Report for 1972 - Part 1

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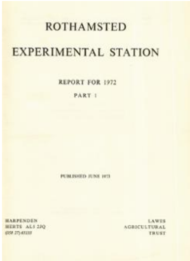
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REPORT FOR 1972
PART 1

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 Surveys 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 nearly 1300 km^2 to be surveyed in detail in 28 of them. Seventeen maps at this scale have now been published with explanatory publications—Soil Survey Records—for eleven of them. Progress was also made in reconnaissance survey and compilation of maps of soil associations at a scale of 1 : 250 000 for the counties of the West Riding of Yorkshire, Berkshire, Pembrokeshire, Avon, Cheshire and Norfolk.

The 1 : 25 000 maps are intended to serve as sample areas in the later construction of the 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*).** The Record was completed. (Furness and S. J. King)

***Sheet SJ 45E/55W* (*Burwardsley*).** A reconnaissance survey was made, a provisional legend prepared and 35 km^2 mapped in detail.

The map includes part of the mid-Cheshire ridge, an outcrop of Triassic sandstone rising to 227 m (745 ft) O.D. Coarse textured soils of the Bromsgrove and Bridgnorth series (1) and the deeper Wick (2) and Newport (3) series form a complex soil pattern on the sandstone with fine loamy soils of the Escrick (4) series occupying glacial spillways.

Much of the area is covered by reddish brown till of Keuper Marl origin and associated glacifluvial sands. To the north-west of the ridge the soils are dominantly clayey, giving profiles of the Salop (5) and Flint (6) series. To the east, the influence of the sandstone and of reworking with sandy glacifluvial deposits results in fine loamy soils of the Salwick and Clifton series (5).

The glacifluvial deposits of the Middle Sands are found in the east and south. At Cholmondeley Castle, the third retreat stage of the Lower Boulder Clay glaciation has

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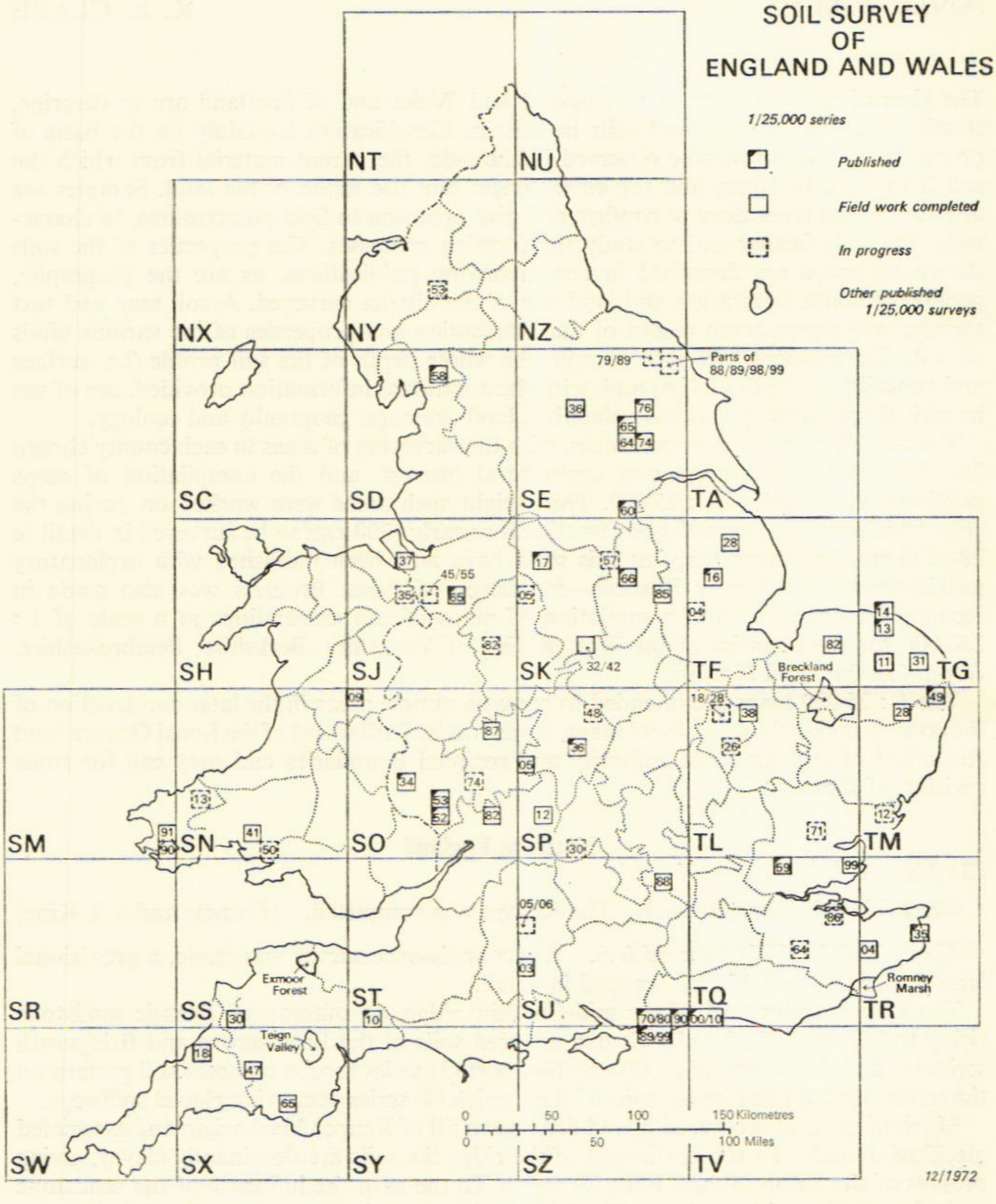

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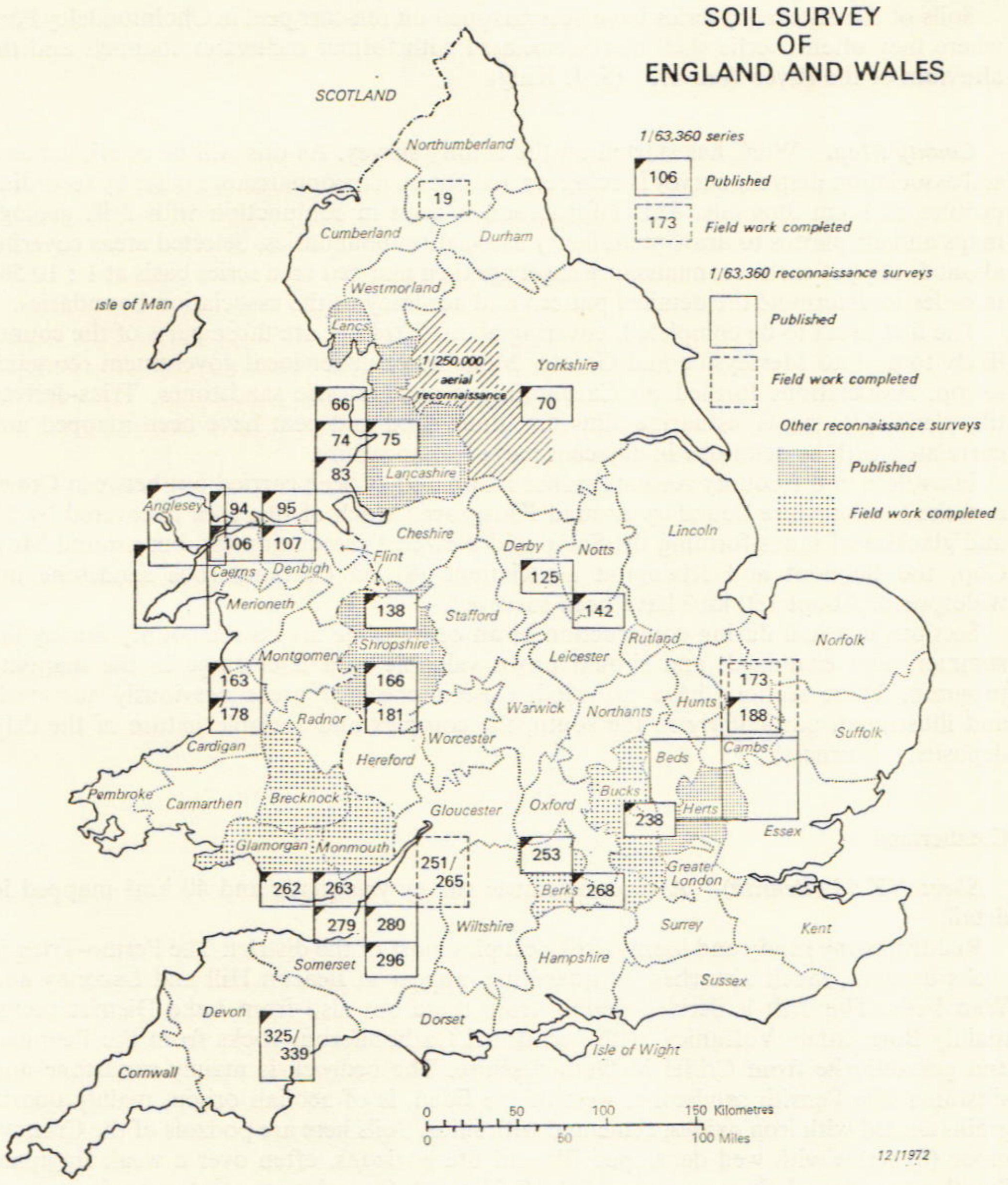

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been recognised and is represented by dissected mounds of sand and gravel giving soils of the Newport (3) and Ollerton (7) series. Deposits of Upper Sands are seen in terraces and outwash spreads associated with late-glacial Lake Lapworth. In the Ridley Pool area deposits 7 m thick were laid down by meltwaters entering the Pool through the Peckforton spillway and give soils of the Blackwood (6) series.

Soils of the Altcar (6) series have been mapped on fen-carr peat in Cholmondeley Park where they often overlie shell marl associated with former meltwater channels and the alluvium of the River Weaver. (S. J. King)

County Map. Work has started on the county survey. As this will be published as a soil association map the survey is being carried out on a reconnaissance basis by recording profiles at 1 km intervals. This information is used in conjunction with drift geology maps and air photos to draw preliminary association boundaries. Selected areas covering about 5–10% of each reconnaissance sheet are then mapped on a series basis at 1 : 10 560 in order to determine the detailed pattern and accuracy of the association boundaries.

The first areas to be completed, covering about 200 km^2, are those parts of the county likely to go into Merseyside and Greater Manchester under local government reorganisation. Associations formed on Carboniferous and Triassic sandstones, Trias-derived till, glacifluvial sands, estuarine alluvium, dune sand and peat have been mapped and correlated with associations in adjacent parts of Lancashire.

