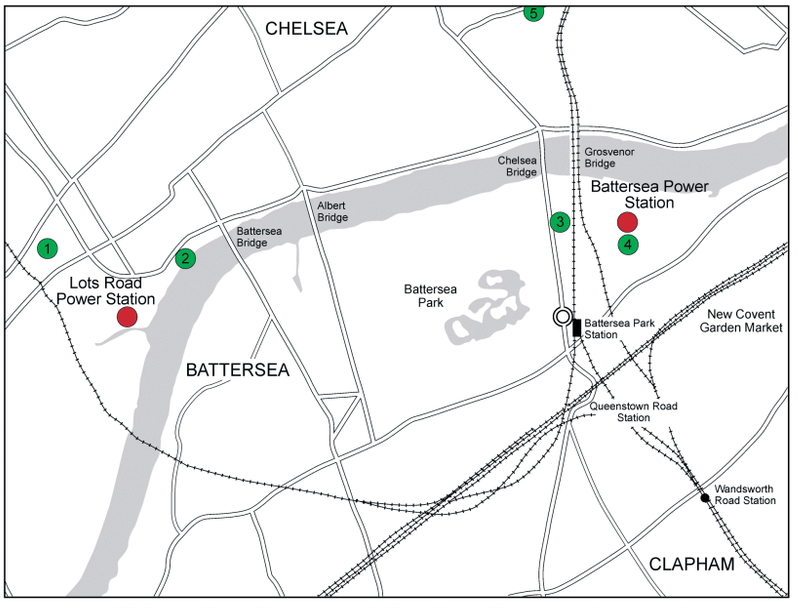
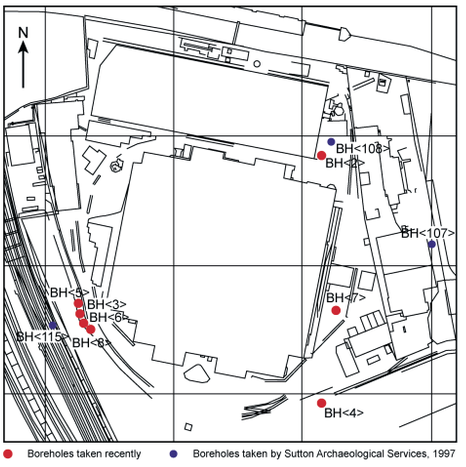
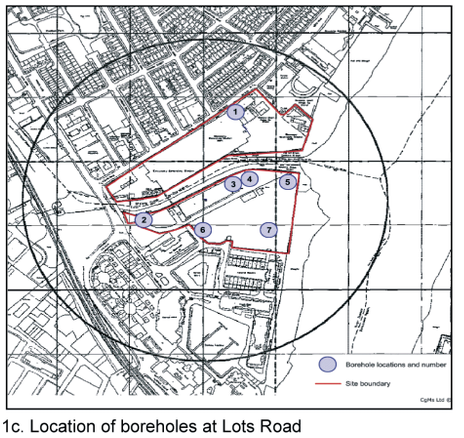


1a. Location of Battersea Power Station and Lots Road Power Station and other sites of interest.



1b. Location of boreholes at Battersea



1c. Location of boreholes at Lots Road

Fig. 1: location of Battersea and Lots Road Power Stations and nearby sites mentioned in the text (nos. 1–5)

A tale of two power stations: environmental archaeological investigations at Battersea and Lots Road

Nicholas Branch, Christopher Green, Robert Batchelor, Daniel Young, Scott Elias, Nigel Cameron and John Athersuch

Introduction

Environmental archaeological investigations at Battersea Power Station (TQ 290 775) and Lots Road Power Station (TQ 264 769), in advance of proposed development, provided an opportunity to enhance our understanding of the timing and nature of sedimentary and vegetation changes in this part of the Middle Thames Valley (Fig. 1). Due to the long history of industrial development of both sites, recovery of high-quality borehole core samples (by cable percussion), suitable for laboratory analysis, proved to be extremely challenging. Nevertheless, each core sample recovered was described (noting the physical properties, composition, unit boundaries and inclusions) and sub-samples extracted for radiocarbon dating (calibrated using OxCal v4.0.1 and the IntCal04 atmospheric curve)[1-3] from selected sequences having organic-rich sedimentary units. Assessment of the biostratigraphic remains (pollen, diatoms, Ostracoda, Foraminifera, plant macrofossils and insects) was conducted on selected core samples using standard extraction and evaluation procedures.[4-7] Only those

few pollen samples having the best preservation and concentration were subject to full analysis.

