IRISH - DUTCH

GEOHYDROLOGY AND ECOLOGY STUDY

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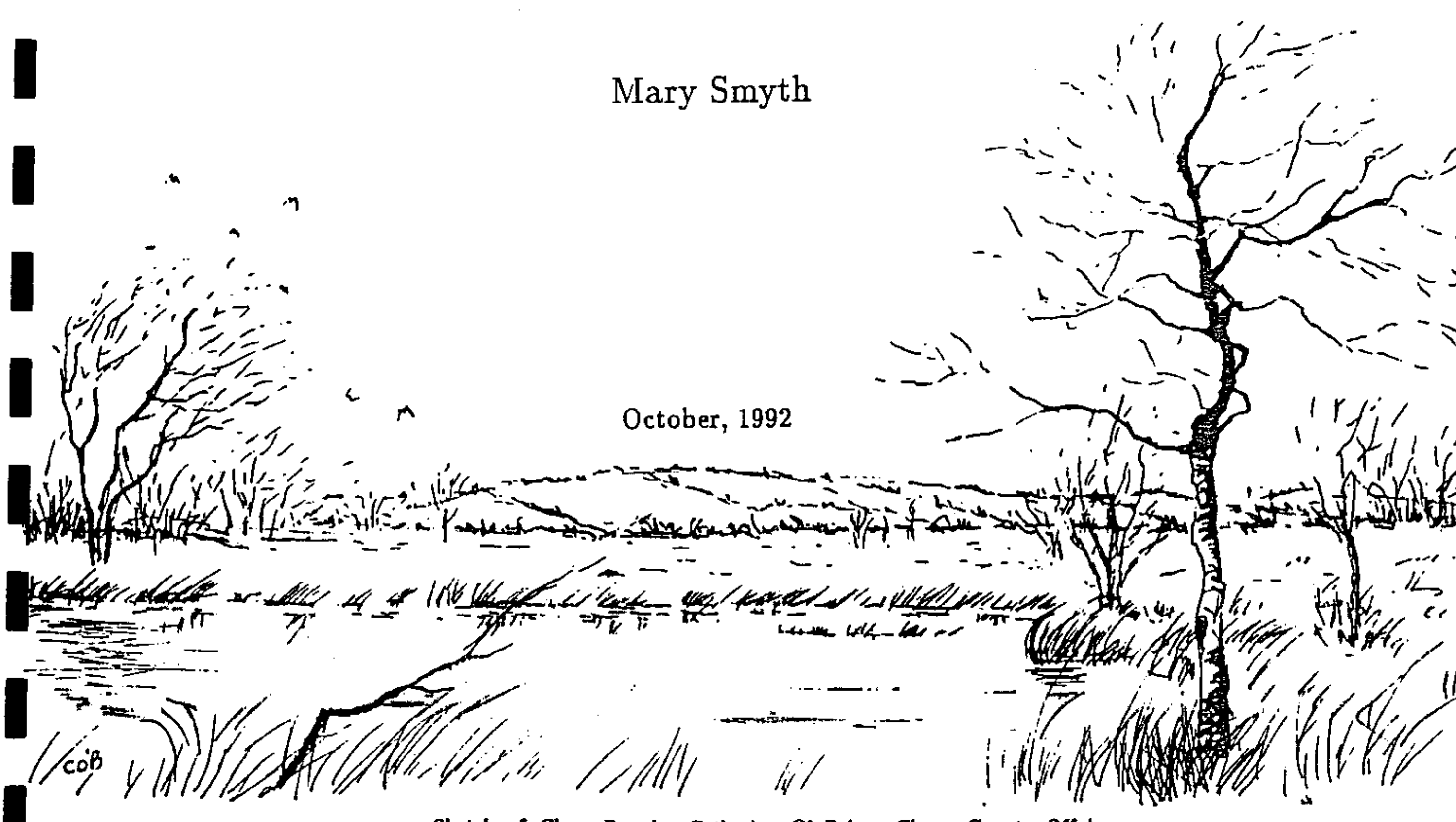
Resistivity Vertical Electric Sounding Survey on Clara Bog, Co. Offaly: Complementing initial VES work.

By

Mary Smyth

October, 1992



Sketch of Clara Bog by Catherine O' Brien, Clara, County Offaly.

AGP 92/5

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Project Report Series

Applied Geophysics Unit
University College
Galway

October, 1992

Contents

3

List of Figures

Chapter 1

Introduction

An account of the geophysical work carried out on Clara bog, in June 1992 is given in this report. This work was carried out by Malcolm Dowling, assisted by Ethel Naughton and Marco Scheffers, under the supervision of the Applied Geophysics Unit, UCG.

During the fieldwork period, a total of 58 resistivity vertical electric soundings (VES) were conducted on and around the area of Clara bog. The purpose of the survey was to a produce a more detailed sounding coverage over the area of the bog, to complement the previous sounding coverage (Smyth, 1992). In addition, soundings were carried out at borehole locations for callibration purposes, and on areas on the margin where additional information was required.

Interpretation of these soundings was carried out in the Applied Geophysics Unit, by Malcolm Dowling using the "RESCURVE" computer package. Borehole logs and information on peat depths (Bloetjes,1992) were taken into account in the interpretation, for callibration purposes, where possible. The interpretation of the soundings is discussed in Chapter Two. Problems encountered in the interpretation, and assumptions made are discussed.

Figure 1.1 shows the location of all soundings carried out on Clara bog. Sounding Nos. 101 to 118, refer to soundings using the Schlumberger array. Nos. 201 to 268 refer to soundings using the Offset-Wenner array. Both these sounding sets were carried out during previous resistivity sounding surveys. The soundings carried out during the present resistivity survey are referred to as Nos. 269 to 326. Geological boreholes are numbered 401 to 410 in Figure 1.1. Contour maps are compiled from the information yielded by the interpreted sounding data, and the geological borehole logs. Chapter Three is a description of the contour maps of the topographical surfaces and the thicknesses of the various geological units. Appendix one shows the field curves and the theoretical curves for the respective soundings.

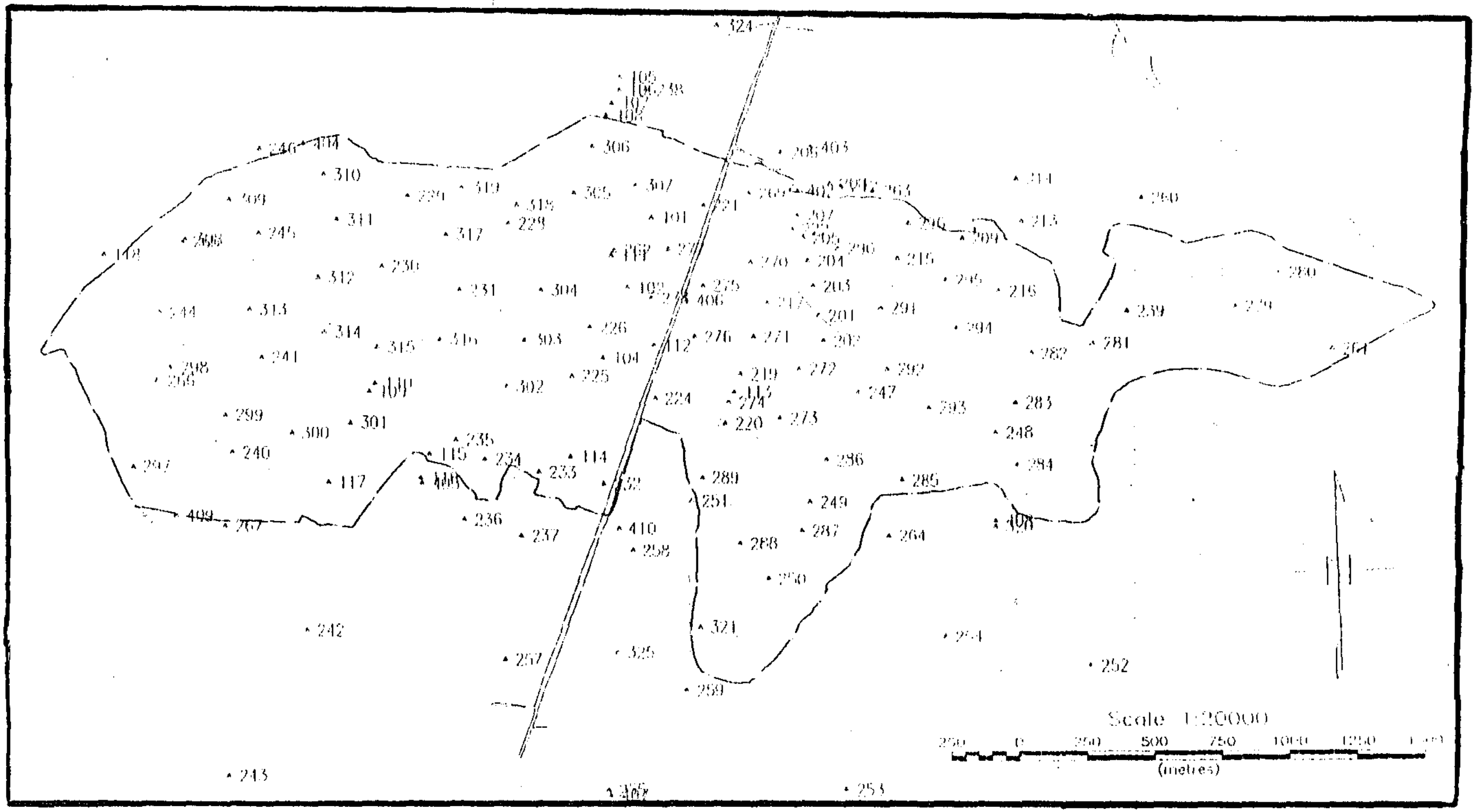

Figure 1.1: Resistivity Vertical Electric Sounding Locations

Chapter 2

Interpretation of soundings

All resistivity vertical electric soundings were interpreted using the "Rescurve" computer programme, which allows forward modelling of the resistivity curves. Sounding interpretations were based on the assumption of a four layer model; geological units being peat, lacustrine clay, till and limestone bedrock. This assumption was based on information from geological boreholes drilled in the area of Clara bog (Smyth, 1992). Some of the aspects involved in the interpretation of the soundings, and the assumptions made in order to produce the maps, are discussed in this chapter.

Sounding no. 258, which was carried out last year, was reinterpreted to take account of geological information from borehole CL10 (Smyth, 1992), which was drilled this year. This sounding is positioned in the forest plantation to the south of the bog, just east of the road. Borehole CL10 showed peaty topsoil to be 1.7m thick; below the peat, a layer of lacustrine clay is 3m thick. A clayey gravel till 4.3m thick, rests on bedrock at a depth of 9m. The sounding curve (appendix 1) shows that there is an irregularity in the data between the inner electrode spacings, from about 2m to 10m. This may be due to difficult terrain encountered in the forest. Interpretation of the sounding took the geological information into account. Sounding results show a layer of topsoil to be 1m thick. Beneath the topsoil, a 1m thick layer with an apparent resistivity of 37 ohm-m, compares favourably with the resistivity of lacustrine clay. The layer resting on bedrock is shown to have an apparent resistivity of 200 ohm-m, which is a reasonable expected apparent resistivity of a clayey gravel till. The main problem with this sounding is that it does not resolve the exact boundary between the respective geological units, due to the irregularity in the sounding curve at the inner electrode spacings.

A large number of soundings (e.g. VES Nos. 79-81, 91-94, 309-316 and 318,319) show the layer directly below the peat, to have an apparent resistivity of 38 ohm-m to 46 ohm-m. This layer is also shown to rest directly on bedrock. Peat coring carried out in this area (Bord na Mona, 1981; Bloetjes, 1992) showed a gritty clay to underlie the peat. In the interpretation of the soundings, this latter layer is described as a lacustrine clay, due to the low apparent resistivities displayed. It is difficult to distinguish between a very clayey till deposit and a gravelly lacustrine clay deposit, as the apparent resistivity variation is not significant.

Other soundings (e.g VES Nos. 82-84, 95-96), where a gritty clay is also shown to be present from peat corings, are interpreted as a till layer in the soundings. Therefore at these locations, peat is shown to rest directly on the till deposits, and the lacustrine clay layer is absent. Again it is difficult to distinguish between the gravelly lacustrine clay and clayey gravel till, however for interpretive purposes this layer, with apparent resistivities exceeding 70 ohm-m, is described as till.

Sounding Nos. 97 and 98, are locations where silty clay is shown to lie directly below the peat. However the soundings show a relatively high apparent resistivity layer to lie between the peat and bedrock. This layer is described as a till deposit. The clay layer is possibly very thin, and the apparent resistivity variation between the till and clay is insignificant, therefore the soundings cannot distinguish between two distinct layers.

Sounding Nos. 305, 306 and 317, show extremely deep bedrock, ranging from 40m to 50m. The layer above bedrock, has a thickness of 25m to 35m, and an apparent resistivity of about 450-650 ohm-m. However when this latter layer is omitted, the sounding results show depths to bedrock of about 12-14m, which are more realistic depths for this area. These latter depths compare with other soundings in the area (e.gs. Nos. 228, 229, 318, and 319). The VLF-R map (Smyth, 1991, 1992) shows the subsurface in this area to have greatly contrasting apparent resistivity values, over short distances. This indicates that the subsurface topography varies greatly, thus the sounding data is displaying a curve which is being influenced by 3-dimensional effects, and therefore not representing the true depths at one particular location.

Four soundings carried out in the previous VES survey, showed inconclusive results. Instrumentation problems were occuring, giving rise to unstable readings for some of the soundings. It was decided to repeat these soundings in the present survey. Sounding Nos. 274 and 275 were carried out in the exact location of Nos. 113 and 223, respectively. Both these soundings gave very favourable results. VES 274 was carried out with its electrode array orientated perpendicular to VES 113. Therefore no problems arose in the interpretion of VES 274, as the ground conditions over which the latter array was orientated, probably had less lateral variation than that of VES 113. Electrode array orientation for VES 275 was similar to that of 223, but problems arose with unstable readings for VES 223 due to a low battery charge. However sounding Nos. 271 and 307, which were carried out at the same loction as Nos. 218 and 227, respectively, did not give favourable results.

Both these areas have a high apparent resistivity variation, shown on the VLF-R map, which cause lateral effects to come into play. Therefore neither of these soundings gave favourable results, but they do however reflect the significant effects of sharply undulating topography. Electrode array orientation for VES 218 and 271 were perpendicular to each other, but lateral variation in both directions was significant to affect the curve.

Two soundings, Nos.322 and 323, were carried out on the esker deposits to the north of the bog. VES 322 was carried out at the base of a depression in the esker, however the base of this depression had a considerable topographical variation. This sounding showed a layer from a depth of 0.5m to 5m below the surface, to have an apparent resistivity of 900 ohm-m. Below this layer, the apparent resistivity falls to 150 ohm-m, before fising to 550 ohm-m, 10m below the surface. Esker topography varies greatly over short distances, and the respective subsurface layers are not horizontal, therefore no clear results can be concluded from this sounding. VES 323 was carried out in a longitudinal depression to the north of the latter sounding. From a depth of 0.5m to 3m, a layer with an apparent resistivity of 110 ohm-m is shown. Below the latter layer, an apparent resistivity of 560 ohm-m is indicated for a 5.6m thick layer, which probably represents dry sands and gravels. Bedrock at a depth of 8.6m is a reasonable depth for this location, based on seismics carried out at location 322 (Keohane, 1991).

In the extreme north east, to the north of the esker deposits, sounding No. 226 is located. This location is on a flat area approximately 100m north of the esker ridge. Shallow bedrock, at a depth of around 4m is shown.

The information from the interpreted sounding results are used to produce the following contour maps in Chapter 3: sub-peat surface topography; till surface topography; bedrock surface topography; clay thickness; till thickness and overburden thickness. Data were organised in "xyz" format; the "xy" columns referring to National Grid northings and eastings, and the "z" columns referring to the respective data sets. All maps were produced with the Geosoft mapping package at the Applied Geophysics Unit. In compiling the maps, certain data columns were arranged to prevent misleading information being displayed on the contour maps. At sounding locations where no till is present, the bedrock surface elevation is used to avoid interpolation by the computer programme. Also, as mentioned above, areas which display a sub-peat layer with a relatively low apparent resistivity value of less than 60 ohm-m, are interpreted as lacustrine clay. Soundings showing a sub-peat layer with apparent resistivity values greater thgan 60 ohm-m are interpreted as till deposits.

Chapter 3

Contour Maps of Geological Units

3.1 Comparison of Contour Maps

Sub-peat Surface Topography

Figure 3.1 shows the sub-peat surface of Clara bog. Since the data used in compiling this map is based on the vertical electric sounding positions shown in Figure 1.1, it is not as detailed as that of the contour maps based on more intensive peat coring data (Bord na Mona Survey (Smyth,1992) and Bloetjes (1992)). This map does however give a very good impression of the sub-peat surface topography, showing the central area to be lower than 52m O.D.

Till Surface Topography

A contour map of the till surface topography is shown in Figure 3.2. This map is similar to the contours of the sub-peat topography in areas where till directly underlies the peat. This map is an indication of the topography of the area, before the lacustrine clay was deposited. A general depression exists in the central area of the bog, which is shown enclosed by the 50m O.D. contour line. An area of low surface elevation, less than 48m O.D., extends out from the centre to the north, west, east and south west. Contained within this region, localised areas to the south, north and east are less than 46m O.D.; the very central area shows an elevation lower than 44m O.D. On Clara West, high elevation areas of the till surface, intrude from the north west and south west, showing a relatively steep increase in the till surface elevation in both areas, to 60m O.D. at the bog margin. This has the result of making a depression, with surface elevation less than 54m O.D., extending in the form of a channel westwards. To the south east, till surface elevation is much lower than that of the south west and north west. The

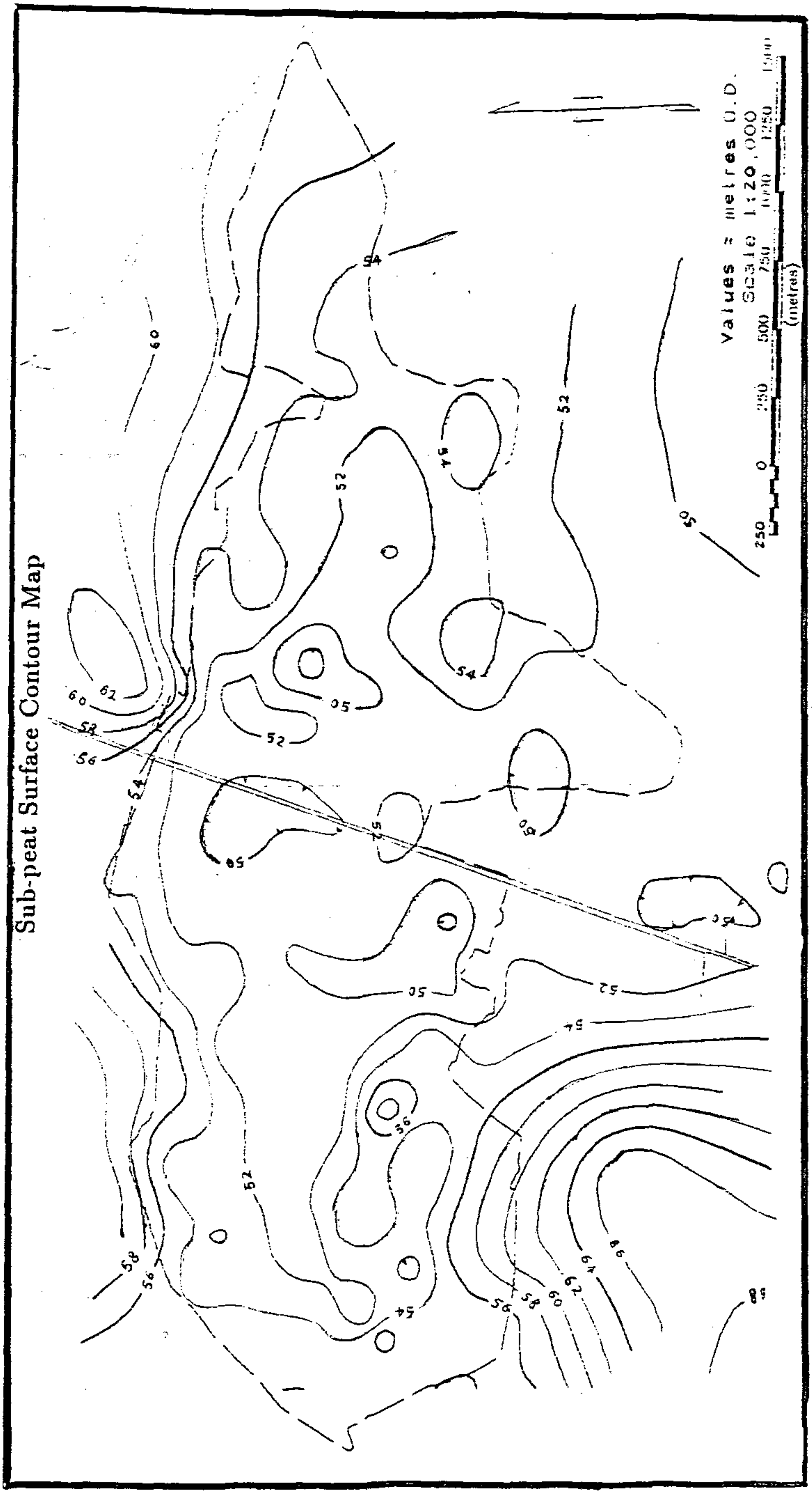

Figure 3.1: Sub-peat Surface Topography

surface elevation does not rise steeply like the latter two areas, but forms a relatively elevated platform, due to the intrusion of the 52m O.D. contour line into the south east area of the bog, from the west. Eastwards, the surface elevation rises gradually from 48m O.D. to 54m O.D. on the east margin of the bog. In the north eastern area, the till surface elevation also rises gradually. From 50m to around 54m O.D. towards the esker deposits to the north. In the south, a shallow depression lower than 50m O.D. extends from the central area southwards. This depression is bounded by the steeply rising surface elevation contour lines to the west, and the slightly elevated till platform to the east. In general, the till surface topography consists of a central depression, with surface elevation less than 50m O.D., bordered by a gradual till surface rise to the east, and abrupt rise in the north west and south west. The lowest elevation depression is in the south, where the till surface is shown to be lower than 50m O.D. A longitudinal depression, in the form of a channel exists in the west, however the base of this depression is at a relatively high elevation of 54m O.D.