Elsewhere in the county reconnaissance mapping has been carried out between Crewe and the Staffordshire boundary around Kidsgrove. Much of this area is covered by till and glacifluvial sands forming the Salop and Newport association (8), but around Mow Cop, the Belmont and Rivington associations (8) on Carboniferous sandstone are widespread. About 150 km^2 have been surveyed.

Sections exposed during construction of an oil pipeline across the county during the summer were examined, and should prove valuable at a later stage in the mapping program. These sections have provided a useful check of areas previously surveyed, and illustrated, particularly in the south, the complex and variable nature of the drift deposits. (Furness)

Cumberland

Sheet NY 53 (Penrith). A reconnaissance survey was made and 40 km^2 mapped in detail.

Reddish stony sandy and loamy drift occupies most of the district. The Permo-Triassic rocks beneath, much disturbed by quarrying, appear at Beacon Hill and Lazonby and Wan Fells. The drift is derived mainly from these but also from Lake District rocks, mainly Borrowdale Volcanics, with occasional Carboniferous rocks from the Pennines and granodiorite from Criffel in Dumfriesshire. The bedrock is mainly sandstone and siltstone. The Penrith sandstone, west of the Eden, is of aeolian origin, mainly quartz grains coated with iron oxides, cemented with silica. Soils here are podzols of the Crannymoor (6) series with well developed Bh and Bfe horizons, often over a weak fragipan. Small areas of sandy brown earths of the Bridgnorth (1) series are on steeper slopes.

Typical brown earths, sandy brown earths, gleyed brown earths and gleyed sandy brown earths are on the sandy and coarse loamy drift associated with many glacial spillways, especially near Plumpton. East of the Eden the drift is fine loamy, with soils of the Clifton (5) series. The Eden valley contains alluvium with small patches of peat over algal marl. River terraces and morainic and kame mounds border the alluvium and the sandy and coarse loamy drift has typical sandy and gleyed brown earths.

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Most of the farmland is in grass, particularly in the east. The Helm, a locally strong wind from the Cross Fell escarpment further east, damages germinating root crops occasionally and can retard the growth of grass. (Matthews and Kilgour)

Northumberland

***Sheet 19* (*Hexham*).** Soils were correlated with series established elsewhere, a legend constructed and the map completed. (R. A. Jarvis)

Yorkshire (North Riding)

***Sheet SE 76* (*Westow*).** The Record was completed. (Matthews)

***Sheets SE 79E/89W* (*Pickering Moor*) *and SE 88NE/89SE/98NW/99SW* (*Troutsdale*).** These two composite sheets were chosen to study the use of air photography in mapping soils of the North York Moors, and to take advantage of soil mapping done there by Forestry Commission staff. 50 km^2 were mapped in detail.

Jurassic sedimentary rocks underlie the whole area and there is little evidence of glacial deposits. Most soils are clearly related to solid geology. There is usually a brown earth in arable land equivalent to podzolised soils under moorland or forest, but traces of the original podzolised profile are often found.

On rolling moorland in the north-west, clays and shales of the Estuarine Series give fine textured peaty gley soils and ridges of Kellaways Beds sandstone have coarse loamy peaty gleyed podzols. To the north-east are steep-sided valleys and flat-topped ridges. On the ridge tops, coarse loamy peaty gleyed podzols and brown earths are associated with sandy Passage Beds and loamy fragmental peaty gleyed podzols with the Lower Calcareous Grit. A gleyed brown earth in fine loamy Head normally covers Oxford Clay on the steep valley sides, but soils of the Denchworth (9) series are found in Troutsdale, where the slope is less steep. Kellaways Beds form the lower valley slopes and give sandy brown earths and peaty gleyed podzols. The Estuarine Series forms the valley floor, with clayey surface-water gley soils. To the south is the Wykeham plateau, where the soils are often deeply weathered. Here, the Middle Calcareous Grit, and, in part, the Lower Limestone, are covered by clayey brown earths and peaty gleyed podzols. Shallow fine loamy soils over limestone are acid under forest but slightly calcareous where farmed. The soils associated with Passage Beds are deep sandy clay loams on the plateau, but loamy sands in valleys incised in it. (Carroll and Bendelow)

Yorkshire (West Riding)

***Sheet SE 36* (*Boroughbridge*).** The remaining 53 km^2 were mapped to complete field work.

Soils are mostly in varied drift deposits, with subordinate areas of Magnesian Limestone in the south-west. Fine and medium textured tills, mainly from Permian and Carboniferous rocks are in the western half of the sheet area, with coarse and medium textured tills, mainly from Triassic rocks, in the east. They are separated by a late-Glacial lake basin, with clayey lacustrine deposits, and by the valleys of the Ure and some minor tributaries whose courses were diverted during the last glaciation. These valleys contain peat, gravel and varied alluvium. Algal marl occurs near springs of calcium-rich water.

Where the Magnesian Limestone is free of drift there are brown calcareous soils and rendzinas. (Hartnup)

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County Map. The Bowland portion of the West Riding is to be included in the new Lancashire and a map at 1 : 250 000 was prepared from work already completed. The parish of Saddleworth is to be included in the Greater Manchester Metropolitan County and a map at 1 : 250 000 was prepared from work already completed. Field work was completed for the West Yorkshire Metropolitan County. A map at 1 : 250 000 and a report are in preparation. Field work in the south Pennines continued and the upland portion of the South Yorkshire Metropolitan County will be completed in 1973. (Carroll, Hartnup, Bendelow, Thompson and Briggs)

East Anglia

Cambridgeshire and the Isle of Ely

Sheet TL 38 (Chatteris). The Record has been prepared. The map will be published in four quarter sheets at a scale of 1 : 10 500 on a photo-mosaic base which shows the extensive creek-ridge soil pattern. (Seale)

Sheet 135 (Cambridge and Ely). The legend and soil boundaries for this 1 : 63 360 soil association map have been settled and the report completed. (Seale and Hodge)

Huntingdonshire

Sheet TL 18E/38W (Stilton). A further 80 km^2 were mapped and 20 profiles fully described.

A Calluna-Eriophorum-Sphagnum raised bog remnant over fen and carr peat occurs in Holme, Conington and Woodwalton Fens, much disturbed in the past by turbary operations. Depth to a mineral substratum, as a means of estimating the future shrinkage of the area of peat fenland, and pH are thought to be the two most useful agricultural factors in subdividing the fenland. Considerable areas of peat over 2 m thick still remain and depth phases have been demarcated at 1 m intervals. The peat will also be subdivided according to the degree of humification and type of plant remains.

Stretham (9) soils occur with the Hanslope (3) series on the Chalky Boulder Clay plateau of the south and west. Occasional distinctly reddish coloured drifts and tills (with mainly Jurassic erratics) occur at the edge of the plateau on the sides of some of the deeper emerging valleys.

Drift covers much of the Oxford Clay lowland, extending beneath the peat to the north and east. The drift is of three types: (a) A well drained non-calcareous fine sandy clay loam colluvium, giving soils of the Childerley series in re-entrant valleys in the Chalky Boulder Clay plateau and which issues forth over the Oxford Clay, mainly beside streams and eventually grading into clayey alluvium with soils of the Fladbury (3) series. (b) Coarser textured and gravelly drift with Aldreth (9) soils top low ridges between 9 and 18 m (30–60 ft) but also occur in lower land as broad sheets. At the fen edge a humose topsoil occurs and the soil is of the Bracks (9) series. (c) A more recent, possibly aeolian, non-calcareous drift of silt loam or silty clay loam texture and with characteristic manganese concretions, is particularly common between Sawtry and Stilton occupying shallow valleys and slopes to a height of 30 m (100 ft) O.D. Often the drift is over 1 m deep but where thin, the clayey Aldreth, Wicken and Denchworth soils (9) have a coarser textured and more workable topsoil. At the fen edge a previously undescribed practically stoneless acid bleached silt loam humic gley soil is found. (Seale and Burton)

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Norfolk

Sheet TG 11 (Attlebridge). Mapping of the 100 km² of the sheet has been completed. Five landscapes have been distinguished. Sandy upland forms the largest area and is dominated by soils of the Freckenham (9) series with Redlodge (9) soils on more sloping sites in woodlands and heath. Textures are commonly loamy sand with sandy loam top-soils. Patches of fine sandy loam give Hall (10) soils in areas marginal to the cover-loams found further to the north-east. The upper terrace of the Wensum contains much gravel, giving Freckenham stony phase and in places, Hall stony phase soils.

On crests in the Weston Longville, Witchingham and Swannington area, Freckenham soils merge into Acle and Wroxham series with a non-calcareous till below 70 cm. Small tributary valleys contain Freckenham and Acle soils associated with Head from the immediate surrounding land.

A Norwich Brickearth landscape is found in the north-east, near Horsford. A new series, an iron-pan gleyed podzol, occurs on the slopes in woodland and heath where iron-pan and concretions are in the sand immediately above the Brickearth. The slope complex includes Lakenheath (11), Row (10), Gillingham (10) and Gresham series; valley floors have Isleham (10) soils.

Chalky Boulder Clay outcrops on valley sides and slopes in the Honingham area in the south-east, normally under thin non-calcareous leached till, giving Beccles (10) soils on upland, and Ashley and Hanslope soils (9) on slopes.

In the Wensum and Tud valleys a steep slope phase of the Freckenham is on upper slopes and a Freckenham and Methwold (11) complex, with Worlington and Newmarket soils (11) on lower slopes where soft, weathered cryoturbated chalk lies under the sandy surface. The lower terrace of the Wensum is also largely stony Freckenham soils. Adventurers' (11) series is widespread on the Wensum floodplain and a Midelney (9) variant where a silty topsoil masks the peaty alluvium. Isleham, Highlodge (11) and Row soils are on sand and gravel banks at the floodplain margin. The Tud floodplain has more clayey alluvium. (Eldridge)

County Map. Work on the 1 : 250 000 county map was started and reconnaissance survey completed for 1 : 25 000 sheets TF 84, TF 91, TF 93, TG 00, TG 02, TG 04 and the parts of TF 80 and TL 88 not covered in the Breckland Forest Survey (11). These sheets, with the detailed surveys of those already completed, cover mid-Norfolk from Wymondham to Swaffham with a chequerboard mosaic of maps surveyed in detail or in reconnaissance and enclosing unsurveyed areas. The county map will be made by reduction of the surveyed sheets and extrapolation into unsurveyed sheets followed by studies to check boundaries and quantify unit composition.