Geology, sedimentary successions and geochronology

Battersea Power Station

Battersea Power Station is on the south bank of the River Thames, occupying a site that extends back from the present waterfront for about 300 m. The whole site is mapped by the BGS as Alluvium obscured by Made Ground, and can be regarded therefore as part of the historic floodplain of the River Thames. Beneath the floodplain in this area, up to 7.6 m of sand and gravel have been recorded (the Shepperton Gravel) resting on London Clay, which is overlain by alluvial deposits including peat (the Staines Alluvial Deposit).[8] The new sedimentary records from Battersea Power Station confirm this general sequence, with Shepperton Gravel (BH<2>, <3>, <7> and <8>), succeeded by various fine-grained and sometimes organic alluvial sediments. The mineral deposits have occasional fragments of wood and organic detritus, representing either long-distance transportation of organic matter or *in situ* deposition of detritus from plants growing within, or on the margins of, the open water body. BH<2> (-2.10 to -2.16m OD), BH<3> (-2.18 to -2.22m OD), BH<7> (-1.52 to -1.56 m OD) and BH<8> (-2.92 to -2.97 m OD) record the presence of peat formation and / or deposition of highly organic sediments (Fig. 2). The earliest phase of peat formation was recorded in BH<2> at 4360–4230 cal BC, with later phases dated to 3370–3010 cal BC (BH<2>), 2030–1870/1840–1780 cal BC (BH<3>) and 2050–1740 cal BC (BH<7>). These data confirm previous investigations,[9] indicating the presence of a topographic depression, probably a former river channel with incision greater than -3.22 m OD, which had progressively infilled with mineral sediments and peat during the Holocene. The radiocarbon dates obtained from BH<2>, <3>, <7> and <8>, together with those from previous work (KTL97; Fig. 1a, no. 4: 2201–1779 cal BC (BH<108>), 9283–8919 cal BC, 806–408 cal BC and 620–890 cal AD (BH<107>), and 3310–2877 cal BC (BH<115>) indicate discontinuous organic sediment / peat accumulation from the Mesolithic period onwards.

Other sites close to Battersea Power Station, such as Queenstown Road (QST01; Fig. 1a, no. 3),[10] have also recorded phases of organic sedimentation at 4242–3800 cal BC, 1220–1426 cal AD and 1160–1390 cal AD. On the north bank of the river at 199–203 Buckingham Palace Road (BPR97; Fig. 1a, no. 5),[11] organic sediments and peat accumulated at 9216–8481 cal BC, 8232–7595 cal BC, 348 BC – 119 cal AD and 27–383 cal AD.

Lots Road Power Station

Lots Road Power Station is 250 m from the modern course of the River Thames on the north bank of the river. Chelsea Creek, the lower reach of a minor left-bank tributary of the Thames, is close by to the west and south of the site. The broad spread of alluvium marking the confluence of Chelsea Creek with the Thames extends for a short distance into the southern corner of the site. The remainder of the site is mapped by the BGS as Kempton Park Gravel, with the alluvium abutting this gravel to the east of the Creek. The alluvium in other areas overlies the Shepperton Gravel. Both the Kempton Park Gravel and Shepperton Gravel overlie London Clay. The ground surface is underlain by substantial but varying thicknesses of made ground (Fig. 3). The highest level at which undisturbed natural/semi-natural alluvium was recognised was 4.57 m OD in BH4 (Fig. 1c). In the other boreholes, natural/semi-natural alluvial sediments were encountered at levels between 3.52 m OD (BH7) and 0.91 m OD (BH5). Sandy gravel was encountered beneath the fine-grained alluvium at -0.02 m OD in BH5 and at 0.80 m OD in BH7. Gravelly silt was encountered in BH3 at 0.49 m OD and in BH4 at the higher level of 2.16 m OD. Thus, in broad terms, the alluvial sequence beneath Lots Road Power Station consists of silts and sandy and clayey silts overlying sand and gravel. In the fine-grained alluvium, plant remains are common throughout, and mollusc remains are common in the upper part of the sequence. In BH1, 3, 6 and 7, thin peat horizons were present between 1.99 m OD (BH6) and 0.29 m OD (BH1).

