London - History of the survey

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The first geological survey of the district was carried out by W Whitaker and others, on a scale of one inch to one mile (1:63 360). The maps, covering a larger area than in this account, were published on [Old Series] sheets 1, 6, 7 and 8 between 1861 and 1868. A wealth of local detail on exposures in the area was published in the first memoir of the district (Whitaker, 1872). Drift deposits were mapped later and shown on new editions of the maps, published between 1869 and 1889. Information about the superficial deposits was incorporated in a revised memoir (Whitaker, 1889). Four special 1:63 360 scale maps covering London were published in 1903, and these made use of the first mapping at the scale of six inches to one mile (1:10 560) in part of the present district by T I Pocock and J A Howe. A memoir (Woodward, 1909) was also produced, and subsequently revised by C E N Bromehead and C P Chatwin for a second edition published in 1922.

The first systematic large-scale mapping (1:10 560) of the district on the County Series maps, was completed in 1922; C E N Bromehead, H G Dines, F H Edmunds and H Dewey were the principal geological surveyors. The mapping was compiled and published on the new component one-inch (1:63 360) map sheets for the district: North London (256), Romford (257), South London (270) and Dartford (271). The memoirs for the sheets, respectively, by Bromehead (1925), Dines and Edmunds (1925), Dewey and Bromehead (1921) and Dewey et al. (1924) describe information obtained from the detailed survey and supplement the data from the earlier memoirs. Minor amendments to the 1:10 560 scale maps, as a consequence of temporary exposures, were incorporated in later editions of the one-inch maps. A partial resurvey at 1:10 560 scale was made by F G Berry, T E Lawson and B S P Moorlock in south London from 1973 to 1980, as part of an environmental geological study funded by the former Department of the Environment, which also funded similar work in south-west Essex that entailed resurvey at 1:10 000 scale and the publication of a set of thematic applied geology maps (Moorlock and Smith, 1991). In 1992, a new project, known as LOCUS (London Computerised Underground and Surface) was initiated to produce digital 1:10 000 scale maps for the district, a comprehensive borehole database and three-dimensional models of the geology of London (Ellison et al., 1993). Between 1992 and 1996 Artificial deposits were added to all the maps, the North London and South London sheets were revised, and large areas of the Romford and Dartford sheets were resurveyed, largely by A J M Barron, R A Ellison, D H Jeffery, R T Mogdridge, B S P Moorlock, A Smith, P J Strange and I T Williamson. This work led to the publication between 1993 and 1998 of new 1:50 000 scale geological maps, available also in digital format. Further details on survey dates of specific sheets can be obtained on the BGS web site: www.bgs.ac.uk.

Internal BGS Reports on various aspects of the geology have contributed to this memoir: notably by C Hallsworth on heavy minerals in the Palaeogene, J M Pearse, S J Kemp and V L Hards on the mineralogy and petrography of the Lambeth Group, G E Strong on the petrography of the Thanet Sand, R Harland on the Palaeogene dinoflagellates and M A Woods on the Chalk palaeontology.

Geological history

In early Palaeozoic times, most of the district lay within the tectonic province known as the Midlands Microcraton, which consists of crystalline basement rocks of Neoproterozoic age overlain by a relatively thin cover (3000 m maximum) of early Proterozoic strata. The crystalline substrate comprises island-arc volcanic rocks which were erupted about 600 Ma and associated marginal basin, sedimentary rocks comparable to the Neoproterozoic strata of Charnwood Forest. The nearest proving of these rocks to the London district is in the Withycombe Farm Borehole about 75 km to north-west.

The oldest cratonic cover rocks are clastic sedimentary rocks of Cambrian and Tremadoc age. These are overlain by Silurian, shallow-water, shelf sediments and Devonian fluvial deposits derived from newly emergent Caledonide massifs of Wales and northern England. Ordovician strata are probably absent beneath the district.

The edge of the Midlands Microcraton lay in the north-east of the district. Beyond it, Silurian strata of turbiditic facies were deposited in relatively deep water, as proved in deep boreholes in East Anglia and north-east Kent (Molyneux, 1991; Sumbler, 1996). The Palaeozoic cratonic cover rocks were deformed in Early Devonian (Emsian) times by the Acadian phase of the Caledonide orogeny, which was caused by the collision of the Armorican Microcontinent with the Caledonian Terrane (Soper et al., 1987). North-east of the Midlands Microcraton, in the area now known as the Eastern England Caledonides, this deformation was intense, as shown by Silurian strata proved in boreholes in East Anglia that are folded and show a penetrative cleavage (Bullard, 1940; Pharaoh et al., 1987; Woodcock, 1991).