Bedrock Surface Topography

Surface contours of the bedrock topography is shown in Figure 3.3. The greater central area of the bog shows a large central depression enclosed by the 46m O.D. contour line. Within this area, the 44m O.D. contour line forms a deep depression orientated north-south, centered along the area of the road. A depression showing bedrock surface elevation less than 38m O.D., exists in the very centre of this channel, while two areas to the north west and south west, show minor depressions also. In the south west, bedrock surface elevation rises gradually towards the south margin. South of the margin the surface elevation rises quite steeply, from 58m O.D. at the margin, to 68m O.D. in the south. Along the bog margin in the north west, the 50m O.D. contour line is present. North of this line, no sounding information is available as esker sediments are present. Bedrock surface elevation is 48m O.D. along the northern margin of Clara East, where it rises gradually to approximately 50m O.D., 200m to the north. A ridge of bedrock with a surface elevation of 48m O.D. runs north-south across the central area of Clara East. This ridge separates a circular bedrock depression enclosed by the 48m O.D. contour line, in the east, from the larger central depression. In the south east, the bedrock surface contours shows a broad area where surface elevation is only 50m O.D. Along the east margin of the bog bedrock surface elevation is 46m O.D. Eastwards, bedrock surface contours decrease, which is apparent in the south east where soundings are more numerous.

Clay Thickness Contours

A map displaying the contour lines for clay thickness is shown in Figure

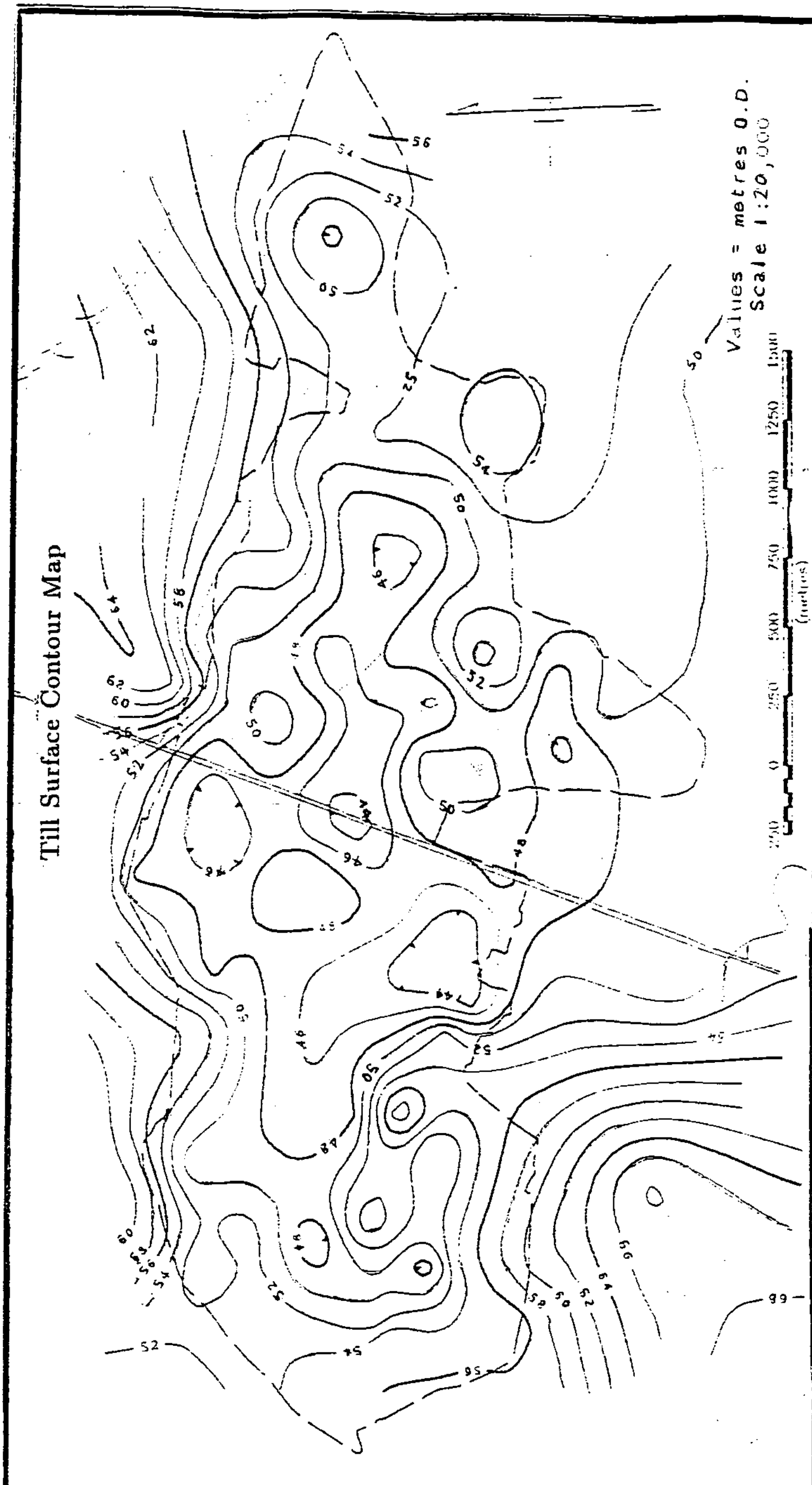

Figure 3.2: Till Surface Topography

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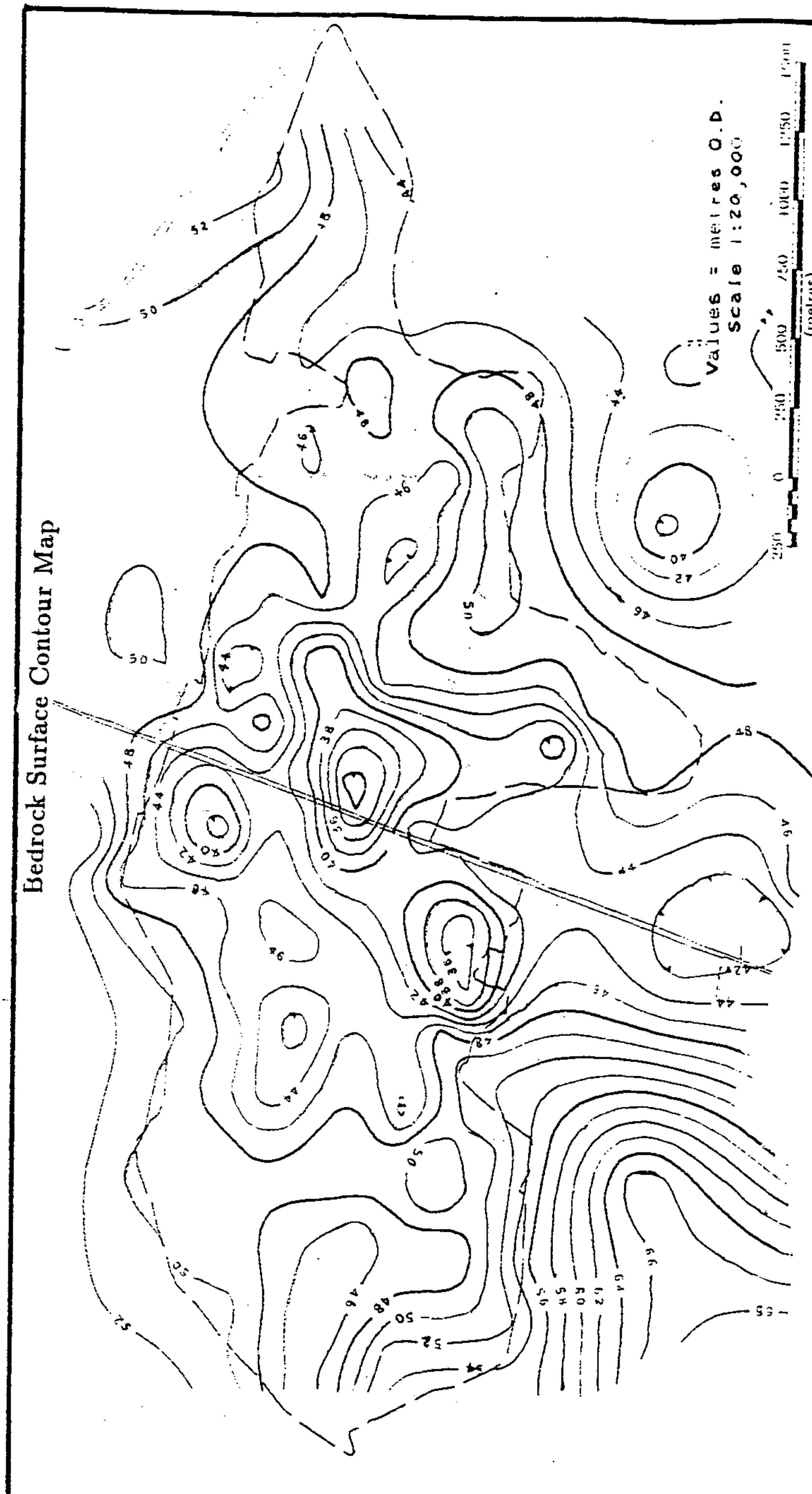

Figure 3.3: Bedrock Surface Topography

3.4. Contour lines show clay thicknesses in excess of 4m, in the central part of the study area. Within this area, two localised areas towards the south and east, show clay thicknesses in excess of 6m. Two isolated areas, with a clay thicknesses in excess of 6m and 4m, exist north of this central area and in the central area of Clara East, respectively. In the north east, contour lines show clay thicknesses greater than 6m. However this clay differs from that of the silty lacustrine clay in the central area, as it is a gritty gravelly clay. Thus it is difficult to distinguish between clay and till in this area. Due to the low resistivity of this material, it is described as a lacustrine clay. Within the bog outline, clay thickness is at least 2m over most of the area. Clay is thinner and absent in the area to the south east. Clay is also absent in a large area to the south west.

Till Thickness Contours

Till deposits are thickest in an area extending from the very central region, towards the south east (Figure 3.5). Till deposits range from 6m to 12m in thickness, at this location. In the central area of Clara East, till is shown to be less than 2m in thickness. South east of the bog margin however, till deposits increase in thickness to 10m to 12m. In the extreme north east of the study area, till deposits decrease in thickness from 8m at the margins, to being absent in a small area in the centre. If till is present it is difficult to distinguish between it and the gravelly clay. Along the east margin till thicknesses are around 4m to 6m. North of Clara East, till thickness is approximately 8m.

Contour lines on Clara west show the till deposit to have a general thickness of around 2m, and not more than 4m. The main deviation from this, is a concentric area just north of the southern margin, where till thickness is in excess of 8m. This region corresponds to the area where a mound exists on the peat surface. Till thicknesses of 6m are shown along the southern margin of Clara West, and 6m to 8m along the western margin. Many isolated pockets showing areas where no till cover exists, correspond to areas where soundings show lacustrine clay to rest directly on bedrock. Along the north margin, to the west, till thicknesses of 6m are shown. Eastwards along the margin, till thickness decreases to around 2m. This latter area also corresponds to thick clay deposits.

Overburden Thickness Contours

Contour lines displaying overburden thicknesses are shown on the map in Figure 3.6. Overburden is defined as deposits below the peat, resting on bedrock. The category includes till and lacustrine clay, and esker deposits north of the bog margin.

