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DENSITIES OF FORMATIONS IN THE NORTH SEA

by

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CONTENTS

1. INTRODUCTION

Details from exploration and appraisal wells on the UK continental shelf are normally released 5½ years after the completion date by the UK Dept of Energy. A number of these released wells have been sampled for formation density values in order to investigate how the values vary spatially and with depth. These values are listed in full in Appendix 3.

Generally, the wells selected were the earliest in each area, as these tended to be the deepest and with the longest density log runs. Those early wells also tend to be widely spaced. Within localised areas around hydrocarbon bearing structures, appraisal and development drilling has resulted in more closely spaced clusters of wells with large numbers of development wells being drilled from single platforms.

2. DERIVATION OF DENSITY VALUES

a Formation Density Logs

The wireline density logs used in well logging work on the principle of Compton scattering of X-rays from electrons in the formations encountered. Generally, the denser a rock, the higher is the electron density and the greater the scattering. Tools originally consisted of a source of X rays and a detector mounted in a sonde which was pressed against the side of the well. On being pulled up the well the sonde measured the density variations of the material between the sonde and the wall as well as the formation rocks.

These uncompensated instruments needed to be calibrated for source intensity, detector sensitivity, mud density and hole diameter. Subsequently an improved tool was developed with two detectors above the source (Fig 1). This allowed a comparison of count rates from different scattering regions in the formation adjacent to the sonde and hence automatic corrections to the readings giving the compensated formation density log. The correction applied is shown on a separate track of the log.

There are a number of exceptions to the electron density/bulk density relationship described above where corrections to the output density log values are required. The main minerals affected are halite which requires a +0.1 gm/cc correction and anhydrite, a -0.05 gm/cc correction. Concentrations of gas in the formations can also reduce the density seen by the log due to the lower electron density within the formation fluid.

In the wells summarised no corrections have been made for these effects. The result of ignoring these corrections is discussed in the sections on each interval.

For a fuller discussion of the technical details of formation density logging the reader is referred to Schlumberger (1972).

b Data Calculation

In order to assess the data, densities within the wells have been averaged over the subsystem intervals shown in Appendix 1. Due to variations in the exploration targets within the different regions of the North Sea and to basic geological conditions the frequency of results from subsystem to subsystem varies markedly. The highest concentration of results is in the Permian of the southern North Sea in this data set. The chronological intervals into which the wells have been divided have been taken directly from the composite logs. Intervals from the Triassic to Palaeozoic predominate in the S North Sea, while Tertiary to Jurassic strata are predominant in the N North Sea results. The clustering of the data is well displayed in the density v depth plots of Appendix 2.

For each interval the thickness over which the density log was run is listed together with the mid point with respect to mean sea level. There may be some complete or part chronological intervals present in certain wells which have not been sampled by the density runs and are not therefore reflected in the results.

Each chronological interval was assigned a density value based on its average estimated value. Where a number of well defined density bands occurred within one zone these were each separately logged and a density obtained by depth weighing over the whole interval (Fig 2). No further weighing was applied to the data.

In certain cases the correction track of the compensated density log showed corrections of greater than $\pm$ 0.15 gm/cc due to bad hole conditions or tool malfunction. Where this occurred that section of log was ignored in computing the average.

The density values are quoted with a $\pm$ figure related to the amplitude of the short period oscillations arround the mean rather than be a true RMS figure.

In certain cases the composite logs were not subdivided into the selected chronological intervals. These cases are indicated in the listings and plots to indicate the age uncertainty involved, even though the chronological age of the rocks may in fact actually be completely within one interval. This type of uncertainty occurs mainly in the older systems such as the Permo-Trias and Carboniferous and where good palaeontological dating can not be obtained.

The linear curves plotted on each density/depth plot of Appendix 2 are derived from a least squares fit to the data and in comparison with log, exponential and power curves are felt to provide a reasonable description of the trend of the data points. Uncompensated values and those where the intervals have not been differentiated on the composite logs as described above, have not been used in the construction of these curves nor in the statistical lists presented in Appendix 3.

Extrapolation of the curves much beyond the range encompassed by the data points will lead to erroneous density values.

The results are presented in Appendices 1 - 5 as listings, statistical calculations and plots. Because of localised variations and the method of analysis described above it is felt that the density v depth plots will be of most relevance as they highlight general trends and show the full variability of the data. Due to the limited nature of the data in certain zones and areas, contour plots are presented only for those areas and zones with a reasonable spread of points. The contour plots have been contoured in line with the trends on the maps of Day et al (1981). The chronologically undifferentiated values have been annotated to show the range of intervals involved eg T for Tertiary in intervals 1 and 2. Uncompensated density values are indicated by arrows and will be plotted in all interval plots covering the possible range of ages.

DISCUSSION OF RESULTS

a Tertiary

As there are only a small number of Neogene points, all the Tertiary data have been plotted on one diagram, unanotated points are for the Palaeocene. A linear relationship of $\rho = 1.9 + 1.57 \times 10^{-4}Z$ is obtained with a small data spread. The bulk of the data is from the Central and Northern North Sea areas and is dominated by mudstone through with deep marine to continental clastics developed in areas and chalk in the Palaeocene.

b Upper Cretaceous

This interval is almost lithological in nature with the vast majority of wells penetrating chalk. Towards the northern North Sea, deeper marine shale begins to predominate and these points plot in the lower half of the density v depth plot on the lower density side of the linear trend defined by $\rho = 2.15 + 1.44 \times 10^{-4}Z$ The scatter of points in the southern North Sea is possibly related to inversion in the general area. Although an attempt to relate the data to the uplift plots shown in Marie (1975) was made no correlation was observed. In general terms, shales will retain compacted density with minor elastic expansion, sandstones will return to the efficiently packed density while cemented sandstones will expand less and limestone will be unpredictable. Jankowsky (1970) has shown that by taking uniform lithologies similar sonic velocity versus depth relationships are observed in limestones and shales, however the relatively crude overall averaging of the densities performed here will tend to smother such effects. Bulat (personal communication) has also shown that over pressuring effects, where the fluid content of the chalk takes up some of the geostatic pressure, which at 1.0 psi/ft is much greater than the hydrostatic gradient at 0.465 psi/ft, have significant effects on the porosity and thus density of the rocks.

c Lower Cretaceous

Again a strong trend of the form $\rho = 2.09 + 1.43 \times 10^{-4}Z$ is observed with a slightly smaller spread of data points than the Upper Cretaceous values. The Lower Cretaceous is dominated by shallow and deeper marine shales with sandstones as a minor component. No correlation was observed with the uplift plots of Marie.

d Jurassic

The number of data points from the Jurassic intervals are limited and each interval shows very similar trends with data points from each of the major North Sea basins. Lithologically shales and sandstones predominate and the data scatter is greater than that for the Lower Cretaceous.

The increase in density with depth is given by:

$\rho = 2.17 + 9.02 \times 10^{-5}Z$ for the Lower Jurassic.

$\rho = 2.20 + 8.24 \times 10^{-4}Z$ for the Middle Jurassic,

$\rho = 2.06 + 1.13 \times 10^{-4}Z$ for the Upper Jurassic, e Triassic

The difference in the linear trends of the three Triassic subdivisions is relatively small and shows the greatest variability at the top and base of the density v depth plots, due to the lower number of data points in these regions of the plot. The values for which no chronological subdivision has been made to subsystem level by mainly in the deeper parts of the plots and have not been used calcualting the linear trends. The number of data points and their density v depth scatter increases with age. As before, attempts to relate the variability in the data to regions which have suffered uplift after burial prevent no apparent connection with Marie (1975) plots for the southern North Sea. This perhaps not surprising given that most of the points are from the southern North Sea where halite, anhydrite limestones, sands and shales are found, each of which will react differently to overburden increases and reductions. In the central and northern Northern Sea clastic continental influences increase northwards and the proportion of evaporites and shallow marine carbonates has almost died out by 58°N, apart from the Rhaetian.

f Permian

Zechstein values derived predominantly from the southern North Sea show the greatest variability in density of all the groups studied. This is related to the wide range of rock types present in this interval, (Appendix 1) and results in a negative slope for the linear density v depth trend. The cluster of low values of density on the density v depth plot reflects wells with higher proportions of halite, which as indicated in the methodology section was not corrected for. Higher values around 2.9 gm/cc will reflect greater anhydrite concentrations. If these values were ignored, the data spread would still be quite large and due consideration should be given to diapirism and major thickness changes in the rocks across the area. It is important to stress that the depth contours merely reflect the depth to density intervals available and the contour plot is too complex to contour easily.

The Rotliegendes however shows a much more marked clustering of data points and a greater confidence in the average trend. Again given the sandy lithology of aeolian origin there is no correlation with Marie's curves. Gas concentrations in some of these wells is likely to reduce the density somewhat but the effect will be relatively minor and have a small effect on the average trend. More basinal lithologies are developed in the centre of the southern Permian basin with halite and shale development (Ziegler 1982). In the northern Permian basin of the central North Sea area shales become better developed towards the median line with Norway but no evaporitic basinal facies is developed.

g Carboniferous

As most of the carboniferous values are undifferentiated to subsystem level all points have been plotte on one density v depth plot. A lineartrend is visible though a density of 2.65 gm/cc provides a reasonable average for the bulk of Carboniferous values which are predominantly derived from the Southern North Sea area and consist mainly of sandstone and shales. This value is about matri density for sandstones.

The Carboniferous of the North Sea lay to the north of the Variscan Front and didn't suffer the severe folding of the area to the south of the front.

i Devonian

The Devonian data are few in number and show a wide scatter giving a negative trend though an average value of 2.52 gm/cc is a bit surprising given the predominantly sandy nature of the rocks sampled and the wide depth and areal variation of the values.

j Silurian and Ordovician

There is only one dated point from rocks older than the Devonian in the date set and no density v depth or contour plots are presented.

4. CONCLUSIONS

A linear depth trend provides a reasonable approximation to the behaviour of densities with depth and in using the data presented in the appendices the density v depth plots provide the best assessment of data variability within the North Sea. The values from individual basins may be analysed to provide more specific values particularly in those areas where halite diapirism is present.

The uplift trends seen by Marie (1975) are not represented when various lithological groups of rocks are averaged.

The composite linear trend plot shows a range of approximately 0.2 gm/cc in density value at 3,000 metres depth for rocks ranging in age from Tertiary to Devonian. At sea level and 5,000 meters depth there is an apparent variation of aproximately 0.66 gm/cc and 0.44 gm/cc respectively though projecting the linear trends beyond the actual dat spread will tend to exaggerate the true data spread.

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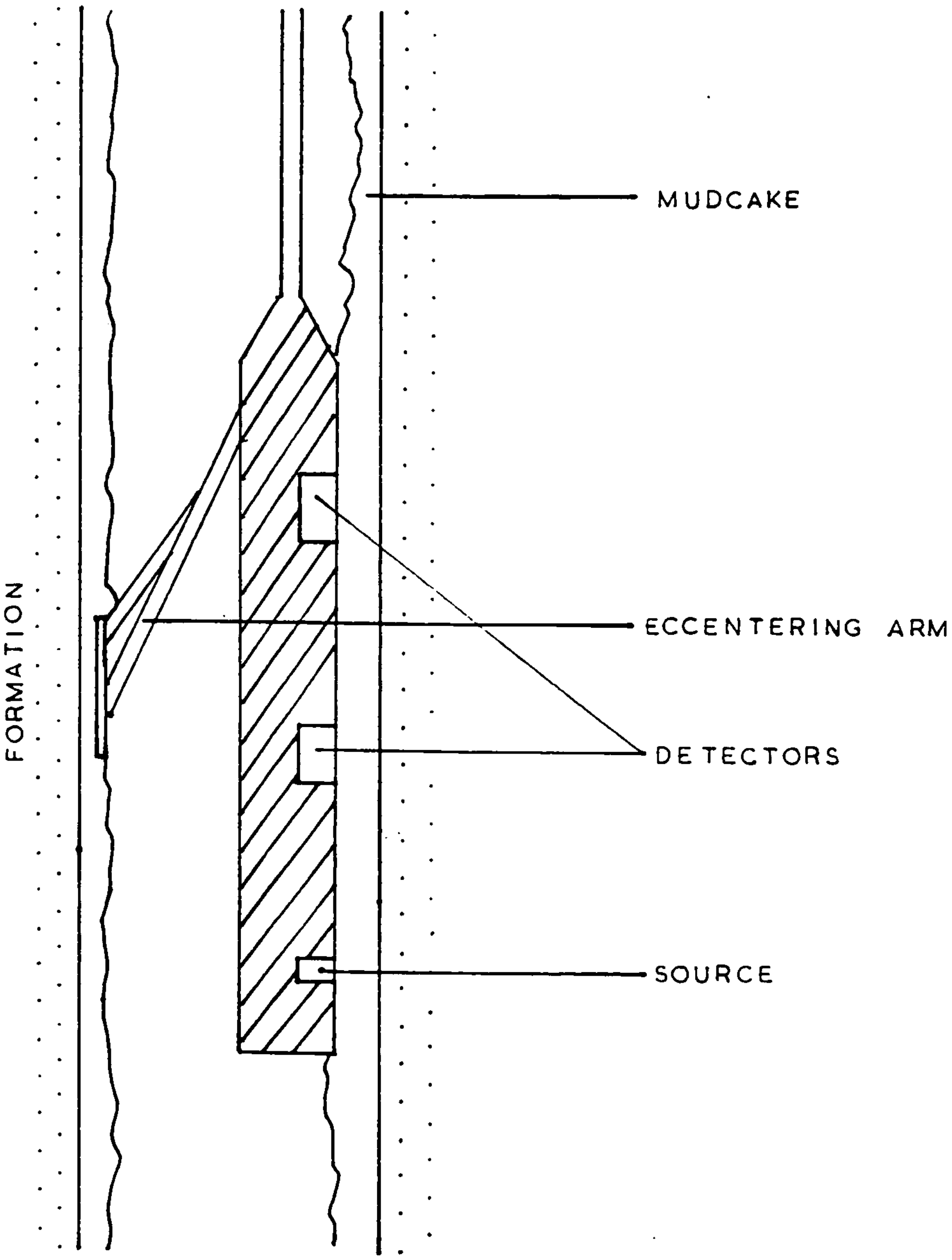


FIGURE I

SCHEMATIC DIAGRAM OF FDC TOOL

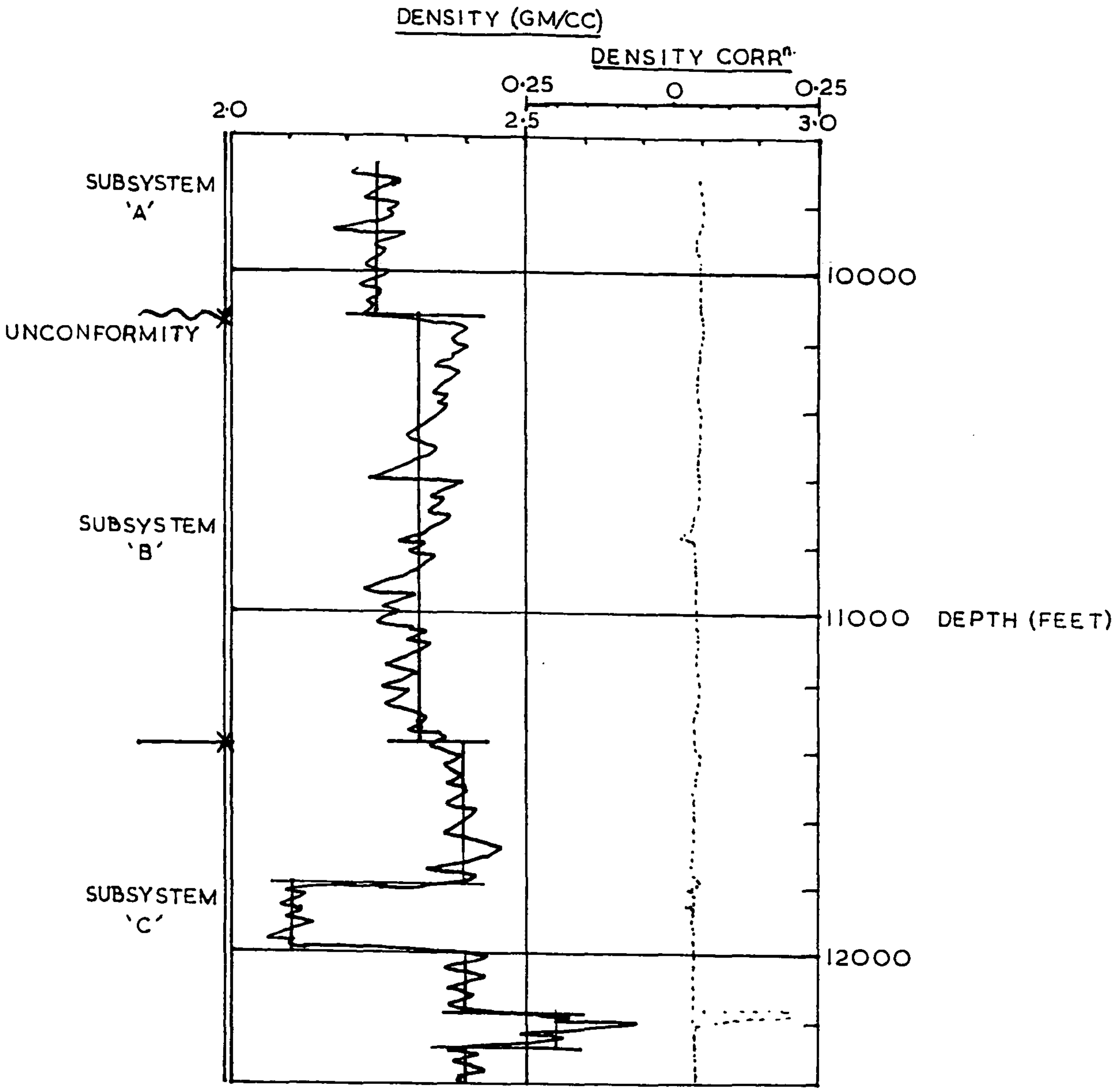


FIGURE 2

DENSITY LOG BREAKDOWN

APPENDIX 1

WELLS USED DURING ANALYSIS WITH POSITIONS

WELL	LATITUDE DEG	LATITUDE MIN		LONGITUDE DEG	LONGITUDE MIN	
Northern North Sea (NNS)						
3/4-1	60	59.5	N	1	42.2	E
3/14A-1	60	33.3	N	1	40.3	E
3/15-1	60	36.1	N	1	49.9	E
9/13-1	59	33.0	N	1	31.9	E
9/23-1	59	14.9	N	1	32.3	E
16/8-1	58	44.9	N	1	32.3	E
211/21-1A	61	11.2	N	1	6.1	E
211/28-2	61	5.8	N	1	25.3	E
Moray Firth (MF)						
12/22-1	58	15.2	N	2	43.0	W
12/23-1	58	17.5	N	2	26.8	W
13/24-1	58	14.3	N	1	21.9	W
14/19-7	58	28.2	N	0	13.6	W
14/20-1	58	20.2	N	0	5.6	W
14/20-2	58	20.5	N	0	8.7	W
14/24-1	58	17.8	N	0	22.9	W
14/25-1	58	10.2	N	0	0.9	W
15/4-1	58	57.0	N	0	43.0	E
Central North Sea (CNS)						
16/23-1	58	14.2	N	1	35.3	E
20/19-1	57	22.0	N	0	15.7	W
21/3-1A	57	57.0	N	0	28.0	E
21/9-1	57	42.3	N	0	46.1	E
21/10-1	57	43.8	N	0	58.5	E
21/11-1	57	38.2	N	0	3.8	E
27/3-1	56	57.5	N	0	32.3	W
27/10-1	56	42.5	N	0	1.5	W
29/3-1	56	50.4	N	1	33.9	E
29/10-1	56	45.1	N	1	55.1	E
29/20-1	56	27.6	N	1	55.3	E
29/25-1	56	18.2	N	1	51.8	E
30/1-1	56	57.7	N	2	11.0	E
30/12-1	56	39.0	N	2	23.0	E
30/13-1	56	34.0	N	2	31.8	E
30/13-2	56	36.7	N	2	27.2	E
30/16-1	56	24.7	N	2	1.7	E
30/16-2	56	23.2	N	2	4.2	E
30/16-3	56	24.5	N	2	4.2	E
30/16-4	56	26.0	N	2	3.9	E
30/17A-1	56	23.8	N	2	12.5	E
30/18-1	56	25.6	N	2	32.7	E
30/19-1	56	26.8	N	2	42.3	E

