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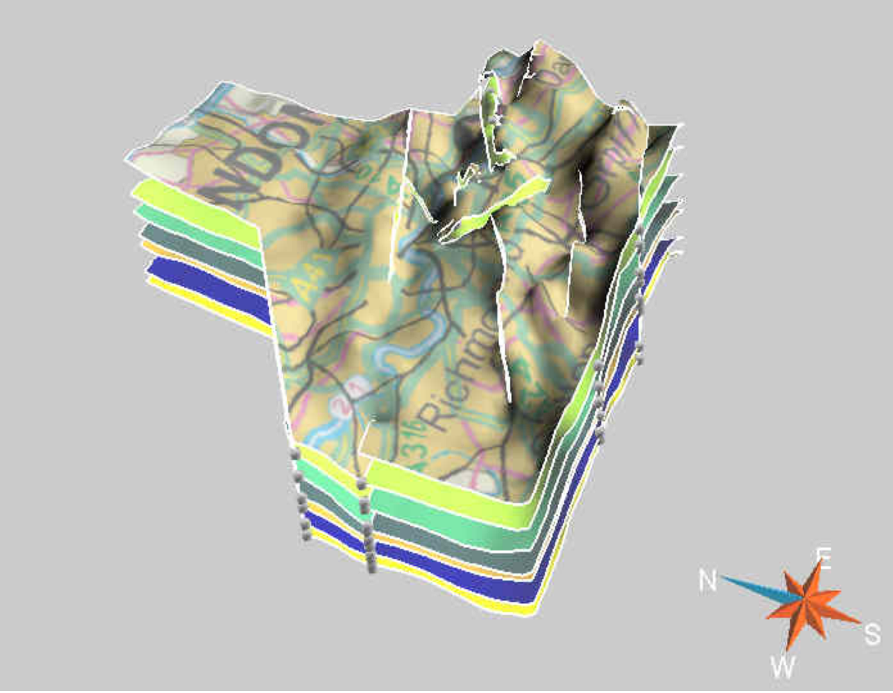
The London Chalk Model

Land Use and Development
Theme Commissioned Report
CR/08/125N



BRITISH GEOLOGICAL SURVEY

LAND USE AND DEVELOPMENT
PROGRAMME COMMISSIONED REPORT
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The London Chalk Model

K R Royse

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3D model of the Chalk under London

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Prof R N Mortimore
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Mr M Woods
Mr R Terrington
Ms H Cullen
Mr C Slater
Mr S Thorpe

Contents

Summary

This report describes the work undertaken to produce the London Chalk Model (LCM) within the catchment of the River Thames. This work was funded by the Environment Agency, Thames Region, to support work on the production of a new hydrogeological model for the region.

STRUCTURE OF REPORT

The introduction describes the background to the project. The second chapter describes the sources for the data used in the model. An account is then given of the processes that led to the generation of the geological model; this includes notes on the criteria used to subdivide the Chalk according to the new lithostratigraphy and how faulting was elucidated. A discussion of the structure of the Chalk starts with observations on the kinds of influence exerted on the Chalk by tectonic structures, and on the difficulties of specifically identifying faults in the Chalk. The final chapter ends with a short discussion on the possible timing of fault movements and how fault movements may have influenced sedimentation of the Chalk.

1 Introduction

This report describes the modelling methodology adopted to produce the London Chalk Model (LCM) and the structure of the Chalk under London as elucidated from the above 3D model. The model encompasses an area within the catchment of the River Thames; it extends from Hornchurch Marshes in the East to Hounslow in the West, up to Enfield in the North and down to Croydon in the South (Figure 1).

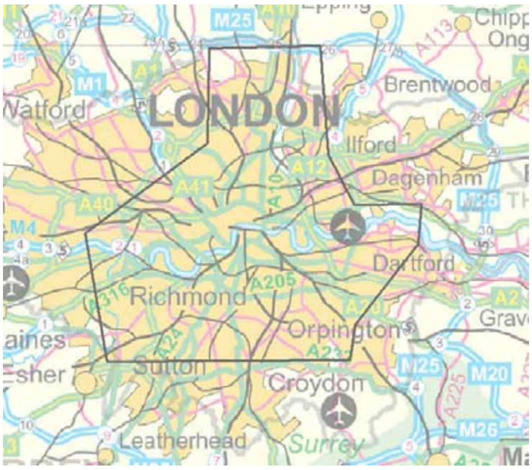

Figure 1 : Location of project area (outlined in black)

1.1 GEOLOGICAL AND STRUCTURAL SETTING

The Chalk is present at subcrop throughout the London basin and comes to the surface along the southern margin (the North Downs) and along the northwest margin (Chiltern Hills) and is locally at or close to the surface e.g. along the Greenwich and Purfleet anticlines in East London. The Chalk Group of London sits within the London Basin. The London Basin is described in the literature (Ellison et al., 2004) as a broad, gentle synclinal fold whose axis can be traced from Marlborough through to Westminster. The London Basin formed in the Oligocene to mid-Miocene times during the main Alpine compressional event. Formations in this region range from Cretaceous (144 to 65 Ma) to Quaternary (2 Ma to present day) in age.