In BH1, located to the north of the Chelsea Creek, a very dark brown sandy peat was present from 0.29 m to 1.13 m OD. This represents the earliest phase of peat formation at Lots Road, which commenced 910–790 cal BC and finished 400–350/300–210 cal BC. A second peat unit was also present from 1.29 to 1.40 m OD. These two peat units were separated by grey sandy silt containing common plant remains (1.13 to 1.29 m OD).

In BH3, located to the south of the Chelsea Creek, thin peat horizons were described within dark grey silt (0.49 to 1.15 m OD) between 0.56 to 0.61 m OD. Directly above this unit further thin peat horizons (between 1.48 and 1.54 m OD and 1.65 and 1.67 m OD) were described within very dark grey silt (1.15 to 1.75 m OD). These phases of peat formation were radiocarbon dated to 420–610 cal AD and 430–640 cal AD respectively. However, nearby sites have produced markedly older radiocarbon ages for phases of organic sedimentation; at 552 Kings Road, Chelsea (KRC98),[12] a radiocarbon date of 8201–7748 cal BC was obtained from the fill of a palaeochannel, whilst at Chelsea Harbour (FKN01; Fig. 1a, nos. 1 and 2), three samples from a peat unit provided ages of 3936–3652 cal BC, 3650–3376 cal BC and 3888–3642 cal BC.

Biostratigraphy

Detailed analysis of all suitable core samples from Battersea and Lots Road Power Stations was hindered by the poor preservation and low concentrations of sub-fossil biological remains. The reason for this is

