1 PRO L1

PROJECT 4

MONITORING OF UNDERGROUND AND STREAMWATER USING SELECTED OPERATIONAL COUPES AS EXPERIMENTAL CATCHMENTS

Project 4 studies began in 1975, their objective to provide an early warning system of any effects that heavy cutting practices used in the license area might have on stream and groundwater. Four experimental catchments were chosen to represent different conditions of rainfall, soils, and forest types (Table 1). Each catchment covers between 100 - 200 hectares and samples the complete range of topographical situations and associated forest types (Kelsall 1980).

TABLE 1: Soil and Forest Types and Rainfall Data for the Project 4 Coupes

COUPE	SOIL TYPES	FOREST TYPES	MEAN ANNUAL RAINFALL (MM)
Crowea	podzolics on upper slopes red earths in valleys	jarrah-marri karri	1380
Poole	podzolics red earths	jarrah-marri karri	1290
Iffley	laterites (extensive) red earths	jarrah-marri	1220
Mooralup	podzolics	jarrah-marri	900

LOGGING AND REGENETATION

All coupes were cut during the 1976/77 summer, after at least one year of monitoring in each case. Crowea and Poole coupes, predominantly karri, were burnt in April 1978 and planted with karri seedling in June 1978. Iffley and Mooralup coupes, where jarrah is the dominant species, was burnt in November 1979 and allowed to regenerate naturally.

MEASUREMENTS AND INSTRUMENTATION

Rainfall or throughflow was measured by 6 bulk sampling rain gauges to test the level of precipitation and its seasonal distribution. Streamflow is measured by a V notch weir placed at the head of the catchment, in addition provides a sample collection point for analysis of water salinity and suspended sediment.

Ten bore holes were drilled in each catchment, as to sample different topographical locations, (ridge, midslope and valley). A further two bore holes have been drilled outside but close to the catchment to provide controls for comparison. All bores have been visited regularly to measure depth to water table and samples collected for laboratory analysis.

RESULTS - Rainfall

Analysis of rainfall data of the Project 4 catchments for 1975-83 is presented in Table 2.

TABLE 2: Rainfall - (mm)

YEAR	IFFLEY	CROWEA	POOLE	MOORALUP
1975	925	1164	1121	732
1976	897	1013	1023	673
1977	789	1090	953	669
1978	1037	1116	1023	767
1979	904	1085	915	668
1980	884	1158	1111	658
1981	927	1275	1279	815
1982	736	1238	898	611
1983	808	1215	1053	750

The within-coupe rain gauges used in the study have revealed an increase of approximately 10% in the amount of rainfall reaching the ground after cutting reduced interception by tree crowns (Kelsall Committee 1978). This agrees with local and eastern states results (butcher 1977, Smith 1974).

Analysis of rainfall for the three long term recording centres nearest the experimental catchments (Nannup, Pemberton and Manjimup) clearly shows that rainfall for the period 1975-79 has generally been below average (Table 3). This trend has continued to date.

TABLE 3: Annual Rainfall (mm) at the Long Term Recording Centres in the License Area.

YEAR	NANNUP	PEMBERTON	MANJIMUP
1975	851	1117	922
1976	831	1124	1022
1977	739	984	898
1978	960	1170	1052
1979	553	1009	894
Long Term Average	985	1258	1066

- Groundwater Observations

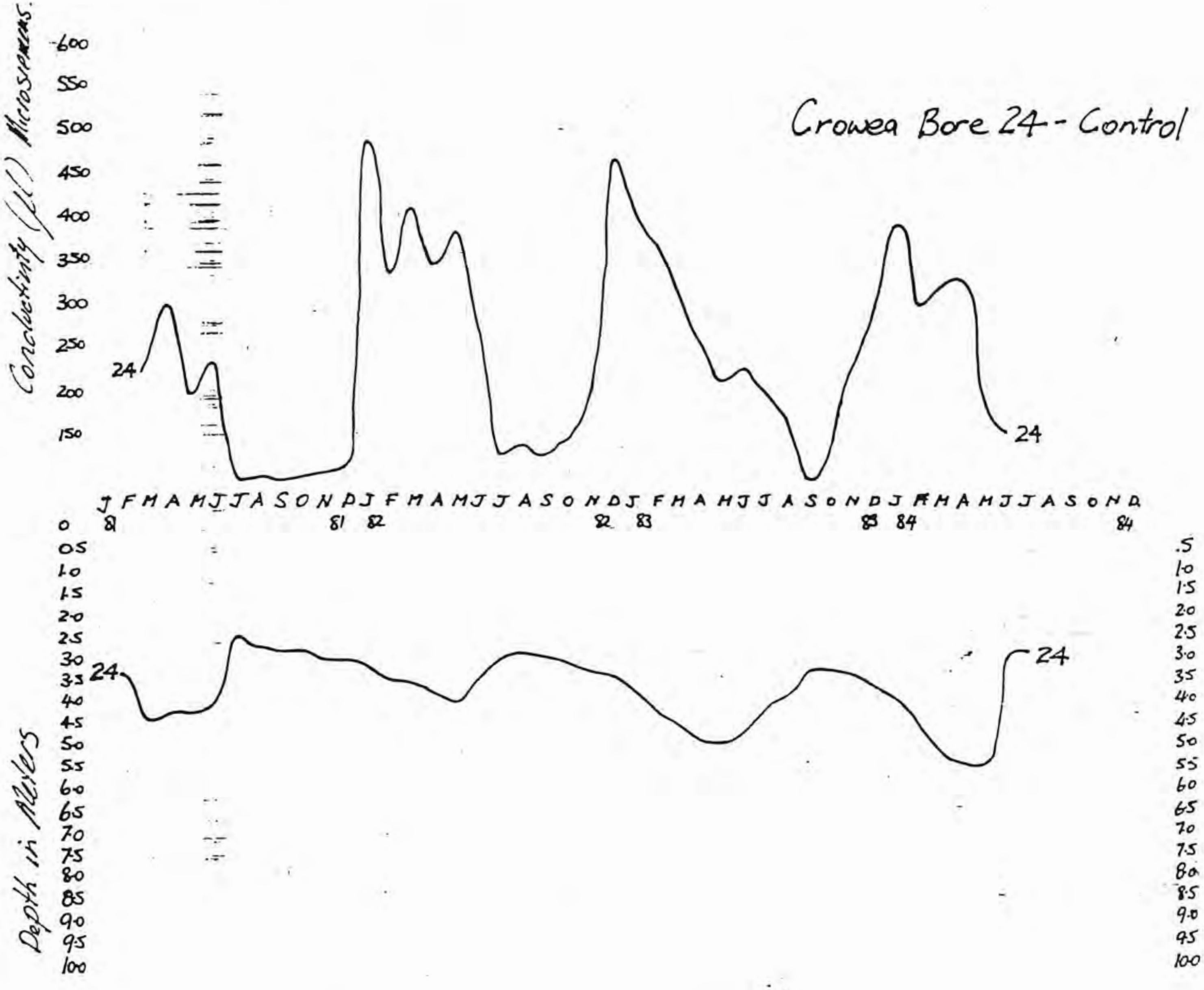
Water level movement within the bores has characteristic seasonal fluctuations, a pattern of steadily rising water levels during winter and spring, followed by a steady fall during summer and autumn.

Cutting commenced in the summer of 1976/77 and continued through most of winter 1977 for most coupes, Iffley the exception commenced in spring 1976.

As a generalisation groundwater tables rose in most bores within the coupes after cutting. Generally the rises in groundwater was not large averaging only 2 m in Poole and Crowea to 1 m in Iffley and only a few centimeters in Mooralup (Kelsall 1980).

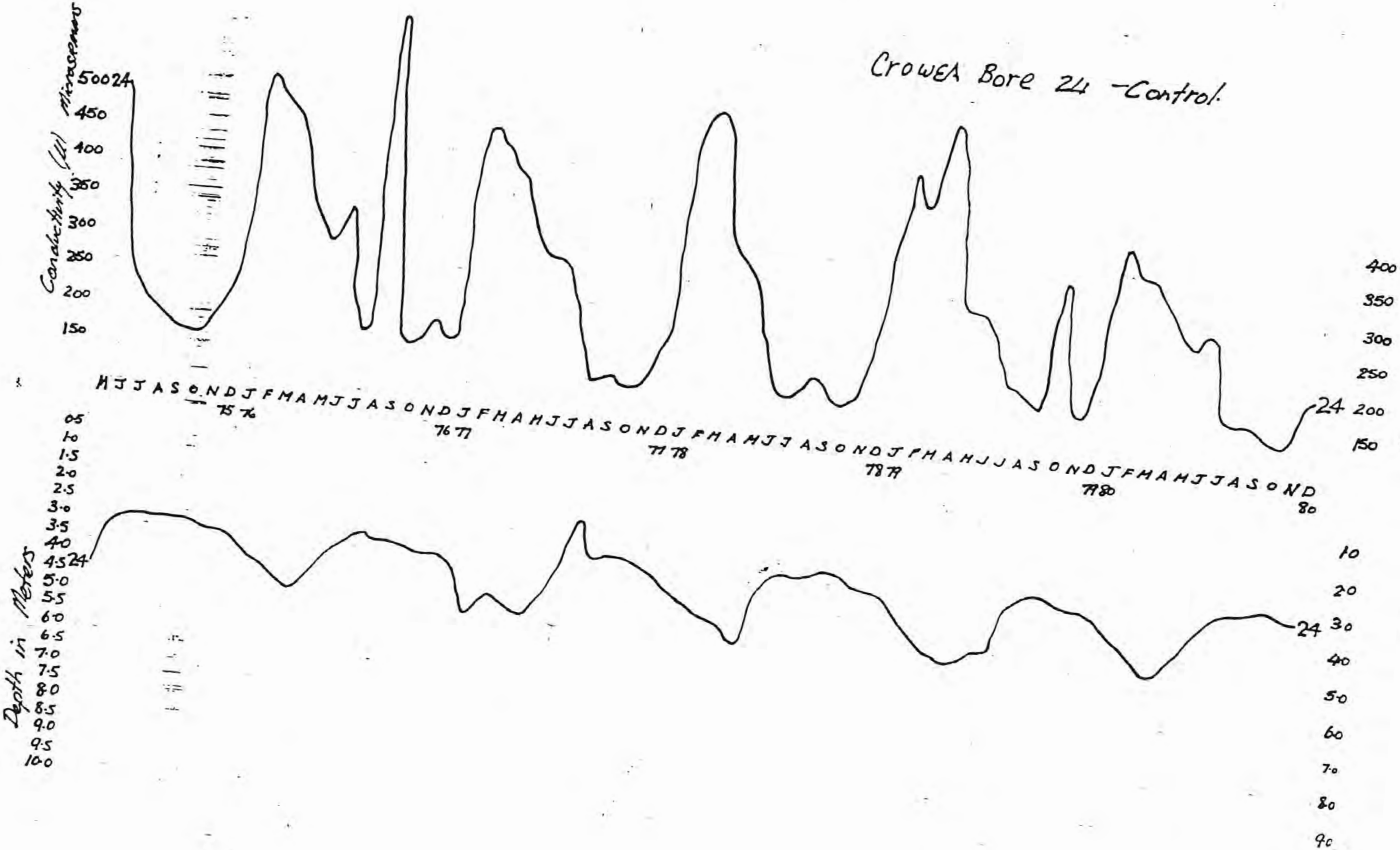
Four representative bores are presented in Figure 1 from different topographical positions in the catchment. Bore 20 a ridge top bore, Bore 22 midslope and Bore 18 a lower valley slope. A further bore, Bore 24 is a control bore. Examination of the graphs reveals several trends. Firstly groundwater rose after September 1977, within 3 months of cutting. Secondly groundwater had stabilised at a new higher level until 1982, after which there is evidence of a gradual decrease in groundwater levels.