The Cretaceous Chalk is typically a fine grained white limestone. Bristow et al., (1997) provides a detailed description of the Chalk lithostratigraphy). It has a total thickness of between 170 and 210 m and generally thins from the west to the east. Overlying the Chalk is the oldest Palaeogene deposit, the Thanet Sand Formation. This formation consists of a coarsening upwards succession of fine grained, grey sand. The formation reaches a maximum thickness of around 30 m in the area. A basal conglomerate which consists of rounded black flint pebbles (the Bullhead Beds) defines the base of the Thanet Sand. Above the Thanet Sand Formation lies the Lambeth Group. This group consists of three formations: the Upnor, the Woolwich and the Reading Formations. The Lambeth Group is between 20 and 30 m thick in the area and lithologically, the group is highly variable, consisting of variable proportions of sands, silts, clays and gravels.

Overlying the Lambeth Group are the Eocene sediments of the Thames Group which consist of the Harwich and London Clay Formations. The Harwich Formation (formally known as the Blackheath or Oldhaven Beds) consists predominantly of sand and pebble beds up to 4 m thick. Above this is approximately 90 to 130 m of London Clay. The London Clay Formation consists of grey to blue grey, bioturbated, silty clay. Quaternary deposits are encountered throughout the London Basin. These include evidence of ancient river systems and the development of the present-day River Thames valley. Deposits include alluvium, peat, brickearth and river terrace deposits (for example the Kempton Park, Taplow and Shepperton Gravels).

2 Data sources and data acquisition

2.1 1:50 000 SCALE GEOLOGICAL MAP DATA AND OTHER PUBLICATIONS

Four 1:50 000 scale geological maps published by the BGS cover the project area [sheets 256 (North London), 257 (Romford), 270 (South London) and 271 (Dartford)]. These maps were all re-surveyed between 1970–1995. The London Memoir (Ellison et al., 2004) covers all four map sheets within the study area and has been used as the definitive text in this study (additional information sources are listed below). The map sheets 256, 257 and 270 all use the traditional three-fold subdivision of the Chalk. However, map sheet 271 uses the new lithostratigraphic scheme developed for the Chalk over the last eleven years (Bristow et al., 1997).

2.1.1 Other Publications and Data Sources included

Below is a list of the major information sources which were used in this study:

- The LOCUS (London Computerised Underground and Surface) dataset. This project was initiated in 1992 and produced digital 1:10,000 scale maps and a three-dimensional model of the geology of London (Ellison et al., 1993). Surfaces included the base of the London Clay, base of the Palaeogene (i.e. the base of the Thanet Sand Formation) and base of Drift.
- The results from the tide gauge bench mark project in the London area (Bingley et al., 1999; Bingley et al., 2007). This project looked at the effect of current subsidence and uplift in the London area as shown by high precision satellite based surveying.
- Data was taken from a variety of older maps, which included 1:10,650 scale maps produced by Mylne (1871), Bristow (1861) and Dines (1925)
- Two technical reports looking at the geology of the Cray Catchment (Newell and Bloomfield, 2007) and the structure of the Top Chalk and Palaeogene in the Ravensbourne catchment (Newell, 2002)
- Information contained within a paper in preparation by Prof Rory Mortimore and others titled ‘Chalk: its stratigraphy and engineering geology in East London and the Thames Gateway’
- Colour shaded relief Gravity anomaly map
- SE England London Lithoframe group’s lineament analysis of the Palaeogene

2.2 BOREHOLE LOGS (LITHOLOGICAL)

This study looked at the records of about 12,400 boreholes in the London area which are held in the National Geological Records Centre. These records are of variable age and quality and many lack useful lithological (or lithostratigraphical) information, the descriptions being too vague, imprecise or inaccurate. Furthermore, in many cases, close examination suggests that the borehole location details are unreliable. Another 62 were collated from Union Rail, CrossRail and from Prof Rory Mortimore’s own collection. Some 4,300 borehole logs were found to provide useful information about at least one stratigraphic boundary.

Where possible, the level of each stratigraphic boundary recorded in these logs was determined. In some cases, only the level of the top Chalk surface could be determined. Inaccuracies can occur in any aspect of the borehole data: in the original record, in its subsequent interpretation, in the recorded location of the borehole, or in the ground elevation at the borehole site. So far as possible, these elements were checked for in each individual borehole. The National Grid coordinates for boreholes with useful information were taken from the BGS Single Onshore Borehole Index (SOBI). The ground surface level (relative to Ordnance Datum) for each borehole was taken from the borehole record, where recorded. Recorded levels were checked against the NEXTMAP DTM for plausibility. Where levels were not recorded, or were obviously incorrect for a known borehole location, the level was interpolated from the NEXTMAP DTM elevation data.