The reconnaissance procedure is that used in detailed mapping in Norfolk, in which 400 auger borings are made in 25 clusters on each 1 : 25 000 sheet. The clusters are at grid intersections 2 km apart and consist of four sub-clusters 100 km to the north, south, east and west of the centre. Each sub-cluster has four borings 10 m north, south, east and west of its central point. This sampling pattern is aimed at finding variation within landscape facets (20 m interval) between facets (200 m interval) and across landscapes (2 km interval).

The reconnaissance shows mid-Norfolk has three main soil landscapes. The Chalky Boulder Clay landscape of sheets TM 49 (Beccles North) and TM 28 (Harleston) extends to the north-west to near Fakenham and Swaffham though from Wymondham the high ground includes capping gravels with Freckenham (9) soils. In the west is the Breckland landscape and in the north-west the North Norfolk Gravel landscape of sheet TF 82 (West Raynham). Small soil landscapes are the Cromer Ridge on sheet TG 13/14

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(Sheringham and Barningham) in the north-east and the coastal landscape between Wells and Burnham Market in the north-west. (Corbett)

East Midlands

Derbyshire and Leicestershire

***Sheet SK 32E/42W* (*Melbourne*).** Mapping of the remaining 25 km^2 was completed and a final legend and map have been prepared. Owing to the complexity of soil pattern on the alternating shales and sandstones of much of the Millstone Grit outcrop around Melbourne, some 600 ha (1500 acres) were mapped as the Melbourne complex, in which topsoils are mainly of coarse loamy texture but the texture and gley morphology of the subsoils are extremely variable. On the Trent floodplain, wide areas of fine loamy gleyed brown alluvial soils were mapped as the Trent series. A Record is in preparation. (Reeve)

Lincolnshire

***Sheet TF 04* (*Sleaford*).** About 75 km^2 were mapped in detail. Sherborne (3) soils are extensive on the Jurassic limestones but many limestone soils have inclusions of extraneous drift. The two main sources are (a) a presumed extensive glacial outwash deposit now represented by remnants of plateau sands and gravels with many Triassic stones near Rauceby, (b) aeolian sand from gravelly river terraces aligned with the Ancaster Gap. The drift contamination results in a sequence of thin sandy, coarse loamy and fine loamy soils on limestone with increasing distance from the drift source. These soils are in a complex pattern and deep sandy soils can be non-calcareous to 70 cm. Final correlation with other regions is in progress.

Newport (3) and Wick (2) soils are on the sandy and coarse loamy plateau outwash deposits. The soils on the river gravels have calcareous subsoils and are liable to wind erosion.

Outcrops of the fine sandy and clayey Kellaways Beds at the base of the Oxford Clay are not extensive but there is a range of soils from deep well drained brown earths of fine sandy loam texture to gley soils where clayey bands occur within 1 m of the surface.

Hanslope and Ragdale soils (3) occur on Chalky Boulder Clay in the south-west. A Hanslope-Ragdale intergrade soil with a calcareous but prominently mottled sub-plough layer is also present.

Humic gley soils with calcareous subsoils similar to the Fordham (9) series occur in Quarrington Fen near Sleaford. (George and Heaven)

***Sheet TF 28* (*Donington on Bain*).** A reconnaissance survey was made and about 10 km^2 mapped in detail. Much of the district is on the deeply dissected Lower and Middle Chalk dipslope. Icknield (12) soils are extensive usually as a brown rendzina variant because the land is in arable cultivation. Deeper Coombe (12) soils on chalky Head are in many valley bottoms. Reddish boulder clay of the last glaciation is present in many valleys in the east of the district. Aerial photographs are invaluable for delimiting the valley soils.

The steep scarp slope has narrow outcrops of Red Chalk and Carstone (coarse brownish sands equivalent to the Lower Greensand) but more extensive Lower Cretaceous deposits in the form of the Tealby Beds (clays with limestone and ferruginous bands) and Spilsby Sandstone (sandy beds of variable hardness and colour) are present in footslope and valley positions. Well drained sandy and coarse loamy soils are present on the sandstone.

Denchworth (9) and Rowsham (3) soils occur on Kimmeridge Clay. Hanslope (3) soils are present on the Chalky Boulder Clay west of the Wolds. (Robson and Heaven)

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Nottinghamshire

***Sheet SK 57* (*Worksop*).** This represents an undulating lowland region across the outcrops of Magnesian Limestone, Permo-Triassic sandstones and marls, and Bunter Sandstone. On limestone, a reconnaissance survey indicated that Wetherby and Aberford series (13) are present in equal proportions with small areas of Saxton (13), Micklefield (13) and Worcester (3) series on relic pockets of marl. A shallow variant of the Micklefield series is recognised where marl thins out over limestone. Where groundwater is present near Welbeck, a gleyed variant of the Aberford series has been recognised. The outcrop of Permian sandstones and marls carries soils of the Bromsgrove (1) and Dunnington Heath (3) series on its south-eastern end, but within Welbeck Park, more marly beds give the Worcester (3), Brockhurst (7) and Watnall (13) series. To the east, the Bunter outcrop is dominated by the Newport (3) series which has been divided into four phases according to topsoil texture and stone content. The Bridgnorth (1) series is found on steeper slopes, and soils of the Wick (2) series are mapped where profiles are predominantly coarse loamy in texture. The Ollerton (7) complex occurs in minor valleys in the south-east whilst small streams draining the limestone give calcareous soils of the Ulleskelf (13) series. Approximately 30 km^2 were mapped. (Reeve)

West Midlands

Herefordshire and Worcestershire

***Sheet SO 74* (*Malvern*).** A reconnaissance survey was made early in the year and 27 soil mapping units established; 30 km^2 have since been mapped in detail. The prominent north–south ridge of the Malvern Hills rising to 425 m (1394 ft) O.D. at the Worcestershire Beacon, has a core of pre-Cambrian igneous and metamorphic rocks. The ridge, which divides the district, is geologically complex but sesquioxidic brown earths, typical brown earths, gleyed brown earths and rankers on it are often in Head from a range of Malvernian rocks rather than rock *in situ*.

West of the Malvernian axis, steeply dipping, north to south striking Silurian strata form scarp and vale topography. Impersistent limestones and calcareous siltstones with argillic brown earths and brown calcareous soils of the Wilderhope-Gatley complex (14) frequently form high ground. The intervening vales are cut into siltstones, shales and mudstones and, depending on drainage conditions, give Yeld, Stanway and Speller series (14). Munslow (14) soils are found occasionally on the less argillaceous siltstones.

Extensive Head deposits flank the Malvern Hills. To the east they consist of mainly angular Malvernian material over Keuper Marl, but to the west they are more varied in composition including Silurian and Devonian material.

In the south around Colwall a fine silty, stony, surface-water gley soil in Malvernian and Silurian-derived Head, often less than 100 cm thick over Devonian marl, is extensive. This soil is also widespread in the upper reaches of the Cradley Brook valley. Further downstream the valley is cut into Devonian marl and contains dissected patches of reddish brown outwash sands and gravels especially around Mathon and Cradley. These deposits form flats some 20 m (65 ft) above the present stream giving the loamy and stony Newnham (14) series and slopes down to Cradley Brook have soils of the Bromyard-Newnham complex.

The Head east of the Malverns thins eastwards. Where the Keuper Marl is relatively free of drift, as around Newland, Worcester and Spetchley soils (15) predominate. The Head generally gives surface-water gley soils with coarse loamy or fine silty stony horizons over Keuper Marl, and these soils await correlation. East of Malvern Wells coarse loamy angular gravels often greater than 80 cm thick give as yet unnamed brown earths and gleyed brown earths.

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In the west near Coddington and Wellington Heath on the flanks of Oyster Hill, slightly stony silty soils of the Wootton and Vernolds series (14) are in Head from Silurian and Devonian rocks. (Palmer)

Staffordshire

***Sheet SJ 82* (*Eccleshall*).** A further 45 km² were mapped in detail and representative profiles were sampled.

Over much of the west and central parts of the district solid Keuper Marl, and occasionally Head from Keuper Marl, is under a mantle of Weichselian till, usually less than 2 m thick and somewhat variable in texture. Four series predominate, fine loamy over clayey profiles have been mapped as the Salop (5) and Flint (6) series. The coarse loamy over fine loamy soils of the Clifton and Salwick series (5), have proved more widespread than previously thought and the coarse loamy over clayey profiles of the Rufford and Astley Hall series (5) appear to be limited in extent.

Near Knightley the till passes into outwash and ice-contact deposits, in an intricate landscape pattern with eskers, gravelly outwash fans and kettle holes, which formed during a halt in the northward retreat of the Weichselian ice. Gleyed brown earths of sandy texture have been correlated with the Ollerton (7) series, and ground-water gley soils have been mapped as the Blackwood (6) series. The Newport (3) series occurs where the soils have no groundwater-table. Broader belts of glacial outwash fan out south-eastwards from Knightley and gravelly loamy material extends eastwards along the flanks of the Gamesley and Hextall Brooks, which were most probably occupied by eastward flowing sub-glacial streams. Brown earths, gleyed brown earths and ground-water gley soils of the Wick (2), Arrow and Quorndon (3) series have been mapped on these deposits.

An undifferentiated gley soil of clayey texture in thicker till in the extreme south-west and on the upper slopes of the Meece Brook valley in the north, has been mapped tentatively as Crewe (6) series. In the north it contains some material from Carboniferous shales.

In Ellenhall Park and on the upper slopes of Berry Ring the solid Keuper Marl is near the surface though it retains a mantle of fine loamy, occasionally fine silty, thin drift. The Brockhurst (7) and Whimple (1) series are the most extensive mapping units. They include soils either in fine loamy or fine silty drift ($<$ 80 cm thick) over clayey Keuper Marl. Small areas of Dunnington Heath (3) series occur where the drift becomes coarse loamy. Where the silty clay marl occurs within 25 cm of the surface, on steep and upper convex slopes, the Worcester (3) series has been mapped.

Twenty-one mapping units are distinguished all in accordance with the proposed new system of classification. (Jones)

***Sheet SK 05* (*Onecote*).** A further 50 km² were mapped in detail and the mapping units correlated with similar soils in Derbyshire, Yorkshire and Lancashire. Twenty-seven mapping units have been recognised, including five composite units and four as yet unnamed series.

The recognition of soil parent materials is a problem, as although during the last glaciation, ice appears to have been confined to land west of the Morridge, intense cryoturbation occurred over the ice-free region to the east. Consequently, few profiles have developed in solid parent materials, and the solifluxion deposits in the east are similar to, and difficult to distinguish from, the till deposits of the west.