FIGURE 1



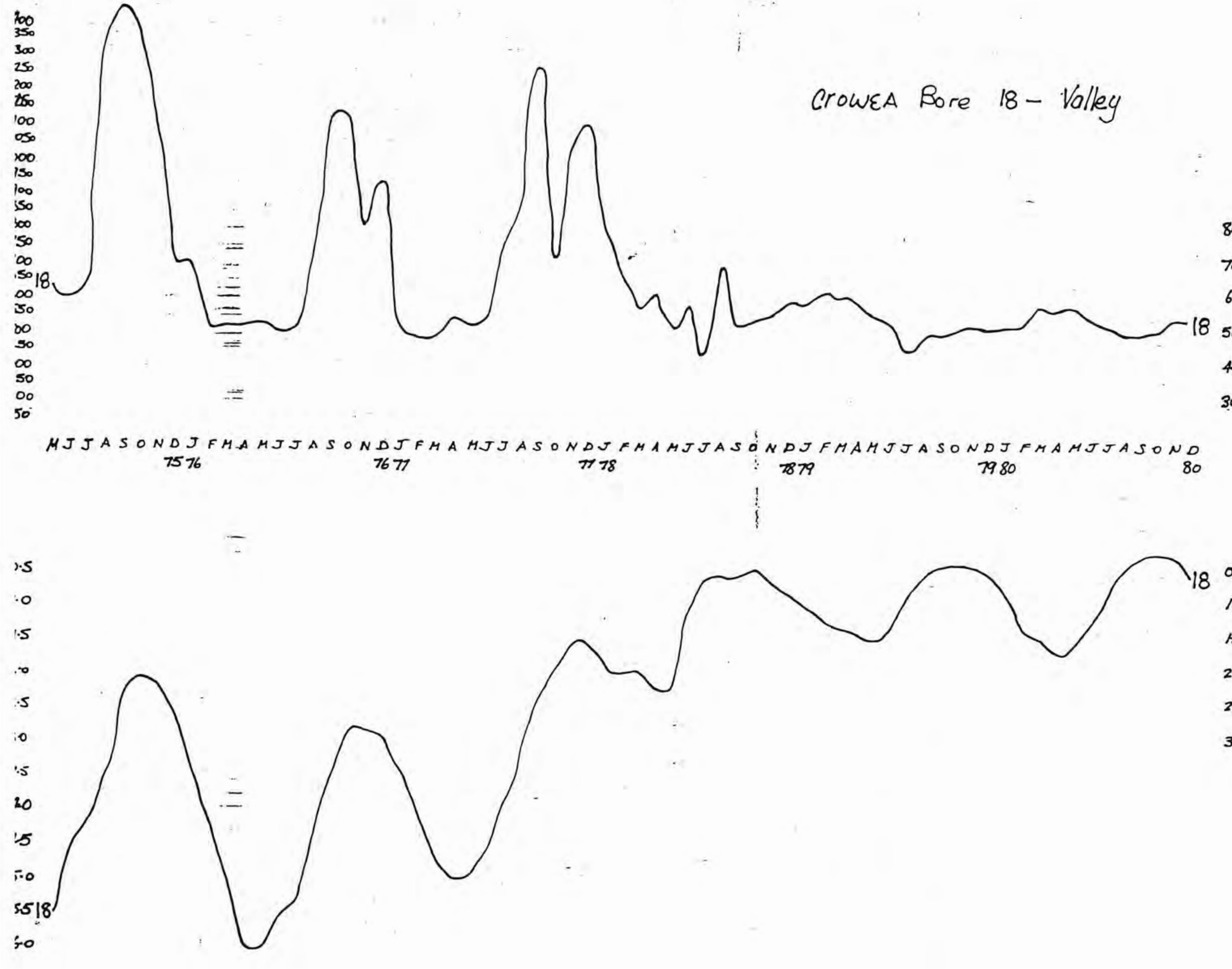
Crowea Bore 24 - Control
Conductivity (µS) Microsiemens.
Depth in Meters
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
81 81 82 82 83 83 84 84
24

4.

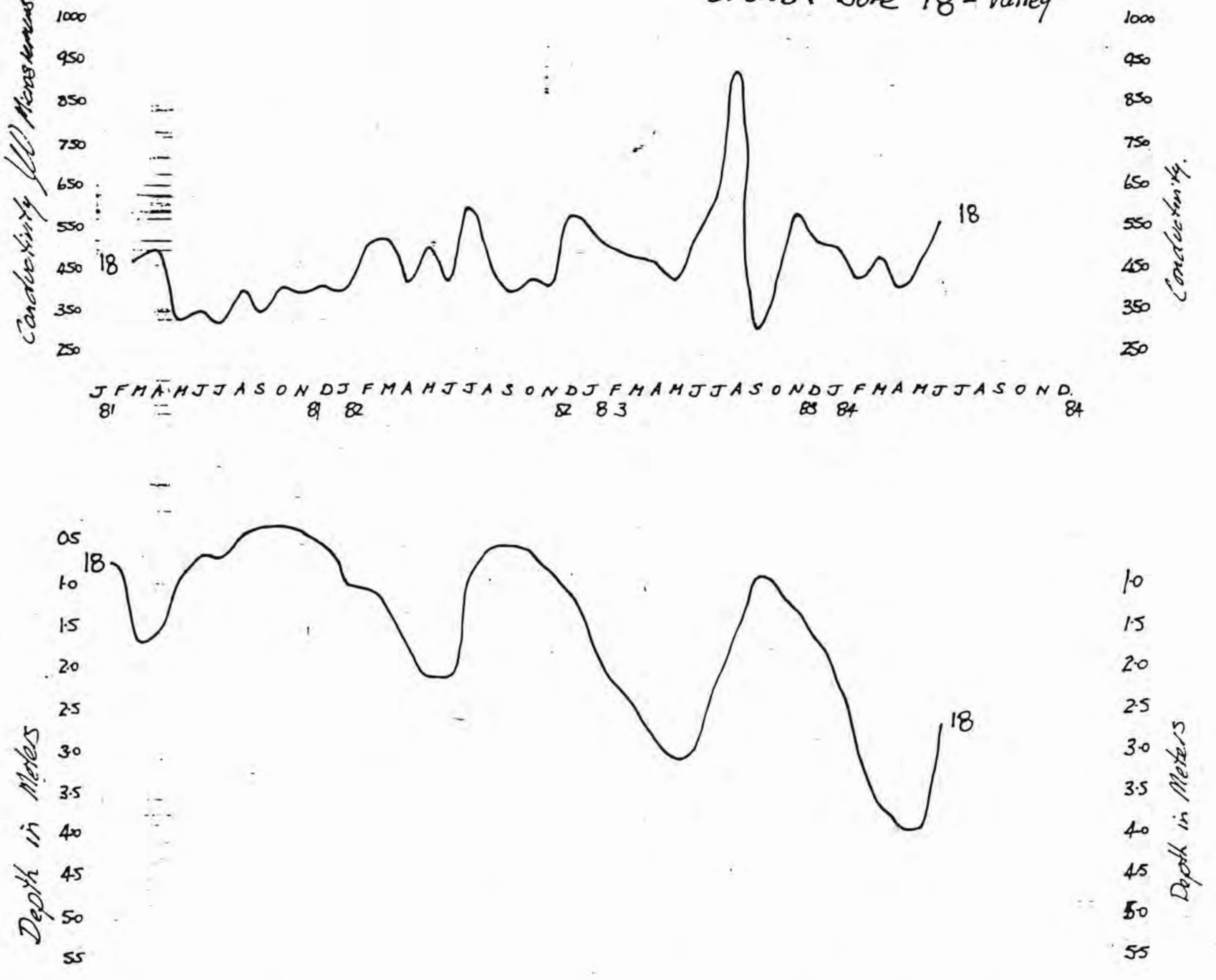

Crowea Bore 24 - Control
Conductivity (μ) microsiemens
500 24
450
400
350
300
250
200
150
M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
75 76
76 77
77 78
78 79
79 80
80
24
400
350
300
250
200
150
Depth in Meters
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5 24
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10
20
24 30
40
50
60
70
80
90

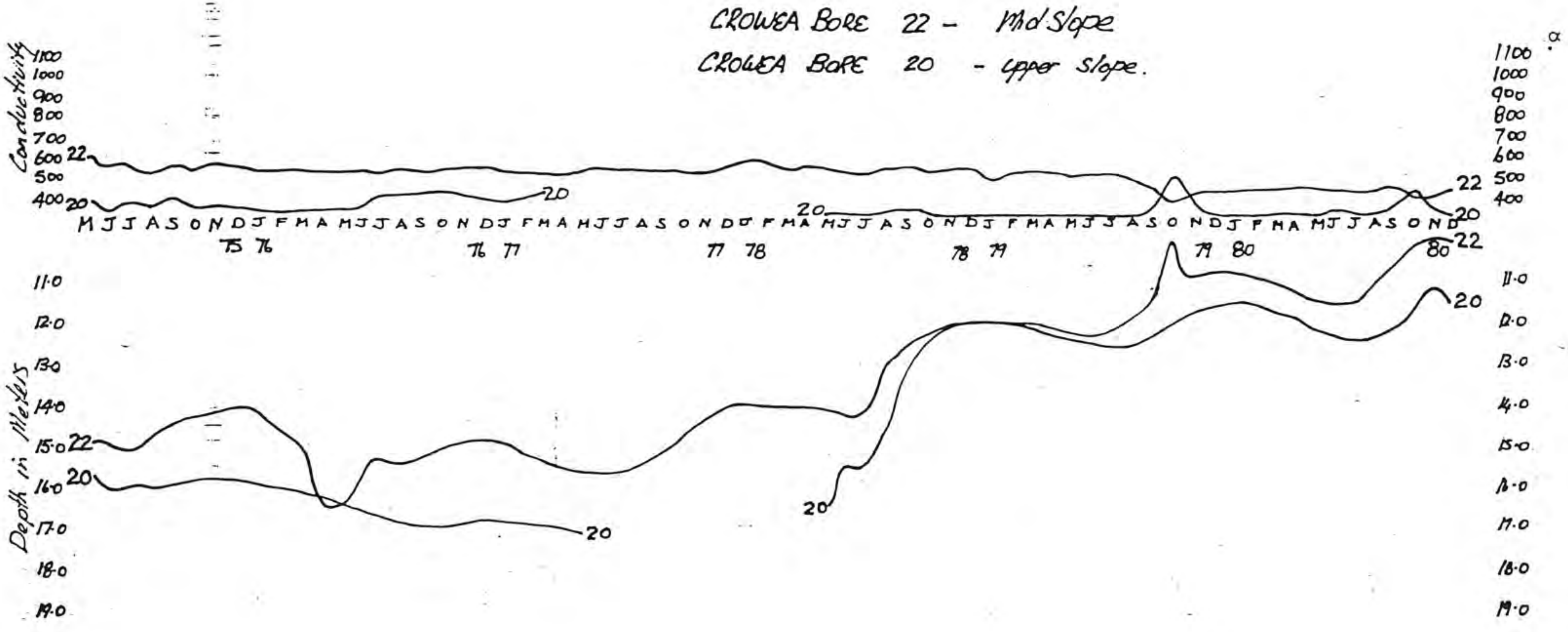
5

Crowea Bore 18 – Valley



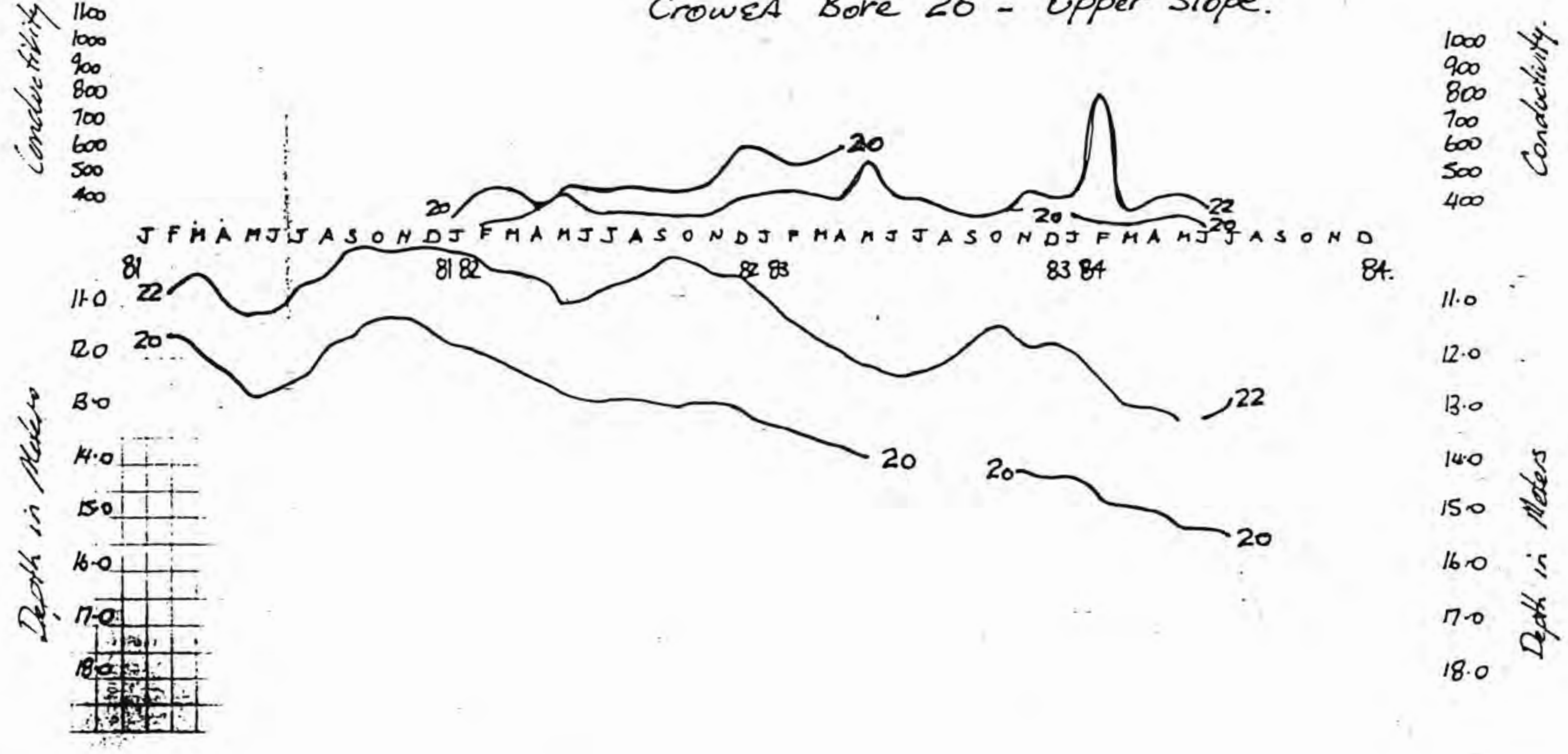
Crowea Bore 18 - Valley




CROWEA BORE 22 - Mid Slope
CROWEA BORE 20 - upper slope.
Conductivity
1100
1000
900
800
700
600
500
400
22
20
M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
75 76
76 77
77 78
78 79
79 80
80
Depth in Meters
11·0
12·0
13·0
14·0
15·0
16·0
17·0
18·0
19·0

CrowEA Bore 22 - MidSlope

CrowEA Bore 20 - upper Slope.



