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Summary of the Carnaby Moor Borehole investigation

J P Bloomfield and P Shand

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	BRITISH GEOLOGICAL SURVEY	BRITISH GEOLOGICAL SURVEY KEYWORTH NOTTINGHAM NG12 5GG UNITED KINGDOM TEL (0115) 9363100 FAX (0115) 9363200

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JP Bloomfield & P Shand

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			CO-AUTHOR		
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			CO-AUTHOR		
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Keyworth, Nottingham NG12 5GG
☎ 0115-936 3100 Telex 378173 BGSKEY G
Fax 0115-936 3200

Murchison House, West Mains Road, Edinburgh, EH9 3LA
☎ 0131-667 1000 Telex 727343 SEISED G
Fax 0131-668 2683

London Information Office at the Natural History Museum, Earth Galleries, Exhibition Road, South Kensington, London SW7 2DE
☎ 0171-589 4090 Fax 0171-584 8270
☎ 0171-938 9056/57

St Just, 30 Pennsylvania Road, Exeter EX4 6BX
☎ 01392-78312 Fax 01392-437505

Geological Survey of Northern Ireland, 20 College Gardens, Belfast BT9 6BS
☎ 01232-666595 Fax 01232-662835

Maclean Building, Crowmarsh Gifford, Wallingford, Oxfordshire OX10 8BB
☎ 01491-838800 Fax 01491-692345

Parent Body
Natural Environment Research Council
Polaris House, North Star Avenue, Swindon, Wiltshire SN2 1EU
☎ 01793-411500 Telex 444293 ENVRE G
Fax 01793-411501

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SUMMARY

This report is a compilation of data obtained from a 100 m deep borehole that was drilled in the Chalk at Carnaby Moor [TA 1505 6486], south of Bridlington, Yorkshire. The borehole was drilled in December 1996 as part of the National Groundwater Survey Programme, hydrogeology of the Chalk of Yorkshire and Lincolnshire. The borehole was drilled to provide information on the stratigraphy, geophysical characteristics and hydrogeology of the Flamborough Chalk in the vicinity of Bridlington. The following is a summary of the principal observations.

- The Chalk consists mostly of hard, creamy coloured chalk with frequent marl bands and stylolitic horizons. Flint is absent. The only perceptible lithological changes are the occurrences of slightly greyer, marly, bioturbated chalks from 75.4 m to 76.25 m bGL and from 83.85 m to 94.05 m bGL. Initial correlations with the standard succession described by Whitham (1993) suggest that the borehole is located in the Sewerby Member of the Flamborough Chalk Formation, and that the bottom of the borehole is at least 110 m above the base of the Formation.

- Fracture intensity is relatively high (with an average spacing in the borehole trajectory of 17 cm) and consistent with depth. In addition, matrix porosity is relatively low (17.8 to 28.4%). There is a (non-systematic) correlation between matrix porosity and $\delta^{13}C$ and $\delta^{18}O$ stable isotope profiles. From this it is inferred that the Chalk has been significantly modified by diagenetic processes that may have been associated with the Howardian-Flamborough faulting episode.

- Five localised inflows can be identified on the flowmeter logs at 42, 50, 56, 72 and 80 m bGL, generally associated with bedding plane fractures. Pore water chemistry is consistent with relatively young recharge waters, however, there is evidence that pore waters are out of equilibrium with water in the borehole. No systematic changes in pore water chemistry can be seen across the depth intervals where there are localised inflows into the borehole.

Additional work could be undertaken to confirm the precise stratigraphic position of the borehole. This may include; (i) correlation of the geophysical logs with logs from boreholes in the Yorkshire Wolds, (ii) extension of the biostratigraphic correlation to standard successions to the south of the area, eg. Trunch, (iii) correlation of the $\delta^{13}C$ profile with the Trunch $\delta^{13}C$ stratigraphic profile, and (iv) deepening of the borehole to prove the base of the Flamborough Chalk. Deepening of the borehole would also provide additional information concerning the depth trends in fracture and matrix properties and in pore water chemistry. Additional work could also be undertaken to investigate the correlations between porosity and whole rock ^{13}C and $\delta^{18}O$ stable isotope by studying changes in profiles into the Howardian-Flamborough fault zone. This would provide insights into the processes of Chalk diagenesis.

FOREWORD AND ACKNOWLEDGEMENTS

The Carnaby Moor borehole study was co-funded by the Environment Agency and the British Geological Survey (BGS). Both organisations have interests in the broad survey of Chalk aquifer and both organisations recognised that there was limited data in the area of Carnaby Moor. The site was chosen because BGS required a borehole located on the Flamborough Chalk and the Environment Agency wanted a borehole in area of Carnaby Moor for groundwater monitoring purposes. Following completion of the BGS borehole study the borehole was passed over to the Environment Agency and is now part of the Environment Agencies groundwater monitoring network in the Yorkshire Region. We would like to thank J Aldrick (Environment Agency, Yorkshire Region), Dave Allen and Ian Gale (BGS) for initiating the project. We would also like to thank Mike Bird for field logistics, Mark Woods for the lithological logging, Dave Buckley for geophysical logging and interpretation, Janice Trafford, George Darling and the staff of the BGS hydrogeochemistry laboratories for pore water sampling and analyses and stable isotope analyses, and Peter Williams for the porosity analyses.

1. INTRODUCTION

Work on the Hydrogeology of the Chalk of Yorkshire and Lincolnshire was begun in 1996 as part of the National Groundwater Survey Programme. During the review of data from boreholes in the region, it was recognised that stratigraphic secessions and geophysical logs could be correlated from south of the Humber Estuary northwards to the Yorkshire Wolds, and that it was potentially possible to correlate major flowing horizons based on these regional geological correlations. However, it was also found that it was not possible to tie in observations from boreholes from the Yorkshire coast south of Flamborough Head with the stratigraphic and geophysical logs to the west and south. This was because boreholes on the coast were located too high in the geological secession (in the Flamborough Chalk). Consequently, it was decided to drill a deep borehole near the coast, south of Bridlington, in an attempt to identify the base of the Flamborough Chalk and to establish a correlation with the underlying Burham Chalk. To this end, a 100 m borehole was drilled in December 1996 at Carnaby Moor. The purpose of this technical report is to collate the data from the Carnaby Moor borehole investigation and to present a brief summary interpretation.

The report is organised as follows: Details of the site and the borehole construction are given after a description of the regional and site geology and hydrogeology. The geological log is presented, with a stratigraphic interpretation, followed by the hydrogeological logs, including physical properties, and solid phase and pore water chemistry logs. The report is concluded with a summary interpretation and an outline of possible future activities at the site. References and data appendices are attached.

2. REGIONAL GEOLOGY AND HYDROGEOLOGY

The object of this section is to describe very briefly the regional geology and hydrogeology of the Chalk of Yorkshire.

2.1 Regional Extent of the Chalk

The Chalk of Yorkshire and Lincolnshire forms a thick belt on the east coast of England from Bempton in the north to Skegness in the south and to Market Weighton and Caistor in the west. Figure 1 illustrates the distribution of the Chalk, Quaternary and Recent deposits (from Allen et al. 1997). In the western and northern parts of the area the Chalk crops out at the surface, forming the downland scenery of the Yorkshire and Lincolnshire Wolds and sea cliffs of up to 100 m in height where the Wolds meet the coast at Flamborough Head. However, in the central and eastern part of the region the Chalk is buried beneath drift deposits, mainly Late Pleistocene (Devensian) tills, sands and gravels of glacial origin and post-glacial (Holocene) coastal and marsh sediments. The Chalk is absent to the north of the region, but to the south of the region it re-emerges from beneath the drift cover on the Norfolk coast at Hunstanton.

2.2 Thickness of the Chalk across the Region and Chalk Stratigraphy

Throughout Yorkshire the Chalk is characterised by a relatively homogeneous lithology and there are only very limited thickness variations across the region. There are no significant lateral facies changes at the regional scale although variations in matrix characteristics with stratigraphic age and in response to localised tectonic activity can be recognised. In the central and southern part of the region the Chalk Group overlies the East Midlands Shelf on which a moderate thickness of at least 500 m of chalk sediments built up (Barker, 1994; Berridge and Pattison, 1994). There is a general expansion of the Chalk succession eastward offshore. A total thickness of over 800 m of Chalk is present some 40 km from the coast in a late Cretaceous basin adjoining the Sole Pit Trough an inverted Jurassic basin. The Chalk is thin or absent across this inverted basin, but is over 1200 m thick to the east of the Sole Pit Trough, in the central North Sea. North of the River Humber, the Market Weighton High or 'Axis' was an area of relative uplift which affected Jurassic and Cretaceous sedimentation. In this area, the Chalk Group is thinner than in the central and southern part of the region, the changes in thickness being particularly noticeable in the lower part of the Group (Jeans, 1973). The preserved thickness of the Chalk in Yorkshire is illustrated in Figure 2 (from Allen et al, 1997), and Table 1 presents a summary of the Cretaceous stratigraphic secession of the region.

2.3 Regional Structure

The Chalk of Yorkshire and Lincolnshire forms an open syncline, known as the Wolds Syncline (Donovan, 1968), plunging gently (2° to 5°) towards the south-east along an axis between Driffield and Bridlington. The syncline extends out into the North Sea and the eastern limb of the syncline abuts against the Flamborough anticline and Dowsing Fault Belt approximately 50 km off-shore (Donovan and Dingle, 1965; Kent 1980a, 1980b). Across much of the southern and central part of the region the Chalk forms the south-western limb of the syncline and dips fairly uniformly to the north-east, away from the escarpment of the Wolds, with an average dip of approximately 1° (*ie.* 15 to 20 m per kilometre). In the north-east of the region the Chalk forms the north-eastern limb of the syncline and dips to the south-west. In addition to the main syncline, Kent (1974), Neale (1974), and Foster and Milton (1976) have described a series of minor fold axes which plunge concordant with the main synclinal structure. Contours on the base of the Chalk are offset slightly by the Caistor Monocline (Barker, 1984; Berridge and Pattison, 1994), an east-west trending structure which can be traced eastwards from the Chalk outcrop through to the coast at Grimsby.

Over the Market Weighton High (Figure 1), the dip of the bedding swings round to the south-east, and at Flamborough the average dip is 3° to 5° to the south or south-south-west. This zone is associated with a belt of faulting and flexuring that can be traced westward across the Wolds towards Malton and is known as the Howardian-Flamborough Fault Belt. It relates to late Cretaceous or early Palaeogene uplift, or inversion, of the buried southern margin of the Cleveland Basin (Kirby and Swallow, 1987; Rawson and Wright, 1992; Peacock and Sanderson, 1994). The Howardian-Flamborough Fault Belt consists of several disturbance zones, generally trending west-east, best exposed in the area of Flamborough Head (Kirby and Swallow, 1987). Smaller folds and faults are common throughout the Chalk of the Lincolnshire and Yorkshire region. Rawson and Wright (1992) have described minor folding from the north end of Selwicks Bay, mainly developed above décollement horizons formed by thin marls. It is thought that these small-scale folds associated with local displacements on marls, may be common throughout the entire Wolds Syncline.

2.4 Regional Hydrogeology

In Yorkshire the Chalk aquifer is unconfined in the drift-free Wolds and confined where it is covered by glacial tills. The unconfined-confined boundary coincides generally with the position of the buried cliff-line, east of which there is up to about 40 m of drift covering the aquifer. The unsaturated zone in the Yorkshire Wolds varies in thickness from less than 10 m in the Wold valley to up to 120 m on the higher ground. Seasonal fluctuations of the water table can be up to 20 m on the highest ground, and around 10 m in the dry valleys. Perched water tables are uncommon. Flow in the unsaturated zone is thought to take place by a combination of matrix flow and by-pass flow through fractures, although it is not clear whether flow is vertical to the water table, or whether a horizontal component of flow occurs along more permeable horizons.

In Yorkshire groundwater movement on a regional scale tends to follow the dip of the Chalk; flow is away from a major groundwater divide which closely parallels the Chalk escarpment, generally trending north-west. The hydraulic gradient in the confined Chalk is very shallow, but is steeper in the Wolds, where it mirrors the topography. Flow variations in the heavily disturbed Chalk in north Yorkshire have not been studied in detail.

The groundwater head in the Chalk has declined historically through pumping. Boreholes which were once artesian now require pumping. The fall in head has resulted in saline intrusion from the Humber Estuary, which is controlled by groundwater management. Based on 87 pumping tests, the average transmissivity value for the Chalk in the region is about 1200 m^2/d, but ranges over more than four orders of magnitude from less 1 to 10,000 m^2/d. The average storage co-efficient is 7.2×10^{-3} with an interquartile range of 1.5×10^{-3} to 0.018 (Allen et al, 1997).

Groundwaters are dominantly of Ca-HCO_3 type but increasing salinity in the coastal zone results from the greater influence of Na and Cl. Down the groundwater flow gradient, notable changes in water chemistry occur, influenced particularly by the position of the redox boundary.

3. SITE DESCRIPTION AND BOREHOLE CONSTRUCTION

The Carnaby Moor borehole [TA 1505 6486] (NGRC Reg. No.: TA16SE/6) is located south west of Bridlington on the edge of a domestic waste landfill site owned by Wastewise Ltd. Figure 3 shows the site and borehole location. The site was chosen, in conjunction with the Environment Agency, because: i) it was believed to be located in the lower part of the Flamborough Chalk, ii) there was easy access to the site, and iii) the Environment Agency, who co-funded the construction of the borehole, required a borehole in that area for groundwater monitoring purposes. It was agreed that on completion of the borehole study the borehole would become the property of the Environment Agency. A historic leakage of leachate from one of the neighbouring landfills was known to have effected some local surface watercourses but it was not thought to have affected the groundwater at the site (J. Aldrick, pers. comm.).

The borehole was drilled between the 2nd and 19th December 1996. Air flush rotary core drilling was used because of difficulties in supplying large amounts of water for water flush, and because of problems associated with disposal of dirty drilling water at the site. The borehole was cored to a total depth of 100.64 m and superficial deposits and soft and poorly consolidated Chalk near the surface were cased out to a depth of 26 m using Demco plastic casing (cement grouted). The casing projects 0.2 m above ground level and has a threaded top to allow for additional casing to be added or fitting a cap on the borehole. It has been reported that the bore become artesian during the winter of 1998 (J. Aldrick, pers. comm.).

It was found that 17.5 m of superficial deposits and drift overlie the Chalk, with the top 4 m of the Chalk being soft and putty-like. Table 2 shows core recovery in the Chalk below 17.5 m. 'Soft ground' was recorded by the driller in the interval 19.10 to 20.73 m, chalk rubble was obtained in the interval 19.10 to 20.02 m and between 20.02 and 20.73 m the borehole was open-holed. Core recovery is poor in the interval 21.58 to 23.72 m but is good below this latter depth and is generally greater than 95%.

4. LOGGING AND SAMPLING ACTIVITIES

A standard suite of geophysical logs were run by BGS on the 19th and 20th December 1996. These included caliper, Gamma ray, resistivity, magnetic susceptibility, fluid EC, temperature, and flowmeter logs. The core was sealed in Mylar coreliners and taken to the BGS core store in Keyworth where geological and hydrogeological logs were made and where it was sub-sampled for physical properties and pore water chemistry samples (7th to 10th January 1997). Samples were taken at an interval of approximately one every metre for physical properties and solid phase chemistry tests and samples for pore water chemistry analysis were taken at intervals of approximately one every two metres. Where possible samples for pore water were taken adjacent to samples for physical properties analysis.

5. GEOLOGICAL LOG AND STRATIGRAPHIC INTERPRETATION

The cored section consists mostly of hard, creamy coloured chalk with frequent marl bands and stylolitic horizons. Flint is absent. The only perceptible lithological changes are the occurrences of slightly greyer, marly, bioturbated chalks from 75.4 m to 76.25 m bGL and from 83.85 m to 94.05 m bGL. A detailed lithological log (from Woods, 1997) is given in Appendix 1.

Figure 4 shows the inferred correlation between the standard succession as described by Whitham (1993) and the Carnaby Moor borehole (from Woods, 1997). Figure 5 shows the inferred stratigraphic position of the Carnaby Moor borehole with respect to the stratigraphy of the Chalk of northern England. The frequent marl seams and absence of flints are characteristic of the Flamborough Chalk. However, precise marl correlations between the Carnaby Moor borehole and stratotype successions are highly problematical and there is an absence of good faunal markers in the core. This has led to possible two interpretations of the succession.

Woods (1997) has suggested that the base of the Flamborough Chalk lies about 135 m below the bottom of the borehole, while M Sumbler (pers. comm.) suggests that the base of the Flamborough Chalk lies about 110 m below the bottom of the borehole.

6. GEOPHYSICAL LOGS

Figure 6 presents the geophysical logs for the Carnaby Moor borehole. The caliper log shows an enlarged and very variable borehole aperture immediately below the casing at 26 m bGL, probably due to pervasive fracturing of the shallow chalk. The induction resistivity log shows a marked reduction in resistivity below about 75 m and again below about 84 m bGL. These changes in the resistivity log are probably associated with an increased clay content in the greyer, marly, bioturbated chalks described in the lithological log between 75.4 m and 76.25 m bGL and between 83.85 m and 94.05 m bGL. There is an increase in fluid conductivity at about 70 m bGL and a fall in temperature at about 80 m bGL. These could be interpreted as reflecting more saline waters towards the base of the borehole, but this interpretation is not substantiated by the pore water chemistry profiles, Figure 9 (see section 7.2). The flow logs suggest localised inflows to the borehole at 42, 50, 56, 72 and 80 m bGL, and, with the exception of the inflow at 80 m bGL, they all appear to correlate with local (fracture controlled?) enlargements in the caliper log.

7. HYDROGEOLOGICAL LOGS

7.1 Physical Properties

A detailed hydrogeological log of the Carnaby Moor borehole is given in Appendix 2. The fracture data summarised in Figure 7 is taken from the hydrogeological log. Figure 8 is a depth plot of the core porosity data along with the $\delta^{13}C$ and $\delta^{18}O$ stable isotope data for each of the samples tested for porosity. The porosity and stable isotope data are also listed in Table 3.

Figure 7 is a graphic log of the fracture data and shows the location of each fracture (left hand plot) and the fracture density profile (right hand plot). 473 fractures were logged in the borehole over a total length of c. 80 m of core and have an average spacing of 17 cm. Fractures are not clustered and are probably dominated by joints, although faults have been inferred from slickensides on fracture surfaces at 70.35 m bGL and 90.19 m bGL. Fracture density is relatively constant through the section and only shows a slight decrease with depth. This contrasts markedly with the large changes in the caliper log with depth. Higher fracture densities in the 72 m bGL, 77 m bGL and at 99 m bGL intervals may correlate with steps seen in the flow meter logs at 72 m bGL, 80 m bGL and 96 m bGL (Figure 6).

Porosities are in the range 17.8% to 28.4% with a mean porosity of 23.0%. Figure 8 shows a general decease in porosity with depth. The porosity values are relatively low for the Upper Chalk of Northern England, a typical value being 35% (Bloomfield et al. 1995). Many of the samples contain stylolites, indicating that the section has undergone extensive pressure solution compaction (Bloomfield, 1997). The reduction in porosity with depth may be interpreted simply as being due to burial diagenesis. However, the Chalk exposed at Flamborough Head, to the north of Bridlington, is extensively stylolitised, and some workers (eg. Peacock and Sanderson, 1994) have suggested that these stylolites and the low matrix porosity are primarily tectonic in origin (associated with regional scale faulting).

Figure 8 shows that $\delta^{13}C$ is in the range 2.32 to 2.88 with a mean of 2.54 and that $\delta^{18}O$ is in the range -5.75 to -3.30 with a mean of -3.89. Small changes in the gradient of the porosity profile appear to correspond with changes in the gradient of the stable isotope profiles, but no consistent relationships can be identified. These correlations are thought to reflect both primary sedimentalogical characteristics and diagenetic events.

Values of $\delta^{13}C$ are thought to primarily reflect patterns of organic carbon content in Chalk. This is because organic carbon is preferentially enriched in the lighter isotope $\delta^{12}C$, and its removal from the oceanic reservoir causes oceanic waters to be relatively enriched in $\delta^{13}C$. Jenkyns et al. (1994) demonstrated: (i) the remarkable similarity of $\delta^{13}C$ profiles across the UK, (ii) between the Chalk of the UK and the Cretaceous Scaglia deposits of Italy, and (iii) that $\delta^{13}C$ profiles may be used for stratigraphic correlation. Visual comparison of the $\delta^{13}C$ profile in Figure 8 and the $\delta^{13}C$ profile for the Trunch borehole (Jenkyns et al, 1994, Figure 8) suggests that the Carnaby Moor profile corresponds with a section towards the base of the Companion in the Trunch borehole (this is consistent with the biostratigraphic interpretation, Figures 4 and 5).

The ratio of oxygen in pore waters to oxygen in initially porous carbonate sediment is high, consequently, there is potential for considerable diagenetic change in values of $\delta^{18}O$. For example, burial diagenesis at elevated temperatures and diagenetic meteoric-water cementation can add isotopically light $\delta^{18}O$ cements. Although the exact stratigraphic position of the Carnaby Moor borehole is uncertain, comparison with the $\delta^{18}O$ profile from the Trunch borehole (Jenkyns et al, 1994, Figure 8 - where values are typically in the range -1.75 to -2.5) indicates that the Carnaby Moor borehole has undergone significantly greater diagenetic alteration than the Trunch borehole.

