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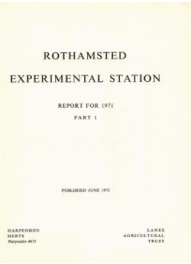
ROTHAMSTED RESEARCH

Report for 1971

Full Table of Content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Soil Survey of England and Wales

K. E. Clare

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SOIL SURVEY OF ENGLAND AND WALES

K. E. CLARE

The aims of the Soil Survey of England and Wales and of Scotland are to describe, classify and map the different soils in Britain. Classification is mainly on the basis of properties of the soil profile observed in the field, the parent material from which the soil is thought to come, and the environment and use made of the land. Samples are analysed in the laboratory to confirm and give precision to field observations, to characterise the soils further and to study soil-forming processes. The properties of the soils shown on maps are described in accompanying publications, as are the geography, geology, climate, vegetation and land use of the district surveyed. A soil map and text together are a permanent record of the distribution and properties of the various kinds of soils. Descriptions take into account the whole depth of the soil profile (i.e. surface and subsoil to a depth of 1 m) and, with the additional information provided, are of use in agriculture, forestry, land-use planning, land drainage, geography and ecology.

The mapping programme continues, with the surveying of areas in each county chosen for their geomorphological and agricultural interest, and the compilation of maps published at a scale of 1 : 25 000. Thirty-eight such areas were worked on during the year, which provided enough good weather for 920 km^2 to be surveyed in detail in 21 of them. Twelve maps at this scale have now been published with explanatory publications—*Soil Survey Records* for nine of them. Progress was also made in compiling maps of soil associations at a scale of 1 : 250 000 for the counties of the West Riding of Yorkshire, Berkshire and Pembrokeshire.

The 1 : 25 000 maps are intended to serve as sample areas in the later construction of county, regional and national maps. Approval by Parliament of the Local Government Act could alter some local authority and regional boundaries and may call for some revision of sheets.

Northern England

Cheshire

Sheet SJ 37 (Ellesmere Port West). Detailed mapping of 77 km^2 completed the sheet now being prepared for publication with an explanatory text.

Coarse textured soils of the Bridgnorth (1) series cover Triassic sandstone near Burton, Ness and Neston and include deep, shallow and podzolised phases. Soils on sandy to coarse loamy fluvio-glacial drift and Head occupy the transition zone between sandstone and till. A sequence from acid brown earths (Wick (1) series) to ground-water gley soils, including a gley podzol (Reaseheath (2) series), was mapped on these deposits.

A pattern of old channels, seen on air photographs of the Dee alluvium, probably reflects differences in texture but these were not always found in detailed mapping. The estuary was mapped as two units; sandy to coarse silty calcareous ground-water gley soils on reclaimed areas and fine silty to clayey active and recent alluvium on the salt marsh. Both resemble soils in the Hesketh (3) complex in the Ribble estuary. Two raised beaches were found near Puddington along the old eastern shore of the Dee (represented by the 25 ft contour).

The Salwick (gleyed brown earth) and Clifton (surface-water gley soil) series (3), on

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fine loamy reddish brown till, predominate. In the north the Clifton series follows the area of deep till infilling the NW–SE trending 'Mid-Wirral Iceway', which runs from Eastham to Capenhurst, reaching a depth of 42 m near Hooton. (Furness and S. J. King)

Westmorland

Sheet SD 58 (Sedgwick). The Record was completed. (Furness)

Yorkshire (East Riding)

Sheet SE 64 (Escrick). This map, originally part of 1 : 63 360 Sheet 71 (Selby), was completed; also a Record prepared describing it and Sheet SE 74 (Barmby Moor.) (Bullock)

Yorkshire (West Riding)

Sheet SD 85 (Hellifield). A further 45 km^2 were mapped in the north-east and south-west quarters.

Large terraces, over 1 km wide in places, on the west side of the Ribble valley have gleyed brown earths, non-calcareous gley soils and brown calcareous soils. An intricate network of old drainage channels in gravelly deposits contains amorphous peat over 90 cm thick. The junction of the terraces and the gently sloping till-covered plateau is ill-defined. In Halton West parish, outcrops of sandstone protruding through the till have well drained, sandy, Kirkby Overblow (4) soils.

The drumlins in Otterburn and Airton have poorly drained non-calcareous surface-water gley soils, peaty gley soils, and peaty gleyed podzols covered with rough grass, rushes, Sphagnum moss and heather. The drumlin tops are much more poorly drained than those of drumlins south of Bank Newton. Between the drumlins there is a network of drainage channels with sandy and silty alluvium, peat and algal marl. Limestone outcrops on Scosthrop Low Moor have brown earths, brown calcareous soils and gleyed brown earths.

The main land use problems are impeded drainage, made worse in places by poaching, and thistle infestation. Many old turf and stone drains have collapsed under the weight of farm machinery and cattle. Some land is purposely kept poorly drained, such as parts of Ged Beck Moor, to encourage duck and grouse to breed. (Matthews)

Sheet SE 36 (Boroughbridge). A further 25 km^2 were mapped before work was postponed in favour of the Aire–Calder Development survey. (Hartnup)

County Map. Work started in the lowlands on the 1 : 250 000 County Map, complementing that already done in the Pennines by the Upland Air Photo Unit. As the scale is small, the mapping units will be soil associations, i.e. sets of areas with different kinds of soils usually occurring in recognisable patterns and occupying characteristic parts of the landscape. The series in each association and their relationship to slope, geology and other factors will be described in the accompanying text.

Mapping units on the existing detailed maps (published at 1 : 25 000 or 1 : 63 360) were grouped into associations. Only 5–10% of the remaining area will be mapped in detail (at 1 : 10 560), in sample blocks, the rest being inspected in pits about 1 km apart. Association boundaries are drawn by relating the soils to the landscape, using geological and land use maps, and often air photos. A preliminary county map is being compiled at 1 : 100 000 and reports written for each 1 : 25 000 sheet. A start was made

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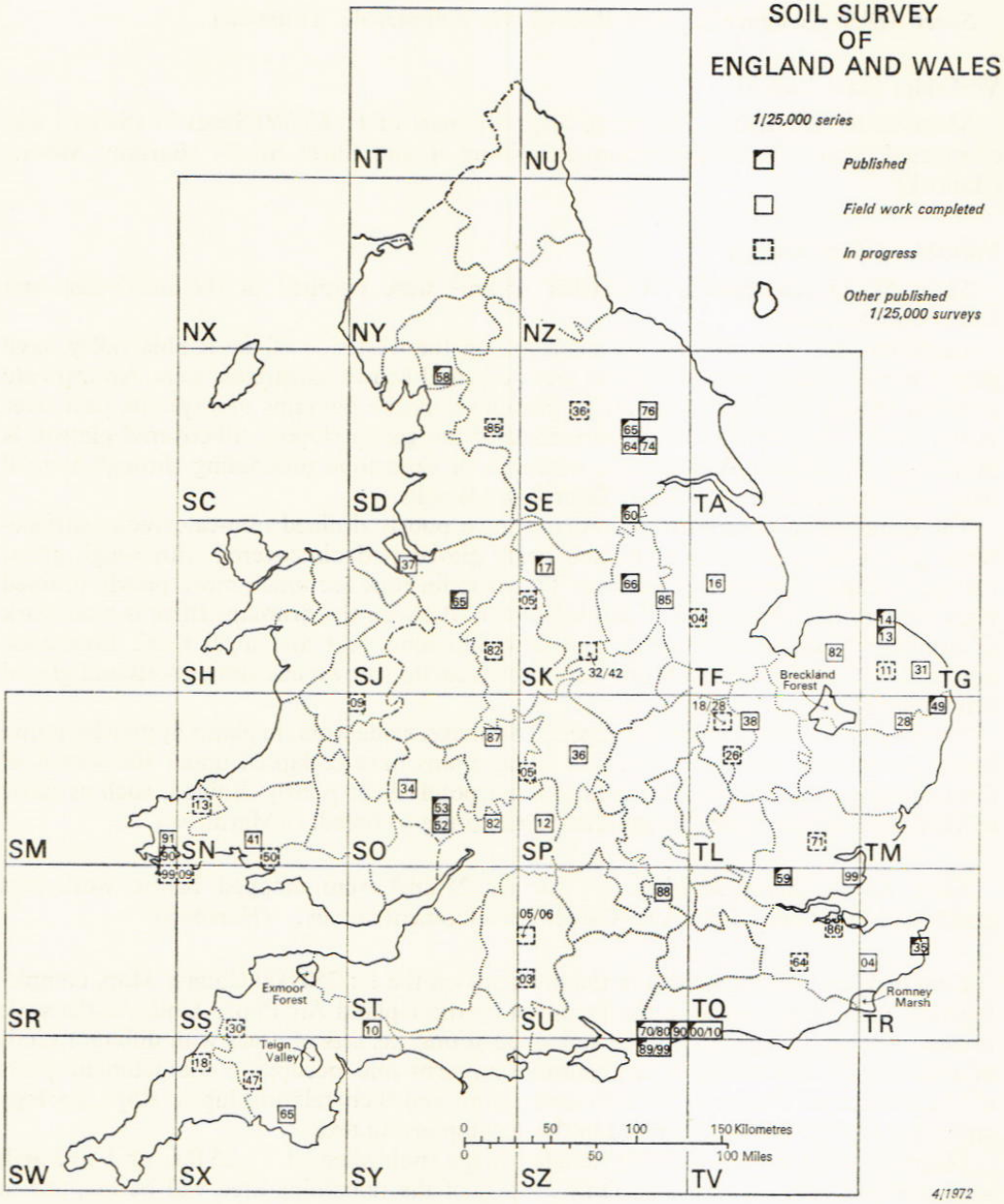