The control bore (Bore 24) shows no increases in groundwater levels but exhibits common seasonal fluctuations in groundwater levels. Graphs of the bores of all the catchments are presented in Appendix 1.

Although Figure 1 presents graphs taken from the one catchment trends observed are common to all catchments.

- Streamflow

As stated previously recorded rainfall means are well below the long term mean. Although rainfalls in 1978 were close to the long term mean, streamflows in 1978 would be below average because of the preceding two dry years. Therefore the bias towards low flows in the recorded streamflow is likely to be higher than the bias in the rainfall.

Despite the considerable bias to low streamflow over the period of record the water balances of the catchment reflects an important general characteristic. Streamflow increases as a percentage of the rainfall from the low rainfall to high rainfall catchments. For example, 1978 flow in Mooralup (767 mm) represents 4.3% of rainfall while Crowea 1116 mm represents 39.6% of rainfall (Table 4).

The data presented in Table 4 shows that streamflow as a percenage of rainfall has increased since cutting although rainfall inputs are of similar amounts. Another trend emerging is that the catchments appear to be returning gradually to their pre-cutting levels, this is more evident in the higher rainfall coupes of Crowea and Poole where both 1982 and 1983 percentage of rainfall figures have reduced.

- Salinity

Streamwater salinity is shown graphically in Figure 2. Generally streamflow salinity has increased after cutting, however there is a trend towards lower streamflow salinities in later years. The P.W.D. found in their catchments that coupes which have groundwater tables less than 5 m from the surface have higher stream salinities than coupes where ground is greater than 5 m. This is due to the combining of fresh infiltration flow and higher saline water from the perched water table. However none of the catchments have

TABLE 4:

CROWEA

YEAR	RAINFALL INPUT		STREAM OUTFLOW	
	(mm)	($10^3 m^3$)	($10^3 m^3$)	% OF RAINFALL
1976	1,013	1,094	145.5	13.3
1977	1,090	1,177	272.7	23.1
1978	1,116	1,205	478.3	39.6
1979	1,085	1,172	336.1	28.6
1980	1,158	1,251	335.9	26.8
1981	1,275	1,377	499.9	36.3
1982	1,238	1,337	254.1	19.0
1983	1,215	1,312	276.6	21.1

POOLE

YEAR	RAINFALL INPUT		STREAM OUTFLOW	
	(mm)	($10^3 m^3$)	($10^3 m^3$)	% OF RAINFALL
1976	1,023	1,228	61.464	5.0
1977	953	1,144	107.88	9.4
1978	1,023	1,228	420.33	34.2
1979	915	1,098	273.54	22.2
1980	1,111	1,333	354.80	26.6
1981	1,271	1,534	503.14	32.8
1982	898	1,077	182.16	16.9
1983	1,053	1,264	175.19	13.8

M O O R A L U P

YEAR	RAINFALL INPUT		STREAM OUTFLOW	
	(mm)	(10^3m^3)	(10^3m^3)	% OF RAINFALL
1976	673	707	7.18	.01
1977	669	703	5.01	0.7
1978	767	805	34.38	4.3
1979	668	701	0.61	0.01
1980	658	690	5.98	0.9
1981	815	855	30.49	3.56
1982	611	641	No flow	-
1983	750	788	12.476	1.58

I F F L E Y

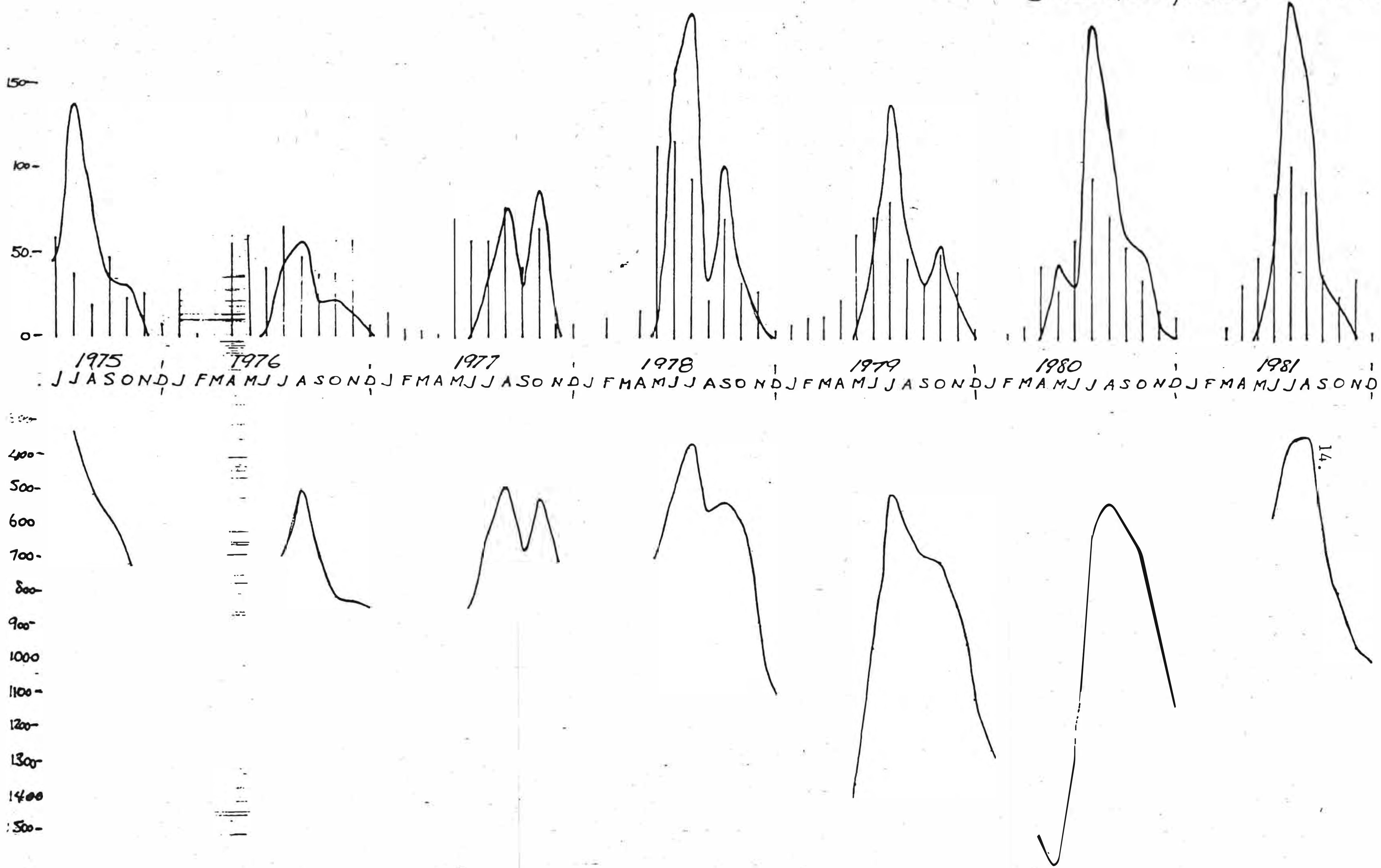
YEAR	RAINFALL INPUT		STREAM OUTFLOW	
	(mm)	(10^3m^3)	(10^3m^3)	% OF RAINFALL
1976	897	1,794	160.02	8.90
1977	78[illegible]	1,578	239.53	15.2
1978	1,03[illegible]	2,074	550.92	26.6
1979	90[illegible]	1,808	377.54	20.9
1980	884	1,768	474.14	26.8
1981	927	1,824	496.78	27.2
1982	736	1,472	393.65	26.7
1983	808	1,616	292.88	18.1

produced unacceptably high saline concentrations.

Total salt exports are related to volume of streamflow and stream salinity. From streamflow figures listed in Table 4, it can be seen that streamflow is highest from 1978 to 1981, which corresponds to the period of highest stream salinity. Hence total salt export for this period would be at its highest. The proceeding two years 1982/83 streamflow has reduced together with reduction in stream salinity.

