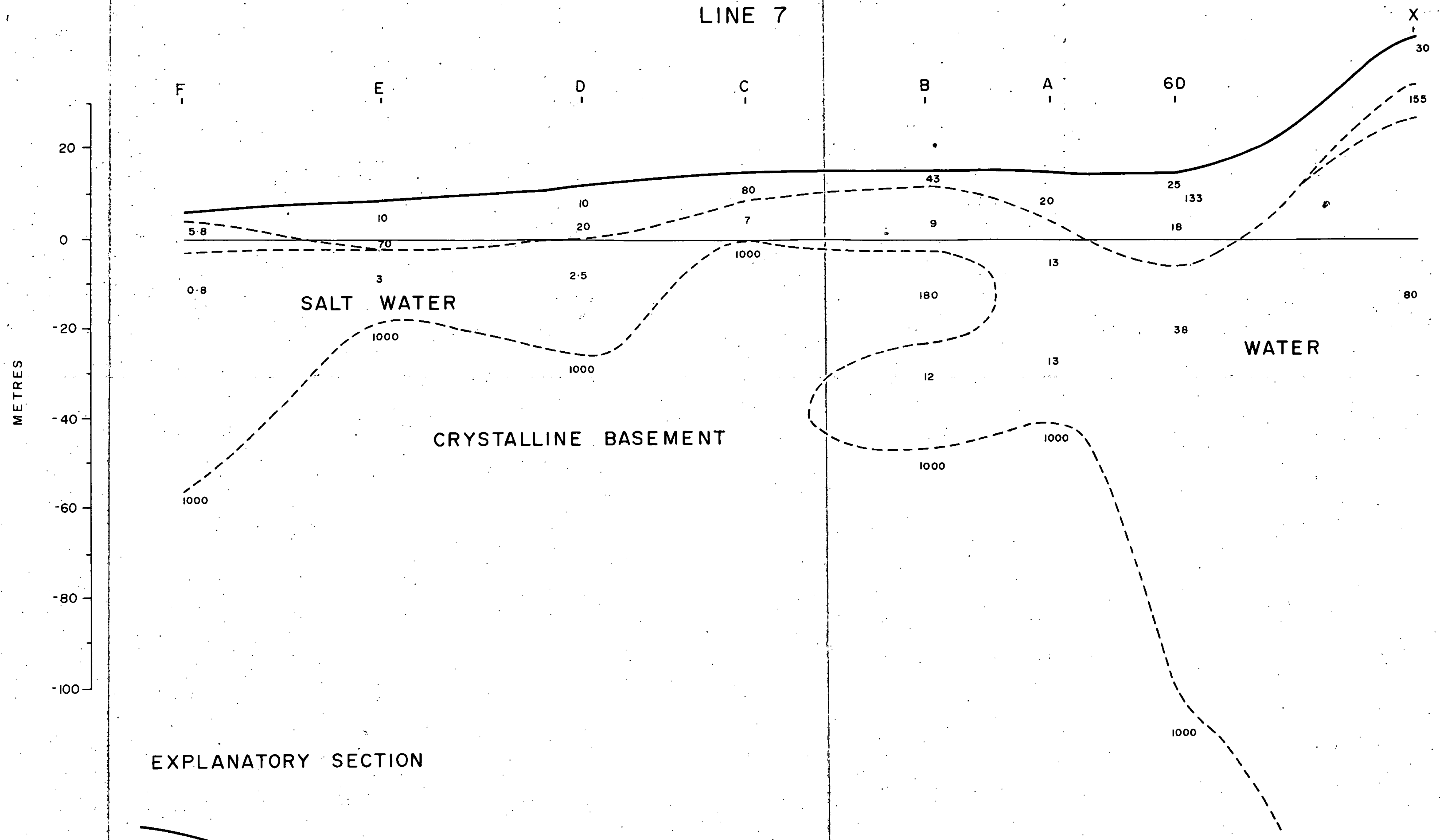
DIRECTOR OF MINES		CKD: A.F.	DATE: Nov. 1976	77-176





EXPLANATORY SECTION

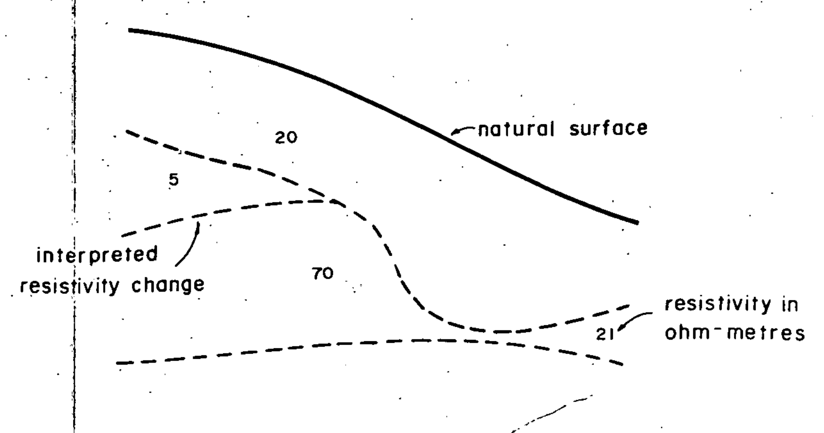


Fig. 3

	DEPARTMENT OF MINES–SOUTH AUSTRALIA	SCALE 1:50000 horizontal
COMPILED: G.P.	STENHOUSE BAY RESISTIVITY SURVEY INTERPRETED SECTION LINES 6 AND 7	DATE: Nov. 1976
DRN: L.P.R. CKD: A.F.		PLAN NUMBER: 77-177