None of the boreholes had been previously interpreted using the new Chalk lithostratigraphy. Borehole logs intersecting the top of the Chalk beneath the Palaeogene were extrapolated downwards to the base of each of the new Chalk formations, using an estimated thickness for each. Although this is better than no data, it should be emphasised that the thickness of each unit is known to vary somewhat across the area, and so these ‘phantom data points’ are correspondingly uncertain.

Interpreted borehole data was then used to generate the 3D model (see section 3 for details), enabling the borehole records to be considered relative to each other, in their local context. Borehole records which gave rise to obvious anomalies in the modelled surfaces and which seemed to be in some way unreliable (e.g. over-simplified drillers’ logs) were noted within the modelling metadata files and then discarded. This is a subjective process but it tends to lead to a model based on a relatively self-consistent dataset. However, possibly anomalous but apparently correct records were left in the dataset, on the grounds that the apparent anomalies could be, in some way, ‘real’. Note that borehole records which are somehow incorrect but which are nevertheless consistent with the model will generally remain unsuspected. The location of borehole data used for the geological model appears as a theme in an Arcview project displaying digital datasets generated from the LCM.

2.3 BOREHOLE LOGS (GEOPHYSICAL)

Geophysical borehole logs (natural gamma and resistivity) were collated from BGS archives and the Environment Agency. These logs were interpreted in terms of the new Chalk stratigraphical units by Mr M Woods. The stratigraphic interpretation of the boreholes is based on work by Mortimore and Pomerol (1987) and Murray (1986) and is described more fully by Woods (2001; 2002). About 200 geophysical borehole logs were found to provide useful information about at least one stratigraphic boundary. Lithological borehole logs were available for some of these boreholes. Geophysical boreholes were scrutinised in a similar way to those of the lithological

3 Geological Modelling

The LCM comprises a series of seven layers, representing the six Chalk Formations and the overlying Palaeogene strata (undivided). Contoured images of the seven basal surfaces appear in an Arcview project displaying digital datasets arising from the LCM and also as a full 3D model within Subsurface Viewer. Data on the position of the surfaces bounding each layer was compiled from the sources described in Section 2. The ground surface was modelled using NEXTMap^{TM} (Interp Technologies Inc) DTM with a vertical resolution of 1 m.

The quality of 3D geological models is highly dependent on the data that is used to construct them. In this study area, the quality and quantity of the data available to define the position of each geological surface in the model is spatially variable. In general, uncertainty in the thickness and geometry of the modelled geological units is greatest in data-poor areas. Confidence is highest in data-rich areas. Data-rich areas are represented by dense areas of closely spaced boreholes. The available data is, however, generally of reasonable or high quality at outcrop and in subsurface records.

The resulting model provides a best-guess for the faulting within the Chalk under London. This takes account of the available information and the modelling criteria outlined in section 2 and 3.1. It should be understood that, over time, as new data comes to light during the hydrological modelling phase of the work or during major engineering work in London, the geological model may need to be reassessed and modified. The LCM has been constructed and metadata captured so that the model can be readily revisited at a later data, should the need arise.

3.1 MODELLING METHODOLOGY

Modelling was performed using GSI3D^{TM} (version 2.5) and Gocad (version 2.1.5). GSI3D enabled the modeller to use a ‘knowledge driven’ approach allowing the model to capture the geologist’s interpretation of the geometry and thickness of each geological unit. It was therefore possible to achieve a geologically reasonable solution even in areas where the borehole data was sparse or uncertain. This method also allowed the modeller to pick out areas of possible faulting within the Chalk and base Palaeogene, which was then generalised in the final model. The GSI3D^{TM} model was then imported into Gocad where it was possible to combine the fault and stratigraphic analysis to give a more complete picture of the London Basin.

The model was constructed by correlating outcrop data with boreholes linked in a network of intersecting cross-sections. The network was constructed by linking in all the deep borehole data and resistivity logs in the first instance. Data was included from a considerable distance beyond the study area in order to ensure that regional trends were correctly represented.

The cross-sections were constructed in roughly orthogonal directions (North-South and West-East), enabling “loop tying” to check borehole correlations iteratively across the area. Where possible, they were placed at right angles to valleys and known geological structures. Additional cross-sections were constructed in areas of sparse borehole coverage and were based on projected intersections from nearby, better constrained ones. Shorter, ancillary cross-sections on other alignments were constructed between the major ones, in order to encompass local variations and anomalies. Errors caused by limitations in the software and anomalies caused by data deficiencies were checked against the supporting data and removed or smoothed. A total of 100 sections were constructed in the study area.