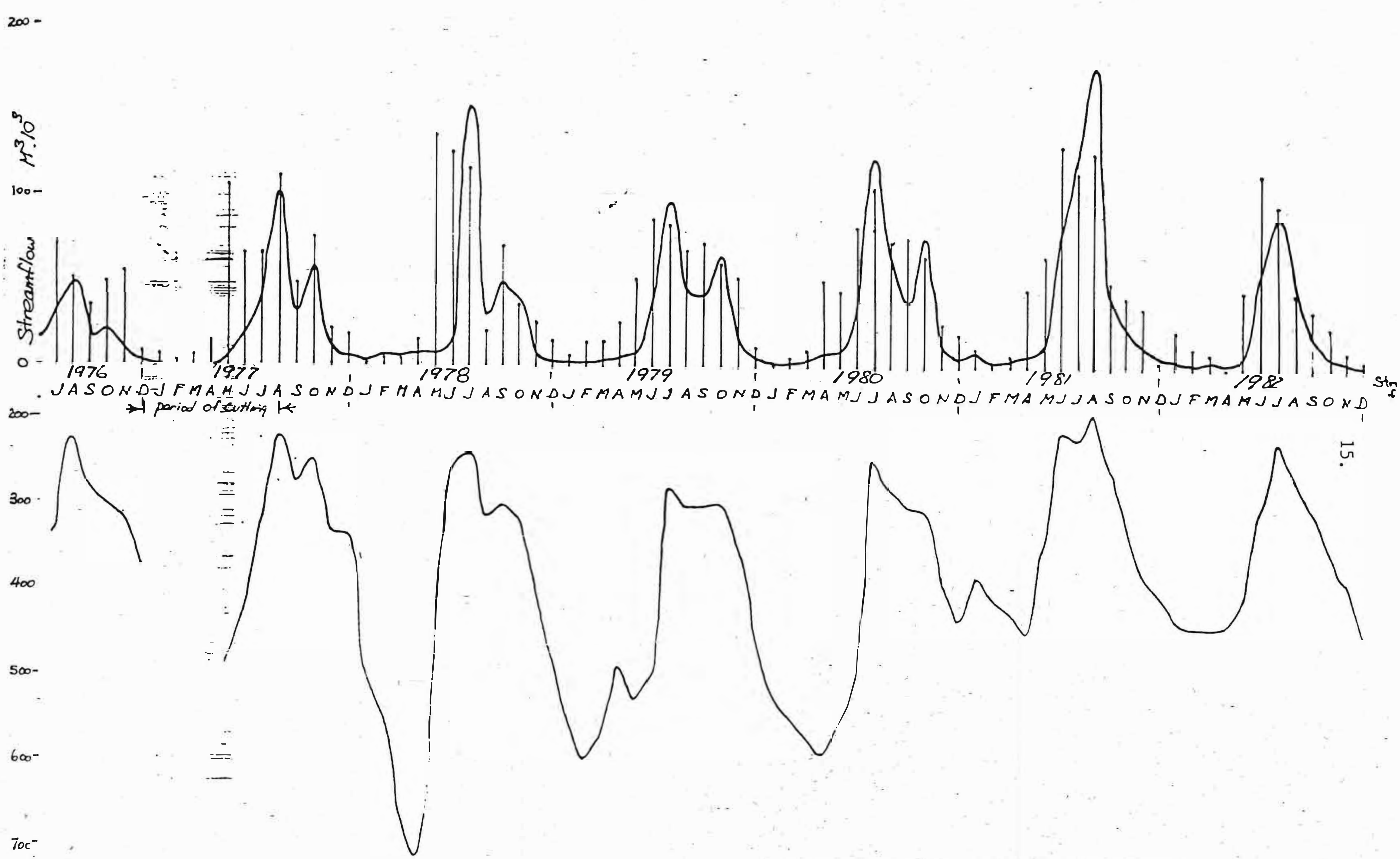
FIGURE 2

Streamflow / Rainfall Iffle



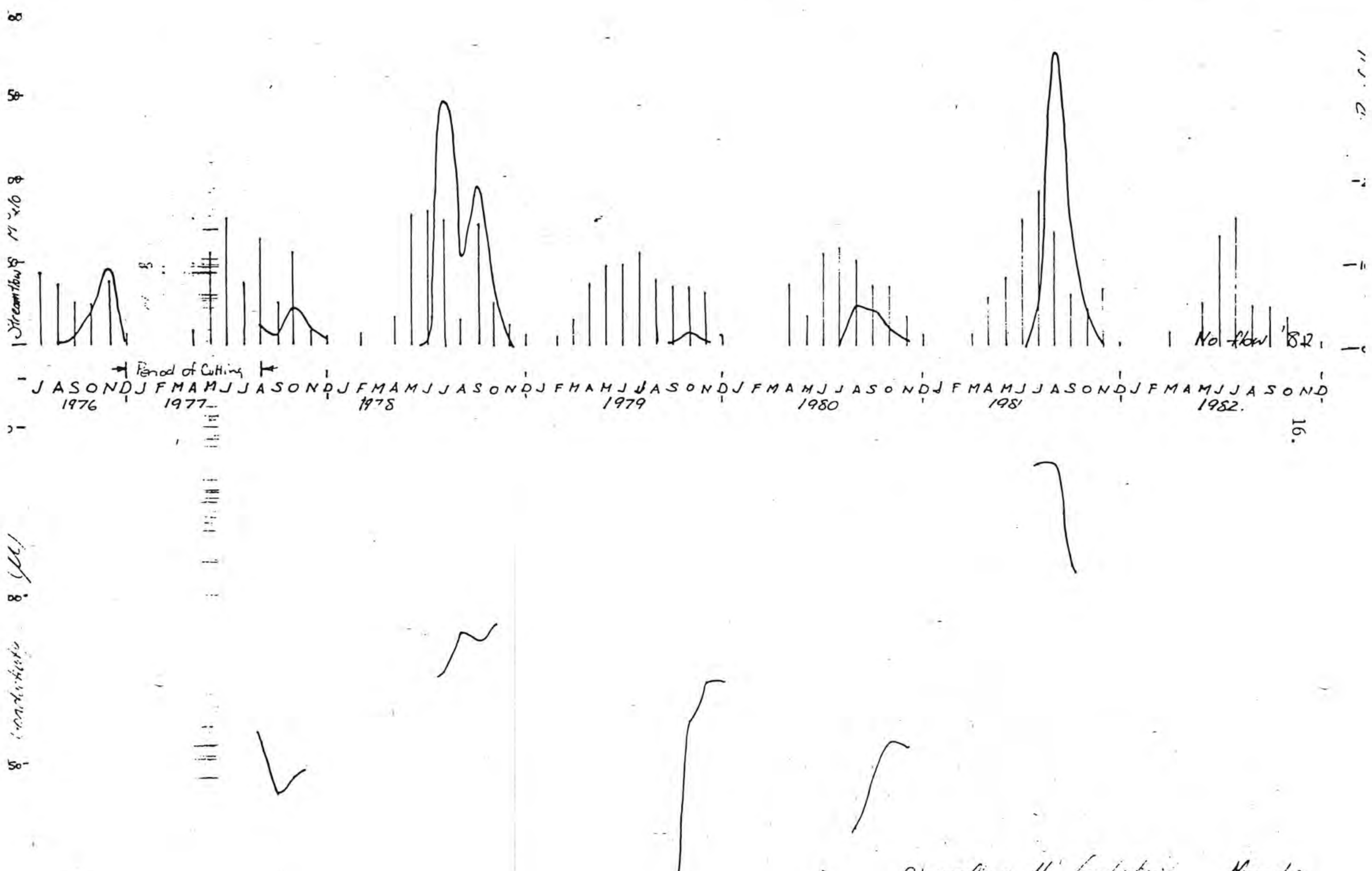
Conductivity (U) Streamflow Iffley

Streamflow / Rainfall Crowea.

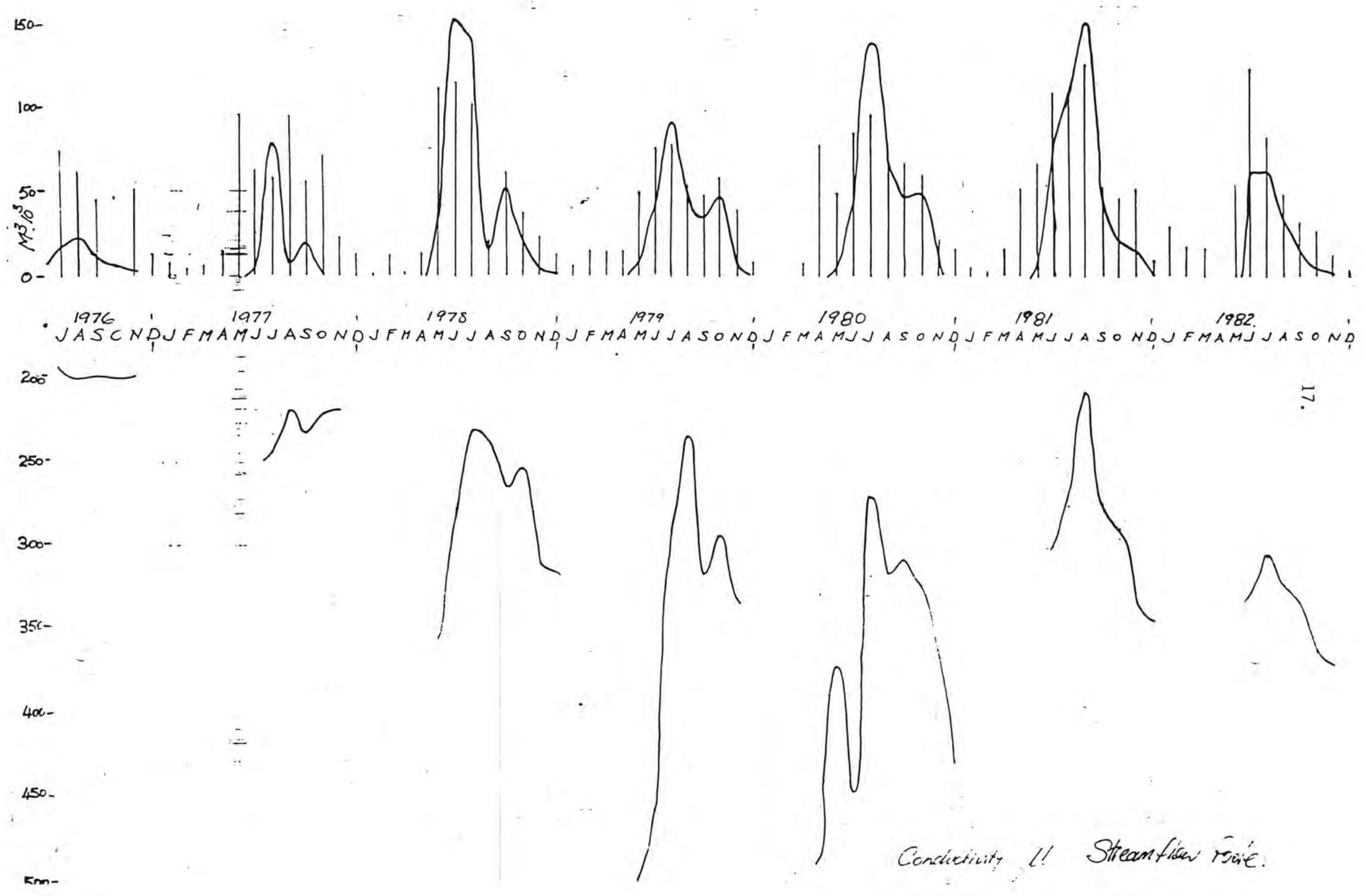


15.

Conductivity (U) of Streamflow Crowea



Streamflow / Conductivity Mooralup.



Conductivity // Streamflow Fooie.

- Stream Sediment Levels

Stream sediment levels have been measured by passing sediment samples through a 50 micron filter. Although summary data of sediment levels past 1979 is not available for this report a quick examination of records on file has revealed some characteristics. Firstly that results of sediment level are variable. Secondly concentration of sediment have not changed markedly, however as levels of sediment are dependent on volume of flow than general level of sediment would have reduced as streamflow decreased.

SUMMARY.

1. Streamflow as a percentage of rainfall increases from low to high rainfall catchments.

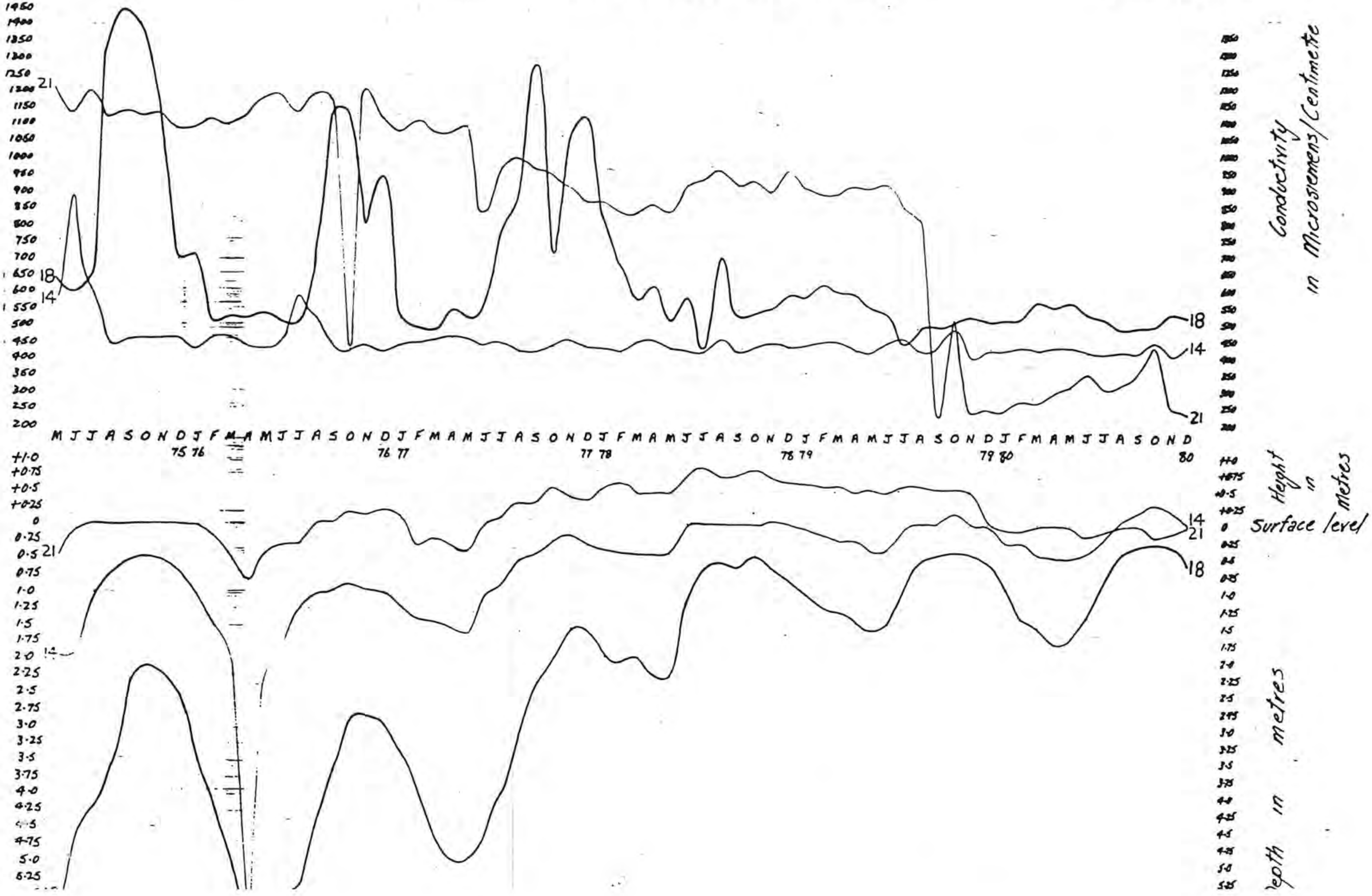
2. Streamflow has increased since logging in all four coupes studied. The increase is attributed to increased throughfall following reduction in the overstorey. A trend in reducing streamflow in latter years is observed.

3. There has been a rise in the water table since logging, but similar to streamflow, indications are that bore levels are reducing as transpiration increases with increasing vegetative cover.

4. Total salt flow has increased in all four coupes. This is attributed more to increased streamflow than increased salinity. But a current trend of reduced streamflow from increased transpiration has lowered the total export of salts from the catchments.