30/23-1	56	10.3	N	2	28.2	E
30/24-2	56	10.3	N	2	46.0	E

Mid North Sea High (MNSH)

36/13-1	55	30.6	N	0	28.0	E
36/15-1	55	33.1	N	0	59.1	E
36/23-1	55	11.6	N	0	27.1	E
37/10-1	55	44.5	N	1	58.7	E
38/16-1	55	22.9	N	2	4.6	E
38/22-1	55	12.5	N	2	15.8	E
38/25-1	55	17.7	N	2	52.0	E

Southern North Sea (SNS)

42/13-1	54	37.0	N	0	35.3	E
42/23-1	54	15.9	N	0	34.6	E
42/28-2	54	4.7	N	0	27.3	E
42/29-1	54	6.9	N	0	38.2	E
43/7-1	54	44.7	N	1	15.5	E
43/21-1	54	13.0	N	1	0.3	E
43/30-1	54	0.1	N	1	50.4	E
44/2-1	54	52.6	N	2	23.5	E
44/7-1	54	48.4	N	2	18.0	E
44/11-1	54	34.4	N	2	0.1	E
44/19-1	54	28.3	N	2	38.4	E
44/23-1	54	12.5	N	2	27.3	E
44/26-1	54	2.7	N	2	7.5	E
47/3-1	53	56.4	N	0	33.9	E
47/4-1	53	55.6	N	0	42.7	E
47/5-1	53	56.4	N	0	53.8	E
47/8-1	53	49.7	N	0	27.2	E
47/13-2	53	39.2	N	0	27.6	E
47/14A-1	53	36.7	N	0	43.3	E
47/15-1	53	36.9	N	0	54.9	E
47/29A-1	53	9.1	N	0	36.7	E
48/3-1	53	53.0	N	1	25.3	E
48/6-1	53	42.6	N	1	8.4	E
48/7-1	53	44.1	N	1	13.1	E
48/7-2	53	44.5	N	1	12.7	E
48/11-1	53	33.3	N	1	8.4	E
48/11-2	53	31.1	N	1	5.8	E
48/12-1	53	39.4	N	1	18.7	E
48/13-2A	53	37.2	N	1	31.1	E
48/17-1	53	22.2	N	1	14.8	E
48/18B-1	53	22.1	N	1	35.8	E
48/20-1	53	28.9	N	1	52.3	E
48/22-2	53	15.6	N	1	22.6	E
48/22-3	53	17.5	N	1	16.1	E
48/23-1	53	14.0	N	1	32.1	E
48/25-1	53	17.1	N	1	56.0	E
48/29-1	53	4.2	N	1	39.6	E
48/29-2	53	3.1	N	1	40.8	E
49/1-1	53	52.5	N	2	7.3	E
49/2-1	53	55.9	N	2	23.2	E
49/6-1	53	42.3	N	2	5.1	E
49/6-2	53	40.7	N	2	7.9	E
49/6-3	53	45.7	N	2	6.2	E
49/8-1	53	42.1	N	2	26.1	E
49/12-1	53	31.6	N	2	15.4	E
49/12-2	53	31.6	N	2	15.4	E
49/12-3	53	32.5	N	2	13.7	E
49/16-1	53	22.2	N	2	7.8	E
49/16-4	53	21.2	N	2	11.3	E

49/16-6	53	29.3	N	2	10.6	E
49/17-1	53	26.5	N	2	19.4	E
49/18-1	53	23.6	N	2	31.4	E
49/19-1	53	20.8	N	2	45.4	E
49/19-2A	53	20.9	N	2	36.6	E
49/20-1	53	24.1	N	2	51.9	E
49/20-2	53	27.4	N	2	58.3	E
49/21-1	53	10.5	N	2	1.8	E
49/21-4	53	19.2	N	2	4.4	E
49/22-1	53	19.9	N	2	14.8	E
49/23-1	53	19.3	N	2	31.6	E
49/26-1	53	5.3	N	2	7.8	E
49/27-1	53	3.3	N	2	14.0	E
49/28-1	53	1.8	N	2	24.2	E
49/29-1	53	9.9	N	2	43.3	E
52/5-1	52	60.0	N	1	50.9	E
52/5-2	52	58.6	N	1	54.3	E
52/5-3	52	57.0	N	1	55.5	E
53/1-1	52	57.5	N	2	8.0	E
53/2-1	52	59.9	N	2	13.4	E
53/3-1	52	54.6	N	2	30.1	E
53/4-1	52	53.0	N	2	45.1	E
53/5-1	52	51.6	N	2	55.2	E
53/7-1	52	48.9	N	2	17.4	E
53/12-1	52	38.9	N	2	22.6	E
53/14-1	52	39.4	N	2	42.1	E
53/16-1	52	29.1	N	2	9.2	E
54/11-1	52	33.0	N	3	2.4	E

APPENDIX 2

INTERVALS USED IN ANALYSIS

TABLE	INTERNAL
1	Neogene
2	Palaeogene
3	Upper Cretaceous
4	Lower Cretaceous
5	Upper Jurassic
6	Middle Jurassic
7	Lower Jurassic
8	Upper Triassic
9	Middle Triassic
10	Lower Triassic
11	Upper Permian
12	Lower Permian
13	Upper Carboniferous
14	Lower Carboniferous
15	Devonian
16	Silurian and Ordovician

APPENDIX 3

DENSITY VALUES FOR INTERVALS AND WELLS

Tables list the wells and density values included in each chronological interval. The data are held as the table OFFSHORE WELL-DENSITIES under the ORACLE database management system on the VAX 8600 computer in Keyworth. The age of the formations in each well are given according to the following abbreviations:

O - Ordovician
D - Devonian
C - Carboniferous
P - Permian
T - Triassic
J - Jurassic
K - Cretaceous
G - Palaeogene
N - Neogene
L - Lower
M - Middle
U - Upper

A U in the left-hand margin indicates that the log is uncompensated. The depth is the average of the top and bottom of the interval, below mean sea level.

TABLE 1 NEOGENE

WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE
9/23-1	2.30	0.10	1937.5	161.5	MDST+SHAL	GN
14/24-1	2.00	0.15	662.5	467.0	SDST+MDST+COAL	GN
14/25-1	2.21	0.10	1575.5	1323.0	MDST+SLST+SDST	GN
15/4-1	2.10	0.05	1170.0	855.5	MDST+SLST+SDST	GN
16/8-1	2.22	0.10	2213.0	952.0	SHAL+SDST+CHLK	GN
21/9-1	2.20	0.03	694.4	157.0	MDST	GN
21/11-1	2.10	0.05	1115.0	1064.5	MDST+CHLK	GN
29/10-1	2.12	0.05	1687.5	2133.5	MDST+SHAL+SDST+CONG	GN
29/20-1	2.19	0.05	1323.0	1810.0	MDST+SDST	GN
29/3-1	2.15	0.05	2215.0	1237.0	MDST+SHAL+CHLK	GN
30/16-2	2.10	0.20	1824.5	657.0	MDST	GN
30/16-3	2.12	0.20	1854.0	707.0	MDST	GN
30/16-4	2.02	0.10	1329.5	1860.0	MDST	GN
30/18-1	2.00	0.03	1377.5	152.5	MDST+SHAL	GN
30/19-1	2.37	0.07	3012.5	309.5	MDST+CHLK	GN
38/16-1	2.00	0.10	512.0	327.0	MDST	N
53/14-1	1.85	0.15	257.0	56.5	MDST	GN
211/21-1A	1.95	0.05	945.0	642.0	SDST+MDST	GN

TABLE 2 PALAEOGENE

	WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE
	3/15-1	2.15	0.15	1975.0	502.0	SHAL+SDST	G
	9/13-1	2.21	0.15	1844.0	1208.5	MDST+SHAL+SDST	G
	9/23-1	2.30	0.10	1937.5	161.5	MDST+SHAL	GN
	13/24-1	2.20	0.10	707.5	482.0	SDST+MDST	G
	14/24-1	2.00	0.15	662.5	467.0	SDST+MDST+COAL	GN
	14/25-1	2.21	0.10	1575.5	1323.0	MDST+SLST+SDST	GN
	15/4-1	2.10	0.05	1170.0	855.5	MDST+SLST+SDST	GN
U	16/23-1	2.15	0.05	2073.5	436.5	MDST+SHAL+SDST	G
U	16/23-1	2.25	0.10	2575.5	220.5	MDST+SDST	G
	16/8-1	2.22	0.10	2213.0	952.0	SHAL+SDST+CHLK	GN
	20/19-1	1.95	0.10	701.5	635.5	MDST+SLST+SDST	G
	21/10-1	2.30	0.10	2279.5	482.0	MDST+SDST+SHAL	G
	21/11-1	2.10	0.05	1115.0	1064.5	MDST+CHLK	GN
	21/3-1A	2.20	0.10	1909.0	1189.0		G
	21/9-1	2.30	0.03	2328.0	624.0	MDST+SHAL+SDST+LMST	G
	29/10-1	2.12	0.05	1687.5	2133.5	MDST+SHAL+SDST+CONG	GN
	29/20-1	2.19	0.05	1323.0	1810.0	MDST+SDST	GN
	29/3-1	2.15	0.05	2215.0	1237.0	MDST+SHAL+CHLK	GN
	30/1-1	2.53	0.05	3197.5	610.0	MDST+LMST	KU G
	30/12-1	2.36	0.05	2834.5	286.5	SLST+CHLK	G
	30/13-1	2.33	0.05	2823.5	308.0	MDST+SHAL	G
	30/18-1	2.25	0.10	2584.5	433.0	MDST	G
	30/19-1	2.37	0.07	3012.5	309.5	MDST+CHLK	G
	30/13-2	2.38	0.05	2835.5	554.5	MDST+SDST+LMST	G
	30/16-2	2.10	0.20	1824.5	657.0	MDST	GN
	30/16-3	2.12	0.20	1854.0	707.0	MDST	GN
	30/16-4	2.02	0.10	1329.5	1860.0	MDST	GN
	30/23-1	2.16	0.20	2136.0	443.5	SHAL	G
	30/24-2	2.35	0.20	2616.5	101.5	SHAL	G
	44/19-1	1.92	0.05	479.5	284.0	MDST	G
	53/14-1	1.85	0.15	257.0	56.5	MDST	G
	211/21-1A	1.95	0.05	945.0	642.0	SDST+MDST	G

TABLE 3 UPPER CRETACEOUS

WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE
3/14A-1	2.55	0.05	3109.0	372.0	MARL+SHAL+LMST	KU
3/15-1	2.39	0.08	2549.5	647.0	SHAL+MDST	KU
3/4-1	2.45	0.05	2616.0	103.5	SLST+MDST	KU
9/13-1	2.45	0.10	2721.0	545.0	LMST+MARL+MDST	KU
13/24-1	2.55	0.03	1191.0	484.5	LMST	KU
14/20-1	2.51	0.03	2180.5	71.0	CHLK	KU
14/24-1	2.15	0.10	905.0	17.5		KU
14/25-1	2.50	0.12	2253.5	33.5	SHAL	KU
14/20-2	2.60	0.03	2308.5	95.0		K
15/4-1	2.55	0.07	1675.0	155.0	CHLK	KU
U 16/23-1	2.41	0.04	2712.5	53.5	LMST	KU
16/8-1	2.57	0.04	3190.5	1002.5	CHLK+MDST+SHAL+MARL	KU
20/19-1	2.20	0.05	1178.5	318.0	CHLK	KU
21/11-1	2.55	0.03	1804.5	315.5	CHLK	KU
21/3-1A	2.60	0.05	2770.0	547.0	LMST+SHAL	KU
21/9-1	2.60	0.05	2874.0	467.5	LMST+MARL	KU
27/3-1	2.15	0.05	523.0	365.5	CHLK	KU
29/20-1	2.55	0.04	2255.0	53.5	CHLK	KU
29/3-1	2.55	0.03	3025.0	383.0	CHLK	KU
30/1-1	2.53	0.05	3197.5	610.0	CHLK	KU G
30/12-1	2.50	0.10	3022.0	89.0	CHLK	KU
30/16-1	2.55	0.05	2244.5	119.0	CHLK	KU
30/18-1	2.30	0.20	2829.0	56.0	MDST	KU
30/19-1	2.62	0.05	3452.5	570.0	LMST	KU
30/13-2	2.55	0.05	3368.0	519.5	LMST	KU
30/16-2	2.55	0.05	2198.5	91.0	LMST	KU
30/16-3	2.58	0.03	2242.5	70.5	CHLK	KU
30/16-4	2.58	0.05	2278.0	36.0		KU
30/23-1	2.58	0.03	2384.0	52.0	CHLK	KU
30/24-2	2.55	0.03	2685.0	35.0	CHLK	KU
36/13-1	2.31	0.05	728.0	409.0	CHLK	KU
36/15-1	2.35	0.10	1018.5	459.5	CHLK	KU
37/10-1	2.29	0.05	1453.5	255.0	CHLK	KU
43/30-1	2.21	0.05	259.5	26.5	CHLK	KU
43/7-1	2.19	0.05	842.5	513.0	CHLK	KU
44/19-1	1.93	0.10	631.5	21.0	CHLK	KU
44/26-1	2.20	0.07	602.5	640.5	CHLK	KU
49/2-1	2.33	0.03	363.0	28.5	CHLK	KU
49/20-1	2.45	0.10	1358.5	275.5	CHLK	KU
53/12-1	2.03	0.02	505.0	18.5	CHLK	KU
53/14-1	2.13	0.05	344.5	118.5	CHLK	KU
53/16-1	2.20	0.05	476.0	241.5	CHLK	KU
53/4-1	2.46	0.06	1334.0	47.0	CHLK	KU
53/5-1	2.40	0.05	1258.5	759.5	CHLK	KU

TABLE 4 LOWER CRETACEOUS

	WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE
	3/14A-1	2.60	0.10	3302.0	14.0	SHAL	KL
	3/4-1	2.60	0.05	2670.0	5.0		KL
	9/23-1	2.37	0.10	2050.0	63.5	SDST	KL
	12/22-1	2.08	0.10	498.0	351.0	SDST+MDST	KL
	12/23-1	2.10	0.10	438.0	626.5	MDST+SDST	KL
	13/24-1	2.45	0.10	1665.5	464.0	SHAL+MDST+SDST	KL
	14/20-2	2.60	0.03	2308.5	95.0		K
	15/4-1	2.35	0.15	1772.0	38.5	SHAL	KL
	16/8-1	2.55	0.10	3748.5	113.0	MDST+MARL	KL
	20/19-1	2.20	0.05	1252.0	29.0	MDST	KL
	21/11-1	2.35	0.10	2082.5	126.5	SHAL	KL
	27/3-1	2.10	0.10	742.0	72.0	CLAY+SHAL	KL
	29/25-1	2.40	0.10	2361.5	198.0	SHAL+MARL	KL
	29/3-1	2.50	0.05	3272.5	113.0	MDST+SHAL	KL
U	30/12-1	2.33	0.03	3450.5	13.0		KL
	30/16-1	2.40	0.10	2306.0	3.5		KL
	30/19-1	2.65	0.05	3759.5	44.0	LMST	KL
	30/23-1	2.50	0.05	2425.5	27.5	SHAL	KL
	30/24-2	2.45	0.10	2710.5	16.0	MARL	KL
	36/13-1	2.25	0.05	947.0	28.5		KL
	36/15-1	2.33	0.07	1272.5	48.0	SHAL	KL
	37/10-1	2.30	0.15	1615.5	70.0	MARL+MDST	KL
	43/7-1	2.20	0.05	1120.0	42.0	MDST	KL
	44/26-1	2.44	0.07	926.0	6.5	MARL	KL
	44/7-1	2.10	0.20	1417.5	52.5	SHAL	KL
	48/11-1	2.20	0.07	934.0	81.5	SHAL	KL
	49/12-1	2.17	0.07	720.5	42.5	MDST	KL
	49/18-1	2.25	0.20	1071.5	68.5	MARL	KL
	49/20-1	2.45	0.10	1625.0	257.0	MARL+SHAL	KL
	49/23-1	2.35	0.05	1157.0	54.0	MARL	KL
	53/12-1	2.08	0.04	572.0	116.0	SHAL	KL
	53/14-1	2.20	0.07	499.0	190.5	SHAL	KL
	53/16-1	2.13	0.15	605.0	16.5	SHAL	KL
	53/4-1	2.32	0.07	1377.5	39.5	MDST	KL
	53/5-1	2.55	0.05	1673.0	69.5	SHAL	KL
	53/7-1	2.15	0.07	443.0	10.0	SHAL	KL
	211/21-1A	2.30	0.20	2684.0	235.0	MDST	KL
	211/28-2	2.51	0.05	2954.5	54.0	MDST	KL

TABLE 5 UPPER JURASSIC

WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE
3/14A-1	2.38	0.03	3310.0	2.0	SHAL	JU
3/15-1	2.35	0.05	3156.0	54.0	MDST	JU
3/4-1	2.45	0.05	2689.5	33.5	SHAL	JU
12/22-1	2.21	0.15	831.5	316.5	SHAL+SDST	JU
12/23-1	2.21	0.10	817.5	133.0	SHAL+SDST	JM JU
14/20-1	2.21	0.05	2337.5	243.5	SDST	J
14/20-2	2.29	0.05	2446.0	181.0		J
16/8-1	2.55	0.67	4125.0	640.0	SHAL+SLST	JU
29/20-1	2.28	0.07	2326.5	90.0	SDST	JU
30/13-2	2.55	0.05	3910.0	87.5	SHAL	JU
30/16-3	2.63	0.05	2282.0	8.0		JU
30/23-1	2.25	0.02	2484.5	94.5		JU
36/13-1	2.05	0.10	983.0	44.0	SHAL	JU
36/15-1	2.15	0.10	1318.5	43.5	SHAL	JU
37/10-1	2.17	0.20	1680.0	59.0	SHAL	JU
38/22-1	2.40	0.07	1689.0	41.5	MDST	JM JU
47/13-2	2.06	0.20	1027.5	409.0	MDST	J
48/11-1	2.30	0.20	1026.0	102.0	SHAL+LMST	JU
48/29-2	2.09	0.10	401.5	139.5	SHAL	J
211/21-1A	2.35	0.10	2738.0	84.5	MDST	JU
211/28-2	2.35	0.05	2994.5	26.0	MDST	JU

TABLE 6 MIDDLE JURASSIC

WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE
3/4-1	2.35	0.10	2769.5	127.5	SDST	JM
9/13-1	2.35	0.05	3061.5	136.0	SDST	JM
12/23-1						JM JU
14/20-1						JL JU
14/20-2						JL JU
16/8-1	2.60	0.20	4648.5	407.0	MDST+SDST	JM
30/17A-1	2.44	0.05	3076.0	233.0	SHAL+SDST	JL JM
30/13-2	2.60	0.03	4060.5	213.5	SLST	JM
38/22-1						JM JU
47/13-2						J
48/11-1	2.35	0.13	1138.0	122.0	SHAL	JM
48/29-2						J
211/21-1A	2.45	0.20	2832.0	103.5	SDST+SHAL	JM
211/28-2	2.50	0.20	3016.0	16.5	MDST	JM

TABLE 7 LOWER JURASSIC

WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE
3/14A-1	2.35	0.01	3338.0	54.0	SDST	JL
3/4-1	2.28	0.05	2867.0	67.5	SDST	JL
14/20-1						J
14/20-2						J
16/8-1	2.65	0.10	4867.5	30.5	SHAL	JL
30/17A-1						JL JM
43/7-1	2.23	0.07	1207.5	133.0	MDST	JL
47/13-2						J
48/11-1	2.45	0.10	1414.0	430.5	SHAL	JL
48/29-2						J
53/1-1	2.15	0.20	220.5	144.0	SHAL	JL
211/21-1A	2.53	0.10	2910.0	52.5	MDST	JL
211/21-1A	2.51	0.10	3172.0	472.0	SLST	TU JL
211/28-2	2.50	0.10	3105.0	138.5	MDST	JL