7.2 Pore Water Chemistry

7.2.1 *Chemical Evolution of Chalk Groundwaters*

The reaction of rainwater and soil water with the chalk matrix (dominated by low Mg calcite) is rapid and shallow groundwaters quickly attain saturation with respect to calcite by the following reaction:

$$Ca(Mg)CO_3 + H_2O + CO_2 = Ca^{2+} + Mg^{2+} + 2HCO_3^-$$

This reaction is congruent with the ratios of dissolved ions having the same proportions as those of the chalk. This process occurs until saturation with respect to calcite is reached and equilibrium achieved, the amount of ions dissolved being largely controlled by the initial amount of CO_2 entrapped in the water from the atmosphere and soil zone. Further reaction continues through incongruent reactions, even though saturation is achieved, because the waters are in dynamic equilibrium with chalk i.e. further dissolution is balanced by precipitation of chalk. This process effectively leads to an increase in the waters of the impurities which are present in the calcite (e.g. Mg, Sr), and waters with relatively high Mg/Ca and Sr/Ca ratios are, therefore, indicative of a longer residence time. These processes are highlighted on a cation trilinear diagram (Figure 9) where recharging waters are shown to be dominated by Ca and further reaction leads to waters with higher Mg/Ca ratios. Mixing may also occur with deeper more saline groundwaters or with remnant pore waters leading to displacement towards the Na and K apex of Figure 9.

7.2.2 *Water Type and General Characteristics*

The porewaters extracted from the chalk are alkaline with laboratory-measured pH values of 8.0 - 8.4 (Figure 10), but aquifer values are probably less due to an increase caused by degassing of CO_2 between collection and analysis. It is difficult to estimate what the redox condition of the porewaters was before coring; the presence of NO_3-N and SO_4 and low Fe and Mn may provide evidence for relatively oxidising conditions although the rapid changes which take place within the core are not known. The waters are relatively fresh with low mineralisation (SEC: 307 - 426 $\mu S\ cm^{-1}$; Table 1) and the waters are all of Ca-HCO_3 type, typical of shallow chalk groundwaters (Figure 9). Note that the SEC range in the pore water profile is significantly grater and the depth trends significantly more heterogeneous than the equivalent SEC depth profile measured by the geophysical logging (Figure 6). From this, it is inferred that the pore waters are not in equilibrium with the water in the borehole.

7.2.3 *Vertical Variations in Chemistry*

The pH of the porewaters shows little change with depth in the borehole profile and is well buffered with reactions with the chalk matrix. There are relatively small but significant changes in SEC (Figure 10a) with a pronounced high at c. 45-56 m bGL and possibly a slight increase in trend towards the base of the borehole.

The major element chemistry of the porewaters are very similar and there are no large changes in concentration with depth. There is possibly a slight increase in concentration of Ca and K and a slight decrease in HCO_3 and Mg. Sodium and Cl show a slight increase towards the base of the borehole although Na/Cl ratios are similar to seawater and the rest of the profile indicating that this is not due to water-rock interaction, but may be related to a remnant saline porewater phase. Sulphate is relatively low through most of the profile but shows a distinct enhancement between 84 and 94 m bGL. The nitrate profile shows an increase in concentration to c. 84 m bGL and then a rapid decline: this may well be an indication of the presence of a redox boundary and the onset of reducing conditions. An increase at the lower part of the borehole possibly indicates a bypass route at depth. Between 86 and 94 m there is an increase in F concentration which, until saturation is reached, generally increases in the chalk aquifer with reaction time and, therefore, residence time.

7.2.4 *Indicators of Residence Time and Relative Ages of Porewaters*

There is no information on absolute ages in these chalk porewaters, but several indicators are present which may provide some information on relative ages as well as a very rough indicator of residence time in the Chalk aquifer. These include element concentrations such as Sr and F (until saturation with fluoride is reached) and ratios such as Sr/Ca and Mg/Ca which increase with reaction time and therefore often can be used as an indicator of residence time. As discussed above there is little vertical stratification of the major elements in the chalk pore water profile. Strontium does show a gradual increase with depth but concentrations are low in comparison with many Chalk groundwaters and point to a relatively young age. In addition, Sr/Ca and Mg/Ca ratios are also low; consistent with this observation. The Mg/Ca ratio is, rather surprisingly, highest in the lowest part of the profile and it is not clear whether this may be related to a lithological control; Sr/Ca ratios are also slightly high but do not decrease to the same degree as Mg/Ca deeper in the profile. Nevertheless the relatively small changes indicate that there is unlikely to be significant differences in the age of the waters in this part of the profile.

The relatively high F concentrations towards the base of the borehole are mirrored by relatively high SO_4, Mg/Ca and a slight increase in Sr/Ca and Li and may indicate an older water which has undergone more enhanced water-rock interaction. The decrease in these parameters below this depth, in agreement with the higher NO_3 may be due to bypass flow.

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TABLES AND FIGURES

Table 1 Summary of the regional Cretaceous stratigraphy (from Allen et al. 1997).

System	Stage	Formation	Lithological division	Approximate thickness (m)
		Flamborough Chalk		unknown
	Senonian	Burnham Chalk		unknown
Upper Cretaceous	Turonian			unknown
		Welton Chalk		
	Cenomanian	Ferriby Chalk	Hunstanton (Red) Chalk	7
	Albian	Carstone	Carstone Grit	3
	Aptian		Carstone Sand and Clay	4
		Sutterby Marl		3
			Upper Roach	3
		Roach	Roach Stone	5.5
	Barremian		Lower Roach	7.5
Lower Cretaceous			Upper Tealby Clay	11
		Tealby Clay	Tealby Limestone	4
			Lower Tealby Clay	13
	Hauterivian		Upper Claxby Ironstone	
		Claxby	Hundlby Clay	9
	Valanginian		Lower Claxby Ironstone	
	Ryazanian		Upper Spilsby Sandstone	2
	Portlandian	Spilsby Sandstone	Lower Spilsby Sandstone	22

Table 2 Core recovery in the Chalk.

Core Run No.	Top (m)	Base (m)	Interval (m)	Recovery (m)	Recovery (%)
1	17.5	17.72	0.22	0.18	81.82
2	17.72	18.5	0.78	0.5	64.10
3	18.5	18.85	0.35	0.21	60.00
4	18.85	19.1	0.25	0.2	80.00
5	20.73	21.58	0.85	0.77	90.59
6	21.58	22.63	1.05	0.8	76.19
7	22.63	23.72	1.09	0.78	71.56
8	23.72	24.77	1.05	0.98	93.33
9	24.77	26.31	1.54	1.38	89.61
10	26.31	27.71	1.4	1.29	92.14
11	27.71	29.3	1.59	1.4	88.05
12	29.3	30.63	1.33	1.32	99.25
13	30.63	32.11	1.48	1.43	96.62
14	32.11	33.47	1.36	1.3	95.59
15	33.47	34.95	1.48	1.47	99.32
16	34.95	37.96	3.01	2.85	94.68
17	37.96	40.89	2.93	2.77	94.54
18	40.89	44.02	3.13	2.89	92.33
19	44.02	47.05	3.03	3.03	100.00
20	47.05	50.05	3	2.97	99.00
21	50.05	53.02	2.97	2.94	98.99
22	53.02	55.86	2.84	2.82	99.30
23	55.86	58.82	2.96	2.89	97.64
24	58.82	61.83	3.01	2.97	98.67
25	61.83	64.76	2.93	2.9	98.98
26	64.76	67.72	2.96	2.96	100.00
27	67.72	70.58	2.86	2.75	96.15
28	70.58	73.57	2.99	2.86	95.65
29	73.57	76.17	2.6	2.59	99.62
30	76.17	78.89	2.72	2.71	99.63
31	78.89	81.71	2.82	2.81	99.65
32	81.71	84.59	2.88	2.83	98.26
33	84.59	87.48	2.89	2.88	99.65
34	87.48	90.14	2.66	2.64	99.25
35	90.14	93.07	2.93	2.88	98.29
36	93.07	95.98	2.91	2.7	92.78
37	95.98	98.65	2.67	2.55	95.51
38	98.65	100.64	1.99	1.74	87.44

Table 3 Porosity and stable isotope data.

Sample number	Porosity (%)	Top Depth (m bGL)	Base Depth (m bGL)	Mean Depth (m bGL)	d13C (PDB)	d18O (PDB)
1523/1H	27.48	20.90	21.00	20.95	2.55	-4.00
1523/2H	21.93	22.00	22.10	22.05	2.47	-3.73
1523/3H	22.81	23.05	23.10	23.08	2.53	-3.79
1523/4V	22.54	24.00	24.11	24.06	2.50	-3.48
1523/5H	26.74	25.00	25.20	25.10	2.58	-3.88
1523/6H	24.32	26.00	26.15	26.08	2.51	-3.68
1523/7H	27.73	27.30	27.40	27.35	2.59	-3.68
1523/8H	22.26	28.00	28.10	28.05	2.52	-3.87
1523/9H	23.09	28.93	29.01	28.97	2.49	-3.81
1523/10H	26.72	29.92	30.03	29.98	2.54	-3.79
1523/11H	27.01	30.95	31.12	31.04	2.44	-4.04
1523/12H	24.89	31.95	32.08	32.02	2.54	-3.30
1523/13H	22.31	32.61	32.68	32.65	2.46	-3.70
1523/14H	22.38	32.92	33.03	32.98	2.45	-3.5
1523/15H	22.92	33.98	34.11	34.05	2.38	-3.73
1523/16H	22.49	34.79	34.91	34.85	2.53	-3.54
1523/17H	25.93	35.88	36.02	35.95	2.52	-3.43
1523/18H	24.40	36.98	37.08	37.03	2.52	-3.70
1523/19H	22.71	38.07	38.28	38.18	2.47	-3.74
1523/20H	22.30	38.98	39.08	39.03	2.42	-3.75
1523/21H	21.18	39.97	40.15	40.06	2.41	-3.75
1523/22H	21.44	41.19	41.29	41.24	2.32	-3.72
1523/23H	24.17	42.17	42.25	42.21	2.43	-4.04
1523/24H	22.98	43.10	43.26	43.18	2.58	-3.97
1523/25H	25.29	44.40	44.47	44.44	2.43	-3.65
1523/26H	25.36	45.02	45.15	45.09	2.53	-3.99
1523/27H	24.25	45.99	46.10	46.05	2.44	-3.75
1523/28H	24.29	46.98	47.05	47.02	2.46	-3.96
1523/29H	24.87	47.81	47.89	47.85	2.47	-3.85
1523/30H	22.50	49.07	49.16	49.12	2.47	-3.77
1523/31H	22.14	50.26	50.40	50.33	2.50	-3.83
1523/32H	23.85	51.20	51.32	51.26	2.51	-3.55
1523/33H	23.32	52.02	52.08	52.05	2.37	-3.73
1523/34H	22.45	52.87	53.02	52.95	2.56	-3.72
1523/35H	21.70	54.06	54.17	54.12	2.56	-3.71
1523/36H	23.91	55.08	55.24	55.16	2.45	-3.90
1523H37H	26.09	56.04	56.19	56.12	2.42	-3.94
1523/38H	22.28	57.22	57.30	57.26	2.43	-3.84
1523/39H	23.05	58.10	58.24	58.17	2.48	-3.90
1523/40H	26.41	58.82	59.01	58.92	2.45	-3.96
1523/41H	21.95	60.00	60.11	60.06	2.49	-3.78
1523/42H	25.18	60.92	61.04	60.98	2.51	-3.82
1523/43H	20.53	61.90	62.05	61.98	2.50	-3.82
1523/44H	22.82	62.95	63.05	63.00	2.54	-3.76
1523/45H	26.14	63.94	64.12	64.03	2.42	-3.94
1523/46H	26.15	65.09	65.17	65.13	2.57	-3.85
1523/47H	23.61	65.89	66.08	65.99	2.52	-3.79
1523/48H	24.95	67.02	67.07	67.05	2.53	-3.77
1523/49H	25.66	67.90	68.03	67.97	2.62	-3.96
1523/50H	23.14	69.27	69.34	69.31	2.49	-3.64
1523/51H	20.91	69.88	69.95	69.92	2.52	-3.73

Table 3 Porosity and stable isotope data (continued).

Sample number	Porosity (%)	Top Depth (m bGL)	Base Depth (m bGL)	Mean Depth (m bGL)	d13C (PDB)	d18O (PDB)
1523/52H	24.87	71.01	71.15	71.08	2.53	-3.84
1523/53H	21.59	72.07	72.17	72.12	2.47	-4.31
1523/54H	22.61	72.96	73.03	73.00	2.6	-3.95
1523/55H	24.14	73.87	73.94	73.91	2.58	-3.78
1523/56H	20.48	74.92	74.99	74.96	2.52	-3.89
1523/57H	22.15	76.17	76.25	76.21	2.58	-4.07
1523/58H	21.15	77.25	77.34	77.30	2.59	-4.02
1523/59H	19.68	77.97	78.11	78.04	2.53	-3.87
1523/60H	22.16	79.32	79.42	79.37	2.57	-4.07
1523/61H	21.79	79.98	80.13	80.06	2.62	-3.82
1523/62H	21.12	81.18	81.27	81.23	2.56	-4.04
1523/63H	21.99	82.32	82.43	82.38	2.52	-3.95
1523/64H	24.78	82.99	83.03	83.01	2.61	-4.11
1523/65H	22.62	83.96	84.07	84.02	2.6	-4.18
1523/66H	20.98	85.19	85.29	85.24	2.66	-3.89
1523/67H	17.77	86.03	86.18	86.11	2.55	-5.75
1523/68H	24.37	86.92	87.07	87.00	2.77	-4.09
1523/69H	24.94	88.09	88.20	88.15	2.76	-4.1
1523/70H	20.94	87.92	87.98	87.95	2.88	-3.89
1523/71H	20.30	90.33	90.39	90.36	2.69	-3.75
1523/72H	20.43	91.18	91.27	91.23	2.69	-4.11
1523/73H	28.40	92.17	92.26	92.22	2.78	-4.44
1523/74H	19.99	92.88	93.02	92.95	2.77	-3.85
1523/75H	19.79	94.20	94.34	94.27	2.65	-4.2
1523/76H	18.31	95.21	95.36	95.29	2.75	-4.1
1523/77H	19.79	96.17	96.25	96.21	2.62	-4.18
1523/78H	18.16	97.02	97.07	97.05	2.6	-3.89
1523/79H	21.40	97.94	98.00	97.97	2.64	-4.09
1523/80H	24.61	99.14	99.19	99.17	2.73	-4.38
1523/81H	18.53	99.89	100.01	99.95	2.66	-4.2

ID Number	Topdepth	Botdepth	pH (lab)	TOC	SEC $\mu S\ cm^{-1}$	Na $mg\ l^{-1}$	K $mg\ l^{-1}$	Ca $mg\ l^{-1}$	Mg $mg\ l^{-1}$	HCO_3 $mg\ l^{-1}$	SO_4 $mg\ l^{-1}$	Cl $mg\ l^{-1}$	NO_3-N $mg\ l^{-1}$	Si $mg\ l^{-1}$
970160	17.82	17.90	8.10	5.85	321	16.1	1.3	47.5	2.39	143	21.3	22.7	0.10	2.70
970161	20.73	20.90	8.18	2.90	307	12.9	1.6	48.6	2.68	140	18.8	22.6	0.50	3.72
970162	22.90	23.05	8.26	2.65	333	14.3	1.6	49.7	2.59	135	19.0	23.1	2.30	3.96
970163	24.80	25.00	8.20	2.95	316	12.5	1.5	50.1	2.17	134	18.9	23.6	2.10	3.25
970164	27.05	27.25	8.21	2.15	350	14.9	1.8	52.2	2.19	134	17.0	27.0	4.29	3.04
970165	29.48	29.65	8.24	1.85	362	14.0	1.8	58.6	2.40	152	16.2	24.6	4.40	3.18
970166	31.13	31.32	8.22	1.70	365	14.6	1.9	56.3	2.42	147	17.0	25.2	4.60	3.21
970167	33.03	33.23	8.19	2.45	359	14.8	2.0	54.3	2.34	139	17.0	27.8	5.13	3.19
970168	35.09	35.23	8.26	2.90	344	14.9	1.7	50.9	2.18	122	18.0	27.7	4.92	2.94
970169	37.08	37.19	8.26	3.05	340	14.5	2.2	51.4	2.18	124	17.2	28.9	4.85	2.96
970170	39.20	39.39	8.21	4.00	339	14.7	1.9	50.1	2.08	120	17.9	26.8	4.97	3.16
970171	41.96	42.17	8.22	2.10	336	14.4	1.6	48.6	1.97	117	16.2	26.1	5.11	2.94
970172	44.02	44.28	8.23	2.80	346	13.6	1.6	51.3	1.99	122	17.3	25.3	4.69	3.36
970173	46.20	46.35	8.23	2.05	405	13.7	1.8	60.1	1.87	142	15.9	27.5	6.96	3.11
970174	47.89	48.05	8.34	2.65	405	13.3	1.4	59.2	1.80	137	16.2	26.5	7.66	2.99
970175	50.13	50.26	8.19	2.25	413	14.8	1.5	58.9	1.71	131	19.1	30.0	8.06	3.26
970176	52.08	52.24	8.23	3.90	413	14.2	1.8	62.4	1.70	138	15.7	31.4	8.36	3.01
970177	54.19	54.36	8.19	4.80	414	18.1	3.5	55.2	1.71	116	17.5	31.5	7.99	2.86
970178	55.86	56.04	8.26	2.60	411	14.7	1.5	58.6	1.55	130	17.4	28.7	8.76	2.99
970179	57.87	58.10	8.31	3.00	395	14.7	1.8	56.5	1.61	130	11.5	27.8	7.70	3.09
970180	60.11	60.28	8.22	3.75	368	13.8	1.5	52.0	1.42	113	11.9	29.4	7.69	2.96
970181	62.05	62.25	8.29	4.40	315	15.7	1.6	54.6	1.58	123	14.4	29.4	7.95	3.04
970182	64.12	64.28	8.19	3.25	309	14.9	1.5	52.7	1.55	106	14.2	27.6	8.27	2.78
970183	66.08	66.25	8.29	2.65	338	14.7	1.8	60.2	1.68	126	19.5	28.4	8.61	3.17
970184	68.03	38.18	8.27	2.25	324	14.3	1.4	55.0	1.48	104	19.4	29.8	8.76	2.75
970185	69.95	70.16	8.31	3.60	332	14.4	1.4	55.4	1.45	120	16.3	29.2	8.43	2.93
970186	72.23	72.37	8.26	2.30	384	13.9	1.6	58.3	1.52	119	19.4	28.7	8.34	2.87
970187	73.94	74.14	8.26	3.25	344	13.0	1.6	54.3	1.53	121	9.8	28.9	5.81	2.93
970188	76.02	76.15	8.26	3.70	355	12.6	1.7	53.6	1.42	117	17.7	26.4	5.97	3.35
970189	77.84	77.97	8.34	4.40	384	14.1	2.0	58.3	1.74	126	44.5	25.4	1.86	3.62
970190	80.13	80.26	8.27	3.40	353	14.2	1.6	52.4	1.46	103	19.3	29.7	6.46	3.24
970191	82.43	82.56	8.36	5.10	358	13.0	1.9	58.9	1.61	142	19.1	25.2	4.09	3.59
970192	84.07	84.20	8.22	4.60	426	13.8	2.1	63.8	2.10	86	96.6	26.1	0.62	2.62
970193	86.41	86.60	8.30	4.20	364	13.1	2.0	52.9	1.75	119	35.3	25.9	1.59	3.23
970194	87.95	88.09	8.22	4.80	341	12.1	2.2	48.8	1.66	55	65.1	23.0	1.14	1.39
970195	90.14	90.32	8.05	5.15	335	13.1	2.2	46.4	1.79	47	70.0	31.6	0.78	1.40
970196	92.01	92.17	8.30	2.90	357	12.0	2.3	50.7	1.96	69	85.8	22.1	0.84	1.77
970197	94.02	94.20	8.18	3.35	393	14.7	2.4	56.3	1.90	135	32.4	23.9	1.23	4.08
970198	95.98	96.17	8.18	3.20	406	15.3	1.7	57.6	1.56	121	18.7	31.2	8.27	3.03
970199	98.07	98.22	8.18	3.00	394	14.8	2.0	56.5	1.50	123	22.8	30.9	4.95	3.87
970200	100.18	100.40	8.17	5.60	401	15.7	1.9	55.6	1.57	112	20.4	33.5	7.59	3.71

