Geoscience solutions for the Thames Gateway

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Abstract: It's the biggest building programme the UK has seen for over 50 years. It covers a 40-mile stretch of land along the Thames, from East London out into Essex and Kent. The key areas for redevelopment have been identified. So if this has already been decided, why do we need to understand the geology?

The Thames Gateway has extensive areas of difficult ground, including soft soils, high groundwater levels, and contaminated sites. Prevention is definitely better than cure, as failure to appreciate the geological ground conditions fully can cost vast sums of money. Cost-effective forward planning decisions can only be made when the potential impact of such factors is considered. If sound decisions are to be made, then clearly those organizations involved in planning and development need easy access to all relevant information.

Rapid developments in three-dimensional (3D) modelling software are now providing challenging and exciting possibilities for constructing high-resolution geological models of the shallow sub-surface. Using this new technology (supported by our geological and geotechnical archives), we can predict not only the type of rocks that lie beneath our feet, but also their engineering properties (rock strength, shrink-swell characteristics and compressibility) and hydrological properties (permeability, porosity, thickness of the unsaturated zone or the presence of perched water tables). The data can then be imported into standard GIS packages and queried along with other complementary GI data, resulting in a powerful tool to assist in strategic planning and sustainable development. The 3-dimensional geological map can be queried, sliced, diced and uncovered to answer any specific questions asked by users who need to understand the make up of the ground beneath their feet.

Résumé: C'est le plus grand programme de construction que le Royaume Uni a entrepris depuis plus de 50 ans. Il s'étend sur 65 kilomètres en bordure de Tamise, de l'est londonien jusqu'aux comtés d' Essex et du Kent. Les secteurs clés pour le réaménagement ont été identifiés. Or, si ce plan a déjà été décidé, pourquoi avez-vous besoin de comprendre la géologie des sols concernés?

La " Thames Gateway" a de vastes secteurs de sols difficiles (terrains meubles, nappes phréatiques près de la surface et zones contaminées). Mieux vaut prévenir que guérir. Ne pas prendre en compte l'état du sous-sol pourrait se montrer beaucoup plus onéreux que prévu! Des decisions de planification, rentables à long terme, ne peuvent être faites que si l'impact potentiel de tels facteurs sont pris en considération. En cas de prises de décisions définitives, les organisations engagées dans la planification et le développement doivent avoir un accès facile à toute information pertinente.

Les applications du logiciel de modélisation à trois dimensions (3D) fournissent aujourd'hui d'excellentes possibilités de construire des modèles géologiques, de haute résolution, du sous-sol. L'utilisation de cette technologie nouvelle (alimentée par nos archives géologiques et géotechniques) nous permet de prédire, non seulement le type de roche qui se trouve sous nos pieds, ainsi que ses propriétés mécaniques et chimiques (résistance, compressibilité), mais aussi ses propriétés hydrologiques (perméabilité, porosité, l'épaisseur de la zone non saturée ou la présence de poches d'eau). Les données peuvent être importées alors dans des progiciels de SIG (Système d'Information Géographique) standards et utilisées avec d'autres donnees de IG complémentaires, ce qui produit un outil puissant pour aider dans la planification stratégique et le développement durable. La carte géologique 3D peut être coupée en tranches ou en portions afin de répondre à n'importe quelle question spécifique posée par les utilisateurs qui ont besoin de comprendre la nature et les caractères du sol et du sous-sol.

Keywords: 3D models, data visualisation, geological hazards, geology of cities, geotechnical engineering, and groundwater contamination

INTRODUCTION

The research project on which this paper is based has come about through the British Geological Survey's response to the UK Government's development initiative in the Thames Gateway. In June 2004, BGS commissioned a scoping study to assess the geoscience needs of stakeholders in the Thames Gateway (a 40-mile stretch of land along the River Thames to the east of London) and how best to serve those requirements. A result of the study's findings has been the initiation of a 5-year interdisciplinary applied research project focused on making geoscience information for the Thames Gateway more accessible, relevant and understandable to the wide range of users involved in the sustainable regeneration and development of the Gateway. This overarching project will collate information from past and current projects and interpret and present it in new ways.

Traditionally, geological information has been displayed as two-dimensional (2D) - on maps supported by cross-sections and map keys. Recent digital advances have introduced the routine use of Geographic Information Systems (GIS), which enable an unlimited range of spatial data to be displayed as single or multiple 'layers' and, importantly, these layers may be queried.