From the central area of the study region, extending southwards, over-

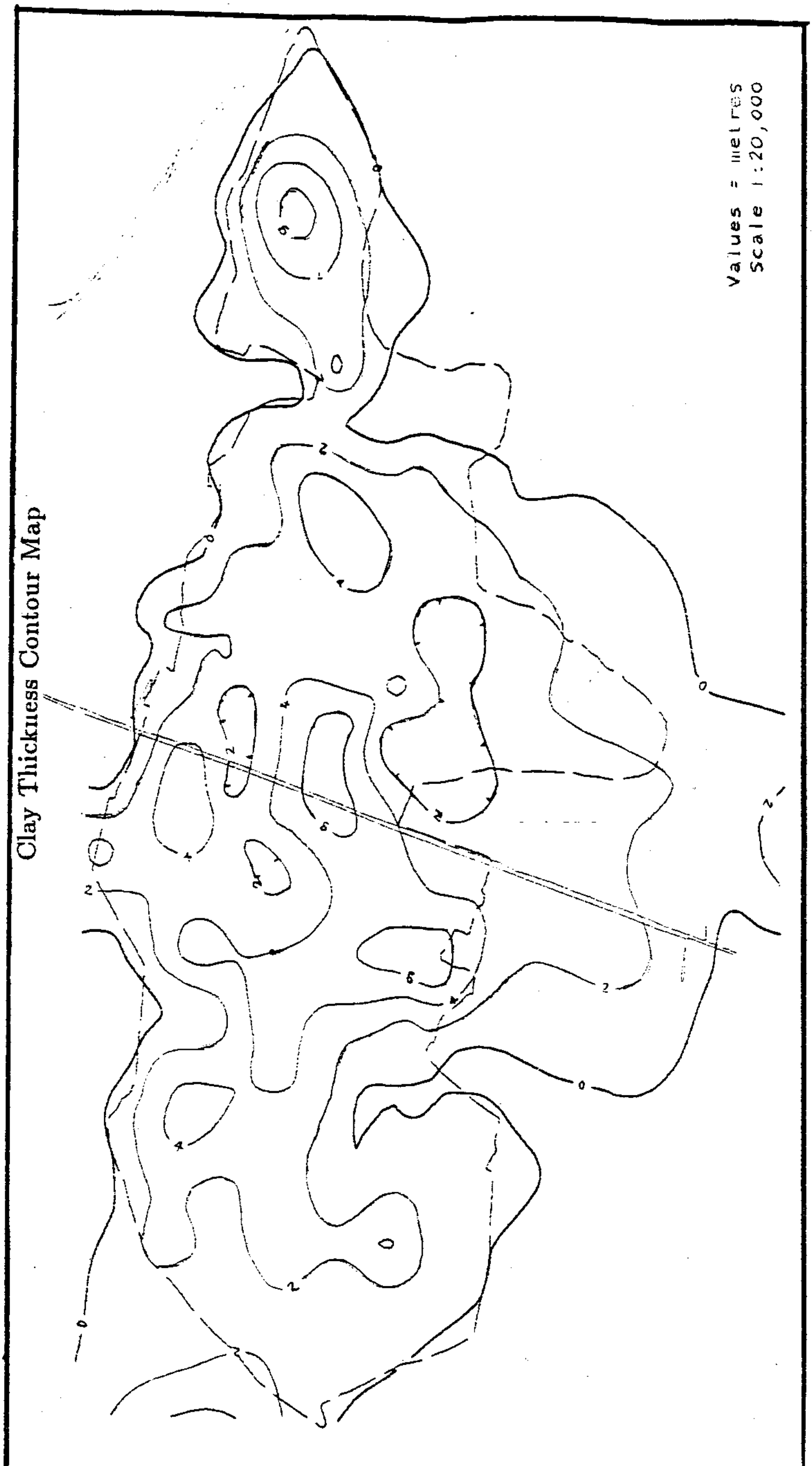

Figure 3.4: Clay Thickness Contour Map

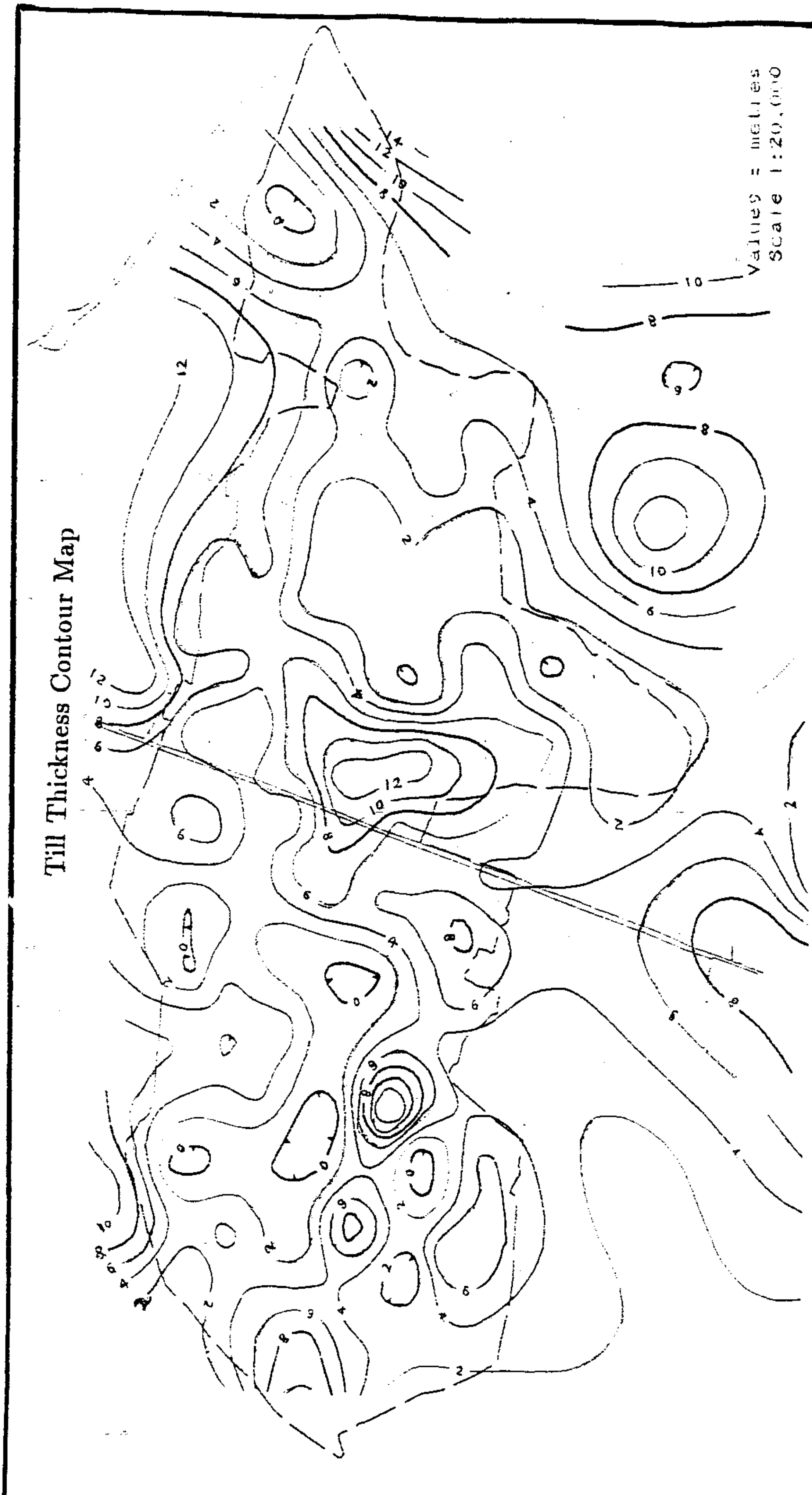

Figure 3.5: Till Thickness Contour Map

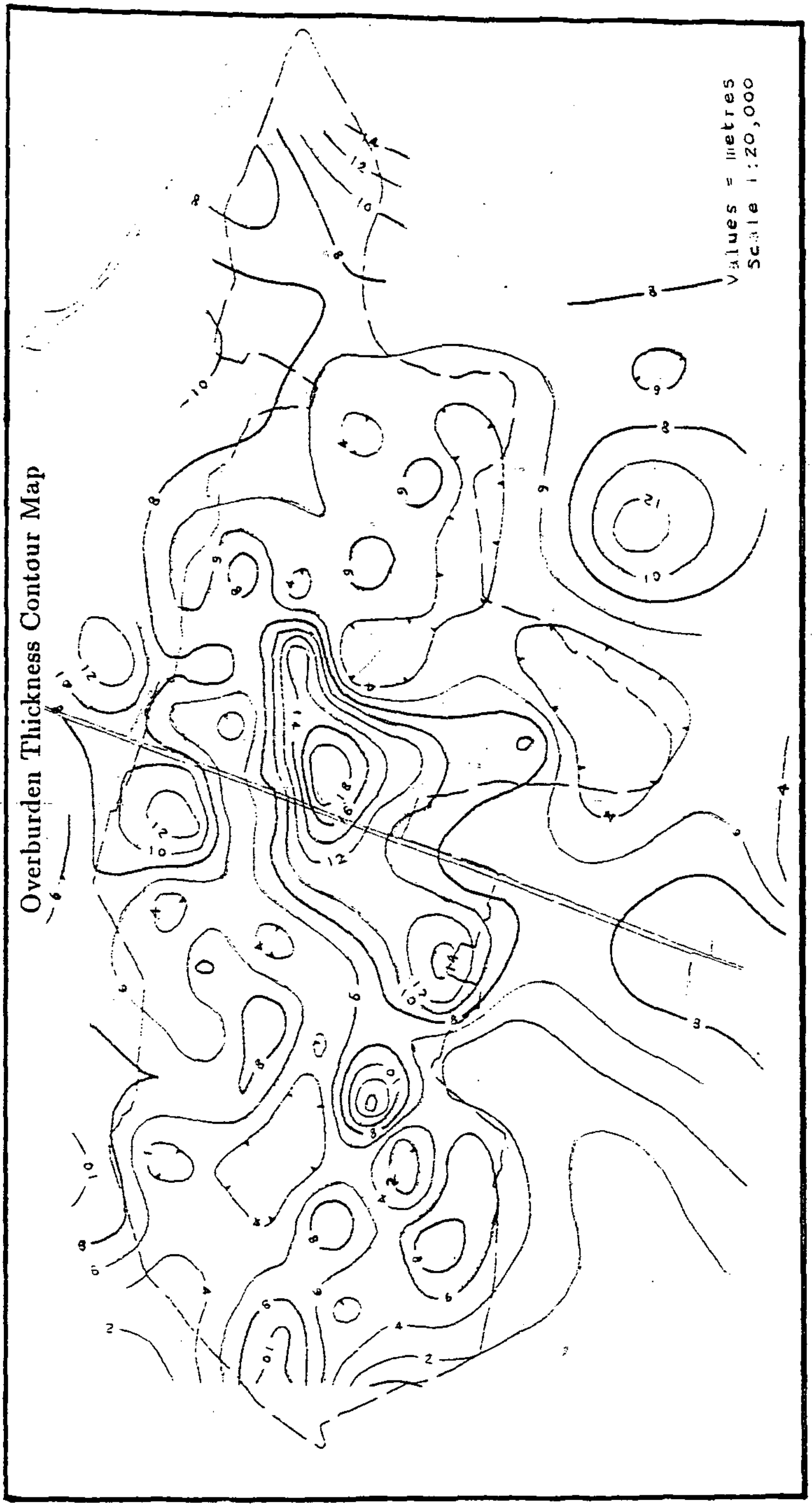

Figure 3.6: Overburden Thickness Contour Map

burden thicknesses are in excess of 8m. Overburden reaches a maximum thickness of 16m to 18m in the very centre. Directly south of the central region, overburden is 4m to 6m, increasing to 8m in the extreme south. On Clara East, the central area shows an overburden thickness of 6m. The southern area of Clara East shows overburden thicknesses thinning out to less than 4m. Overburden thicknesses increase greatly, being 10-12m in the extreme south east. East of the road, along the northern margin of Clara East, overburden thicknesses of 8m are recorded, increasing to about 10-12m in the central area of the northern margin of Clara East. North of the bog Esker deposits account for overburden thicknesses of around 14m. In the north east, average overburden thickness is 8m.

On Clara West, a general overburden thickness of around 6m, is shown. Isolated areas where overburden thicknesses are less than 4m are scattered, throughout the area. In the south central area of Clara West, overburden thickness is shown to be 10m to 12m. This area corresponds to the mound on the peat surface, mentioned previously. Directly south west of this latter area, overburden thicknesses of 8m are shown along the south margin. Overburden thicknesses then decrease from 4m in thickness, south westwards from the southern margin of the bog. This pattern is similar in the north west of the study area. Along the north margin of Clara West, overburden thicknesses of 8m decrease to 6m eastwards. In the extreme west, overburden thicknesses increase westwards to about 10m.

To summarise, overburden is thickest in the central area, ranging from about 8m to 18m in thickness. In the East, overburden is an average thickness of 4m-6m, being less than 4m in some locations. On Clara West, average overburden thickness is 6m; however, isolated pockets occur on Clara West, showing some areas where overburden exceeds 8m in thickness, and other areas where thickness is less than 4m.

3.2 Comparison of Maps

Bedrock Surface Topography and Till Thickness Maps

In general, till is thickest where bedrock depressions occur, and thinnest in areas of shallow bedrock. This is extremely apparent in the central area of the bog, towards the south. South east of this latter area, the high elevated shallow bedrock corresponds to an area of relatively thin till cover of less than 2m. West of this area bedrock deepens and till thickness increases from 4m to 8m. In the south west, steeply shallowing bedrock corresponds to a relatively thin till cover of 2m to 4m. Similarly in the central area of Clara West, shallow bedrock extending north westwards corresponds to a relatively thin till cover. Two areas, one in the extreme west and the other in the north, just west of the road, show a depression in the bedrock surface topography.

Both these areas correspond to relatively thick till deposits in excess of 6m.

Bedrock Surface Topography and Till Surface Topography

The above pattern is more apparent when comparing the till surface topography in Figure 3.2, with that of the bedrock surface topography in Figure 3.3. The 46m O.D. contour line of the bedrock surface, enclosing the central area of the region, corresponds remarkably with that of the 50m O.D. contour line of the till surface. Within this main bedrock depression, the area to the north, south and the very centre, representing very deep depressions below 38m O.D. in the bedrock surface, also correspond to areas showing a depression in the till surface below 46m O.D. In the south west of the region, the steeply shallowing bedrock surface intrudes north eastwards into the central area of Clara West. This is represented by a similar pattern on the till surface topography. Till surface contours show a relatively broad elevated area of 50m to 52m O.D. in the South east. Bedrock surface contours in this area also show the bedrock surface to have a relatively higher elevation, of 48m to 50m O.D. In the north west, till surface contours rise gradually from 50m to 54m O.D., corresponding to a rise in the bedrock surface from 46m to 50m O.D.

Till Surface Topography and Clay Thickness Contours

A striking feature of the clay thickness contour map is that clay is thickest where depressions occur in the till surface. This is apparent in the central area of the bog, where till surface elevation is below 48m O.D. Here clay ranges in thickness from 4m to 6m in thickness. Clay is also 4m thick in the central area of Clara East, where the till surface shows a depression below 46m O.D. The gradual rise in the till surface of the south east region, and the absence of any depressions in the till surface, result in a clay cover of only 2m of less. In the central area of Clara West the till surface gradually rises westwards, forming a flat area, which rises northwards and southwards. The absence of a depression prevents the accumulation of a thick clay cover; thus clay is only around 2m thick over most of Clara West. In the south west, clay is absent due to the steeply rising till surface, south westwards. In the north west clay is shown to be 6m thick. No till cover is indicated in a small central area, and thus clay has accumulated in a depression between the till and the esker deposits to the north.

Till Surface Topography and Sub-peat Surface Topography

A comparison of till surface topography and sub-peat surface indicates that the latter topographical contours are much gentler. This is as a result of the lacustrine clay infilling the depressions in the till surface, and producing a smoother sub-peat surface topography. This is particularly evident when looking at the 52m O.D. contour line on the sub-peat surface map. In the central area, enclosed by this line, only a slight variation occurs on the sub-peat surface, unlike the area enclosed by the same contour line on the till surface map. Till surface elevations have a higher range within this area.

Overburden Thickness and Bedrock Surface Topography

Overburden thickness is defined as the total cumulative thickness of the till and lacustrine clay deposits. In general, overburden thickness does not exceed 8m, apart from the central area of the bog. Overburden ranges in thickness from 8m to 18m in the very centre of the study area, and from 12m to 14m, in the area to the south west of this central area. A slight depression in the bedrock of the central area of Clara East, corresponds to an overburden thickness of approximately 4m to 6m. South of this area, the overburden decreases in thickness to less than 2m, where bedrock forms a relatively flat elevated area. Beyond the bog outline, overburden increases in thickness to about 10m to 12m in the extreme south east corresponding to a decrease in bedrock surface elevation. Isolated areas where overburden thickness exceeds 8m, occur on Clara West. These areas correspond to localised depressions in the bedrock surface.

Chapter 4

Conclusion

While the Resistivity Vertical Electric Sounding technique is limited in many respects (Smyth, 1992), it does however offer a very good means of investigating geological units, which vary significantly in resistivity, with depth. However geological borehole information is necessary in the interpretation of the results, as results can often be ambiguous and of little use. Problems arise when a layer grades gradually into another layer, and the resistivity variation is very small. This results in failure to distinguish between two distinct geological units, as the sounding curve will only show one continuous layer, with an intermediate apparent resistivity. Lateral variation in geological units, is another major factor to be considered. These effects distort actual sounding data, which in theory assume a horizontally layered earth.

Acknowledgements

Special thanks to Malcolm Dowling for his work in the field, in addition to the difficult task of interpreting the soundings. Thanks also to Ethel Naughton and Marco Scheffers who made the fieldwork possible. Colin Brown's assistance in compiling this report is greatly appreciated.

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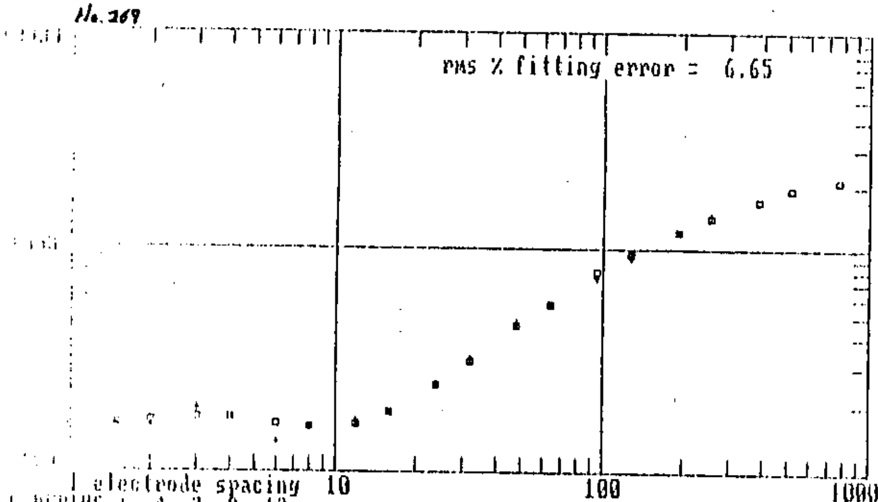
Appendix A

Sounding Curves



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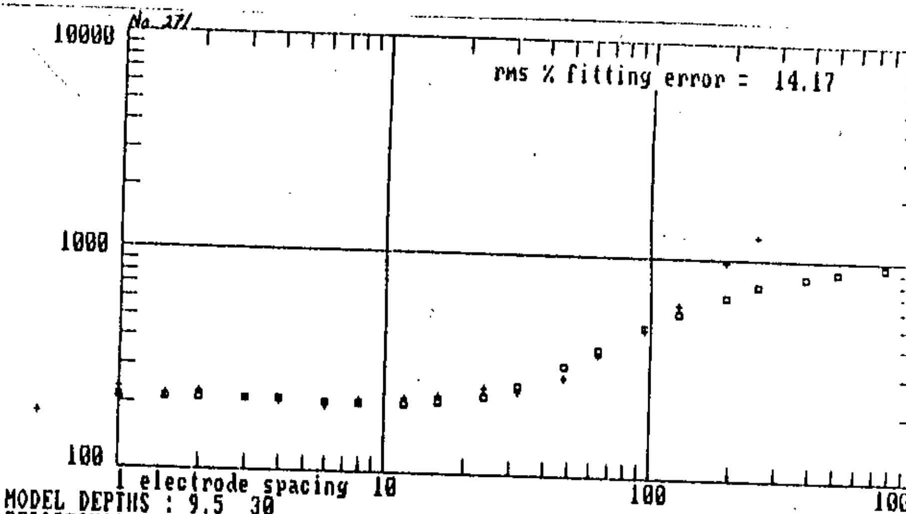

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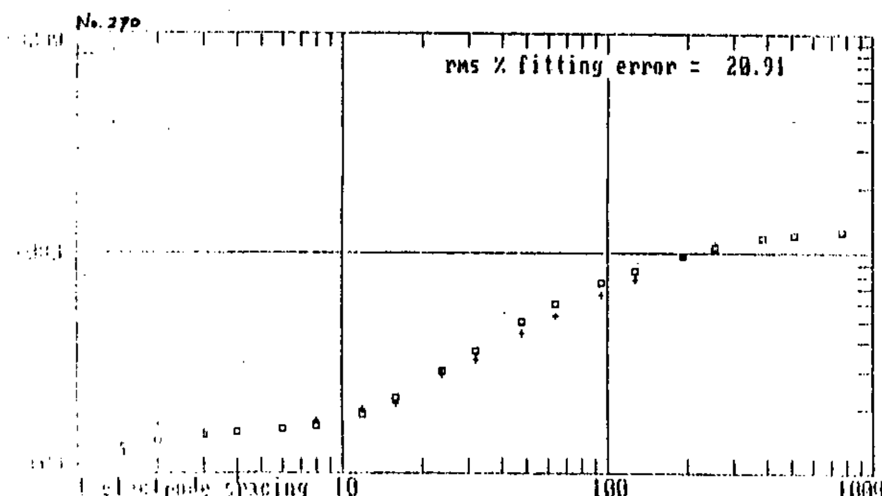

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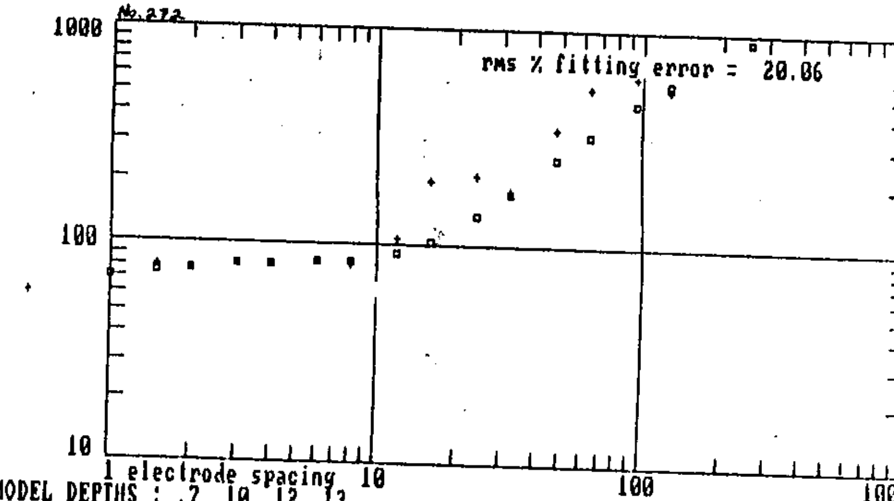

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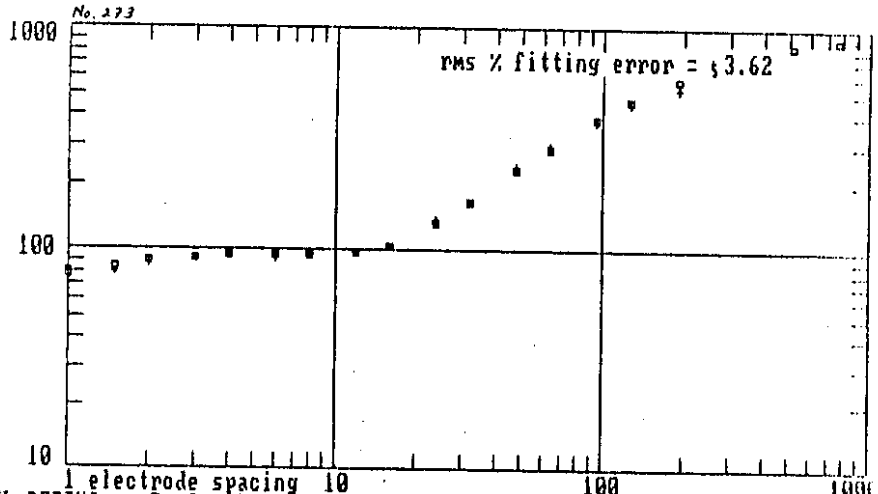
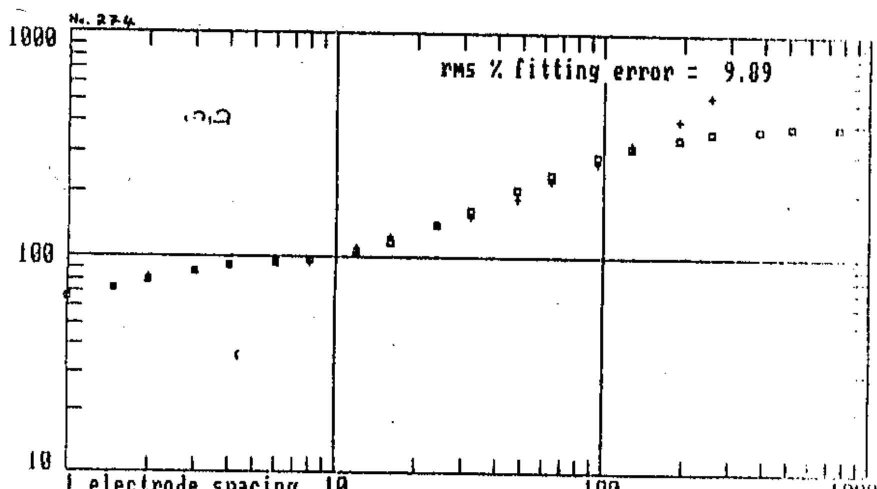