Table 4. Porewater chemistry data

ID Number	Sr mg l^{-1}	Ba mg l^{-1}	Li mg l^{-1}	B mg l^{-1}	Fe total mg l^{-1}	Mn mg l^{-1}	Cu mg l^{-1}	Zn mg l^{-1}	Al mg l^{-1}	As mg l^{-1}	F mg l^{-1}	Br mg l^{-1}	I mg l^{-1}	P total mg l^{-1}
970160	0.347	0.472	0.028	0.35	<.006	<.001	<.008	0.032	<.04	<0.004	0.48	0.08	0.030	<.2
970161	0.490	0.334	0.031	0.14	<.006	0.001	<.008	0.035	<.04	<0.004	0.39	0.09	0.025	<.2
970162	0.489	0.466	0.007	0.16	<.006	<.001	<.008	0.028	<.04	<0.004	0.60	0.08	0.016	<.2
970163	0.543	0.235	0.017	0.15	<.006	<.001	0.016	0.018	0.16	<0.004	0.45	0.09	0.026	<.2
970164	0.578	0.340	<.003	0.23	<.006	<.001	<.008	0.030	<.04	<0.004	0.45	0.10	0.029	<.2
970165	0.580	0.269	0.004	0.20	<.006	<.001	<.008	0.022	<.04	<0.004	0.37	0.09	0.025	<.2
970166	0.679	0.253	0.004	0.21	<.006	<.001	<.008	0.015	<.04	<0.004	0.60	0.09	0.029	<.2
970167	0.647	0.289	0.004	0.21	<.006	<.001	<.008	0.024	<.04	<0.004	0.47	0.10	0.032	<.2
970168	0.571	0.266	0.006	0.22	<.006	<.001	0.021	0.021	<.04	<0.004	0.52	0.10	0.026	<.2
970169	0.665	0.223	0.003	0.22	<.006	<.001	<.008	0.019	<.04	<0.004	0.56	0.09	0.034	<.2
970170	0.617	0.258	0.005	0.26	<.006	<.001	<.008	0.021	<.04	<0.004	0.48	0.10	0.035	<.2
970171	0.593	0.245	0.004	0.28	<.006	<.001	<.008	0.013	<.04	<0.004	0.56	0.10	0.036	<.2
970172	0.584	0.273	0.006	0.24	<.006	<.001	<.008	0.025	<.04	<0.004	0.48	0.09	0.027	<.2
970173	0.522	0.268	0.004	0.14	<.006	<.001	<.008	0.023	<.04	<0.004	0.42	0.10	0.023	<.2
970174	0.554	0.185	<.003	0.13	0.075	<.001	0.009	0.021	<.04	<0.004	0.42	0.10	0.023	<.2
970175	0.570	0.272	0.005	0.19	<.006	<.001	<.008	0.023	<.04	<0.004	n.d.*	0.10	0.041	<.2
970176	0.578	0.233	<.003	0.20	<.006	0.001	0.012	0.027	<.04	<0.004	0.48	0.11	0.032	<.2
970177	0.576	0.244	0.003	0.22	<.006	0.001	0.038	0.041	<.04	<0.004	0.48	0.11	0.039	<.2
970178	0.530	0.278	0.003	0.21	<.006	<.001	<.008	0.023	<.04	<0.004	0.48	0.10	0.022	<.2
970179	0.606	0.213	<.003	0.27	<.006	<.001	0.011	0.020	<.04	<0.004	0.44	0.10	0.036	<.2
970180	0.518	0.228	<.003	0.20	<.006	<.001	<.008	0.015	<.04	<0.004	0.47	0.10	0.028	<.2
970181	0.626	0.281	0.004	0.34	<.006	<.001	<.008	0.014	<.04	<0.004	0.52	0.10	0.040	<.2
970182	0.623	0.226	<.003	0.24	<.006	<.001	<.008	0.015	<.04	<0.004	0.45	0.10	0.029	<.2
970183	0.623	0.228	0.004	0.21	<.006	<.001	<.008	0.018	<.04	<0.004	0.64	0.10	0.033	<.2
970184	0.504	0.233	<.003	0.25	<.006	<.001	<.008	0.015	<.04	<0.004	0.40	0.10	0.028	<.2
970185	0.523	0.238	<.003	0.38	<.006	<.001	<.008	0.015	<.04	<0.004	0.37	0.11	0.031	<.2
970186	0.551	0.213	0.004	0.19	<.006	0.001	<.008	0.014	<.04	<0.004	n.d.	0.10	0.024	<.2
970187	0.642	0.361	0.003	0.21	0.008	0.004	0.021	0.032	<.04	<0.004	0.38	0.10	0.034	<.2
970188	0.442	0.282	0.004	0.19	<.006	<.001	<.008	0.022	<.04	<0.004	n.d.	0.11	0.024	<.2
970189	0.668	0.272	0.007	0.27	<.006	0.001	<.008	0.018	<.04	<0.004	0.40	0.09	0.037	<.2
970190	0.517	0.249	0.004	0.31	<.006	<.001	<.008	0.020	<.04	<0.004	0.44	0.10	0.047	<.2
970191	0.558	0.228	0.004	0.26	0.010	0.006	<.008	0.021	<.04	<0.004	0.46	0.09	0.042	<.2
970192	0.684	0.194	0.012	0.23	<.006	0.002	<.008	0.022	<.04	<0.004	0.48	0.09	0.041	<.2
970193	0.676	0.178	0.007	0.25	<.006	<.001	<.008	0.013	<.04	<0.004	0.58	0.09	0.049	<.2
970194	0.570	0.187	0.010	0.26	0.008	0.005	<.008	0.012	<.04	<0.004	0.72	0.07	0.028	<.2
970195	0.570	0.163	0.011	0.25	<.006	0.002	<.008	0.010	<.04	<0.004	0.90	0.10	0.056	<.2
970196	0.648	0.174	0.011	0.18	<.006	<.001	0.020	<.008	<.04	<0.004	0.78	0.07	0.017	<.2
970197	0.657	0.240	0.009	0.38	<.006	0.002	0.009	0.026	<.04	<0.004	0.74	0.07	0.026	<.2
970198	0.666	0.246	<.003	0.36	<.006	<.001	<.008	0.021	<.04	<0.004	n.d.	0.11	0.023	<.2
970199	0.517	0.235	0.005	0.30	<.006	<.001	<.008	0.021	<.04	<0.004	0.44	0.14	0.035	<.2
970200	0.697	0.212	0.005	0.40	<.006	0.002	0.028	0.015	<.04	<0.004	0.48	0.11	0.030	<.2

Table 4. Porewater chemistry data (contd.) *n.d. not determined

ID Number	Be mg l^{-1}	Sc mg l^{-1}	Y mg l^{-1}	Co mg l^{-1}	La mg l^{-1}	V mg l^{-1}	Cd mg l^{-1}	Zr mg l^{-1}	Cr mg l^{-1}	Ni mg l^{-1}	Mo mg l^{-1}	Pb mg l^{-1}
970160	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	0.007	<.02	<.02	<.04	<.06
970161	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970162	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970163	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970164	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970165	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970166	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970167	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970168	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970169	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	0.008	<.02	<.02	<.04	<.06
970170	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970171	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970172	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970173	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970174	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970175	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970176	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970177	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970178	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970179	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	0.009	<.02	<.02	<.04	<.06
970180	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970181	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970182	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970183	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970184	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970185	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970186	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970187	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970188	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970189	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	0.011	<.02	<.02	<.04	<.06
970190	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970191	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970192	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	0.04	<.06
970193	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970194	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970195	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970196	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970197	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970198	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970199	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06
970200	<.0004	<.0008	<.001	<.008	<.008	<.006	<.01	<.006	<.02	<.02	<.04	<.06

Table 4. Porewater chemistry data (contd.)

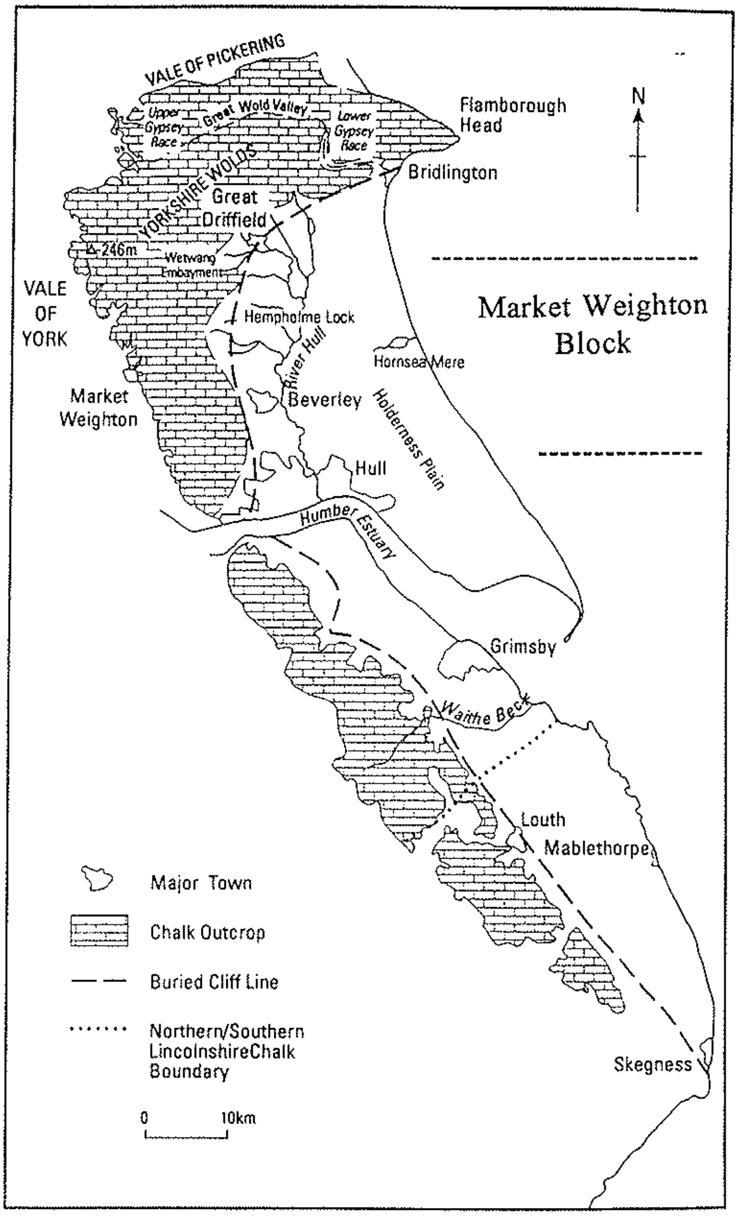


Figure 1 Illustration of the distribution of the Chalk in the region (from Allen et al. 1997).

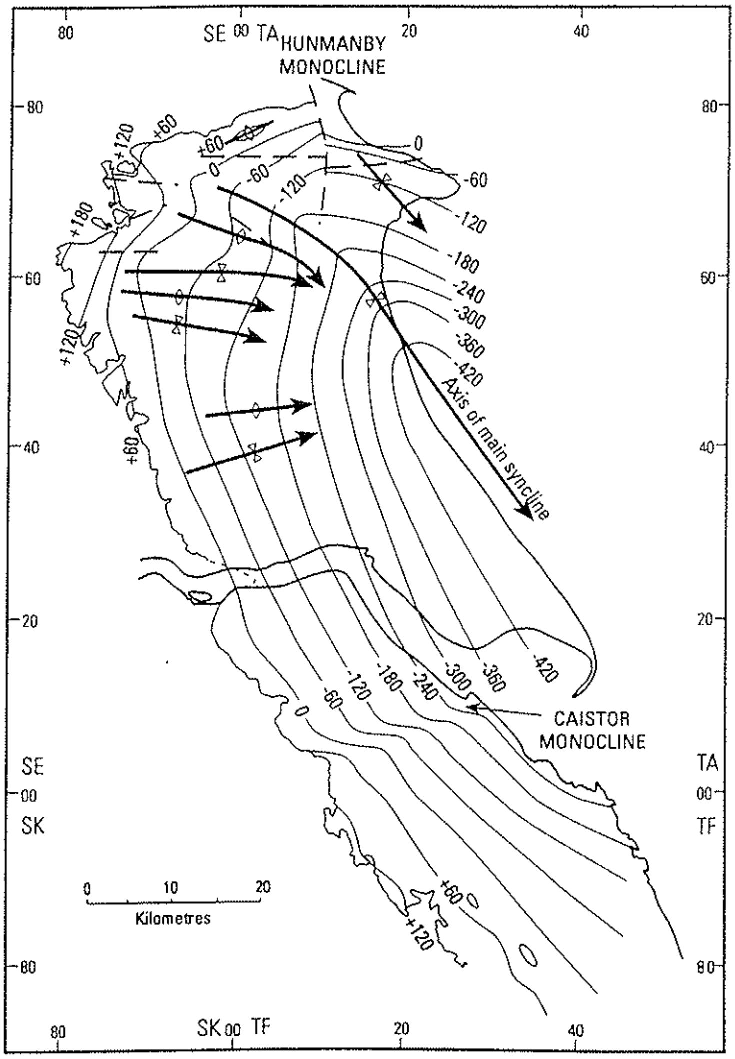


Figure 2 Isopach map for the Chalk in the region(from Allen et al. 1997).

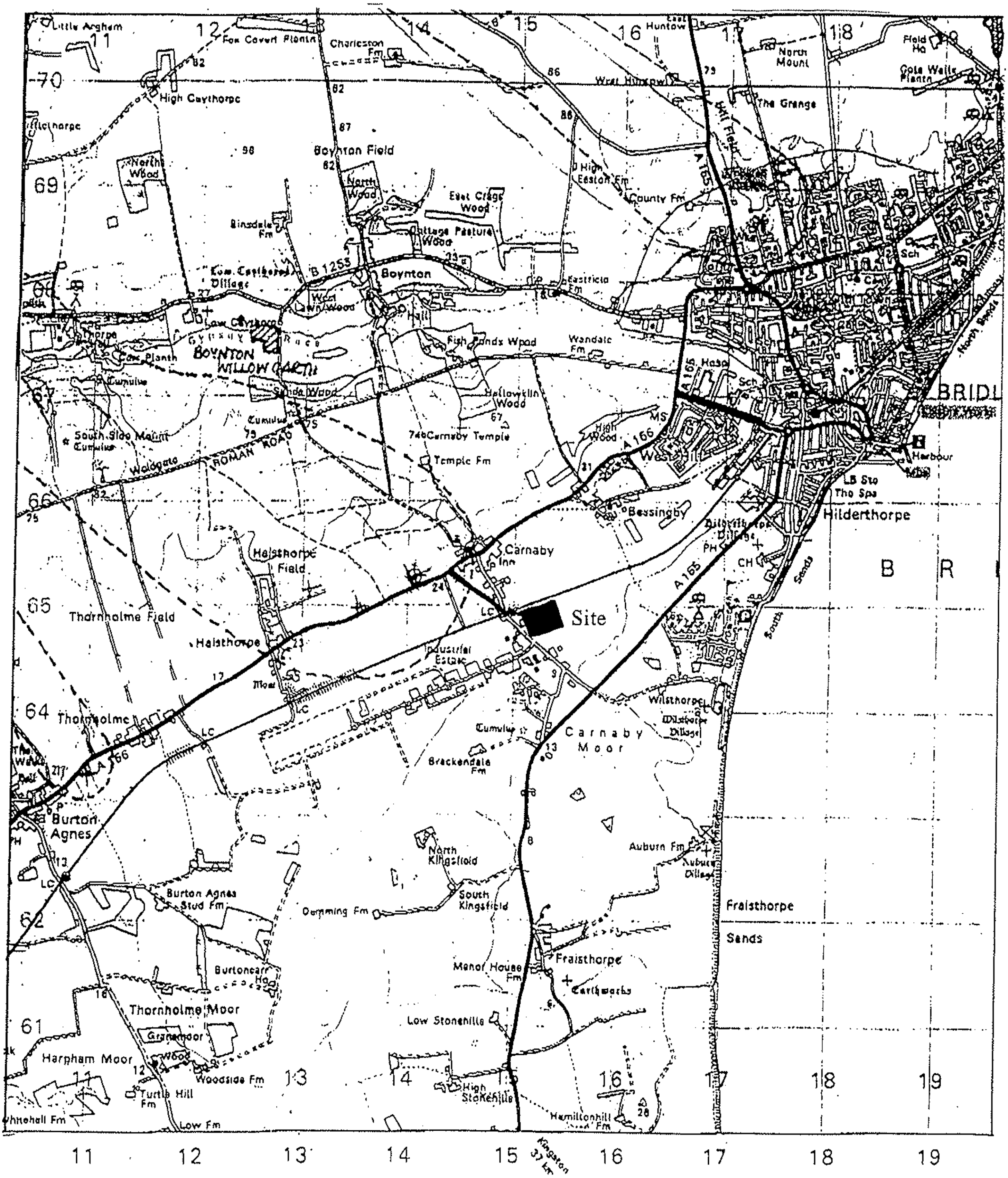


Figure 3a. Carnaby Moor site location.

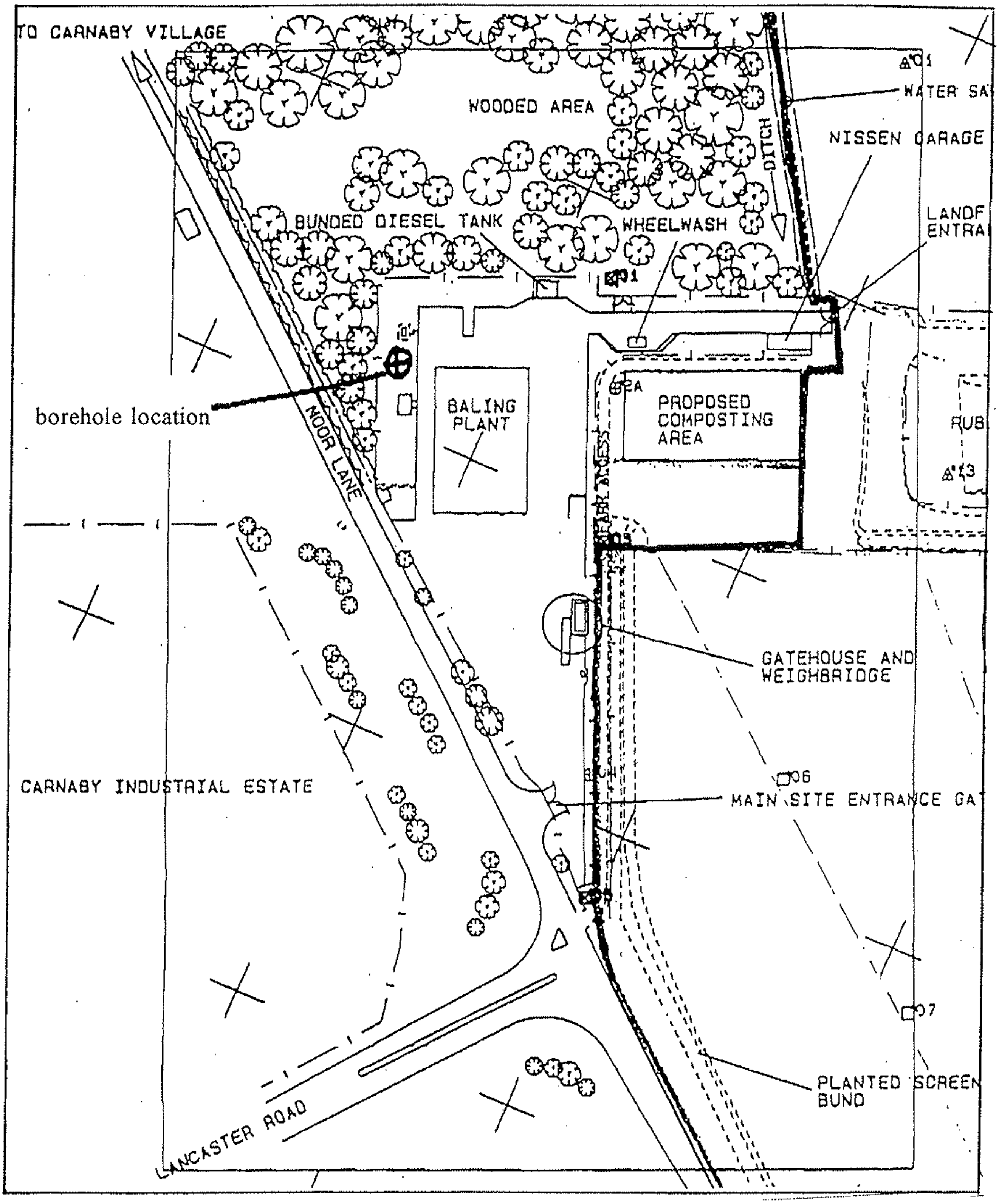


Figure 3b. Carnaby Moor site map and borehole location (continued).

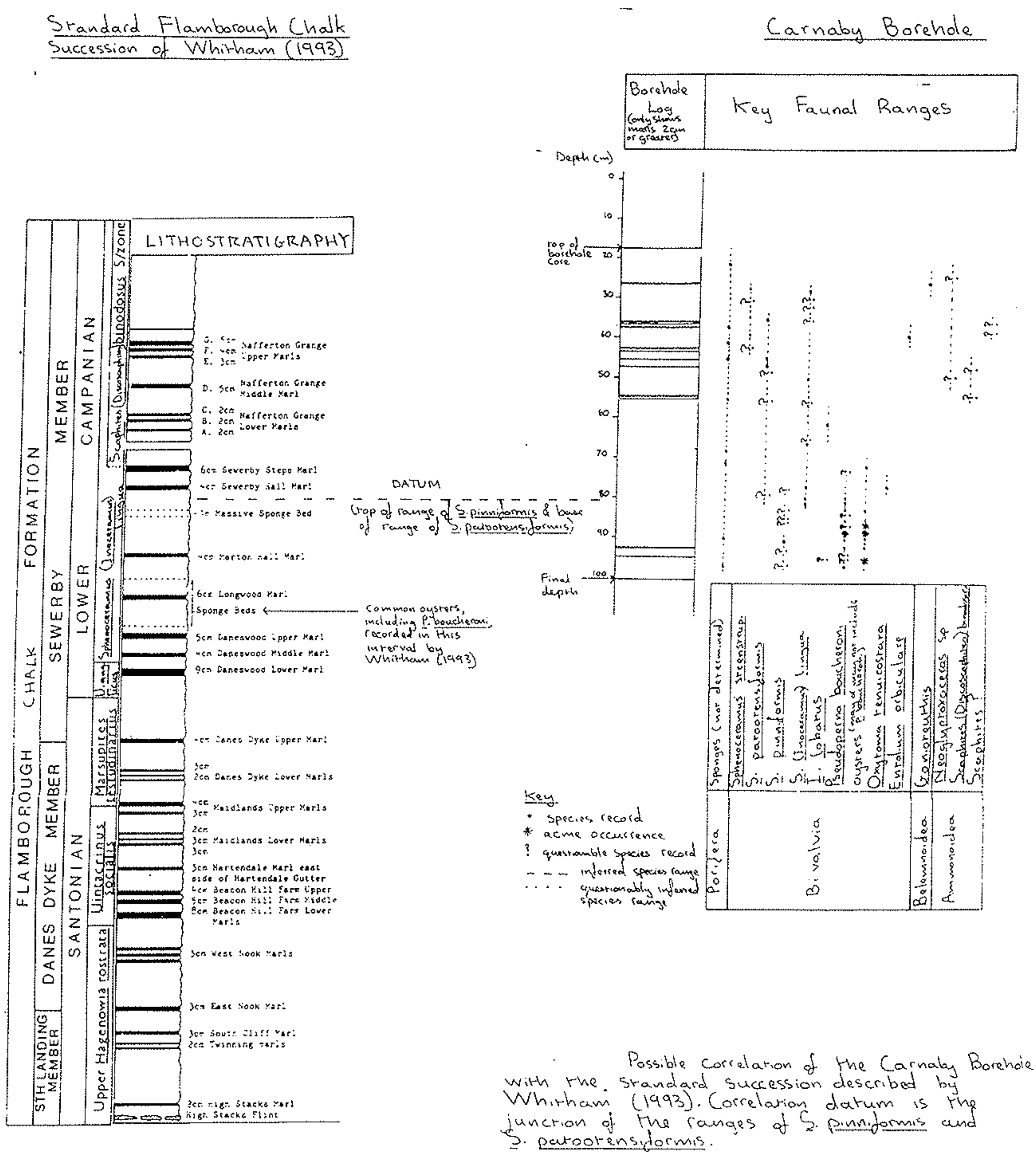


Figure 4 Inferred correlation between the standard succession as described by Whitham (1993) and the Carnaby Moor borehole (from Woods 1997).