Determination of faulting within the chalk was undertaken by using a set of criteria agreed between the BGS and the Environment Agency. These included the following:

- Dip of units: where the dip is greater than 5 degrees, then the Chalk strata were considered to be faulted
- Where boreholes show a change in depth of a unit progressively across a section, then the strata were considered to be folded.
- Where boreholes show a sharp change in depth, then the strata are considered to be faulted. However, because of the size of the area being modelled, the spacing between boreholes was checked, as it was common for this feature to present itself when boreholes were in fact 100s of metres apart.
- Shape and style of folding: where folds are monoclinal with steep limbs dipping greater than 5 degrees, then the limb was considered to be faulted. Monocline folds were considered to be likely candidates for faulting
- Facing direction: in the London area folds are generally northwards facing. Where folds are southward facing, therefore at odds with main trends, then these may be candidates for faulting
- Information gathered in section 2.1.1 of the report was digitised and used to inform and back up the decision-making process

It should be noted that known (mapped) faults e.g. the Greenwich fault, occur as single planes within the model and are accurately positioned. In reality, although faults are generally depicted as single lines on maps and in the model, they generally consist of zones of disruption which may include a number of closely spaced fractures. Unless faults are observed at outcrop, their positions are usually based on a topographic feature (e.g. gully, break of slope, etc) and/or on outcrop evidence, both of which provide only a general indication of their position.

During model construction, metadata was recorded describing: the geologist’s decision-making processes, any boreholes found to be erroneous and the procedures undertaken. Once the model was assembled in GSI3D, the sections were revisited to check that fault determinations were valid. The LCM at this stage suggested the presence of 90 individual faults across the project area. At this stage, the model was checked by an independent reviewer (Dr D T Aldiss). Next, the modelled surfaces and fault locations were input into ARCGIS where a generalised fault pattern was derived and compared with known basement structures, gravity anomaly data and facies maps for the Lambeth group.

The generalised fault map consisting of 13 faults and the modelled 7 surfaces was exported into Gocad. Fault planes were generated with a dip of 70 degrees and the surfaces were cut by the faults and smoothed. The base Palaeogene surface was then cut to outcrop. The resulting model was then exported back into ARCGIS and into the Subsurface viewer. The final LCM was then shown to Dr D T Aldiss and Prof R Mortimore for comment.

3.2 MODIFICATIONS APPLIED TO SURFACES IN THE SUBSURFACE VIEWER

In order to place the LCM into the Subsurface viewer, several modifications had to be completed to account for the fact that the Subsurface viewer cannot handle faults at the present time. These are listed below:

- Gaps generated in each surface by the fault planes were filled
- Fault surfaces which generated border errors within GSI3D were adjusted by reducing the fault plane slope angle
- The outline area shape has been adjusted in a graduated manner, so that the West Melbury Marly Chalk has the smallest area and the base Palaeogene has the greatest area. This reduces the amount of ‘bleeding’ of a surface into another

4 Structure

4.1 GENERAL CONSIDERATIONS

Tectonic activity during deposition has influenced the thickness of the Chalk succession and its lithological composition on a local and regional scale. There is growing evidence that tectonic and sea-level movement occurred in phases throughout the Upper Cretaceous (Mortimore and Pomerol, 1987, 1991; Mortimore et al., 1998; Evans and Hopson, 2000; Evans et al., 2003). Four major tectonic phases (demonstrated in Germany and in the eastern Anglo-Paris basin) caused local channelling and slumping and the local formation of hardgrounds and phosphatic chalks, as well as variations in marl seam development throughout southern England.

In some parts of southern England, faulting within the formations beneath the Chalk becomes attenuated upwards, apparently passing into broad anticlinal folds. Where faulting does occur in the Chalk, the displacement may have been accommodated by movements of numerous small faults within a zone some tens, perhaps hundreds, of metres wide, rather than on a few discrete fault planes. In unexposed Chalk terrain, it is rarely possible to distinguish a broad, gentle anticlinal fold from a broad fault zone. Indeed, it is difficult to demonstrate the unequivocal existence of faults in unexposed Chalk unless the faults are relatively large. This inherent ambiguity has led to caution in the depiction of faults on maps of the Chalk published by BGS: in general, faults have been shown only when their presence is beyond dispute. Unfortunately, this caution may have led to situations in which faults have been disguised by over-generalisation of outcrop patterns consistent with the belief that no significant faulting is present.

A less cautious approach was adopted during the compilation of the London Chalk Model: linear zones of displacement have been interpreted as faults, by preference, rather than regarding them as the possible consequence of folding. This preference is justified by the general style of the linear zones (they are narrow, and laterally persistent), by their association with truncated and offset landforms, and by displacements determined from borehole data during the modelling process. The presence of faults inferred from surface data was substantiated by subsurface data.

Indeed, the difficulty in distinguishing between the effects of folding and faulting is probably not of critical importance in the context of the London Chalk Model. Many of the minor faults inferred from the first phase of modelling probably mark vertical displacements of less than 5 m (Figure 2), but even so, it seems likely that such faults mark zones of anisotropy within the aquifer. It seems likely that, in most local folds, the Chalk will have undergone some brittle fracture and sufficient minor faulting to influence the local hydrogeology.