MODEL DEPTHS : .5 9 13.5 14
RESISTIVITIES : 60 100 35 120 1000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : 1 7 8 18
RESISTIVITIES : 60 105 46 110 400
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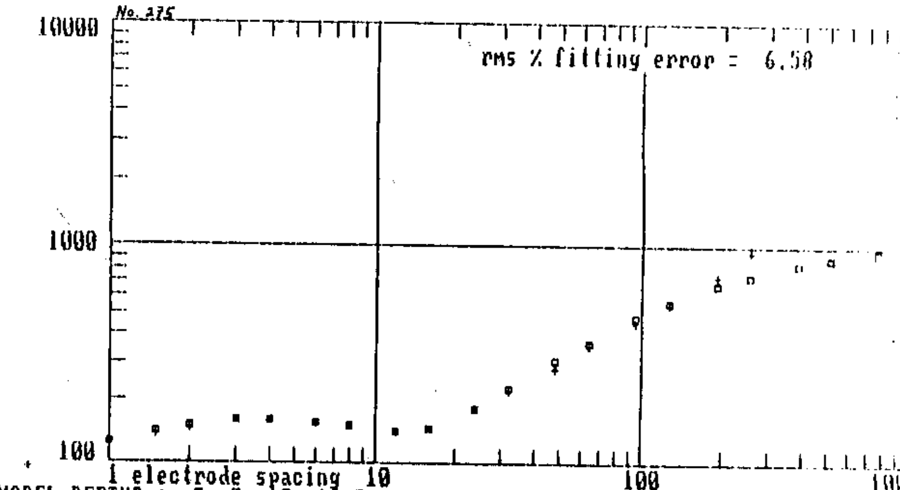
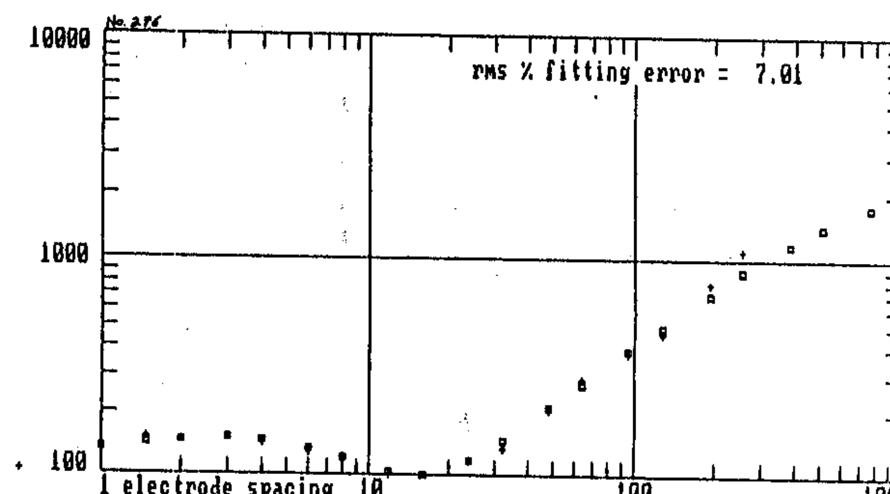
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 7 10 16.5
RESISTIVITIES : 90 178 40 150 1000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 6 12.8 26.6
RESISTIVITIES : 110 162 50 116 3000
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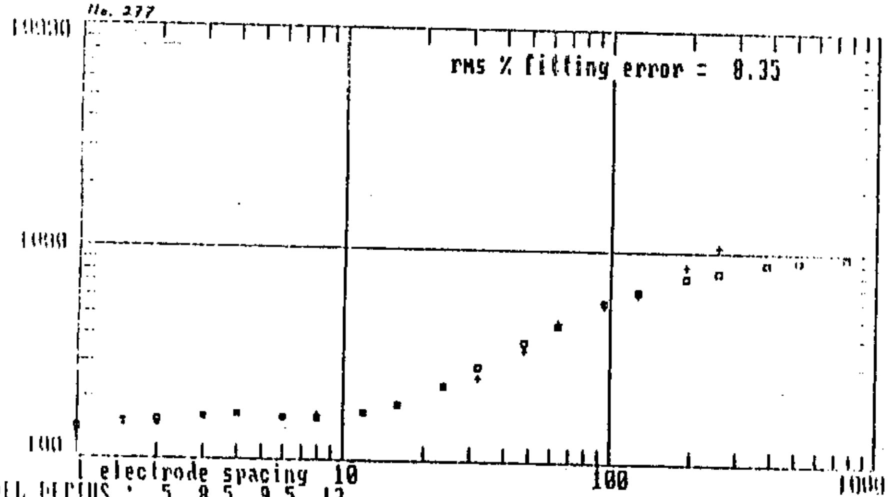
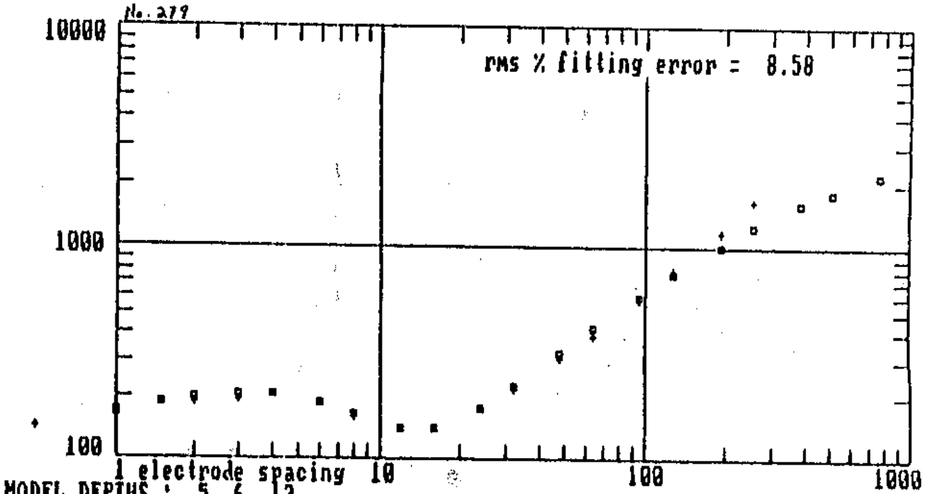
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 8.5 9.5 13
RESISTIVITIES : 120 170 30 110 1000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 6 13
RESISTIVITIES : 126 235 46 3000
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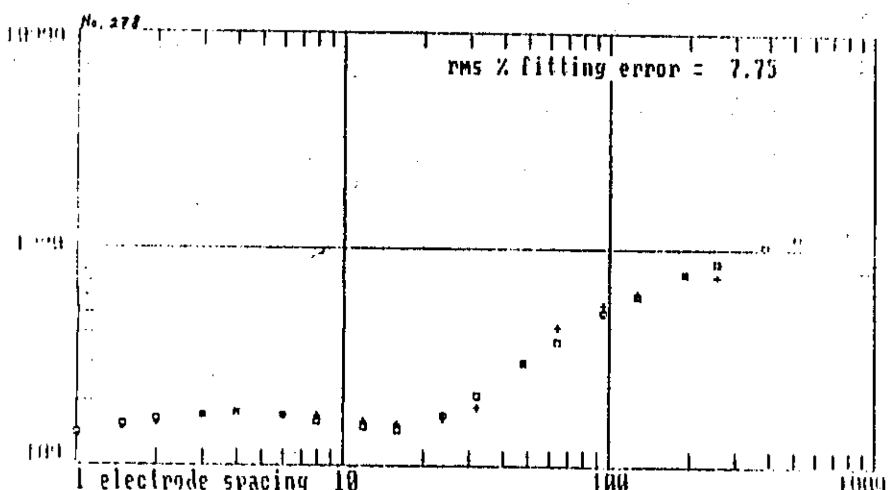
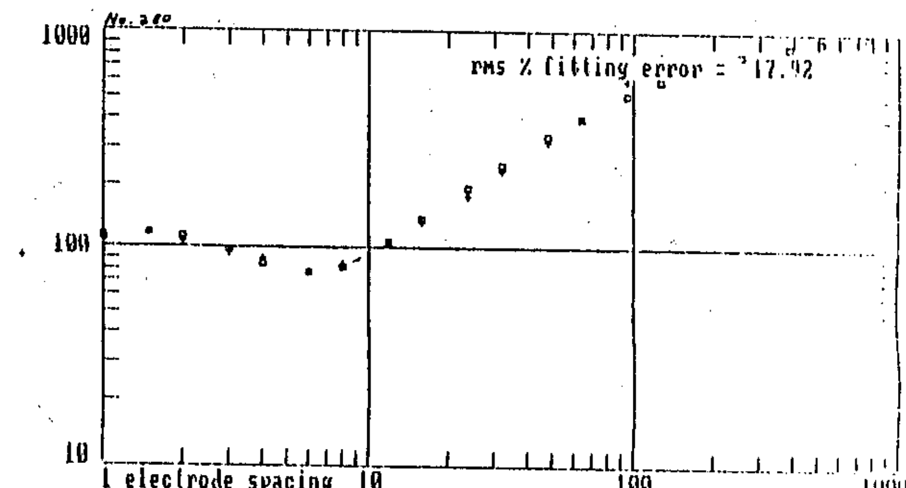
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 8 13.5 16
RESISTIVITIES : 105 190 50 90 1400
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : 0.5 2 7
RESISTIVITIES : 95 155 40 1000
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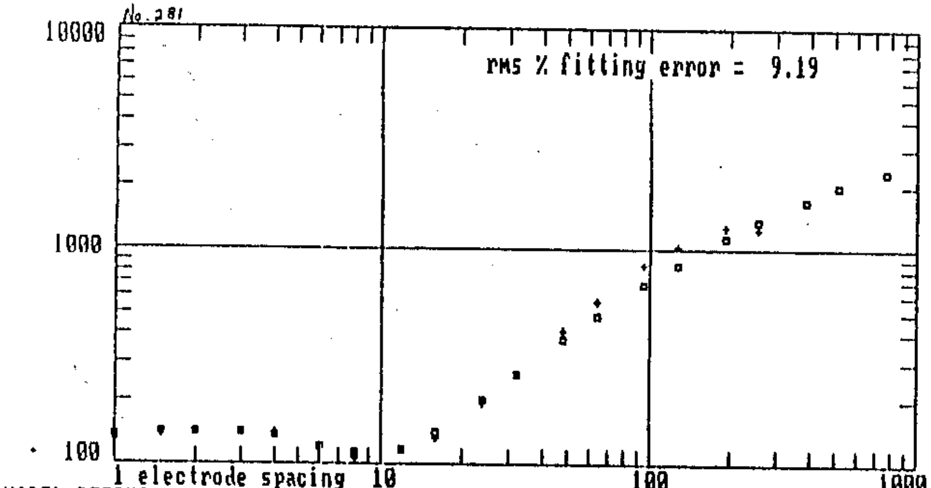
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 5 9.6
RESISTIVITIES : 120 154 38 3000
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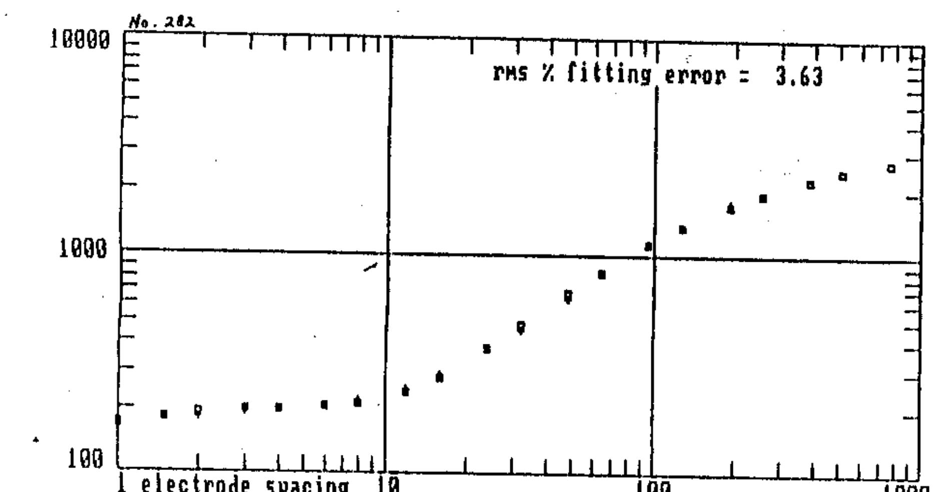
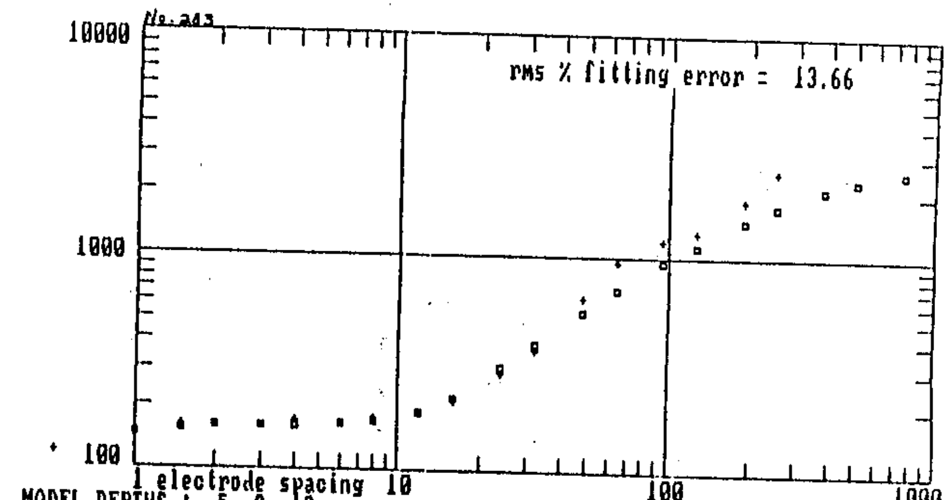
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 7.8 11.4
RESISTIVITIES : 140 210 90 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 8 12
RESISTIVITIES : 133 166 78 3000
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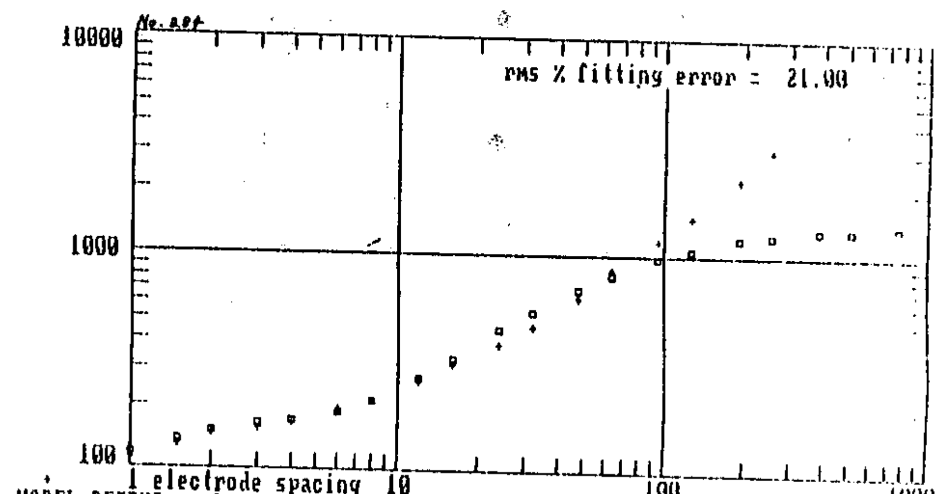
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 4 7
RESISTIVITIES : 80 190 105 1400
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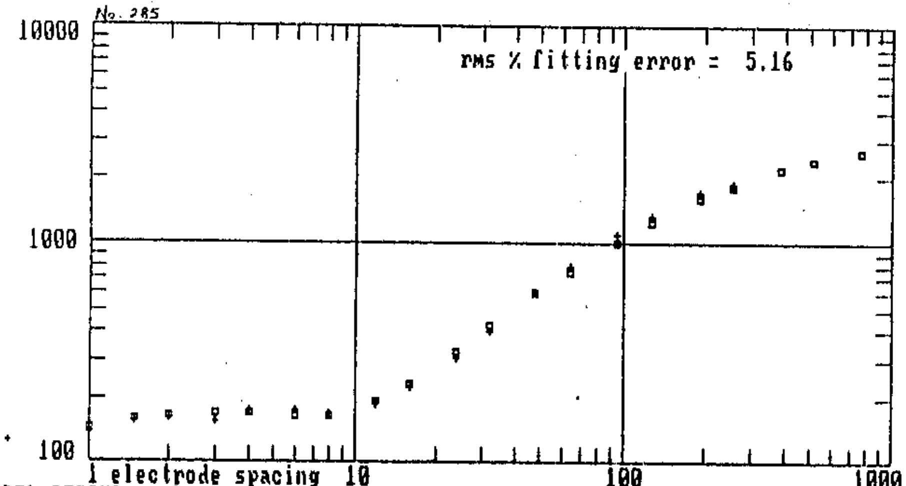
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 5 8.4
RESISTIVITIES : 112 190 55 3000
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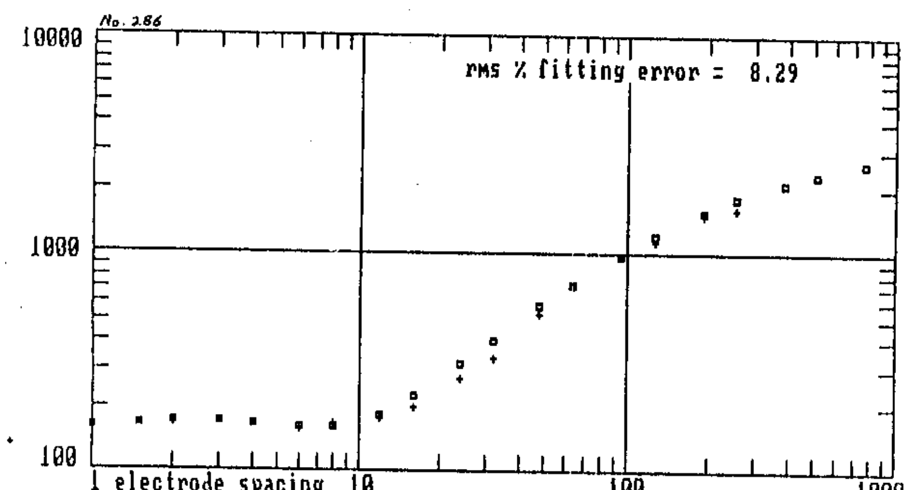
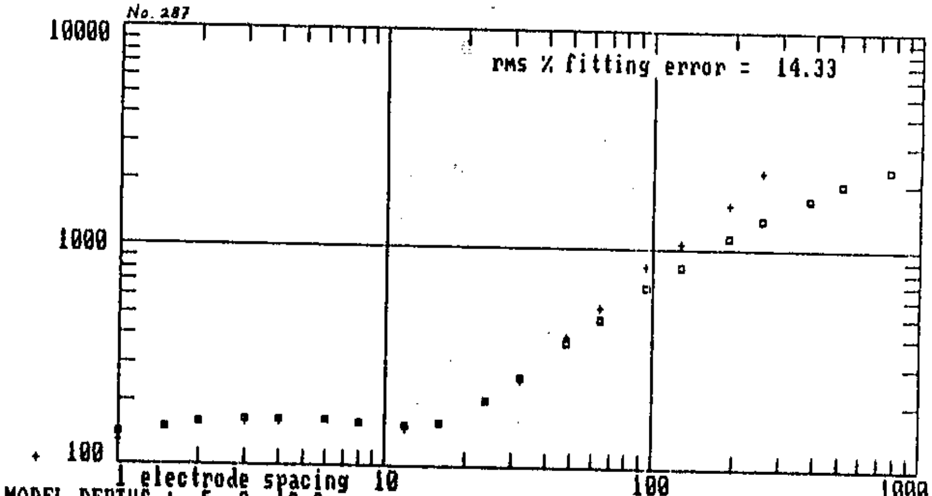
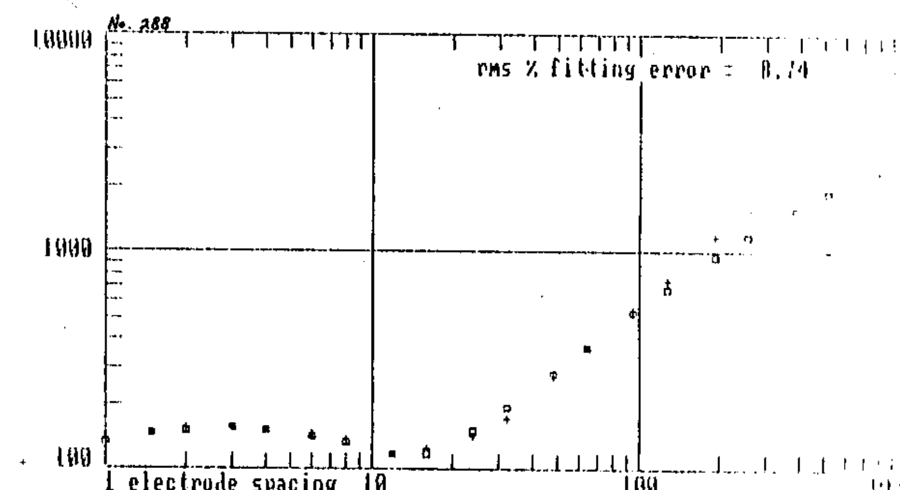
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 5 9.6
RESISTIVITIES : 140 180 70 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit

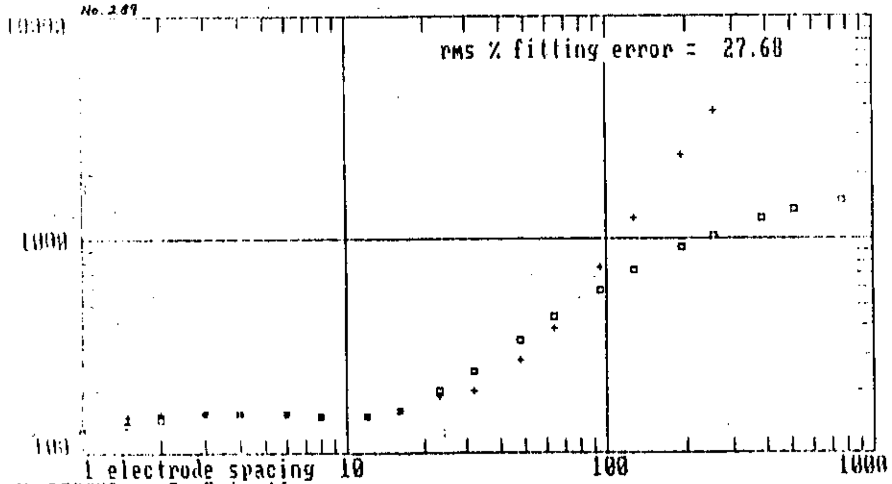


MODEL DEPTHS : .5 8 12.3
RESISTIVITIES : 110 180 40 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit