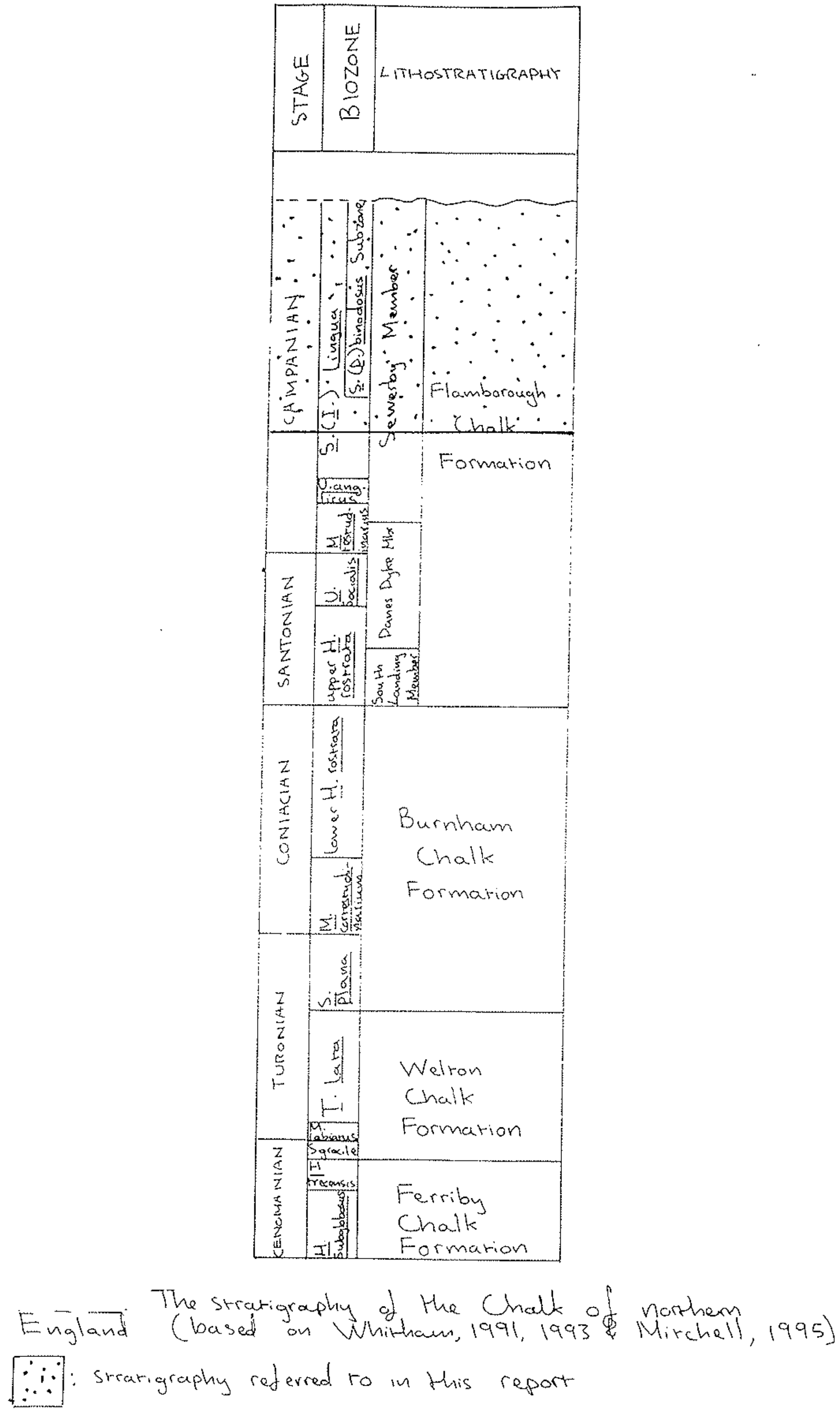


Figure 5 Inferred position of the Carnaby Moor borehole with respect to the stratigraphy of the Chalk of northern England (from Woods 1997).

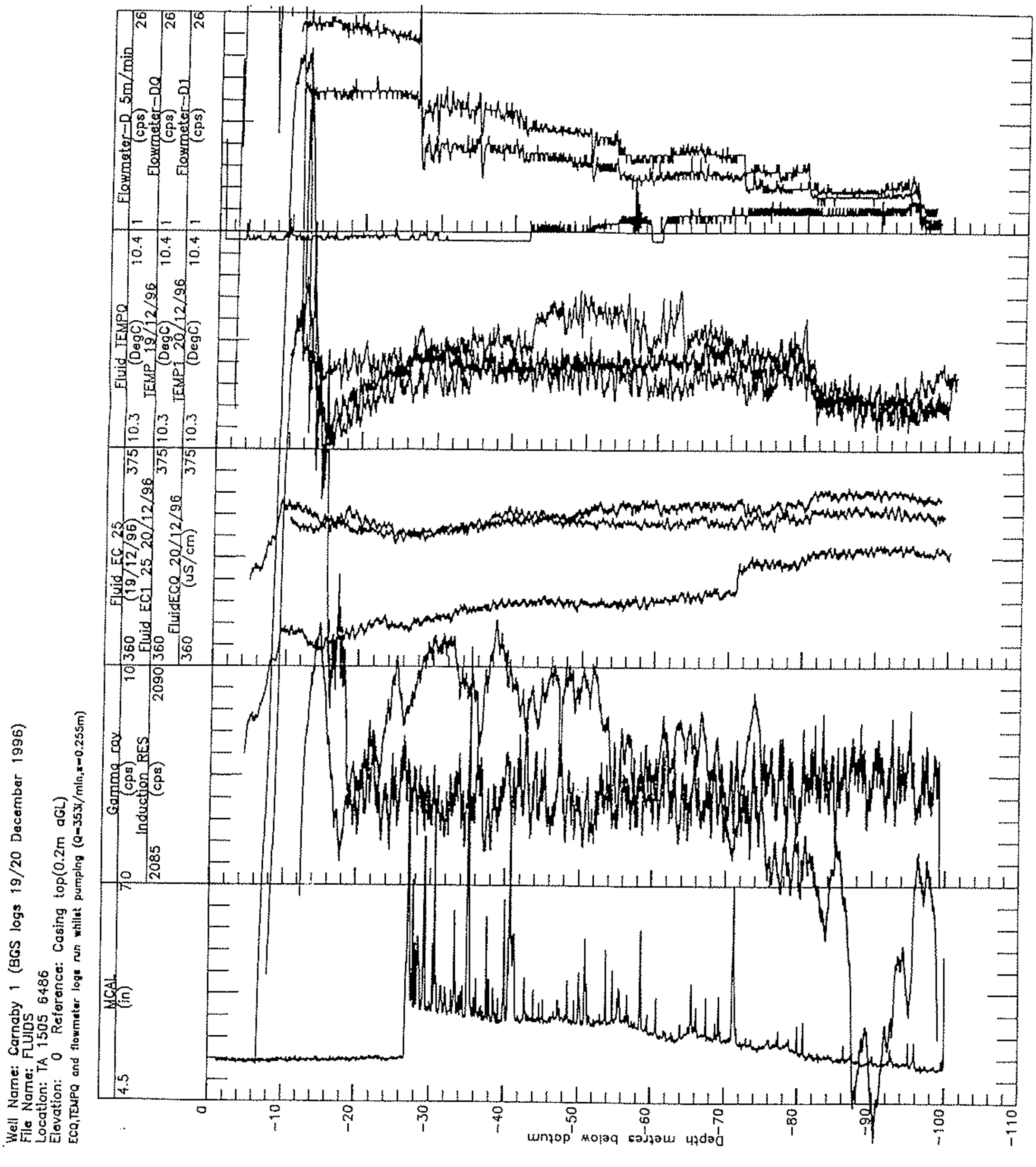


Figure 6 Geophysical logs for the Carnaby Moor borehole.

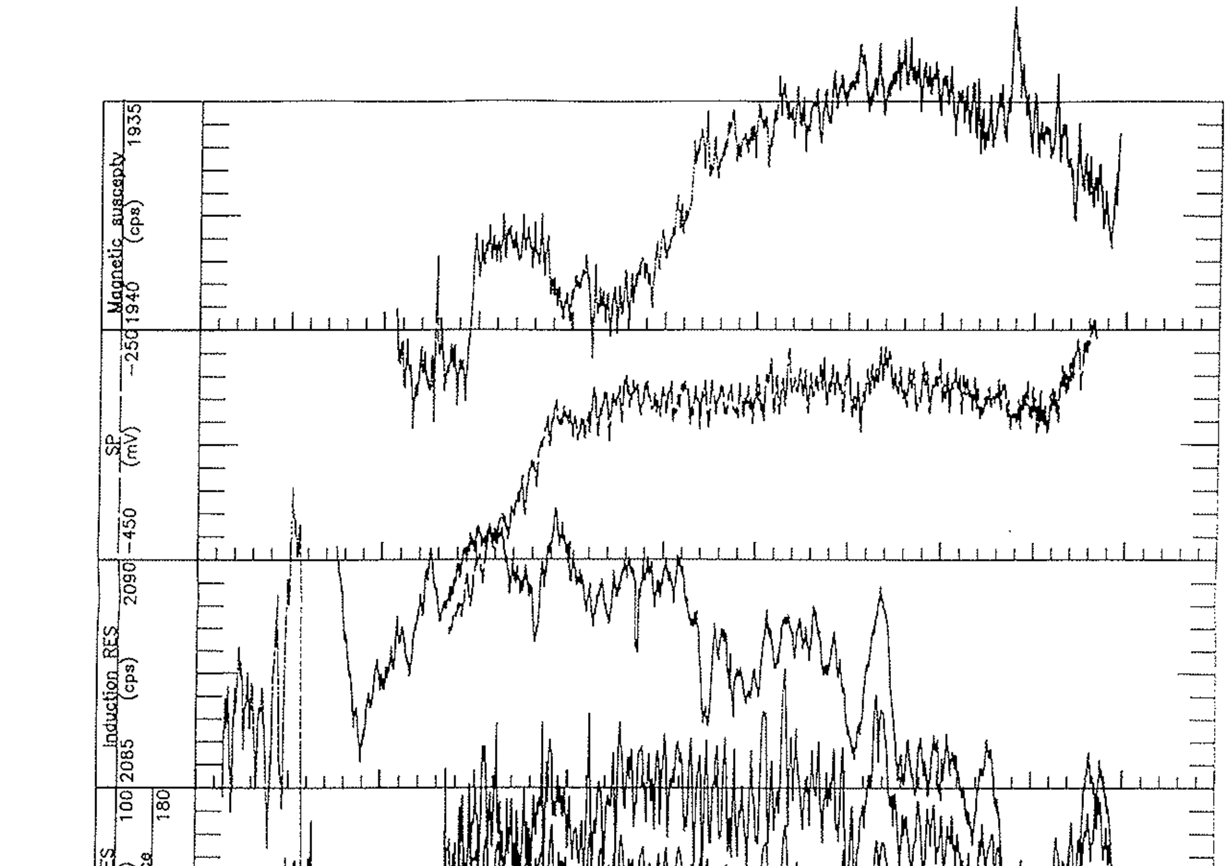


Figure 6 Geophysical logs for the Carnaby Moor borehole (continued).

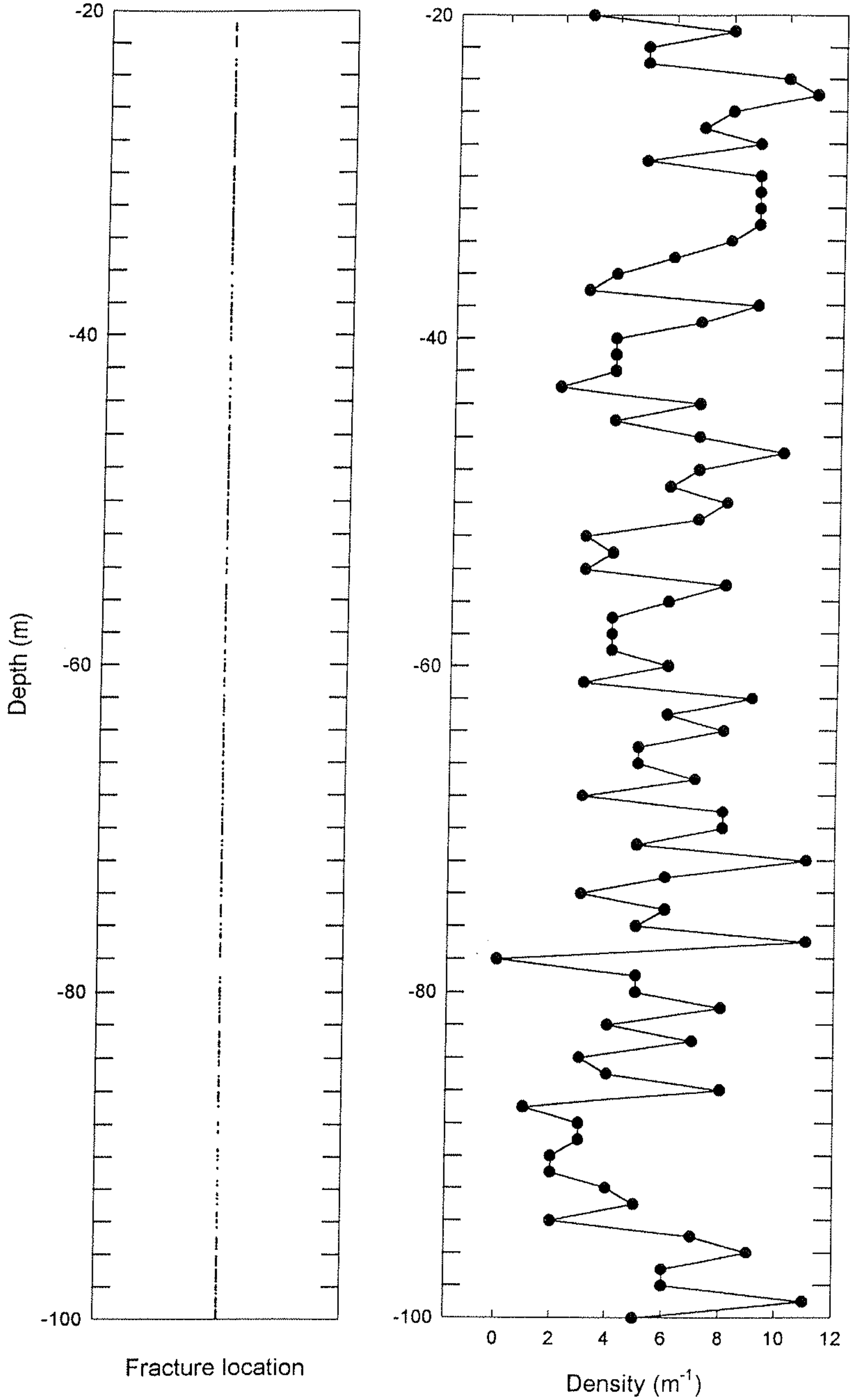


Figure 7 Summary of fracture data.

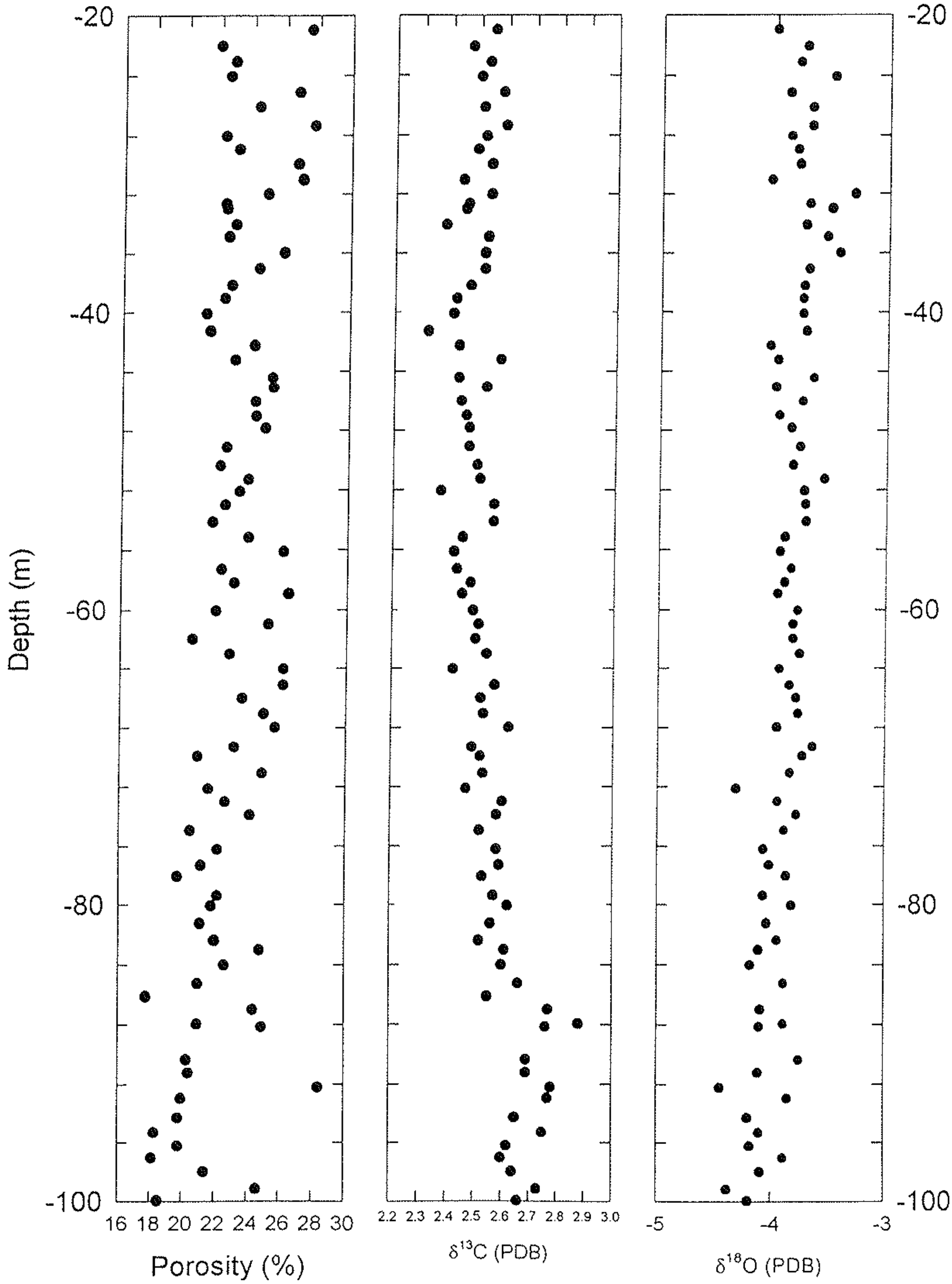


Figure 8 Depth plot of core porosity and whole rock $\delta^{13}C$ and $\delta^{18}O$ stable isotope data.

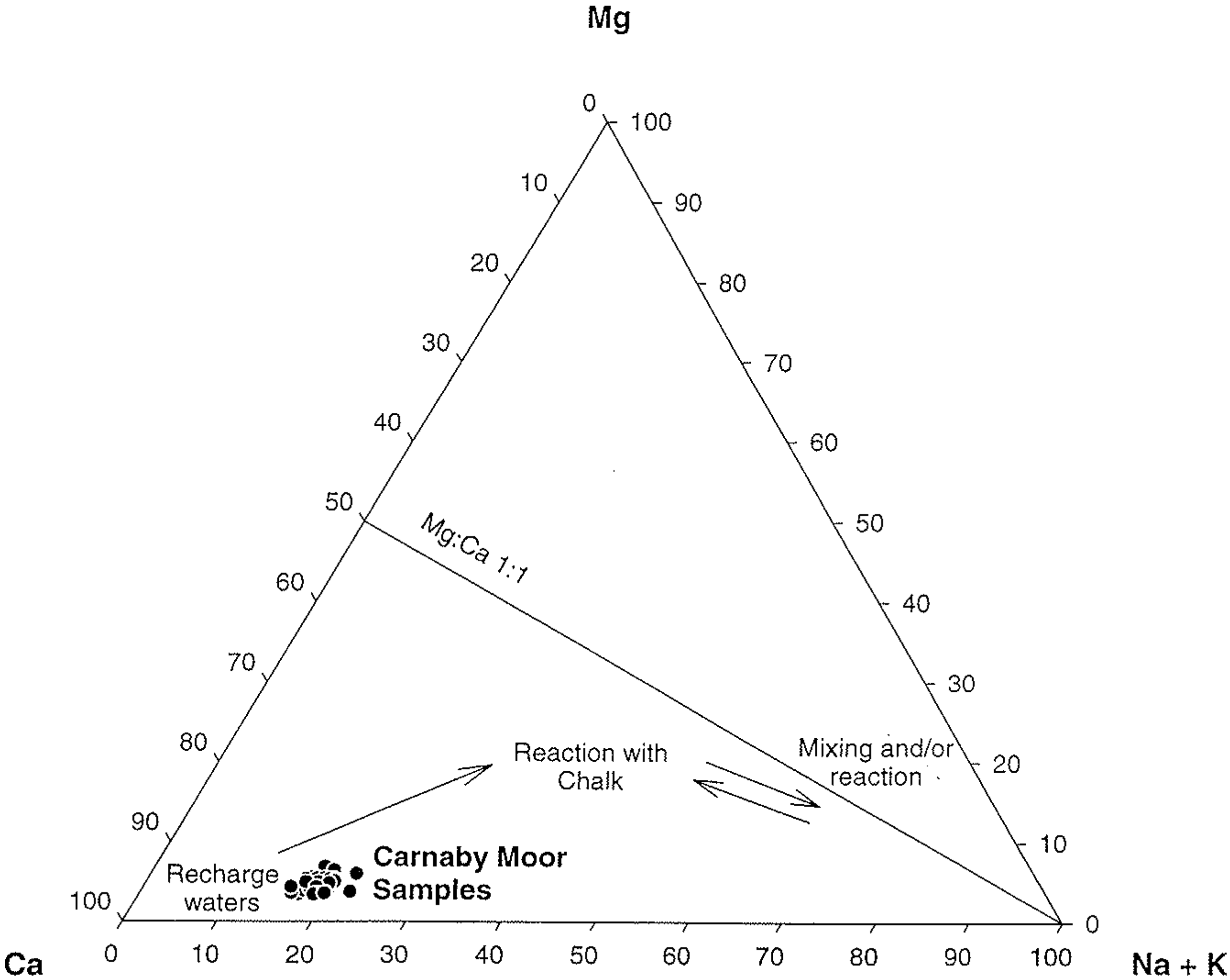


Figure 9 Cation trilinear diagram for pore water chemistry.