Rapid developments in three-dimensional (3D) modelling software are now providing challenging and exciting possibilities for constructing high-resolution geological models of the shallow sub-surface. In recent years it has become apparent that to gain full value from the 3D geological model in the urban environment, attribution of the model with geotechnical and hydrological data is necessary (Fig 1). The resultant model can be used to predict not only the type of rocks and their vertical and lateral variation, but also the variation in their engineering properties (rock strength, shrink-swell characteristics and compressibility) and hydrological properties (permeability, porosity, thickness of the unsaturated zone or the presence of perched water tables). Geoscientists are not just providing raw data but interpreted data, which can be used to answer problems encountered by planners and developers straight away without the need for further manipulation.

DRIVING FORCE FOR CHANGE

London is one of the most densely populated cities in Europe with only Copenhagen, Brussels and Paris having higher densities. The Mayor of London's Plan (2004), predicts that the total population of London will rise by 900,000 by the year 2016 (greater than the current population of Leeds). It is obvious that, for London to cope with such a huge increase in population, it must grow and develop. The only way London can achieve this will be by looking outside its natural boundaries.

To the east of London is the Thames Gateway Region, a 40-mile stretch of land along the River Thames. The region is an area of contrast, on the one hand containing areas with international and national conservation designations such as the Thames and Medway Marshes but on the other containing the largest collection of brownfield sites in Western Europe. This is a result of the area's main industries (such as docks, gas works and power plants) closing down. With the loss of the region's main employers, the area has also suffered from a high level of unemployment and deprivation.

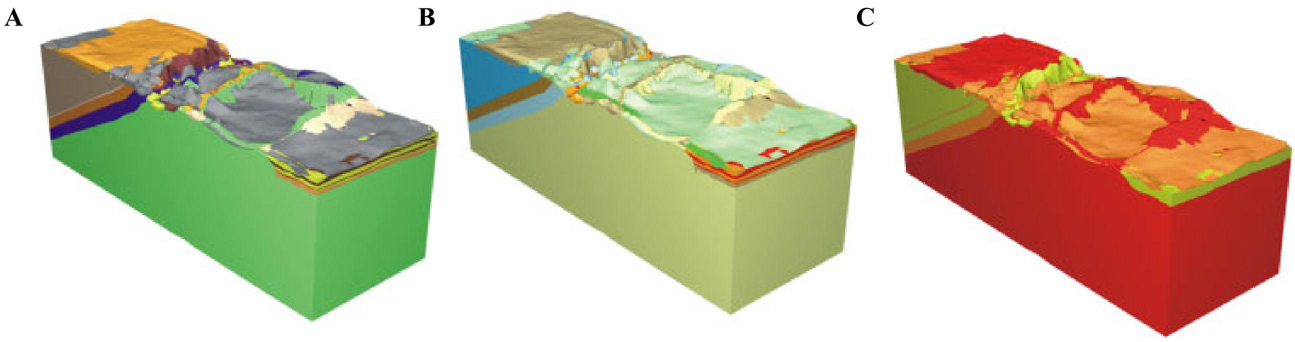

Figure 1. 3D Geological and property models for West Thurrock, A is the geological model, areas of peat (brown) are revealed beneath deposits of alluvium (yellow), River Terrace Deposits (orange) and man-made deposits (grey). Bedrock is composed of Palaeogene deposits (orange, blue and pink) underlain by Chalk (green); B displays 3D information on the variation of compressibility. Areas of high compressibility are coloured in orange and red, variable compressibility coloured in light brown to green and areas of low compressibility are in blue to brown and finally C shows the variation in hydraulic conductivity, high conductivity in red and low conductivity in green.

There are approximately 212 major brownfield sites amounting to 4,597 hectares of brownfield land, (ODPM and Roger Tym and Partners, 2002). If all this unused land were used to build houses, there would be enough space for 200,000 homes at a moderate density of less than 50 homes per hectare, thereby providing London with a solution to its current housing crisis and giving the region a chance to rejuvenate itself. As the Prime Minister and Deputy Prime Minister have said, "If we are to meet this housing need responsibly and sustainably, and provide for continued prosperity, we must seize the opportunity offered by this huge area of brownfield land and bring it back into productive use "(ODPM 2005).

This resulted in the Thames Gateway region being recognised as an area of substantial growth potential and in 1995 its own sub-regional planning guidance (RPG9a) was published. Shortly afterwards, the Department of the Environment published a good-practice guide on the impact of environmental improvements in urban regeneration (Thompson et al, 1998). The report suggested ways in which economic and environmental initiatives might be complimentary. The Thames Gateway offered a unique opportunity for the Government to put these ideals into practice. The Government's vision for the Thames Gateway is set out in the Sustainable Communities Plan and other related reports (ODPM 2003a and b, ODPM and DEFRA, 2004, ODPM 2005). Since then, within the Thames Gateway a raft of regeneration programmes and enterprises, including the Single Regeneration Budget, have sprung up in support of the Government's regeneration initiative.