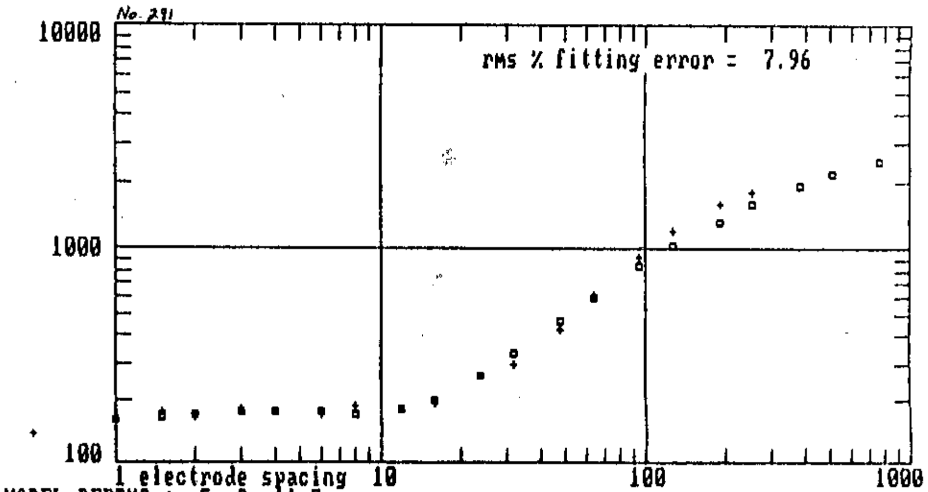


MODEL DEPTHS : .5 6.8 11 17
RESISTIVITIES : 110 167 38 90 4000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit

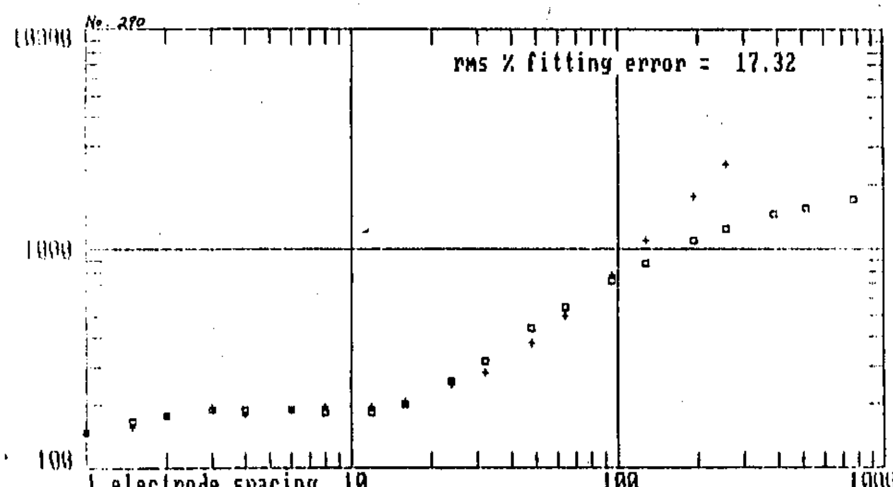
8



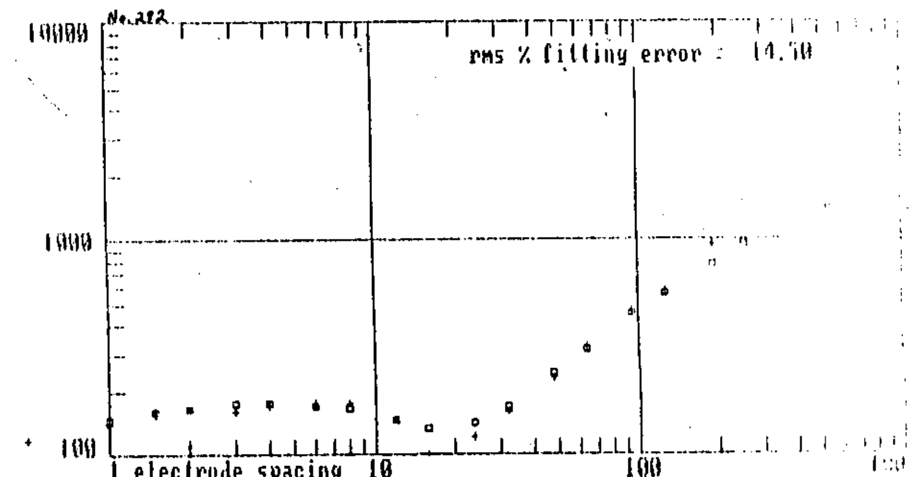
MODEL DEPTHS : .5 7.1 16
RESISTIVITIES : 95 170 80 1700
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



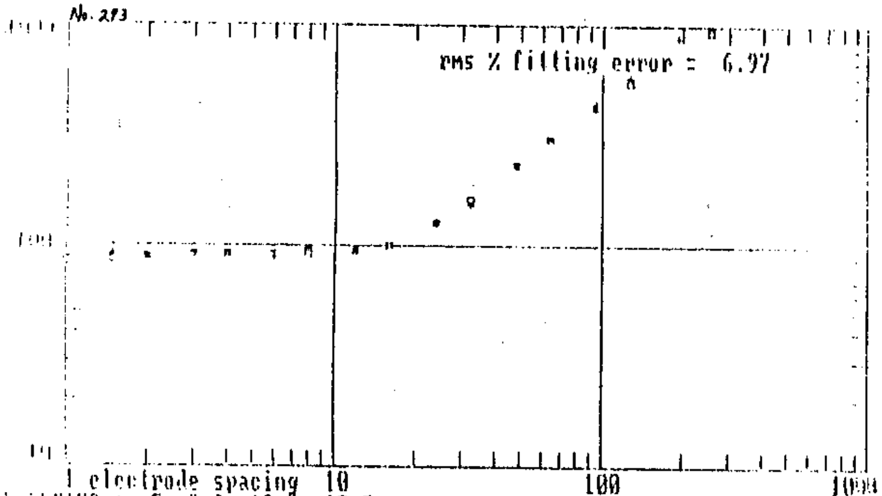
MODEL DEPTHS : .5 9 11.7
RESISTIVITIES : 140 180 40 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



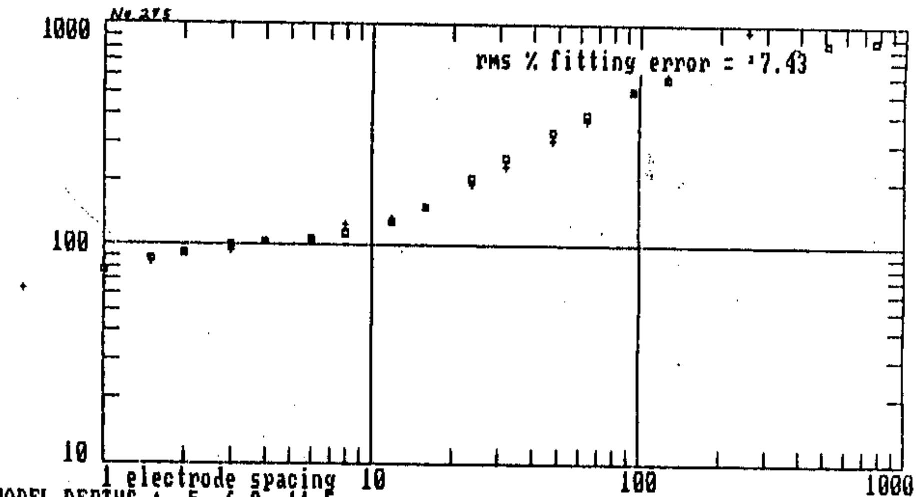
MODEL DEPTHS : .5 8 10.3 14.5
RESISTIVITIES : 110 205 40 200 1900
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



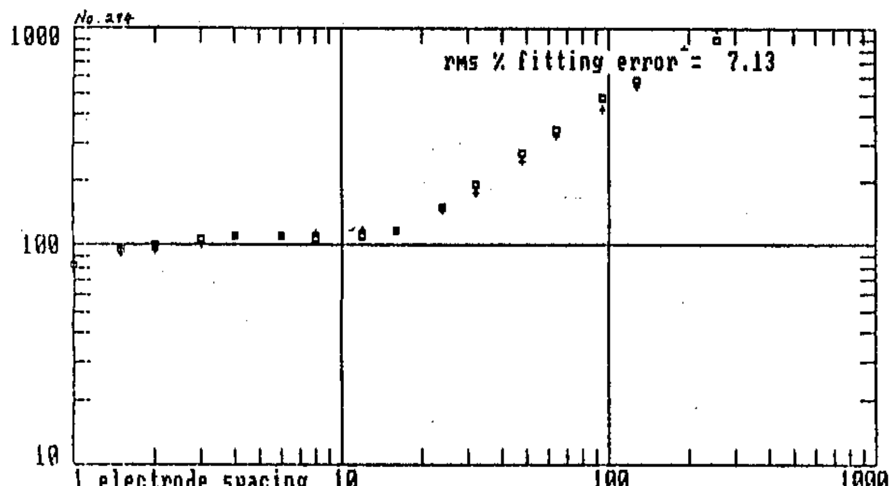
MODEL DEPTHS : .5 9.5 14 16
RESISTIVITIES : 112 190 27 75 2500
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 9.6 13.5 15.5
RESISTIVITIES : 72 96 30 130 2500
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 6.8 11.5
RESISTIVITIES : 56 111 70 900
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 7.5 13.6
RESISTIVITIES : 58 122 44 1670
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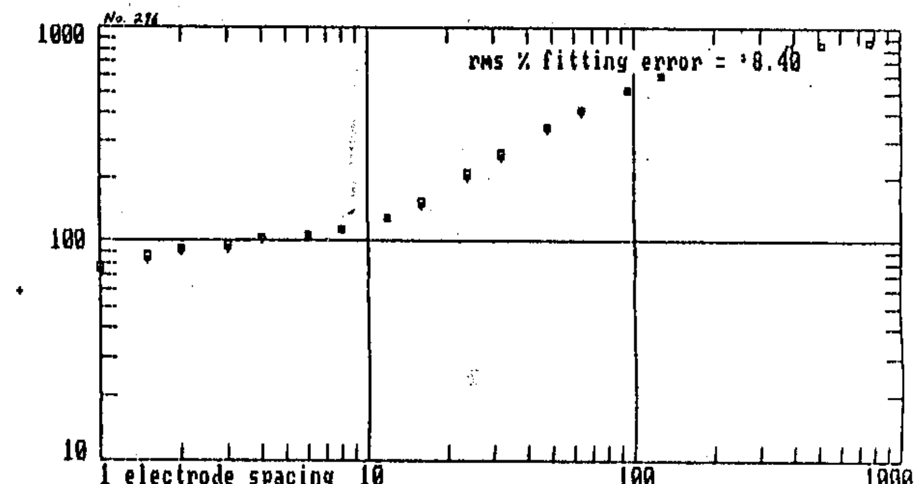
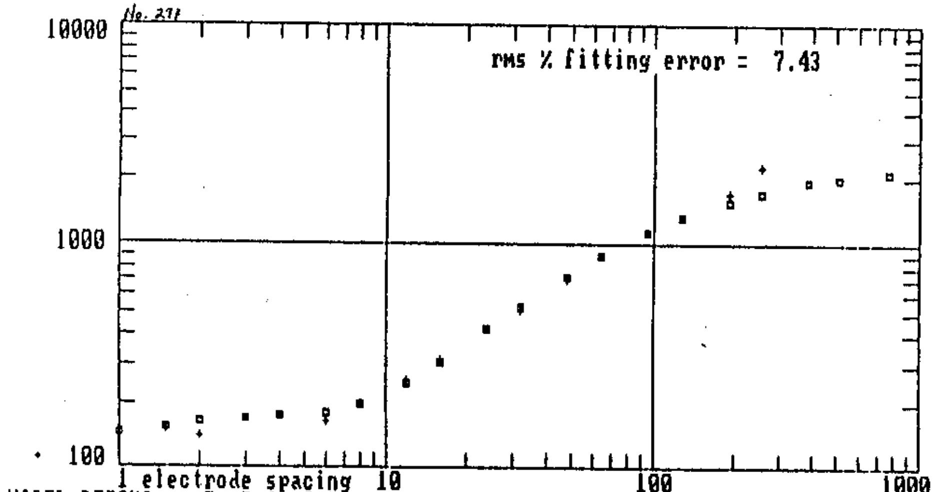
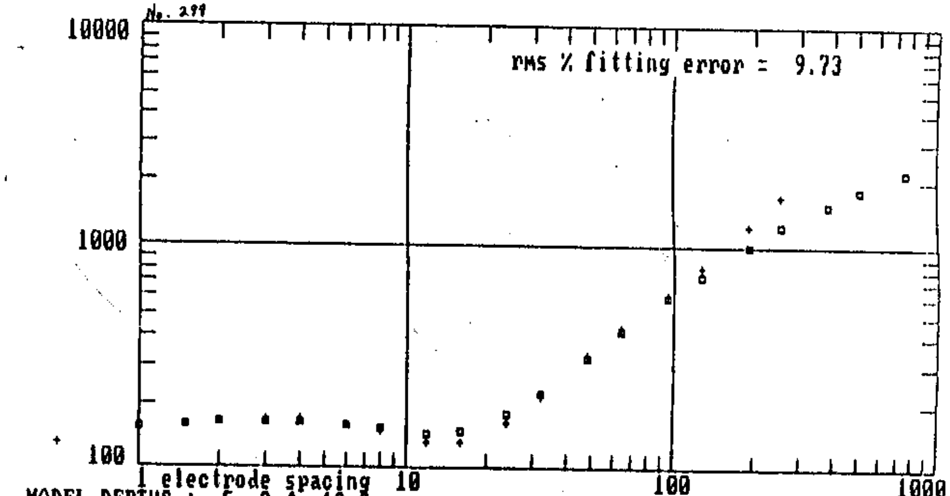
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



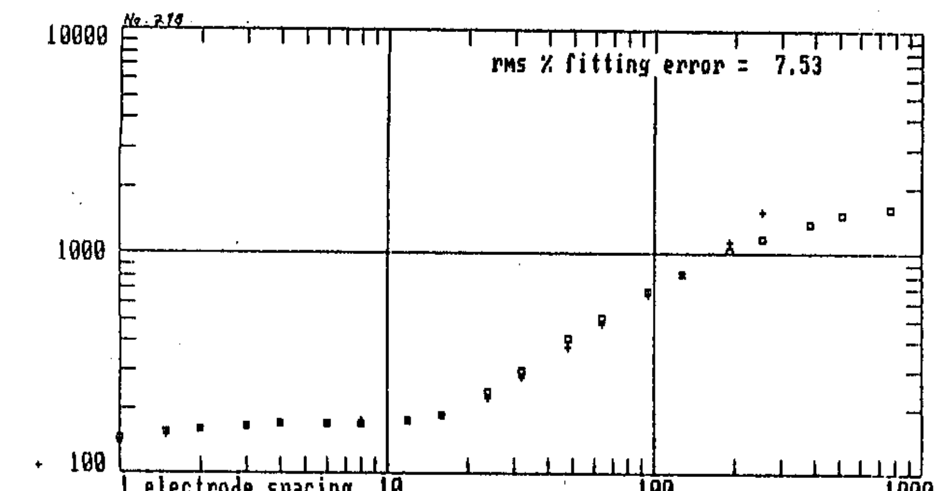
MODEL DEPTHS : .5 6.5 11
RESISTIVITIES : 56 110 70 900
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



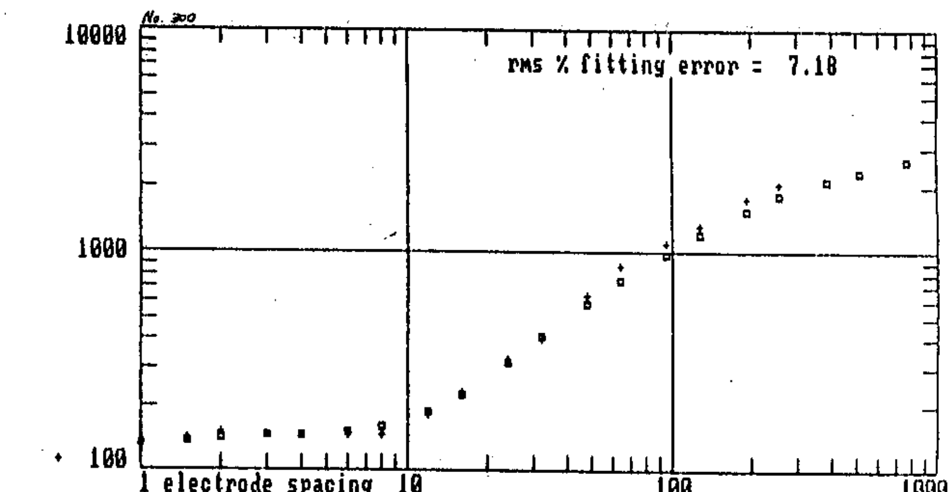
MODEL DEPTHS : .5 5.6 7.8
RESISTIVITIES : 120 180 68 2222
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



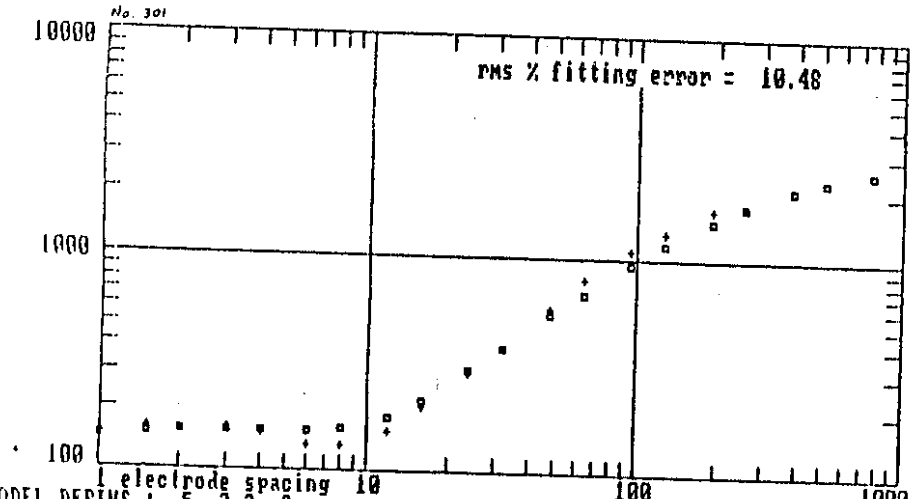
MODEL DEPTHS : .5 9.4 13.8
RESISTIVITIES : 140 172 35 3000\
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



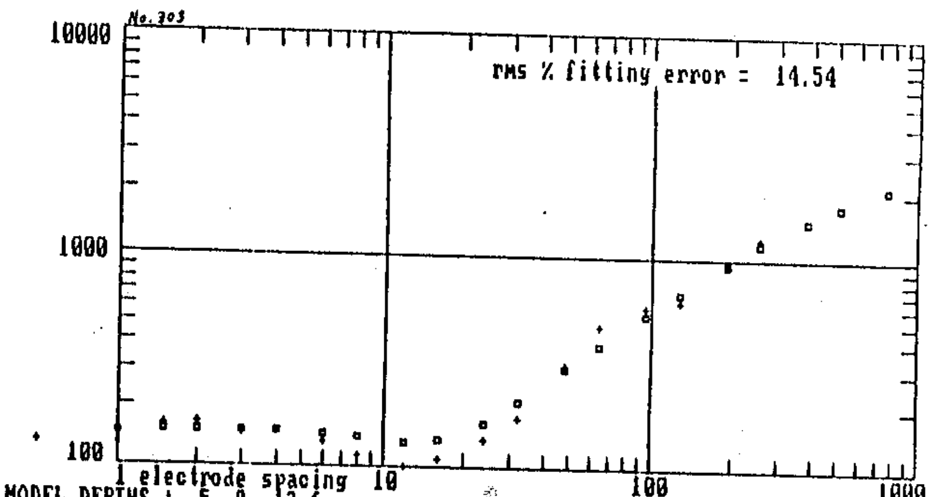
MODEL DEPTHS : 0.5 10 13
RESISTIVITIES : 120 175 43 1800
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



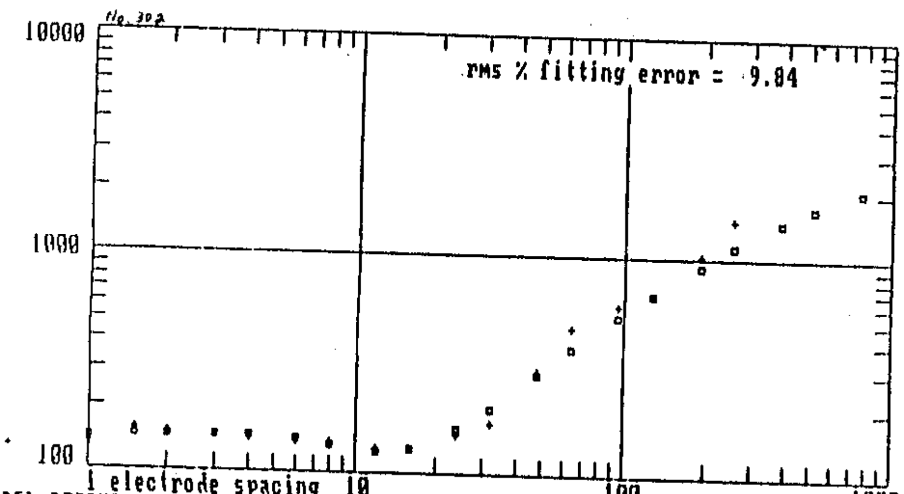
MODEL DEPTHS : .5 7.5 9.2
RESISTIVITIES : 118 150 40 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