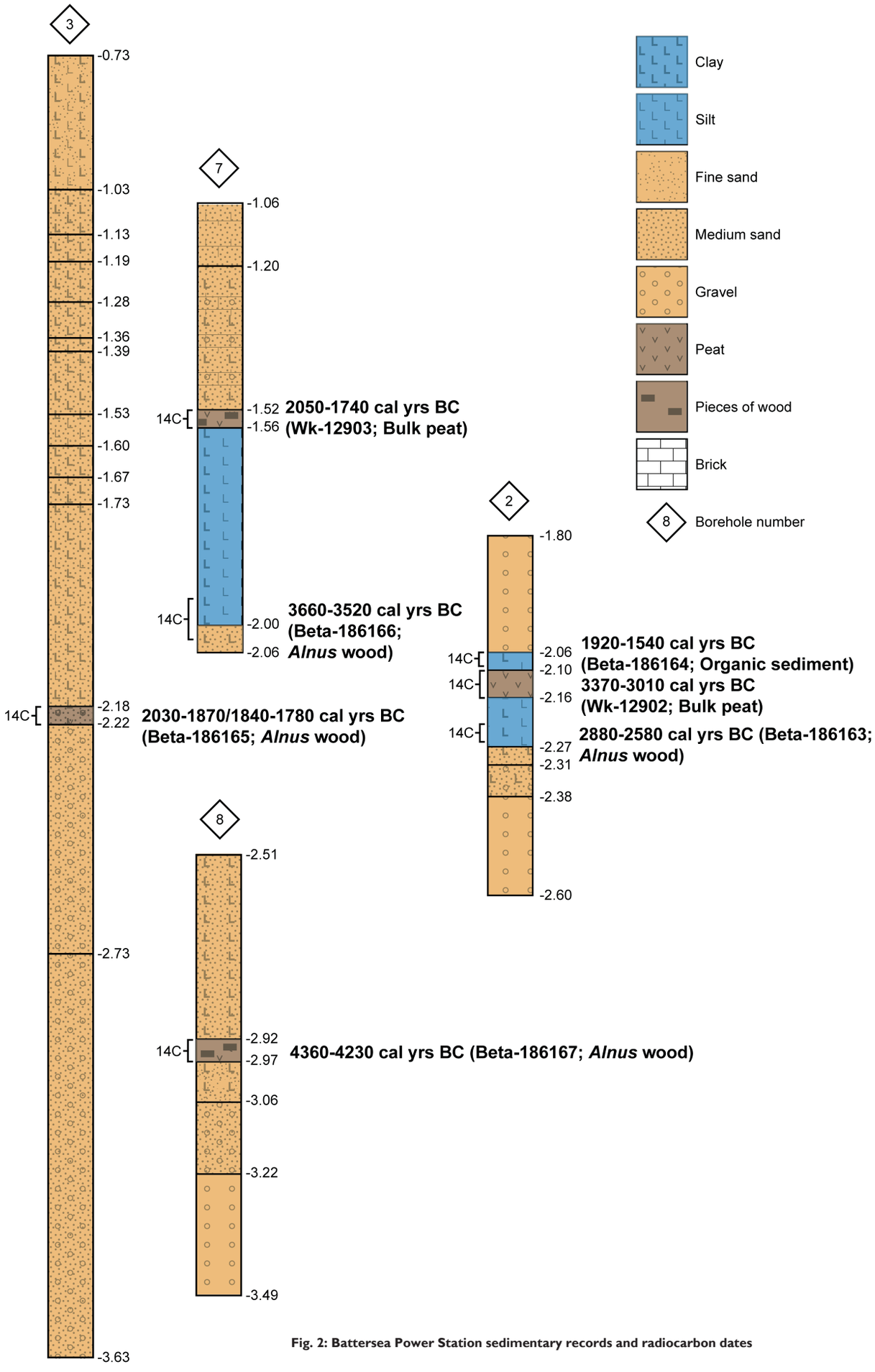


Fig. 2: Battersea Power Station sedimentary records and radiocarbon dates

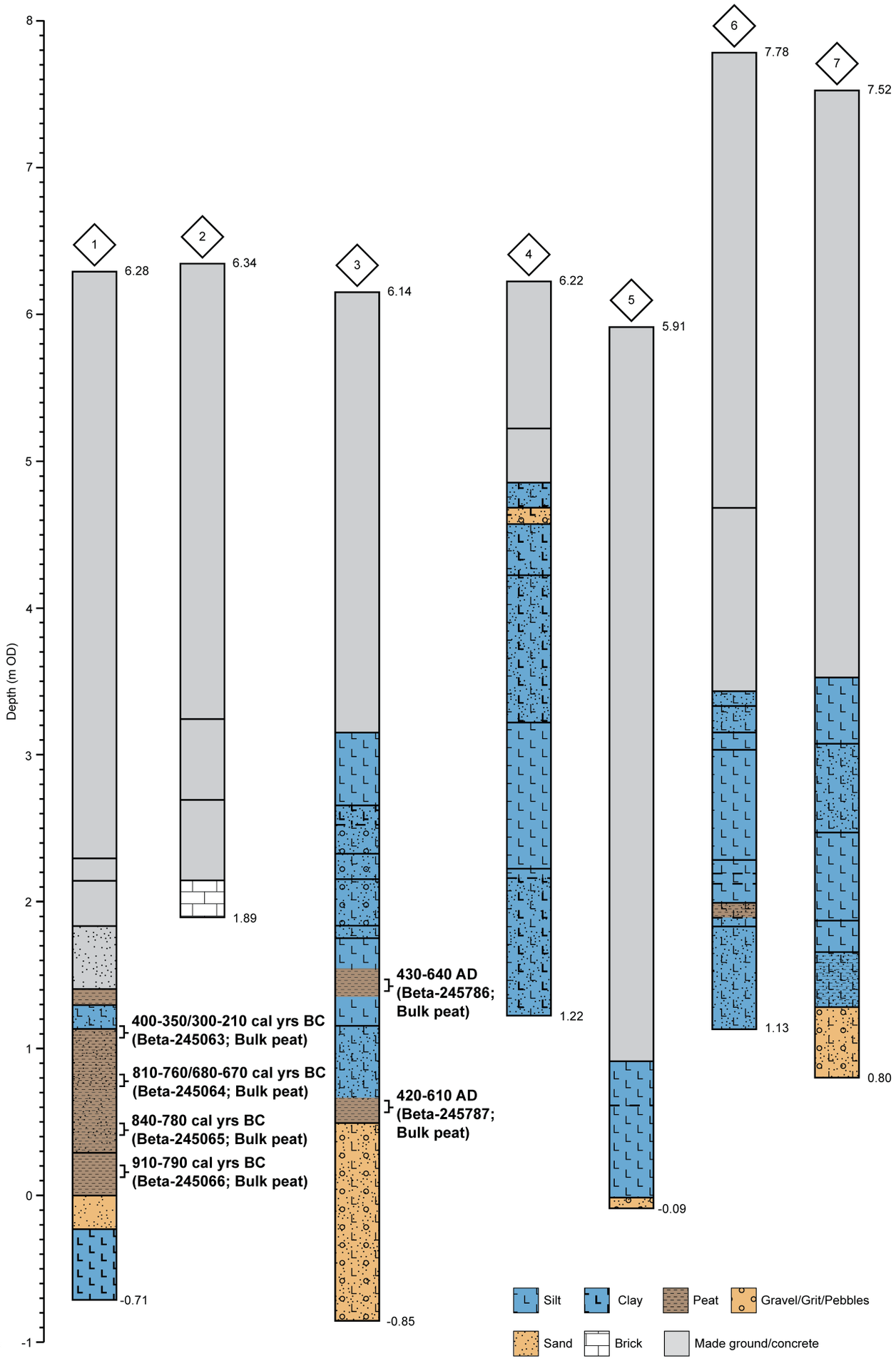


Fig. 3: Lots Road Power Station sedimentary records and radiocarbon dates

unclear, but it may be due to a combination of factors, especially physical and chemical destruction, that occurred both at the same time as the deposition of the sediments and more recently due to industrial development. Nevertheless, the assessment and analysis data from both sites (Figs 4 and 5), together with the sedimentary and geochronological records (Figs 2 and 3) does permit a general reconstruction of the environmental history, which may be tested against data from future investigations in this part of the Middle Thames Valley.

Late Mesolithic – Early Neolithic

The pollen-stratigraphic assessment from Battersea Power Station (BH<8>; -3.04 to -2.51 m OD) tentatively suggest the presence of mixed coniferous-deciduous woodland during the Late Mesolithic – Early Neolithic, although the precise composition and structure is uncertain. Detailed palaeo-vegetation records from other parts of the Thames valley broadly support this interpretation.