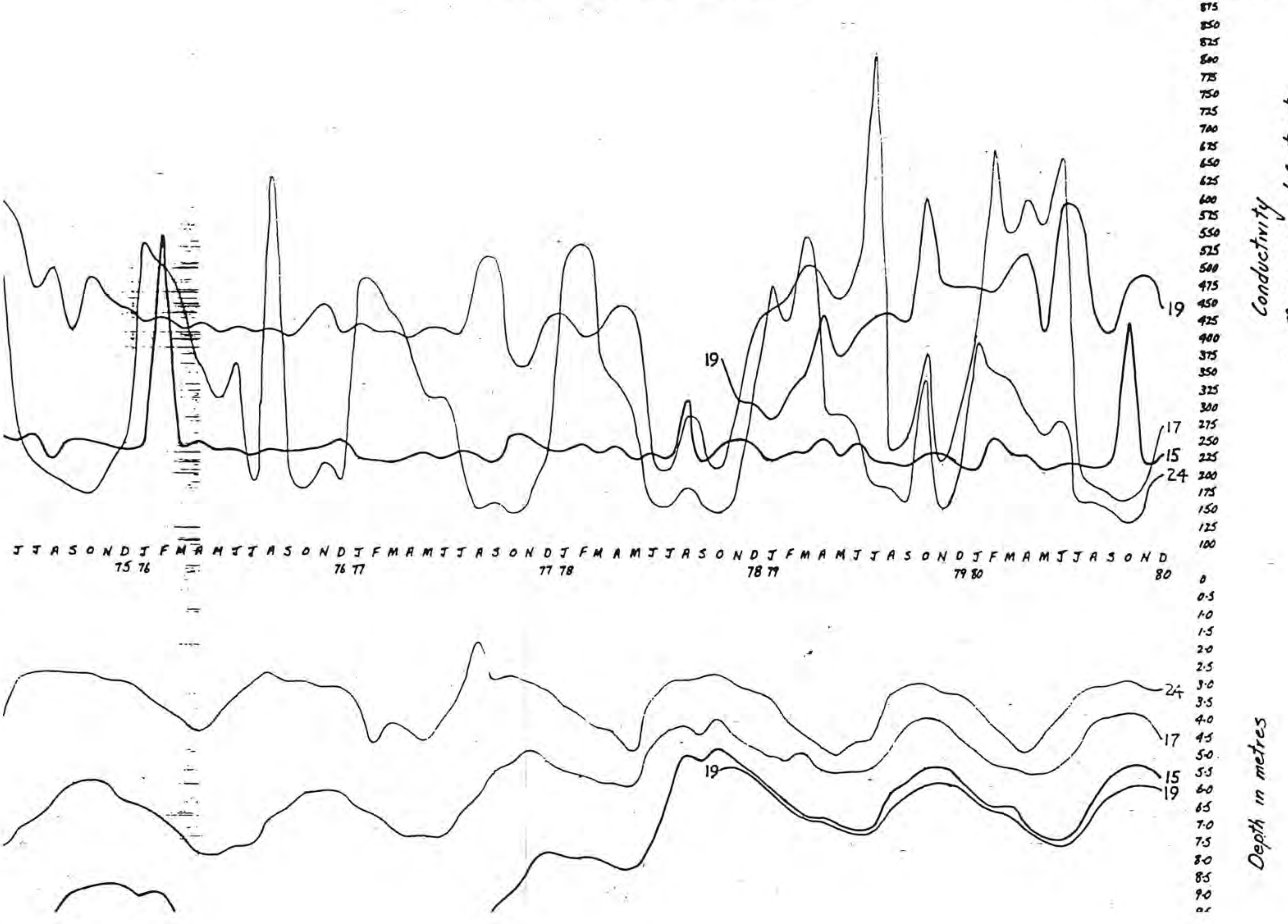
APPENDIX 1

DEEP BORE DATA - CROWEA BORES 14, 18, 21

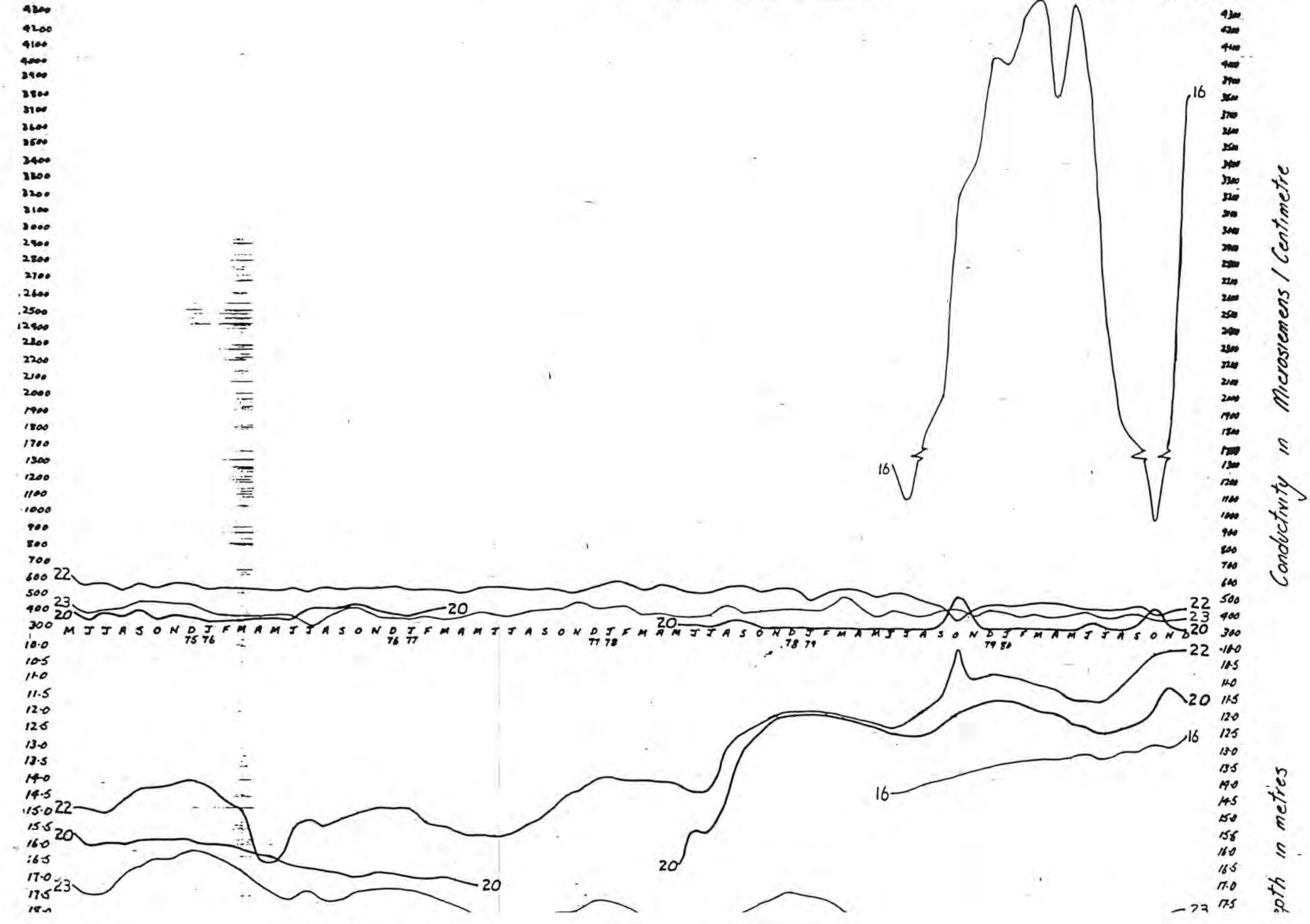


DEEP BORE DATA - CROWER

BORES 15, 17, 19, 24

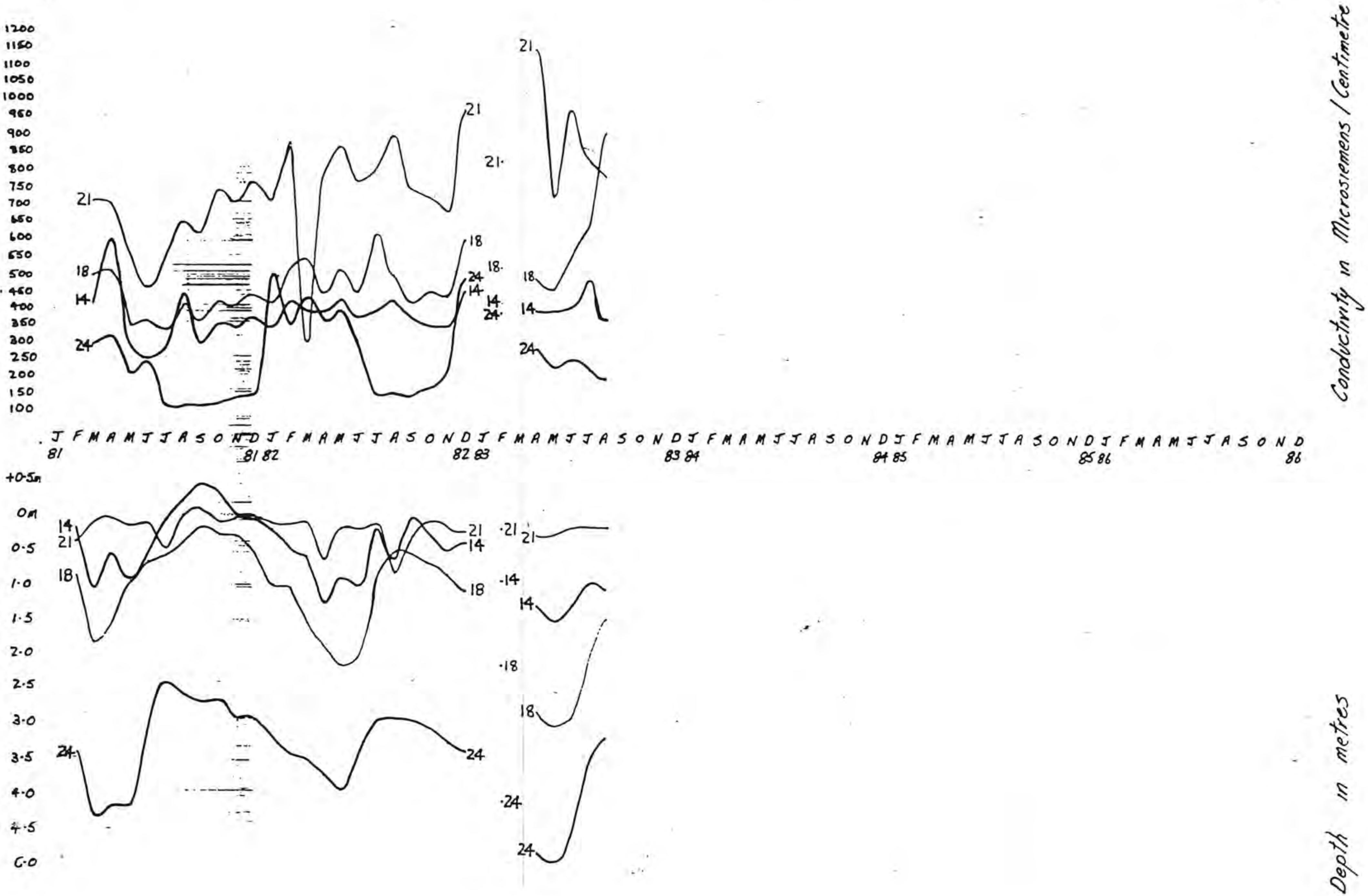


DEEP BORE DATA - CROWEA BORES 16, 20, 22, 23



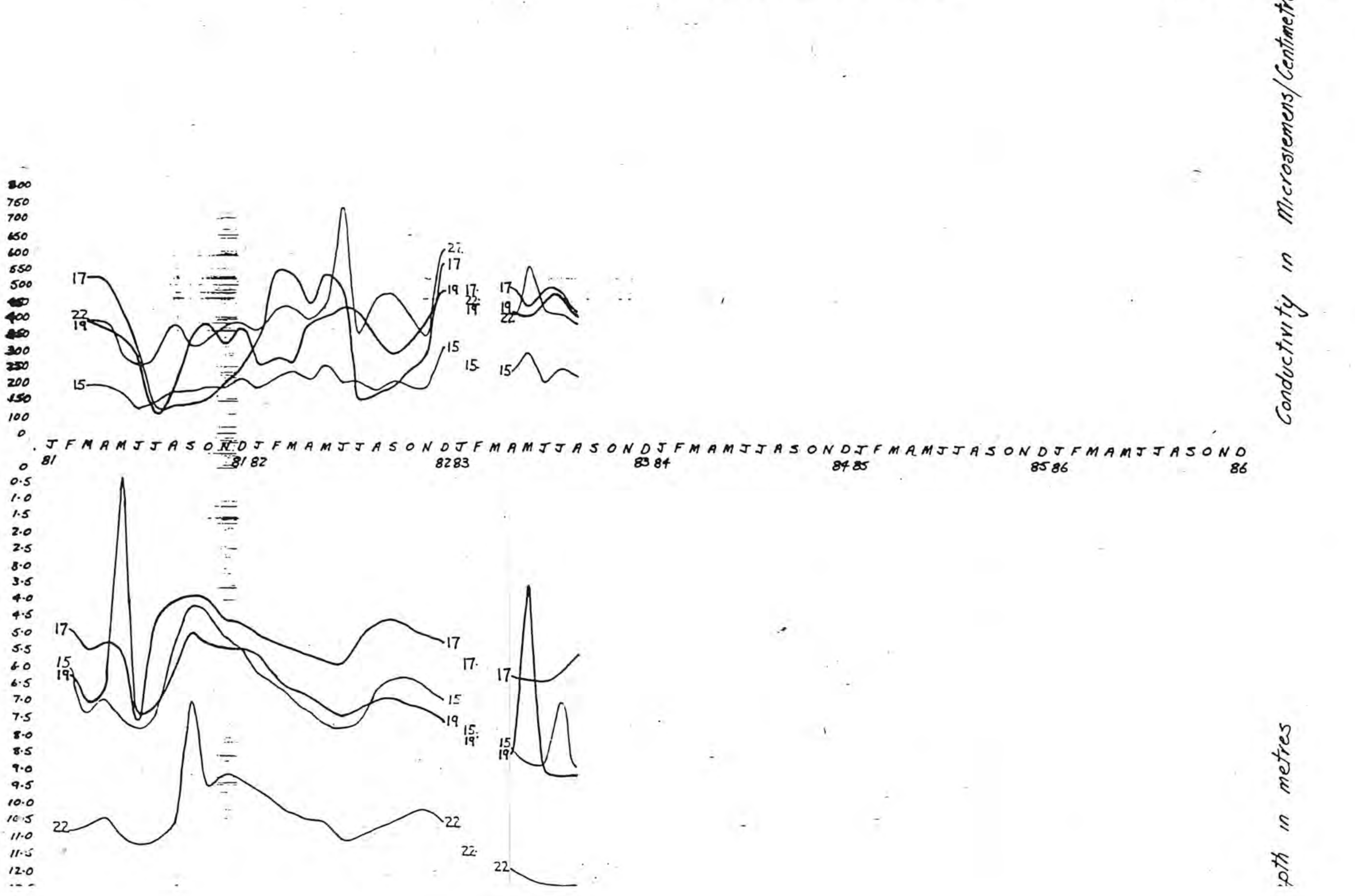
DEEP BORE DATA - CROWEA

BORES 14, 18, 21, 24