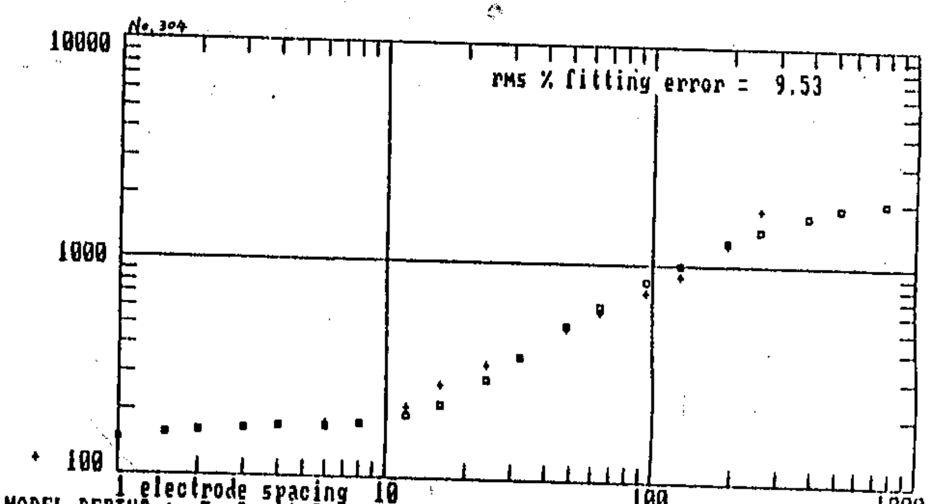
MODEL DEPTHS : .5 7.2 9
RESISTIVITIES : 133 162 34 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



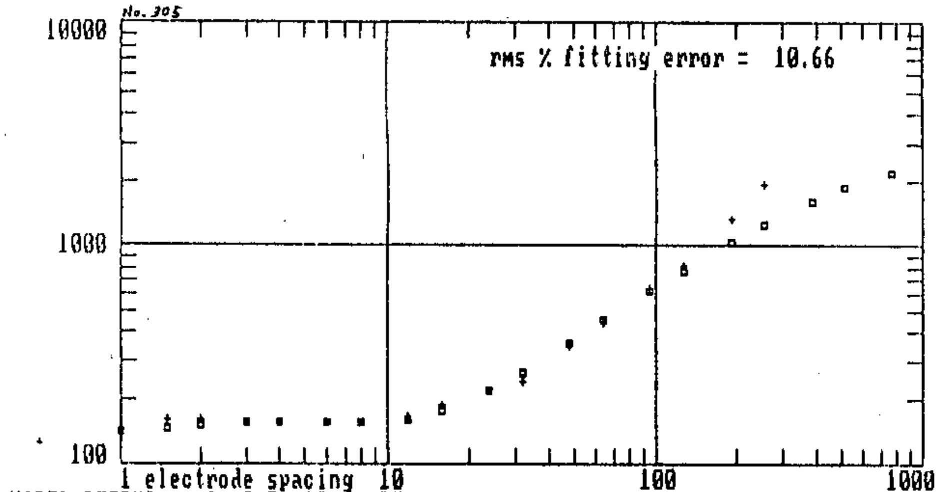
MODEL DEPTHS : .5 9 13.6
RESISTIVITIES : 135 156 33 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 8.5 14.8
RESISTIVITIES : 130 152 42 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 9 11.8
RESISTIVITIES : 120 176 56 2222
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .6 9.5 12.4 50
RESISTIVITIES : 132 160 50 630 3000
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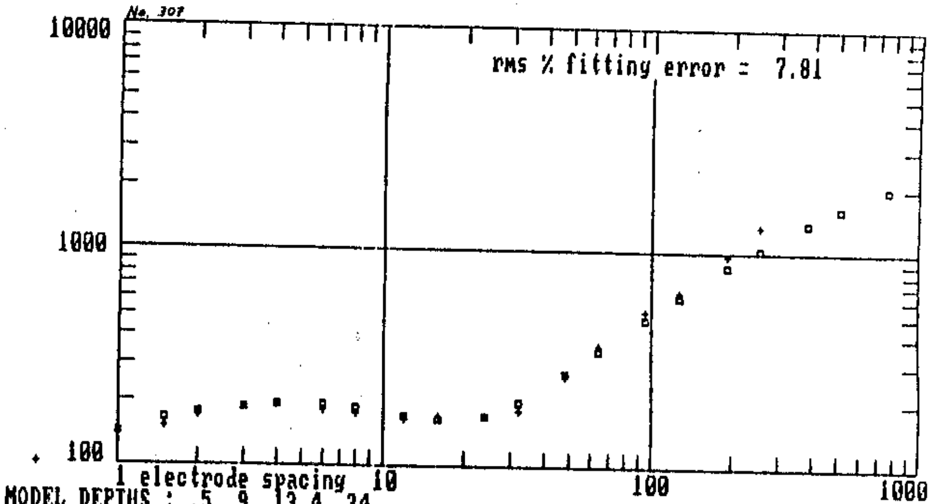
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 9 13.4 34
RESISTIVITIES : 100 215 54 200 3000
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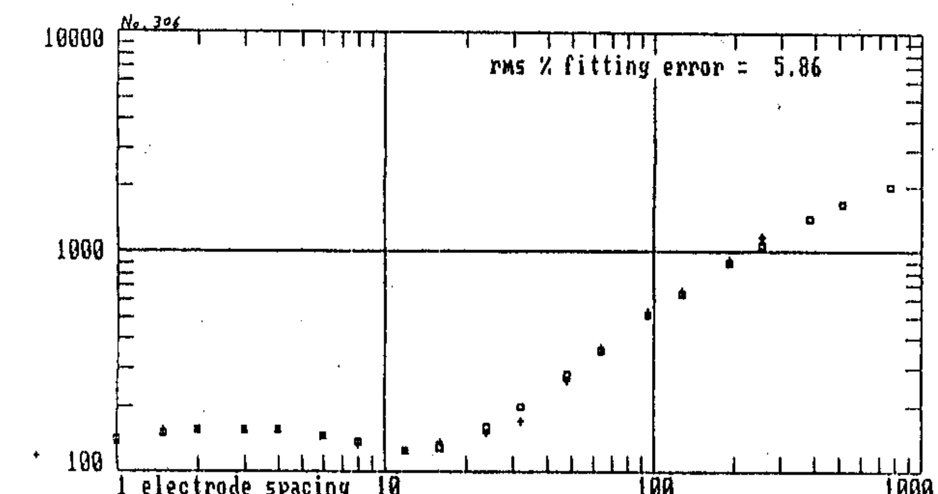
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 6 14 40
RESISTIVITIES : 116 170 64 444 3000
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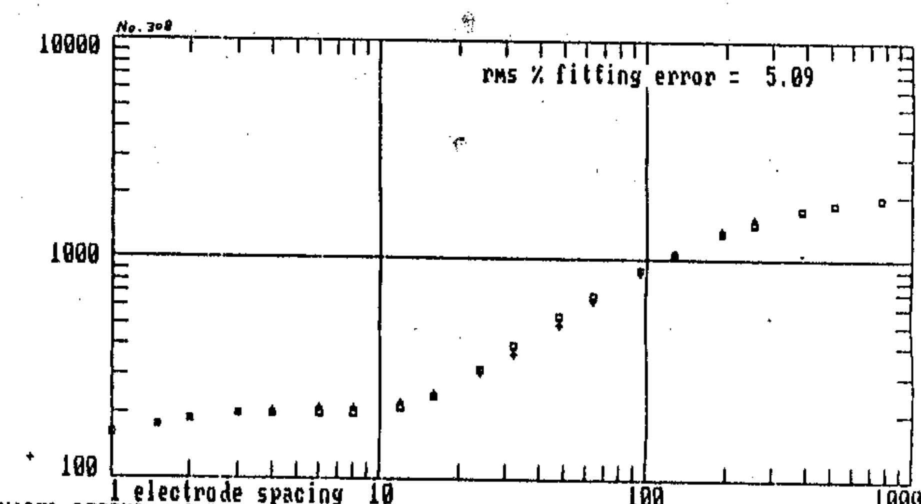
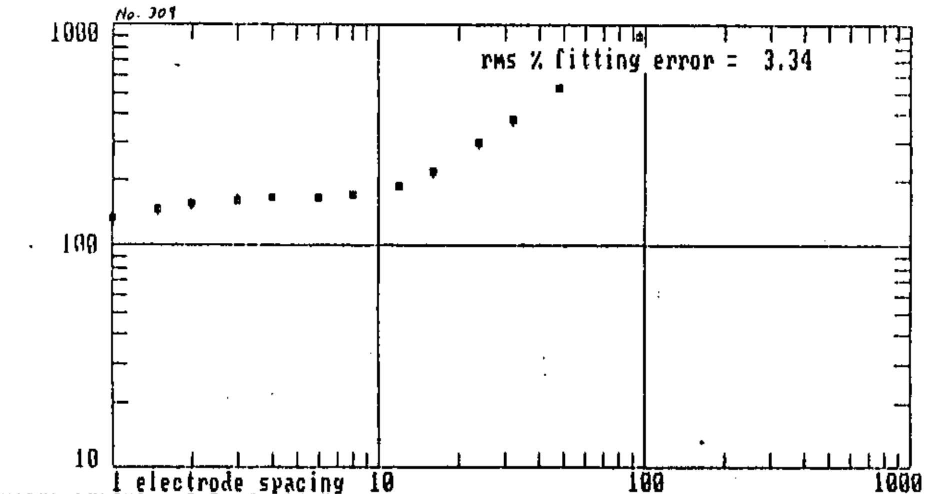
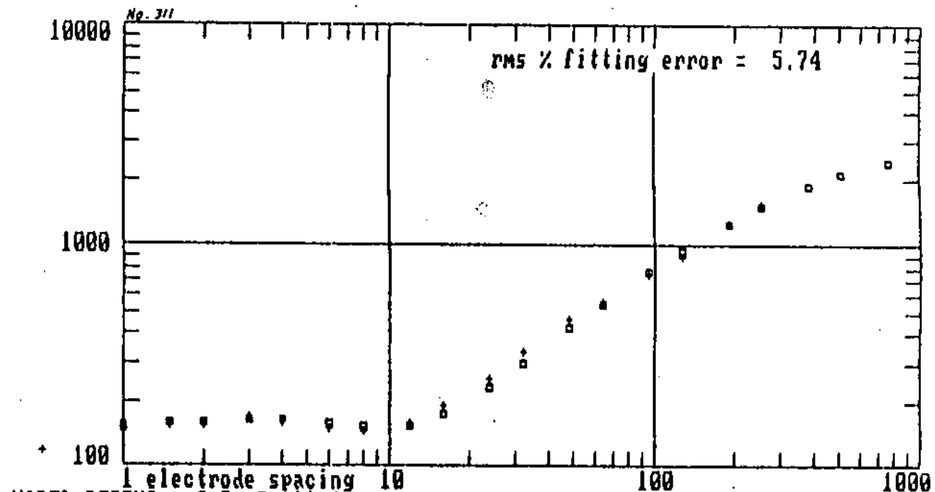
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : 0.5 7 12.2
RESISTIVITIES : 120 215 90 2111
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : 0.5 7 10.7
RESISTIVITIES : 106 173 66 2450
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : 0.5 7 11.6
RESISTIVITIES : 130 174 50 3000
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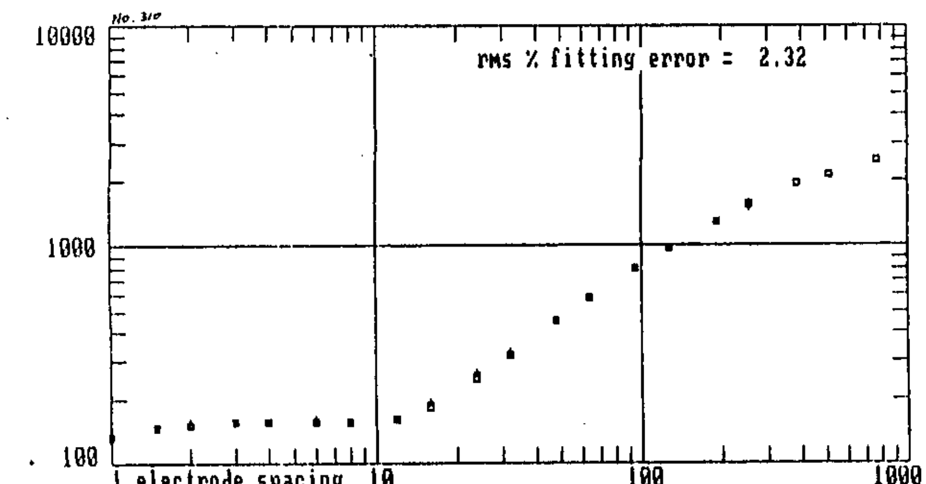
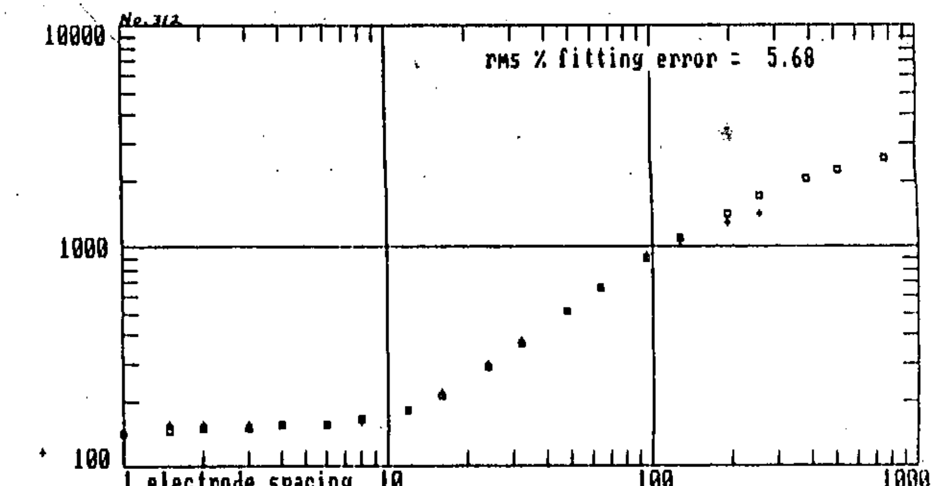
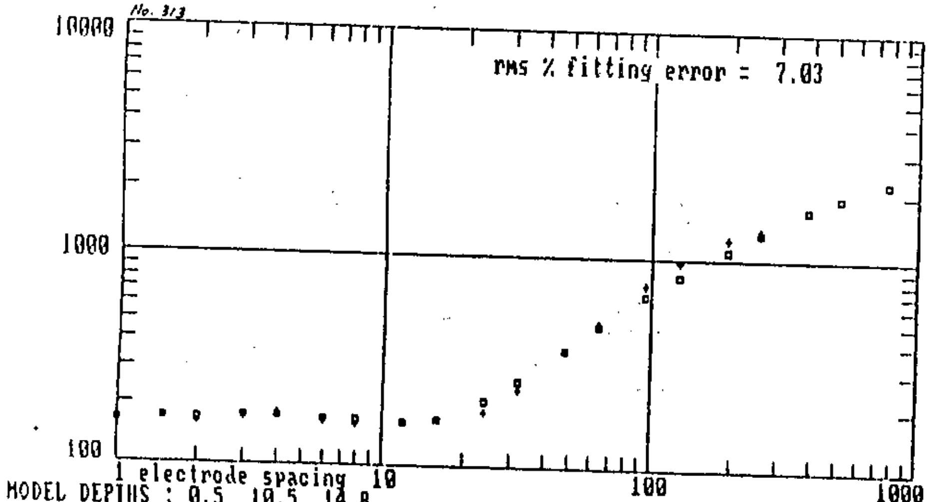
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : 0.5 7.8 11
RESISTIVITIES : 110 165 42 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : 0.5 10 12.4
RESISTIVITIES : 127 157 57 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : 0.5 10.5 14.8
RESISTIVITIES : 150 178 44 3000
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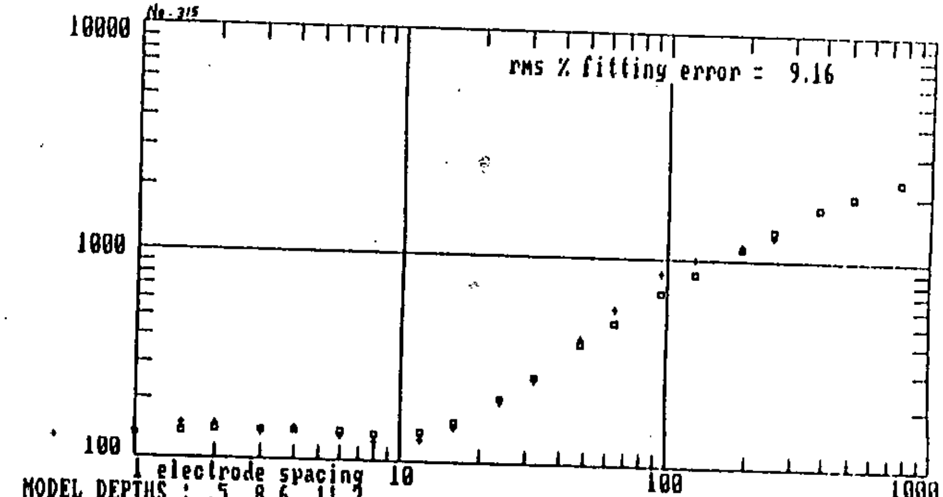
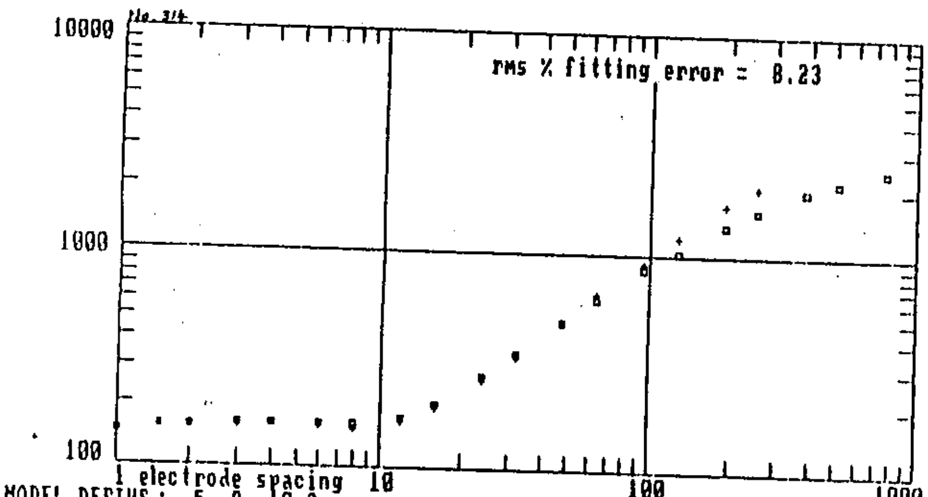
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 8.6 11.7
RESISTIVITIES : 122 148 34 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 8 10.3
RESISTIVITIES : 130 166 35 3000
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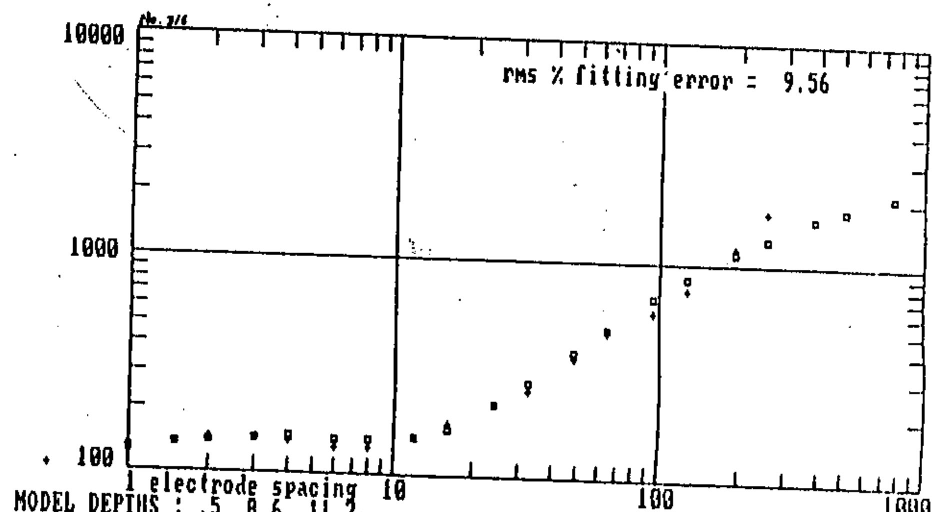
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : .5 8.6 11.7
RESISTIVITIES : 108 156 36 2555
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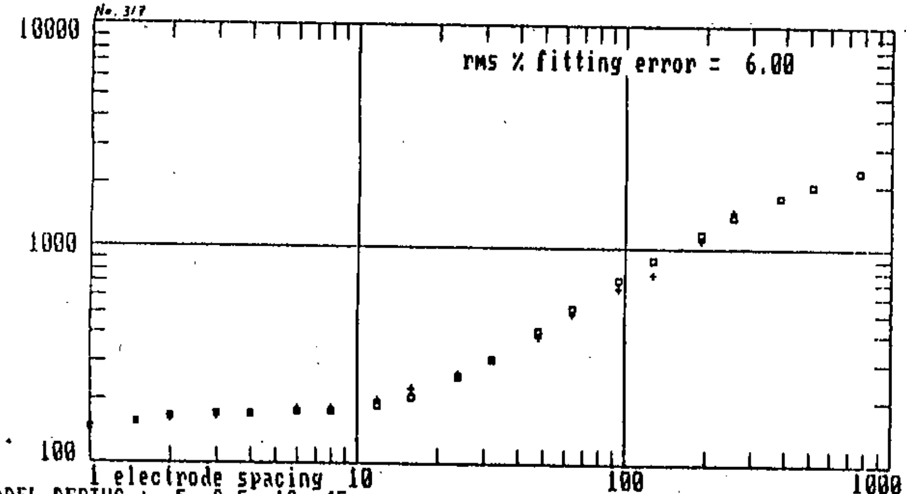
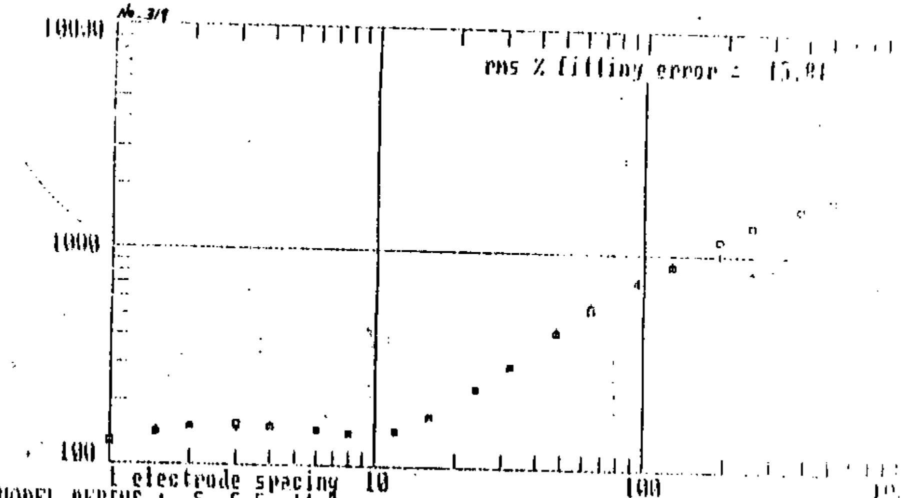
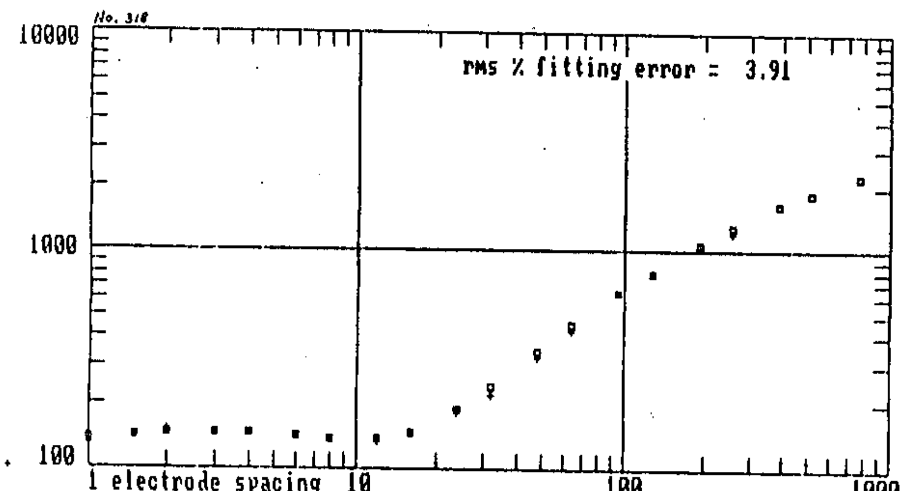
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