Fine loamy soils of the Wilcocks and Brickfield series (5) in drift from Carboniferous shales and sandstones, occur on till around Bradnop and Tittesworth, on the deposits of

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the west-facing slopes of the Morridge, and on slope deposits on interbedded shales and sandstones (Onecote sandstone) which stretch south from Butterton, through Grindon Moor, to Onecote. The surface-water gley and humic gley soils in clayey drift occurring between Pethills Bank and the Ipstones Edge, and in small isolated patches between Grindon and Waterhouses, have been correlated with soils of the Hallsworth and Roddlesworth series (5).

Surface-water gley soils of clayey texture, in Carboniferous shales, or Head from Carboniferous shales, and previously correlated with the Windley (16) series have now been amalgamated with the Dale (13) series. This occurs in a small area round Sharpecliffe, in the north round Mixon, and on the lower western slopes of the Morridge. It often merges into a closely related unnamed humic gley soil. Most of the Dale series however, is found to the west of the main limestone outcrop, around Grindon and Butterton, where it occurs as a complex with a similarly textured gleyed brown earth, correlated with the Alton (17) series and a surface-water gley soil of clayey texture, in Carboniferous shales in which limestone occurs within 80 cm depth.

Mainly fine silty to fine loamy soils of the Heapy (5), Stanley (13) and another unnamed series are in Carboniferous shales or Head from Carboniferous shales. They correspond to the gleyed brown earth, surface-water gley and humic gley soil groups respectively, and occur in deposits over interbedded shales and siltstones (Gun Hill Siltstone). They are common along the east-facing slopes of the Morridge as far south as Onecote, near Butterton Moor, around Brund Hays and Blackbrook Farms and in a small patch south of Warslow.

Earlier in this survey the Nordrach (15) series was mapped as containing soils of both fine silty over clayey texture as found in the Mendips, and soils of fine silty texture similar to those described in the Tideswell area (16). Those have now been separated and the latter are correlated with the Malham (18) series. (Hollis)

Sheet SP 05 (Alcester). The remaining 44 km² were mapped in detail. The legend includes 18 soil series in 19 mapping units. Soils of the Worcester (3) series are mapped on the clayey Keuper Marl and extensive areas of Whimple (1) series are recognised where fine silty or fine loamy Head is over the marl. Near Inkberrow and in Ragley Park, Greinton (15) and Clive (8) series have been mapped on the outcrop of the Arden Sandstone. Evesham and Charlton Bank series (3) occur on Jurassic clays and clay shales and include small areas of shallow Haselor (15) soils on interbedded limestones and clay shales.

The ridge from New End to Weethley is covered with glacifluvial drift and till, and soils of the Salwick (5) series are mapped over most of this land. Small areas of Flint (6) series occur on higher ground around the Lenches and the fine loamy over clayey soils of the Salop (5) series are mainly on gentle slopes along the Alcester–Redditch road.

Wick (2), Arrow, Brockhurst (7) and Whimple (1) soils are mapped on the glacifluvial terraces along the Avon and Arrow and clayey alluvial soils of the Compton (15), Fladbury (3) and Thames (12) series floor the valleys.

Some soils need further correlation before Record and map are prepared for publication. (Whitfield and Beard)

Warwickshire

Sheet SP 36 (Leamington Spa). The map and Record were prepared for publication. (Whitfield).

Sheet SP 48 (Wolvey). About 80 ha have been surveyed during reconnaissance. Soils of the Ragdale (3), Hanslope (3) and Beccles (10) series have been recognised on Chalky Boulder Clay. Wick (2) and Newport (3) soils occur on gravelly outwash at

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Copston Magna. Small patches of Worcester (3) soils are found on drift-free slopes at Monks Kirby. (Whitfield)

South-east England

Berkshire

Sheet 253 **(*Abingdon*).** In co-operation with Drainage and Water Supply Officers of the Agricultural Development and Advisory Service, underdrainage treatments have been designed for the different soil series, and indicated on a map at a scale of 1 : 63 360. (M. G. Jarvis)

County Map. Field work was completed, the map revised and a final legend prepared. The number of associations has been reduced from 21 to 17. Soil data collected from sites located at grid intersections are being analysed to provide means and variances of many soil parameters within both series and associations. (Mackney and M. G. Jarvis)

Essex

Sheet TL 71 **(*Little Waltham*).** Work has been limited to selected areas, chosen to confirm and extend understanding of the nature and distribution of deposits and soils established in the Saffron Walden area (19). Reconnaissance of the selected 25 km^2 was completed and 16 km^2 mapped in detail; 18 pits and 15 proline cores have been described.

Much Chalky Boulder Clay in the district is patchily covered by brown, more or less flinty, clayey or fine loamy non-calcareous material probably not derived by solution from the boulder clay. Surface-water gley soils and gleyed brown earths of the Oak and Chelmer series (20) respectively are identified. Essendon (20) series occurs in a few isolated places where red mottled clay appears within 75 cm, below a loamy surface. Hanslope and Stretham series (20) mainly occupy the flanks of interfluves.

The great thickness of glacial gravels under the boulder clay is obscured by a loamy or loamy over clayey Head on gentle valley slopes, and gravels appear at the surface only on moderate slopes just above alluvium. Chelmer and Bengeo series (20) are identified in the former situation, and a stony phase of Hall (10) series in the latter. Gley soils on sandy and fine loamy gravelly Head are tentatively identified as Canewdon and Southminster series, but occur only sporadically in association with Chelmer soils. Humic gley soils on flush sites constitute the Dunmow (20) series.

Hamble and Hook series (20) (classified together as Hatfield series in the Saffron Walden area) occur on thin brickearth above boulder clay, and small areas of Wickham and Titchfield (20) soils are mapped on strips of London Clay exposed on lower valley slopes. (Allen and Sturdy)

Sheet TM 12 **(*Weeley*).** Reconnaissance has been completed of this district situated on extensive glacial loams and gravels east of Colchester.

The district consists of a plateau falling from 38 m (125 ft) in the north-west to about 24 m (80 ft) in the south-east. South-easterly flowing streams, notably the Holland and Tendring Brooks, dissect the plateau and expose London Clay below. Red Crag, shown on geological maps around Beaumont Hall, is obscured by at least 1·5 m of non-calcareous Head.

Gley soils predominate on the plateau, and are in a thin silt loam or loam over sandy loam or sandy clay loam resting on gravels or sands below 1–1·5 m. They are provisionally correlated with the Sustead series in thick cover loams and the Gresham series in thin cover loams over Norwich Brickearth in north Norfolk. Brown earths and gleyed brown earths in similar material are of restricted occurrence.

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Underlying gravels are exposed at the surface almost solely on breaks of slope at the plateau margins, and consist of gley soils or gleyed brown earths in coarse loamy over sandy gravelly material. As in the Burnham-on-Crouch district much of the thin loamy Head obscuring London Clay is silty, and a silty variant of Wickham will be mapped.

The district is one of mixed farming with dairy herds and sheep using a significant acreage of grass. Besides cereals, sugar beet, green beans, potatoes and onions are extensively grown on the plateau soils as well as top fruit on slopes. Drought can be severe and many farmers have irrigation reservoirs. Marked soil patterns due to differential moisture stress are seen on aerial photographs taken in summer and can be used to delineate soil boundaries. (Sturdy)

Sheet TQ 99 (Burnham-on-Crouch). The soil map and Record are complete, and a land use capability map and report are being prepared, the latter with the Agricultural Development and Advisory Service. (Sturdy)

Kent

Sheet TQ 64 (Paddock Wood). Some 30 km² were mapped south of the Medway where clayey alluvium flanked by brickearth over Weald Clay rises to the strongly dissected High Weald, chiefly of Tunbridge Wells Sands and Wadhurst Clay.

Gley soils and gleyed brown earths are dominant. Fladbury (3) soils on the floodplain grade to Park Gate and Hook soils (20) on nearly flat brickearth or to Thorne and Hildenborough series on Weald Clay. In the High Weald there are similar clayey surface-water gley soils in allied Wadhurst and Grinstead Clay, either on valley slopes or ridge crests. These are provisionally assigned to Hildenborough series where there is superficial silty drift, partly downwash from Tunbridge Wells Sands, and Thorne series elsewhere.

Silty surface-water gley soils with a compact Bg horizon and substratum (Cranbrook (21) series) and allied gleyed brown earths (Curtisden (21) series) dominate much of the Tunbridge Wells Sands. Due to varied lithology, including sand and hard sandstone, the formation also gives soil types ranging from podzols to shallow brown earths; podzols under semi-natural woodland are common in a soil complex north-west of Pembury.

Drift of varied origin and texture, including brickearth, is commonly thick in valleys and on footslopes, giving deep gleyed brown earths (Teise (21) or Hook (20) series), gley soils (Gyll (21) or Park Gate (20) series) and some brown earths (Hamble (20) series). (Green and Fordham)

Sheet TQ 86 (Rainham). A further 60 km² were surveyed in detail; parts of the Record were drafted and work on the associated agronomic section, undertaken jointly with the officers of the Agricultural Development and Advisory Service, is progressing. Six representative gley soils from Eocene Beds and alluvium have been sampled, with monoliths retained as records. Air photo interpretation techniques have been effectively applied in mapping. (Fordham and Green)

Oxfordshire

Sheet SP30 (Witney South). This sheet was chosen to represent soils of the Thames valley and Oxford Clay vale. After reconnaissance a provisional mapping legend was established, including many soils already mapped in north Berkshire. About 8 km² have been mapped in detail.

Alluvium and gravel terraces of the Windrush and Thames extend over much of the district. The gravels are mainly of oolitic limestone, thinly covered with loamy Head, in which brown calcareous soils (Badsey (2) series) are developed; deeper leached soils with

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Bt horizons (Sutton (22) and Hamble (20) series) have also been encountered. Calcareous ground-water gley soils (Thames (12) series) are common in the clayey recent alluvium but clayey over loamy gley soils in older alluvium are commonly non-calcareous. Loamy over gravelly calcareous ground-water gley soils occur in patches of thin Head over wet limestone gravel (Kelmscot series).

Clayey surface-water gley soils (Denchworth (9) series) and gleyed calcareous soils (Evesham (3) series) are common on convex and gentle even slopes of the undulating Oxford Clay country with other fine loamy or clayey surface-water gley soils in Head on footslopes and in bottomland. Loamy gley soils in the Kellaways Beds form a narrow zone across the northern part of the Oxford Clay outcrop.

A small area of shallow brown calcareous soils (Sherborne (3) series) over Cornbrash and Forest Marble limestones but interspersed with deeper calcareous soils in Forest Marble clays occurs in the north-west corner of the district. (M. G. Jarvis and Hazelden)

South-west England

Avon

County Map. Avon county, approximately 1400 km² (530 sq miles), is an amalgamation of parts of north Somerset and south Gloucestershire, centred on Bristol, except in the east where Bath is a major node. Fifteen per cent of the land is urban and a similar percentage is planned for future development.