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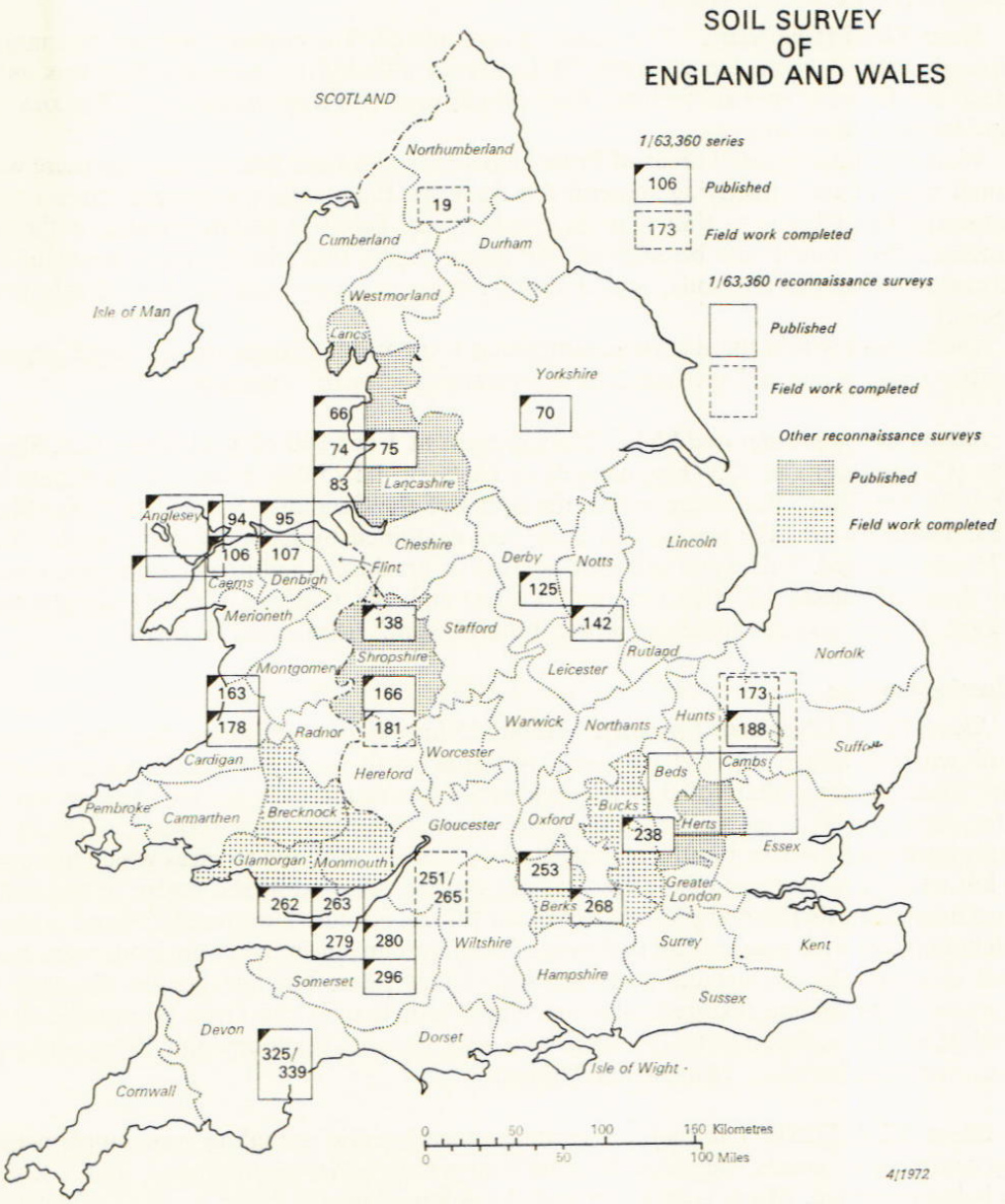

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on Sheet SE 41 (Hemsworth), on Coal Measures and Magnesian Limestone, between Wakefield and Doncaster.

In the West Riding Pennines, 12 soil associations were recognised that occur on the Lancashire County Map and five new ones delimited. Eleven associations were established in the lowlands; the total will be about 35. (R. A. Jarvis and Carroll)

East Anglia

Cambridgeshire and the Isle of Ely

Sheet TL 38 (Chatteris). The sheet was completed. The country mapped was mainly upland, with Wicken, Denchworth, St Lawrence and Milton soils (5). Part was skirtland, the fringing area of fenland from which peat has now wasted, and Peacock (5) and Ireton soils occur here.

West of Chatteris small areas of Prickwillow (5) series were found wherever there were small rises in the underlying mineral fen floor. In these soils the mineral zone of the estuarine Fen Clay is so thin that the (Lower) peat below is within a metre of the soil surface. They could not be seen on air photographs that clearly show much of the distribution of the fen soils, and a more intensive survey was needed of this land. (Seale)

The fenland within the sheet was sampled at 1 km grid intersections and depth, organic matter content and pH measured to characterise the peat. (Burton)

Sheet 135 (Cambridge and Ely). The soil maps at 1 : 63 360 of 3rd Edition O.S. Sheets 188 (Cambridge) and 173 (Ely) as well as parts of 1 : 25 000 Sheet TL 38 (Chatteris) and the Breckland Forest are within the limits of the Ordnance Survey 7th Series Sheet 135. The soils over the rest of this area were examined by reconnaissance while Sheet 173 was mapped. This work will now be used to produce a soil association map similar to those of Sheets 147 (Bedford and Luton) and 148 (Saffron Walden) already published. A draft was compiled and a brief report begun. (Seale and Hodge)

Huntingdonshire

Sheet TL 26 (Papworth Everard). About 15 km^2 were mapped on the Ouse terraces and nearby boulder clay and Jurassic clay slopes on the west and north-east portion of the Sheet. A stony phase of the Hanslope series was found over limited areas as well as Hanslope and Wicken soils (5) on slopes overlooking the Ouse terraces. Aldreth (5) soils were found in the mouths of small valleys issuing on to the terraces which are up to 3 km wide. The surfaces of the terraces are coarser textured in the centre of the valley and finer towards the margins where Milton (5) soils occur. Landbeach (5) and a newly identified soil with some visual evidence of clay enrichment in lower horizons were mapped as a complex on terraces away from the valley sides. The terraces are dissected by narrow strips of fine textured alluvium which join that of the Ouse floodplain in the middle of the valley. Earith (5) series and soils akin to Fladbury and Wyre series (1) occur on the alluvium. (Burton and Hodge)

Sheet TL 18E/28W (Stilton). Reconnaissance by grid sampling was supplemented by sampling at points suggested by tone changes on aerial photographs, and a legend is being compiled. Much land is fen and the depth of peat is being mapped in detail.