TABLE 8 UPPER TRIASSIC

WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE
12/23-1	2.30	0.10	1110.5	439.0	SLST	T
14/20-2	2.40	0.05	2572.5	73.0		T
21/11-1	2.45	0.15	2179.5	67.5		T
29/20-1	2.35	0.10	2410.0	77.5	SDST	T
30/16-1	2.45	0.10	2313.0	10.5		T
30/13-2	2.60	0.10	4189.5	44.0	SHAL	T
30/16-2	2.25	0.20	2259.5	31.0		T
30/23-1	2.57	0.20	2614.5	147.5	SHAL+HALI+MARL	PU T
43/21-1	2.40	0.05	605.5	183.0	MDST	TU
43/30-1	2.21	0.10	399.5	253.5	SHAL	TU
43/7-1	2.25	0.05	1288.0	28.5	SHAL	TU
U 44/2-1	2.48	0.10	2123.0	200.5	MDST	T
44/26-1	2.30	0.10	962.0	65.5	SHAL	TU
47/15-1	2.42	0.05	1727.0	183.0		T
47/13-2	2.26	0.30	1333.0	202.0	MDST	TU
47/3-1	2.34	0.20	1572.5	342.0	EVAP+SHAL	TU
48/11-1	2.35	0.30	1679.0	98.5	SHAL	TU
48/12-1	2.25	0.15	969.5	262.0	EVAP+SHAL	TU
48/13-2A	2.14	0.15	636.5	345.0	EVAP+SHAL	T
48/23-1	2.40	0.25	1531.0	165.0	EVAP+MDST	TU
48/29-2	2.35	0.20	627.5	312.0	SHAL	TU
49/12-1	2.40	0.17	964.0	445.0	SDST+MDST+EVAP+SHAL	TU
49/16-1	2.27	0.15	934.0	363.5	MDST+EVAP+SHAL	TU
49/23-1	2.45	0.05	1318.0	248.0	SHAL	TU
49/26-1	2.40	0.10	1385.0	14.5		T
52/5-1	2.51	0.05	784.0	75.0	MDST	TM TU
52/5-2	2.45	0.11	808.5	88.0	MDST	TM TU
52/5-3	2.42	0.11	882.0	13.0	SHAL	TM TU
53/1-1	2.10	0.15	560.5	536.0	SHAL+EVAP+MDST	TU
53/12-1	2.15	0.15	769.0	278.5	SHAL	TU
53/14-1	2.30	0.10	781.0	373.5		T
53/7-1	2.25	0.20	631.5	367.0	SHAL	TU
211/21-1A						TU JL
211/28-2	2.50	0.10	3105.0	138.5	MDST	TU

TABLE 9 MIDDLE TRIASSIC

	WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE
	12/23-1						T
	14/20-2						T
	21/11-1						T
	29/20-1						T
	30/16-1						T
	30/13-2						T
	30/16-2						T
	30/23-1						PU T
	38/22-1	2.40	0.04	1726.5	34.0	MDST	TM
	43/21-1	2.40	0.05	774.0	154.0	MDST+EVAP	TM
	43/30-1	2.13	0.15	570.0	88.0	SHAL	TM
	43/7-1	2.45	0.10	1412.0	219.0	SHAL+DOLM	TM
U	44/2-1						T
	44/26-1	2.63	0.05	1038.0	87.0	SHAL	TM
	47/15-1						T
	47/13-2	2.70	0.07	1466.5	65.5	DOLM	TM
	47/3-1	2.25	0.15	1888.5	290.5	EVAP	TM
	48/11-1	2.33	0.25	1837.5	219.0	SHAL+EVAP	TM
	48/12-1	2.26	0.20	1278.5	356.5	EVAP+SHAL+MDST	TM
	48/13-2A					SHAL+EVAP	T
	48/29-1	2.39	0.07	893.0	8.0	SHAL	TM
	48/29-2	2.46	0.17	838.5	110.5	SHAL	TM
	49/12-1	2.15	0.06	1293.5	213.5	EVAP	TM
	49/16-1	2.37	0.01	1181.5	132.0	SHAL+EVAP	TM
U	49/17-1	2.38	0.15	1539.5	826.5		TL TM
	49/22-1	2.28	0.10	1487.5	795.0	MDST+SDST+EVAP	TL TM
	49/23-1	2.50	0.05	1449.5	34.5	SHAL	TM
	49/26-1						T
	49/28-1	2.35	0.20	988.5	118.0	SHAL	TM
	49/6-2	2.18	0.03	1449.0	21.5	EVAP	TM
	52/5-1					MDST	TM TU
	52/5-2						TM TU
	52/5-3					SHAL	TM TU
	53/1-1	2.43	0.10	896.0	135.0	EVAP+MDST	TM
	53/12-1	2.40	0.10	951.5	86.0	SHAL	TM
	53/14-1						T
	53/7-1	2.35	0.15	877.0	124.0	SHAL	TM

TABLE 10 LOWER TRIASSIC

WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE
12/23-1						T
14/20-2						T
20/19-1	2.45	0.03	1543.5	354.0	MDST	TL
21/11-1						T
27/3-1	2.10	0.10	822.0	88.0	SHAL	TL
29/20-1						T
30/13-1	2.45	0.10	3936.0	356.5	SHAL	TL
30/16-1						T
30/13-2						T
30/16-2						T
30/23-1						PU T
36/13-1	2.26	0.07	1009.0	8.5		TL
38/22-1	2.91	0.10	1921.0	355.0	ANHY+DOLM	TL
42/29-1	2.65	0.03	2292.0	49.5	MDST	TL
42/28-2	2.65	0.02	2459.0	46.0	SHAL	TL
43/21-1	2.33	0.07	1090.5	479.0	MDST+EVAP+SDST	TL
43/30-1	2.24	0.05	854.0	479.5	SHAL+EVAP+SDST	TL
43/7-1	2.38	0.05	1576.5	110.5	SDST+MDST	TL
44/11-1	2.35	0.15	2300.5	23.0	MARL	TL
U 44/2-1					MDST	T
44/23-1	2.33	0.10	1434.5	182.0	SDST+MDST	TL
44/26-1	2.37	0.10	1298.5	433.5	SHAL+EVAP+SDST	TL
44/7-1	2.40	0.10	1640.5	394.0	SHAL	TL
47/14A-1	2.25	0.04	2106.5	4.5		TL
47/15-1						T
47/13-2	2.54	0.15	1836.5	674.0	MDST+EVAP+SDST	TL
47/29A-1	2.33	0.10	1133.5	282.5	MDST+SDST	TL
47/3-1	2.52	0.10	2372.0	676.0	EVAP	TL
48/11-1	2.50	0.12	2201.0	508.0	SHAL	TL
48/12-1	2.50	0.05	1783.0	652.5	SDST+MDST	TL
48/17-1	2.60	0.03	1881.0	48.5	MDST	TL
48/13-2A					EVAP+SDST+SHAL	T
48/23-1	2.60	0.05	1708.5	190.0	MDST	TL
48/29-1	2.33	0.10	1093.0	392.5	SDST+SHAL	TL
48/22-2	2.63	0.03	1804.5	38.0	MDST	TL
48/29-2	2.43	0.08	1096.0	404.0	SDST+SHAL	TL
48/7-1	2.65	0.05	1609.0	335.5	MDST	TL
49/12-1	2.45	0.20	1815.0	830.0	SHAL	TL
49/16-1	2.47	0.10	1640.0	785.0	MDST+SHAL+EVAP	TL
49/17-1						TL TM
49/16-4	2.35	0.20	1985.0	12.0	SHAL	TL
49/16-6	2.48	0.10	1834.0	632.5	SDST+SHAL	TL
49/2-1	2.27	0.10	515.0	276.5	SHAL+ANHY+SDST	TL
49/20-1	2.40	0.15	1760.5	14.0	SHAL	TL
49/21-1	2.65	0.05	1508.0	256.5	MDST	TL
49/22-1						TL TM
49/23-1	2.45	0.10	1718.5	503.0	SDST+SHAL	TL
49/26-1						T
49/27-1	2.62	0.03	1385.0	13.0	SHAL	TL
49/28-1	2.45	0.10	1208.5	522.0	SDST+SHAL	TL
49/21-4	2.40	0.10	1388.5	146.5	SHAL+EVAP+SDST	TL
49/6-1	2.58	0.03	1266.0	30.0	MDST	TL

	49/6-2	2.40	0.10	1601.5	283.5	SDST+MDST	TL
	49/6-3	2.68	0.03	3162.0	252.0	SHAL	TL
	52/5-1	2.45	0.10	1038.5	434.0	SDST+MDST	TL
	52/5-2	2.29	0.10	1084.0	463.0	SDST+MDST	TL
	52/5-3	2.32	0.12	2046.5	246.5	SDST+MDST	TL
	52/5-3	2.35	0.15	1325.5	45.5	MDST	TL
	53/1-1	2.30	0.10	1288.5	649.5	SDST+SHAL	TL
	53/12-1	2.25	0.07	1119.5	250.5	SDST	TL
	53/14-1	2.30	0.10	781.0	373.5		T
	53/16-1	2.20	0.10	667.5	109.0	SDST+SHAL	TL
	53/3-1	2.35	0.10	1691.5	49.5	SHAL	TL
	53/4-1	2.25	0.02	1516.5	239.5	SHAL	TL
	53/7-1	2.35	0.15	1250.0	621.5	SDST+SHAL	TL
U	54/11-1	2.35	0.10	1487.0	80.5	SHAL	TL
	211/21-1A	2.51	0.10	3172.0	472.0		T JL

TABLE 11 UPPER PERMIAN

	WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE	
	12/23-1	2.40	0.17	1404.5	149.0	DOLM	PU	
	14/20-1	2.60	0.10	2475.5	32.5	LMST	PU	
	14/24-1	2.51	0.07	1117.5	407.5	SDST	PU	
	14/20-2	2.95	0.03	2660.5	103.5		PU	
	20/19-1	2.15	0.03	1968.5	495.5	SLST+SDST+EVAP+DOLM	PU	
	21/11-1	2.06	0.05	2741.0	1055.0	EVAP+SHAL	P	
U	27/10-1	2.75	0.05	1319.0	290.5	ANHY+EVAP+POLY+DOLM	PU	
	27/3-1	2.80	0.03	1108.5	485.0	EVAP+ANHY+DOLM	P	
	29/20-1	2.74	0.10	2527.5	1575.0	ANHY+TUFF+DOLM	PU	
U	29/25-1	2.40	0.05	2807.0	550.0	ANHY+EVAP	P	
U	30/12-1	2.63	0.03	3620.5	24.5	ANHY	PU	
	30/16-1	2.55	0.10	2335.0	33.0	EVAP+SDST	PU	
	30/17A-1	2.67	0.05	3203.5	21.5	SLST	PU	
	30/13-2	2.26	0.05	4310.5	198.0	ANHY+EVAP	PU	
	30/16-2	2.55	0.10	2282.0	14.0		PU	
	30/16-3	2.55	0.10	2296.0	20.5	EVAP	PU	
	30/16-4	2.30	0.10	2495.5	399.0		PU	
	30/23-1						PU	T
	30/24-2	2.60	0.20	2734.0	31.5		PU	
	36/13-1	2.59	0.13	1124.0	221.0	ANHY+DOLM	PU	
	36/15-1	2.82	0.05	1488.5	297.0	ANHY	PU	
	38/25-1	2.95	0.03	2043.5	266.0	ANHY+DOLM	PU	
	42/13-1	2.22	0.10	1987.5	775.5	ANHY+EVAP+SHAL	PU	
	42/23-1	2.80	0.06	2766.5	70.0	ANHY+LMST+SHAL	PU	
	42/29-1	2.27	0.10	2479.0	324.0	EVAP+ANHY+LMST+SHAL	PU	
	42/28-2	2.35	0.05	2703.5	443.0	EVAP	PU	
U	44/2-1	2.51	0.15	2489.5	533.5	ANHY+EVAP+LMST+SHAL	PU	
	44/7-1	2.17	0.10	2386.5	1098.0	ANHY+EVAP	PU	
	47/14A-1	2.40	0.10	2390.5	563.5	EVAP	PU	
	47/13-2	2.60	0.10	££££.£	492.5	EVAP	PU	
	47/29A-1	2.45	0.15	1353.0	156.5	EVAP	PU	
	47/3-1	2.20	0.20	2933.5	448.0	EVAP+SHAL	PU	
	47/4-1	2.70	0.05	3239.0	142.0	EVAP+SHAL	PU	
	47/5-1	2.52	0.05	2859.0	287.0	EVAP	PU	
	47/8-1	2.75	0.06	2783.0	3.5	EVAP	PU	
	48/11-1	2.54	0.15	2597.5	284.3	EVAP+DOLM+ANHY	PU	
	48/12-1			2507.5	796.0	EVAP+ANHY+DOLM	PU	
	48/17-1	2.61	0.05	2162.5	515.0	EVAP+ANHY+DOLM+SHAL	PU	
	48/18B-1	2.90	0.05	2507.0	203.5	EVAP	PU	
	48/11-2	2.40	0.10	2566.5	456.0	EVAP+ANHY+DOLM+SHAL	PU	
	48/13-2A	2.29	0.10	2090.5	636.5	EVAP	PU	
	48/20-1	2.45	0.15	2278.5	376.5	EVAP+ANHY+DOLM+SHAL	PU	
	48/23-1	2.58	0.10	2004.0	401.0	EVAP+SHAL+ANHY+DOLM	PU	
	48/25-1	2.26	0.10	2061.0	668.5	EVAP+ANHY+DOLM	PU	
	48/29-1	2.75	0.10	1409.0	239.5	ANHY+EVAP+DOLM	PU	
	48/22-2	2.67	0.10	2022.0	398.0	EVAP+ANHY+DOLM+MDST	PU	
	48/29-2	2.69	0.05	1406.5	217.5	ANHY+EVAP+DOLM+SHAL	PU	
	48/22-3	2.93	0.03	2310.0	56.0	ANHY	PU	
	48/3-1	2.19	0.15	2710.0	1214.0	EVAP+ANHY+LMST	PU	
	48/6-1	2.65	0.20	2608.0	71.5	LMST+ANHY+DOLM+MDST	PU	
	48/7-1	2.18		2363.5	1174.0	EVAP+DOLM+ANHY+LMST	PU	
	49/1-1	2.49	0.10	3298.5	375.5	SHAL+ANHY+EVAP	PU	

	49/16-1	2.26	0.10	2302.5	540.0	EVAP+DOLM+SHAL	PU
U	49/17-1	2.35	0.10	2354.5	803.1	EVAP+ANHY+DOLM+SHAL	PU
U	49/19-1	2.25	0.25	2182.5	481.5	EVAP+ANHY+LMST	PU
	49/16-4	2.85	0.05	2430.5	92.5	EVAP	PU
	49/16-6	2.63	0.15	2778.0	81.5	EVAP	PU
	49/20-1	2.47	0.05	2075.0	6145.0	ANHY+DOLM+SHAL+LMST	PU
	49/21-1	2.61	0.10	1918.5	564.5	EVAP+ANHY+DOLM+SHAL	PU
	49/22-1	2.27	0.15	2276.1	782.5	EVAP	PU
	49/23-1	2.45	0.10	2280.0	619.5	EVAP+ANHY+DOLM+SHAL	PU
	49/26-1	2.70	0.05	1597.5	411.5	EVAP+ANHY	PU
	49/27-1	2.49	0.10	1597.5	411.5	EVAP+ANHY+DOLM+SHAL	PU
	49/29-1	2.69	0.10	2450.5	498.5	EVAP+DOLM+ANHY	PU
	49/21-4	2.56	0.04	2110.0	279.0	EVAP+DOLM	PU
	49/6-1	2.00	0.10	1807.0	137.5	EVAP+ANHY	PU
	49/6-2	2.86	0.11	3433.0	42.5	ANHY+LMST+SHAL	PU
	49/8-1	2.50	0.25	3455.0	83.0		PU
	52/5-1	2.55	0.30	1380.0	248.5	MDST+DOLM+SDST	PU
	52/5-2	2.73	0.10	1429.0	227.0	SHAL+DOLM	PU
	52/5-3	2.58	0.07	1371.0	46.0	SLST+ANHY	PU
	53/1-1	2.80	0.05	1768.5	311.0	EVAP	PU
	53/12-1	2.40	0.10	1344.0	198.5		PU
	53/14-1	2.45	0.18	1120.5	306.5	DOLM+SDST	P
	53/16-1	2.27	0.10	734.0	23.5	SDST	PU
	53/3-1	2.80	0.15	1821.0	209.5	DOLM	PU
	53/4-1	2.80	0.08	1731.5	190.0	ANHY	PU
	53/5-1	2.75		1795.5	175.2	DOLM	PU
	53/7-1	2.65	0.10	1634.5	148.0	DOLM	PU
U	54/11-1	2.46	0.10	1614.0	174.5	SLST	PU

TABLE 12 LOWER PERMIAN

	WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE	
	12/23-1	2.38	0.05	1825.0	692.5	SHAL	PL	
	14/24-1						O	P
	20/19-1	2.60	0.03	2239.5	47.5	SLST	PL	
	21/11-1					SHAL	P	
U	27/10-1	2.66	0.03	1468.0	6.5	SDST	O	P
	27/3-1						P	
	29/20-1	2.38	0.05	2685.0	157.5	SDST	PL	
U	29/25-1					SDST	P	
U	30/12-1	2.45	0.03	3710.0	154.0	SDST	PL	
	30/16-1	2.33	0.05	2368.5	34.0	SDST	PL	
	30/17A-1	2.50	0.05	3239.5	50.5	SHAL	PL	
	30/16-2	2.35	0.05	2367.5	157.5	SDST	PL	
	30/16-3	2.33	0.10	2438.0	263.5	SDST	PL	
	30/16-4	2.30	0.10	2495.5	399.0	SDST	PL	
	30/23-1	2.28	0.03	2714.5	52.5		PL	
	30/24-2	2.37	0.10	2777.0	54.5	SDST	PL	
	42/23-1	2.70	0.03	2848.5	93.5	SDST	PL	
	42/29-1	2.66	0.05	2723.5	165.0	MDST+SDST	PL	
	42/28-2	2.60	0.05	2971.0	91.5	SLST	PL	
	47/14A-1	2.30	0.05	2684.5	25.5	SDST	PL	
	47/13-2	2.50	0.12	2679.0	27.0	SDST	PL	
	47/29A-1	2.35	0.15	1455.0	47.0	SDST	PL	
	47/3-1	2.60	0.05	3203.5	91.0	SDST+SLST	PL	
	47/4-1	2.43	0.20	3343.5	66.5	SDST	PL	
	47/5-1	2.52	0.05	3097.0	188.5	SHAL+SDST	PL	
	47/8-1	2.44	0.07	2798.5	26.5	SDST	PL	
	48/12-1	2.50	0.15	3022.5	234.5	SDST	PL	
	48/17-1	2.50	0.15	2446.0	52.0	SDST	PL	
	48/18B-1	2.45	0.05	2646.0	74.0	SDST	PL	
	48/11-2	2.45	0.04	2817.5	46.5	SDST	PL	
	48/13-2A	2.50	0.10	2554.0	290.5	SDST	PL	
	48/20-1	2.42	0.10	2616.5	300.0	SDST	PL	
	48/23-1	2.45	0.07	2262.5	116.0	SDST	PL	
	48/25-1	2.54	0.01	2531.5	223.0	SDST	PL	
	48/29-1	2.34	0.05	1593.5	129.0	SDST	PL	
	48/22-2	2.43	0.06	2258.5	74.5	SDST	PL	
	48/29-2	2.30	0.04	1524.0	18.0	SDST	PL	
	48/22-3	2.40	0.10	2400.0	124.5	SDST	PL	
	48/3-1	2.60	0.20	3432.0	230.0	MDST+SDST	PL	
	48/6-1	2.50	0.15	2729.0	170.0	SLST+SDST	PL	
	48/7-1	2.50	0.15	2995.0	88.5	SDST	PL	
	49/1-1	2.60	0.03	3592.5	212.5	MDST	PL	
	49/16-1	2.35	0.09	2692.5	240.0	SDST	PL	
U	49/17-1	2.45	0.05	2824.5	137.0	SDST	PL	
U	49/19-1	2.45	0.10	2463.5	62.5	SDST	PL	
	49/16-4	2.40	0.09	2593.5	234.0	SDST	PL	
	49/16-6	2.40	0.15	2913.0	188.5	SDST	PL	
	49/20-1	2.40	0.05	2423.5	83.0	SDST	PL	
	49/21-1	2.45	0.10	2306.0	210.5	SDST	PL	
	49/22-1	2.40	0.10	2770.0	205.5	SDST	PL	
	49/23-1	2.45	0.10	2615.5	52.0	SDST	PL	
	49/26-1	2.35	0.10	1943.5	280.5	SDST	PL	