A survey is at the planning stage. Accumulation of data and the assimilation of information and ideas from similar projects, is proceeding. Nearly half the area has been mapped in detail: parts of Sheets 279 (Weston-super-Mare), 280 (Wells), 265 (Bath) and 251 (Malmesbury). In addition, unpublished surveys provide another 7% coverage. The accompanying publication will contain information of help to a variety of land users. (Colborne)

Cornwall

Sheet SX 18 (Camelford). 100 km² were mapped in detail and the sheet completed. Map and Record are being prepared. (Staines)

Devonshire

Sheet SS 30 (Holsworthy). 80 km² were mapped in detail and the sheet completed. Map and Record are being prepared. (Harrod)

Sheet SX 47 (Tavistock). 60 km² were mapped in detail and the sheet completed. Map and Record are being prepared. (Hogan)

Gloucestershire

Sheet SP 12 (Stow-on-the-Wold). Owing to resignation of the surveyor, preparation of the Record has been delayed but is proceeding. (Courtney)

Wiltshire

Sheet SU 03 (Wilton). The remaining 80 km² were mapped and measurements of stoniness made at eight sites. Mapping of shallow soils on chalk was done on the basis of recent proposals for classifying calcimorphic soils at subgroup level (23). These were mainly recognised by colour which was used to distinguish different contents of insoluble chalk residue or silty drift, calcium carbonate, and organic matter.

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Humic rendzinas (Icknield (12) series) with Munsell colours of 10 YR 3/2 or darker were found on old downland usually only preserved on steep slopes and on rolling cultivated land which was downland until the 1940s. Most cultivated soils are either brown rendzinas with moist colours, 10 YR 4/3 or 3/3 (Andover series), or belong to the typical subgroup (Upton (22) series) which includes both 10 YR 5/3 or 5/2 (moist) soils with carbonate in the fine earth, and also 10 YR 4/3–5/3 (moist), 10 YR 5/3 (dry) soils with common gravelly chalk fragments.

In the south-west a small (12 km^2) wedge-shaped area of Upper Greensand and Gault is cut in two by the Nadder floodplain. The Gault outcrop is covered by Rowsham (3) soils. Most of the southern Greensand bench and the crest of the northern ridge is capped by Plateau Drift giving stony loamy over clayey soils. Stony olive-brown to dark brown sandy loam soils provisionally correlated with the Luppitt (24) series occupy most of the remaining Greensand, which is also covered by small unseparated patches of soils on flinty river drift by the floodplain, and podzols in sandy drift over loamy Greensand in woods south of the Nadder. Fladbury (3) soils dominate the Nadder floodplain. (Cope)

Sheet SU 05N/06S (Devizes). A further 50 km^2 was mapped, completing the portion on SU 05. On Upper Greensand the most extensive soils are deep olive sandy loams or loamy sands with local yellowish brown variants. Finer textured soils with texture profiles (Ardington (22) series) are derived from Chloritic Marl at the junction of the Greensand with the Lower Chalk and less typically from finer textured bands within the sands. Below the glauconitic sands are beds of micaceous slightly glauconitic sandstone (gaize) which exhibit strong ochreous mottling in the weathering zone and give soils with varying degrees of drainage impedance, depending on site. The malmstone at the base of the Greensand is very thin and soils derived from it have not been found.

The Gault–Greensand junction and the Gault outcrop occupy two very different sites. West of Stert, headwaters of the Bristol Avon have cut a valley, the sides of which display prominent landslipping. On the floor of the vale the Gault gives clayey or fine loamy gley soils of the Denchworth (9) series. East of the Stert lies the flat watershed area where early geological surveys identified extensive drift deposits. South of the railway these deposits appear to consist of the remnants of a former chalk-gravel occupying cryoturbation pockets in the Gault Clay and under a prominently mottled clay. Where chalk gravel is absent within 1 m the soils are essentially of Denchworth character but the intricate mosaic of gravels demands a complex mapping unit. Where similar gravelly and clayey drift, clearly remnants of a once extensive deposit, overlies pervious Greensand or Chalk relatively well drained soils have been mapped at several concordant sites.

Alluvium is extensive along the intricate network of headwater streams and consists of two rather variable groups, one essentially mineral and the other organic in character; both are subject to high water-tables throughout most of the year, though recent arterial drainage works may improve their moisture regimes. (Findlay and Colborne).

Wales

Carmarthenshire

Sheet SN 41 (Llangendeirne). The map was prepared for publication and the Record written. (Clayden and G. D. Evans)

Sheet SN 50 (Llanelli North). A further 20 km^2 were mapped, progress being interrupted by the resignation of the surveyor primarily responsible.

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The loamy brown earths in stony drift principally from Pennant Measures are not consistently coarser in the fine earth than the fine loamy Dunsford (1) series mapped in drift from Lower and Middle Coal Measures on SN 41, but are distinguished by their stoniness as the Neath (25) series. The fine loamy surface-water gley soils are mainly the Talog (26) series, and peaty and humose phases of humic gley soils are classed as the Hirwaun (25) series. Similar medium textured soils in drift from Carboniferous rocks on the Pennine footslopes are known as the Brickfield and Wilcocks series (5) respectively. Soil series concepts in materials of this origin need to be reviewed following the principles of the new classification (23). (G. D. Evans, Clayden and Gibson)

Denbighshire

Sheet SJ 35 **(*Wrexham*).** A legend was established after describing profiles at 1 km grid intersections and detailed mapping of key areas. Some 30 km^2 were surveyed leaving less than half of the sheet to complete as almost 25 km^2 is urban or land disturbed by coal, sand and gravel extraction.

Coal Measures, with Millstone Grit around Hope Mountain, underlie much of the district with the eastern third floored by Triassic rocks. The soils are mainly in superficial deposits which largely obscure the solid geological formations. The ground rises to above 200 m (655 ft) on the flanks of Hope Mountain in the west and falls to below 10 m (30 ft) on the Dee alluvium in the east. The land is drained by the Alun, Gwenfro and the Pulford Brook into the Dee which skirts the eastern edge of the sheet.

The district can be divided into the following physical regions reflecting the drift geology shown in Fig. 1.

1. Western hills of Hope Mountain and the Moss area in Carboniferous rocks.
2. Wrexham 'delta' of glacifluvial sands and gravels.
3. Irish Sea till plain extending through Holt to beyond Pulford.
4. Hummocky till lowland in the north-west around Hope.
5. Rossett terrace of loamy, gravelly and sandy Alun river drift.
6. Alluvial flats of Trevalun and Burton meadows.

Till was deposited by North Welsh and Irish Sea glaciers. Reddish brown Irish Sea till is most widespread and gives surface-water gley soils of fine loamy over clayey and fine loamy texture; the more clayey soils corresponding to the Salop (5) series predominate on the till plain of the east.

Most land over Coal Measures shale is disturbed. Loamy brown earths occur on Millstone Grit and coarse loamy humus-iron podzols (Anglezarke (5) series) on the small Byn-y-Gaer inlier. The Wrexham delta, extending from the footslopes of the hills, is of outwash deposits of glacial meltwaters, locally mixed with till. Its edge is clearly defined by moderate or strong slopes descending to the low-lying till and is most pronounced along the Marford escarpment. The soils of the glacifluvial deposits are brown earths, sandy brown earths (Newport (3) series) and gleyed brown earths, with surface-water gley soils in reddish brown till.

In the loamy and gravelly river drift of Rossett terrace the main soils are brown earths, gleyed brown earths and ground-water gley soils, though surface-water and humic gley soils are also present. Both clayey and fine silty non-calcareous gley soils are recognised in the alluvium of Trevalun and Burton Meadows, and distinct areas of humic gley soils. (Lea and Thompson)

Montgomeryshire

Sheet SO 09 **(*Caersws*).** Field work was completed, and the map and Record are being prepared for publication.

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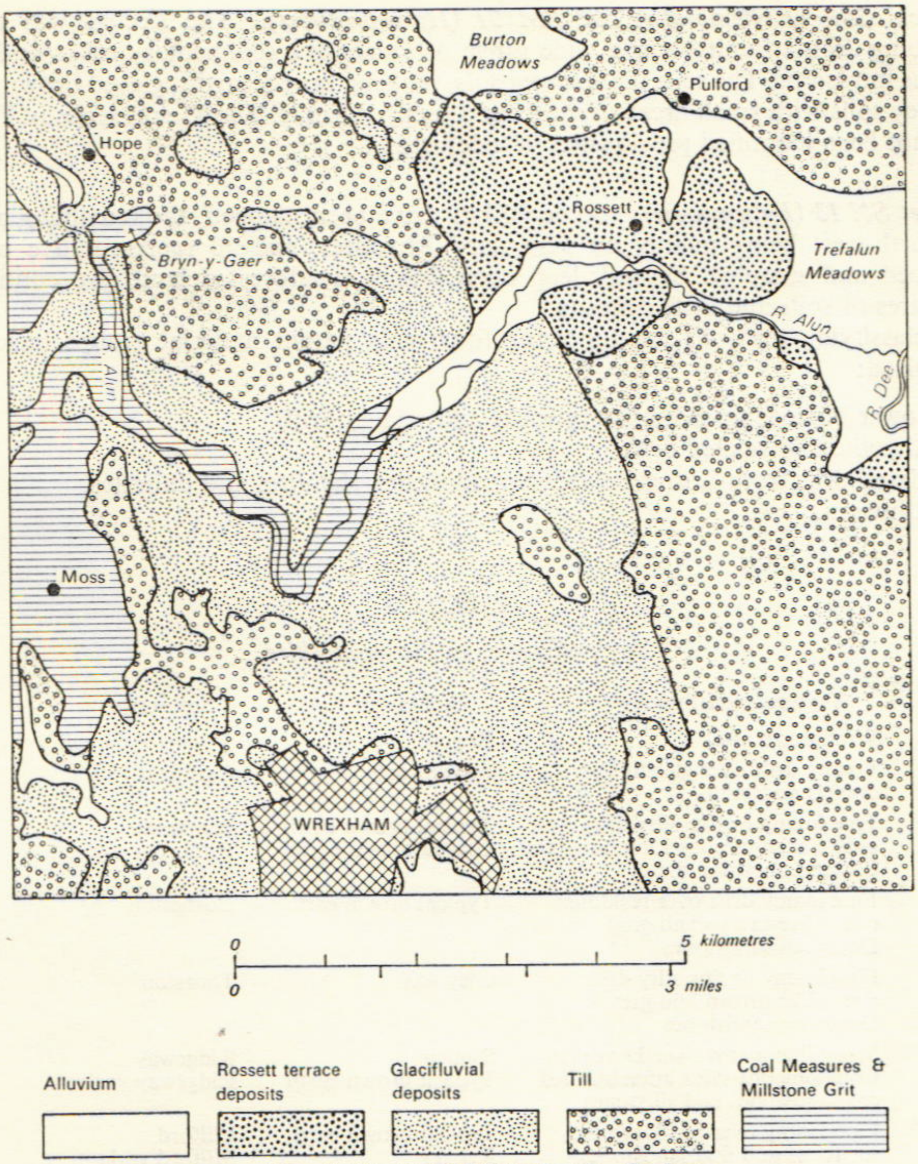

FIG. 1. Sheet SJ 35 (Wrexham)—Geology

Peaty gleyed podzols, on the moorland in the north-west, are mainly without iron pans, like the 'iron-pan intergrade soils' described by the Forestry Commission (27) in the Hafren Forest of mid-Wales. A cultivated phase of these soils is also present. Thick peat occurs in several places above 400 m (1300 ft) and is mapped as Undifferentiated Organic Soils. Tregaron (28) soils in fine silty alluvium with peaty layers were distinguished in the vale below Gregynog Hall.