The landscape is diverse. Forty square kilometres, mostly below sea level, are peat fen over Jurassic clay, reclaimed for arable agriculture during the middle of last century and mostly dyshumic and euhumic basin peat (Adventurers' (5) series) up to 4 m thick, although with horizons of sphagnum peat. Five per cent is occupied by the Nature

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Reserves of Holme Fen and Wood Walton Fen, where natural fen, carr and woodland environments are preserved. Parts of the woodland are on raised moss peat.

About 9 km² in the north-east has a layer of estuarine fen clay between the upper and lower peats, in which is developed the familiar patterns of roddons like those near Chatteris of the Chatteris-Adventurers'-Downholland complex. There is a small area (3 km²) of soils in lake deposits on the sites of Whittlesey and Ugg Meres.

A belt of humose clayey and fine loamy soils on Jurassic clay, often with thin drift, skirts the fenland. The topsoil retains a remnant of the former covering of peat.

To the west and south, on gradually rising ground of Jurassic (Oxford) clay and thin drift the main soils are Wicken series on steeper slopes and Denchworth and Aldreth series (5).

The Hanslope (5) series on Chalky Boulder Clay is on higher plateau land in the west and south (up to 55 m). A valley floor pattern is easily seen on air photographs, resembling that near Papworth. (Burton and Seale)

Norfolk

Sheet TG 31 (Horning). The proportions of soils within adjoining Hall-Ashley and Ashley-Hall complexes (6) were determined by intensive sampling on several 50 × 20 m grids (Tatler and C. A. Righton—*Student Worker*)

Sheet TM 28 (Harleston). The significance of mapping units on the Chalky Boulder Clay uplands with varying proportions of Beccles and Aldeby series (6) was tested by sampling nine randomly selected sites, three within each unit. The variation at each site, recorded by augering at 50 × 20 m grid intervals, differed between map separates; the main soil properties distinguishing the series, altitude and slope were correlated. The range of slope of the sites was small, between 0 and 2°. (Corbett and E. Shepard—*Student Worker*)

Sheet TG 11 (Attlebridge). Detailed reconnaissance of this sheet was completed. (Tatler and Eldridge)

Sheet TF 82 (West Raynham). Mapping was completed.

The district has features similar to the Breckland and to south-east Norfolk. The landscape in the north-east has three facets; small flat uplands with Freckenham (6) soils on thin gravels over chalky drift covering chalk; long slopes with Worlington, Moulton, Swaffham Prior and Newmarket soils (5) on chalky drift over chalk with thin discontinuous surface sands; and wide valley floors with Adventurers' soils on peat near streams or central ditches, and Isleham and Row soils (6) on gravelly sands towards the periphery. The pattern is thus broadly similar to that in parts of the Breckland.

The landscape in the south-east differs in that the flat upland has Beccles and Aldeby soils on Chalky Boulder Clay resembling those near Harleston (TM 28) and Beccles (TM 49). The upper slopes carry moderately well drained Ashley soils (6). Valley floors with permanent streams are narrower and mainly filled with peat soils of the Adventurers' series. (Corbett)

East Midlands

Derbyshire and Leicestershire

Sheet SK 32E/42W (Melbourne). This comprises the western half of Sheet SK 42 and the eastern half of SK 32 and represents a lowland region with a range in relief of 30 to 175 metres. The land is mostly in ley/arable use but has important market garden-

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ing, mainly in Melbourne parish, supplying produce to Derby and Nottingham. About 75 km² were mapped.

South of the Trent, which flows from west to east across the north of the area, there are two geological subdivisions.

To the west, the cover of till and glacial outwash has been partially removed from the basement of Keuper sediments. On the drift-free land, the Worcester, Hodnet and Bromsgrove series (7) were mapped, with Dunnington Heath and Brockhurst series (1) where thin drift is over the Marl. Poorly drained clayey soils of the Spetchley and Compton series (1) occur in colluvial and alluvial sites. Loamy soils of variable drainage over interbedded Keuper sandstones and marls were mapped as the Greinton (8) complex. Many hilltops are capped by reddish boulder clay, some under Chalky Boulder Clay. Mapping units here are Salop (1), Ragdale and Hanslope soils (9), with Newport and Wick (1) series on sandy and coarse loamy spreads of outwash.

To the east, Carboniferous rocks predominate, and south of Ticknall, Coal Measures shales and sandstones give an undulating landscape with a simple pattern of soils of the Dale and Swindon Bank series (7). However, near Melbourne the outcrop of alternating beds of shale and sandstone in the Millstone Grit gives an intricate soil pattern, complicated further by local reddening from Triassic weathering and deposition. During reconnaissance, areas of Wike, Swindon Bank, Kirkby Overblow, Bardsey (4) and Hazelwood (7) series were found, with small patches of Greatrix and Cockey (10) complexes.

A thin layer of Permian Marl over part of the Carboniferous outcrop gives Worcester, Brockhurst and Dunnington Heath soils, but the patchy nature of this veneer over Millstone Grit, Carboniferous Limestone and Keuper sandstone in Calke Park results in an intricate pattern mapped as the Calke complex.

On limestone inliers of Breedon Hill and Barrow Hill, the Marian (11) series was mapped and on the Bunter sandstone outcrop near Ingleby, the Bridgenorth (1) series is the main soil.

The Trent floodplain is dominated by soils of the Wharfe (4), Wyre and Fladbury series (1), the latter mainly on backswamp and abandoned channel sites. Several terraces are associated with the Trent, some within the floodplain, some at its margins, and others on Keuper Marl and boulder clays north of the river. The Wick, Arrow and Quorndon (9) series were identified on them.

Poorly drained non-calcareous clayey soils in greenish (Keuper) marl occur on the south side of Sinfin Moor. (Reeve)

Lincolnshire

Sheet TF 16 (Woodhall Spa). The map was completed and the Record prepared.

Sheet TF 04 (Sleaford). A reconnaissance survey was made, a provisional legend established and 10 km² mapped in detail. More than half the sheet is part of the dissected Jurassic limestone dip-slope which is extensive in Lincolnshire. Sherborne (8) soils are on Inferior Oolite, Great Oolite and Cornbrash limestones and stoniness and soil depth vary. A bed-rock jointing pattern, seen in aerial photographs, gives uneven crop growth locally, the poorer growth being over unbroken flaggy limestone at 30 cm. Grey clayey surface-water gley soils are on the Upper Estuarine and Great Oolite clays. These soils are often calcareous below 60 cm and are, as yet, uncorrelated. Imperfectly drained soils on fine loamy Head over limestone brash are in some valleys.

Clayey surface-water gley soils similar to the Charlton Bank (8) series are on Oxford Clay in the east but gley morphology is more subdued than on Lias clays. Soils of the Rowsham (9) complex are mapped where sandy inclusions occur within 80 cm.

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Deep coarse loamy soils on fen edge gravels near Evedon have brownish, relatively stone-free, upper horizons. Subsoil horizons are calcareous and greyish but the formerly fluctuating ground-water table is now controlled. A wide range of agricultural and horticultural crops is grown. (Robson, George and Heaven)

West Midlands

Herefordshire

Sheet SO 34 (Staunton-on-Wye). The remaining 47 km² were mapped in detail. The Dore series, the Woofferton-Wigmore and Hollington-Woofferton-Peat complexes were established. The Dore series is a brown earth with a deep silt loam profile, in stoneless outwash silts. It is most extensive in the Dore valley and along the former terminal moraine of the Wye Glacier at Staunton-on-Wye. The Woofferton-Wigmore mapping unit at the centre of the Letton Lakes alluvial flat consists of clayey soils of the Woofferton and Wigmore series with a range of profiles intermediate in character. The Hollington-Woofferton-Peat complex, under poor rush-infested permanent pasture or rough grazing, occurs along the bottom of an old drainage channel in the till country near Preston-on-Wye. The Woofferton and Hollington soils (12) within this mapping unit are often over peat or include thin interbedded layers of peat within their profiles.