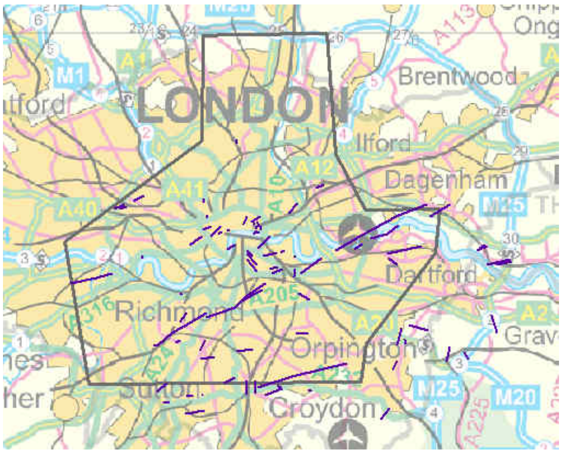

Figure 2: Fault distributions (in purple) as derived from the first phase of modelling

It should be noted that the relatively sparse distribution of subsurface data does not allow the delineation of any but the most obvious structures in the 3D model, particularly where the wavelength of small to medium-scale folds in the Chalk is less than the general spacing of the boreholes in the area.

As with all geological models, including that which accompanies this report, the London Chalk Model is an interpretation of information available at the time of compilation. It is felt to represent a reasonable position between ‘cautious under-interpretation’ and ‘ambitious over-interpretation’. Other interpretations of the same information are possible, although it is thought likely that the differences compared with the present interpretation would be in matters of detail. Consideration of the significance of the detail of the present map should bear this in mind.

4.2 REGIONAL STRUCTURE

The geological structure of the district is generally thought to be relatively simple, being dominated by a broad North-East trending syncline (the London Basin). The main limbs are coincident with the slopes of the North Downs in the South and the Chilterns in the North (Ellison et al., 2004). However, the London Chalk Model suggests that, in detail, the London Basin is a more complex structure, being a collection of at least 4 fault-bounded basins (see section 4.5 for details).

The model also indicates that the structural style of the basin changes moving north to south across the project area. This corresponds to the two structural provinces observed within the basement strata in the region. The Northern portion of the project area is underlain by the London Platform, part of the Midlands Microcraton; the Southern section by the zone of transition between the London Platform and the Variscan fold-thrust belt (Figure 3).

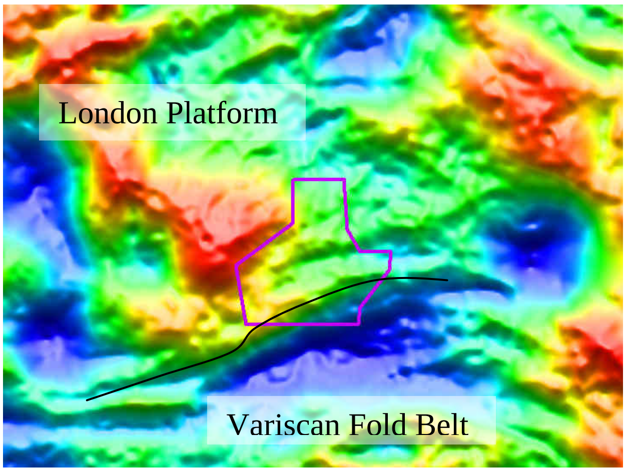

Figure 3: Colour-shaded Bouguer gravity relief map showing the location of the two structural provinces dissecting the project area (outlined in purple)

4.3 REGIONAL DIP AND THICKNESS VARIATIONS

Within the project area, the modelling indicates that the Chalk dips between 0–1 degrees except where it is steepened in the South by faulting and to a lesser extent folding. The typical thickness of the Chalk group within the project area is between 170 to 210 m, with a general thinning of between 30 to 40 m from East to West (Figure 4). Note that thinner successions also appear to be associated with most of the synclinal lows throughout this part of the basin.