With the opening of an office at Mold, further work in Montgomeryshire will be postponed until surveys in Flint and Denbigh are finished. (Lea)

Pembrokeshire

A further 166 profiles are described and sampled at 1 km intervals to complete the grid survey of south Pembrokeshire and part of Preseli. (Rudeforth and Bradley)

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Sheets SM 90 (Pembroke) and SM 91 (Haverfordwest). The Record was written describing 26 map units over a wide range of Palaeozoic sedimentary rocks and some igneous intrusions. The soils include regosols, rankers, brown earths, gleyed brown earths and gley soils with small areas of sandy and rocky variants. The 11 soil series in Table 1 have not been identified previously. (Rudeforth)

Sheet SN 13 (Eglwysw-rw). Some 90 km² have been mapped, the remaining area in the north-west being mainly on Fishguard Rhyolites, and 30 representative profiles described and sampled. Several deep open drains in afforested land give continuous exposures of soils and drift deposits.

In classifying the soils the following four main parent material groups have been recognised:

1. Lower Palaeozoic sedimentary rocks and related drift.
2. Rhyolite and related drift.
3. Mixed drift from Lower Palaeozoic sediments, rhyolites and dolerites.
4. Alluvium.

TABLE 1

New soil series in Pembrokeshire

Texture and lithology	Soil group	Soil series
Windblown sand	Regosol	Tywod variant
Loamy drift over glacifluvial gravels and sands	Brown earth	Cashfield
Fine loamy or fine silty drift over Carboniferous Limestone and Lower Limestone shales	Typical brown earth Gleyed brown earth	Pembroke Pembroke variant
Fine loamy drift over residuum over olive-brown and grey Devonian sandstones	Typical brown earth	Cosheston
Fine loamy or fine silty drift over olive-brown and grey Devonian sandstones	Gley soil	Thurston
Stony fine loamy over Devonian Conglomerate with interstratified red sandstones and siltstones	Ranker Typical brown earth	Ridgeway Ridgeway variant
Fine loamy over red Devonian siltstones and fine sandstones	Typical brown earth Ranker	Milford Milford variant
Fine silty drift from Devonian red siltstones and fine sandstones	Gley soil	Fforest*

* Named from SN 41 Sheet (Llangendeirne), Carmarthenshire

Air photograph patterns were identified at sites described and sampled during the 1 km grid reconnaissance with a view to extrapolating boundaries for the county map.

South and east of Crymych cultivated upland soils in material from Lower Palaeozoic rocks with surface horizons of humose loam are mapped as Ynys series humic phase and Hiraethog series cultivated phase (28); similar soils were distinguished in north Wales as the Tryal and Ithel series (29) respectively. The Hiraethog soils have eluvial horizons largely masked by organic matter over a sesquioxidic B horizon, locally slightly gleyed, separated sporadically by a thin iron-pan. (Bradley)

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Supporting research

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

A1, A2. Field Handbook, General soil classification

The following revised classification of soil materials according to organic-matter content and mineral particle-size distribution has been formulated for use from 1973 onwards.

Organic soil materials either;

1. Are seldom saturated with water for more than a month at a time and have more than 20% organic carbon (35% organic matter).
2. Are saturated with water for at least 30 consecutive days in most years or artificially drained, and have more than 18% organic carbon (30% organic matter) if the < 2 mm fraction is 50% or more clay, more than 12% organic carbon (20% organic matter) if there is no clay, or proportionate organic-carbon contents with intermediate clay contents.

The first criterion applies to well drained surface accumulations of more or less decomposed litter and the second to materials commonly described as peat or peaty. The variable limits for the latter accord with field experience that a given weight-percentage of organic matter modifies physical properties of a sand more than it does those of a clay. Materials with more than 40–60% loss on ignition (depending on clay content as above) are classed as peat, and those with less as sandy peat or loamy peat, depending on the composition of the inorganic fraction. Peats are further categorised as fibrous (fibric), semi-fibrous (mesic or hemic) or amorphous (humic or sapric) according to the degree of decomposition of plant remains as determined by solubility in sodium pyrophosphate and proportions and durability of 'fibres' retained by an 0·15 mm sieve (30, 31).

Mineral soil materials, with less organic carbon, are differentiated as humose and non-humose, and into particle-size classes based on proportions of stones (> 2 mm) by volume and weight percentages of sand (2–0·06 mm), silt (0·06–0·002 mm) and clay (< 0·002 mm) particles in the inorganic fraction < 2 mm. Clay-size carbonates are treated as silt for this purpose.

Humose mineral materials have more than 4·5–7·0% organic carbon (8–12% organic matter), depending on clay content as above.

The particle-size (textural) classification (Fig. 2), replacing the USDA (32) system now in use, accords with those used by engineers (33, 34) in so far as class limits are based on M.I.T. size grades and similar separations are made. Sandy classes are subdivided according to the proportions of coarse (2–0·6 mm), medium (0·6–0·2 mm) and fine (0·2–0·06 mm).

Proportions by volume of stones > 2 mm are described by terms prefixed to the name of the 'fine-earth' particle-size class, as follows.

<1%—stoneless
1–5%—very slightly stony
6–15%—slightly stony
16–35%—moderately stony
36–70%—very stony.

The size, shape and lithology of stones are described using a standard nomenclature. Materials with more than 70% stones (*c.* 80% by weight) are classed simply as fragmental or where appropriate (transported material with mostly rounded or subrounded stones < 60 mm) as gravel.

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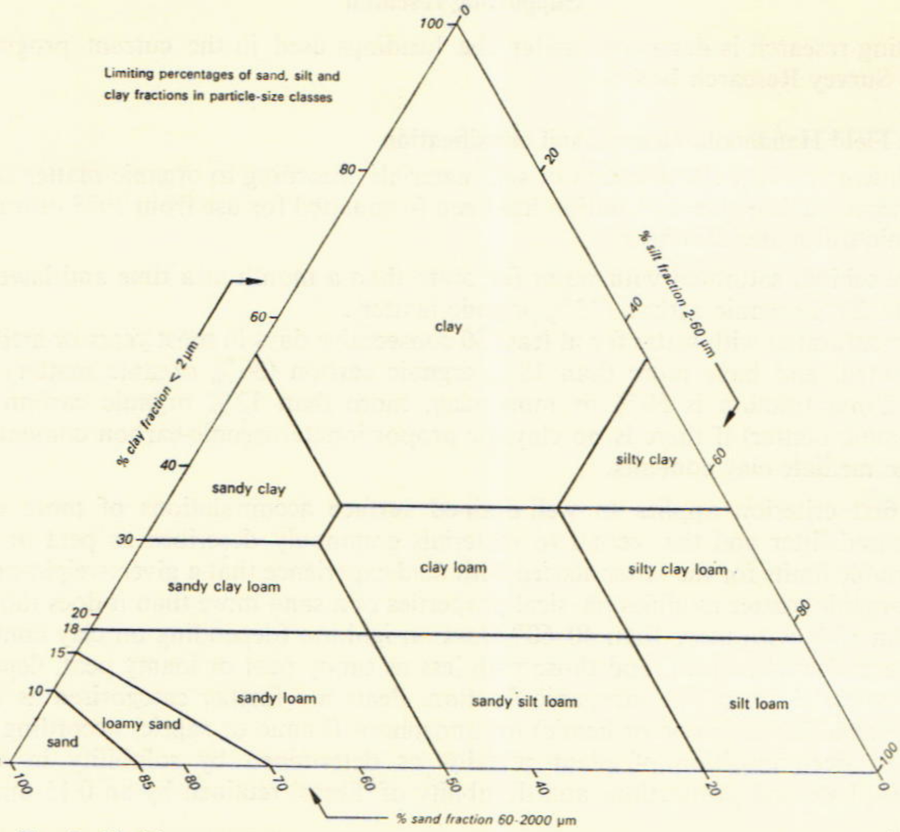

FIG. 2. Limiting percentages of sand, silt and clay fractions in particle-size classes

Terms for describing mineral soil materials in more general terms are defined as follows:

Stoneless to moderately stony materials
- Sandy—sand, loamy sand
- Loamy—sandy loam, sandy clay loam
  sandy silt loam, clay loam,
  silt loam, silty clay loam
- Clayey—sandy clay, silty clay, clay.