Social and economic needs are therefore the main drivers for development within the Thames Gateway. Within Government, the major controlling force behind the development of sustainable communities is the Office of the Deputy Prime Minister (ODPM). ODPM's mission statement is to create prosperous, inclusive and sustainable communities for the 21st Century; places where people want to live that promote opportunity and a better quality of life (ODPM website June 2005).

The Thames Gateway region has, in the 2003/04 financial year, seen a 20% increase in the number of new houses being built compared to figures for 2002/03. The Government has pledged that 60,000 new homes will be built by 2010 and by 2016 the new build total will increase to 120,000 (ODPM, 2005). With the speed of development taking place, is the Government able to take account of environmental issues? Can sustainable development be achieved?

GEOSCIENCE ISSUES IN THE THAMES GATEWAY

All development involves the ground; therefore it is the ground that is the key natural resource that is affected by sustainable development. 90% of groundwater use within the Thames Water region is for public consumption, making up 34% of total water supply in the Thames Region. Pollute this resource and we will be affecting the lives of millions of people in the South East.

Our building foundations are buried within the ground, therefore the ground conditions are critically important if building stability is to be maintained. Change in climatic conditions or ground water levels will have significant effect on the physical properties of the ground.

There are six major geoscience issues in the Thames Gateway that need to be considered if development is to be sustainable:

Flooding

56% of land within the zones chosen for major redevelopment is within the floodplain. This means that these areas are vulnerable to flooding from both tidal surges and peak river-flows. This double-threat will make it very challenging to develop an effective approach to managing flood risk (ABI, 2004). Tidal surges from the North Sea have the greatest potential to lead to a catastrophic event. In 1953, over 300 people lost their lives and over 24,000 houses were flooded on the east coast of England after high winds and a swelling tide breached flood defences.

Although flood defences currently protect the area, the quoted design life for these is 2030, after which time flood protection within the London Thames area will be significantly reduced. The Environment Agency's strategic flood management plan for the Thames Estuary is due to be delivered to the Government in 2008/9, by which time nearly 60,000 new homes will have already been built.

According to a study by the Association of British Insurers (ABI), a third of new homes built in the Thames Gateway will face an "unacceptably high risk" of flooding. An extreme flooding event would, according to the ABI (2004), lead to damage in the order of £12-16 billion in the Thames Gateway, with £4-5billion coming from new developments.

Urban Water Budget

One of the major uncertainties of urbanisation is the urban water budget (the amount of water getting into the underground aquifer), which is much more complicated to calculate than its rural equivalent. This is because, currently, it is difficult to measure the total amount of leakage from underground pipes, particularly those which carry sewage, and to quantify the effects of the ground surface (whether covered by impermeable pavements, roads and houses or permeable parkland). Get it wrong and the resulting uncertainty can be costly, as groundwater levels rise beyond their historical levels, causing major problems of flooding (tunnels, basements, underground car parks) and foundation instability. Water-level rebound is already a recognised problem in London. The inability to capture and represent, for scenario modelling purposes, the complex processes at work in an urban area's water budget can be regarded as a deficiency in regional water management and makes modelling future scenarios impossible.

Contaminated land

As brownfield sites are targeted for redevelopment, planners are increasingly interested in the ability of the subsurface to detain, attenuate or dilute the products of former contaminating activities, especially if they are toxic. Can a developer confidently construct foundations and site services (e.g. on-site pluvial drainage) when the extent, thickness and geotechnical/engineering geology properties of made ground are so poorly mapped and measured? Will contaminants be mobilised during construction to surface watercourses or to a deeper receptor aquifer? Are proposed urban drainage solutions appropriate or will they compromise the sustainability of underlying water resources?

Foundation conditions

Most major development projects in the Thames Gateway will necessitate construction on ground that would be classed as 'difficult' in engineering terms such as compressible and collapsible soils often associated with alluvium and brickearth deposits associated with the River Thames.

Chalk bedrock underlies much of the Thames Gateway region. The upper Chalk surface is likely to have been effected by weathering. This weathered Chalk is often called "putty" chalk, which has similar characteristics to silt. This results in Chalk often having an irregular karstic surface characterised by sinkholes or infilled by compressible superficial deposits. In general, foundation conditions within the Chalk improve with depth. However, how deep do we have to go before we can be certain of reaching unweathered Chalk?