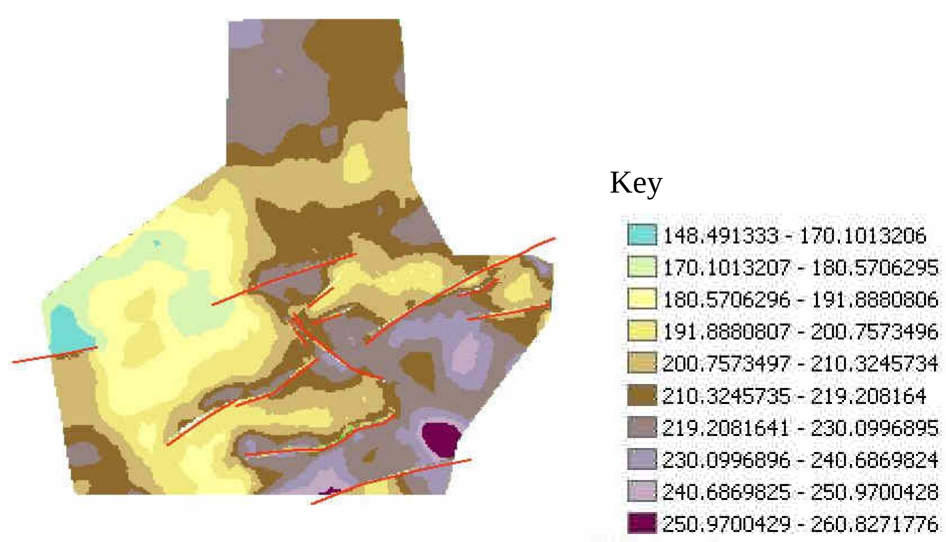

Figure 4 : Thickness map for the Chalk Group showing decrease in thickness East to West across the project area

This is a relatively thin succession compared to elsewhere, such as in the Hampshire Basin, which is over 400 m thick. The average thicknesses for each formation as derived from the LCM are listed in the table below:

Formation Name	Average Thickness (m)
Seaford Chalk Formation	32 - 47
Lewes Nodular Chalk Formation	34 - 46
New Pit Chalk Formation	33 - 49
Holywell Nodular Chalk Formation	11 - 18
Zig Zag Chalk Formation	30 - 50
West Melbury Marly Chalk Formation	14 - 31

4.4 FOLDING

Folding within the project area can be divided into two groups (Figure 5). The first group found south of the London Basin Axis and coincidently South of the River Thames consist of East-North-East trending periclinal folds, including the Greenwich and Streatham anticlines. The periclinal fold belt lies on the Southern edge of the Midlands Microcraton, just North of a large negative gravity anomaly thought to mark thick Upper Palaeozoic (probably chiefly Devonian, Figure 3) sedimentary rocks beneath the Northern edge of the Wealden Basin. The folds are aligned with a series of small linear positive gravity anomalies. These features are generally high amplitude and short wavelength folds, many of which are asymmetric, usually with steeper North-facing limbs. The second group are confined to the Northern part of the project area and are in the main low amplitude, long wavelength folds.

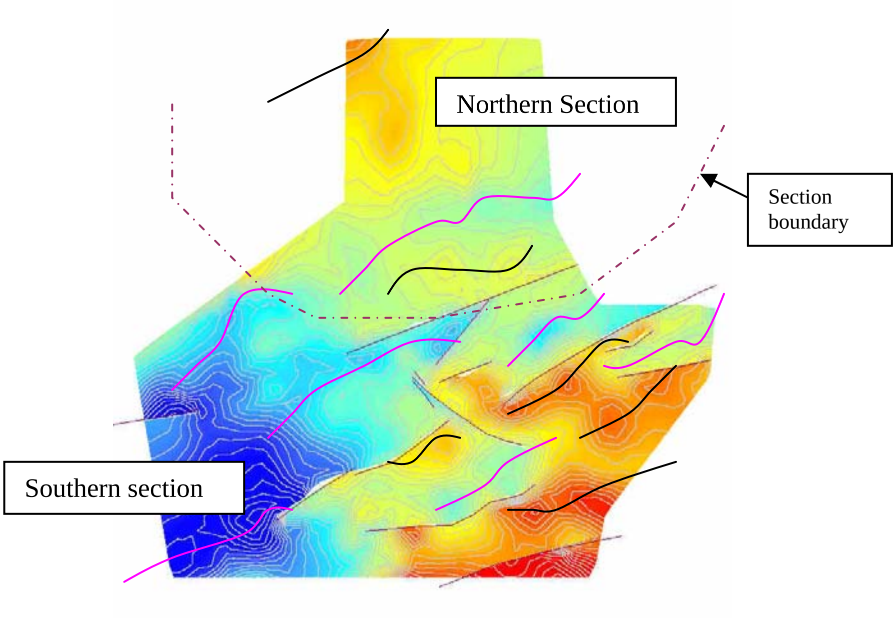

Figure 5 : Base of Seaford Chalk showing fold axial plans (lines : black = anticlines ; magenta = synclines and brown = faults)

4.5 FAULTING

The faults are confined to the South-eastern portion of the project area (Figure 6). In detail, as described in section 4.1, there are numerous small-scale faults within the Chalk succession. Described within this section are what are considered the dominant structural features as derived from the London Chalk Model.

The faults have been found to divide the Southern part of the project area up into 5 basins. The faults, broadly speaking, can be divided into 3 groups (Figure 6): ENE trending faults, which downthrow to the North (the majority of faulting within the South-eastern sector); ENE trending faults, which downthrow to the South (Northern boundary faults); and Northwest trending faults, which downthrow to the West (located between Lambeth and Catford). Displacements range between 10 to 50 m. Generally, the intensity of faulting reduces along the fault trends across the basin. The majority of faults, although shown as straight lines within the model, are in fact zones of en-echelon faulting (see section 4.1).