	49/27-1	2.40	0.06	1944.0	281.0	SDST	PL
	49/28-1	2.36	0.10	2056.0	178.5	SDST	PL
	49/29-1	2.30	0.07	2741.0	82.5	SDST	PL
	49/21-4	2.50	0.05	2300.0	101.0	SDST	PL
	49/6-1	2.65	0.07	3376.5	170.0	SHAL	PL
	49/6-2	2.68	0.08	3541.0	173.0	SHAL	PL
	49/6-3	2.62	0.10	3444.0	185.5	SHAL	PL
	49/8-1	2.63	0.05	3588.5	184.0	SHAL	PL
	52/5-2	2.30	0.07	1565.5	46.5	SDST	PL
	53/1-1	2.38	0.05	2046.0	244.0	SDST	PL
	53/14-1					SDST	P
	53/16-1	2.25	0.10	765.5	39.5	SDST	PL
	53/2-1	2.48	0.05	2007.5	224.5	SDST	PL
	53/3-1	2.35	0.10	2014.5	177.0	SDST	PL
	53/4-1	2.32	0.05	1886.5	119.5	SDST	PL
	53/5-1	2.35		1938.5	111.5	SDST	PL
	53/7-1	2.32	0.10	1811.0	204.5	SDST	PL
U	54/11-1	2.30	0.10	1737.0	71.0	SDST	PL

TABLE 13 UPPER CARBONIFEROUS

	WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE	
	14/20-1	2.50	0.20	2623.0	262.0	SLST	C	
	14/24-1						O	P
	14/20-2	2.40	0.10	2745.0	65.5		C	
U	27/10-1						O	PL
	27/3-1	2.75	0.03	1654.0	606.0	SDST+SLST+SHAL	O	C
	36/13-1	2.43	0.15	1292.5	116.0	SHAL	C	
	42/13-1	2.62	0.06	2424.0	97.0	MDST	C	
	42/23-1	2.67	0.03	2912.5	34.0	SHAL	CU	
	42/29-1	2.65	0.04	2824.5	37.5	SHAL	C	
	42/28-2	2.62	0.02	3035.5	37.5	SHAL	C	
	44/7-1	2.50	0.10	2965.0	59.5	SDST	C	
	47/14A-1	2.62	0.03	2712.5	30.5		CU	
	47/15-1	2.55	0.10	2852.5	62.5		CU	
	47/13-2	2.60	0.10	2729.5	73.5		CU	
	47/29A-1	2.60	0.10	1562.5	168.5		CU	
	47/4-1	2.75	0.04	3409.0	65.0	SHAL	C	
	47/5-1	2.50	0.20	3228.0	73.5		CU	
	47/8-1	2.60	0.15	2826.0	28.5		C	
	48/12-1	2.65	0.10	3142.5	5.0	SHAL	C	
	48/17-1	2.50	0.13	2502.5	61.5	SDST	C	
	48/11-2	2.60	0.05	2849.0	16.5	SHAL	C	
	48/20-1	2.75	0.05	2794.5	55.0	SHAL	CU	
	48/23-1	2.60	0.07	2329.5	17.5	SDST	C	
	48/25-1	2.70	0.05	2675.5	65.0	SHAL	CU	
	48/29-1	2.60	0.10	1924.5	533.5	SDST+SHAL	CU	
	48/22-3	2.45	0.10	2465.0	13.5	SHAL	C	
	48/3-1	2.60	0.20	3432.0	230.0	SHAL	CU	
	48/6-1	2.50	0.15	2729.0	170.0	SLST	CU	
	49/1-1	2.60	0.10	3742.0	87.0	MDST	C	
	49/12-1	2.59	0.05	2797.5	14.5	SHAL	C	
	49/16-1	2.58	0.05	2820.5	16.0	SHAL	C	
U	49/17-1	2.58	0.06	2921.0	55.5	SHAL	CU	
U	49/19-1	2.60	0.10	2766.5	544.5	SDST	CU	
	49/16-4	2.55	0.10	2719.5	18.0	SHAL	CU	
	49/16-6	2.65	0.10	3152.5	291.0	SHAL	CU	
	49/20-1	2.60	0.05	2489.0	48.0	SHAL	CU	
	49/22-1	2.60	0.10	2907.0	68.5		C	
	49/23-1	2.67	0.05	2670.5	58.0	SHAL	C	
	49/26-1	2.68	0.07	2088.0	8.0	SHAL	C	
	49/27-1	2.65	0.07	2088.0	718.0	SHAL	C	
	49/28-1	2.45	0.15	2151.5	13.0	SHAL	CU	
	49/29-1	2.60	0.07	2786.0	8.0	SHAL	C	
	49/6-1	2.68	0.03	3491.5	50.0	SHAL	CU	
	49/6-2	2.67	0.07	3632.5	10.5	SHAL	CU	
	49/6-3	2.60	0.10	3560.0	45.5	SHAL	C	
	49/8-1	2.50	0.20	3688.0	15.0	SDST	C	
	53/1-1	2.65	0.05	2201.5	68.0	SHAL	C	
	53/16-1	2.35	0.15	841.0	111.0	SDST	CU	
	53/2-1	2.70	0.05	2137.5	36.0	SHAL	CU	
	53/3-1	2.30	0.20	2124.0	42.5	SHAL	CU	
	53/4-1	2.52	0.10	1973.0	53.5	SHAL	C	
	53/5-1	2.57	0.05	2002.0	15.0	SHAL	C	

53/7-1	2.40	0.07	1930.5	35.0	SDST	C
U 54/11-1	2.55	0.10	1813.0	81.5	SHAL	C

TABLE 14 LOWER CARBONIFEROUS

	WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE	
	14/20-1						C	
	14/24-1						O	P
	14/20-2						C	
	21/11-1	2.55	0.20	3283.5	30.5		CL	
U	27/10-1						O	PL
	27/3-1						O	C
	36/13-1						C	
	38/22-1	2.54	0.15	2160.0	123.0		CL	
	42/13-1						C	
	42/29-1						C	
	42/28-2						C	
U	44/2-1	2.55	0.15	3089.5	666.5		CL	
	44/7-1						C	
	47/4-1						C	
	47/8-1						C	
	48/12-1						C	
	48/17-1						C	
	48/11-2						C	
	48/23-1						C	
	48/22-3						C	
	49/1-1						C	
	49/12-1						C	
	49/16-1						C	
	49/22-1						C	
	49/23-1						C	
	49/26-1						C	
	49/27-1						C	
	49/29-1						C	
	49/6-3						C	
	49/8-1						C	
	53/1-1						C	
	53/4-1						C	
	53/5-1						C	
	53/7-1						C	
U	54/11-1						C	

TABLE 15 DEVONIAN

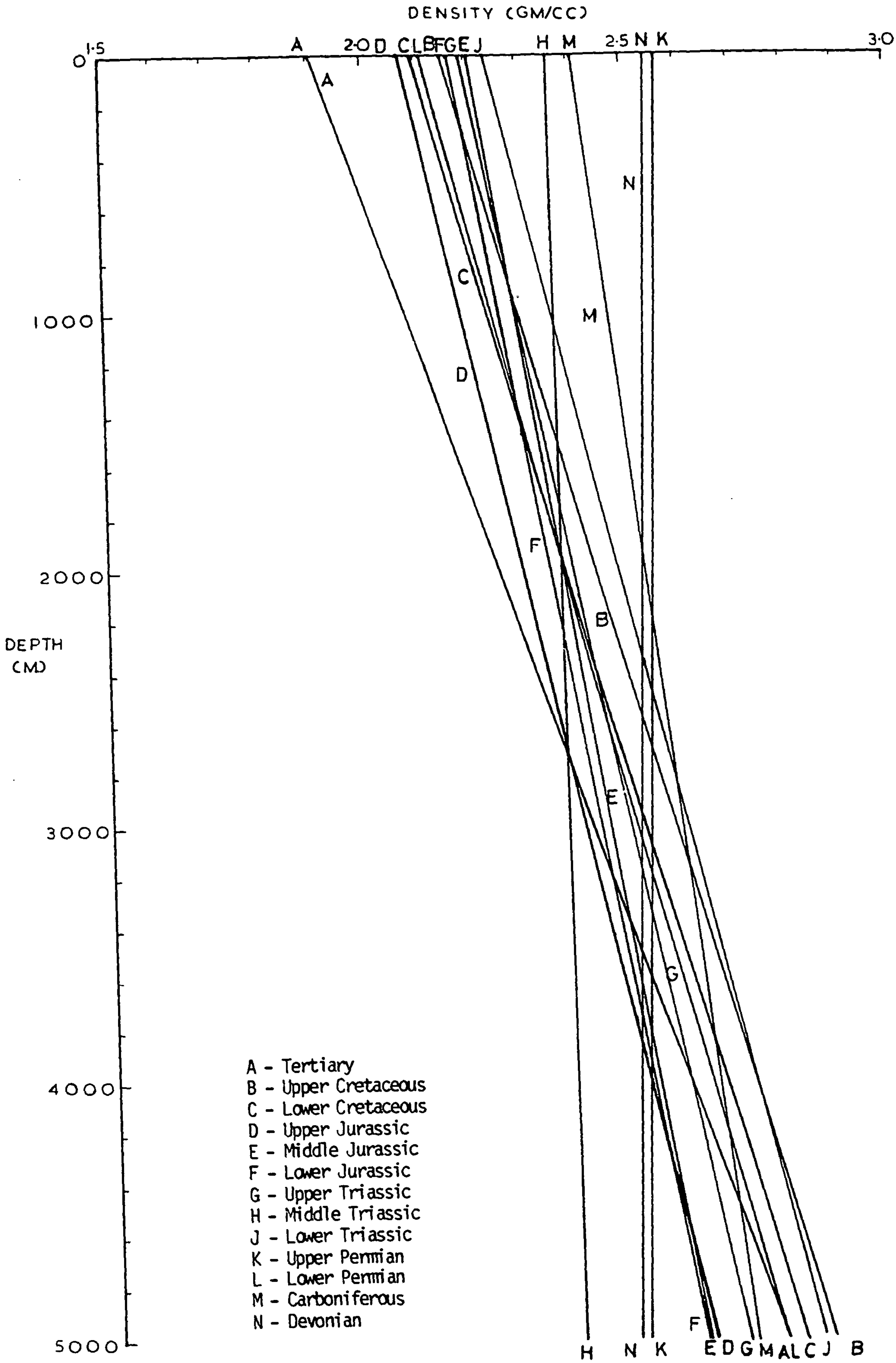
WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE
12/23-1	2.55	0.03	2396.0	333.0	CONG	D
13/24-1	2.55	0.03	2072.0	348.5	SDST+CONG	D
14/24-1						O P
16/23-1	2.46	0.06	3726.5	207.0	SDST	D
U 27/10-1						O PL
27/3-1						O C
29/25-1	2.50	0.10	3122.5	81.0	SDST	D
30/23-1	2.29	0.03	2802.0	122.0	SDST	D
36/15-1	2.45	0.10	1705.0	136.0	SDST	D
44/2-1	2.74		3453.0	59.5		D
53/16-1	2.62	0.05	1011.5	230.0	SDST	D
211/21-1A	2.63	0.05	3425.0	33.0	META	O D

TABLE 16 SILURIAN AND ORDOVICIAN

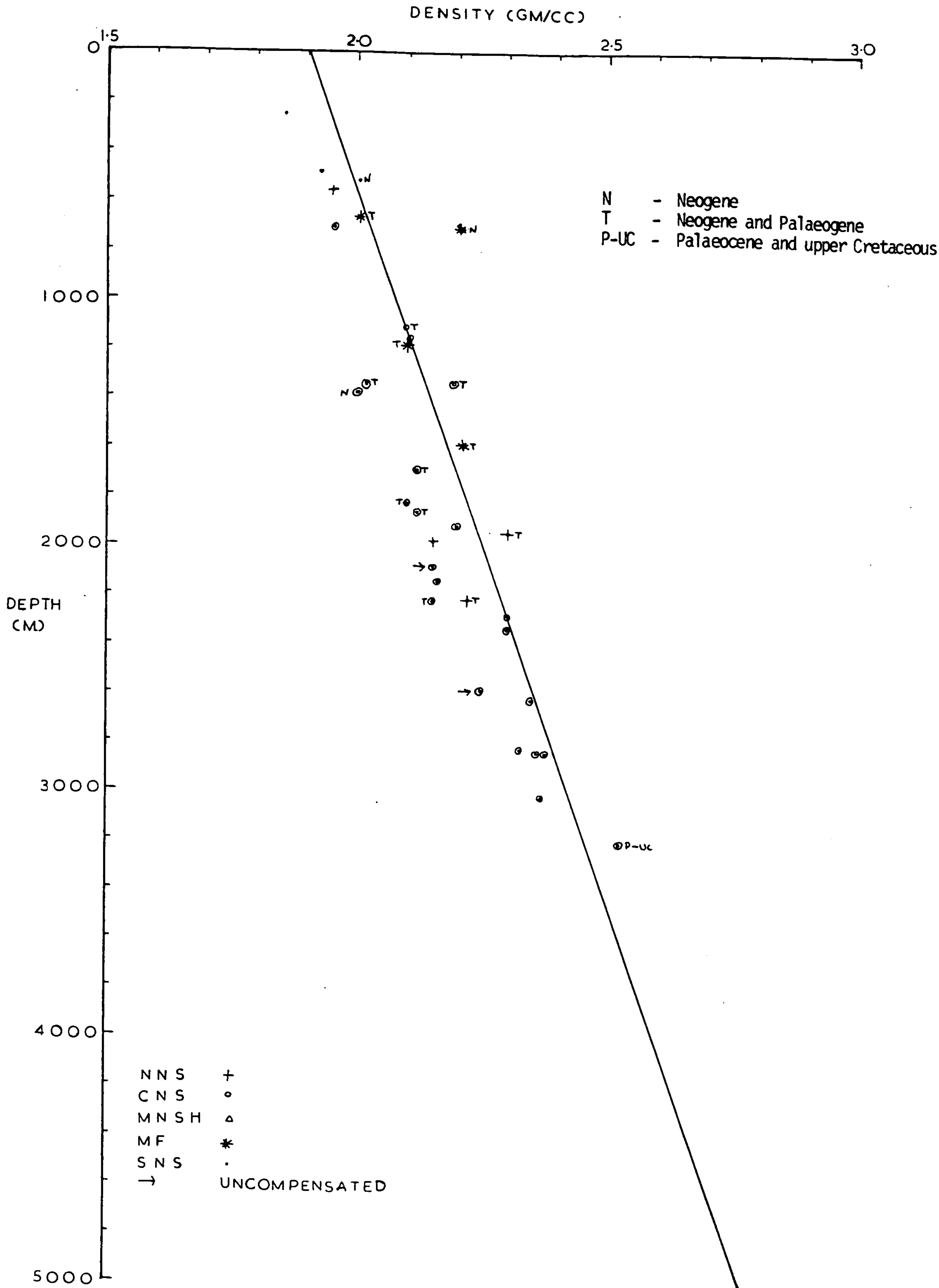
WELL	DENSITY (GM/CC)	ERROR	DEPTH (KM)	THICKNESS (M)	LITHOLOGY	AGE	
14/24-1						O	P
U 27/10-1						O	PL
27/3-1						O	C
47/29A-1	2.74	0.03	1704.5	115.0	SDST	O	
211/21-1A						O	D