Failure to fully appreciate the ground conditions at the planning stage of any development is likely to prove costly and may lead to project over-run. A report by the Institution of Civil Engineers in 1993 found that half of 5,000 industrial building projects surveyed overran their construction programmes by more than one month; those on redeveloped sites had all met unforeseen ground conditions.

Climate change

The effects of climate change will not only affect sea level rise and increase the problems of flooding within the Gateway. It will also increase sediment transport into the estuary. But possibly the most unrecognized consequence would be the changes to physical properties of the ground and therefore the stability of building foundations. For example, if as predicted, our summers get hotter and winters wetter the amount of swell-shrink within clays and peat soils will increase. This is a significant problem for London and the Thames Gateway region as clay-rich deposits cover a substantial portion of the area. This will not only affect houses, but also roads and pipes. Current estimates put the cost of this damage at over £400 million a year, with the cost over the last ten years topping the £3 billion mark (Jones 2004).

Aggregate resources

If we are to develop sustainably, then we need to use our own locally derived natural resources before we go to the expense and environmentally detrimental effects of either dredging or importing from elsewhere.

Sterilisation of what is left of our aggregate resources is the main concern; there are still mineral resources within parts of the Thames Gateway - mainly sand and gravel (in old river channels underneath the present river alluvium) that could be used as construction aggregate but also brickearth (used for making bricks) and Chalk (DETR 1998).

Documentation on the safeguarding of mineral resources from sterilisation is contained in structural plans prepared by the Mineral Planning Authorities - in this case the relevant London Boroughs, Kent CC and Medway (2003), Essex CC (2001), and Thurrock, (2003).

MAKING DATA ON GEOSCIENCE MORE USABLE AND RELEVANT

Geoscience has, in the past and to some extent today, suffered from the data being difficult to interpret and use. The traditional method of presenting geological data is the geological map. It is an excellent way of recording what are essentially several data sets of 2D information on a flat surface. Its limitation is that, although the geoscientists find this an informative way of presenting huge amounts of information, many other users find it difficult and confusing. In essence, the geological map was designed by a geologist for a geologist. As a consequence, much of what the data has to offer, which is critical to the understanding of the urban earth system and therefore developing a sustainable future, has been lost. It has become noticeable that if geoscientists are to get their message across, they need to present their data in very different ways.

Rapid developments in three-dimensional (3D) modelling software are providing challenging and exciting possibilities for constructing high-resolution geological models of the shallow sub-surface. This will ultimately make geoscience data more accessible, relevant and understandable to a wide range of stakeholders within the development areas.

Before these derived products can be developed the geoscientist must first understand fully why geoscience data has not been fully utilised and in what format to place data that stakeholders would be most familiar with and find most useful. A consultation with many of the stakeholders was carried out, and the results of these discussions are listed below.

Relevance and affordability

The relevance of geological data is the number one issue to be resolved. Once the significance of the data is understood, the need will outweigh its cost. If the key areas for redevelopment have already been chosen, one might reasonably ask, “Geology - why consider it now?” The answer to a geoscientist is straightforward. For the most part, the key development areas have been selected primarily on the basis of socio-economic factors. However, environmental issues – sustainable urban drainage, biodiversity, and flood control and foundation conditions – remain important considerations, for which an understanding of the geology can be critical.

However, government, as a whole, can be said to have limited resources, and a tendency to look at the short term. The resulting effect is that only issues that are currently significant are dealt with. An excellent example is Britain’s ‘foot and mouth’ epidemic in 2001. Digital geological information provided government agencies with the data necessary to manage the fast disposal of carcases to prevent the further spread of disease and without contamination to ground water supplies. Because of this immediate need to obtain data quickly, Government realised the importance and power of GIS data resources.

The Government has made local authorities responsible for assessing, cleaning up and redeveloping brownfield sites in preference to developing greenfield areas. They have also been asked to ensure that they make the best use of natural resources and protect and conserve their region’s natural heritage. The Kent County Structure Plan, which applies to much of the Thames Gateway, contains a strategic land use policy stating that: “In the Thames Gateway it is strategic policy to upgrade the quality of the environment and to enhance the economic base of the area… Decisions affecting the environmental quality of the area should take into account the cumulative impact of the proposal in question, in the context of other development and proposals.”

However, local authorities within the Thames Gateway are some of the poorest authorities in the UK and have many priorities. The cost effectiveness of each individual local authority buying its own set of geoscience data is prohibitive unless UK or European legislation changes and even then many authorities will not necessarily purchase the most up to date or appropriate geological information.