The modelled Chalk surfaces suggest the presence of a central structural high near Deptford, located between the Streatham and Greenwich faults. Re-examination of the LOCUS model, (Ellison et al., 1993) also confirms the presence of this previously unrecognised feature (see figure 45 in Ellison et al., 1993). The central structural high is bounded to the West by the NW trending faults and to the North by an ENE trending fault near Bermondsey.

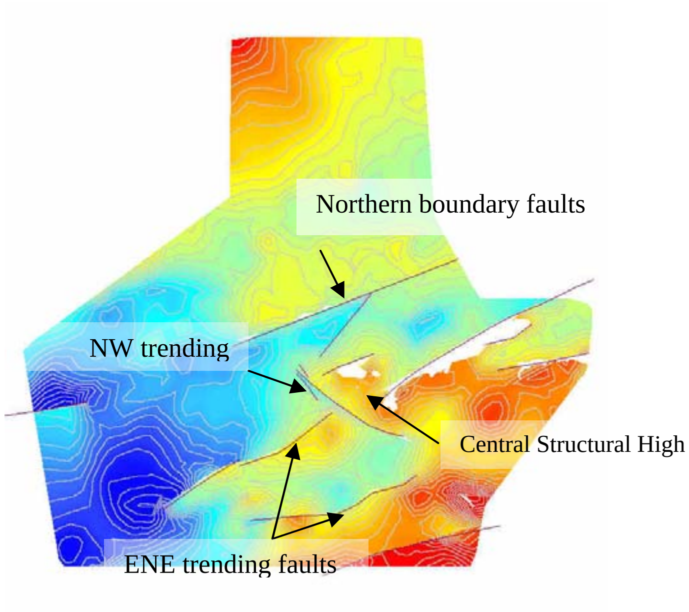

Figure 6 : Structure contour plot of the base of the Palaeogene, showing major fault groups and location of structural high

5 Discussion

The previous section has described the structural features observed in the London Chalk Model (LCM). In this section, we will discuss three issues further:

1) The evidence for the absence of faulting in the Northern portion of the London Chalk Model
2) How the distribution of the Lambeth Group in Central London provides supporting evidence for the proposed fault pattern in the London Chalk Model
3) How thickness variations in the Chalk, proposed by the London Chalk Model, provide clues to the timing of fault movements within the London Basin

5.1 THE ABSENCE OF FAULTING IN THE NORTHERN PORTION OF THE LCM

The LCM suggests that the project area can be split into two sections or regions. Both sections have behaved differently during the evolution of the London basin as a consequence to being underlain by different basements (see section 4.2). The model indicates that the only faulting in the Northern section is on its Southern boundary. This interpretation is supported by the evidence summarised below:

- The Northern section’s structural contours indicate gentle, low amplitude and long wavelength folding. This is in contrast to that observed in the Southern section, where folding is more numerous, higher in amplitude and shorter in wavelength.

- In the Northern section, the Chalk dips to the South East between 0 to 0.7 degrees and the dip is not observed to steepen against structures. However, in the Southern section, the dip is generally between 0.7 and 2 degrees to the North West and the dips do steepen against structures up to a maximum of 14 degrees.

- No evidence for faulting was found in the borehole logs in the Northern section, except for along its Southern boundary. However, numerous small-scale faults were recognised within the Southern section. It should be noted that the distribution of boreholes was not significantly different between the two sections so as to make it more likely to find faults within one section rather than the other.

5.2 COMPARISON BETWEEN THE DISTRIBUTION OF THE LAMBETH GROUP, IN CENTRAL LONDON, AND THE PROPOSED FAULT PATTERN IN THE LCM

Facies variation within the Lambeth Group in London is shown by Figures 17 to 20 of the London memoir (Ellison et al. 2004). These can be expected to be relatively crude in relation to the maps that could be generated with present-day knowledge, borehole information and software. Comparison of these facies maps was made with the proposed fault pattern for the Chalk. This was done in order to test the hypothesis that the Lambeth Group facies distribution is to some extent structurally controlled and that therefore its distribution should reflect the fault pattern proposed for the Chalk Group. The following observations were made:

- The extent of the Lower Shelly Clay – the absence of the unit from Central London appears to be coincident with the central structural high (figure 7). The Western extent of the unit is broadly coincident with the major ENE faults.
- The extent of the Laminated Beds – the absence of this unit coincides, as with the Lower Shelly Clay, with the central structural high, together with the Greenwich and Northern section's Southern boundary fault.
- The extent of the Upper Shelly Clay – the central structural high again appears to account for the absence of this unit from Central and Eastern London. The Northern section boundary fault is broadly coincident with the Northern extent of this unit. The extent of sand in the Upper Shelly Clay appears to be broadly coincident with the Streatham and Wimbledon faults.
- The Upper and Lower Mottled Clay – the Upper Mottled Clay shows some thinning over the ENE faults in the South but there does not appear to be any control on distribution exerted by faulting to the same degree as the units above.