North-west of the Staunton moraine brown Silurian outwash material occurs extensively at levels below 91 m O.D. These deposits, which could in part be old alluvium on a former floodplain of the Wye, give ground-water gley soils of the Pinsley series except where they are thin over reddish brown till and merge into the Vernolds (12) series.

The record, which includes a land use capability map at a scale of 1 : 63 360, was prepared for publication. (Palmer)

Staffordshire

Sheet SK 05 (Onecote). The sheet was chosen to study upland soils in Carboniferous parent materials. Much land is in the Peak District National Park, and two-thirds are above 305 m O.D. The soils are generally poorly or imperfectly drained, and the farming pattern is one of permanent pasture, rough grazing and moorland.

The district is geologically complex, being marginal to the stable blocks of Carboniferous Limestone to the east and Millstone Grit to the north. Interpretation of the geology is hampered by the lack of a comprehensive record, for the early Geological Survey of 1887 by Green and Strachan, is the only full cover. Parent materials are of four main groups: relatively pure limestones; shales with subordinate thin interbedded limestones, siltstones or sandstones; drift (till and Head); and a complex sequence of interbedded shales, siltstones and sandstones.

During reconnaissance, 22 mapping units were provisionally established and 22 km² mapped in detail, mostly in the west. Carboniferous Limestone outcrops in a strip on the eastern edge around the Manifold and Hamps valleys. The soils correlate well with those mapped in the Derby and Tideswell areas, and Lulsgate and Nordrach series and Sprink and Lulsgate complexes were found (7, 10).

Soils on thick drift occur mainly west of the Morredge and around Bradnop, although thin locally derived Head is probably common throughout the district. The till is mainly from Carboniferous rocks with a little Triassic material in places, and soils of the Bardsey and Dunkeswick series (7) were mapped. Carboniferous shales give heavy clay soils of the Windley (7) series and the more intricate areas of interbedded shales, sandstones and siltstones give several as yet unnamed series and complexes. Where thick

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sandstones and gritstones outcrop, soils of the Anglezarke and Swindon Bank (7) series and an unnamed ranker occur.

Some series were redefined to fit the proposed new system of classification, and soils with humose or peaty tops separated from otherwise similar mineral soils. (Hollis)

Sheet SJ 82 (Eccleshall). A reconnaissance survey was made and 40 km² then mapped in detail.

The Keuper Marl outcrop in the north-east around Whitgreave is relatively free from drift and soils of the Worcester (7) series predominate, with the wetter Spetchley (1) series on gentler slopes and lower ground. Further south and west beyond the river Sow, the Keuper Marl is under thin drift giving Brockhurst and Dunnington Heath series (1) and unnamed variants. The central and north-west parts of the area are covered by thicker, variably-textured, till giving soils of the Rufford, Astley Hall, Salop and Cottam series (3). Newport and Wick series (1) with similar less well drained soils were mapped on sandy and loamy glacial outwash associated with a glacial overflow channel at Gnosall. They are also extensive on terraces flanking the overdeepened valley of the Sow which is floored with peat and clayey alluvium giving soils of the Compton (8) series.

The series were redefined where necessary to fit the framework of the proposed new soil classification and several new series will have to be defined. Excellent air photographs helped fieldwork enabling better delineation of some boundaries. (Hodgson and Jones)

Warwickshire

Sheet SP 36 (Leamington Spa). The remaining 52 km² were surveyed and correlated with neighbouring regions. The map and Record are being prepared for publication. (Whitfield)

Sheet SP 05 (Alcester). This district is over Lower Lias Clay and Keuper Marl with subordinate outcrops of Keuper sandstones, but much is on Pleistocene drift of both Riss and Wurm age.

Reconnaissance on selected farm units of 60–80 ha established 20 soil mapping units and 56 km² were mapped in detail.

Soils of the Evesham and Charlton Bank series (9) were found on Jurassic clays forming higher ground between Bishampton, Salford Priors and Weethley. There are smaller inclusions of Haselor (1) series on interbedded limestone and shales. Worcester (9) soils occur on drift free slopes of the Keuper Marl and poorly drained clayey Spetchley (1) soils on lower ground around Abbots Salford. In Inkberrow parish silty Head overlies the Keuper Marl, giving soils of the Whimple series (13). Dunnington Heath and Brockhurst series (1) were mapped on thin drift over Keuper Marl. Freely drained coarse loamy soils of the Clive series (3) generally occur on small outcrops of Keuper sandstone but, where horizontally bedded sandstone is on lower ground as in the parishes of Alcester and Arrow, poorly drained coarse loamy soils were mapped, provisionally named Ragley Park series.

Soils of the Cottam and Salop series (1) occur along the Ridgeway on patches of 'Older Drift' and on high ground at Rous Lench, Oversley Castle and Alcester. Soils on the 'Newer Drift' terraces vary and include the Wick, Newport (1), Arrow and Eathorpe series. Soils of the Norton series were mapped on the older terraces and on low terraces along the river Arrow. Correlation of these terrace soils with similar soils in the East Midlands and the South-west Regions is needed.

Poorly drained clayey soils of the Compton and Fladbury series (8) occur on alluvium of the floodplains of the Avon and Arrow.

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Maps of farming type and land drainage schemes are being prepared as part of the Record. (Whitfield and Beard)

South-east England

Berkshire

Over half the County has been mapped at 1 : 63 360 or 1 : 25 000 Sheet 253 (Abingdon), Sheet 268 (Reading) and Sheet SU 88 (Marlow)), and the second stage of surveying was started to compile a soil association map of the county at a scale of 1 : 250 000. With the help of the detailed surveys, geological maps and air photographs, a provisional legend and map of 21 soil associations was prepared. Map and legend were then tested (a) by observations along selected traverses in unmapped areas and (b) by randomly sampling eight selected associations. The distribution and proportions of individual soil series in the landscape were studied. At 400 randomly chosen points, full profile descriptions were recorded in code and samples taken for chemical and physical analysis. The fieldwork confirmed the relevance and suitability of the provisional soil associations and boundaries.

Information was collected by the Agricultural Development and Advisory Service about land capability, by the Forestry Commission about soil and tree growth, and by the Civil Engineering Department of Brighton College of Technology about the engineering properties of the soils. This co-operation is much appreciated. (M. G. Jarvis)

Buckinghamshire

Sheet SU 88 (Marlow). The map is complete and a legend is being prepared. (Mackney)

Essex

Sheet TQ 99 (Burnham-on-Crouch). Mapping of the remaining 75 km^2 was completed. The soil map and Record are in preparation.

Waveney (6) series dominates the reclaimed estuarine alluvium, with small areas of browner calcareous Newchurch (14) series next to main water courses and on more recently reclaimed parts of the marsh. Romney (14) soils occur on isolated shoals of coarse loamy alluvium in the east of Foulness Island. Much levelling, underdrainage and infilling the old network of drainage ditches has produced larger, more manageable blocks of land. Arable cropping predominates with winter wheat, peas and lucerne for drying the main crops, although grassland is important locally where dairy herds are kept on 'upland' farms.

Next to the estuarine alluvium on the landward side is a narrow strip of gley soils on mixed clayey and fine loamy alluvium incorporating or overlying gravels of the lowest terrace, which rises gradually to 3–5 m O.D. Coarse loamy over sandy gravelly gley soils of the Canewdon series occur locally, but the gravel is mostly under 1–2 m of loess giving Hamble and Hook soils (15). Such land is exclusively arable, growing potatoes, peas, sugar-beet and market-garden crops in addition to cereals.

Succeeding terraces, aligned approximately NE–SW, are not well defined and their gravel spreads become thinner and patchier higher and to the west. Canewdon and Hall (6) series were mapped on the nearly level surfaces, and a grey fine loamy gravelly gley soil, the Southminster series, occurs on gentle slopes in Head from the gravel, with Wickham (16) soils where London Clay below is within 75 cm of the surface. A fine silty over clayey gleyed brown earth, the Ratsborough series, occurs on some nearly level terrace surfaces above gravels, and on slopes leading from them. The origin of this material is uncertain, but the large silt content suggests Head with much loess mixed

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with London Clay. It was found around Ratsborough Farm and the sewage works at Stambridge. This district of mixed soils is chiefly used for arable farming, although some grassland supports dairy herds. Cereals predominate with some peas and maize. Drought can be a problem on the gravelly soils but irrigation is used in only a few places for market-garden crops.