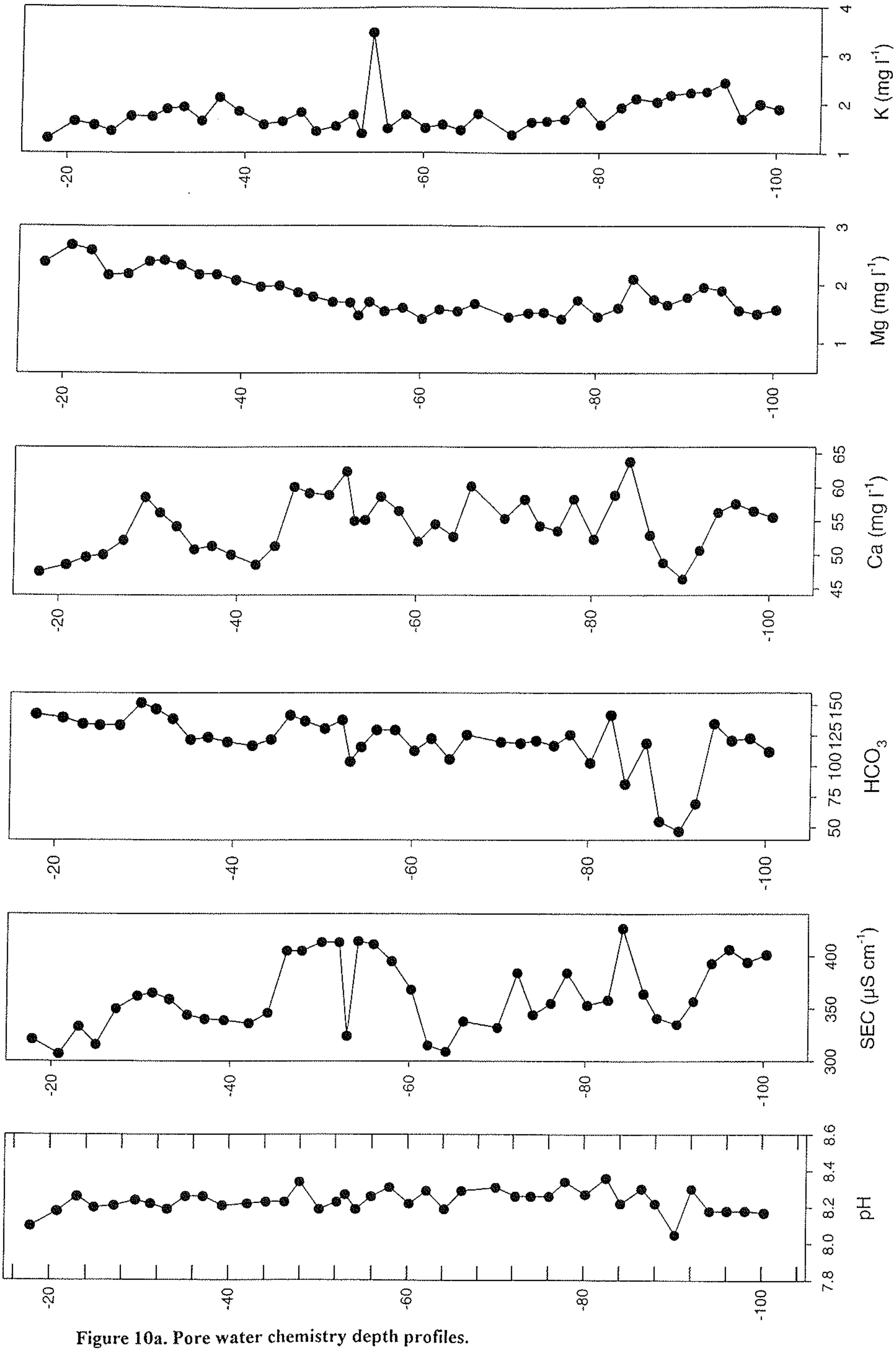


Figure 10a. Pore water chemistry depth profiles.

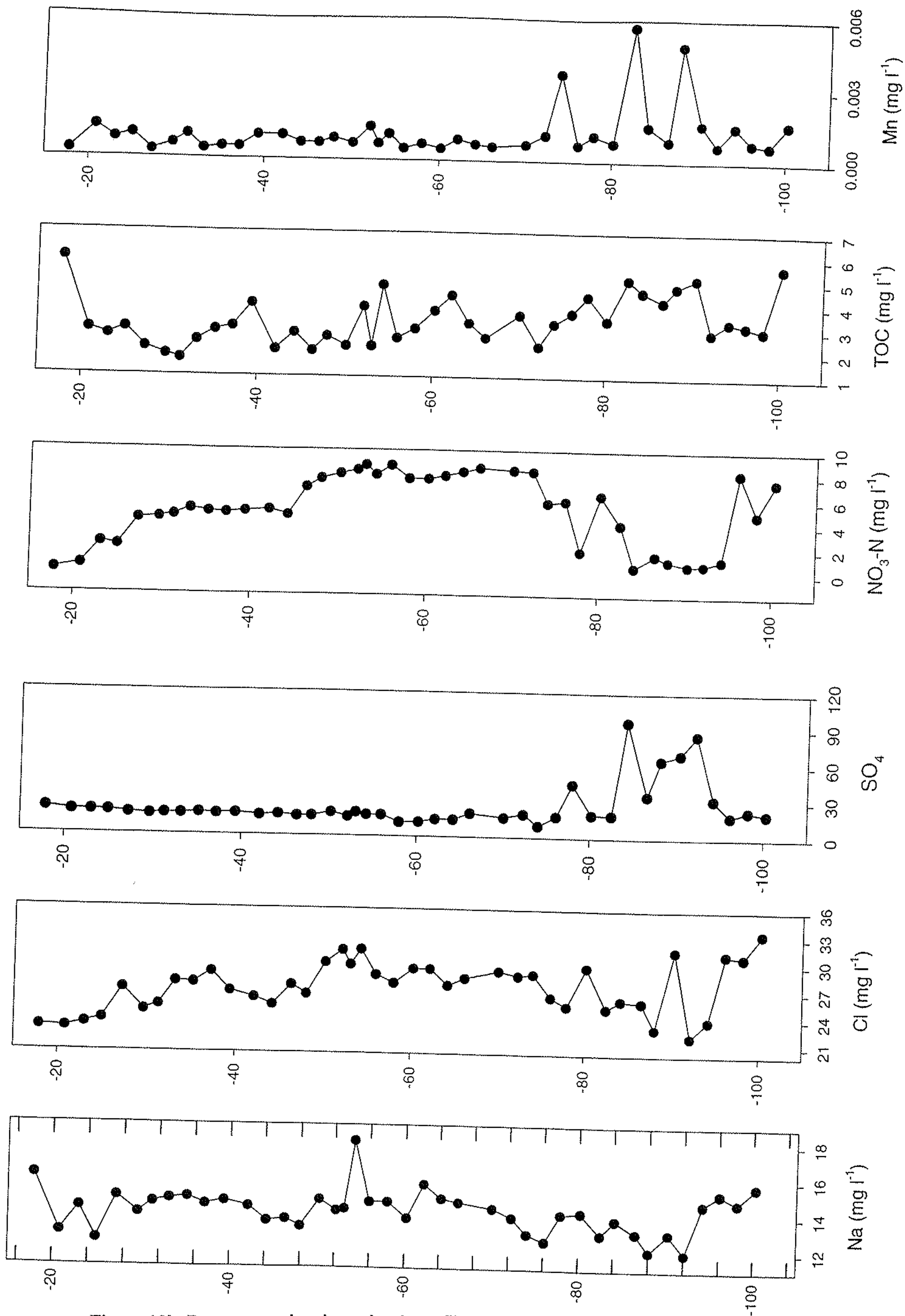


Figure 10b. Pore water chemistry depth profiles.

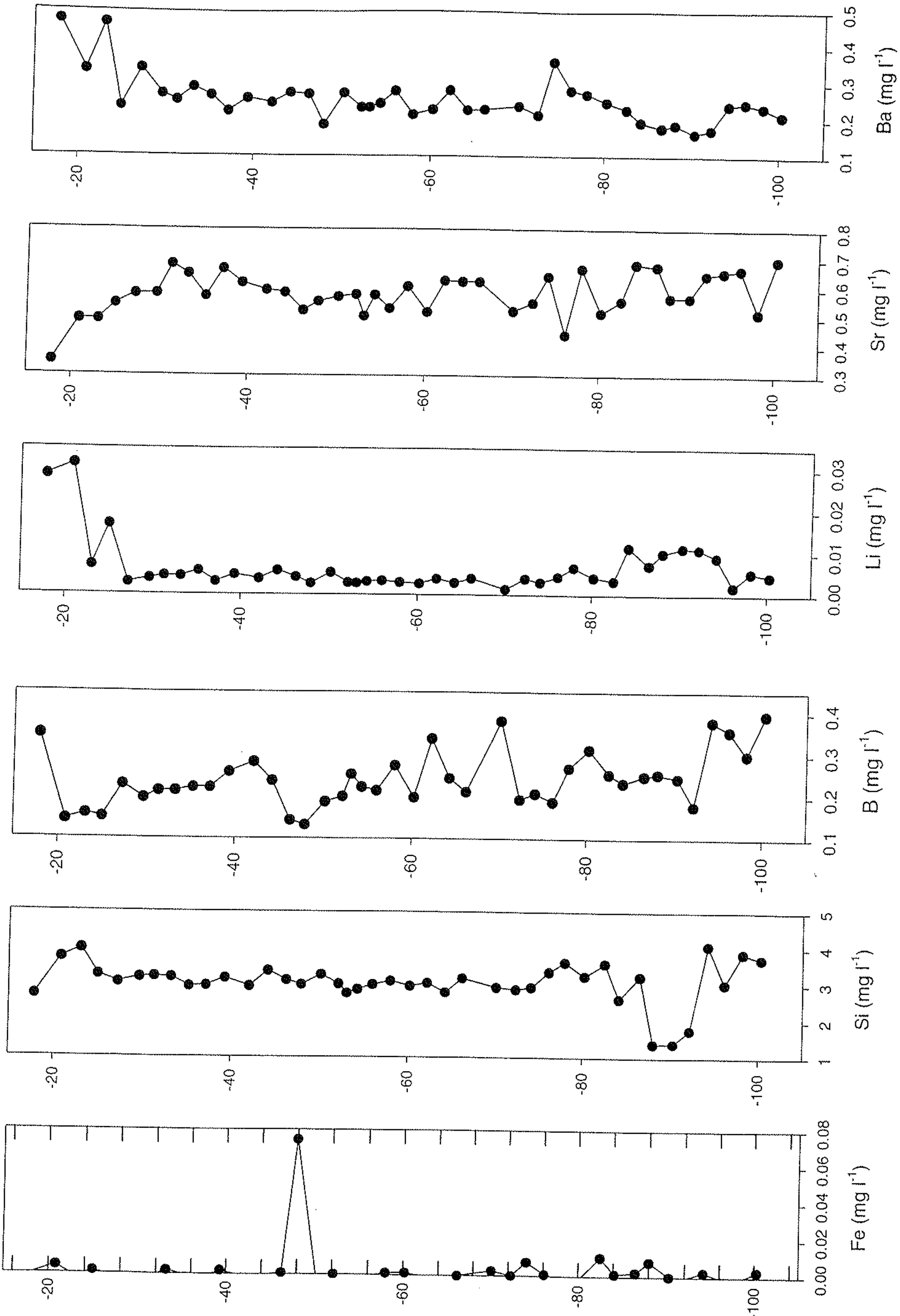


Figure 10c. Pore water chemistry depth profiles.

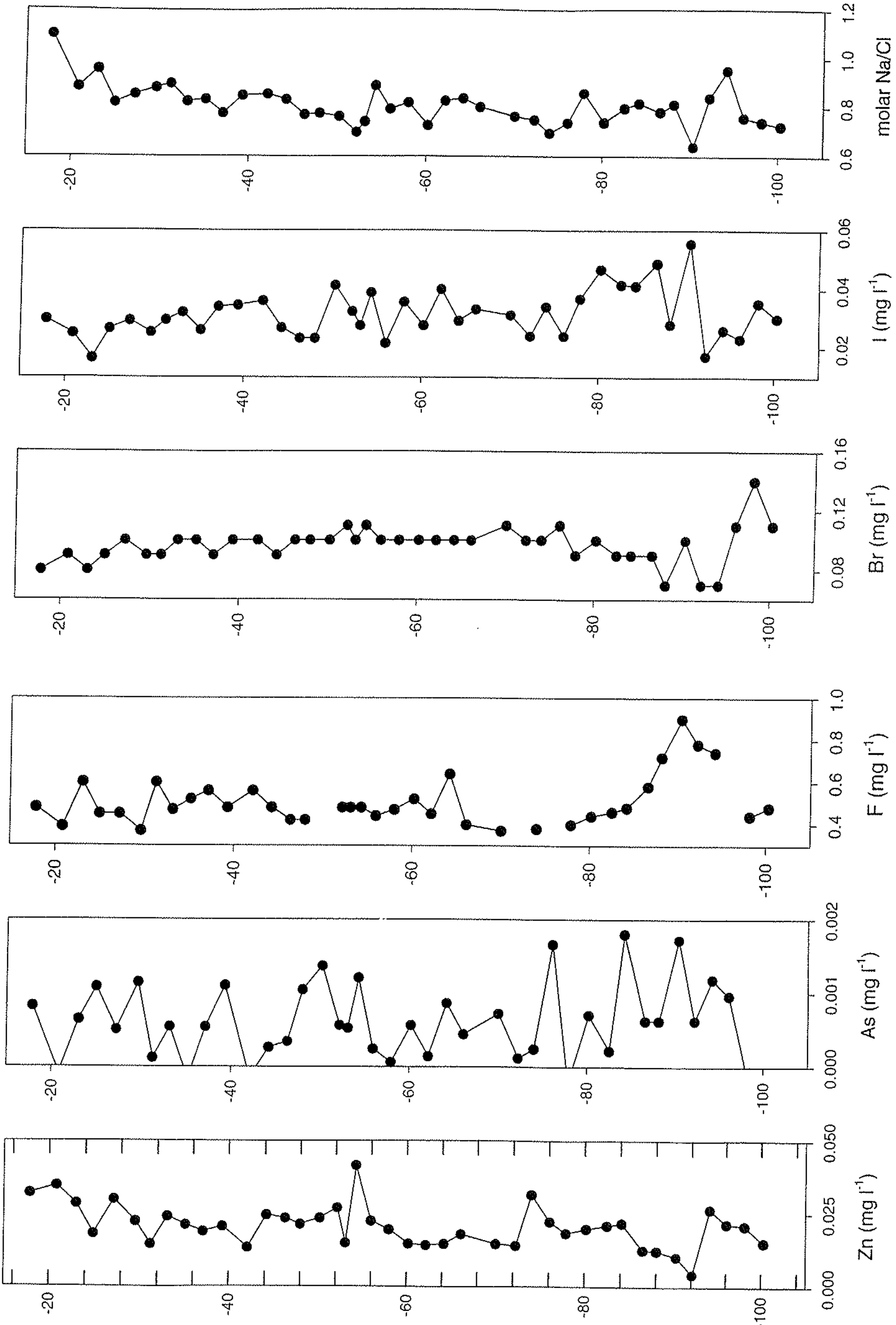


Figure 10d. Pore water chemistry depth profiles.

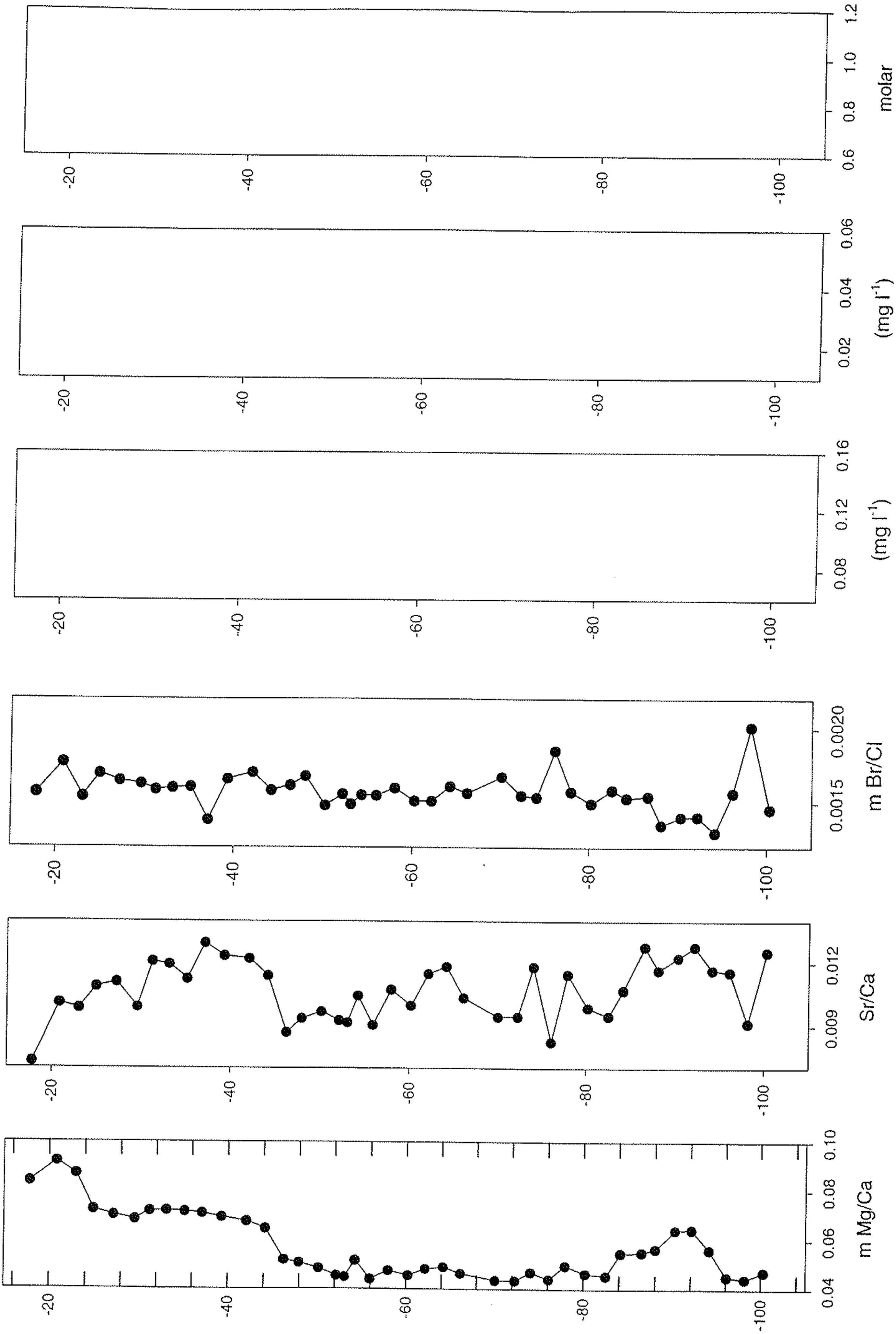
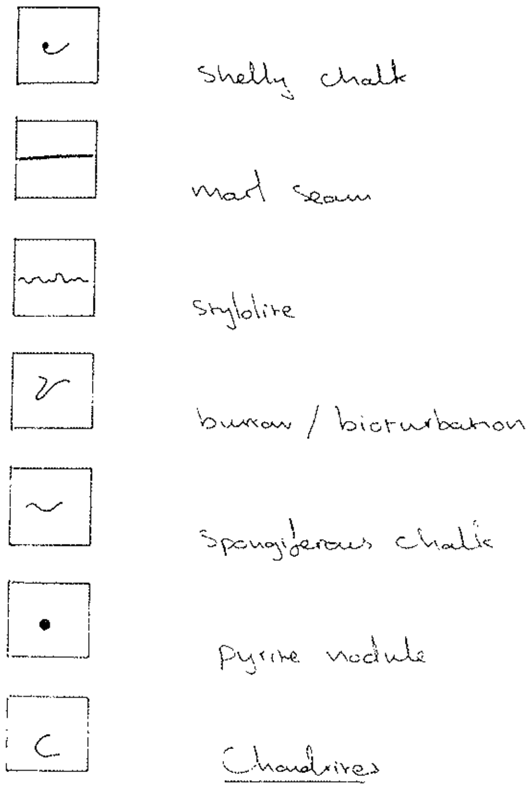


Figure 10e. Pore water chemistry depth profiles.