[13-19] Collectively, these records indicate that from 4800–4300 cal BC, *Poaceae* and a diverse range of herbaceous plant taxa expand during the period in which arboreal taxa, such as *Quercus, Ulmus* and *Tilia*, indicate a temporary decline. The reduction in arboreal taxa, presence of cereal pollen and indicators of disturbed ground, such as *Plantago lanceolata*, provides evidence for clearance of woodland and cultivation sometime during the Late Mesolithic – Early Neolithic transition. The radiocarbon-dated sedimentary records from Battersea Power Station, as well as 552 Kings Road and 199–203 Buckingham Palace Road, do however suggest that there is considerable potential for reconstructing the Mesolithic environment of this part of the valley if suitable fossiliferous deposits are discovered. This would enable testing of the following generalised sequence of vegetation succession for the Middle-Lower Thames Valley:

c. 9500–8200 cal BC: *Pinus* woodland dominated the surrounding dryland area, with sedge and reed-swamp initially colonising the wetland zones although this was gradually replaced by *Salix* woodland.

c. 8200–6900 cal BC: *Quercus, Ulmus, Betula* and *Corylus* invaded areas occupied by *Pinus* resulting in the formation of mixed deciduous woodland. The wetland zone was dominated by *Salix* woodland, although there is evidence for isolated trees of *Alnus*.

c. 6900–4800 cal BC: *Quercus, Ulmus, Tilia* and *Corylus* dominated the dryland vegetation cover. *Alnus* expanded in the wetland zone resulting in the formation of alder 'carr' woodland.