In the west of the district Windsor soils (16) predominate on level and sloping high ground on London Clay around Althorne and Canewdon villages, with Wickham soils on drift-covered slopes and hollows, and Ferrel soils (16) in grey clayey Head on broad footslopes. Most land round Althorne carries grass and dairy herds, but similar land around Canewdon is exclusively cultivated. (Sturdy and Reaves)

Sheet TL 71 (Little Waltham). Reconnaissance was begun to study the boulder clay landscape of mid-Essex with glacial gravels exposed in south-east trending valleys. The main mapping units will be those of the nearby Saffron Walden Sheet (17). (Sturdy and Reaves)

Kent

Sheet TR 35 (Deal). The map and text were completed; an agricultural report with 1 : 25 000 land capability and drainage maps, prepared jointly with the Agricultural Development and Advisory Service, is nearly complete. (Green and Fordham)

Sheet TQ 86 (Rainham). The district extends to the north Kent coast between Sittingbourne to the east and the Medway town of Gillingham to the west. From a southern block of Chalk Downland, with gentle slopes extensively covered by Clay-with-flints and Head, many dissecting dry valleys traverse a rolling belt of Thanet and Woolwich Beds, the latter mostly forming hills widely capped with Head gravel. Undulating London Clay country to the north-east is fringed by coastal marshland including part of the extensive Chetney promontory of reclaimed clayey alluvium. The traditional brickmaking with brickearth, widespread over Eocene strata, has left a patchwork of pits and extraction continues in scattered places.

After preliminary reconnaissance, the Eocene formations and associated drift were mapped first, and nine principal soil series identified (Table 1). Ten proline cores were sampled and about 15 km² surveyed in detail.

Arable farming dominates the higher, extensively dissected, southern part of the

TABLE 1

Soils in Eocene beds and associated drift

Soil group	Texture and geology	Series
Brown earth (*sol lessivé*)	Silty; Head brickearth	Hamble (16)
	Stony loamy; Head gravel	St Albans (16)
Brown earth (*sol brun acide*)	Loamy; drift over fine sandy Woolwich and Thanet Beds	Woodnesborough
	Sandy; Thanet Beds	Shedfield (16)
Gleyed brown earth (*sol lessivé*)	Loamy; drift over fine loamy Thanet and Woolwich Beds	Bursledon (16)
	Loamy; drift over fine sandy and silty Thanet Beds	Hillcross
Surface-water gley soil	Stony loamy over clayey; Head over London Clay and Woolwich Beds Clay	Titchfield (16)
	Loamy over clayey; drift over London Clay and Woolwich Beds clay	Wickham (16)
	Clayey; London Clay	Windsor (16)

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Downland but the lower slopes and Eocene upland are part of the north Kent fruit belt; some London Clay is under alternate husbandry and nearly all marshland is permanent pasture supporting cattle and sheep. The low-lying coastal strip is designated as a development area (MIDA) for industry; some farmland will be used if the plan is implemented but most land will be obtained by embanking saltings. (Green and Fordham)

Sheet TR 04 (Ashford). The Record was revised, and the format of soil description modified. The agricultural report to accompany the 1 : 25 000 land capability map, prepared jointly with the Agricultural Development and Research Service, is nearly completed. (Green)

Sheet TQ 64 (Paddock Wood). Reconnaissance suggests that no new soil series occurs in the northern half of the district, where a flat to gently sloping Weald Clay plain is traversed east and north-east by the Medway floodplain and wide flanking belts of river brickearth, which gives well drained to poorly drained silty soils (Hamble, Hook and Park Gate series (15) respectively) in a pattern partly determined by relief; Thorne and Hildenborough soils occur on Weald Clay and loamy to silty Head on Weald Clay, respectively.

Sixteen soil series named by Bagenal and Furneaux (18) in the High Weald, represented here by southern uplands, are expected to encompass other soil variations. (Green and Fordham)

South-west England

Cornwall

Preliminary reconnaissance. A new centre was set up in St. Austell and a reconnaissance made of the six 1 : 25 000 sheets chosen in the mapping programme to represent the county. The soils were briefly described by Clayden (19).

The range of parent materials is small. Most land lies in the southern limb of a broad Armorican syncline, with argillaceous rocks of Devonian age over much of the area. There are Carboniferous rocks in the north and east of the county and granites form much of the higher ground of Bodmin Moor, St Austell Moor, Carnmenellis and Lands End. Serpentine, gabbro and schists occur on the Lizard Peninsula. The Devonian rocks, although described as ranging from sandstones to slates, seem to provide a very uniform parent material. The soils are mainly freely drained brown earths, as those in south Devon (20).

Sheet SX 18 (Camelford). A reconnaissance survey was completed and a preliminary legend constructed. The land represents much of north-east Cornwall, where gently sloping interfluve ground at 255–285 m is deeply dissected. The upland of the Bodmin Moor Granite, rising to 390 m, occupies the southern quarter of the sheet. Carboniferous shales and slates outcrop in the north, and Carboniferous lavas occupy a SE–NW trending zone. The rest of the district is on Upper and Middle Devonian slates.

Freely drained brown earths with silt loam textures dominate the Devonian outcrop. Brown earths with ochreous (chroma $\geqslant 6$) B horizons also occur, usually on steeper valley sides. Many brown earths on the gently sloping interfluve land have drab BC horizons at 40–60 cm. Humic, peaty gley and peat soils occur around stream heads, and there are peaty gleyed podzols and associated peaty gley soils on moorland above 270 m.

The Tintagel Volcanic Series (sheared lavas and tuffs) give brown earths with silt loam to silty clay loam textures. Loamy brown earths, humic gley soils and peaty gley podzols occur on Carboniferous shales and slates, and peat on low-lying ground.

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Soils on granite resemble those in Devon and many broad basins of streams draining the granite contain basin peat. (Staines)

Devonshire

Sheet SX 65 (Ivybridge). The remaining 40 km² of this sheet were mapped by free survey and the Record was written. (Harrod, Hogan and Staines)

Sheet SX 47 (Tavistock). A reconnaissance survey was made in the summer and 40 km² mapped in detail. The district lies just west of Dartmoor and is drained southwards by the rivers Tamar, Tavy and their tributaries giving a generally undulating plateau with some deeply cut valleys. The land rises from just above sea level (to the south) in the Tamar valley to nearly 300 m to the north.

The rocks are mainly Upper Devonian slates in the south and northwards shales and grits of Upper Carboniferous age with interbedded chert bands. Lower Carboniferous lavas also occur, and there is a little granite in the south-west. Soils on Devonian sediments are mostly brown earths of silt loam to silty clay loam texture similar to those near Newton Abbot (20) and Ivybridge. The Carboniferous rocks give similar soils of silt loam texture. There are a few silty gley soils on Carboniferous rocks in basin, flush and valley bottom sites and more on shales and grits of the northern plateau under heathland, often with an iron pan or layer of ferruginous concretions. Silty soils from well to poorly drained occur in the alluvium of the Tamar. (Hogan)

Sheet SS 30 (Holsworthy). This district is on Upper Carboniferous rocks of the Bude and Crackington Formations, with subdued relief like much of mid and west Devon. After reconnaissance, a mapping legend was prepared and 20 km² mapped, mostly on the Crackington Formation.

The Bude Formation comprises thick sandstones and siltstones with subsidiary shale bands, and thick Head of mixed lithology from these rocks covers much of the outcrop. Soils in this Head have textures from silty clay and clay to silt loam or fine sandy loam.

Two major complex mapping units were found. The first occupies crests and upper flanks of low ridges, with soils whose gleying depends on texture and permeability of the Head. These have been provisionally correlated with the Swindon Bank, Stanley and Halstow series (20). The second complex of strongly gleyed soils occurs on footslopes receiving surface and spring water, and includes the clayey Tedburn (20) series and other hydromorphic soils of fine and coarse loamy and silty textures.