APPENDIX 1. LITHOLOGICAL LOG WITH KEY.

Key to symbols on lithological log



BRITISH GEOLOGICAL SURVEY

Borehole Wo | Location Carnaby | NGR Lat. & Long. 1505 6486
KB Ground level | Logged by M A Woods

Stratigraphy	Core run no.	Micro-fauna sample	Core sample	Core loss	Depth (m)	Sedimentary structures	Graphic lithology	Lithological description
					17			
17.50	1							rubbly core, blocks of very hard pale creamy-coloured chalk with banded iron-staining in clayey matrix
17.72	2				18			[firm chalk and soft brownish-grey mud / marl]
								[mud & chalk fragments] as above
18.50	3							intensely hard creamy coloured chalk with local pale iron-staining
								rubbly chalk in clayey matrix
18.85	4				19			rubbly chalk (v. hard, creamy coloured) in clayey matrix
19.10	Cased interval							'soft ground' recorded by driller
20.02	open-holed				20			
20.73	5							[firm, creamy-grey chalk]
					21			[3 stylolites seen in lower part of core sample]
								[creamy-grey chalk]
								intensely hard creamy coloured chalk with patchy iron-staining. local shell frags.
								7mm thick medium-dark grey marl
21.58	6							very thin stylolite — very hard creamy coloured chalk with weak iron-staining
								inoc. shell frags
								4mm dark grey marl
								thin stylolite
								2mm dark grey marl
					22			c 4mm medium grey marl
								[creamy-grey chalk with stylolites] — hard creamy chalk with patchy iron-staining
								stylolite
22.63	7							hard creamy spongiferous chalk
					23			[creamy-grey chalk]

Borehole No. | Location: Carnaby | NGR Lat. & Long.
KB Ground level | Logged by: M A Woods

Stratigraphy | Core run no. | Sample | Micro-sample | Core sample | Core loss | Depth (m) | Sedimentary structures | Graphic lithology | Lithological description

23

[Creamy-grey chalk, some orange staining; ?stylolite]
[Creamy-grey chalk, possibly including some thin marl horizons]
stylolites

7

23.72

hard creamy chalk

24
c 5mm medium grey marl
[Creamy-grey chalk]
2mm medium grey marl

8

hard creamy chalk

c 12mm iron-stained, medium-dark grey marl. V. sharply defined margins in core
chalk becoming softer & smoother. occasional iron & ?glauconite staining

24.72

[Creamy-grey chalk]

25
[pale grey, creamy coloured chalk ?burrow visible]
[patchy iron-staining locally conspicuous = ? harder chalks]

closely spaced thin stylolites
[creamy-grey chalk with locally conspicuous stylolites and pale yellow-orange iron-staining]

9

Slightly greyish creamy chalk

up to 15mm dark grey marl. Marl has chalk inclusions
Subhorizontal & oblique stylolites

26
[pale grey, creamy-coloured chalk with thin iron-stained horizons, belemnite collected]

26.31

up to 30mm medium grey iron-stained marl
hard, creamy chalk
8-9mm chalky, pale grey marl
hard creamy chalk with patchy iron-staining

27
[Creamy-grey chalk, patchy yellow-orange staining]

10

5-6mm (locally greater) dark grey marl
[Creamy grey chalk]
7mm chalky, medium grey marl
[creamy grey chalk with stylolite. One end of sample has traces of dark grey marl]
hard, creamy chalk
2-3mm chalky marl

27.71

hard creamy, patchy iron-stained chalk

28
fragments of dark grey marl (c 4mm), but might be more in core sample
[Creamy grey chalk with stylolitic seam; excellent inoceramid at one end of core. Other end of core sample shows traces of 3-4mm dark grey marl & orange-grey marl]

11

10mm dark grey marl (locally 20mm)
10mm dark grey marl
hard, creamy, patchily iron-stained chalk
c 14mm dark grey marl
[Creamy grey chalk with stylolitic seams]

29

BRITISH GEOLOGICAL SURVEY

Borehole W...

Location Carnaby

NGR Lat. & Long.

KB Ground level

Logged by M A Woods

Stratigraphy | Core run no. | Micro-sample | Core sample | Core loss | Depth (m) | Sedimentary structures | Graphic lithology | Lithological description

29

Core run 11

hard, creamy, patchily iron-stained chalk

29.30

8mm dark grey marl

hard creamy, patchily iron-stained chalk

[creamy-grey chalk with regularly developed stylolites]

stylolitic marl concentration

Core run 12

30

[creamy grey chalk with stylolites; ?burrow picked out b[y] darker (?marly) chalk infill]

stylolitic marl concentration

Very hard chalk as above

30.63

Very hard creamy-coloured chalk with patchy iron-staining

31

[creamy-grey chalk with conspicuously developed stylolites — some oblique — . Sponge? picked out by convolute iron-staining]

[creamy-grey chalk with weak orange-yellow iron-staining. A couple of stylolitic horizons present]

Core run 13

[creamy grey chalk with conspicuous stylolites; inc example with conspicuous grey marl lining]

burrows picked out in marly iron-stained chalk

Chalk as above

32

c 5mm medium-dark grey marl

[creamy-grey chalk with patchy orange-yellow iron-staining]

32.11

burrows picked out by iron-stained marly chalk

" " " " " + inoceramid sh[ell] frags

" " " " + inoc shell

[creamy-grey chalk with high angle stylolitic seam crossing closely spaced thin stylolitic hor[izons]]

c 4mm dark grey marl

Core run 14

Chalk as above

33

[creamy-grey chalk with regularly developed stylolitic hor[izons]]

[creamy-grey chalk. No obvious stylolites. Some weak yellow-orange staining]

c 5mm dark grey marl

[creamy-grey chalk]

33.47

burrows picked out by iron-stained marly chalk

stylolitic marl concentration

34

c 5mm medium-dark grey marl

Core run 15

[creamy-grey chalk with stylolite]

Chalk as above

subvertical stylolite

steeply inclined stylolite

c ? marl (perhaps up to 10mm)

lge inoceramid

34.95

[creamy-grey chalk with subhorizontal and subvertical stylolitic horizons]

35

burrows

BRITISH GEOLOGICAL SURVEY

Sheet 4 of 14

Borehole W

Location: Carnaby

NGR Lat. & Long.

KB Ground level

Logged by: M A Woods

Stratigraphy | Core run No. | Core sample | Wide-diameter sample | Core sample | Core loss | Depth (m) | Sedimentary structures | Graphic lithology | Lithological description

35

steeply inclined stylolite

[creamy-grey chalk with stylolites]

hard, creamy, iron-stained chalk

burrows picked out by iron-stained, marly chalk

[creamy-grey chalk]

36

39mm medium grey marl; banded iron-staining, sharply defined margins

patchily iron-stained, spongiferous chalk

16

← traces of grey marl

20mm medium grey marl

hard creamy iron-stained chalk

conspicuous marl-lined stylolite

17mm grey chalky marl

thin wispy marl

37

[creamy-grey chalk with some thin stylolites]

[creamy-grey chalk with weakly developed orange-yellow staining — locally strong — = sponges?]

20mm pale to medium grey marl, locally chalky

chalk as above

spongiferous chalk

37·96 → 38

[creamy-grey chalk with stylolites & some small 4.

← possible marl, but could be stylolitic concentration

chalk as above

6mm dark grey marl

patchy iron-staining (spongiferous chalk). burrows picked out by iron-stained marly chalk

39

[creamy-grey chalk with stylolite]

[creamy-grey chalk with stylolites and some locally developed yellow-orange staining]

[creamy-grey chalk. Some marl? in sample]

17

spongiferous locally

thin marl or stylolitic concentration

chalk as above

stylolite with marl concentration

oblique stylolites

highly fractured core interval (? marly)

40

[creamy-grey chalk with stylolites and [illegible] shell fragments]

oblique stylolite

thin marl (3-4mm) - appears to be on stylolitic surface

6mm dark grey marl

chalk as above

40·89 → 18

41

Borehole W | Location Carnaby | NGR Lat. & Long.
KB/Ground level | Logged by M A Woods
Stratigraphy | Core run no. | Core sample / micro-fauna sample | Core loss | Depth (m) | Sedimentary structures | Graphic lithology | Lithological description

41

5mm medium-dark grey marl
Spongiferous chalk
[creamy-grey chalk with stylolitic horizon] — hard creamy, patchily iron-stained chalk
10-15mm medium grey, well defined marl
Spongiferous chalk
Oblique stylolite
[creamy-grey chalk with stylolites]

42

Some core residue from this sample interval

[creamy-grey chalk] — (chalk as above but a little less hard)
oblique stylolite
30mm dark grey marl

18

5mm medium grey chalky marl — (chalk as above but a little less hard)

43

[creamy-grey chalk with stylolitic horizons & patch orange-yellow iron-staining]
(chalk as above but a little less hard)
20mm medium-dark grey marl
Spongiferous chalk

44.02

44

[creamy-grey chalk with one possible stylolitic horizon, burrows filled with darker (? marly) chalk. Patches of pale yellow-orange iron staining and locally stronger iron-staining defining sponges]
[creamy-grey chalk with stylolites]
burrows picked out by iron-stained marly chalk

45

[creamy-grey chalk with stylolitic seam] — (chalk as above but a little less hard)
30mm dark grey marl

19

moderately hard creamy chalk with weakly developed local iron-staining
?burrows picked out by orange-stained chalk
[creamy-grey chalk with conspicuous closely-spaced stylolites]

46

[pale creamy-grey chalk with conspicuous marl-lined stylolites]
burrows picked out by marly iron-stained chalk
stylolitic marl concentration — chalk as above

47

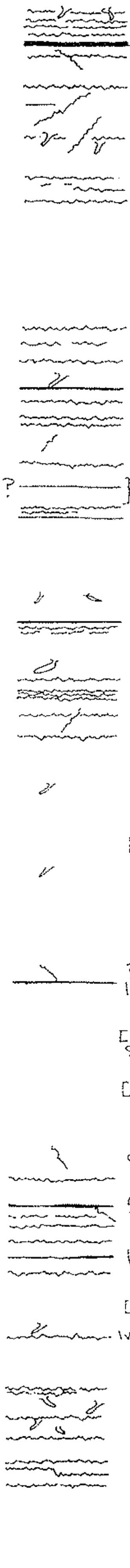
[creamy-grey chalk]

BRITISH GEOLOGICAL SURVEY

Borehole W
Location Carnaby
NGR Lat. & Long.
KB/Ground level
Logged by M A Woods
Stratigraphy

Core run no. | Micro-faunal sample | Core sample | Core loss | Depth (m) | Sedimentary structures | Graphic lithology | Lithological description

47.05 — 47



burrows picked out by marly iron-stained chalk
up to 20mm dark grey marl (thickness possibly affected by shearing)
oblique stylolites

oblique stylolite - Traces of 10mm marl (? sheared)
burrows picked out by pale orange-stained chalk

moderately hard, creamy chalk with weakly developed patchy iron-staining

[pale creamy-grey chalk. Weak orange-yellow iron-staining. Stylolite]

48

[creamy-grey chalk with conspicuous stylolites]

burrow picked out by weakly iron-stained chalk
up to 15mm marl (thickness possibly affected by shearing)

20

oblique stylolite
Chalk as above

? fractured core interval (?containing marl)

49

2mm marl sharply defined; does not appear to be stylolitic concentration

[creamy-grey chalk. Irregular patches of buffish yellow-orange stained chalk (? Fe stained & ? phosphatised) - possibly burrow fill]

burrows picked out by weak orange-staining in core

marl, 10-20 mm

burrows picked out by weak orange-staining
Chalk as above
oblique stylolite

50.05 — 50

burrows picked out by iron-staining

[creamy-grey chalk with thin stylolites and patchy orange-yellow staining]

Chalk as above, but rather featureless - few stylolites

?oblique, marl filled stylolite
10 mm dark grey marl

51

[creamy grey chalk with conspicuous sub-vertical stylolite running along sample length]

[creamy-grey chalk with conspicuous stylolites. Sponge? picked out by pale yellow-orange iron-staining]

21

Chalk as above

oblique stylolite

5mm marl (intersected by stylolitic plane)

locally 5mm marl

52

[creamy-grey chalk with stylolites]
iron-stained chalk infilling ? burrow

burrows picked out by marly chalk infill

Chalk as above

[creamy-grey chalk with stylolites]

53

Borehole Wo | Location Carnaby | NGR Lat & Long
KB Ground level | Logged by M A Woods
Stratigraphy | Core run no. | Micro-faunal sample | Core sample | Core loss | Depth (m) | Sedimentary structures | Graphic lithology | Lithological description

53.02 — 53

[creamy-grey chalk with marl-lined stylolites] Chalk as above

burrows picked out by iron-stained marly chalk

8mm dark grey marl Chalk as above

54

[creamy-grey chalk with stylolites]

22

Chalk as above

35mm medium grey marl seam (locally 50mm but may be due to distortion of seam in drilling) (average marl thickness possibly closer to 40mm)

55

25mm marl in this interval

[creamy-grey chalk with stylolite. Sample includes 25mm grey marl]

} fractured core (? contains 20mm marl)

oblique stylolite Chalk as above

55.86

56

[creamy-grey chalk with conspicuous oblique stylolites]

burrow-like structure picked out by iron-stained chalk

} fractured core with marl fragments suggesting presence of seam around 5-10mm thick

c. 10mm dark grey marl Chalk as above

57

[creamy-grey chalk]

23

[creamy-grey chalk with stylolites & inoc shell frag.]

burrows picked out by iron-stained chalk & iron-stained marly chalk

10-20mm dark grey marl (distorted in drilling?)

burrow picked out by iron-stained marly chalk

Chalk as above

4mm dark grey marl

8mm dark grey marl

oblique stylolite

58

[creamy-grey chalk with thin irregular stylolites]

12mm dark grey marl Chalk as above

?spongiferous

58.82

24

59

[creamy-grey chalk with stylolites and many localised patches (elongated & rounded) of pale orange iron-staining (=? bioturbation or sponges)]

Borehole W

Location Carnaby

NGR Lat. & Long.

KB/Ground level

Logged by M A Wood

Stratigraphy | Core run no. | Micro-faunal sample | Core sample | Core loss | Depth (m) | Sedimentary structures | Graphic lithology | Lithological description

59

[creamy-grey chalk with concentration of conspicuous stylolites. Irregular patches of orange-yellow staining common – : could be sponge bed – some marl shd]

conspicuous marl filled (up to 1mm) stylolite

chalk as above

up to 10mm rusty-grey marl

marl-lined stylolite

burrows picked out by iron-stained chalk & marly iron-stained chalk

60

[creamy-grey chalk with patches of pale yellow-orange staining (=? bioturbation or sponges?)]

24

chalk as above

v. weakly developed stylolites

2mm medium-dark grey marl seam

2mm marl passing laterally into stylolite

2mm marl — local 1mm marl

burrow picked out by marlier chalk

10–20mm dark grey marl

[creamy-grey chalk with conspicuous stylolites. Blebs of pale orange staining (=? bioturbation or sponges)]

61

burrows picked out by iron-stained chalk

burrows picked out by iron-stained chalk

oblique stylolite

chalk as above

61·83

traces of grey marl (unknown thickness)

62

[creamy-grey chalk with conspicuous subhorizontal and oblique stylolites. Local weak orange-yellow iron-staining]

[creamy-grey chalk with conspicuous stylolites and locally conspicuous iron-staining]

10mm dark grey marl

oblique stylolite

fractured core

chalk as above

5mm marl lining oblique surface (c.45° in core)

marl-lined stylolite

63

2–3mm marl

[creamy-grey chalk with thin stylolitic horizons and weak, patchily developed pale yellow-orange staining]

25

[creamy-grey chalk with weakly developed pale yellow-orange iron-staining]

v. weak stylolites

burrow picked out by iron-stained chalk

chalk as above

strong stylolite

64

2mm marl on stylolitic surface

up to 10mm dark grey marl overlying stylolitic surface

[creamy-grey chalk with thin stylolites. Small patches of weak yellow-orange iron-staining]

burrow picked out by greenish-grey marly chalk

10mm marl

chalk as above

64·76

26

weak stylolite

65

Borehole W

Location Carnaby

NGR Lat. & Long.

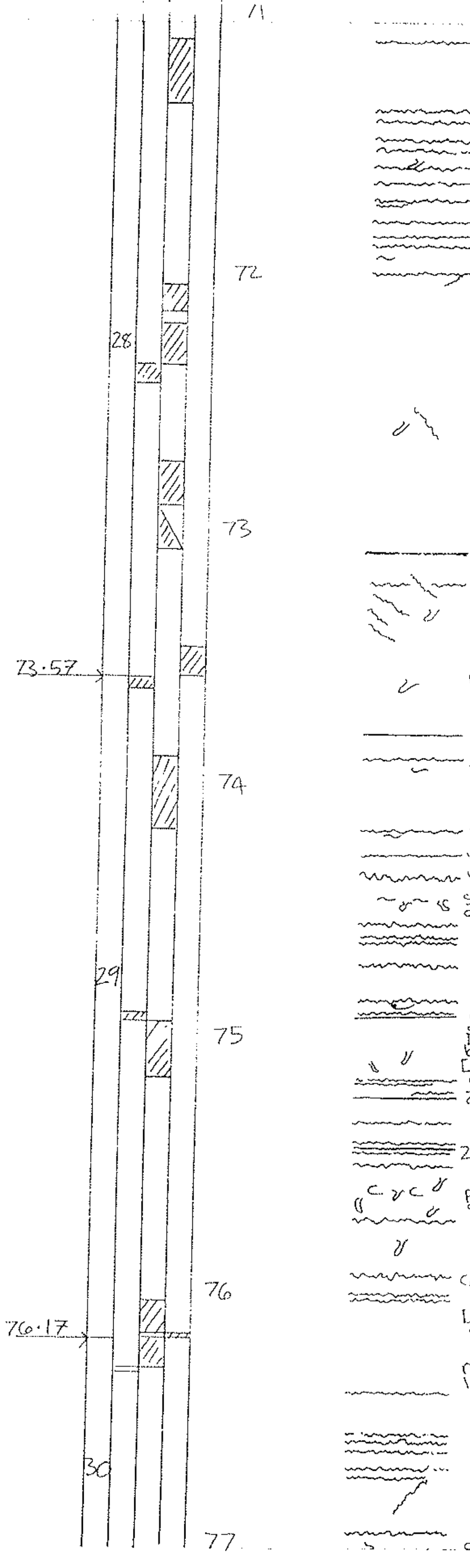
KB Ground level

Logged by [illegible]

Stratigraphy | Core run no. | Micro-fauna sample | Core sample | Core loss | Depth (m) | Sedimentary structures | Graphic lithology | Lithological description

- 65 m: [creamy-grey chalk with thin stylolitic horizon]
- burrow picked out by iron-stained chalk
- chalk as above
- traces of grey marl of unknown thickness
- up to 5mm dark grey marl
- burrows picked out by iron-stained chalk
- 66 m: [creamy-grey chalk]
- Core run 26
- 6mm medium grey marl
- [creamy-grey chalk with conspicuous stylolitic seams]
- 67 m: [creamy-grey chalk]
- chalk as above
- spongiferous?
- burrow picked out by greenish marly chalk
- } conspicuous pair of stylolites
- oblique stylolite
- 67.72
- 5mm medium grey marl
- 68 m: [creamy-grey chalk with a couple of stylolitic seams and fragments of grey marl at one end]
- [creamy-grey chalk with common closely spaced stylolites some conspicuous & marl-lined]
- 1mm medium-dark grey marl
- burrow picked out by iron-stained chalk
- chalk as above
- conspicuous marl lined (2mm) stylolite
- oblique stylolites
- Core run 27
- 69 m: burrow picked out by iron-stained marly chalk
- 2mm medium grey marl
- [creamy-grey chalk with stylolitic surface at one end]
- [creamy-grey chalk with stylolites & ? burrow picked out by orangish-grey chalk. Some weakly developed patchy iron-staining]
- burrow picked out by iron-stained chalk
- chalk as above
- 70 m: [creamy-grey chalk with weakly developed patches of orange-yellow staining]
- [creamy-grey chalk with conspicuous stylolites]
- } highly fractured core
- conspicuous marl-lined stylolite
- 70.58
- Core run 28
- Very hard creamy coloured, locally weakly iron stained chalk. Tougher than above.
- oblique stylolite
- } conspicuous stylolites. Central one has thick marl fill (c 3 m…
- 71 m

Borehole No: | Location: Carnaby | NGR Lat. & Long.
KB Ground level | Logged by: M A Woods
Stratigraphy | Core run no | Sample | Micro-fauna | Core sample | Core loss | Depth (m) | Sedimentary structures | Graphic lithology | Lithological description



[creamy-grey chalk with stylolites]
[creamy-grey chalk with thin stylolites and weak patchy iron-staining]
conspicuous marl-lined stylolite
spongiferous chalk
several mm of dark grey marl on stylolite, burrow picked out by iron-stained chalk
marl-lined stylolite
conspicuous stylolite
weak stylolite — hard, patchily iron-stained, creamy-coloured chalk
?spongiferous
[creamy-grey chalk with stylolites]
[creamy-grey chalk with thin subhorizontal and subvertical stylolites. Weak, locally developed iron-staining]
burrow picked out by iron-stained chalk
[very fractured core
[creamy-grey chalk with closely spaced stylolitic horizons in part of sample]
[creamy-grey chalk]
up to 5mm of dark grey marl
chalk as above
burrow picked out by iron-stained chalk
burrow picked out by marly iron-stained chalk
7mm dark grey marl
? spongiferous [creamy-grey chalk. Conspicuous stylolite. patchy iron-staining]
?spongiferous — chalk as above
v. weak stylolite
v strong stylolite
spongiferous, iron-stained chalk — very hard. burrows also picked out by iron-stained chalk
marl-lined sfc. (up to 5mm thick) — possibly a marl squeezed during drilling process; bounding surfaces are not stylolitic
[creamy-grey chalk]
burrows picked out by iron-stained, marly chalk
[some conspicuous sub-horizontal & sub-vertical marl-lined stylolites]
Concentration of weakly developed stylolites
2mm marl
2mm marl on irregular (?stylolitic) surface ← downward change to slightly greyer marly chalk. More bioturbated
Patches of *Chondrites* bioturbation. burrows picked out by dark marly chalk. Larger burrows with iron-stained, marly chalk infill
gradational downward change to paler chalk, with less conspicuous bioturbation
conspicuous stylolitic surface (locally with ±5mm grey marl)
[creamy-grey chalk. Conspicuous stylolites. Iron-stained spongiferous chalk]
return to pale creamy coloured chalk. hard with weak patchy iron-staining
oblique marl-filled stylolite (very conspicuous)

BRITISH GEOLOGICAL SURVEY

Borehole Wi | Location | NGR Lat. & Long.