APPENDIX 4

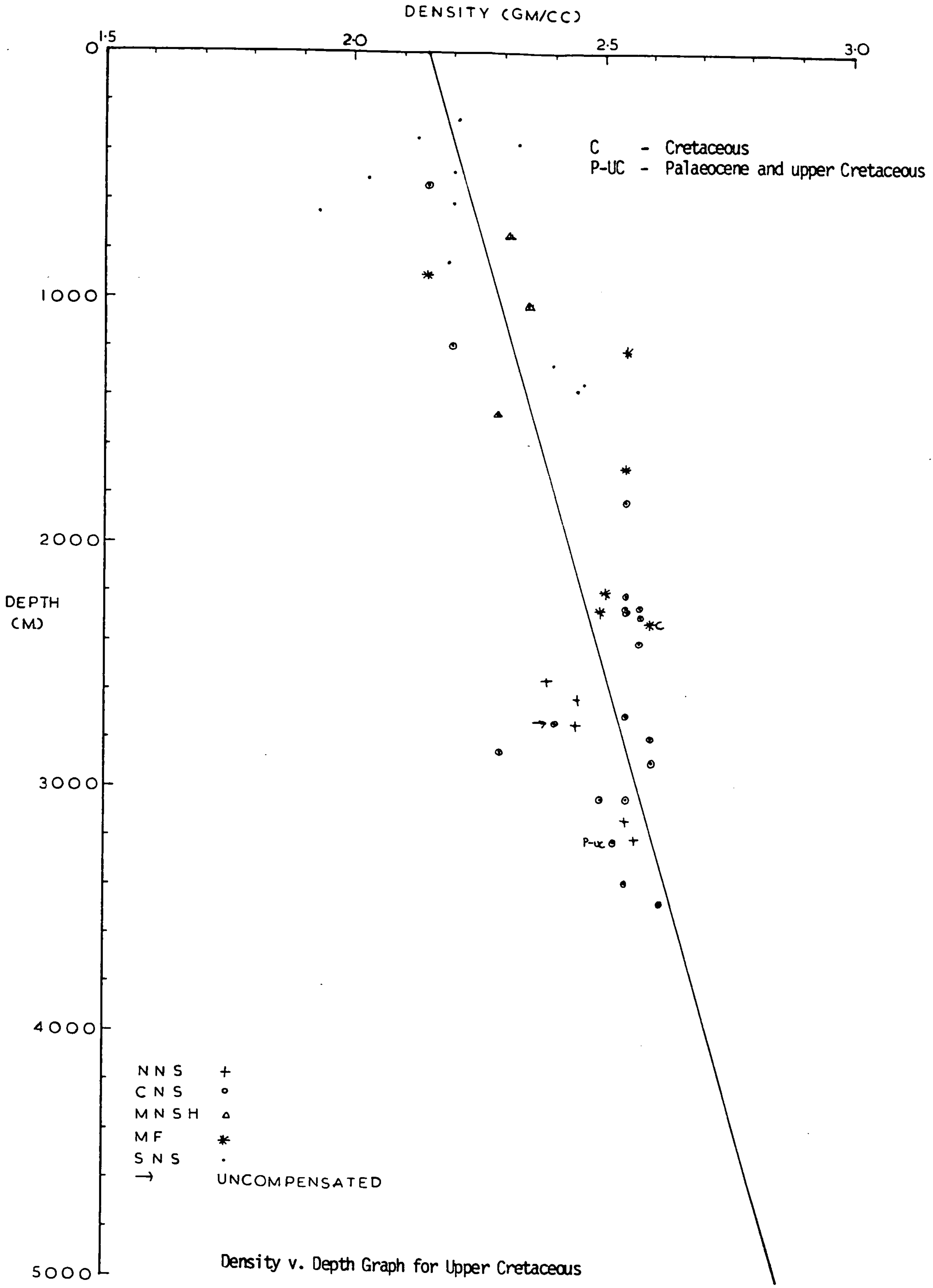
DENSITY V. DEPTH GRAPHS



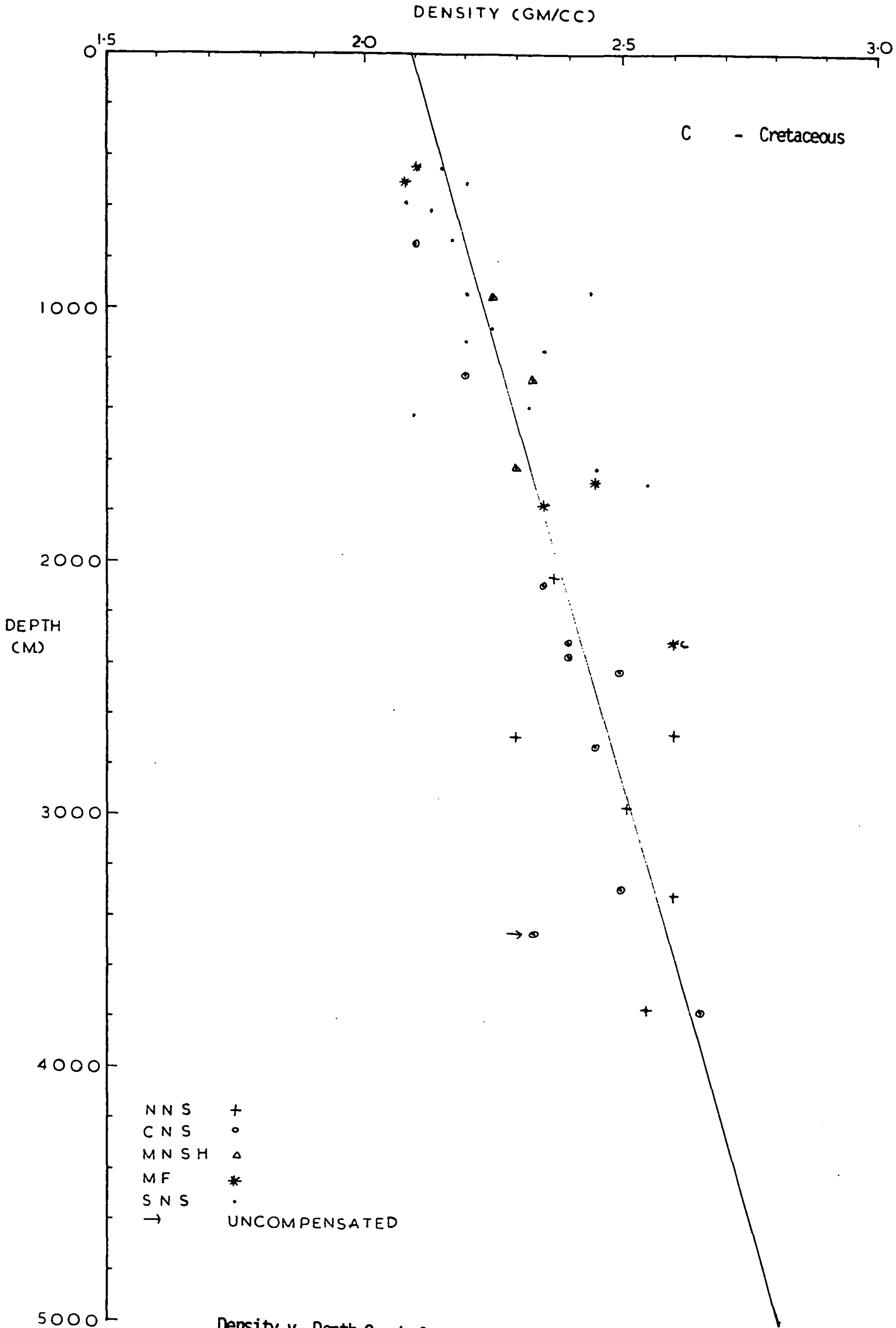
Composite Density v. Depth Graph



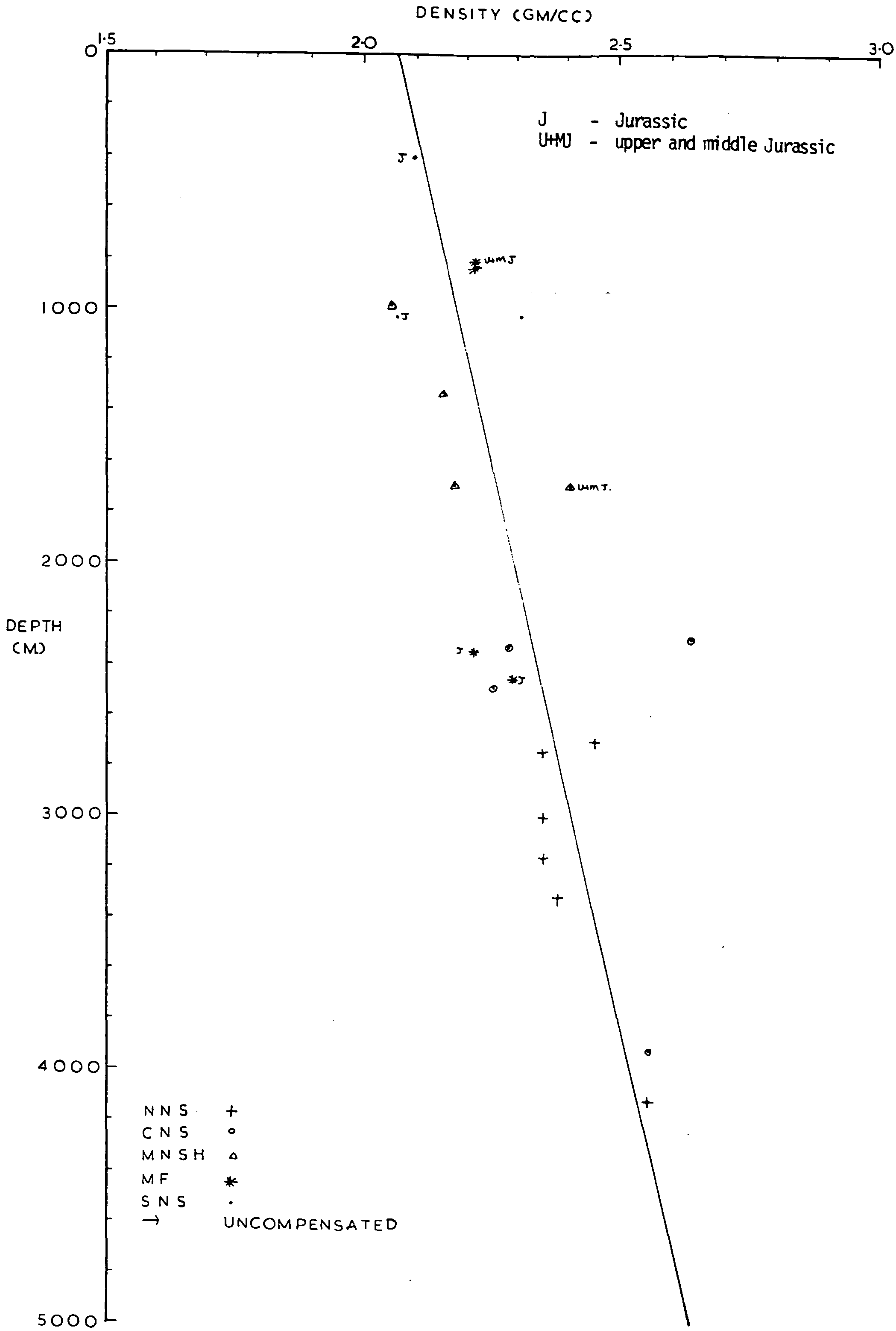
Density v. Depth Graph for Tertiary



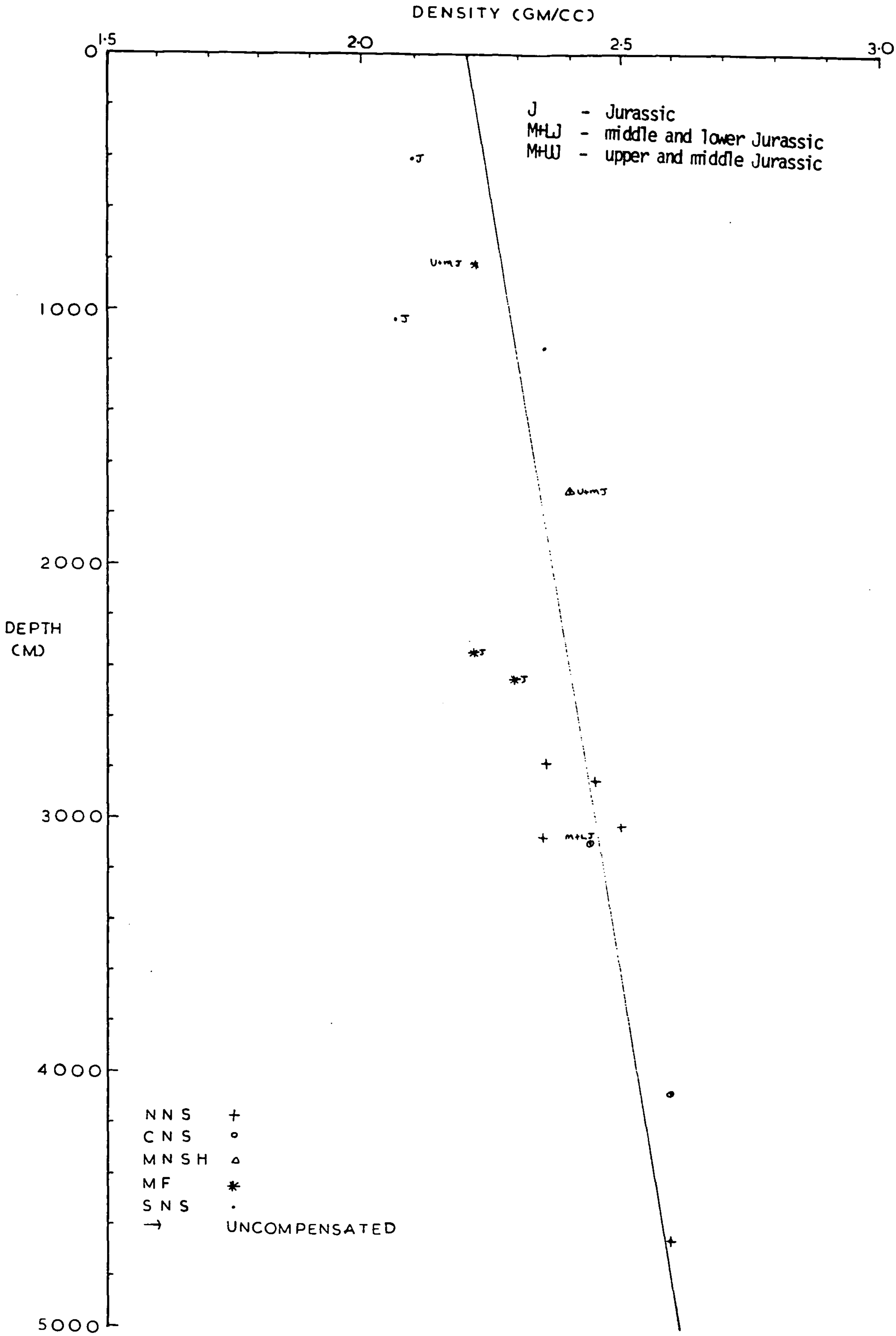
Density v. Depth Graph for Upper Cretaceous



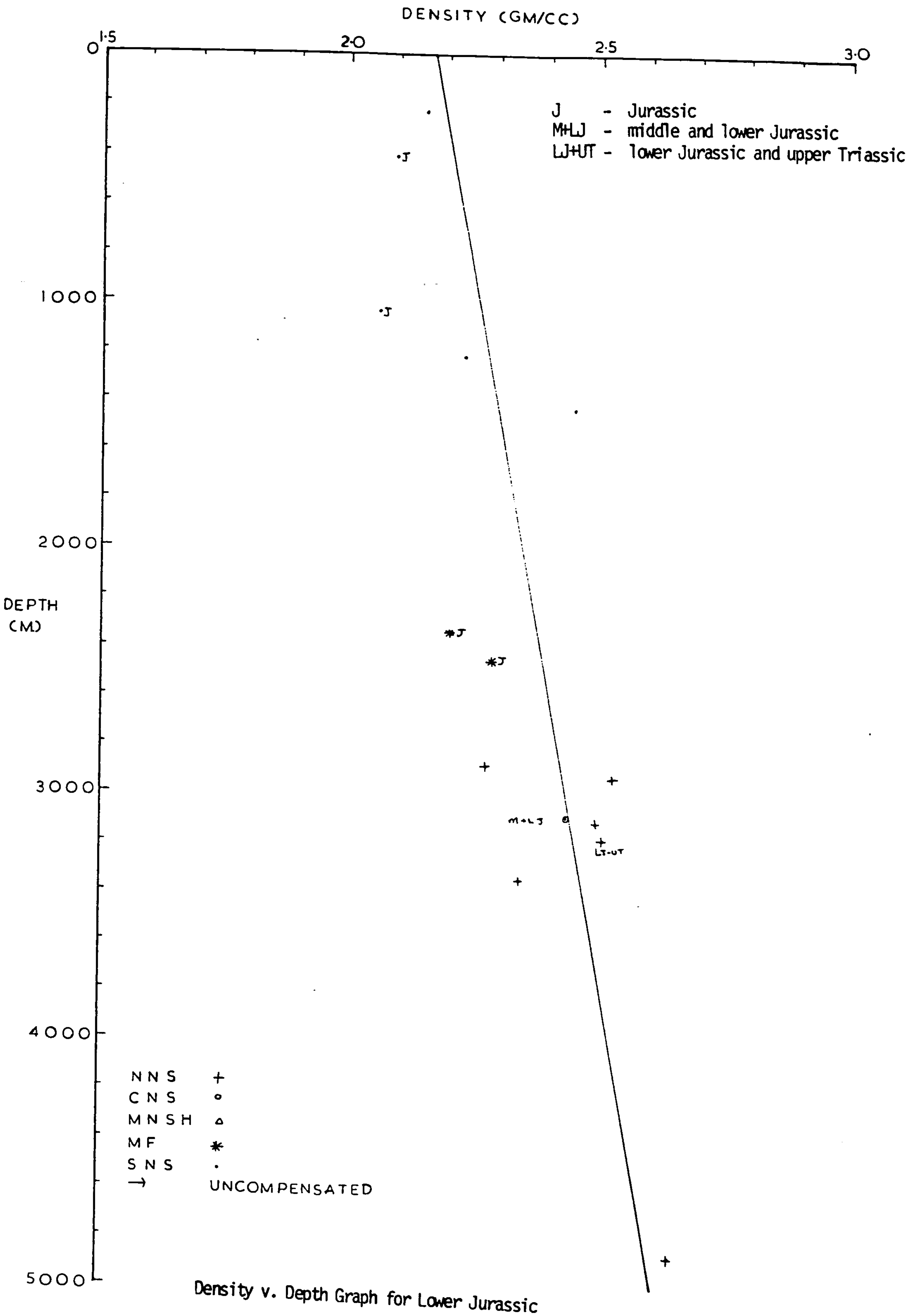
Density v. Depth Graph for Lower Cretaceous



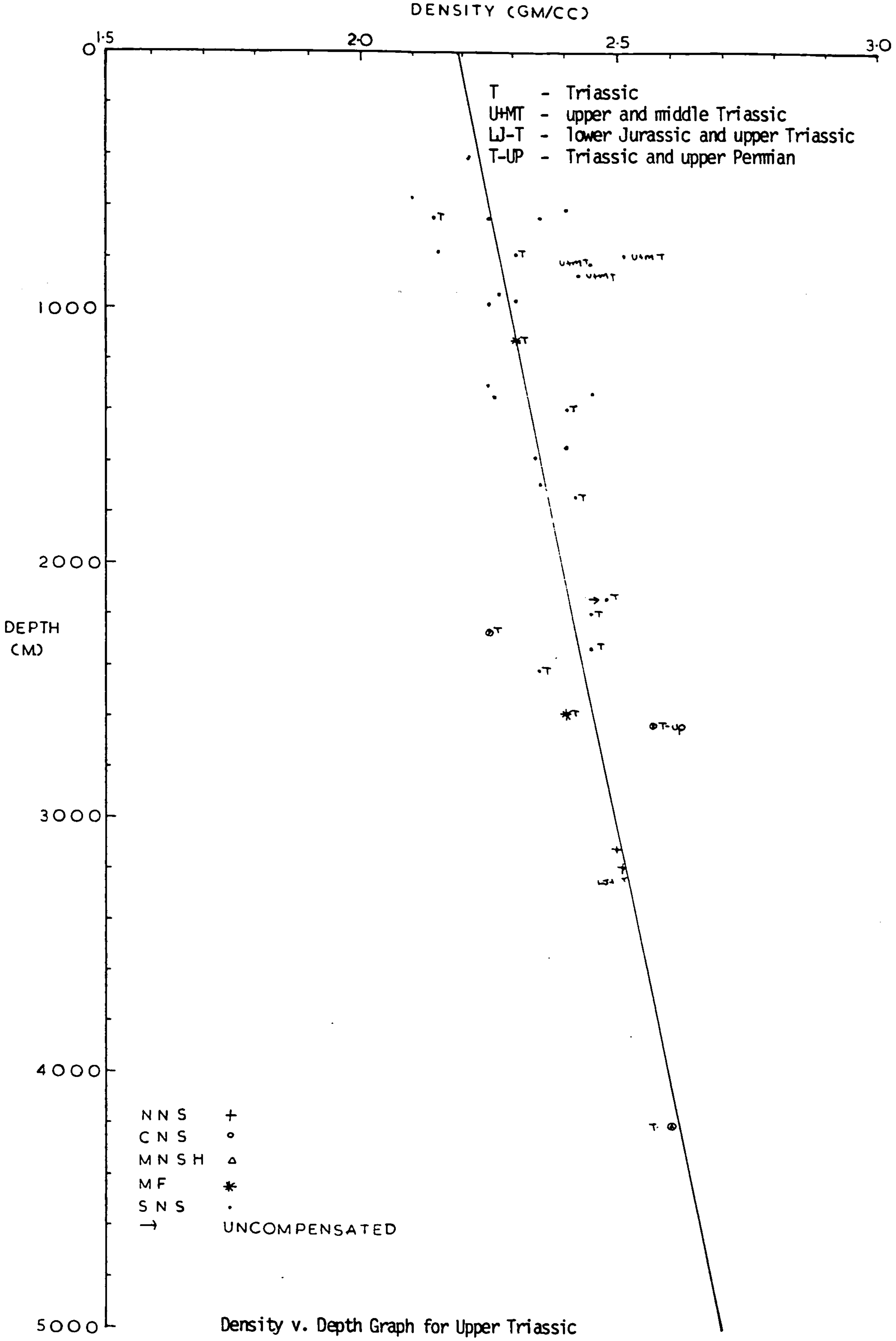
Density v. Depth Graph for Upper Jurassic



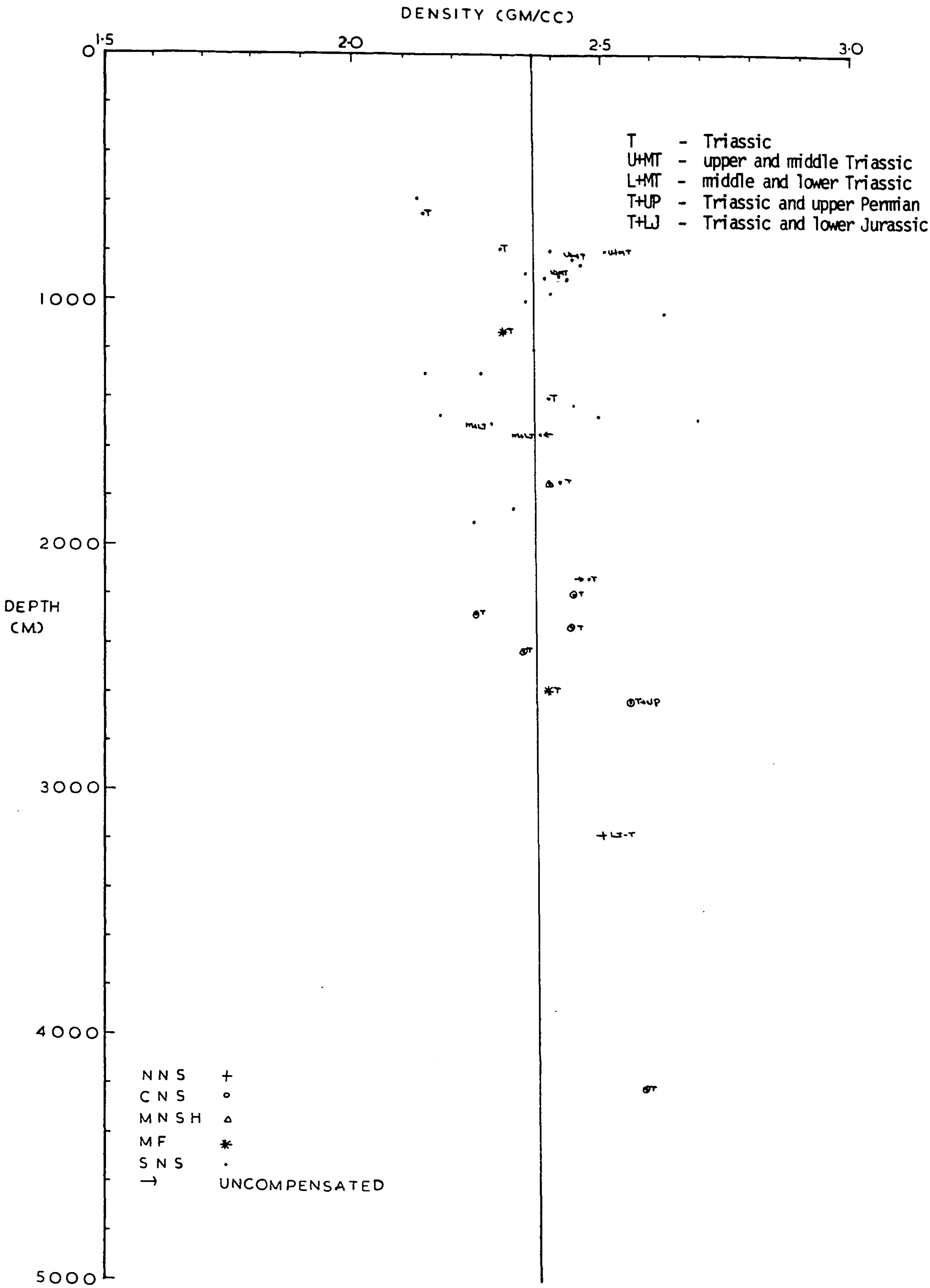
Density v. Depth Graph for Middle Jurassic