The Tedburn series covers most of the shales and thin sandstones of the Crackington Formation south of Holsworthy. Less severely gleyed soils occur at a few places with relatively strong slopes (up to about 11°) and on some ridge crests. (Harrod)

Gloucestershire

Sheet SP 12 (Stow-on-the-Wold). The map was completed and a Record prepared. (Courtney)

Wiltshire

Sheet SU 05N/06S (Devizes). These two adjacent half sheets were substituted for Sheet SU 05 because of difficulty of access on the latter.

The combined sheets lie across the Vale of Pewsey, a broad flat-bottomed vale between Chalk scarps, east of Devizes. Headwaters of streams flowing west to the Bristol Avon and those flowing south to the Hampshire Avon are here. Gault clay outcrops on the lowest ground and merges upwards through silty Passage Beds into Upper Greensand,

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a rather variable glauconitic formation occupying the largest part of the district. The Chalk Marl forms wide flat benches with occasional prominent knolls on either side of the Vale and is backed by steep slopes of Middle and Upper Chalk rising in places to over 290 m O.D.

Farming is mainly mixed, with much arable on chalky and well drained greensand soils and large dairy units on the less well drained greensand, gault and alluvial soils. Major drainage is in hand on the headwaters of the Hampshire Avon to improve the flat watershed.

Some 25 km² of many types of soil were mapped on the Upper Greensand, with a range of textures and profile drainage. (Findlay and Cope)

Sheet SU 03 (Wilton). A reconnaissance survey was made and 20 km² mapped.

This sheet represents the predominantly arable downlands of south Wiltshire. The land is mainly on Upper Chalk but most middle and lower valley sides are covered by chalky and flinty Head. A central ridge occupied by Grovely Wood is capped by Clay-with-flints. The narrow valley of the Wylye and the Nadder to the south contain flinty deposits and calcareous alluvium. In the south-west is part of the Vale of Wardour with small patches of soils on Middle and Lower Chalk, Upper Greensand, Gault, Wealden and Purbeck Beds.

Gentle and moderate slopes on the summits of the Chalk downlands are dominated by shallow flinty soils with very calcareous dark brown clay loam AB horizons about 20 cm thick, resembling the Andover (15) series. Soils with very stony, extremely calcareous, silty clay loam B horizons are in the chalk and flint Head mantling middle and lower valley sides. Icknield (15) soils are on some very steep dry valley sides.

Soils in clay-with-flints on Grovely Wood ridge have flinty silt loam or silty clay loam horizons to about 35 to 40 cm, passing into unmottled, yellowish red (5YR 5/6) clay-with-flints often with manganiferous concretions. Patches of clay-with-flints in the north-east at Druid's Lodge give soils lacking silty upper horizons and with less red profiles on strong brown (7·5YR 5/6) and dark brown (7·5YR 4/4) unmottled flinty clay. These resemble the Winchester (15) series but are less red. Shallow calcareous clayey soils of the Wallop (15) series have been recognised in both places.

Most soils in alluvium have weak, calcareous, silty clay surface horizons over calcareous, gleyed silty clay. These either pass into more silty, chalky alluvium interbedded with clayey and peaty alluvium over flint and chalk river gravel, or they are directly on gravel at between 50 and 100 cm. (Cope)

Wales

Carmarthenshire

Sheet SN 41 (Llangendeirne). The remaining 50 km² were mapped and representative profiles sampled. North of the redland of the Gwendraeth-fâch valley soils are in drift from Ordovician shale and sandstone and, with local variations, the sequence is the same as that in mid-Wales (21). Well drained soils of the Denbigh series are mainly on strong or steep slopes and can pass to rock within auger depth, though more often the substratum is a compact loamy till with rounded fine gravel. Gley soils and gleyed brown earths occur in thick deposits of fine loamy or clayey till containing coarse sandstone and fine conglomerate. Surface-water gley soils (Cegin series) are most extensive, humic gley and peaty gley soils occurring particularly in the north-east on land at about 140 m.

The alluvium of the Tywi, south of Carmarthen, is a uniform silty clay entirely occupied by ground-water gley soils. It is locally bordered by small remnants of fluvial and

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fluvio-glacial terraces where Rheidol soils (21) occur, with gleyed brown earths and gley soils in loamy deposit over gravels.

Narrow outcrops of Carboniferous Limestone and Millstone Grit quartzites and sandstones on the interfluve between the two Gwendraeth rivers form discontinuous lines of hills separated by lower ground covered with loamy reddish brown drift from the Old Red Sandstone rocks to the north. The limestone is extensively quarried and only on narrow rocky ridges are shallow brown silty soils distinguished from red soils of interfingering depressions. The composite cuestas of the Millstone Grit form small rocky complexes of podzols and peaty gley soils under heathy grassland with bare rock on short steeply inclined dip slopes.

South-east of Mynydd Llangyndeyrn, soils are in fine silty or fine loamy till from shale and fine sandstones of the Millstone Grit and Lower Coal Measures. Brown earths are most extensive with silt loam A and B horizons passing to unaltered or weakly gleyed loamy till. The gley soils are finer textured and topographically distinctive. Humic and peaty gley soils border small peat basins particularly at the foot of the quartzite hills. (Clayden and G. D. Evans)

Sheet SN 50 (Llanelli North). This district in the south-east of the county is mainly on sandstones and shales of the Pennant Series of the Coal Measures, which occur extensively in the South Wales Coalfield, passing in the north and west to the Middle Coal Measures of the Gwendraeth-fawr valley. Of the two main landscapes, the larger is a plateau, dissected by steep sided valleys of streams draining to the Loughor, with a summit at about 180 m but rising on Mynydd Sylen in the north-west to 275 m. The second is the undulating lowland bordering the Loughor estuary in the south-east, including parts of the towns of Llanelli, Llangennech and Pontardulais.

A reconnaissance of the plateau was made during which 80 pits were described mostly on a 1 km^2 grid. A legend was prepared and 15 km^2 mapped in detail.

In the north-west the sequence of soils in fine silty drift over Middle Coal Measures resembles that in the Gwendraeth-fawr valley of Sheet SN 41, and gley soils of similar texture extend southward along valley floors. On passing to the more arenaceous Pennant Measures the parent material has more sand and stones. Loamy brown earths were mapped on valley sides and the brows of the lower hills, whereas depressions, benches and flush sites carry surface-water gley, humic and peaty gley soils in fine loamy till. The soils have yet to be correlated with those of similar origin in the Glamorgan Coalfield. (G. D. Evans)

Montgomeryshire

Sheet SO 09 (Caersws). A further 43 km^2 were mapped, the soils being those on Lower Palaezoic sediments and related drift recorded in an earlier report (22). Soils in the mapping units were sampled and analyses confirm the correlation with Cardigan soils. The Sannan, Cegin and Ynys soils (21) in till are consistently of silty clay loam texture with 30–35% clay; on the Severn floodplain, Conway and Clwyd soils have similar textures though with more silt. Well drained soils of the Denbigh and Rheidol series have less clay and are not consistently silty. As in Cardiganshire, it was difficult to distinguish sesquioxidic brown earths. (Lea)

Pembrokeshire

Sheets SM 90 (Pembroke) and SM 91 (Haverfordwest). Surveying was completed and maps prepared for publication. (Rudeforth)

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Sheet SN 13 (Eglwysw-rw). This district represents the uplands of the county, about half being in the Preseli hills. In contrast to west and central Pembrokeshire, where most land lies below 120 m, almost three-quarters is above 150 m and one-tenth above 300 m.

Ordovician sedimentary rocks (shales, mudstones and occasional sandstones) are under much land, with a small area of rhyolites and tuffs of the Fishguard Volcanic Series. Intruded into the sedimentary rocks are sills of dolerite making craggy outcrops on the main ridge of Preseli. Much ground is covered by till and Head; alluvial deposits are limited to narrow valley floors and mappable only around Velindre.

A 1 km grid reconnaissance was completed to establish a provisional legend, and detailed mapping begun. In the north, on the sedimentary rocks, there are brown earths, gleyed brown earths and gley soils as described in Cardiganshire (21) and similar soils also occur on rhyolites. Peaty gley soils dominate in drift of slow permeability in high rainfall areas, especially on Waunbrwynant and Wauncleddau. On the better drained upper slopes of Preseli, mainly over sedimentary rocks, there are Denbigh mor phase soils, with some Hiraethog and shallow peat soils. Flushes draining the slopes contain Ynys soils with only occasional peat deposits thicker than 40 cm. (Bradley)

Supporting research

Supporting research is described under the headings used in the current programme of the Soil Survey Research Board.