KB Ground level | Logged by M A Woods

Stratigraphy | Core run no. | Sample | Micro-faunal | Core sample | Core loss | Depth (m) | Sedimentary structures | Graphic lithology | Lithological description

77

[creamy grey chalk with conspicuous subvertical stylolite]
marl on stylolitic surface
[creamy-grey chalk with thin stylolitic horizon]
chalk much smoother textured
10 mm medium grey marl
1mm marl
} marl-lined stylolites
hard creamy chalk with weak locally developed patches of Iron-staining
?spongiferous

30 — 78

[creamy-grey chalk with thin stylolitic horizons — diffuse patchy pale yellow-orange staining]

chalk as above

← v. conspicuous stylolite
4mm grey marl on stylolitic surface

78.89

79

chalk as above

weak stylolite
[creamy-grey chalk with subhorizontal & oblique stylolitic seams]
[creamy-grey chalk with marl-filled stylolite at one end]
conspicuous stylolite
Inoc. shell bed

80

chalk as above
[creamy-grey chalk, stylolite, burrow infilled with oranged-grey marly chalk? shell material ?Inoc.]

3mm marl
← spongiferous
?spongiferous

31

} highly fractured core interval with marl fragments; up to 3 stylolites with several mm of marl fill
1-2mm marl

81

Slightly oblique stylolite with up to 3mm of marl
[creamy grey chalk with thin stylolitic seams — some locally developed weak iron-staining]
[creamy-grey chalk bounded by stylolitic surfaces]
Stylolitic surface with up to 4mm of marl (locally 9mm)

81.71

chalk as above

82

? spongiferous
10mm marl
2mm marl } separated by stylolite
2mm marl

32

[creamy grey chalk with locally closely spaced thin stylolitic horizons. Patchy, diffuse weak orange staining]
1-2mm marl on stylolitic surface

chalk as above

? spongiferous

83

[creamy-grey chalk]

Borehole W | Location | NGR Lat. & Long.
KB Ground level | Logged by M A Woods
Stratigraphy | Core run no. | Micro-faunal sample | Core sample | Core loss | Depth (m) | Sedimentary structures | Graphic lithology | Lithological description

83

Sample includes 5mm marl

[Creamy grey chalk with conspicuous marl-lined s...
Sample includes 8mm dark grey marl sandwiched between stylolites. Marl locally pyritic
hard, creamy-grey chalk. Common bioturbation and lo... patches of iron-staining
12mm dark grey marl

burrows picked out by darker, marly chalk & iron-stained (
1mm marl on slightly irregular surface
5mm marl
4mm marl
1-2mm marl
32
burrows picked out by darker marly chalk infills
irregular boundary of colour contrast to slightly darker, marlier chalk below

84

[rather grey chalk. Stylolitic horizons and 1-7mm dark grey marl
2mm marl } get one end: fragments of 11mm marl at other e...
5mm marl } laterally cut out on stylolitic surface
3mm marl (overlain by marl c. 0.5mm thick with wavy habit and locally passing into stylolitic surface)
3mm marl

84.59

burrows picked out by marly chalk infills.
V. thick Inoc. shell frag.
chalk as above

85

[very pale grey, bioturbated chalk. Conspicuous marl-fill... stylolite & 2mm marl seam]
4mm dark grey marl
chalk as above
1mm marl on stylolitic surface
stylolitic surface with 1mm marl

86

33
Calcite veining in chalk [rather grey chalk with oblique stylolites against which abut a network of calcite infilled veins]
oblique marl-lined stylolite
10mm marl seam with chalky inclusions
squashed marl, varies from 1mm-10mm
[very pale grey-creamish chalk with slightly darker grey v... chalk infilling burrows. Some locally developed orange staining (= sponges)]
Common bioturbation picked out by marly chalk infills
chalk as above

87

lge Inoc. shell sheet
[very pale grey chalk with conspicuous bioturbation picked out by darker marly chalk infill; thin stylolitic ho...

15mm dark grey marl

87.48

1mm marl. Pyrite nodule beneath
1mm marl
chalk as above
2mm marl
2mm marl
1-2mm marl
2mm marl; pyritic burrow infill

88

[very pale grey chalk with very closely spaced, irregularly developed stylolites]

34
pyritic burrow infill
Common weakly developed stylolites
3 - highly fragmented core interval with 5mm marl at base
2mm marl, becomes stylolitic
1mm marl, stylolitic
chalk as above

89

BRITISH GEOLOGICAL SURVEY

Borehole W

Location

NGR Lat. & Long.

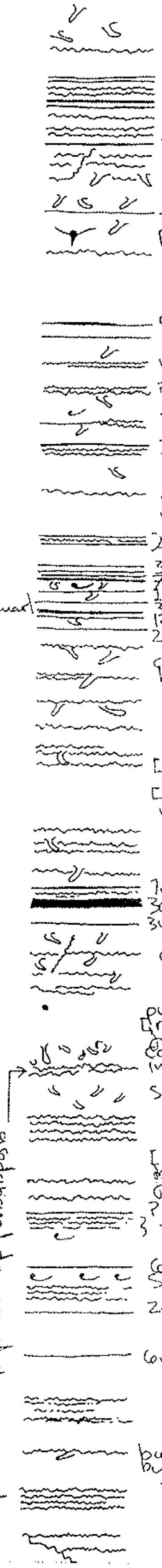
KB Ground level

Logged by M. A Woods

Stratigraphy | Core run no. | Sample micro-faunal | Core sample | Core loss | Depth (m) | Sedimentary structures | Graphic lithology | Lithological description

Depth 89

Core run 34



- pyritic burrow infill
- marl-lined stylolite
- two closely spaced 2mm marls
- up to 15mm dark grey marl closely underlain by 4mm marl
- 2mm dark grey marl

Chalk as above

Depth 90

- 2mm marl
- pyritic nodule & ? burrow infills

Sample 90.14

[very pale grey chalk with oblique and subhorizontal stylolites. ?Bioclastic areas]
[very pale grey chalk with thin stylolites]

- 5mm dark grey marl
- 2mm " " "
- weak stylolites
- ?spongiferous (pyritic preservation)
- 1mm marl passing laterally into closely spaced stylolites
- 2mm marl

Chalk as above

Depth 91

[very pale grey chalk with locally common stylolites. 1-? marl present at one end of sample. Some ?bioclastic shell & bioturbation picked out by darker grey marly chalk burrow infills]

- 2 closely spaced 1mm thick marls, separated by stylolites

[very pale grey chalk, thin stylolites & 1mm marl seam]

- 3 closely spaced marls less than 1mm thick
- 7mm marl — laterally splits into 2mm & 5mm seams
- 12mm marl
- 1mm marl
- 3mm marl
- 1mm marl
- 2mm marl

Core run 35

- conspicuous bioturbation picked out by darker, marly chalk burrow infills

Chalk as above

Depth 92

[very pale grey chalk with stylolites and bioturbation picked out by marly chalk burrow infills]
[pale grey chalk with common stylolites. Conspicuous marl-lined stylolite at one end of sample]

- 1mm marl
- 30mm marl — thin marl stringers and stylolites above marl
- 3mm marl
- common bioturbation

Depth 93

- pyrite crystals

Sample 93.07

[return to pale creamy-grey chalk with thin stylolites. Large fragment of inoceramid shell in core]

- conspicuous burrows picked out by darker marly chalk infill includes *Chondrites*
- small burrows picked out by darker, marly chalk infills

[paler, creamy grey chalk with common stylolites. Bioturbation picked out by darker grey marl infills. Bioclastic fragments]

- ? thin marl
- concentration of very weakly developed stylolites

gradational downward change to paler chalk with less bioturbation

Depth 94

Core run 36

- 6-7mm medium-dark grey marl
- shell concentration
- 2mm marl
- much less conspicuously bioturbated

[pale creamy-grey, rather orange-yellow coloured chalk with thin stylolites]

- 6mm marl
- burrow picked out by iron-stained chalk

hard creamy chalk, less marly than seen above. Patchy iron-staining, some defining bioturbation.

Depth 95

BGS 1835

BRITISH GEOLOGICAL SURVEY

Borehole/Well | Location | NGR Lat. & Long.
KB/Ground level | Logged by M A Woods
Stratigraphy | Core run no. | Micro-fauna sample | Core sample | Core loss | Depth (m) | Sedimentary structures | Graphic lithology | Lithological description

95
- marl (15-25mm)
- 7mm marl
- [pale creamy-grey orangish-yellow coloured chalk with thin stylolites; inoc. shell frags; patchy iron-st
- 7mm marl plexus
- Chalk as above
- 36
- 7mm marl on stylolitic surface
- 1mm marl
- 4mm marl
- burrow picked out by iron-stained marly chalk
- 2mm marl

95.98

96
- [pale creamy-grey chalk with slight pale orange-yellow tinge; conspicuous marl-lined stylolites; shell frags]
- Chalk as above
- 1mm marl
- 3mm marl

97
- 1mm marl (x2)
- [pale creamy-grey chalk with common stylolites]
- 37
- [creamy-grey chalk with conspicuous stylolites and weakly defined bioturbation]
- Very common weakly developed stylolites
- 1mm marl
- Chalk as above
- Very common weakly developed stylolites

98
- [creamy-grey chalk with thin stylolites, traces of dark grey marl seam at one end of sample]
- 2-3mm marl
- 1mm marl
- [creamy-grey chalk with common sub-horizontal and oblique stylolites]
- 4mm marl
- Very common weakly developed stylolites

98.65
- Very common weakly developed stylolites
- 1mm marl

99
- [creamy-grey chalk with pale yellow-orange tinge, several stylolitic seams]
- bioturbation picked out by iron-stained marly chalk burrow infills
- " " " "
- 12mm marl
- 38
- 2mm marl

100
- [creamy-grey chalk with thin stylolitic seam and bioclastic fragments]
- rubbly core interval
- [creamy grey yellow-tinged chalk with conspicuous stylolites and local accumulation of inoc. shell frags]

100.64
- ← Total Depth

101

APPENDIX 2. HYDROGEOLOGICAL LOG.

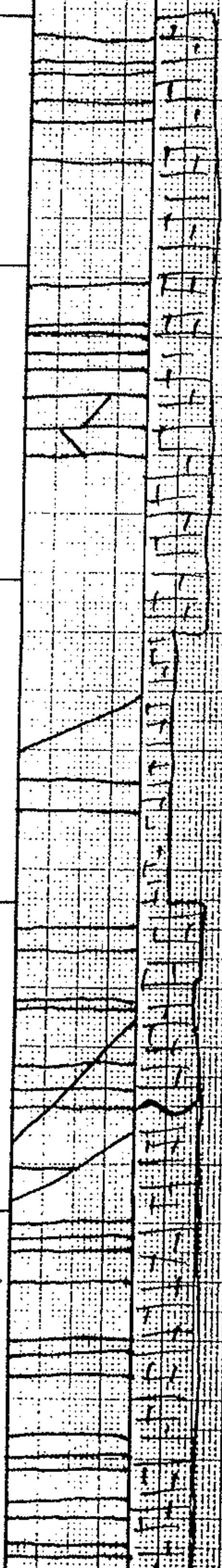
Log – J. V. Beaufort(?) 7-1-77 – 10-1-77

BGS

SAMPLE	DEPTH	DATE & TIME	CORE REC.	FRACTURE	GRAPHIC LOG	COLOUR	DESCRIPTIVE LOG	COMMENTS
	14.00m – 17.50m (15.00m, 16.00m, 17.00m)						No core in interval 0 to 17.50m	No Core
	17.50m – 17.72m						17.50m – 19.78m	Core Run #1
C1; [redacted] 17.87 – 17.90m	17.72m – 18.60m (18.00m)					Ochre	Coombe deposits. Chalk rubble in ochre coloured putty chalk. Fragments are up to ca. 10cm in dia. and highly rounded.	Core Run #2
	18.60m – 18.85m							Core Run #3
	18.85m – 19.78m (19.00m)							Core Run #4
	19.78m – 20.00m						No core in interval 19.78 to 20.73m	No Core

Log – I.J.K. Bloomfield 7.1.97 – 10.1.97 BOREHOLE

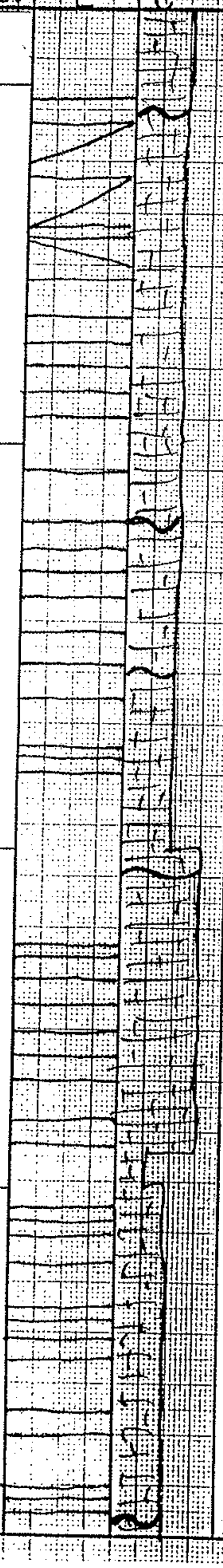
BGS



SAMPLE	DEPTH	DATE & TIME	CORE REC.	FRACTURE	GRAPHIC LOG	COLOUR	DESCRIPTIVE LOG	COMMENTS
	20.00m	No core.					No core in interval 19.78 to 20.73m	No core
C2 20.90–21.10m	20.73m					Grey	20.73m – 21.58m Hard grey white chalk with stylolites passing into pervasively fractured chalk at base of run.	Core Run #4(2)
C3	21.58m					Grey	21.58m – 22.63m Hard chalk with stylolitic partings. Thin marl at 22.00m. Two intervals containing pea-like chalk gravels and chalk frags. with light orange staining at 21.78 – 21.87 m and 21.92 to 22.00m. Ltd MnO spotting on fracts.	Core Run #6
C3	22.63m						22.63 – 23.72m Highly fract. chalk, chalk rubble passing into blocky fract. chalk at base. End of run defined by an orange stained sty. surface. MnO spotting and ltd orange staining on fract. surfaces.	Core Run #7
	23.72m					Grey.	23.72 – 24.77m Hard highly fract. grey chalk with stylolites and a 2cm wide heavily oxidised marl (deep orange) at 24.29–24.31m. Thin marls at 24.00 and 24.14m. Fracts with ltd MnO spotting and light orange staining.	Core Run #8
C4	24.77					Grey white	24.77 – 26.31m Hard relatively massive chalk with stylolites and a marl at 25.75m. Ltd fracts. Bound rubble filled intervals ca 4–6cm wide. Bounding fract. surfaces may be sty. all are sub-horiz. and orange stained. Ltd MnO spotting on fracts.	Core Run #9

Log - J.P. Bloomfield 7.1.97 - 10.1.97

BGS



SAMPLE	DEPTH	DATE & TIME	CORE REC.	FRACTURE	GRAPHIC LOG	COLOUR	DESCRIPTIVE LOG	COMMENTS
PP6	26.00m – 26.31m							Core Run #9 cont.
C5, PP7	26.31m – 27.71m					Grey white	**26.31 – 27.71 m** Hard rel. massive grey white chalk with occasional stylolites and small marls. A 2cm thick marl at 26.38 – 26.40m. Hztl sub v. fracts. and a no. of pairs of sub. hztl fract. surfaces bonding zones of brecciated chalk often containing thin marls and stain. Fracts. with Fe/Mn spotting and pale orange stain. Thick marl at 26.38 – 26.40m acts to confine watertable ??	Core Run #10
PP8, PP9	27.71m – 29.30m					Grey white	**27.71 – 29.30 m** Hard grey white chalk with numerous sty. and marls. Hztl fract. predominantly sub-hztl. partings along stylolites. Interval 28.30m – 28.45m highly fract. chalk breccia with marls. 1cm thick marls at 28.62 – 28.63 and m... sty. surface at this horizon heavily orange stained. Bright orange stain on all sub. hztl. fracts.	Core Run #11
C6, PP10	29.30m – 30.63m					Grey	**29.30 – 30.63 m** Very hard grey chalk with numerous sty. and marls. Sparse sub hztl. fracts. are partings on sty. with heavy orange stain. 1cm wide marl at 29.37 to 29.38m. Chalk between 30.45 and 30.60m becomes rel. soft and fissile. This lower section is heavily orange stained.	Core Run #12
PP11, C7, PP12	30.63m – 32.00m					Grey	**30.63 – 32.11 m** Hard grey chalk with sty. and thin marl seams. This section is relatively fractured with a breccia zone between 31.30 – 31.50m. Sub vert. and hztl. sty. 1cm thick ochre and orange marl at 31.93 – 31.94m.	Core Run #13

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SAMPLE	DEPTH	DATE & TIME	CORE REC.	FRACTURE	GRAPHIC LOG	COLOUR	DESCRIPTIVE LOG	COMMENTS
	32.00 m							Core Run #13 cont.
PP13, PP14, C8	32.11 m – 33.47 m					Grey White	32.11 – 33.47 m Hard white chalk with numerous marl seams and stylolites. Interval 32.11 to 32.42 m is highly fractured. Fracts with MnO spotting. Sub. hztl. fracts. on sty. partings orange stained. 1 cm thick marls at 32.68–32.69 m and 33.24 m to 33.25 m. Breccia between fracts. at 32.69 to 32.80 m.	Core Run #14
PP15, PP16	33.47 m – 34.95 m						33.47 m – 34.96 m Hard grey white chalk with numerous sty. and thin marl bands. Many sub. hzt. sty. partings with heavy orange staining. Hdns. of sub. v. sty. bands. 1 cm thick marl at 33.90 – 33.91 m.	Core Run #15
C9, PP17, PP18, C10	34.95 m – 37.96 m					Grey White	34.95 m – 37.96 m Massive hard grey white chalk with numerous sub. hztl. and few vert. stylolites and thin marl seams. Hdl fract. along sty. partings and as pairs of fracts. Locally ca 5 cm zones containing chalk rubble. Pervasive MnO spotting and Hdl orange staining on fract. surfaces. Many of sub. vert. stylolites contain extensive MnO min. 4 cm thick marls at 36.01 to 36.05 m, 36.51 to 36.55 m, 36.68 to 36.72 m and at 37.84 to 37.88 m Note Hdl degree of fract. in this section compared to chalk above and below.	Core Run #16
	38.00 m							

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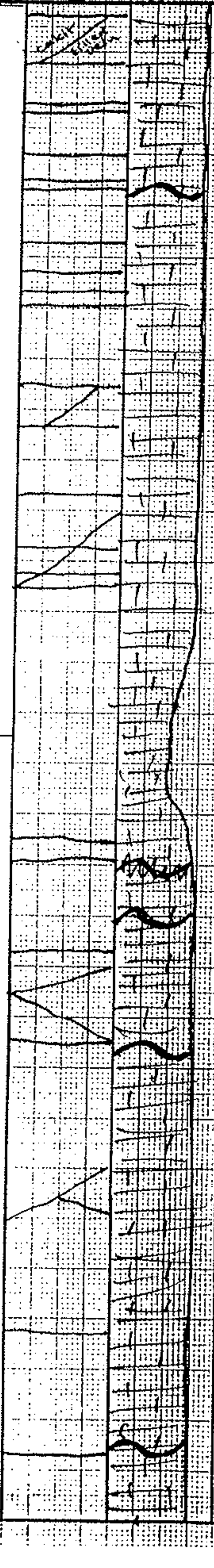
SAMPLE	DEPTH	DATE & TIME	CORE REC.	FRACTURE	GRAPHIC LOG	COLOUR	DESCRIPTIVE LOG	COMMENTS
PP19, PP20, C11, PP21	38.00, 40.00					Grey White	37.96 – 40.89m Hard grey white chalk. Rel. massive with ltd fract. as partings on sub. hztl. stylolites. Sty. common with few thin marls. Closed/tight sub.vert. fracts. heavily stain with MnO spks. Sub.v. calcite filled vein 38.05 to 38.28m. All fract. and sty. orange stained and heavily stain. with MnO. 1cm wide marl at 38.76–38.77m. Pairs of sub. hztl. sty. partings bound zones of chalk rubble at 38.40–38.45m, 38.70–38.77m, 39.15–39.20 and 39.73 to 39.95m. Core becomes highly fract. and brecciated towards base of run (below 40.30m)	Core Run #17
PP22, C12, PP23, C12, PP24, PP25	40.89m, 41, 42.00, 43, 46.00					Grey white	40.89 – 44.02m Chalk rubble at top of core run, 40.89m to 41.15m, passing rapidly into massive sparsely fract. stylolitic chalk with marls. All fracts. in interval are partings along sub. hztl – vert stylolites fract. surfaces with orange stain and clays. 4cm thick marls at 41.56 – 41.60m and 42.13 to 42.17m (43.60–43.70m) with a weld dev. flaser marl complex at 42.52m	Core Run #18