Very stony materials
- Sandy-fragmental (sandy gravel)
- Loamy-fragmental (loamy gravel)
- Clayey-fragmental (clayey gravel)

Extremely stony materials
- Fragmental (gravel) (Avery)

The final draft of the small handbook '*Soil Profile Description*' has been written and circulated to Regional Officers for comment. The text is being prepared for the printers. (Hodgson and others)

A3. Land capability classification

A study has begun of the relative importance of different soil properties as they affect the use made of soil. Data are from sugar-beet experiments where several soil properties, sugar-beet yields and responses to fertiliser have been recorded. (Webster and Hodge, with Draycott and Durrant, Broom's Barn Experimental Station)

Crop yield and soil type. Yields of cereals were measured in two soil landscapes. On soils within single fields on the Cromer Ridge (Sheet TG 13/14), and on Beccles (10), Aldeby (10) and Ragdale (3) soils on south Norfolk Boulder Clay (Sheet TM 28). On the Cromer Ridge yield can be related to soil type, as management is constant within the fields in which the soils occur. On the Boulder Clay soil management varies but the range of yield under different managements within a soil series has been measured. The data help to assess the land use capability of the soil series. (Eldridge and Smyrk—student worker)

A4. Date storage and retrieval

All data from the survey of the Ivybridge district of Devon (Sheet SX 65) were transcribed and punched on Hollerith cards for computer input. They have been read into the Edinburgh Regional Computing Centre's IBM 370 machine, and mapped on the Centre's specially adapted line-printer. Programs are written in IMP, an autocode developed in Edinburgh, for this purpose. (Webster with J. McG. Hotson, Edinburgh University)

The Ivybridge study has shown that transcribing data can take a long time, and that to make automation worthwhile, data should be recorded in a form as near final as possible in the field. Numeric codes have therefore been adopted or devised for descriptive terms, and field record cards designed and printed, so that surveyors can now make records in the field, and send them directly to a computer installation for punching and machine reading. Experience shows that the frequently occurring codes are soon memorised, that recording in this way is quick and adequate, and that errors are few. A program is being written to convert the coded data into English text and print it on the line-printer. Search options are provided so that only data that are of interest may be printed. (Webster with Mrs. C. Lessells, Computer Department)

Several computer programs have been written for *ad hoc* purposes in the Survey, other work has been analysed with existing programs, and help and advice given on computing and quantitative methods of survey. (Webster)

B1. Soil water/air regimes

Moisture release characteristics of soil profiles from the following 1 : 25 000 sheets were determined:

TG 31 (Horning)	3 profiles
TM 29 (Shotesham Catchment)	5 profiles
TL 61/71 (Great and Little Waltham)	3 profiles
SJ 82 (Eccleshall)	28 profiles
SK 05 (Onecote)	27 profiles
SK 57 (Worksop)	2 profiles
SO 74 (Malvern)	14 profiles

Five profiles of mainly clay soils from Bedfordshire and north Buckinghamshire were investigated in connection with the 1972 meeting of the British Soil Science Society at Silsoe. Profiles from Broadbalk and Barnfield at Rothamsted were also studied.

The penetrometer resistance of all core samples sent in for moisture release work is now measured at 50, 100 and 400 mb suction using a simple hand penetrometer. The results have a large random error for many soils and statistical analysis will be required to evaluate them.

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Field work in connection with the study of the effects of soil type on the hydrology of the Kingston Brook catchment was completed in April.

A computer program (Fortran IV) has been written for the Rothamsted computer to calculate and print out the results of laboratory determination. (Smith and Till)

Soil water-level readings were continued at the Cheshire College of Agriculture, Reaseheath. Continuous records for two years now exist and show distinct regimes for each of the soils at the College. (Furness and S. J. King)

Water-table levels were recorded in Southminster and Swanwick (12) series near Burnham-on-Crouch, and in Oak and Chelmer series (20) at Writtle. Recording will continue for another season, and further sites on the principal soils of Sheets TQ 59 (Harold Hill), TQ 99 (Burnham-on-Crouch), and TL 71 (Little Waltham) have been selected for observation. (Allen and Sturdy)

Measurements of water-tables in soils of the Dunnington Heath (3) and Brockhurst (7) series have continued and extended to two further sites. The dry winter and mild spring of 1971–72 reduced the period when water-tables were recorded to about eight weeks. The results, however, indicate that the gley morphology is related to the present water regime and that slowly permeable subsoils are the cause of wetness in these soils. (Whitfield)

C. Soil characterisation (laboratory)

Particle-size and chemical analyses of some 2000 samples submitted by surveyors were done to support the mapping program. (Bascomb and Thanigasalam)

A technical monograph describing methods used in the Survey laboratories to characterise soil samples has been drafted. (Avery, Bascomb, Bullock, Smith and Thomasson)

C1. Particle-size analyses

To facilitate consistent use of the new particle-size classification (described above), 35 reference samples were collected, subdivided for distribution to Survey centres, and analysed using the M.I.T. scale. (Pritchard)

Using the Model T Coulter Counter, reasonable correspondence between particle volumes counted in suspensions with known weight percentages of particle-size grades was obtained for particles in the 10–50 μm e.s.d. range. Difficulty in achieving reproducible sub-sampling of soil suspensions made results erratic for larger particles. Although the Coulter Counter is not a time saving substitute for normal pipette/sieve analyses (2 μm–2 mm) it can be useful for comparing detailed distribution in the sub-sieve range. (E. Sheppard, student worker, and Bascomb)

A pre-treatment procedure in which low-temperature ignition (to destroy organic matter) is followed by ultrasonic disaggregation was devised, and the results of sieve/pipette analyses using this method compared with those obtained following a conventional peroxide/Calgon/shaking procedure on a wide range of soils.

For some soils, the two methods gave accordant results, but for others more disaggregation by the ignition/ultrasonic treatment was found. This disparity was investigated by applying a standardised ultrasonic treatment for varying periods and comparing the resultant particle-size distribution. Soils of the first group evidently include those in which disaggregation occurs much more readily than breakdown of primary particles, with the result that a 'plateau' is reached for all particle sizes within a short treatment period. The second group includes soils that do not behave in this way, either because the inter-particle bond strength of aggregates and the stability of primary particles (e.g. shale, chalk) overlap, or because particularly resistant aggregates occur (e.g. in sesquioxidic B horizons). (Pritchard)

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C2. Chemical analyses

Loss on ignition as a means of estimating organic carbon content. Ball (35) obtained a close correlation between loss on ignition at 375°C and organic-carbon content (determined by wet digestion) for non-calcareous soils from Snowdonia. This relationship was re-examined, using 50 calcareous and non-calcareous soils of varied mineralogy with organic carbon contents ranging from 0·1 to 19·7%.

Samples were ignited at 400°C, and carbon was determined by dry combustion making a correction for loss of CO_2 from carbonates. The following regression equation was obtained.

$$y = -0{\cdot}750 + 0{\cdot}544\, x_1$$
$$y = \text{organic carbon } (\%) \quad x_1 = \text{loss on ignition } (\%)$$

The correlation coefficient was 0·99. A regression equation was also calculated making allowance for percentage clay (x_2)

$$y = -0{\cdot}529 + 0{\cdot}539\, x_1 - 0{\cdot}004\, x_2$$

This procedure did not result in a significant improvement in prediction. (Pritchard, with Lauckner, Statistics department)

C3. Mineralogical analysis

The mineralogy of 64 clay separates (< 2 μm) from horizons of 23 profiles was determined by X-ray diffraction supported by cation-exchange capacity and non-exchangeable potassium measurements.

The clay mineralogy of eight soils in Upper Pleistocene glacial drift and Holocene alluvium is summarised in Table 2. In each profile there is some variation, usually

TABLE 2

Clay mineralogy of soils in Upper Pleistocene glacial drift and holocene alluvium

				Clay mineral	
Soil series	Grid ref.	Parent material	Age of parent material	Dominant	Subsidiary
Hanslope	SP 945464	Chalky Boulder Clay	Saalian	Montmorillonite	Mica, kaolinite
Ragdale	SP 745321	Chalky Boulder Clay	Saalian	Montmorillonite	Mica, kaolinite
Crewe	SJ 653546	Glaciolacustrine drift, mainly from Triassic rocks	Weichselian	Chlorite (incl. swelling chlorite and mica-chlorite)	Mica
Dunkeswick	SE 371384	Grey till, mainly from Carboniferous rocks	Weichselian	Interstratified mica-montmorillonite	Kaolinite, mica
Deighton	SE 551482	Brown till of mixed origin	Weichselian	Montmorillonite	Mica, chlorite, kaolinite
Dymchurch	TR 107322	Marine alluvium	Flandrian	Montmorillonite and interstratified mica-montmorillonite	Mica, kaolinite chlorite
Newchurch	TR 054277	Marine alluvium	Flandrian	Montmorillonite	Mica, chlorite, kaolinite
Fladbury	SP 671195	River alluvium, mainly from Jurassic clays	Flandrian	Montmorillonite and interstratified mica-montmorillonite	Mica, kaolinite

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slight, between horizons. The data refer to B horizon separates from the soils listed. (Bullock and Murphy)

C5. Soil micro-structure

Two hundred thin sections of soil samples were made, of which 80 were described in detail, chiefly to aid characterisation of soils encountered in the current mapping program. The remainder were either examined by field staff or in other departments, or added to a reference collection. Thin sections were used in a variety of studies, including soil classification, measurements of soil porosity experiments to improve soil structure, and movement of insecticides using autoradiographs. (Bullock and Dorrington)

D1. Organic soils

Hill and basin peats in Dartmoor and the Forest of Bowland, and fen and raised bog peats in East Anglia, Lancashire and Somerset were described and sampled to test the suitability of the classification for organic soils in England and Wales detailed on p. 311. In the tests the main diagnostic feature is degree of humification as determined by the colour of humic material adsorbed on white filter paper from a sodium pyrophosphate extract.

This is compared with estimates of humification made by determining the fibre content of both rubbed and unrubbed organic samples, in the field and in the laboratory. (Burton and Bascomb)

D2. Shallow soils over chalk

Samples were taken from typical brown and humic rendzinas and the amount of non-carbonate minerals in the 50 μm–2 mm, 20–50 μm and < 2 μm fractions determined. Fine silty, clayey and fine carbonatic lithologies were distinguished. Light and heavy mineral components of fine sand (50–200 μm) and coarse silt (20–50 μm) fractions are to be examined to determine whether they are similar to those in the fine silty drift covering nearby Clay-with-flints. (Cope and Bascomb)

D3. Soils from Upper Greensand rocks

The glauconite and heavy mineral contents of two samples from each of five soil profiles in the Vale of Pewsey and one from Devon were studied. Glauconite was separated by repeated magnetic separation of two size fractions obtained from each sample by sieving. A crude estimate of glauconite content of the total sand fraction was made. Most glauconite was found in the subsoil samples of the Ardington (22) soils derived from the highest Greensand (partly Chloritic Marl), and least from the subsoil of the poorly drained soil derived from micaceous sandstone (gaize) below the main glauconitic sands. Olive and brown sandy loams in the Vale of Pewsey had similar glauconite contents in the subsoil but the brown soil from Devon contained rather less. All subsurface samples had very similar contents of glauconite, around 10%, about half to one-third of amounts in the subsoil. (Findlay and Tilstone—student worker)

D5. Slate and shale soils

To classify soils on slate and shale parent materials in Devon and Cornwall, samples of the major rock types have been obtained. Thin sections will be examined to determine particle-size distribution. (Staines and Hogan)

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D6. Cover-loams and sands in East Anglia

Two hundred and forty samples were collected in clusters of nine at depths of 30–40 cm from flat crests along three transects running from the coast between Cromer and Happisburgh to near East Dereham. Particle-size analysis by pipette and by Coulter Counter show silt content increases from less than 15% in the south-west to more than 35% north-east of Aylsham. Seventy additional samples collected in clusters of three and uniformly spread over north-east Norfolk have also been analysed by the pipette method. The silt distribution is being studied by Trend Surface analysis to find variation within the loess-affected area, pointing particularly to a possible origin to the north-west. (Bascomb, Corbett, Eldridge and Ridding—student worker)

D8. Soil and landscape evolution in the South Downs

The denudation chronologies outlined by Sparks (37) and Small and Fisher (38) were found to be incompatible with the landscape history inferred from studies of the superficial deposits. The evidence for marine erosion surfaces has been re-examined statistically. Attention is drawn to the significance of the valley dendritic pattern and the protective role of the Clay-with-flints in the formation of the so-called secondary escarpment.