It would seem, however, that, since this data is of such fundamental importance, Central Government itself should provide it, thereby ensuring the data is available to all, and to the high standards that only a national geological survey such as the BGS can provide.

Answers not data

Combined with the difficulty of interpreting geoscience data is the problem of data overload. The wider community does not have the time to interpret geoscience data nor does it feel comfortable with the task. It is clear from discussions with professionals within related disciplines e.g. those in the geotechnical industry, that they do not necessarily understand the relevance or importance of the geoscience data provided to them.

More specific to the Thames Gateway Region is the feeling amongst many non-government agencies that the strength of the social and economic argument is such that, whatever the environmental problems, these will not stop redevelopment from taking place (Evans et al, 2004). Therefore, there is little or no point in providing planners within government with raw data or interpretations that only tell them what they cannot do. The answer is in providing interpreted data in a more palatable form that clearly defines problems with potential solutions placed in GIS packages that are user friendly.

Data visualisation

Data visualisation and presentation is a prime concern for all stakeholders, as most of the geotechnical and environmental data has to be presented to senior officials in central government, local planning officers or potential contractors. 5 key points have come out of discussions:

- The data and information needs to be presented in a way that is understandable.
- There is a need to be able to display point and surface data from other sources together with the 3D geological model.
- All models need to be developed in such a way as to make them easily updatable, so that the effects of new site survey work etc. can be shown quickly and easily.
- Data presentation in the form that the geotechnical engineer needs is particularly appealing to geotechnical consultancies and Government bodies such as Transport for London.
- For local authorities, which do not have GIS systems, the appeal of having data provided for them in a free viewer negates the problem of them having to invest in new software.

DEVELOPMENTS IN GEOSCIENCE DATA PRESENTATION AND VISUALISATION

Developments in three-dimensional (3D) modelling software are now providing new and exciting possibilities for constructing geological models of the shallow sub-surface. Using this new technology, we can start to predict not only the type of rocks and soils that lie beneath our feet, but also their physical and mechanical properties.

3D models of the shallow subsurface

Modelling the shallow sub-surface can help predict potentially difficult engineering ground conditions by assessing the thickness, geometry and distribution of individual geological units (Fig 2). A full assessment of ground conditions using available borehole or trial pit data can be used to reduce uncertainty in understanding the nature of the ground prior to development (Fig 2). Each unit can be characterised in terms of its lithology, lithostratigraphy and attributed with a variety of property information that may include suitability for foundations, strength, compressibility or other property information.

3-D models, especially in urban areas such as the Lower Lea Valley in East London (where the 2012 Olympics will be held), can include information on the thickness and distribution of artificial ground. This can be linked to land use history to fully understand changes in the ground surface as a result of anthropogenic activity that may affect the nature of the sub-surface. This will ultimately provide an assessment in 3D of the potentially contaminated land within a particular area. The 3D model can then be used to estimate the thickness of these deposits providing the developer with a much clearer indication of the likely cost of remediation measures at the beginning of the planning process before ground investigation work has been carried out.

The model can then be used to effectively plan the ground investigation phase and ultimately will result in significant time and resource savings as problems with difficult ground conditions can be anticipated and mitigated.