Middle Neolithic to Early Bronze Age

Pollen analysis conducted at Battersea Power Station (BH<2>; -2.21 to -2.10 m OD) identified the presence of two distinctive vegetation communities during this part of the Middle Holocene (3370–3010 cal BC; Fig. 5): open mixed *Quercus-Tilia* woodland with *Fraxinus, Corylus* and *Hedera* on dry ground, with *Alnus* and

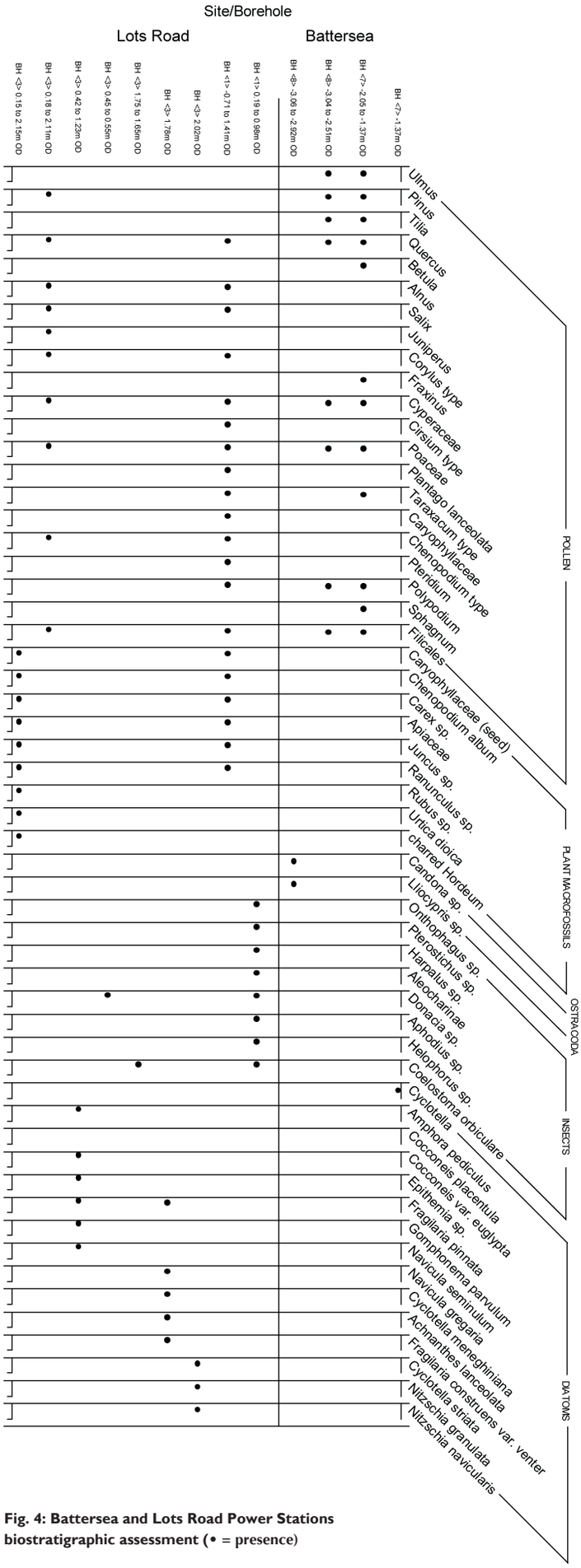


Fig. 4: Battersea and Lots Road Power Stations biostratigraphic assessment (• = presence)