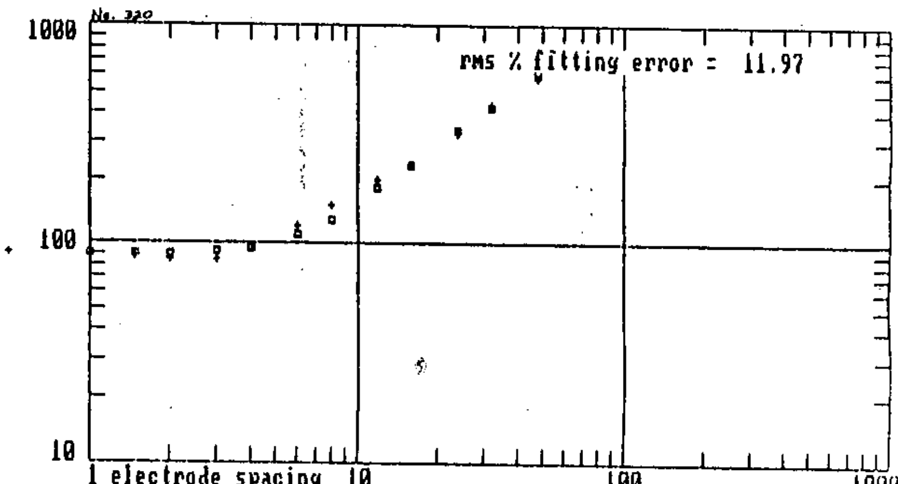
MODEL DEPTHS : .5 9.5 13 45
RESISTIVITIES : 120 178 77 660 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



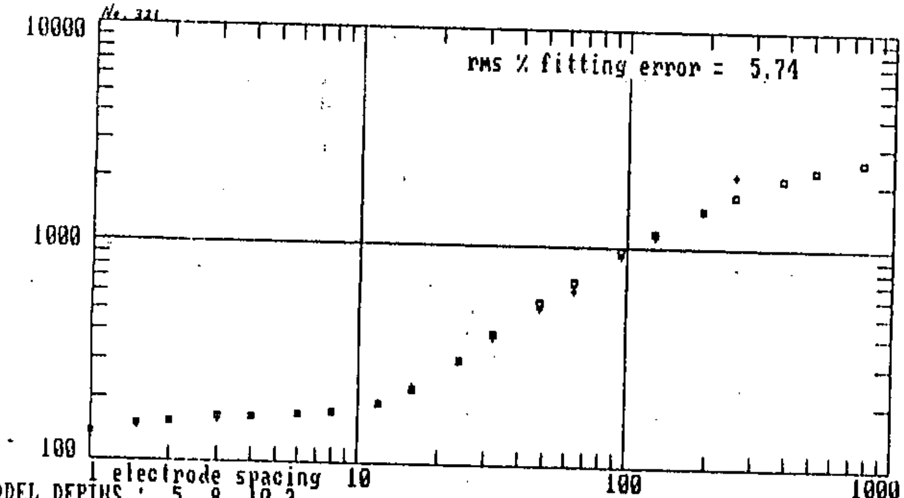
MODEL DEPTHS : .5 5.5 11.2
RESISTIVITIES : 102 170 60 2400
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



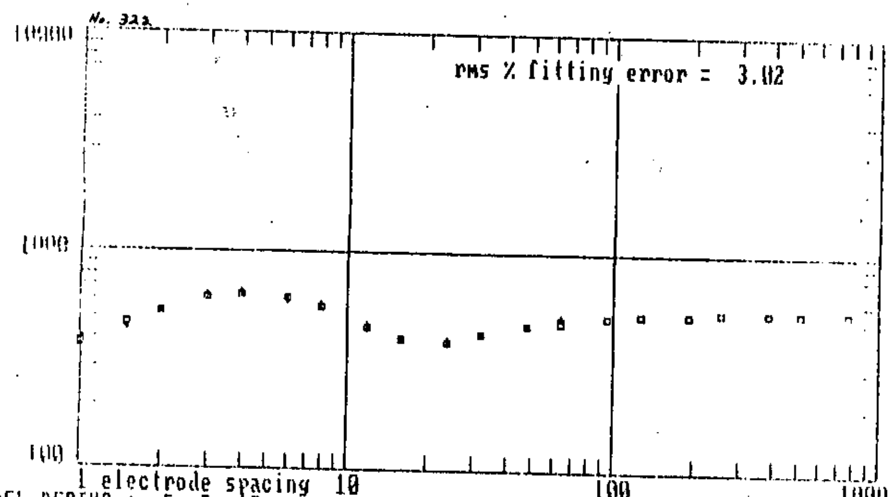
MODEL DEPTHS : .5 8 12.4
RESISTIVITIES : 120 154 38 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



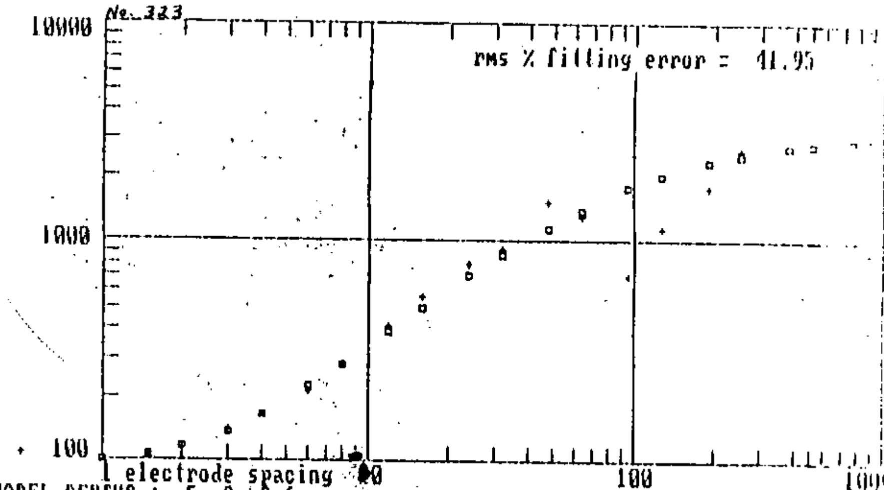
MODEL DEPTHS : 3 7.6
RESISTIVITIES : 90 84 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



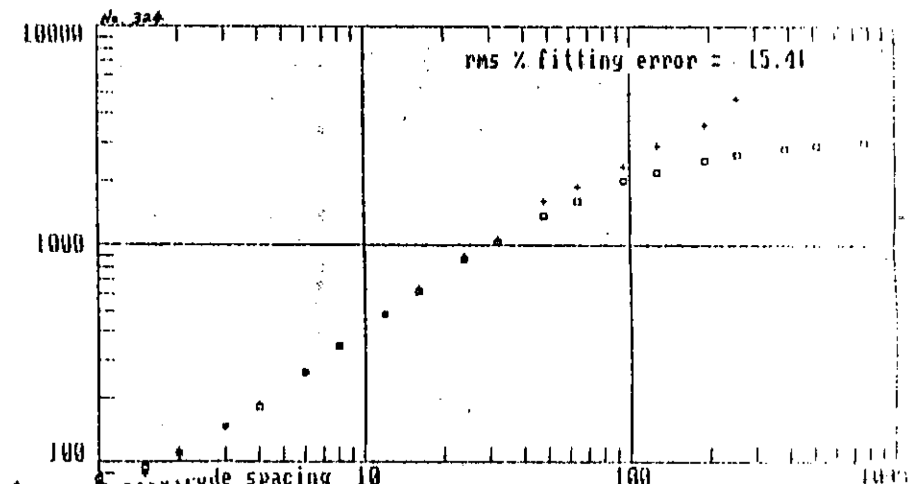
MODEL DEPTHS : .5 8 10.3
RESISTIVITIES : 112 175 46 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



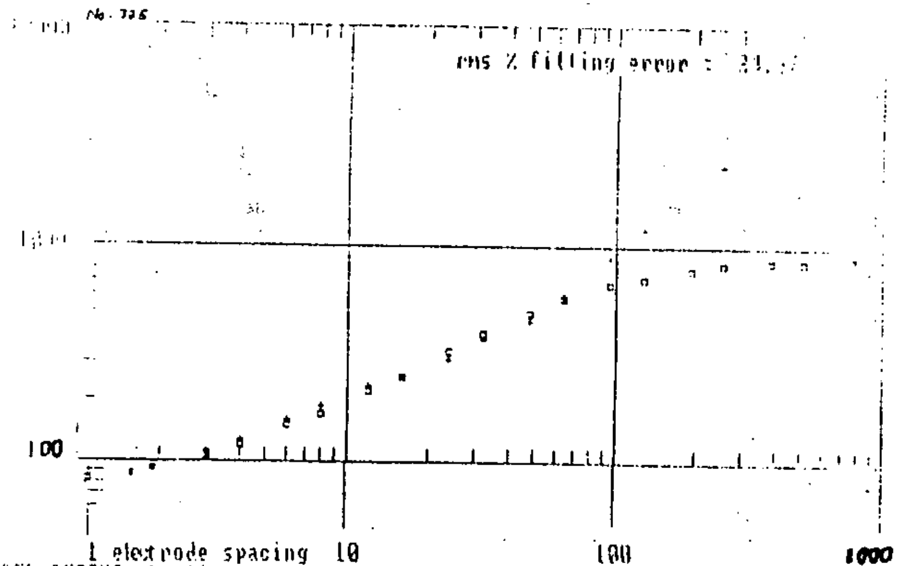
MODEL DEPTHS : .5 5 10
RESISTIVITIES : 200 920 150 550
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



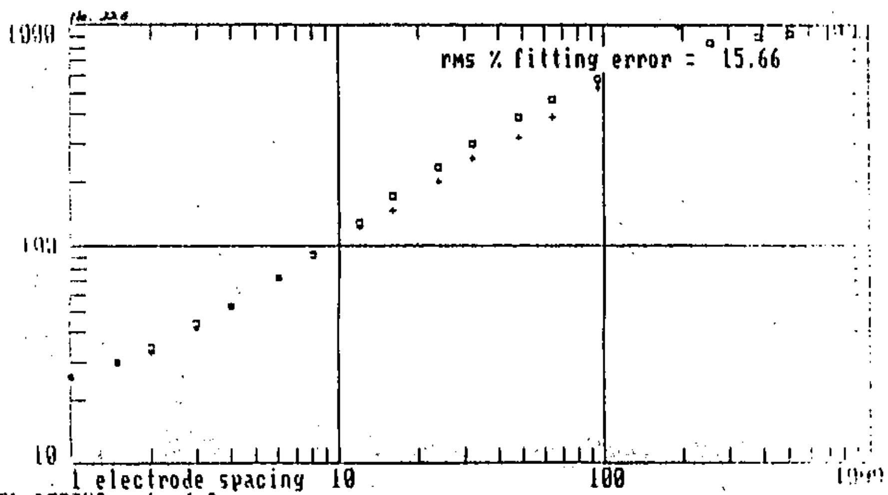
MODEL DEPTHS : .5 3 8.6
RESISTIVITIES : 90 110 560 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



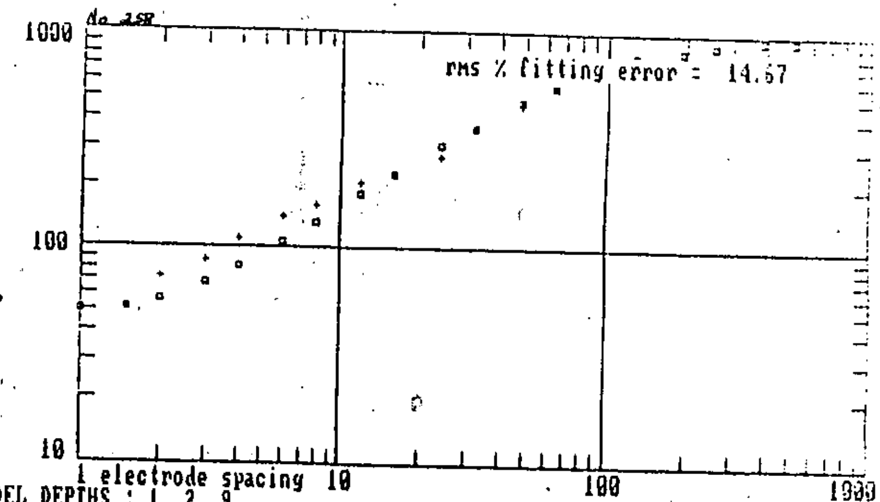
MODEL DEPTHS : 0.7 2 3.2
RESISTIVITIES : 72 100 200 3000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : 2 11
RESISTIVITIES : 79 200 900



MODEL DEPTHS : 1 4.8
RESISTIVITIES : 21 60 1000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS, 1 to shift curve down, 0 to quit



MODEL DEPTHS : 1 2 9
RESISTIVITIES : 50 37 200 1000
ENTER MODEL PARAMETERS
ENTER NUMBER OF LAYERS,

Water Sampling Soaks / Analysis

Backup Debbie

T.C(D) –

Full Suite.