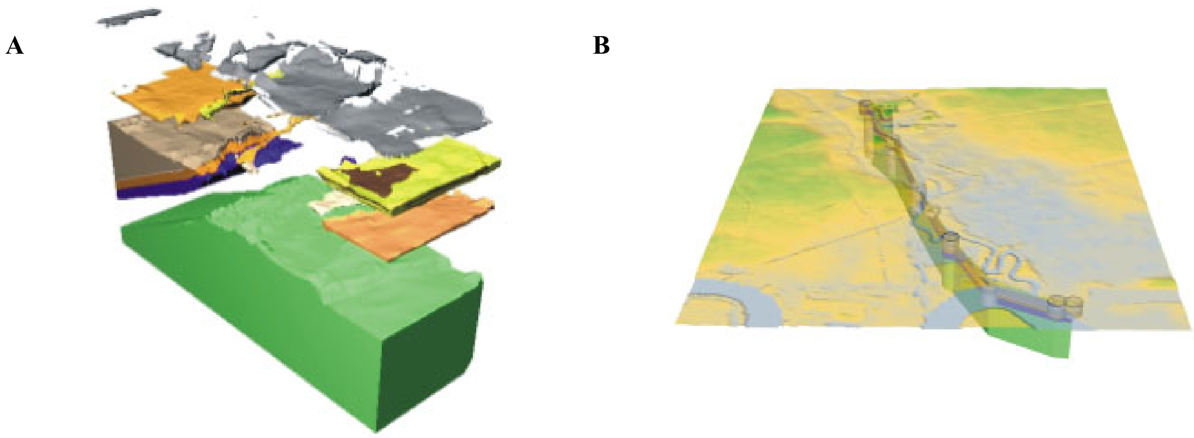

Figure 2. A: 3D model of Thurrock**,** areas of peat (brown) are revealed beneath deposits of alluvium (yellow), River Terrace Deposits (orange) and man-made deposits (grey). Bedrock is composed of Palaeogene deposits (orange, blue and pink) underlain by Chalk (green). B: Digital elevation model of the Lower Lea Valley area with N-S cross-section of the underlying geology superimposed. Man made deposits (grey), alluvium (yellow), Lambeth Group (orange), Thanet Sands (blue) and Chalk (Green).

Sustainable urban drainage and urban flooding

With escalating development and the growth in urban areas of hard paved surfaces, the problems associated with surface water run-off are a significant issue. The Foresight project (2004) predicted that the continued urbanisation of flood-prone areas, such as the Lea Valley, would result in an increase in surface water run-off, such that the flood risk would be increased by up to 3 times its current level.

SUDS (Sustainable Urban Drainage Systems) are an alternative approach to conventional drainage systems that try to mimic natural drainage patterns as far as possible. The successful implementation of SUDS techniques, including swales, balancing ponds and porous pavements can save money, reduce pollution and alleviate flood risk (CIRIA 2001). The environmental statement prepared by the Symonds Group Ltd. (2004) for the London development agency indicated that SUDS as a means of reducing run-off would be used in the Olympic Park area (Lower Lea Valley) as well as brown roofs and stony meadows and permeable paving.

SUDS techniques need to be addressed at the early stages of project design to determine their suitability. The BGS has developed methods that allow the applicability of SUDS to be assessed quickly and simply, by reference to the 3D lithological model (rock type e.g. sand, clay, peat etc). Data used in the assessment includes: the topographic slope angle, the permeability of the near-surface deposits and the thickness of the unsaturated zone. BGS can then provide charts that combine all this information into a simple tri-category map; areas more suited to infiltration techniques can then be easily identified.

Further information can be added e.g. potential contamination, present day land use and aquifer vulnerability. This type of information will be invaluable in the Olympic development, as watercourses will be opened up and wetland areas extended along the riverbanks. If unidentified soil and groundwater contamination is present, there is a potential that these contaminants will migrate via these newly formed pathways posing a significant risk to water quality if unmitigated. The 3D model will be able to assess more accurately the likelihood of such a situation-taking place and provide information to help mitigate the situation before it occurs.

All this data can be easily incorporated into the 3D model, resulting in a more sophisticated site-specific interpretation. These maps provide answers at a click of a button and can be viewed in most GIS software packages, making it easy and simple to use.

GEOENGINEERING REVEALED IN 3D

The 3D model in Fig. 3 is classified for engineering geological characteristics based on description, geotechnical properties and known engineering behaviour. The model could also be attributed for a number of engineering geological themes including: foundation conditions (shallow and deep), excavatability (shallow and deep), use of material as fill.