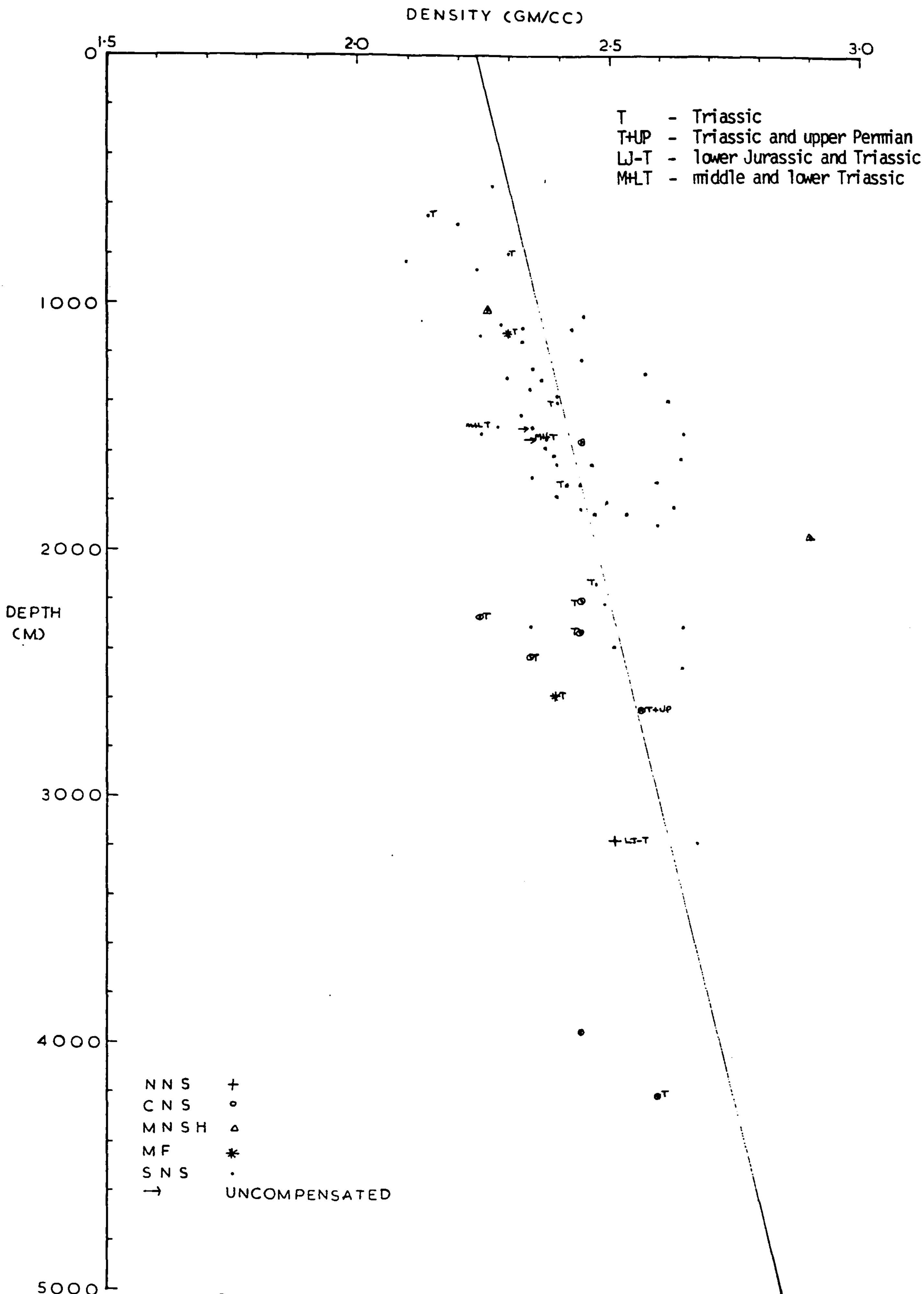
Density v. Depth Graph for Lower Jurassic



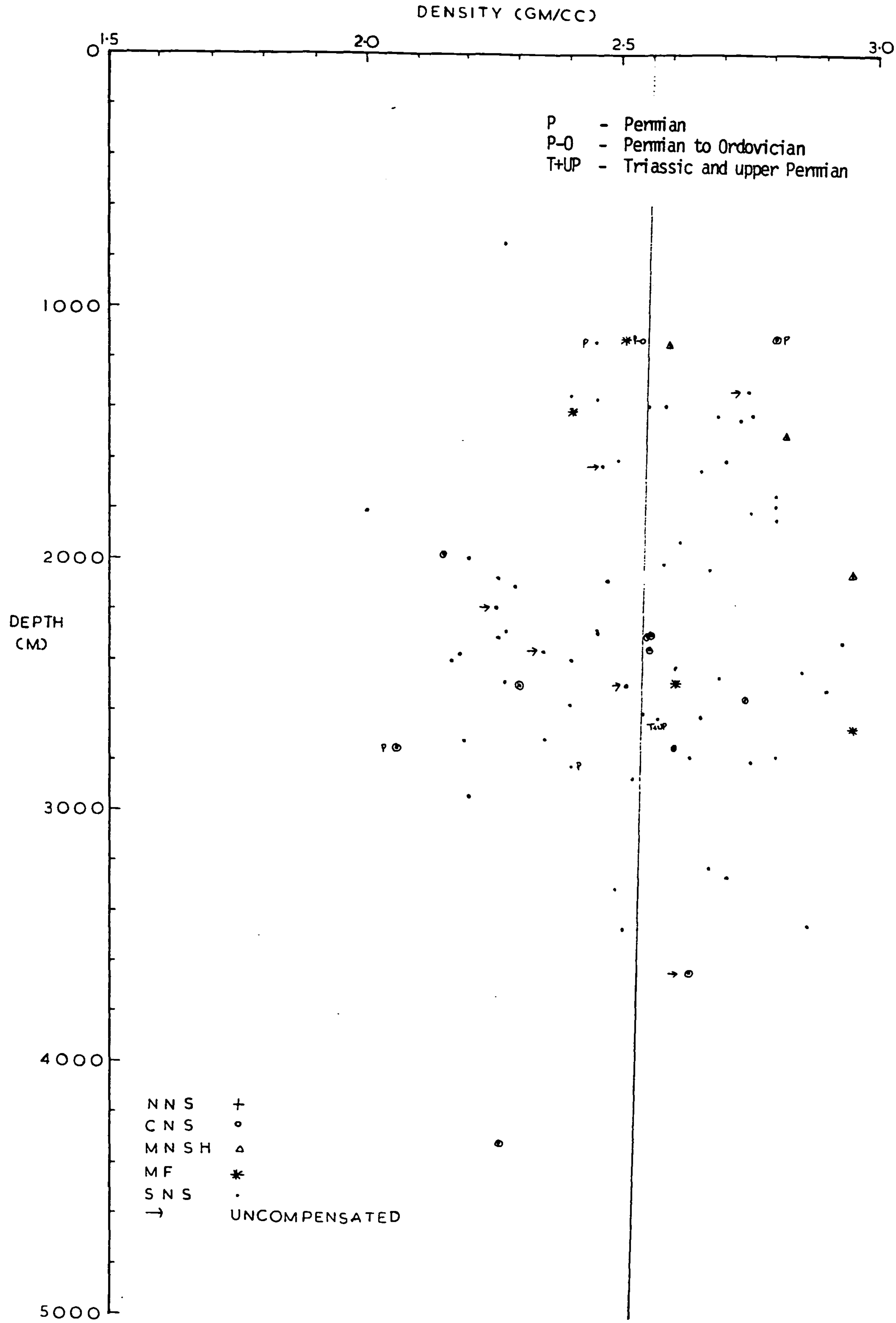
Density v. Depth Graph for Upper Triassic



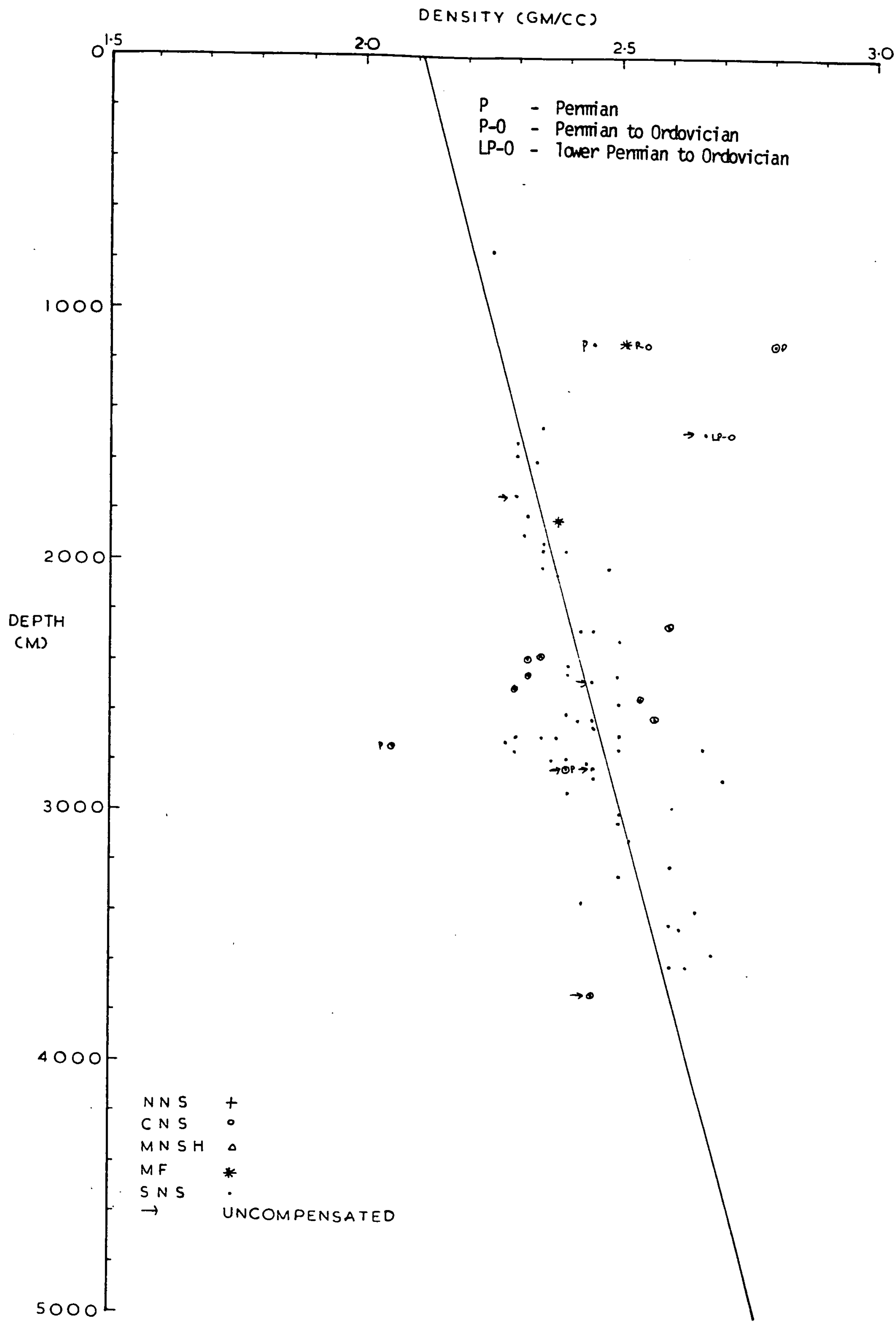
Density v. Depth Graph for Middle Triassic



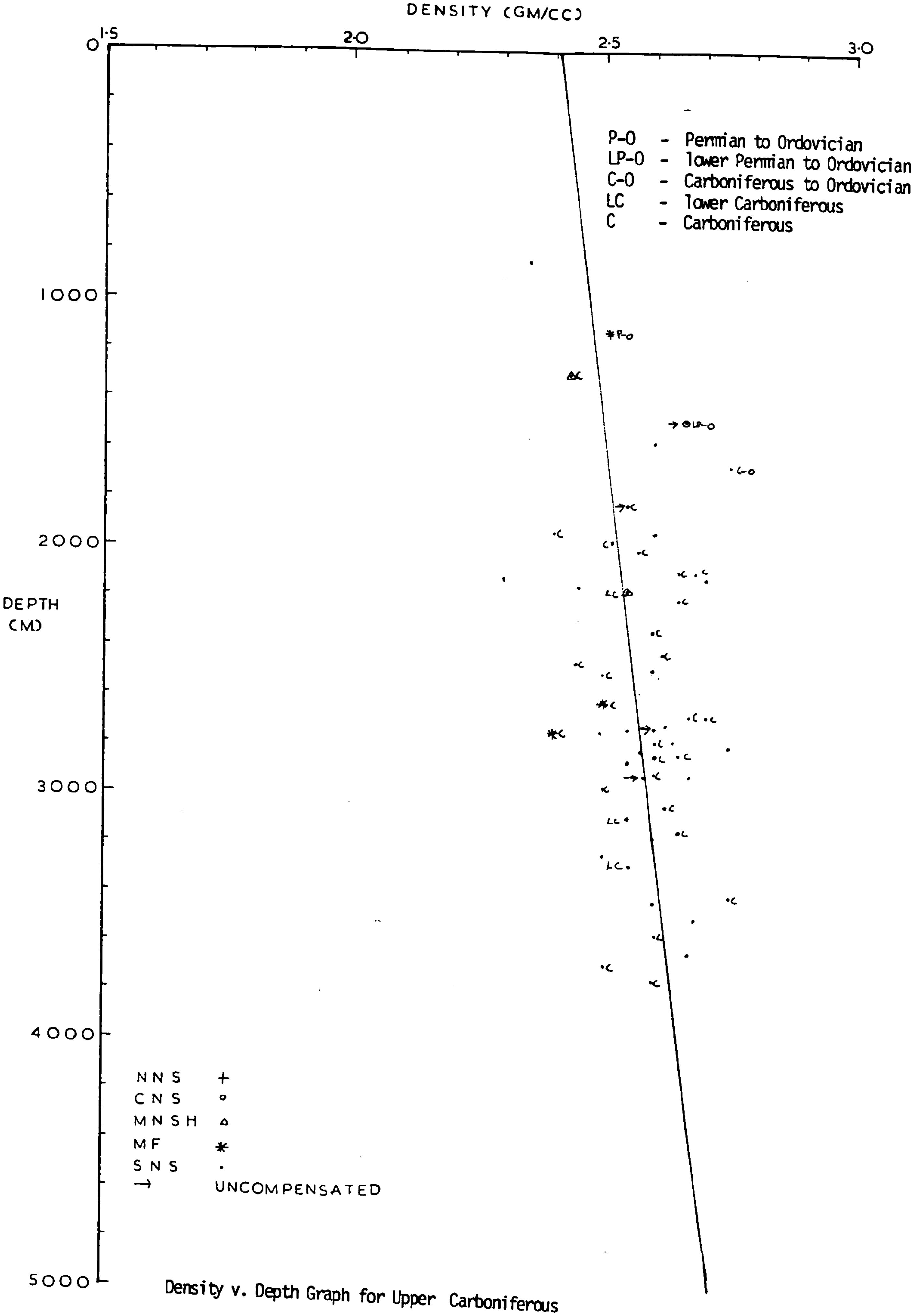
Density v. Depth Graph for Lower Triassic



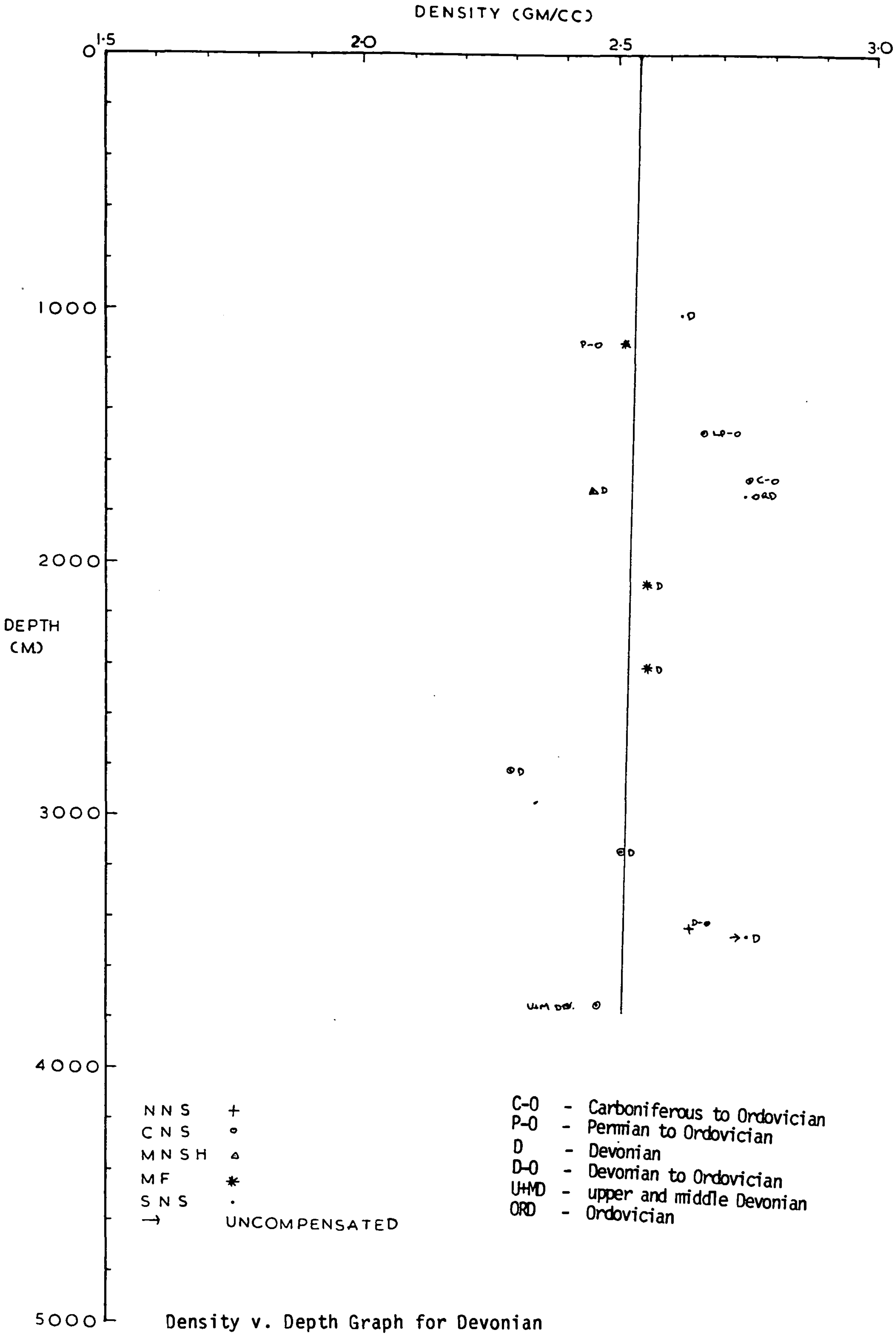
Density v. Depth Graph for Upper Permian