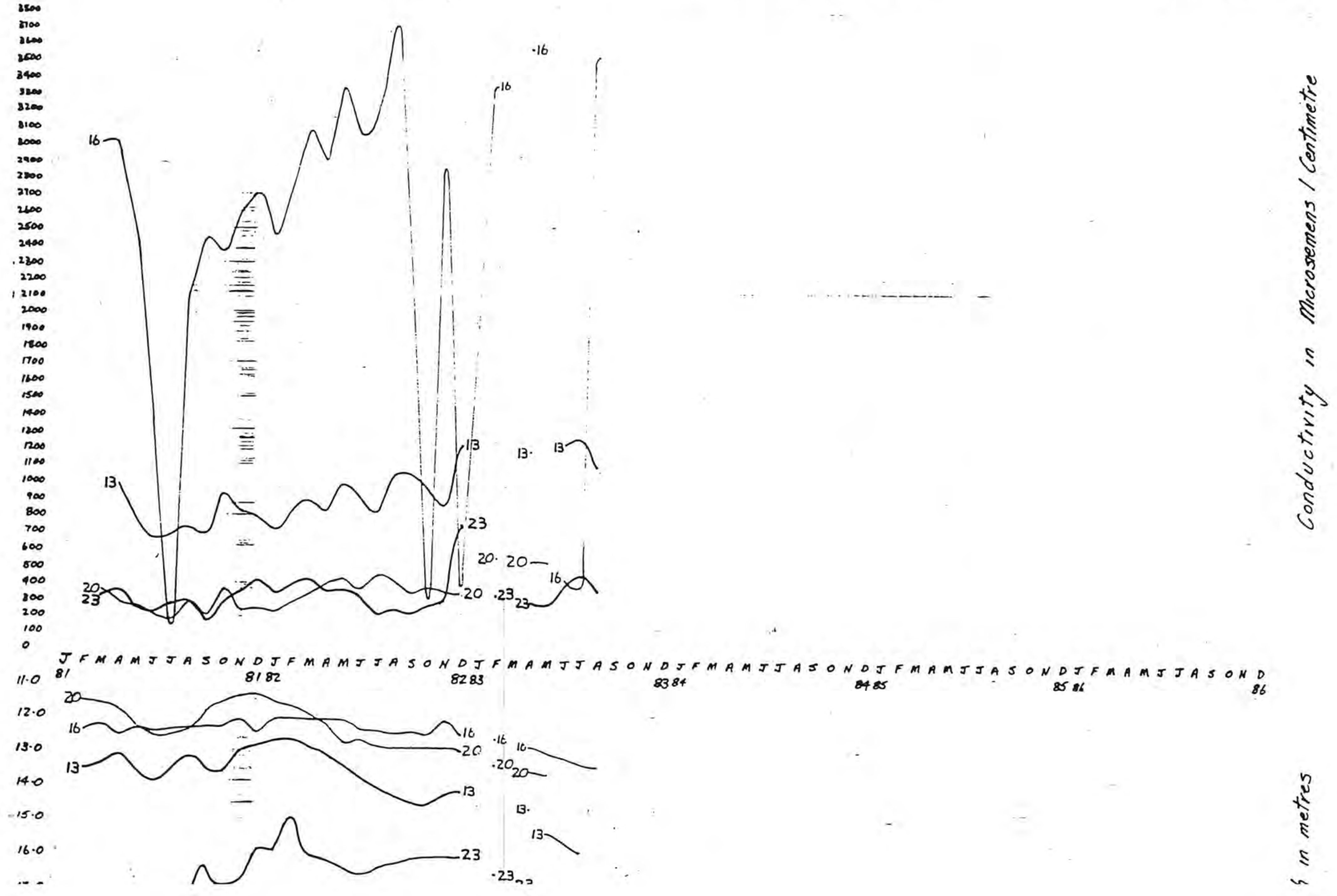
DEEP BORE DATA - CROWEA

BORES 15,17,19,22



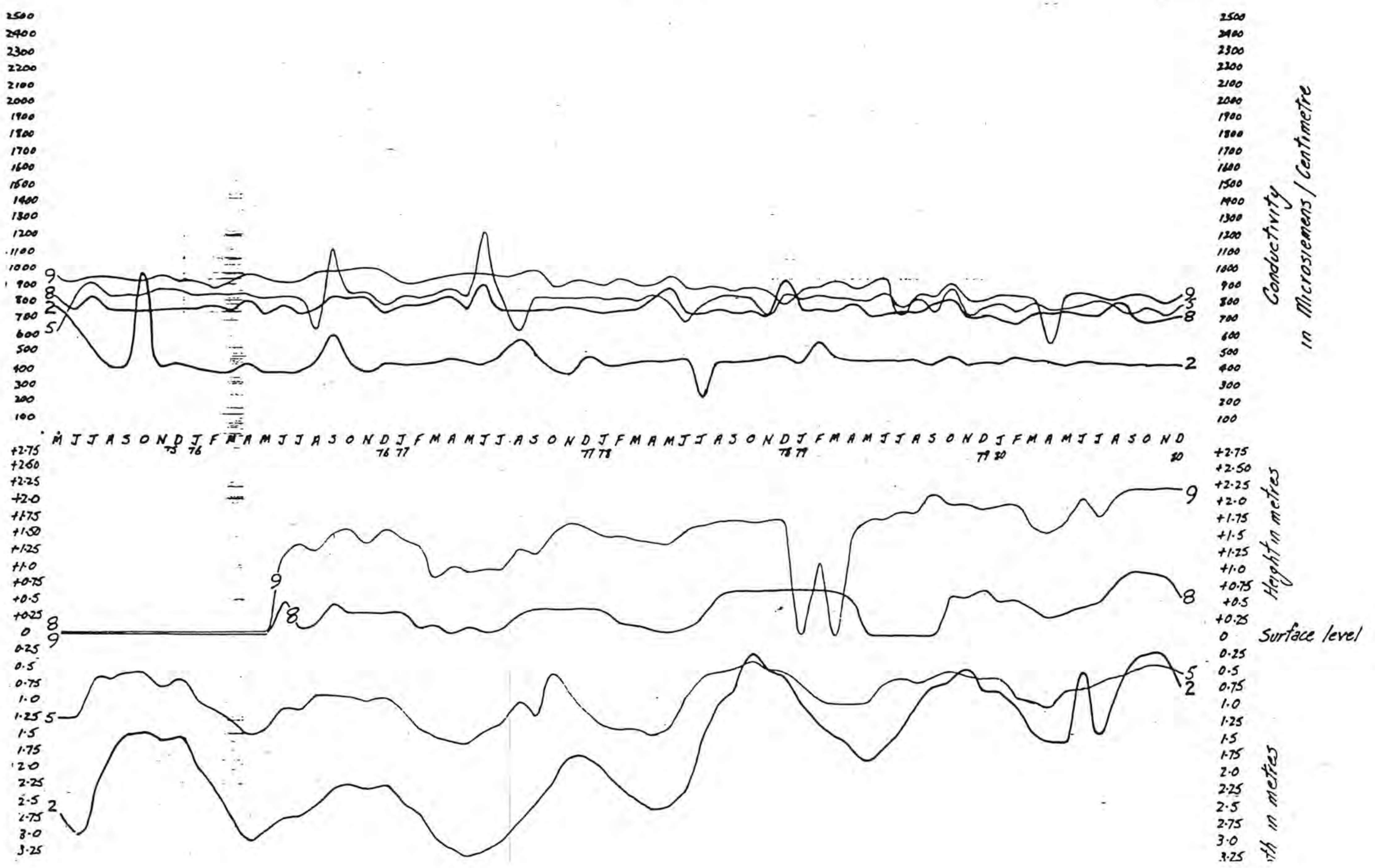
DEEP BORE DATA - CROWEA

BORES 13,16,20,23

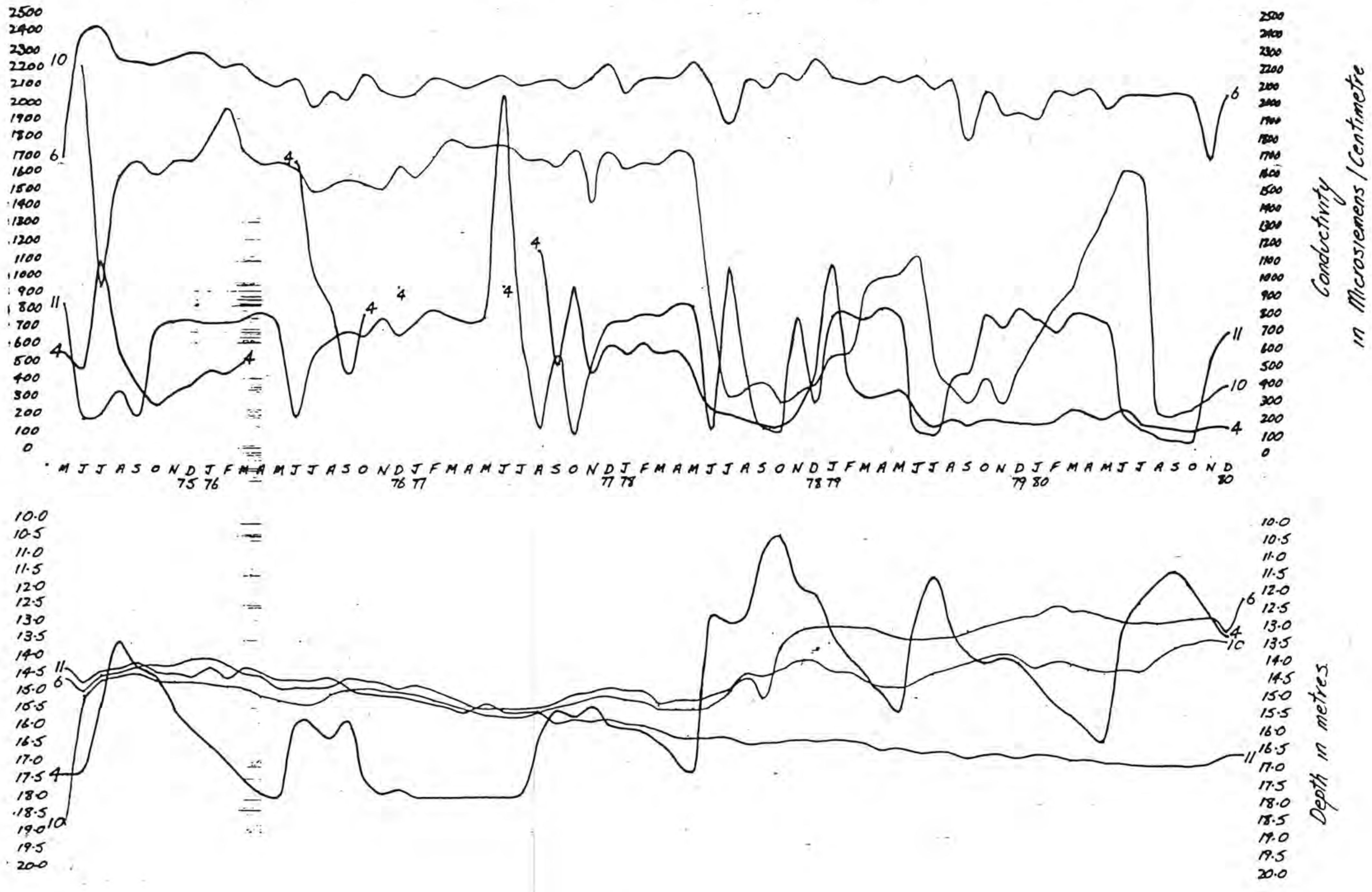


DEEP BORE DATA - IFFLEY

BORES 2,5,8,9

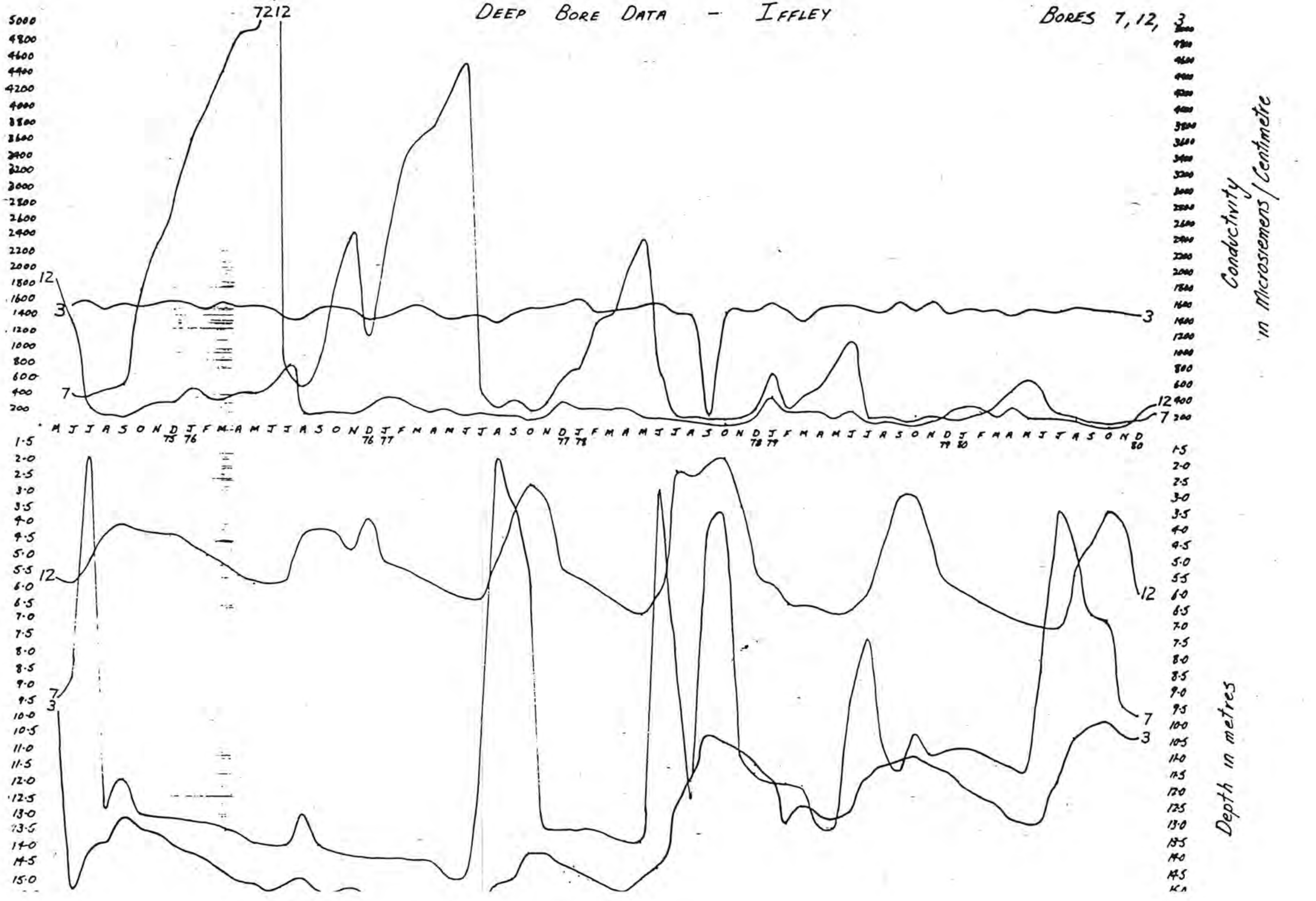


DEEP BORE DATA - IFFLEY BORES 4, 6, 10, 11.