The succeeding middle and late Devonian strata rest unconformably on strata of the Acadian fold-belt. They consist mainly of nonmarine clastic sedimentary rocks intercalated with marine deposits laid down during incursions from the south by the Rheic Ocean. During Carboniferous times the uplifted Devonian succession became part of a new stable high, the Anglo-Brabant Massif that stretched from the Welsh Borders to Belgium. Foreland extensional basins developed within the massif as a consequence of the northward advance of the Variscan orogenic front. These basins received clastic sediment eroded from the Massif (Besly and Kelling, 1988) which accumulated in large deltas to form coal measures and red beds of Upper Carboniferous age. The nearest coal measures to the London district are in the Oxfordshire–Berkshire area and east Kent. Illite crystallinity values for the Lower Palaeozoic strata beneath London indicate former burial beneath 4000 to 5000 m of sediment, possibly including Coal Measures, which has been subsequently removed by erosion.

The main east–west orientated Variscan orogenic front lay to the south of the district, although subparallel linear gravity anomalies in the district may be due to peripheral Variscan thrust faults in the Palaeozoic basement rocks (Figures 42 and 43) (Keary and Rabae, 1996).

Throughout much of the Mesozoic, the district continued to be a stable upland, now known as the London Platform. North–south extension during Permian and Triassic times resulted in the formation of the Weald Basin to the south, which received sediment derived from the London Platform. The bounding structures of this basin had a dominant influence on all subsequent events in the district. From Early Jurassic to Early Cretaceous times, there was further extensional subsidence in the Weald Basin, on reactivated Variscan thrust structures (Chadwick, 1986), including the Addington Thrust (Figure 2). North of this structure, the London district remained as a stable area covered by shallow shelf seas, but lying quite close to land. Jurassic to Early Cretaceous strata record this shallow marine environment but also indicate periods of emergence from time to time with the deposition of nonmarine sediments.

The latest part of the Jurassic Period and the early part of the Cretaceous, sometimes referred to as 'Late Cimmerian', was a time of intense tectonic activity in Europe. Late Cimmerian earth movements were associated with the northward extension of a zone of ocean-floor spreading that caused the gradual opening of the north Atlantic, and led to uplift of the London district, retreat of the sea and extensive erosion of the Jurassic strata, uncovering once more the Palaeozoic basement rocks. Subsidence of the fault-bounded Weald Basin to the south continued, and sediments derived form the London Platform accumulated in terrestrial environments to form the Wealden Group. In the early Aptian, the sea once again flooded the London Platform initiating deposition of a post-rift sequence of shallow marine sediments, beginning with the Lower Greensand Group and culminating with the deposition of the Gault and Chalk during a prolonged period of high sea level.

In late Cretaceous times, this region was affected to some extent by the tectonic events that produced the Alpine mountain chain in southern Europe. An early phase of late Cretaceous to early Palaeogene inversion caused gentle folding and erosion of the Chalk. The overlying Palaeogene sediments were laid down in shallow marine and coastal environments. The main Alpine compressional event occurred in late Oligocene to mid-Miocene times, when the London Basin, a broad synclinorium, was developed. Smaller folds, notably the Greenwich Anticline (Figure 42), were caused by inversion of the long-established, deep-seated faults at the southern edge of the London Platform.

For most of the period between the late Eocene and Quaternary, about 40 million years, the district was land, and pre-existing deposits were weathered and dissected. The sea may have covered the district temporarily in Pliocene times, and remnants of coastal gravel deposits now cap the highest ground. A new drainage pattern was established in the early Quaternary. At this time, rivers flowed across the district from the south and south-west towards a major river, the precursor of the River Thames that flowed from Wales, across the Midlands and East Anglia to the North Sea.

When great ice sheets advanced to cover much of Britain as far south as the outskirts of the London district, about 500 000 years ago, the river system was irreversibly changed and the Thames was diverted to its present-day valley. The succeeding river terrace deposits laid down in the valley are well preserved. The main periods of gravel deposition and intervening phases of downcutting took place during cold episodes when rivers were swollen with glacial meltwaters and erosion was more intense. Finally, the most recent deposits, river alluvium and tidal river sediments, have been deposited in the last 8000 years or so, during an interval of relatively low river discharge and periodic flooding.

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