Density v. Depth Graph for Lower Permian



Density v. Depth Graph for Upper Carboniferous

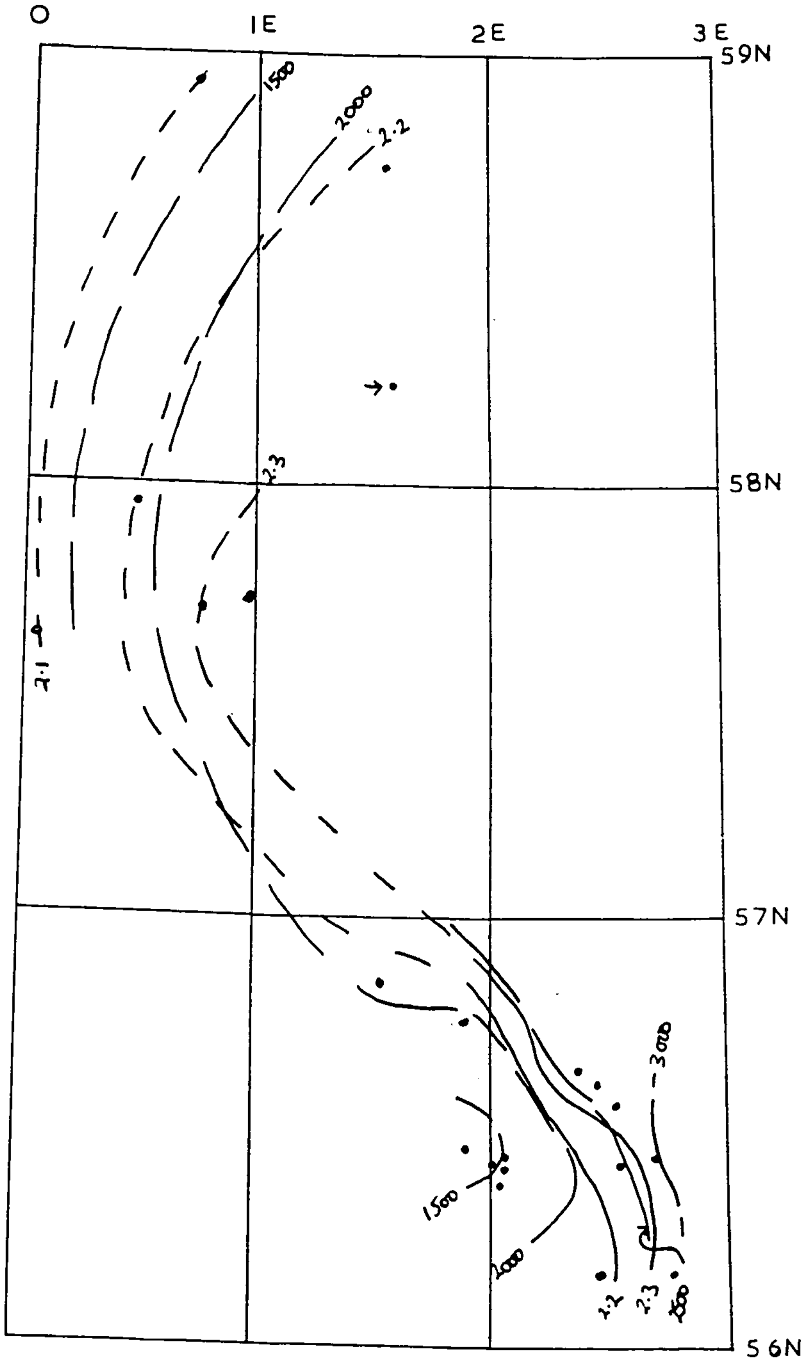


Density v. Depth Graph for Devonian

APPENDIX 5

DEPTH AND DENSITY CONTOURS

Tertiary

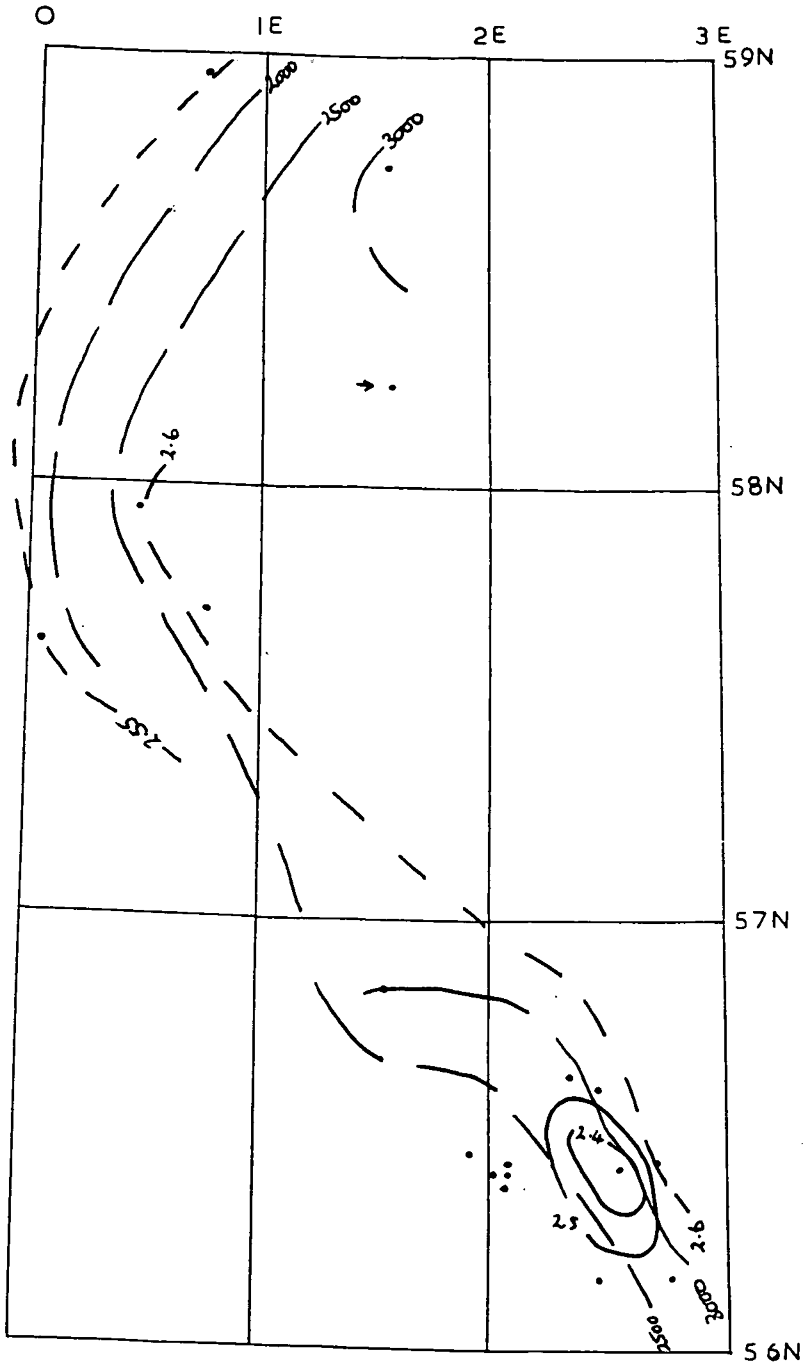


. WELL POSITION

DEPTH CONTOURS

DENSITY CONTOURS

Upper Cretaceous

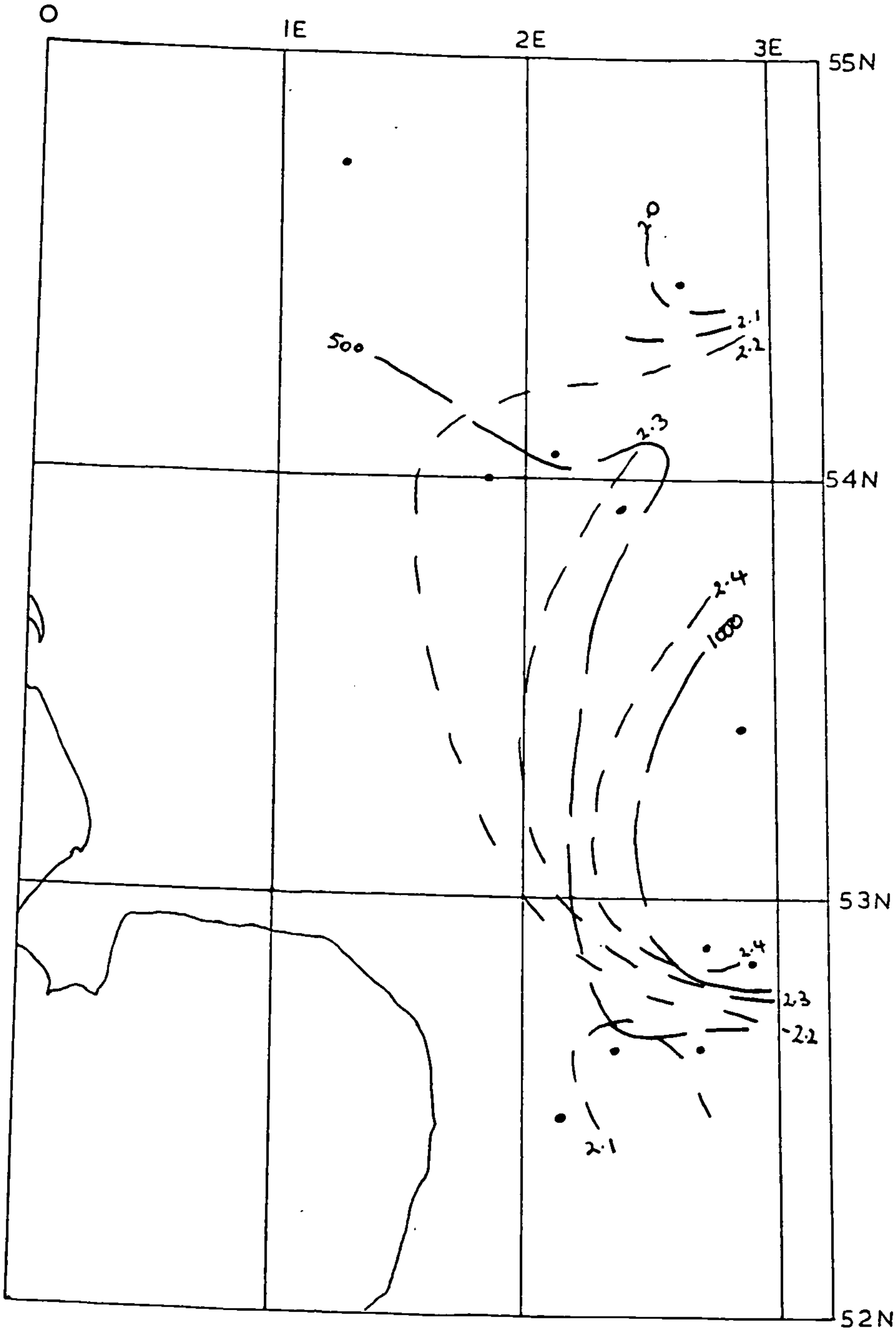


. WELL POSITION

DEPTH CONTOURS

DENSITY CONTOURS

Upper Cretaceous

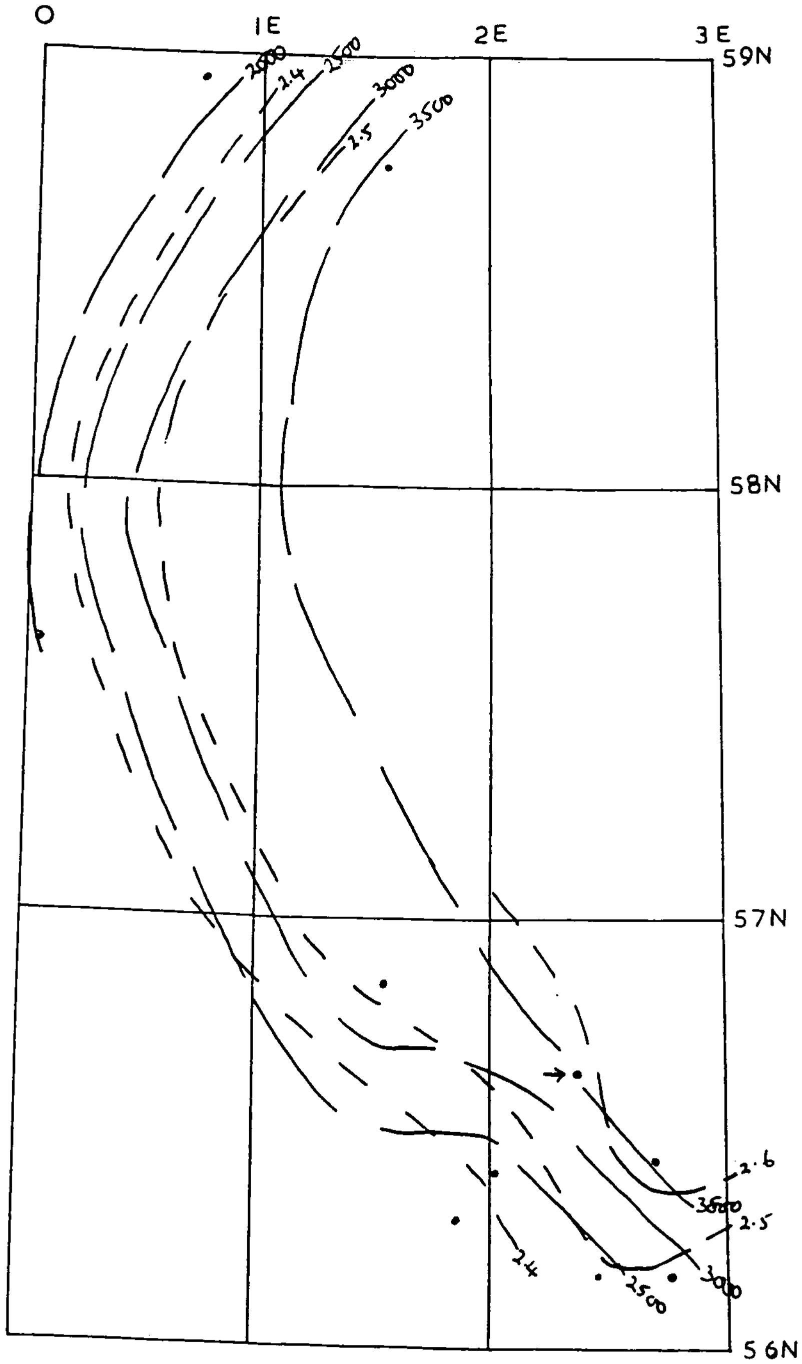


• WELL POSITION

DEPTH CONTOURS ——— ———

DENSITY CONTOURS — — — — —

Lower Cretaceous

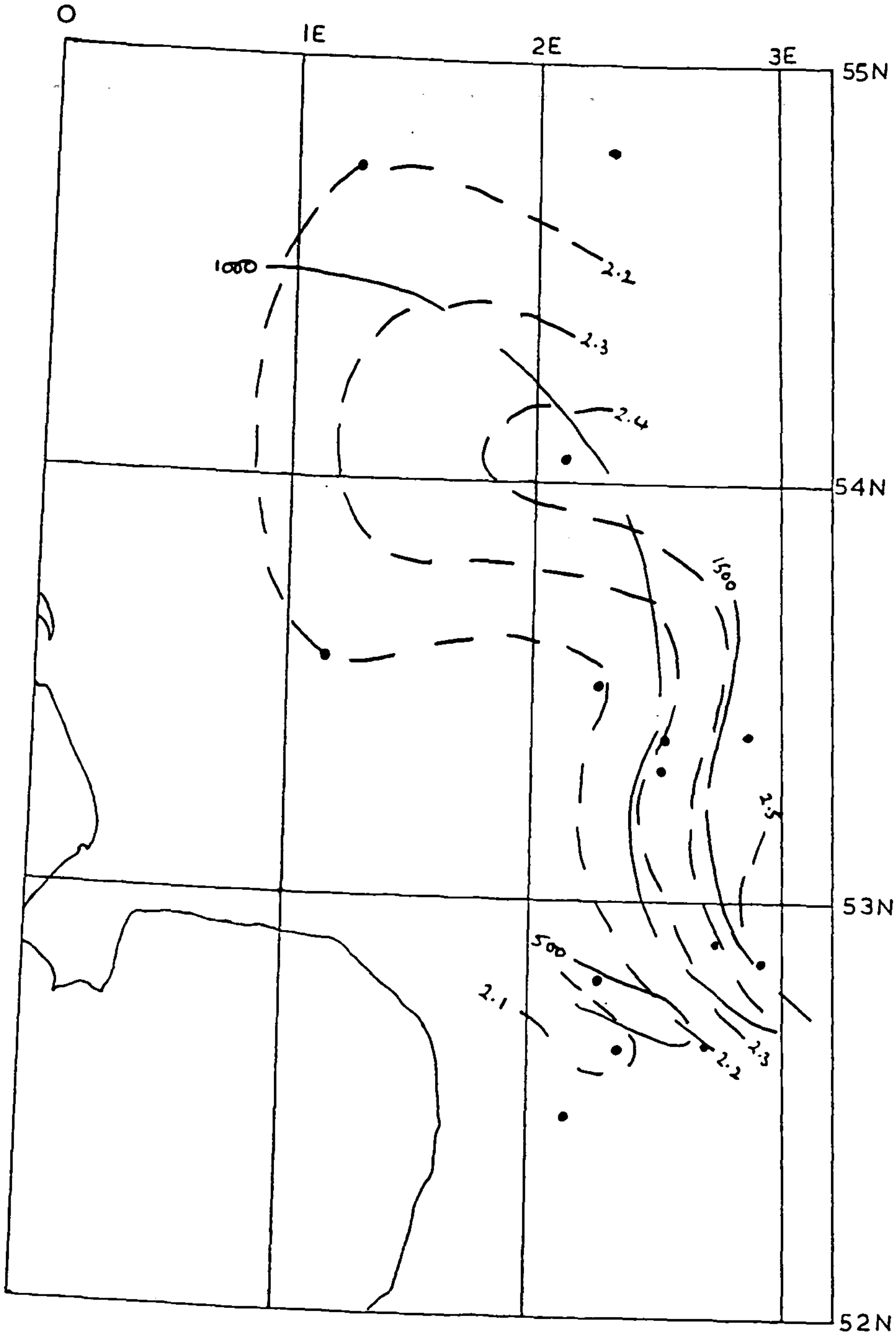


. WELL POSITION

DEPTH CONTOURS ———— ————

DENSITY CONTOURS — — — — —

Lower Cretaceous

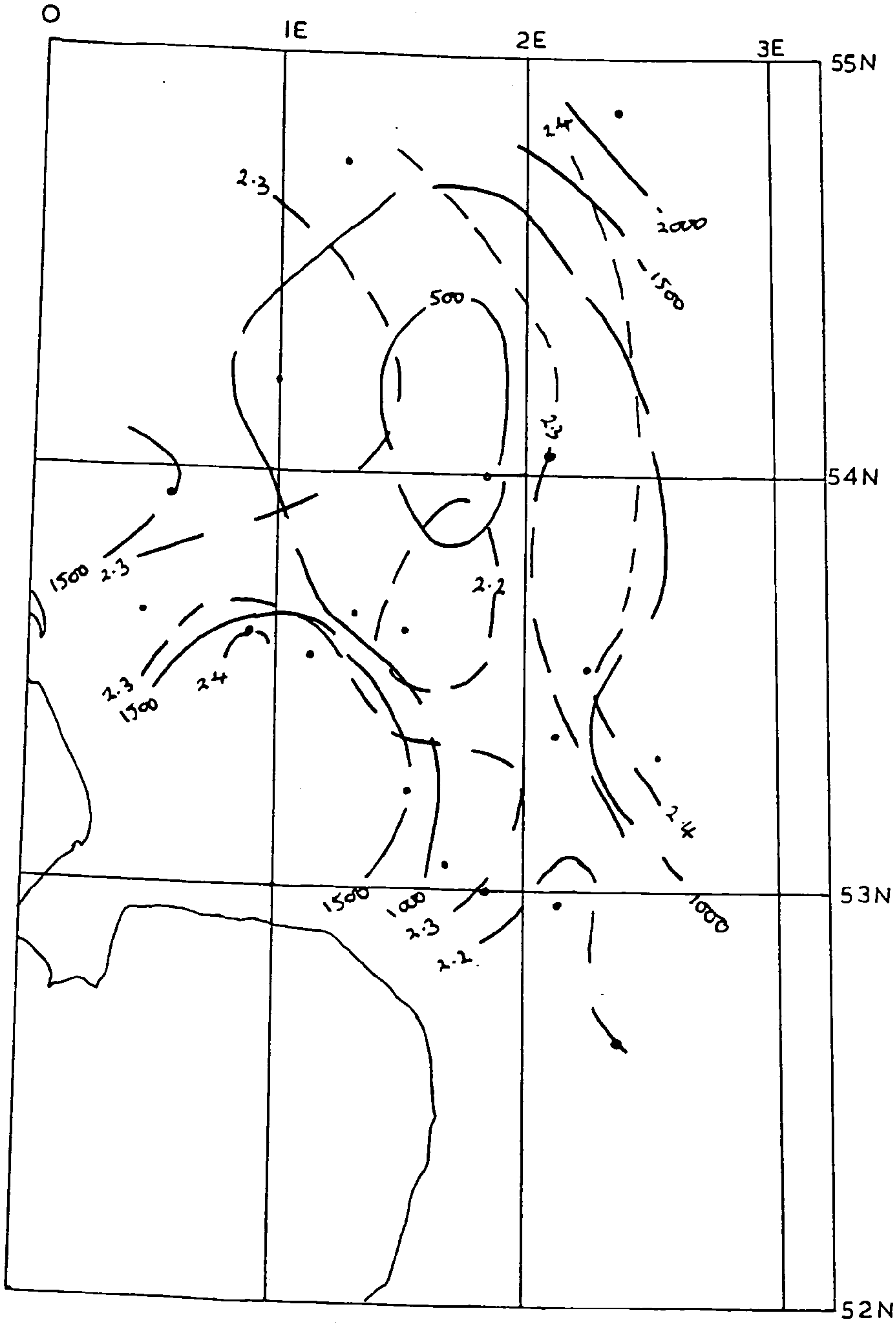