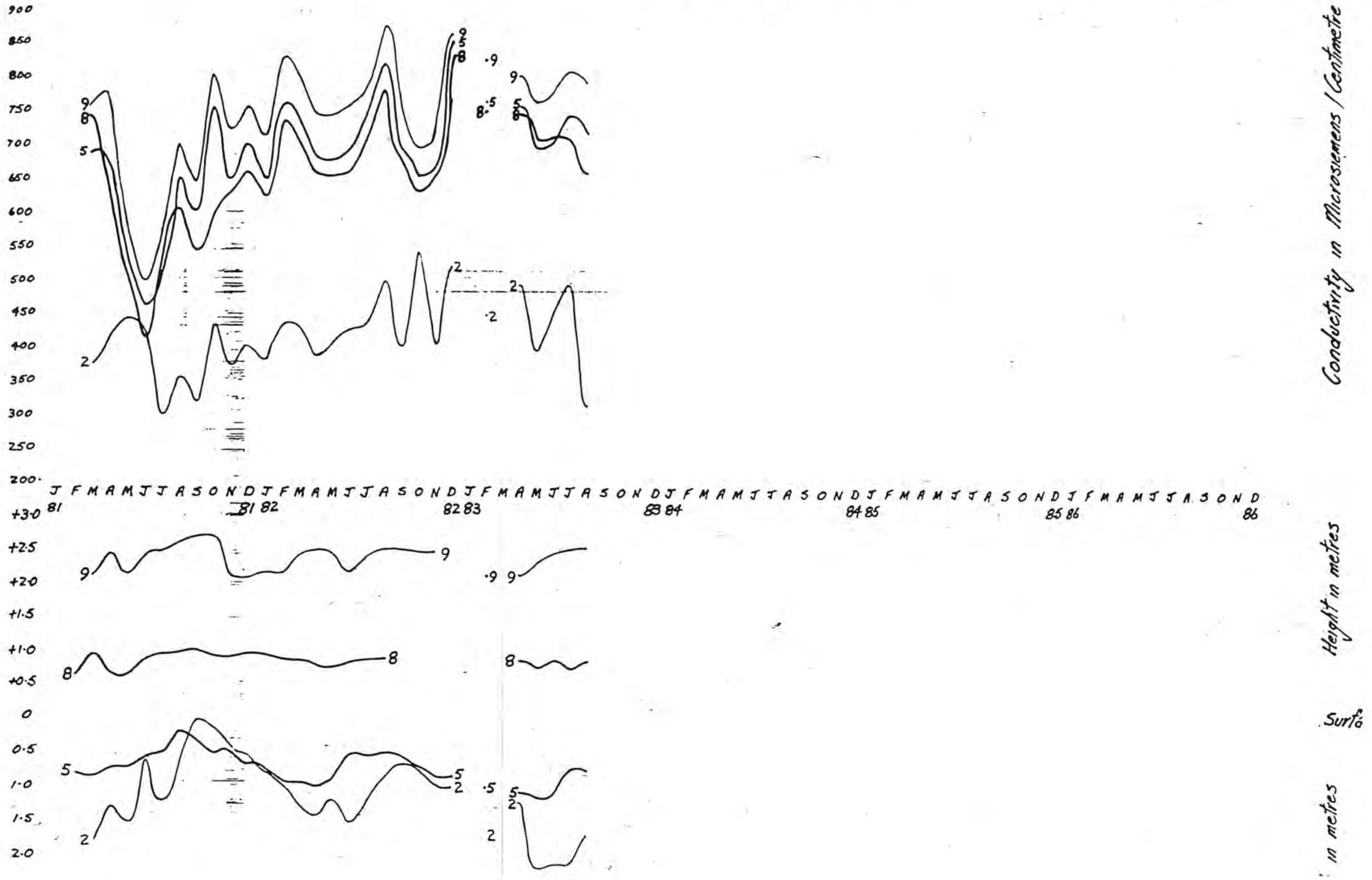
DEEP BORE DATA - IFFLEY

BORES 7, 12, 3



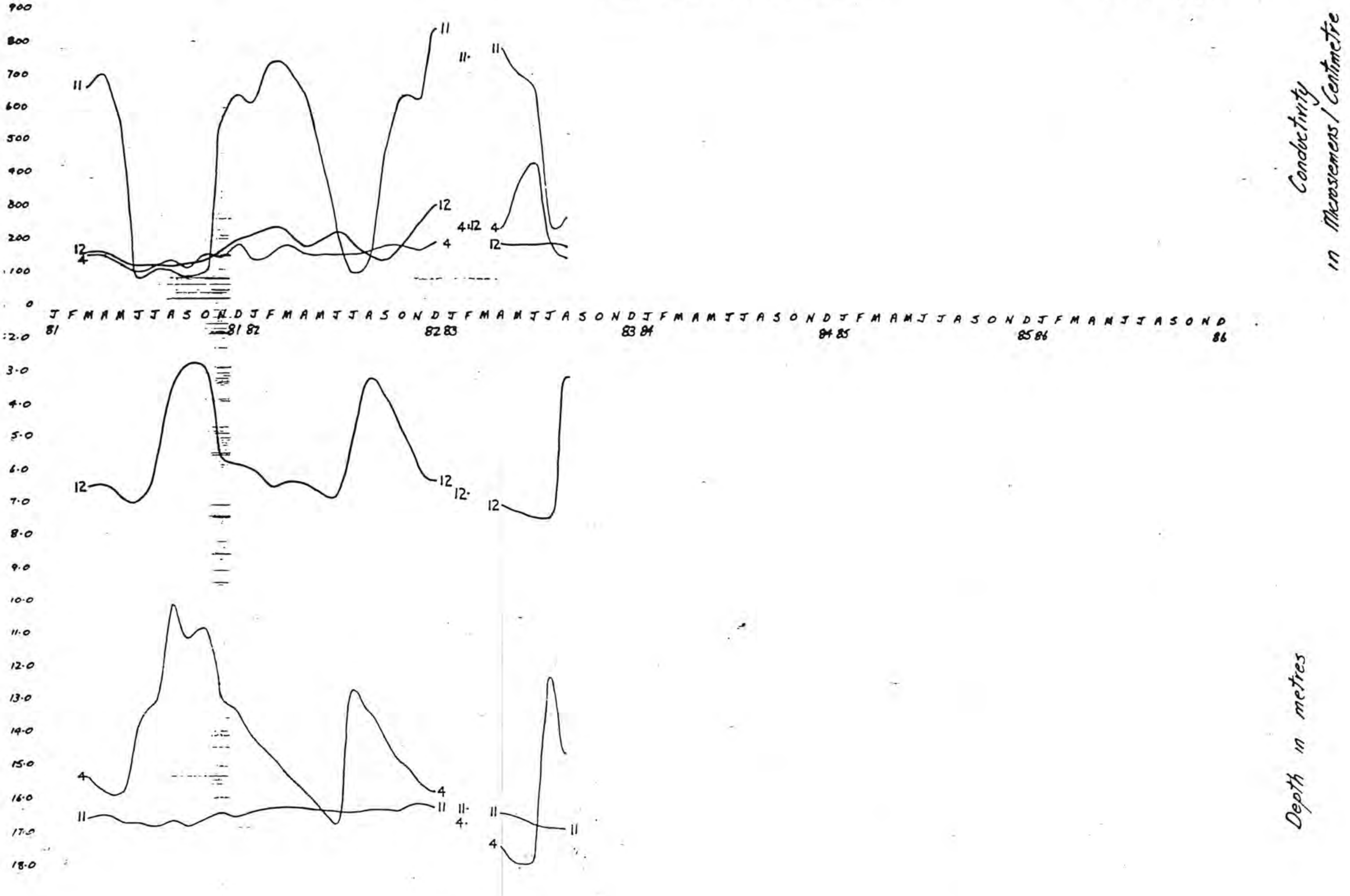
DEEP BORE DATA - IFFLEY

BORES 2,5,8,9



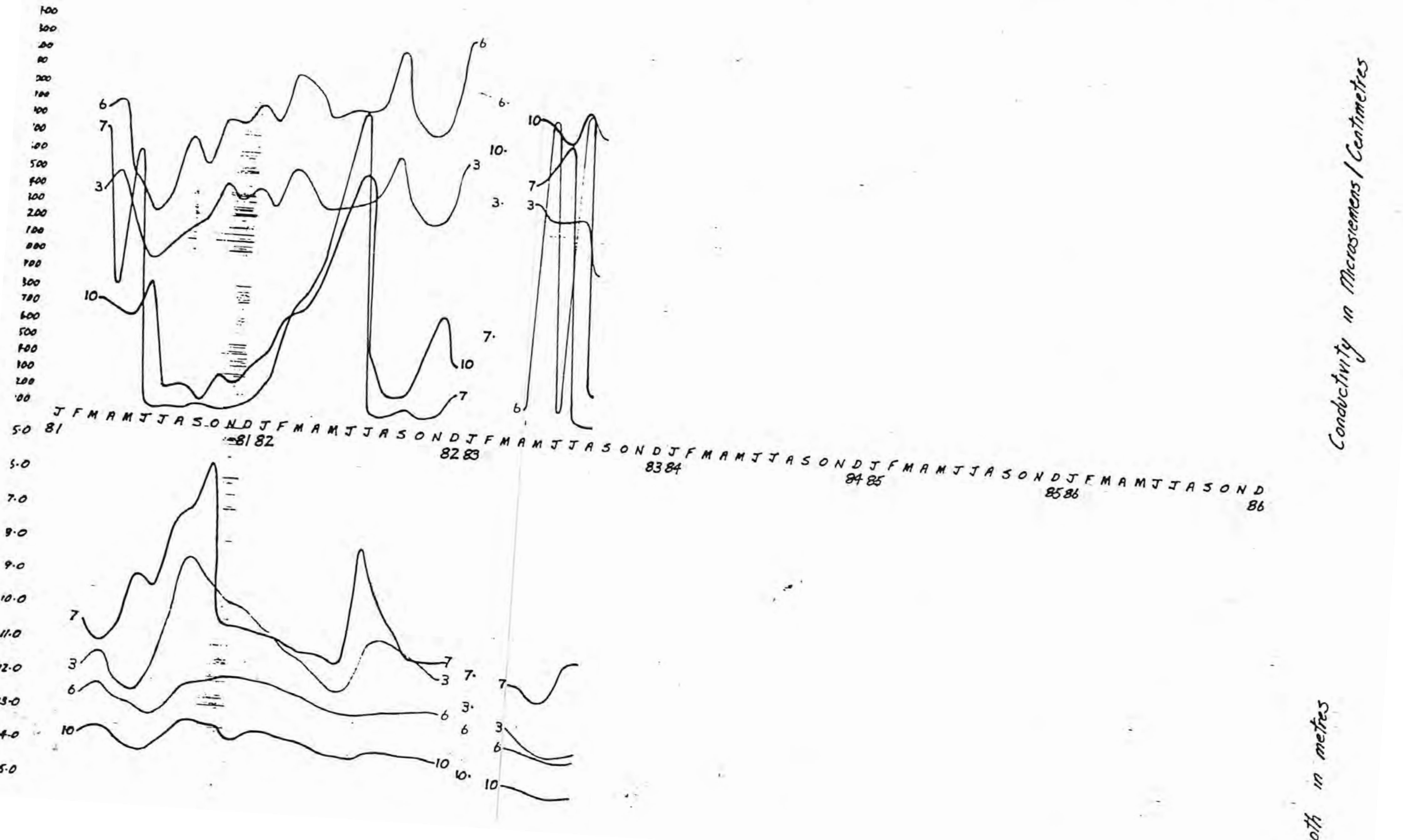
DEEP BORE DATA - IFFLEY

BORES 4, 11, 12



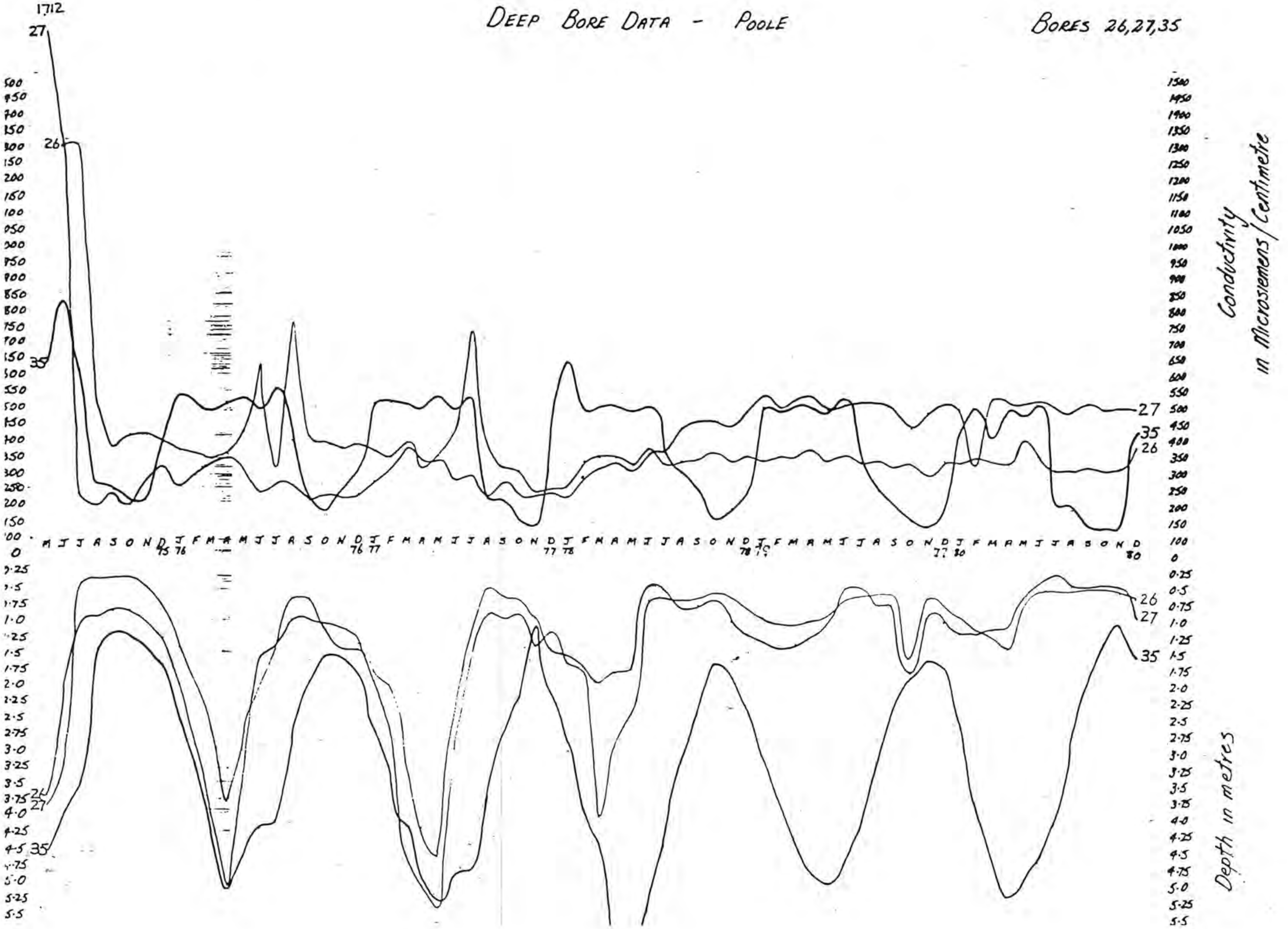
DEEP BORE DATA - IFFLEY