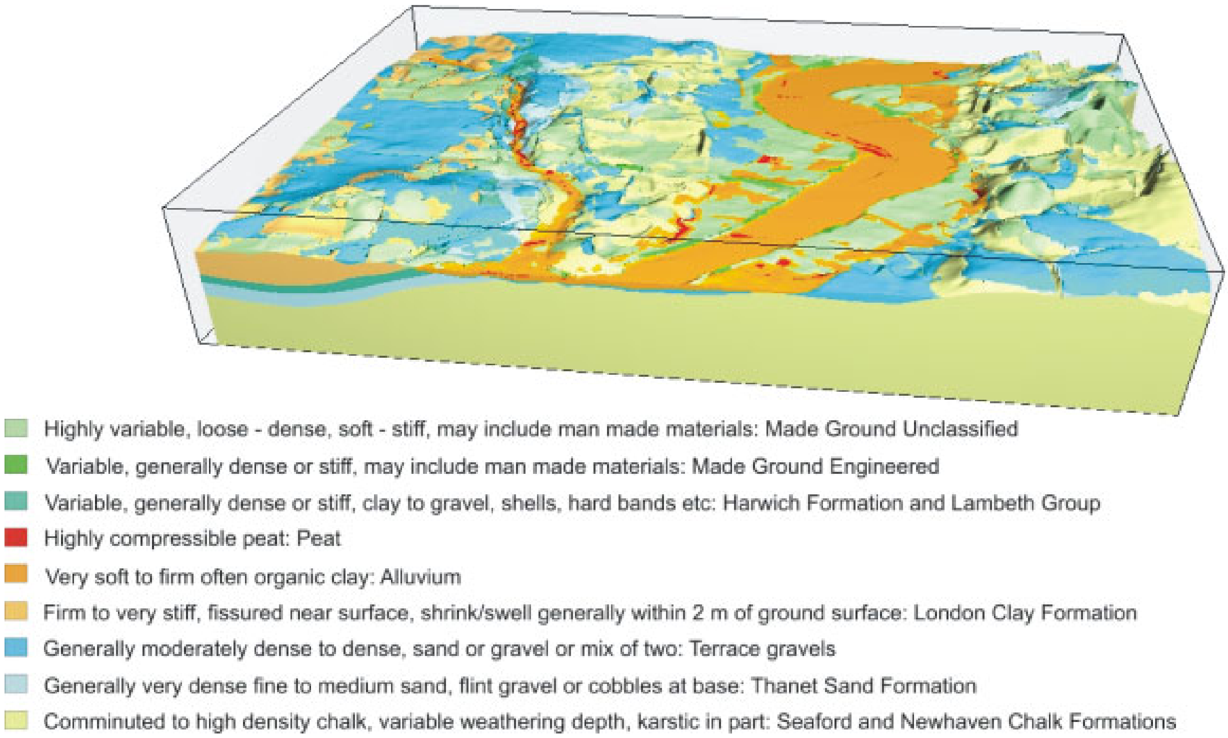

Figure 3. 3D block model of the variation in compressibility for the area between Dartford and Thurrock. Areas of high compressibility are coloured in orange and red, variable compressibility coloured in light brown to green and areas of low compressibility are in blue to brown.

Using the 3D model and data from the National Geotechnical Properties Database, a desk study can be carried out to provide information for, say, the construction of a structure with high foundation loads to be built in Erith (a town in the area) within an area of alluvium.

The geotechnical information indicates that the alluvium is unsuitable for foundations with high loads because it is generally very soft to firm clay with organic peat layers of low bearing capacity and high compressibility. A contour map of the thickness of the alluvium, using data from the 3D model and presented in ArcGIS, shows that the alluvium is more than 15m thick therefore the structure will have to be founded on piles (Fig 4). The 3D model shows that the two deposits below the alluvium are gravels (the Shepperton Formation) and Chalk (the Seaford and Newhaven Formations). Standard Penetration Test (SPT) and particle size data from the National Geotechnical Properties Database show the gravel to be generally moderately dense to dense sandy gravel. A contour map of the thickness (isopachs) of gravel can be produced.

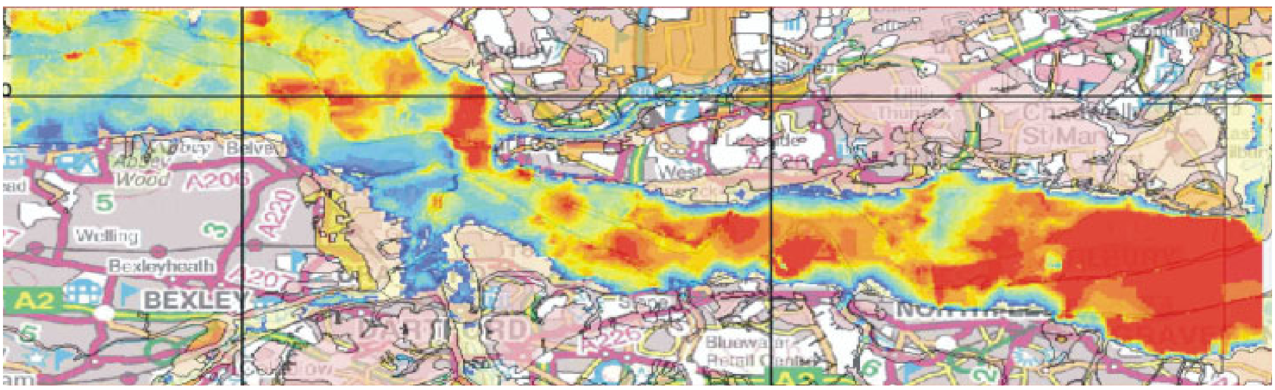

Figure 4. Contour map of the thickness of the alluvium between Bexley and Tilbury displayed in ArcGIS generated from the 3D geological Model.