• WELL POSITION

DEPTH CONTOURS ————

DENSITY CONTOURS — — — —

Upper Triassic

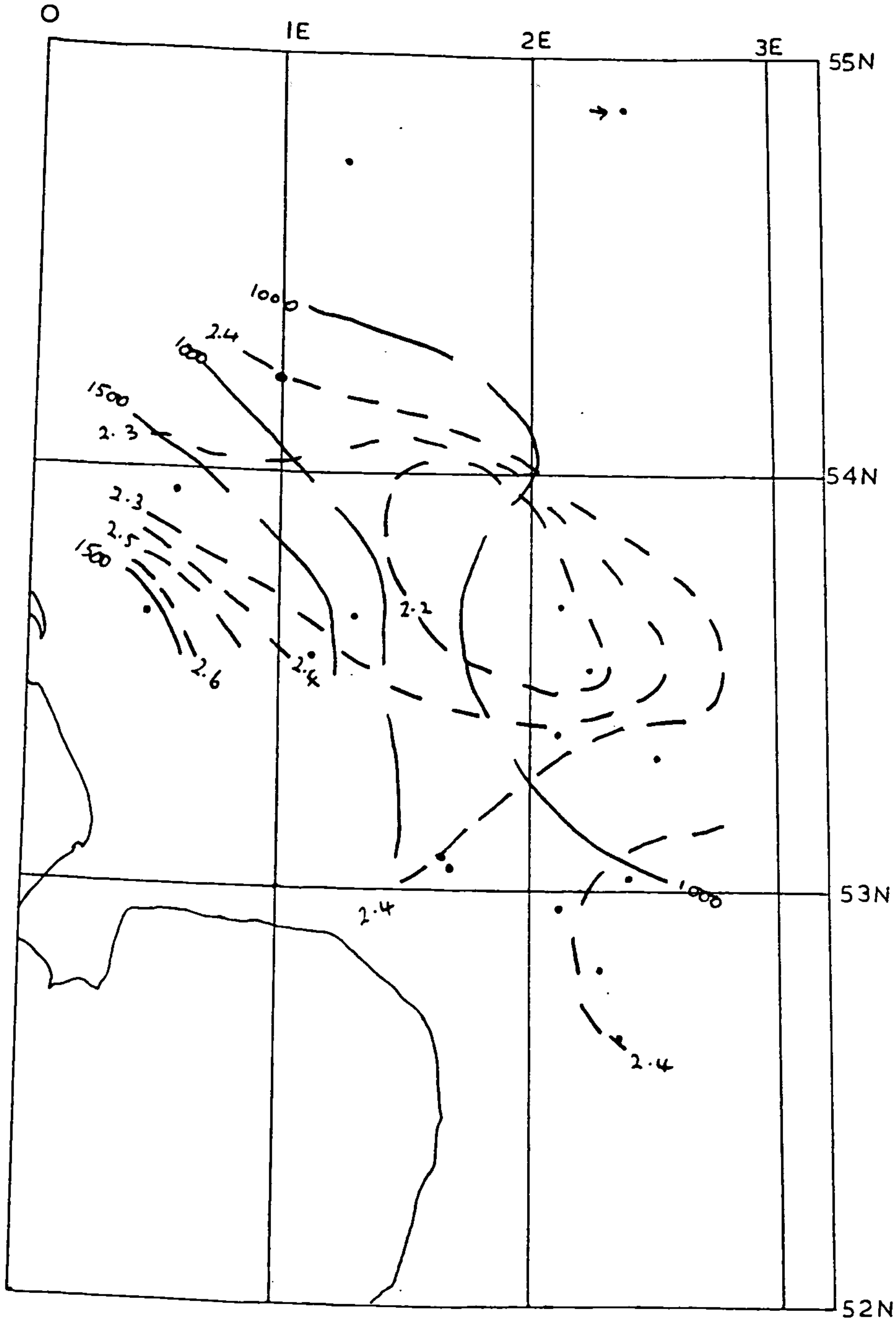


• WELL POSITION

DEPTH CONTOURS

DENSITY CONTOURS

Middle Triassic

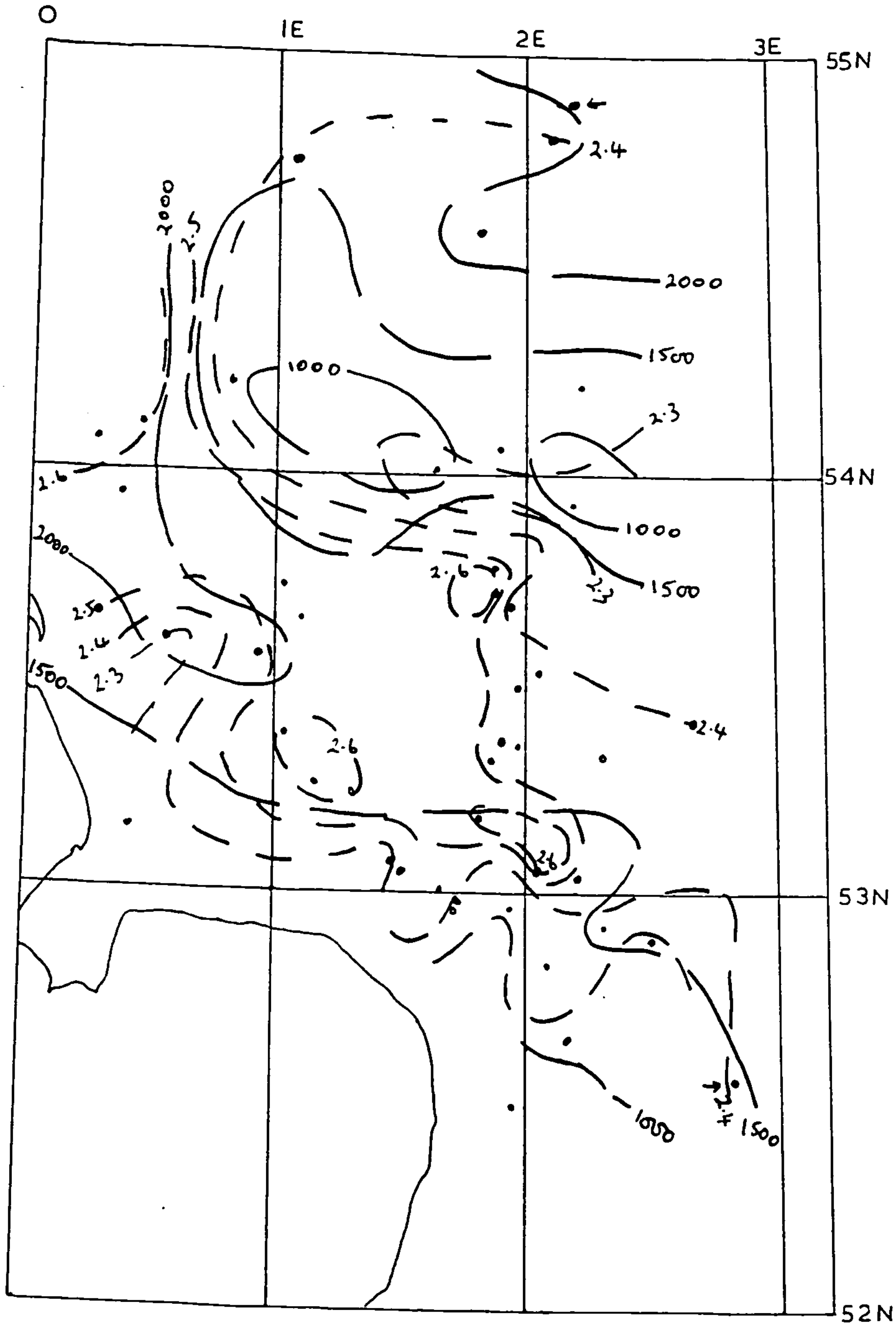


• WELL POSITION

DEPTH CONTOURS

DENSITY CONTOURS

Lower Triassic

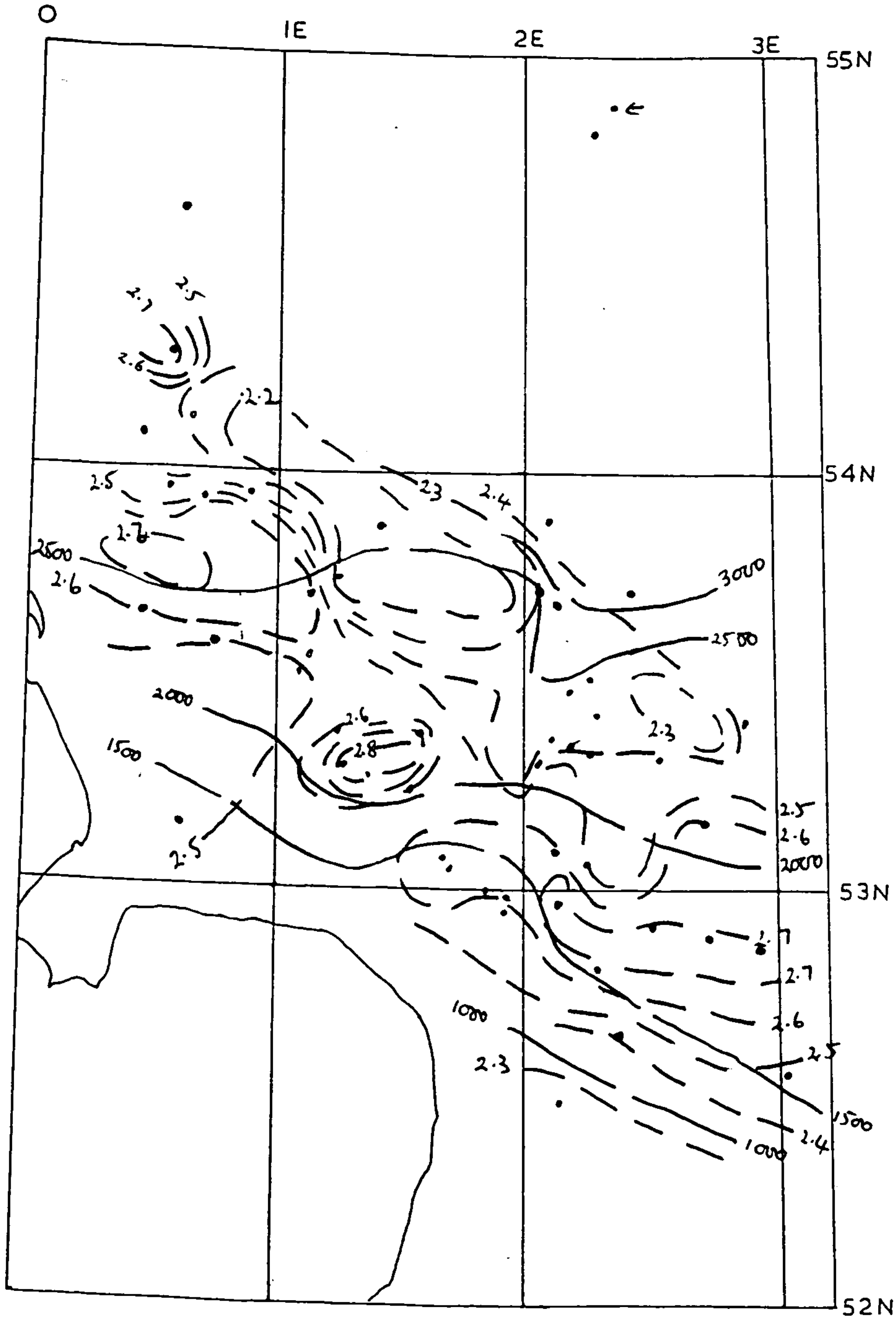


• WELL POSITION

DEPTH CONTOURS ———— ————

DENSITY CONTOURS — — — — —

Upper Permian

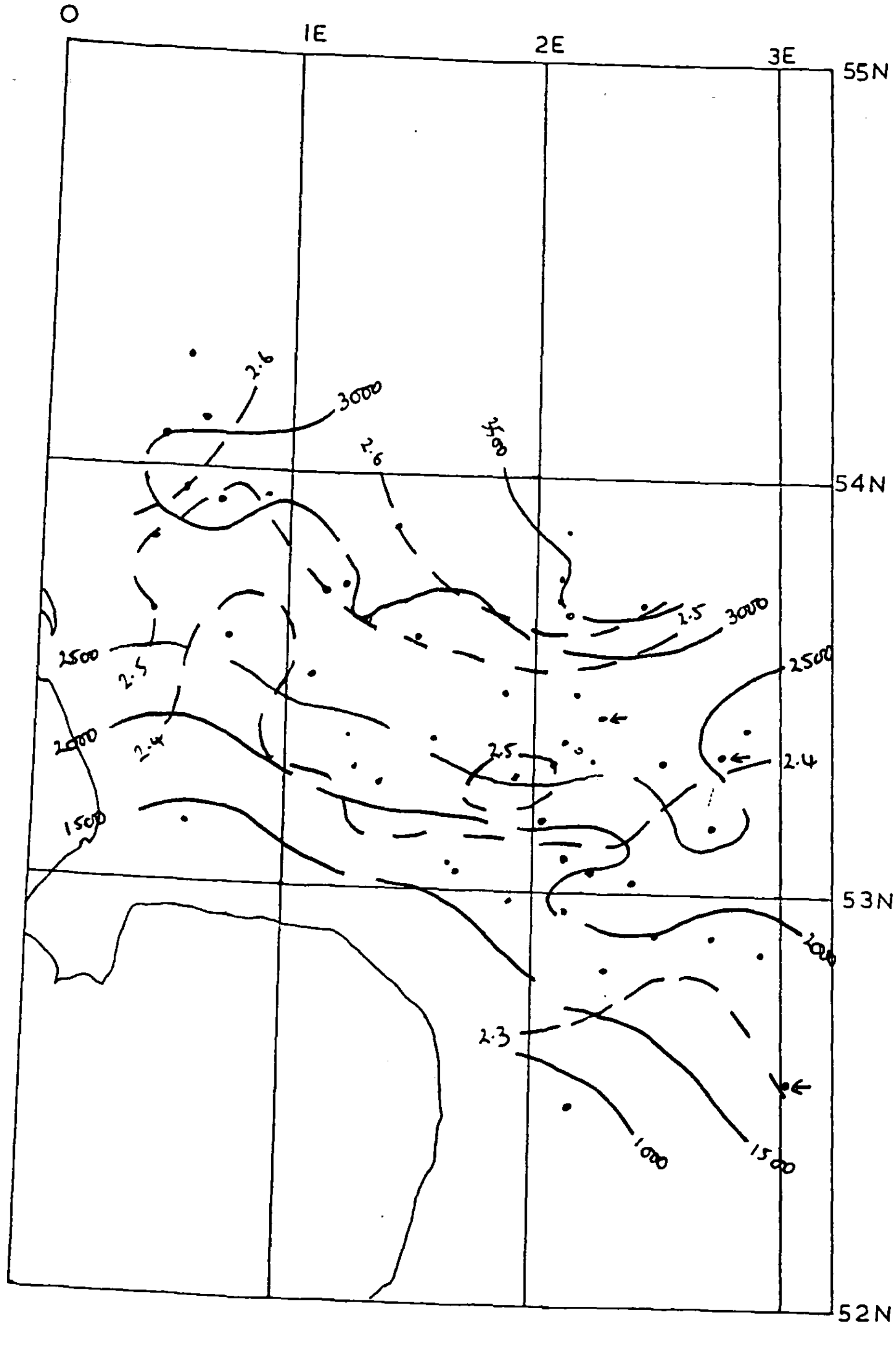


• WELL POSITION

DEPTH CONTOURS ——————

DENSITY CONTOURS — — — —

Lower Permian

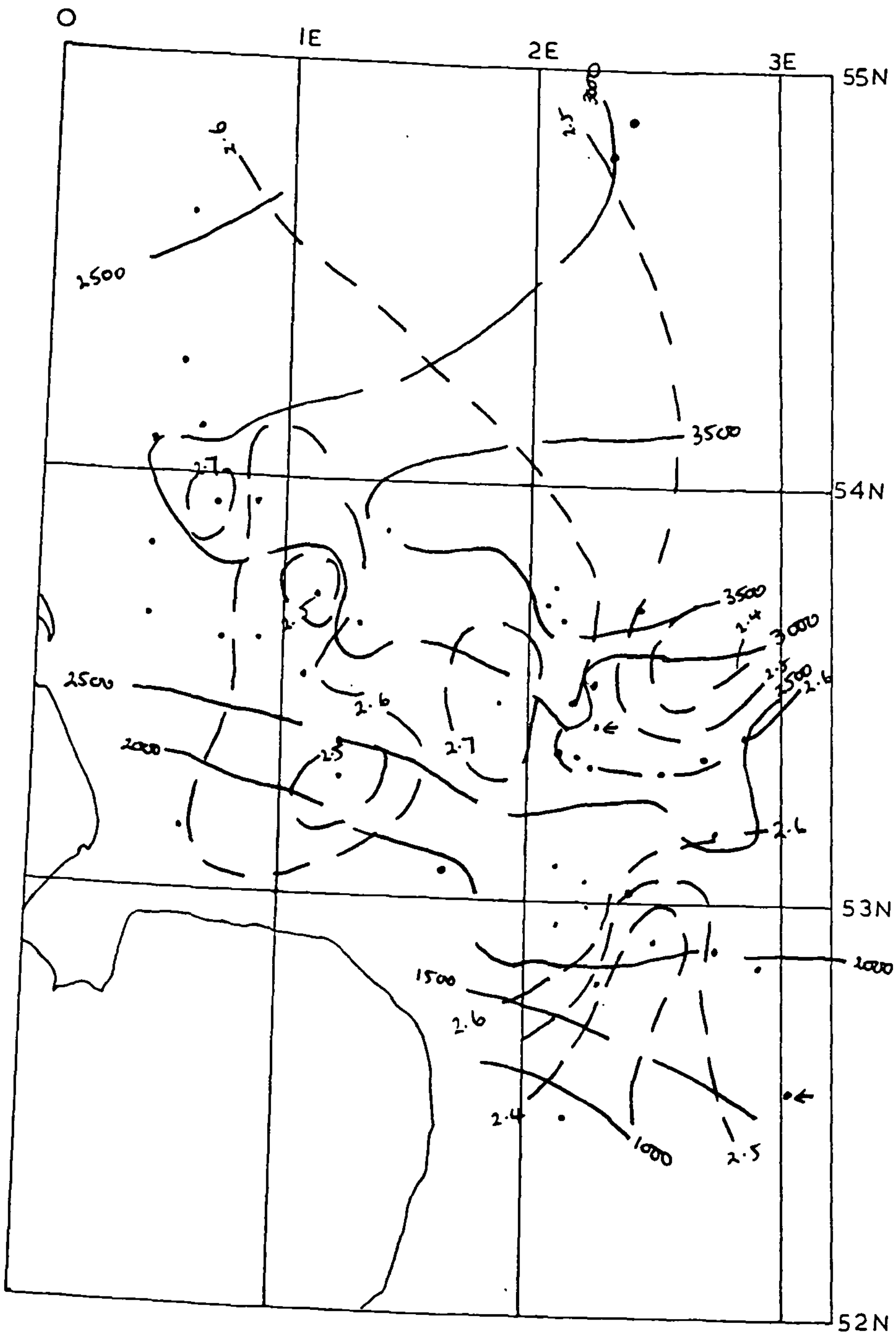


• WELL POSITION

DEPTH CONTOURS ————

DENSITY CONTOURS — — — —

Carboniferous



• WELL POSITION

DEPTH CONTOURS

DENSITY CONTOURS