A2. Methods of analysis

Adding 30% hydrogen peroxide carefully to air-dry soil, saved time when destroying organic matter before particle-size analysis. (Thanigasalam)

Classification of organic (peat or peaty) soils is based partly on degree of decomposition measured by the amount and durability of macroscopic plant remains. To standardise field identification of fibrous, semi-fibrous and amorphous materials, weight percentages of 'fibre' retained on a 100-mesh B.S. sieve were determined for a range of peat samples before and after various mechanical treatments (23) and compared with field estimates of fibre contents before and after rubbing. Solubility of the materials in saturated sodium pyrophosphate solution was also estimated by dipping a strip of white chromatographic paper into a suitably prepared suspension, and measuring the Munsell colour of the extract absorbed by the paper (24). Procedures for these tests were standardised, and will be used to characterise organic soil materials. (Avery and Bascomb)

The proportions of eleven size fractions in the silt and very fine sand range in soils were measured using a Model T Coulter Counter belonging to the School of Environmental Sciences at the University of East Anglia. It was difficult to obtain reproducible and accurate results with known samples, but accuracy can probably be increased by modifying the method. The apparatus is being used to study the variation in silt content of topsoils in north-east Norfolk. (Bascomb and Janice Brereton—*Student Worker*)

Loss-on-ignition and Organic Carbon values for 33 well humified peat samples from fenland were well correlated, suggesting that ignition is a quick method for determining organic matter in very organic soils. (Burton).

A3. Micromorphology and mineralogy

Clay mineralogy of soils from basic igneous rocks. Two sesquioxidic brown earths of the Bowden series, developed in dolerite on Titterstone Clee, Salop, have a large cation exchange capacity in relation to the content of clay (esd $< 2\ \mu$m) determined after peroxide Calgon treatment, especially in the lowest (B/C) horizons. Measured clay contents of

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these horizons were 8 and 6% and cation exchange capacity values by Bascomb's method (25) are 35 and 38 me/100 g respectively. After extended ultrasonic treatment, clay yields increased to 24 and 35%. These increases were paralleled by decreases in surface area of the sand (50–2000 μm) fractions and in the proportion of ochreous sand-size particles, showing that the treatment dispersed clay aggregates. This was confirmed by optical study of fine sand separates, which showed many yellowish clay-mineral aggregates with platy structure.

Smith (26) and McAleese and Mitchell (27) found a similarly large exchange capacity in lower horizons of basaltic soils in Northern Ireland, and attributed it partly to silt and sand-size aggregates of expansible clay minerals. Vermiculite was the dominant clay mineral in well drained soils, and montmorillonite occurred only in poorly drained sites. In the well drained Bowden soils, however, montmorillonite was the dominant clay mineral shown by X-ray diffraction patterns of < 2 μm fractions, and is thought to be an alteration product of olivine. (Avery, Bullock and Pritchard, with G. Brown, Pedology Department)

Techniques. The method for preparing thin sections was improved. A vacuum desiccator was fitted with retractable inlet tubes enabling the impregnating polyester resin to be added while the samples to be impregnated are under vacuum. Impregnation is more thorough, especially of fine textured soils. The desiccator consists of a steel tube with sealed perspex top and a solid metal base. Samples are placed on rotatable tables and resin added to them individually, the quantity being regulated by stopcocks. After the resin is added, the system is evacuated for about 12 hours before samples are removed. The inlet tubes must be cleaned thoroughly after use.

To diminish stresses set up during polymerisation of the resin, the period of gelling was increased from one to six weeks by adjusting the content of catalyst (Table 2). This reduces formation of artefact pores in sections prepared for pore-size analysis.

Formerly, impregnated slices were fixed to glass slides with Lakeside 70 and the cover slip mounted with Canada Balsam. As it is important that the impregnation and mounting material have the same refractive index, the polyester resin was used as a base in a mixture for mounting slides and coverslips. Table 2 also gives the composition of the mounting mixture. (Bullock and Dorrington)

TABLE 2

Composition of impregnating and mounting mixtures

	Impregnating mixture (g)	Mounting mixture (g)
Antoplax 110 Resin	66	25
Styrene Monomer 'C'	34	
Accelerator		0·5
Catalyst	0·20	1·0

A5. Soil moisture studies

Moisture release characteristics and bulk density were measured of samples of soil from profiles of Dale (7), Romney (14), Stockbridge (4), Ragdale (9), Dunnington Heath (9), Cottam (9), Astley Hall (9), Newport (9) and Nordrach (10) series. Moisture characteristics were also measured of samples taken during a special survey in the Aire–Calder Development area near Castleford, in the West Riding. The samples were taken from profiles of the Dale, Swindon Bank (7), Stanley (7) and Aberford (4) series (8 sites).

The effects of compaction on the air and available water capacities of A horizons of four soil series (Ragdale, Saltmarshe, Wick (1) and Newport) were studied. Air capacity

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diminished with increasing bulk density in all the soils. Available water capacity (0·05 to 15 bar) increased from small to moderate bulk densities. At large densities available water is also diminished in all soils except the Newport. The smaller air content is a serious disadvantage at densities greater than 1·3 g/cm in the Ragdale soil.

A gamma transmission probe was calibrated with field soils, sand and fly ash mixtures at different moisture contents and used to measure bulk densities *in situ* during the Aire–Calder Development survey. The logarithm of count time has a linear relationship with wet bulk density. The method gives results as good as the core method of measuring bulk density for most soils, and can be used in stony soils where core sampling is not practicable.

The moisture balance of the Kingston Brook Experimental Catchment was studied further using a 'Wallingford' neutron moisture probe belonging to the University of Nottingham. Annual moisture regimes of four soil series (Ragdale, Cottam, Dunnington Heath and Newport) and the effects of soil moisture content on run-off were examined. Water ran off the Ragdale soils very rapidly on a wet winter day, and profile water content changed only slightly. Water content in Newport profiles increased markedly, however, and then decreased during the next 48 hours. Associated stream flow fluctuated much less. The characteristics of the other soils lay in between. (Smith, Dollard, Reeve and Thomasson)

A survey was made of the catchment of the tributary of the River Tas that flows through Shottisham, 10 km south of Norwich. The hydrology of 16 km² of land is being investigated by the School of Environmental Sciences of the University of East Anglia. The stream valley is cut in Chalky Boulder Clay with Beccles and Hanslope series (6) on higher ground. Ashley (6) soils occur frequently on slopes, and in Chalky Boulder Clay or Head with a loamy calcareous matrix. (Corbett)

Measurements continued of the levels of the water table in soils of the Dunnington Heath and Brockhurst (1) series near Leamington. Measurements are also to be made in similar soils near Wellesbourne and in Evesham and Worcester soils (9). (Whitfield)

Water table level measurements were started in various soils near Woodhall Spa in Lincolnshire. Results show that the gley morphology of drained fen soils does not reflect the present water regime. Water levels in clayey, strongly gleyed soils of the Downholland (3) series were above 60 cm depth for less than one month in winter. (Robson)

Water levels were again recorded in ten soils at the Cheshire College of Agriculture. Records from the previous year confirm that each has a distinct regime. (Furness and S. J. King)

A map was prepared for the Institute of Hydrology showing the soils of south-east England classified according to permeability. (Mackney)

A6. Soil temperatures

Soil temperatures and frost heave were again measured in soils on Magnesian Limestone at Bramham and results for three years examined. There were fewer heaves during the 1970/71 winter than during the previous ones, and in December, Wetherby soils (4) froze to 7 cm, but not to bedrock as in the previous winter. The instruments were transferred to the new office at Calthwaite, Cumberland. (Matthews)

Classification

B1. Soil classification

The Survey needs a better system of classification to identify mapping units consistently and improve transfer of information. A new scheme approved by the Soil Survey Research

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Board is now being prepared for publication in 1972, to complement a revised Field Handbook. (Avery)

Studies on soil systematics by numerical methods continued. Grouping, using mean character distance as the measure of similarity between individual profiles was found empirically to be the best entirely automatic procedure. The most profitable classification procedure of all was to combine intuitive classification by experienced surveyors followed by allocation or reallocation of profiles using multiple discriminant analysis. Sufficient understanding and experience of multivariate classification and ordination was gained for them to be applied in a more-nearly routine way, especially in the early stages of survey.