E 14 – J Bell Day

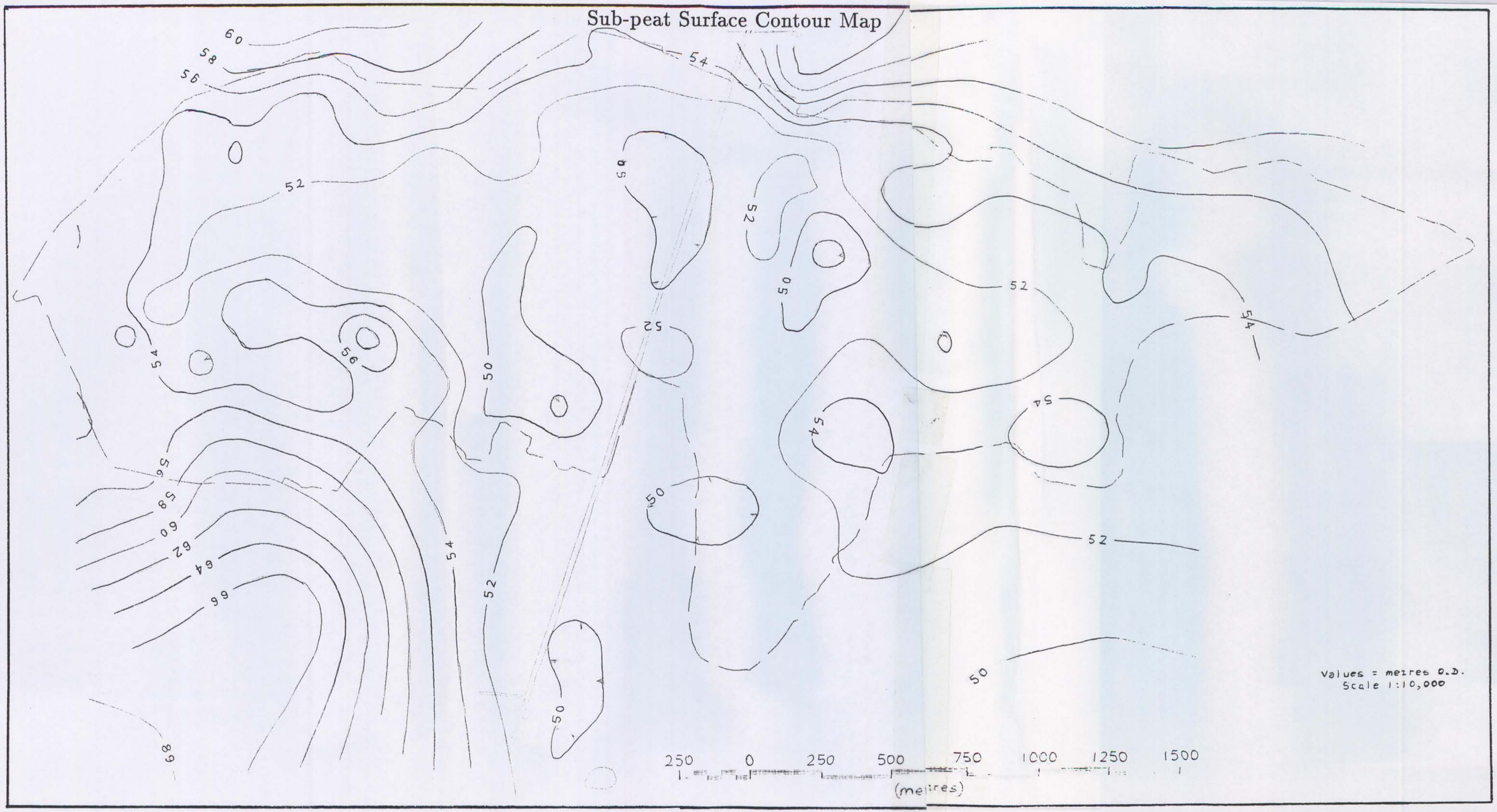
28 · Wells

J + Bell

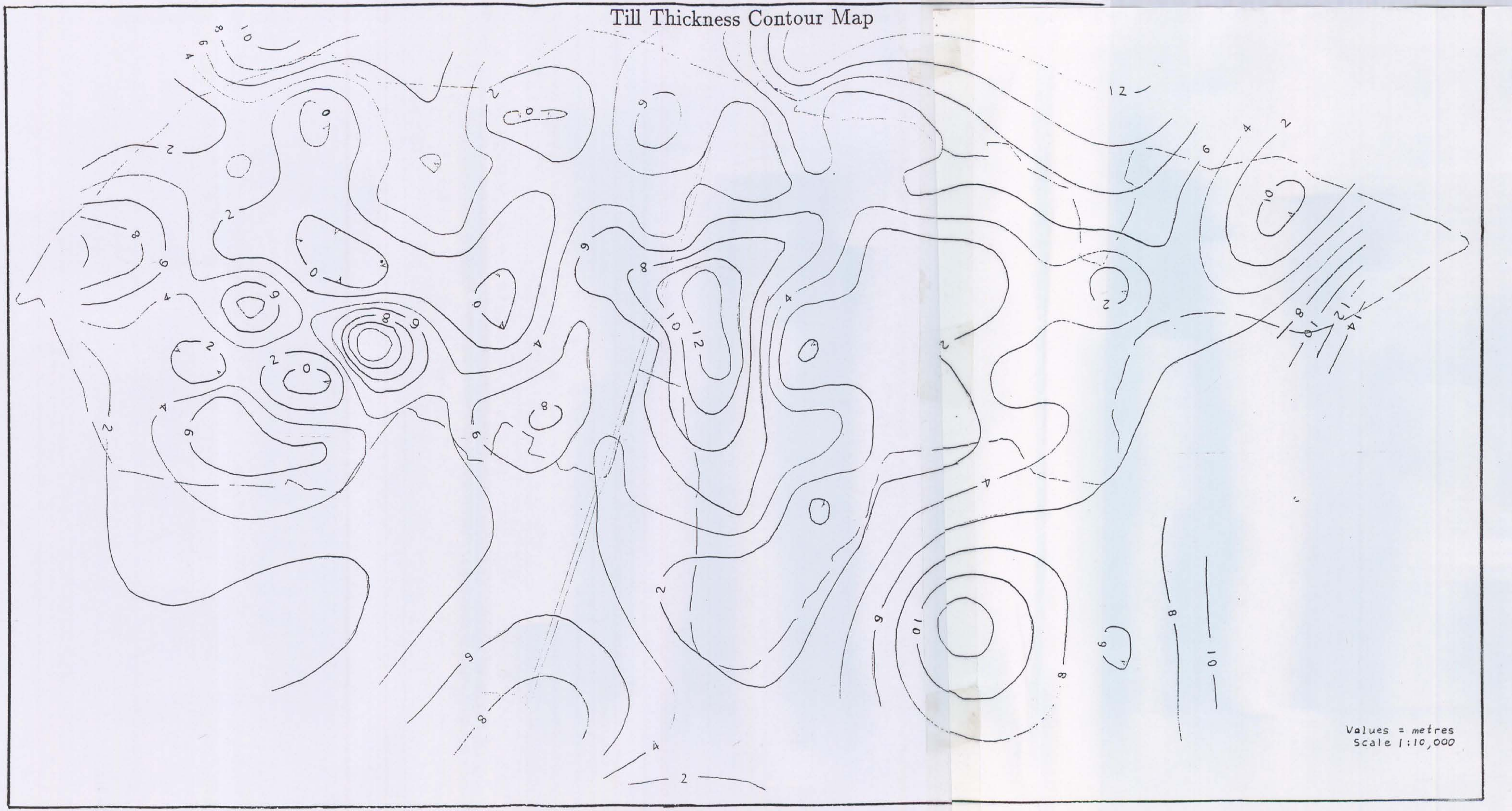
D Rahee

CLARA WELLS

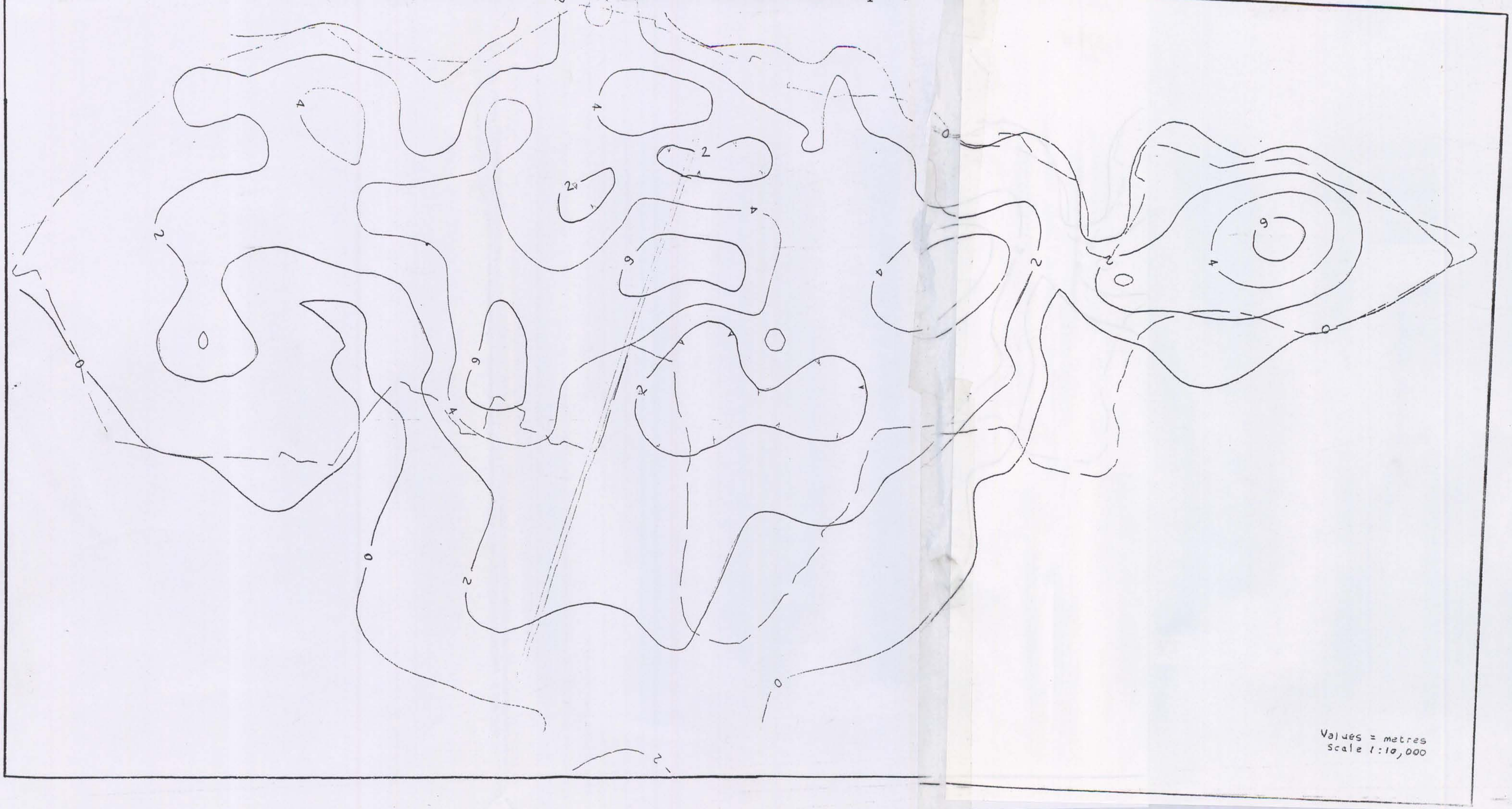
1.	0. Brian Boland.
2.	12. Ned Connally
3.	20. Mr. Kinahan
4.	21. Bolands
5.	15. Donal Fogarty
6.	23. Mrs Mitchell
7.	16. Mrs Owen Malone
8.	2. Mrs Kinahan
9.	3. WALSHES
10.	5. Martin Minnock
11.	7. Mrs Dully
12.	8. Eamon Mc. Redmond
13.	9 Tom Minnock
14	22. J. GAFFEY
15	11. Jim Kinahan


Sub-peat Surface Contour Map
60
58
56
52
54
56
50
52
50
52
50
52
54
54
52
56
58
60
62
64
66
54
52
50
50
52
50
68
Values = metres O.D.
Scale 1:10,000
250 0 250 500 750 1000 1250 1500
(metres)

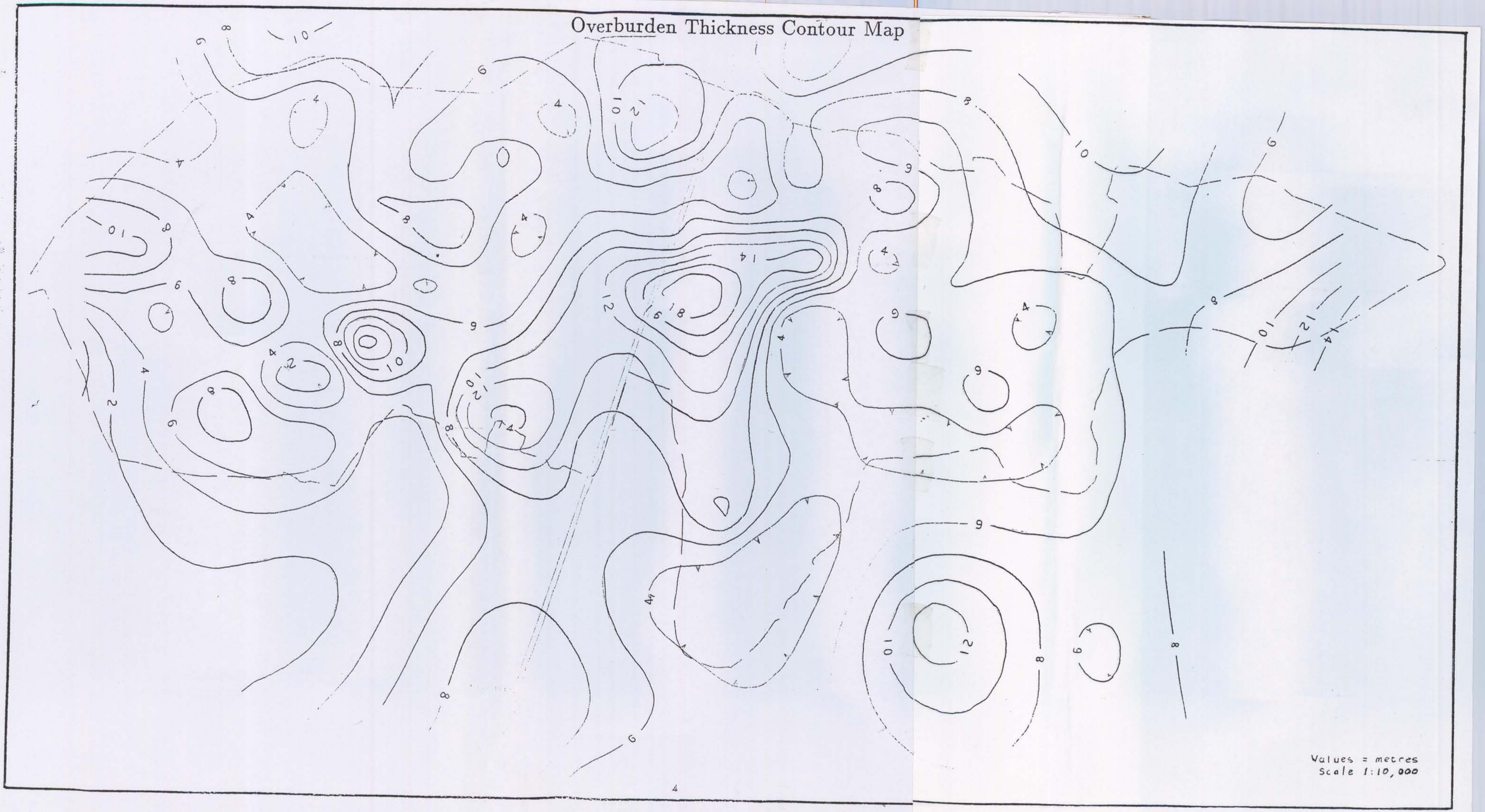
Till Thickness Contour Map

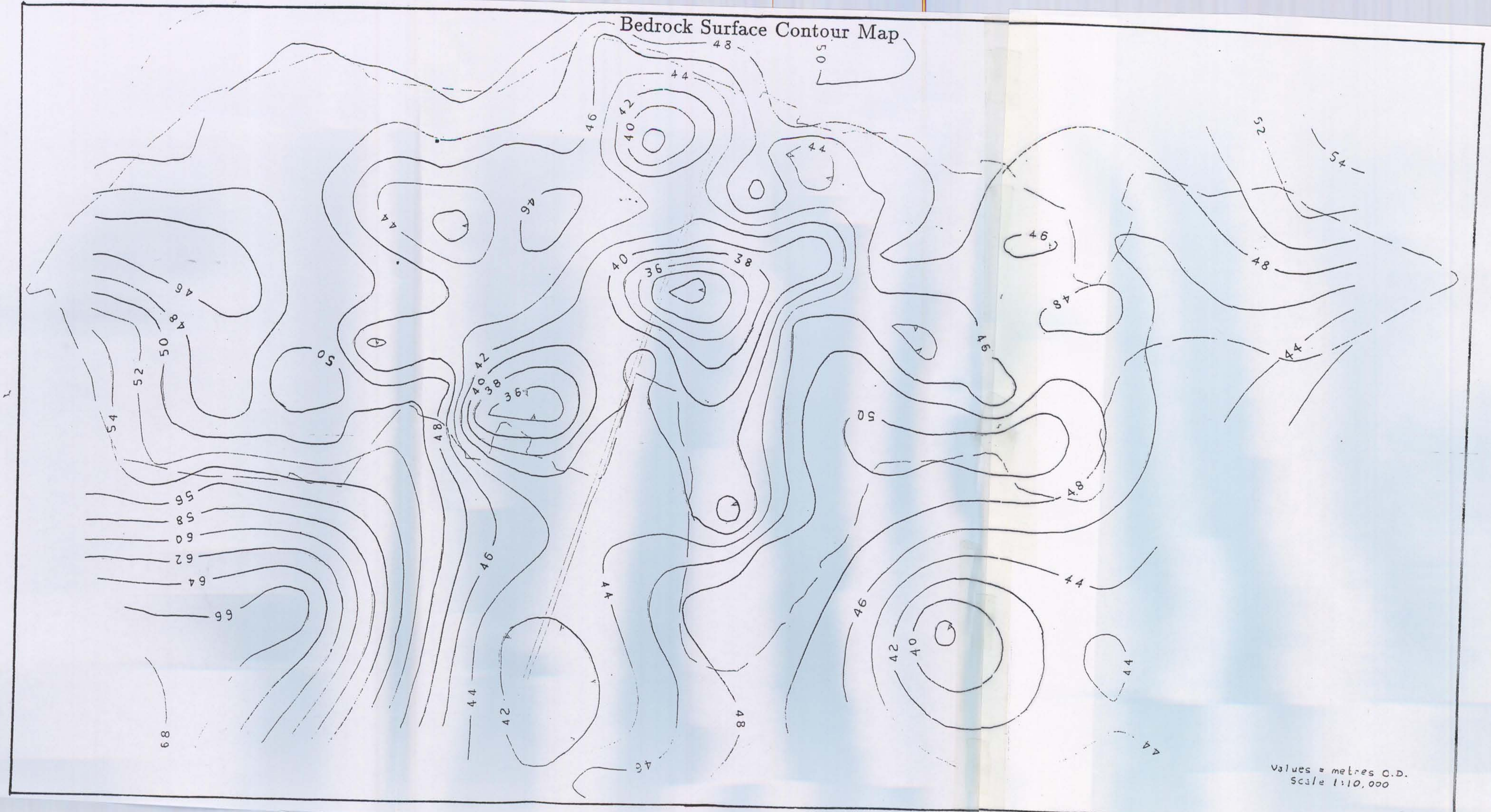


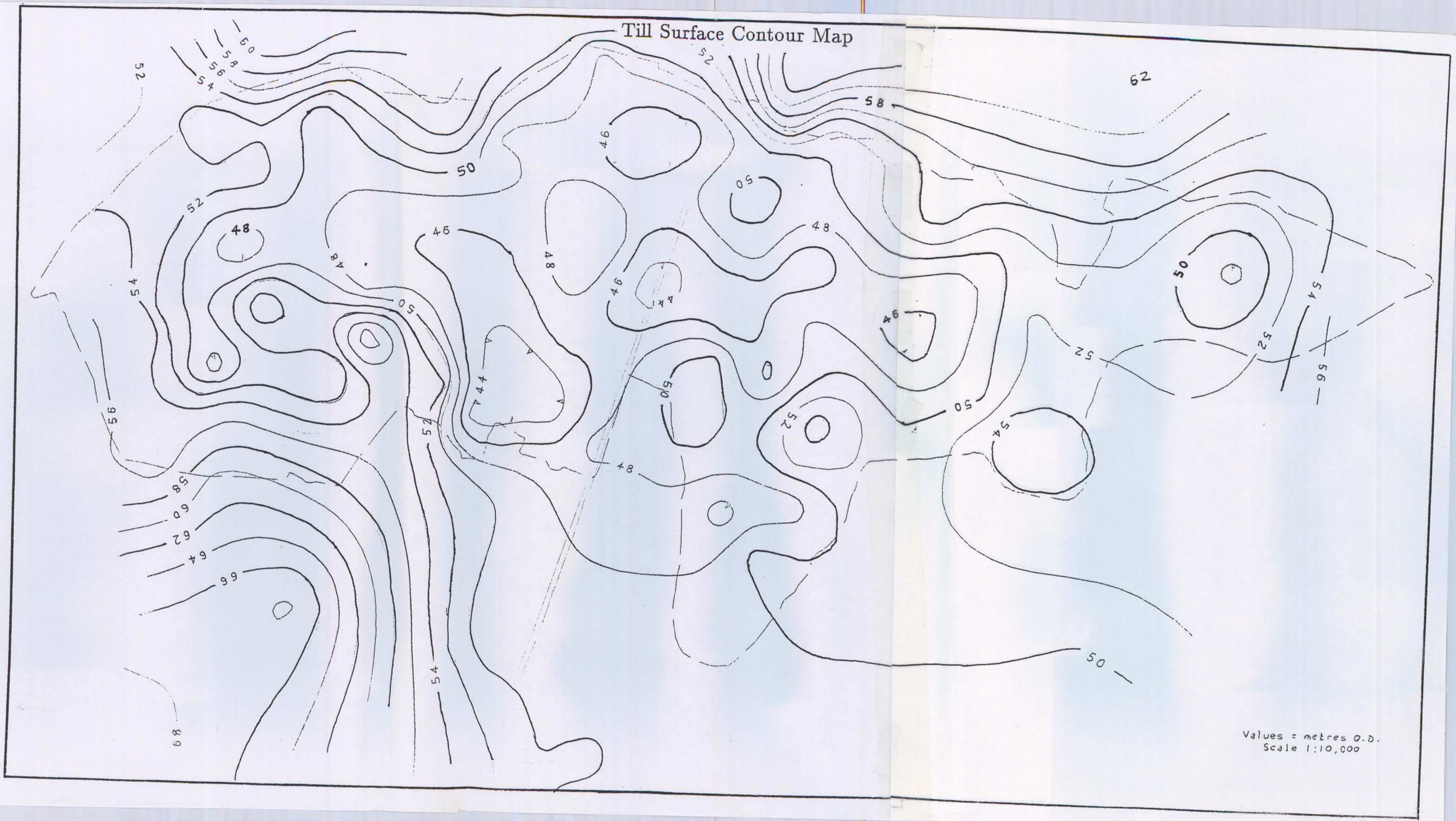
Clay Thickness Contour Map



Overburden Thickness Contour Map




Bedrock Surface Contour Map
Values = metres O.D.
Scale 1:10,000


Till Surface Contour Map
62
58
60
58
56
54
52
50
52
48
46
48
50
48
46
44
46
50
48
54
56
44
52
50
46
50
52
50
52
54
52
56
56
58
60
62
64
66
54
68
48
50
Values = metres O.D.
Scale 1:10,000