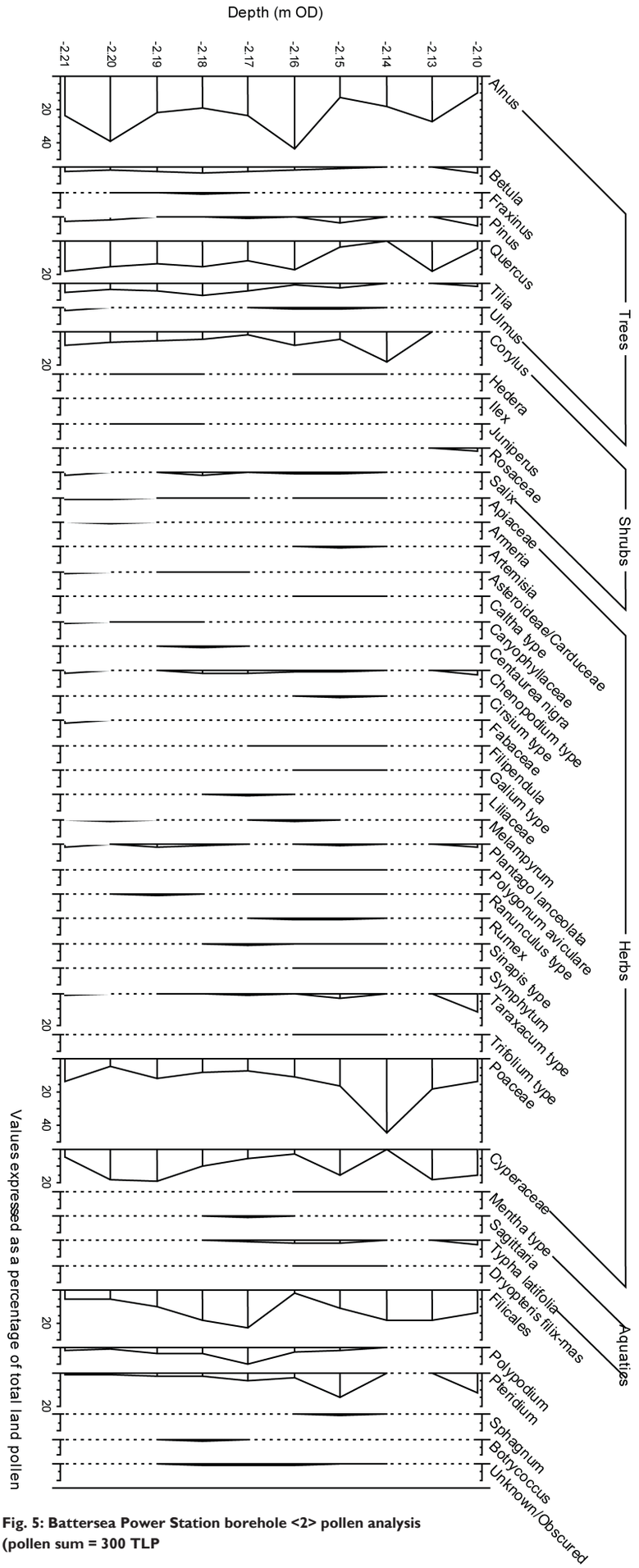


Fig. 5: Battersea Power Station borehole <2> pollen analysis (pollen sum = 300 TLP

Salix 'carr' woodland in wetland areas, especially on the margins of the river and in back swamps. Unfortunately, there is only circumstantial evidence to suggest that the open character of the woodland may be a consequence of the regional decline in woodland cover (e.g. elm) recorded at several sites in the Thames valley from the Neolithic onwards.[18] Based upon these records, the Middle Neolithic landscape of Battersea and Lots Road was probably a mosaic of closed and open woodland, possibly with temporarily cultivated land, grazing land and meadows. During the Early Bronze Age, the pollen-stratigraphic records from Battersea Power Station (BH<2> and BH<7>; Figs 4 and 5) indicate the presence of open woodland and grassland. At Bramcote Green, a broadly similar pollen-stratigraphic record indicates progressive reduction in woodland between *c.* 2000 and 1200 cal BC.[18] In particular, the decline of *Tilia*, followed by *Quercus, Corylus* and finally *Alnus,* coincides with the continuous presence of cereal pollen indicating a sustained period of cultivation. Similar evidence for human interference in natural vegetation succession has been recorded in the Middle Thames Valley, including evidence for clearance, creation of field systems, cereal production and agricultural intensification from Stanwell, Kingston, Meadlake Place and Runnymede Bridge.[13, 14, 20, 21]