Production programs were translated from Algol into FORTRAN IV and transferred from the Oxford University KDF9 computer, which closed down during the year, to the new Rothamsted 4-70 equipment. In March the Survey was provided with direct access to the 4-70 from a teletype terminal at the Oxford office. The Multijob operating system at Rothamsted was at first unreliable, and progress slow, but it has improved.

The details of soil borings on a 100 m × 100 m of 60 km² of the Ivybridge area of Devon (Sheet SX 65) were recorded and transcribed for analysis by computer and automatic map production.

Programs were written to study the spatial distribution of soil in the landscape, by both hierarchical analysis of variance and autocorrelation. A means was developed of automatically finding soil boundaries on transects using Mahalanobis' generalised distance.

Data from sample surveys were used with the SYMAP mapping system, in which a computer line printer creates the map display. The results are satisfactory for *ad hoc* surveys where maps are needed quickly.

Preliminary sampling of Sheets SP 30 (Witney South) and SP 60 (Tiddington) was completed, in collaboration with the Soil Science Laboratory, Oxford. The data will be used to prepare a mapping legend by numerical methods and to plan more effective field sampling. (Webster)

Surveying

C1. Air photography (Uplands)

Pilot studies in the West Riding Pennines were extended and a provisional 1 : 100 000 soil association map prepared from photographs for about 4000 km². The boundaries of mapping units and their composition are being examined by reconnaissance survey in the field.

Five to ten per cent of the area will be surveyed in detail and the rest by regular traverses and spot checks. Survey will be completed in 1972 and published as part of the West Riding County Soil Map, when the lowland parts of the county are completed.

Multispectral photographs of Pembrokeshire were specially taken for the Survey to examine their value in aiding soil mapping. (Carroll and Bendelow)

The COBOL computer program for land classification was modified to take account of aerial photograph pattern complexity and exposure, and applied to west and central Pembrokeshire. (Rudeforth)

Liaison continued with other organisations interested in the applications of aerial photography and remote sensing. (Carroll, Evans and Bendelow)

C2. Air photography (Lowlands)

The study of soil patterns on air photographs continued. Recent photography shows that a pattern reflecting an alternating lithological sequence of shales/clay and limestones/

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sandstones is widespread on Keuper Marl in Derbyshire, Leicestershire, Somerset, Warwickshire and Worcestershire and on the Inferior and Great Oolite Series of the Jurassic in Gloucestershire, Lincolnshire and Rutland.

The most suitable time of year and scale of photography for surveying soils is becoming clearer. In arable land, especially with shallow soils over chalk, fen creek and stripe and polygon patterns, photographs are best taken during winter or early spring when tone contrasts on bare ground are greatest. Patterns in crops resulting from variability in available soil water, e.g. the polygonal pseudomorph frost wedge pattern, and those from deeper soils over stripes, and changes in lithology, are best recorded during July.

A suitable compromise scale of photography for soil survey is 1 : 15 000, at which ground detail is adequately recorded and individual prints give perspective over a large area, and only about 40 prints are needed to cover a 1 : 25 000 map. At smaller scales ground detail is lost, photographs are less useful as base maps in the field and can be taken on only a few days in the year because of the greater flying height.

The Survey collaborated with the Natural Environment Research Council in a study of remote sensing of the environment. Panchromatic, multispectral and infra-red line-scan imagery were obtained of two areas near Thetford, East Anglia where the soils were characterised, and ground temperatures measured. (R. Evans)

The intensity of tone on air photographs of fen creek patterns near Chatteris was measured with a densitometer. Changes in tone correlated slightly better with the moisture content of surface soil than with organic matter content as indicated by loss-on-ignition. (R. Evans with Julia Head—*Student Worker*)

Special surveys

A soil map of England and Wales at a scale of 1 : 10^6 was compiled from seven regional maps and, with a map compiled by the Soil Survey of Scotland, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen, presented to a meeting of the ECA Working Party on Soil Classification and Survey at Helsinki in July, 1971. The 81 soil associations show dominant and subdominant soil groups and subgroups, defined according to World Soil Resources Reports 33 and 37 of the F.A.O. (Findlay)

A survey of 27 km^2 in the Aire and Calder valleys was made for the Planning Department of the West Riding of Yorkshire County Council. Fieldwork was completed. (Hartnup)

The farm and experimental grounds at the Plant Breeding Institute at Trumpington near Cambridge were surveyed. Eight soil series, all previously described in the Cambridge district were mapped. Some ground was reclaimed from coprolite workings opened during the First World War. (Seale)

A short report on the soils of the National Vegetable Research Station, Wellesbourne, was made to its Field Experiments Committee. Soil series were described and 300 auger samples and nine profile pits examined to determine variations in the soils field by field. The report was accompanied by a provisional soil map and analytical data. (Whitfield)

A new detailed soil map of Trawscoed Experimental Husbandry Farm was completed and a report prepared. (Lea)

A soil map (1 : 2500) of the 'Farmers' Weekly' Drainage Demonstration site at Cammeringham was made and a soil monolith exhibition presented. (Robson)

A new survey was made of the Grassland Research Institute farm incorporating earlier surveys. (Mackney)

The soil of Barnfield (Rothamsted Experimental Station) was surveyed in detail, and micromorphological, particle-size, chemical and mineralogical analyses made with samples from twelve 90 × 15 cm cores taken at intersects of inter-plot pathways

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(*Rothamsted Report for 1971*, Part 2, 5–37). (Avery and Bullock, with Catt, Newman, Rayner and Weir, Pedology Department)

Other work

Preliminary analysis of water in several of the Mid-Cheshire Water Board's boreholes suggests that the nitrate contents of soils decreased in recent years, despite the use of more nitrogenous fertilisers on surrounding land. (Furness and S. J. King)

The thickness of peat at 130 places in the Fenland was measured between 10 and 20 years ago, and the measurements were repeated at the same places this year. Where peat was originally between 30 and 90 cm thick, there was an average shrinkage of 14 cm over 19 years, a rate of 0·75 cm/year. At several other places, where the peat was originally between 90 and 230 cm thick, the average shrinkage was 19 cm over nine years or 2 cm/year. (Hodge with Ann Herbert—*Student Worker*)

Soils were recorded in sites where sugar-beet experiments were made in East Anglia by Broom's Barn Experimental Station. (Seale and Burton)

A five-day tour was arranged for a party of staff and students from the Ecole Nationale Superieure Agronomique, Grignon, France, including lectures and discussions on soil classification and cartography at Rothamsted and at Oxford, and a field study of soils on granite and other rocks in Devon.

The biennial joint field meeting of the Surveys of England and Wales and of Scotland was held at the University of Sterling in June, and attended by 29 members of staff. The theme was 'The practical application of soil survey knowledge with special reference to drainage problems'.

Two Memoirs and eight Soil Survey Records were produced. Special Survey No. 5 'Soils of Exmoor Forest' by Mr L. F. Curtis of the Department of Geography, University of Bristol, was published.

Four maps at a scale of 1 : 63 360 and 17 at a scale of 1 : 25 000 were published.

Staff

G. D. Ashley, P. A. Johnson, G. A. Reaves, W. Tatler and J. M. Wood left and R. H. Allen, D. J. Eldridge, I. N. L. Kilgour, Alison Knowles and M. J. Reeve were appointed.

B. W. Avery, P. Bullock and A. J. Thomasson attended the International Society of Soil Science Meeting at Stuttgart on 'Pseudogleys and gleys, genesis and use of hydromorphic soils'. Afterwards Thomasson visited the Land and Federal Institutes for Soil Research near Hanover and Bullock the Soil Science Laboratories in Germany, Holland and Belgium.

Local offices were opened in Cumberland and Cornwall.

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