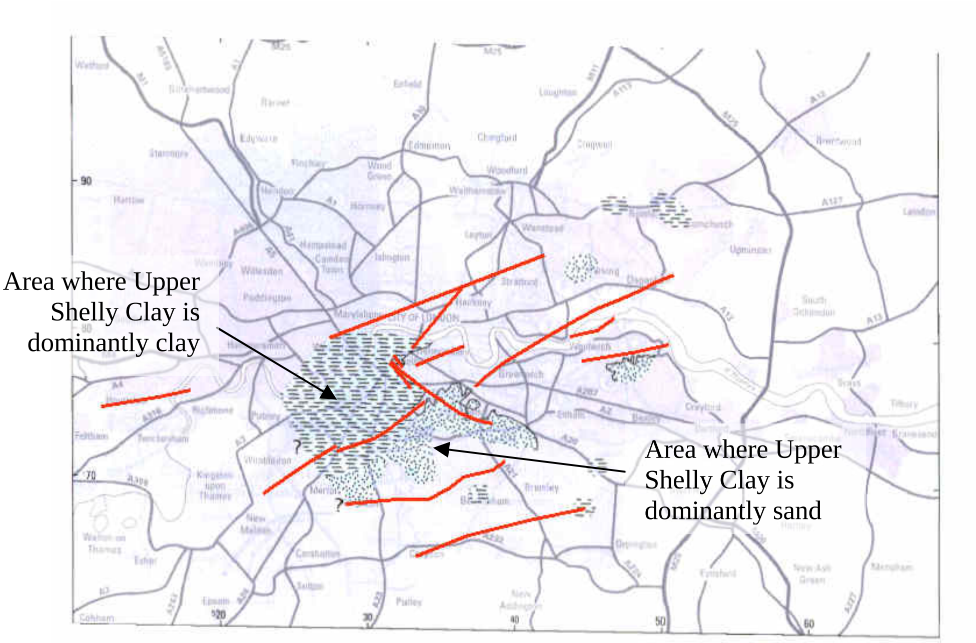

Figure 7: Fault Pattern as proposed by the LCM superimposed on the Upper Shelly Clay distribution (Figure 19 from the London Memoir, Ellison et al., 2004)

It is clear from these correlations that the known area of complexity within the Lambeth Group of London coincides with the proposed fault pattern in the London Chalk Model. The faults appear to have had a persistent control on the extent of marine transgression and regression during Lambeth Group time, and presumably throughout the Palaeogene.

5.3 HOW THICKNESS VARIATIONS OF THE CHALK PROVIDE CLUES TO THE TIMING OF FAULT MOVEMENTS WITHIN THE LONDON BASIN

Thickness variations within the Chalk Group as proposed by the London Chalk Model (Figure 4) indicate that it is likely that faults exerted some control on the deposition of the Chalk, although it should be noted that the subsequent uplift and erosion of the upper Chalk at the end of the Cretaceous Period complicates this picture. Evidence to support this view is discussed below.

If the overall thickness of the Chalk Group is considered, it can be shown (section 4.) that the Chalk thins from East to West across the project area. This is broadly coincident with the NW faults in the centre of the project area and the central structural high. It can also be shown (Figure 4) that Chalk deposited in the base of synclines is generally thinner than that which is deposited over anticlines. This could be explained by the fact that a) uplift at the end of the Cretaceous was controlled by faulting and was greatest in the West, resulting in greater erosion or b) that within the deeper basins, there was less Chalk sedimentation.

The Seaford Chalk Formation sits below the sub-tertiary erosion surface and exhibits a large degree of variation in thickness across the project area. The Seaford Chalk is on average thinner within the base of synclines except for one notable exception, which is the deep basin in the Southwest of the project area. This variation in thickness may suggest that uplift was greatest where basins were fault-bounded. It could also partially be a result of reduced sedimentation, as the model was not able to identify boundary markers such as the Shoreham marls or Bedwell’s Columnar Flints. It is also possible that thicker sequences of Seaford Chalk are superimposed by remnants of Newhaven Chalk Formation.

The final Chalk Formation that was looked at in detail was the Lewes Nodular Chalk Formation. Nodular chalk fabrics like hardgrounds are commonly regarded as a result of reduced sedimentation rates (Aldiss et al., 2004)This relationship is somewhat complex (Aldiss et al., 2004)but it should be possible to see a broad correlation between the thickness of the Lewes Nodular Chalk and basin architecture as proposed by the London Chalk Model. The London Chalk Model suggests that the relationship is not a straightforward one. The Lewes Nodular Chalk was found to be thickest in the West but there was no correspondence to basins in the East. This could be because faults within the London Basin moved at different times and or that the relationship between nodularity and basin depth is not a simple one.

Therefore, to conclude, Chalk sedimentation and uplift appear, at least in part, to have been controlled by faulting within the London Basin. It is likely that fault movement did not take place all at one time but over a period of time and that during Chalk deposition, certain areas of the basin may have been more active than others.

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