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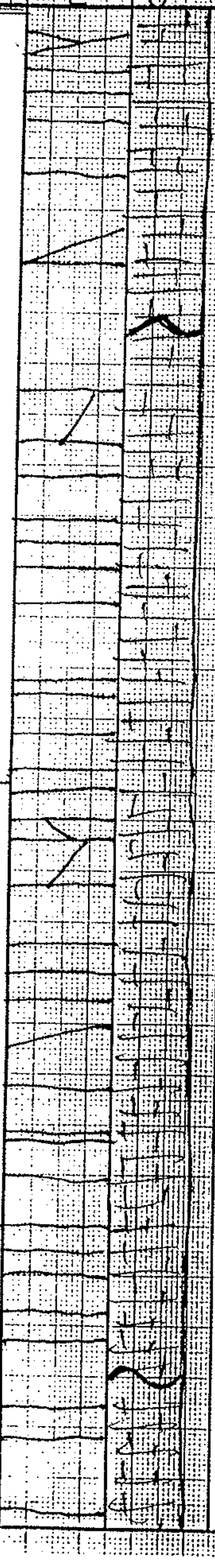
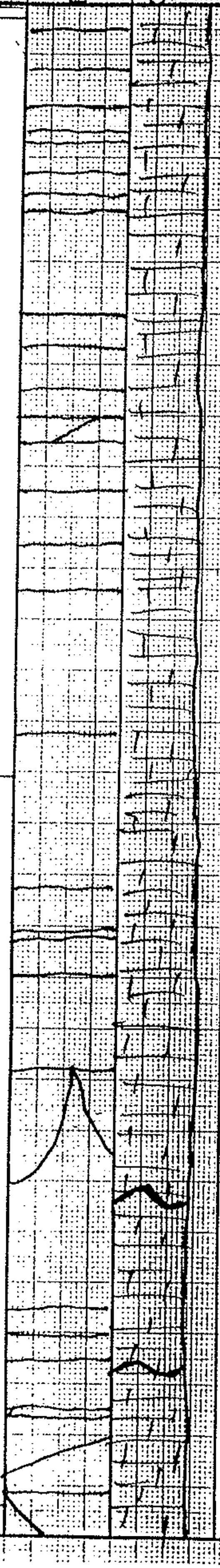
SAMPLE	DEPTH	DATE & TIME	CORE REC.	FRACTURE	GRAPHIC LOG	COLOUR	DESCRIPTIVE LOG	COMMENTS
	44.02m							
PP25, C3						Grey white	**44.02–47.05m** Massive hard grey white sparsely fract. chalk with numerous stylolites and a 7cm thick marl at 45.20 – 45.27m. All fract. surfaces are partings on sty. Fracts are orange stained with MnO min.	Core Run #19
PP26	45							
PP27, C4	46.00m					White		
PP28	47.05m							
						White	**47.05 – 50.05m** massive sparsly fractured white chalk with stylolites and marl bands. Fracts. predominated by partings on sty. Fracts heavily stained orange, MnO spotted and with clays. 2cm wide marl band at 49.40 to 49.42m. Three thin marls at 48.96, 49.00 and 49.5m	Core Run #20
PP29, C5	48.00m							
PP30	49							
	50.00m							



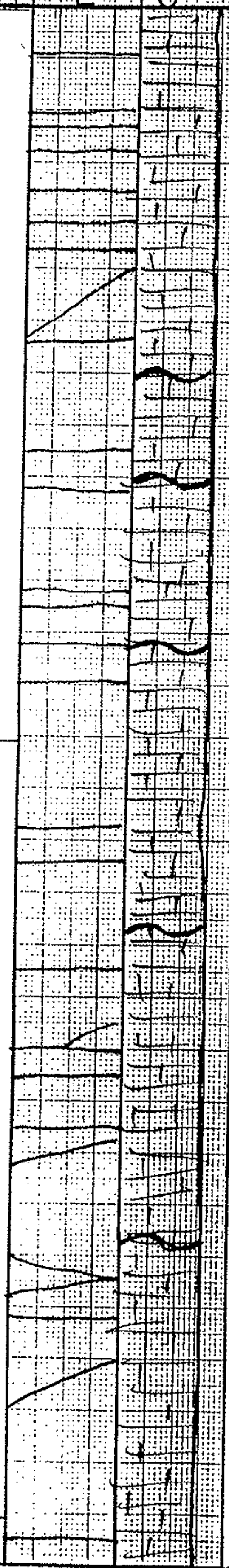
Log. S. P. Bloomfield 7.1.97 - 10.1.97 BOREHOLE **BGS**

SAMPLE	DEPTH	DATE & TIME	CORE REC.	FRACTURE / GRAPHIC LOG	COLOUR	DESCRIPTIVE LOG	COMMENTS
PP31, C16	50.05m					**50.05 - 53.02m** Massive fractured grey white chalk with sty. partings and marls fracts. heavily orange stained with MnO spots and thin clay fills on sty. partings. Thin marls at 50.86m 51.20m, 51.50m and 51.66m. No thick marls in section. Chalk rubble in zone 51.74 to 51.85m	Core Run #21
PP32	51				Grey White		
PP33, C17	52.00						
PP34	53.02m						
						53.02-55.86 Hard massive grey white chalk with numerous stylolites and marl seams. Ecm thick marl at 54.66-54.70m and 2cm thick marl at 55.36-55.38m Zone of brecciated chalk assoc. with thin marls and styl. at 53.62-53.80m Ltd MnO spotting on sub. v. fract at 54.38-54.65m	Core Run #22
PP35	54.00						
C18							
PP36	55						
C19	55.86m						
	56.00m						Core Run #23

Log. J. P. Bloomfield 7.1.97 – 10.1.97

BGS

SAMPLE	DEPTH	DATE & TIME	CORE REC.	FRACTURE	GRAPHIC LOG	COLOUR	DESCRIPTIVE LOG	COMMENTS
PP37	56.00							
C19 PP38	57					Grey white	56.86–58.82m Massive sparsely fract. grey white chalk with sty. and thin marls. 1cm thick marl at 57.41 to 57.42m and 58.44–58.46m. Fracts. with Mno spotting and hztl. sty. partings orange standard with clays. 3cm thick marl at 57.80–57.83m	Core Run #23 cont.
C20 PP39	58.00m							
PP40	58.82m							
	59					Grey white	58.82–61.83m Massive sparsely fract. grey white chalk with sty. and thin marls. 4cm wide marl at 59.54m – 59.58m and a 2cm wide marl at 60.76 – 60.77m. Prominent stylolite parting at 60.11m is highly orange stained.	Core Run #24
PP41 C21	60.00m							
PP42	61							
PP43	61.83m							
	62.00m							Core Run #25



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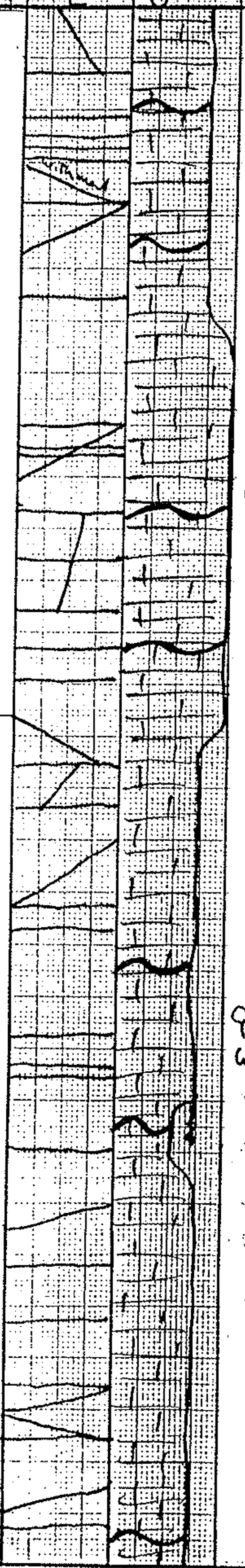
BGS

SAMPLE	DEPTH	DATE & TIME	CORE REC.	FRACTURE	GRAPHIC LOG	COLOUR	DESCRIPTIVE LOG	COMMENTS
C22	62.00 m					Grey white	<u>61.83-64.76m</u> Hard grey white chalk with stylolites passing into massive very hard white chalk below 63.26m 1cm wide marls at 62.92 to 62.93m, 63.93 to 63.94m 62.37-62.38m and 64.43 to 64.44m. The interval contains many clean fracts. not assoc. with sty. all v. heavily min. with MnO. High angle fract. with orange staining at ca. 45° to fract axis contains a thin marl (injection?) at 62.60 to 62.72m. Disturbed interval 62.44 to ca. 62.70m contains chalk breccia sty. + thin marl seams.	Core Run #25 cont.
PP44	63							
PP45, C23	64.00m					White		
	64.76m						<u>64.76m - 67.72m</u> Hard grey massive chalk with sty. and marls. Two zones of chalk rubble assoc. with sty. and thin marls at 65.45 to 65.56m and 66.07 to 66.14m. Small unit of fissile chalk at 66.22 to 66.32m imed. above a thin marl. Ltd. sty. surfaces stained bright orange. 1cm wide marls at 66.32-66.33m and at 65.69-65.71m.	Core Run #26
PP46	65							
PP47, C24	66.00m					Grey white		
PP48	67							
	67.72m						<u>67.72 - 70.58m</u> see over:	Core Run #27
PP49	68.00m							



Nag - J.P. Bloomfield 7.1.97 – 10.1.97

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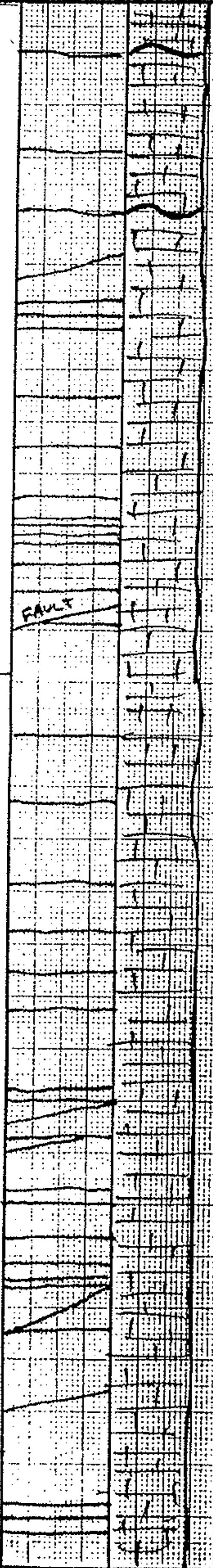
SAMPLE		DEPTH	DATE & TIME	CORE REC.	FRACTURE	GRAPHIC LOG	COLOUR	DESCRIPTIVE LOG	COMMENTS
	C25	68.00m					Grey white	67.72 – 70.58m cont. Massive grey white chalk with stylolites and marls. Hzl. fracts are partings on bright orange stained sty. Sub-vert. fracts. are tight and heavily min. with MnO. 1cm thick marls at 67.87 – 67.88, 68.18 to 68.20m and 68.79 – 68.80m. A small unit of rel. fissile chalk at 68.02 – 68.20m and two zones of highly brecciated chalk at 69.95 to 70.08m and at 70.16 to 70.27m. Fract surface immed. below the 2nd zone exhibits oblique slickensides indicating small fault.	Core Run #27 cont.
PP50		69							
PP51	C26	70.00m							
		70.58m					Grey white	70.58 – 73.57m Massive grey white chalk with stylolites and marls and with a highly fractured interval between 72.15 – 73.10m and containing chalk outside between 72.55 and 77.73m. All fract. surfaces heavily min. with MnO spotting and strong orange staining and clays on sub. hzl partings on stylolites.	Core Run #28
PP52		71							
PP53	C27	72.00m							
PP54		73							
		73.57m						73.57 – 76.17m See over.	Core Run #29
PP55		74.00m							



Log J.P. Bloomfield 9.1.97 – 10.1.97

BOREHOLE ______ **BGS**

SAMPLE	DEPTH	DATE & TIME	CORE REC.	FRACTURE	GRAPHIC LOG	COLOUR	DESCRIPTIVE LOG	COMMENTS
C28, PP56, C29, PP57	74.00m, 76.00m, 76.17m					Grey white	73.57 – 76.17m cont. Massive grey white chalk with stylolites and thin marls. Sub. hztl. fracts as partings on sty. These surfaces are heavily orange stained and contain clays.	Core Run #29 cont.
PP58, C30, PP59	78.00m, 78.89m					Grey white	76.17 – 78.89m Massive grey white chalk with stylolites and marls and three thin zones of brecciated chalk at 76.96 to 77.08m, 77.23 to 77.27m and at 77.40 to 77.48m. Fracts. are partings on sub. hztl. sty. Sub. vert. sty. present in interval. 1cm marl at 78.62	Core Run #30
PP60	80.00m					Grey white	78.89m – 81.71m Massive grey-white chalk with stylolites and thin marls. Disturbed zone containing chalk rubble and thin marls at 80.67 to 80.76m.	Core Run #31

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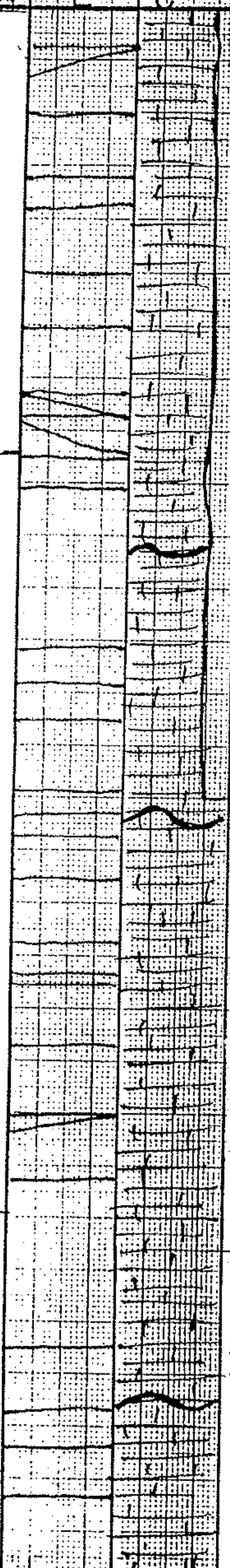
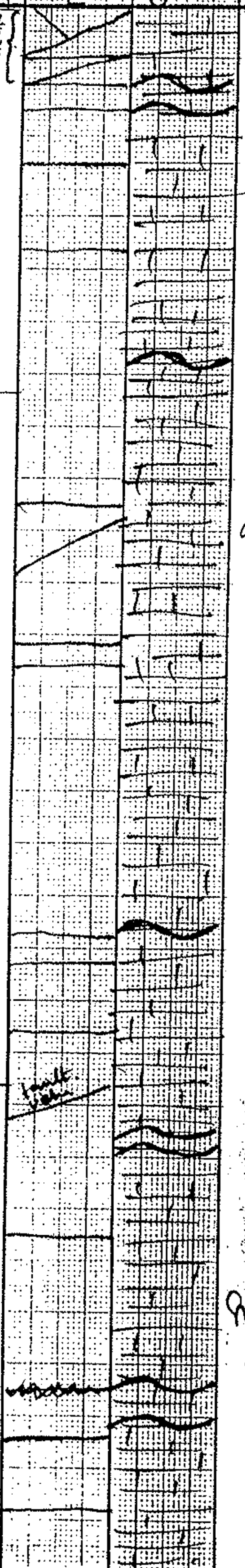
BGS



SAMPLE	DEPTH	DATE & TIME	CORE REC.	FRACTURE / GRAPHIC LOG	COLOUR	DESCRIPTIVE LOG	COMMENTS
C31, PP61	80.00m					78.89m – 81.71m See sheet (1) for notes.	Core Run #31 cont.
PP62	81						
	81.71m						
PP63, C32, PP64	82.00m, 83					81.71m – 84.59m Hard passing into v. hard grey chalk below 83 m with Stylolites and marl seams. 2cm thick marls at 82.04 – 82.06m and 83.17 83.18m, Fracts. are partings along sub. hztl stys. all heavily orange stained with clays. Whole interval with many 0.5cm wide marls particularly towards the base of the run. Chalk below 83m is harder greyer and highly bioturbated.	Core Run #32
PP65, C33	84.00m						
	84.59m						
PP66	85, 86.00m					84.59 – 87.47m Very hard grey chalk strongly bioturbated chalk with stylolites and marls. 1cm wide marls at 85.29 and 86.40m and 2cm wide marls at 86.29 to 86.31m, 87.35 to 87.37m. Dense calcite filled vein array 86.03 – 86.26 m at top of a highly fract. disturbed interval 86.03 – 86.40m	Core Run #33

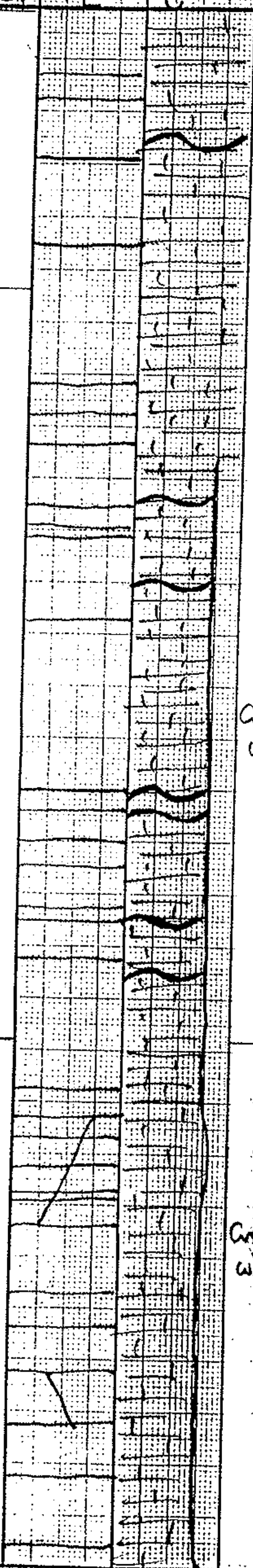
BGS

SAMPLE	DEPTH	DATE & TIME	CORE REC.	FRACTURE	GRAPHIC LOG	COLOUR	DESCRIPTIVE LOG	COMMENTS
PP67, C34, PP68	86.00m, 87.78m					Gy.	84.59-87.47m See sheet ② for notes	Core Run #33 cont.
C35, PP69, PP70	88.00m, 90.00m, 90.14m					Grey	87.47m-90.14m Hard to very hard strongly bioturbated chalk with numerous stylolites and thin marls. 2cm wide marl at 89.51 to 89.53m. Chalk rubble in interval 88.43 to 88.50m. Pyrite nodule, pyritised fossils at 90.00 to 90.04m	Core Run #34
C36, PP71, PP72	92.00m			fault vein		Grey	90.14-93.07m Hard to very hard grey chalk with stylolites and marls. Chalk is strongly bioturbated. Numerous closely spaced thin marls in interval 90.00 to 91.15m. Below 91.15 chalk is more massive. Fracts are partings along sub. hztl. stylolites. 4cm thick marl at 92.51-92.55m and 1cm thick marls at 90.32, 90.39, 91.28 and 91.43m. Calcite filled vein 90.14m to 90.25m displaces small marl by 2cm	Core Run #35



BGS

SAMPLE	DEPTH	DATE & TIME	CORE REC.	FRACTURE	GRAPHIC LOG	COLOUR	DESCRIPTIVE LOG	COMMENTS
PP73, C37	92.00m					Grey.	90.14–93.07m see sheet (13) for notes.	Core Run #35 cont.
PP74	93.07m							
C38, PP75, PP76	94.00m					~~Grey~~ Creamy white	93.07–95.98m Very hard grey coloured massive chalk with sty. and marls passing down into softer cream coloured chalk at ca. 93.70m. Grey chalk is heavily bioturb-ated chalk below 93.70m exhibits only ltd bioturbation. Fracts. are partings on sub. hztl. sty. and marls. Those below 94.20 are heavily orange stained. 1cm thick marls at 93.88 94.21, 95.09, 95.50 and 95.73m. 3cm thick marl at 94.96 - 94.99m and gap in core immed-iately below this marl of 7cm i.e. fr 95.00 to 95.07m. Slickensided fract. surface at 94.00, slicks. sub. hztl.	Core Run #36
C39, PP77, PP78, PP79	96.00m, 98.00m	95.98m				Creamy white	95.98–98.65m Hard creamy white chalk with numerous stylolites and thin marl partings with bright orange staining. Fractured interval 96.25 to 96.70m with sub. vert. fracts with MnO min. Three thin zones of chalk rubble at 96.55- 96.58m, 96.68 to 96.70m and . 1cm thick marls at 96.83m and	Core Run #37



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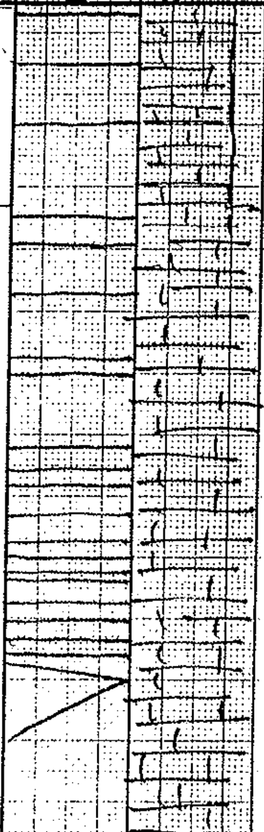
SAMPLE	DEPTH	DATE & TIME	CORE REC.	FRACTURE	GRAPHIC LOG	COLOUR	DESCRIPTIVE LOG	COMMENTS
C40	98.00 – 98.65m						<u>95.98 – 98.65m</u> see sheet (14) for notes.	Core Run #37 cont.
9980 9981 C41	98.65m – 100.00m – 100.64m	T.D.				white	<u>98.65m – 100.64m</u> Very hard white chalk with stylolites and marls passing down into fract. chalk below 99.5m and chalk rubble below 100.00m. 1cm wide marl at 99.51m Sub. hztl. fracts. are partings in marls and are orange stained. Fracts. below 99.50m are unmineralised and may be a drilling artifact. T.D.	Core Run #38. T.D.
	102.00							
	104.00m							