BORES 3, 6, 7, 10



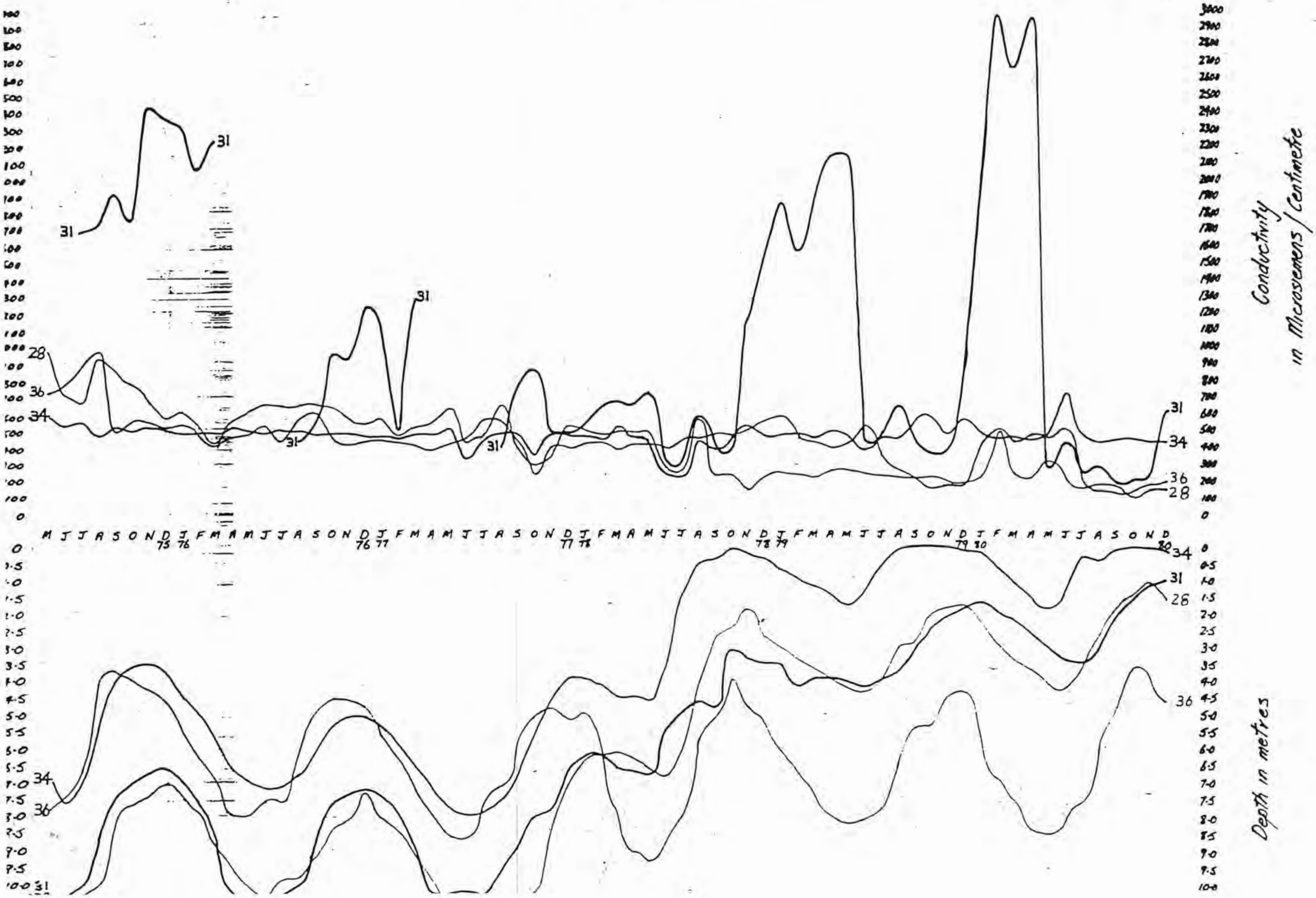
DEEP BORE DATA - POOLE

BORES 26,27,35



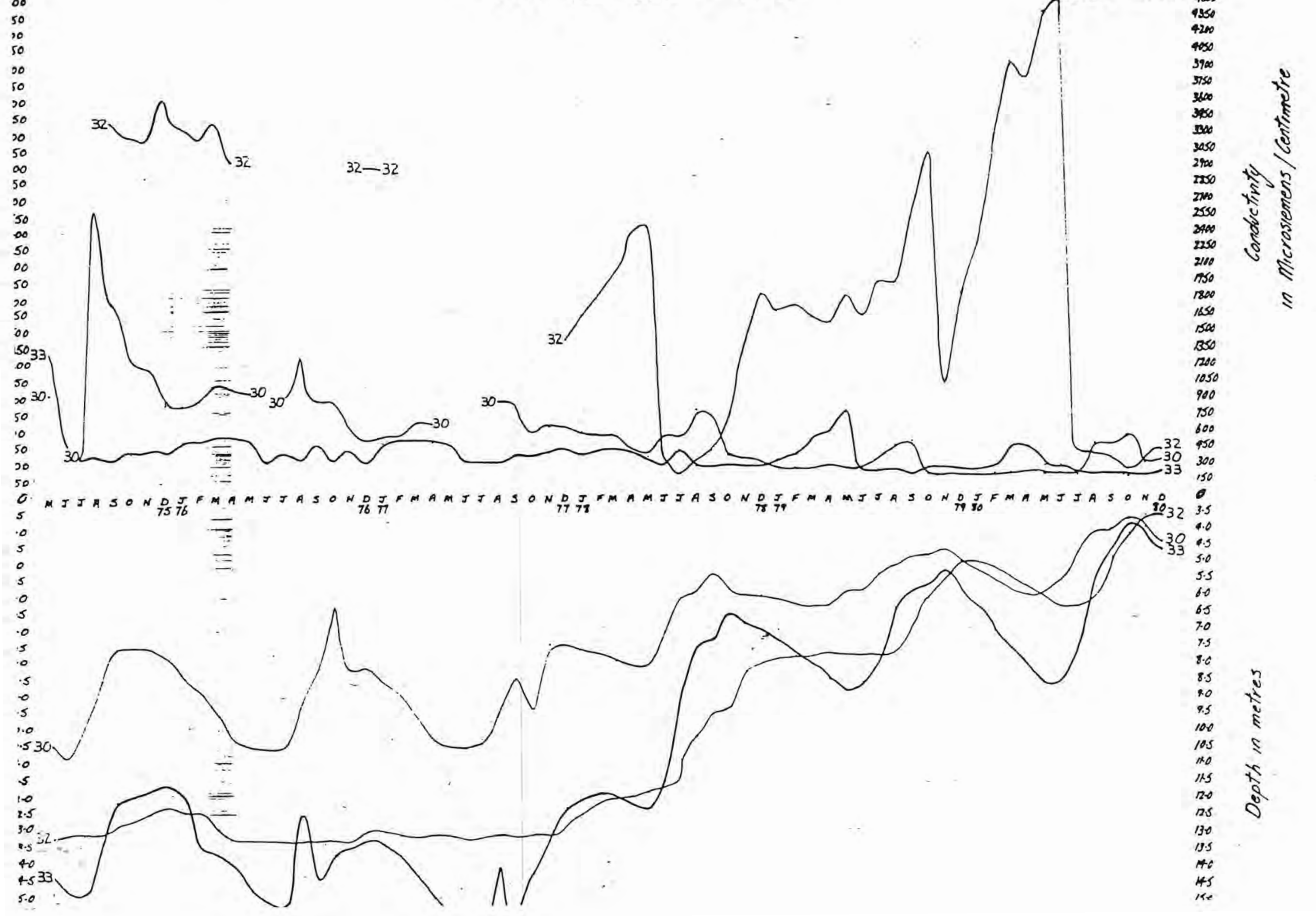
DEEP BORE DATA - POOLE

BORES 28, 31, 34, 36



DEEP BORE DATA - POOLE

BORES 30,32,33



DEEP BORE DATA - MOORALUP

BORES 37, 38, 40, 41, 43, 45, 46, 48