If the gravel is not a suitable foundation medium then the piles will have to be founded in the Chalk. The depth to the Chalk is known from the 3D model. However, the descriptions of the Chalk and geotechnical data, including SPT values, indicate that the upper metre or so contains variable depths of structureless and low-density Chalk ('putty' Chalk) and that in some areas the Chalk is karstic (Fig 5). It is likely that in some areas the depth to 'good' quality

Chalk will be variable. The 3D model combined with geotechnical data can give an indication of depth to 'good' quality chalk. Further data acquired from the site investigation can be added to the 3D model allowing it to be used to aid foundation design and construction.

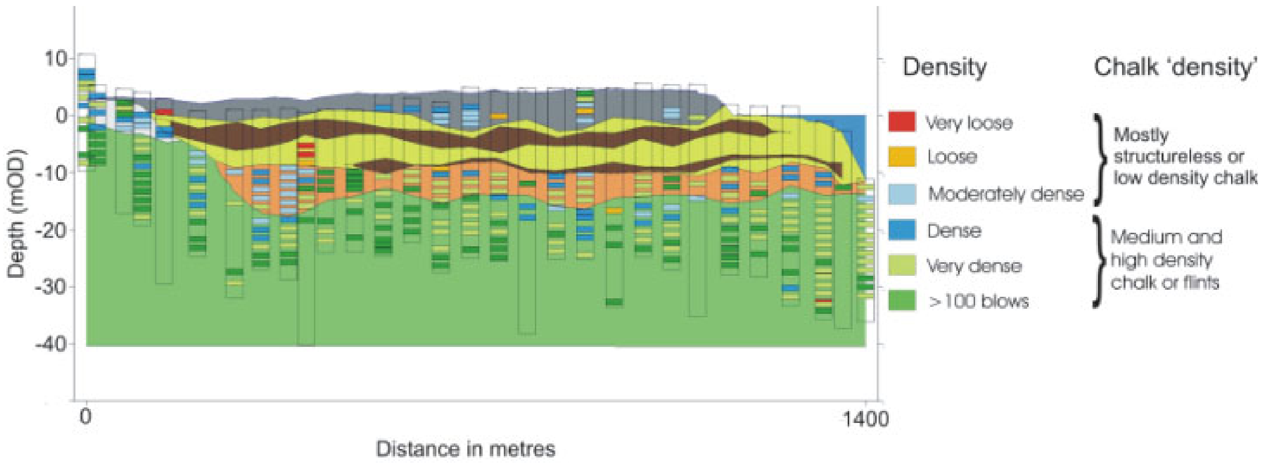

Figure 5. Cross-section showing the variation of SPT values within the Gravels and Chalk within grid square TQ57NW.

Furthermore, a desk study using the 3D model combined with data from the National Geotechnical Property Database provides information on the likely behaviour and thicknesses of the materials to be encountered on site. This allows the ground investigation to be better targeted, including possible changes in drilling methods and the depths to which drilling will have to go to characterise the chalk for the piled foundations. Nearer the surface, the highly compressible alluvium and highly variable made ground may affect the trafficability on site during construction, so ground improvement methods may be required. Using the 3D model in this way, combined with the geotechnical data, should greatly reduce 'unforeseen ground conditions', reducing cost over-runs and allow better planning of the site investigation and more accurate costing of the structure.

CONCLUSIONS

The main drivers for development within the Thames Gateway are social and economic. Although the environment is a key issue and policy documents such as 'Greening the Gateway' (ODPM and DEFRA 2004) have addressed some environmental issues, little action has been taken. Is the Government really interested in sustainable development, when for example the Environment Agency's flood defence plan will not be published until 2008/9 by which time half of the total number of proposed houses will have been built? But can scientists lay all the blame at the Government's door when they have not presented information in a form that can be clearly understood? It is demonstrable that the value in having vast quantities of information is not in the possession of it, but the interpretation and presentation of that data to the people that need it most.

Geoscientists have undergone a revolution in the way that they display and interpret data. Urban geoscientists are now not just providing raw data but interpreted data, not just 3D geological models but 3D models of properties, which can be used to provide answers to many of the problems encountered by planners and developers today, without the need for further manipulation. This data revolution will now allow for a wider uptake of geoscience data by non-specialists.

Once this is done, will developers and planners take notice of the available information? It is evident that the speed of development in the Thames Gateway will not wait for geoscientists; rather, if these issues are to be understood, the onus is on geoscientists to meet the stakeholders. There is a need for the geoscience community to impress upon policy makers and strategic planners that it is only through a full understanding of the ground conditions that sustainable development is achievable and, furthermore, that using geological data need not be a time-consuming or an expensive exercise. Investment now in the management of geo-information and the development of 3D geological models of the shallow subsurface will provide benefits for the whole of the Thames gateway for decades to come.

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