Late Bronze Age to Middle Iron Age

Peat formation at Lots Road Power Station (BH1) commenced at approximately 910–790 cal BC and lasted until 400–350 / 300–210 cal BC. It is difficult to ascertain the precise reason for peat formation during this time, although a rise in ground water levels may have caused localised water-logging and initiated peat formation in a natural, topographic depression, such as a tributary channel. This interpretation is perhaps supported by the presence of fine-grained mineral matter in the peat, and the broadly contemporaneous alluvial sedimentation on the south side of Chelsea Creek (inferred from the OD heights), which suggests continued flooding of the river margin. It remains unclear whether the flooding was purely intermittent or due to a regional phenomenon, such as an increase in the height of relative sea level causing fluvial inundation and saturation of low-lying soils. The latter seems possible given the evidence for sea level rise in the lower reaches of the Thames Valley at this time.[16, 22, 23] The occurrence of peat formation at both Battersea (BH<107>) and Lots Road Power Stations coincides with records from the Lower Thames Valley, which suggest that from the Late Bronze Age (*c.* 1200 cal BC) areas were being inundated by estuarine mineral-rich sediments and there was a reduction in *Alnus* 'carr' woodland on the floodplain surface. At Battersea Power Station the presence of diatom valves in BH<7> (-1.37m OD) indicating tidal conditions may support this interpretation. The pollen and plant macrofossil assessment of BH1 (-0.71 to 1.41 m OD) at Lots Road certainly suggests that the vegetation

cover at this time was open in character with a diverse range of herbaceous taxa, including those associated with human disturbance (e.g. *Plantago lanceolata*). This is consistent with the general trend towards a reduction in woodland and the formation of open fields and meadowland bordering the River Thames. Indeed the insect assessment from Lots Road provided some evidence (dung beetles) in support of the possible presence of animal husbandry and pasture (Fig. 4; BH1).

Late Roman to Anglo-Saxon

Peat formation in BH3 at Lots Road Power Station commenced approximately 420–610 AD (0.61-0.63 m OD) and lasted only a relatively short period until 430–640 AD (1.47-1.50 m OD). This phase of rapid peat accumulation occurred during an extended period of alluvial sedimentation, which was consistent across the site (inferred from the OD heights). The diatom record from this borehole indicates wide salinity ranges during this period but with a stronger estuarine signal in the upper part of the sequence (above 1.78 m OD; Fig. 4). The pollen and plant macrofossil assessment indicates the presence of dryland woodland, including *Quercus* and *Corylus,* and with a wetland element including *Alnus, Salix,* Cyperaceae (*Carex* sp.) and *Juncus* sp. The presence of a single charred *Hordeum* (barley) grain was surprising and simply confirms that somewhere nearby cereal cultivation was being practised (BH3; Fig. 4).

Conclusions

The investigations at Battersea and Lots Road Power Stations have revealed considerable variation in the thickness of alluvial and peat deposits due to truncation associated with successive stages of industrial development. However, at both sites, the alluvial sediments comprise silts and sandy and clayey silts, sometimes organic-rich, overlying sand and gravel (Kempton Park or Shepperton Gravel). These complex stratigraphic sequences indicate deposition of alluvial sediments under progressively lower energy fluvial conditions probably from the suspended sediment load of the river. Localised peat formation at both sites represents semi-terrestrial environmental conditions (e.g. backswamps or channel fills), with signs of intermittent fluvial inundation. Collectively, the radiocarbon dated sedimentary sequences recorded at Battersea and Lots Road Power Stations indicate periods of sediment and peat accumulation from the Mesolithic periods onwards (*c.* 9500 cal BC). During this time, the biostratigraphic assessment and analysis data indicate the transition from freshwater wetland and dryland comprising mixed deciduous-coniferous woodland, to an environment consisting of open deciduous woodland with evidence for human activities. At the beginning of the Late Holocene, the evidence from Lots Road suggests the vegetation cover was more open in character, which was perhaps associated with animal husbandry. During this time, there is some evidence for a stronger estuarine signal in the fluvial record, especially after 430–640 cal AD.

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