A paper has been written in which the wider implications of these conclusions are briefly discussed. (Hodgson with Catt and Rayner, Pedology Department)

D9. Paleosols

Paleosol features in Northern England. Several features indicative of soil formation in a climate with seasons warmer and drier than at present have been recognised during mapping by the Soil Survey and the Forestry Commission in the North York Moors and Slaley Forest, Northumberland.

The most widespread is red mottling, which occurs in lower B horizons of peaty gley soils on estuarine clay and Carboniferous shales and in some deeply weathered brown soils on Middle Calcareous Grit. In the former soils the iron in the red mottles occurs mainly as haematite, whereas lepidocrocite and goethite occur in ochreous mottles in the B1g horizon above. Some profiles with red mottles also contain pisolitic nodules, up to 4 cm in diameter, similar to those found in Oxisols in the sub-tropics.

Ferruginisation of Kellaways Beds sandstone has been noted in the C horizon of a peaty podzol on the North York Moors. Fragments of brownish yellow sandstone have a thick hard, red or yellowish red, rind. Similar ferruginisation of sedimentary rocks has not been reported previously in Britain but is common in the savanna zone of West Africa.

These features are believed to have originated in a warm pre-Weichselian interglacial period or in the late Tertiary. (Bullock, Carroll and R. A. Jarvis)

A paleosol sequence near Granada, Spain. A succession of three buried paleosols formed in calcareous drift from the Otura region of Granada was studied. The uppermost paleosol is separated from a superficial brown calcareous soil by a stone-line of limestone gravel. Each of the two upper paleosols has a red, more or less decalcified clay-enriched (Bt) horizon over a Cca horizon, and the lowest has a weathered B horizon (cambic) over a Cca horizon. In neither is there any sign of an A horizon.

The paleosols were characterised physically, chemically and mineralogically. Their formation, attributed to pluvial periods within the Quaternary, evidently involved phases of decalcification *in situ*, alternating with addition of further sediment. (Bullock, with J. Aguilar, University of Granada, Spain)

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D10. Soil variability and site in Wales

Studies on the application of multivariate methods to soil problems have continued. The main extension has been a study of the relation between soil profile as a whole and the environment as a whole, and a program has been written, using data from the survey of the Dee Catchment. Results showed quantitatively the relationship between the environment as a whole and the soil as a whole. In this district, the relation was known to be present, though the results showed it to be closer than expected. The technique, like other multivariate methods, seems to have greatest value in the exploratory stages of survey, though it may later be used to confirm qualitative impressions. (Webster and Rudeforth)

E2. Soil variability

Close spaced observations at 1, 10 and 100 m from each of 18 sites 1 km apart across various rocks from St. Florence to Bethesda, south Pembrokeshire, show that soil properties on the same landscape unit often differ significantly within 100 m, so that reliable separation of soil groups commonly requires observations at less than 100 m intervals. (Rudeforth)

E3. Use of air photos and other remote sensing techniques

Reconnaissance survey continued in the Yorkshire Pennines and the results will be published as parts of county soil maps. A pilot study of moorland and arable areas in the North York Moors was begun; it is hoped to extend this to similar upland areas. Specially commissioned air photography of Westmorland (at a scale of 1 : 20 000) and the North Riding Pennines (at 1 : 10 000) was obtained. (Carroll and Bendelow)

Multispectral photography of Pembrokeshire, at a scale of 1 : 30 000, was examined. The four 70 mm films used were: true colour, false colour and panchromatic with red or green filters. The transparencies or negatives could not be viewed stereoscopically and only gave partial cover of the county. The initial investigation suggests that there is little difference, for this area, between film types and the standard panchromatic film used as a control. False colour, however, gave good results in certain upland situations. (Carroll and Rudeforth)

A pattern reflecting a rapidly alternating lithological sequence of limestone, sandstone, marl and clay was recorded on the Middle Jurassic outcrop in Northamptonshire, Oxfordshire and Warwickshire and on Keuper Marl and clay in Nottinghamshire. Soils are shallow, generally being less than 50 cm to weathered rock. Valley floor patterns were recorded on the Middle Jurassic outcrop in Oxfordshire and Lincolnshire and on drift-covered chalk in Berkshire, Oxfordshire and north-west Norfolk. These patterns occur in situations similar to those seen previously in other places.

Further work has shown that the taller, greener crop over a polygonal pseudomorph frost wedge pattern on terrace sands and gravels is not only related to the greater availability of moisture in summer in those deeper soils. In some places an indurated layer has formed at the junction of the upper drift and the sands and gravels but is not present over the deeper wedge soils. Root growth is impeded in the shallow soil and waterlogging above the indurated layer results in anaerobic conditions.

Study of the multispectral imagery obtained for the Natural Environment Research Council's remote sensing project shows that in June panchromatic photographs are slightly superior to red waveband images for recording features of use for soil mapping. However, in July red waveband images are slightly better than panchromatic photographs. Near infra-red imagery is more useful in July than June because it distinguishes early ripening cereals more readily than other wavebands. Green, and especially blue

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waveband images are inferior in both months. Different soils do not have different multispectral reflections and it is not possible to distinguish and map soils solely by optical means. Tonal densities of emitted thermal radiation recorded in the 3 to 5 μm waveband by infra-red linescan do not correlate well with soil and crop temperatures either.

Air photo-interpretation soil maps have been compiled for Oxfordshire, part of Berkshire and 2000 km² of north-west Norfolk. Air photos at scales of 1 : 50 000 and 1 : 60 000 were used and boundaries transferred to base maps at a scale of 1 : 63 360. These maps will be assessed to check the usefulness of air photo interpretation for 1 : 250 000 mapping in lowland England. (Evans)

F1. Automated cartography

Collaboration with the NERC Experimental Cartography Unit has continued, and contracts placed for automatic production of two maps in colour of soil in north Berkshire These are a map of types of drainage at 1 : 63 360, and a map of soil series at 1 : 25 000. (Webster and M. G. Jarvis)

G3. Soil compaction in pastures

Soils of pastures have been examined at sites on three major soil series in Devon and Cornwall. The work, in conjunction with ADAS soil scientists at Starcross, is intended to assess changes in soil conditions following intensive stocking with dairy cows.

Ten sites were chosen on each soil, on the Highweek (1) series around Wadebridge and Bodmin, on the Swindon Bank (1) series north of Crediton and on the Tedburn (1) series south of Holsworthy. At each site observations were made using the Survey's gamma transmission probe in the upper 10 cm of the soil before, during and after the grazing season. This enables changes in bulk density to be measured. At the same time penetrometer and shear vane tests were carried out. During the grazing season further penetrometer tests, along with soil moisture determinations, were made immediately prior to each grazing of each site.

The data will be analysed statistically. Interim results for a site near Crediton show considerable increase in bulk density after initial stocking. (Harrod and Staines)

Special surveys

A soil map covering 34 km² around Castleford in Yorkshire was presented to the West Riding County Council with an accompanying report. The map and report were prepared for publication as a Special Survey. (Hartnup and R. A. Jarvis)

12·5 acres were surveyed on a 30 m (100 ft) grid at Luddington Experimental Horticultural Station, Warwickshire, to assess the variability of soils on experimental plots. (Whitfield)

The existing map of Woburn Experimental Farm, Bedfordshire, has been slightly modified, and soil series identified. (Mackney)

A soil map (1 : 2500) of the *Farmers' Weekly* Drainage Demonstration site at Gosfield in Essex was made and help given with description and presentation of two demonstration pits. (Sturdy)

A soil map (1 : 10 560) of 243 ha (600 acres) of the Shuttleworth Agricultural College farms (Old Warden, Bedfordshire) was prepared and monoliths of the eight most important soils presented to the College. (Allen and Sturdy)

At the request of the Meat and Livestock Commission a soil map at 1 : 10 000 was made of Celyn Farm, Northop, Flintshire, and a report prepared. (Lea and Thompson)

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At the request of ADAS (agricultural arm) a reconnaissance survey was made of Laugharne Marshes in south-west Carmarthenshire. (Clayden and Gibson)

A map (1 : 625 000 scale) classifying the soils of England and Wales in terms of the potential rate of acceptance of winter rainfall was prepared for the Flood Studies Team at the Institute of Hydrology. The soils were grouped into five classes, taking into consideration soil and site properties such as drainage class (depth to waterlogged horizons), permeability of upper (not waterlogged) horizons, slope, and in some places, the deeper geological layers. The map is to be used to classify 100 or more experimental catchments for which stream-flow is gauged, and to extend this information to predict behaviour of ungauged catchments. (Mackney, Smith, Thomasson and Gould, Soil Survey of Scotland)

Other work

P. A. Burrough of the Land Resources Division, Overseas Development Administration, spent six weeks with the Survey. He used multivariate techniques, for which Soil Survey programs were already available, to analyse data collected in a reconnaissance survey of Sabah. The relations between different kinds of soil were better understood as a result and better ways of classifying the soil suggested.

A conference on land use capability was held at Sutton Bonington, sponsored by the Agricultural Development and Advisory Service and organised jointly with the Survey at the request of the Soil Survey Research Board. The aim was to obtain from users in agriculture, reactions to the experimental land use capability maps and reports included in some Soil Survey Records. Seventeen papers dealt with land use capability classifications, and their use in agriculture, forestry, recreation, and urban planning.

The annual meeting of the British Society of Soils Science, in its jubilee year, was held at Rothamsted and Silsoe, and the Survey organised tours, demonstrated soils and helped to prepare a Handbook. (Mackney, Avery, Bullock, and Bascomb)

An exhibit was prepared for the British Association for the Advancement of Science meeting at Leicester. This demonstrated the work of the Survey in the East Midlands with the aid of a series of monoliths of representative soils. (Heaven and Reeve)

Three one-day meetings of the Welsh Soils Discussion Group were arranged on the theme of current research on Welsh soils. The field meeting was held in Carmarthenshire and a half-day was spent on the soils of the Old Red Sandstone on Sheet SN 41 (Llangendeirne). (Clayden)

An exhibition of the work of the Survey was organised for the Spring and Autumn National Sugar Beet Demonstrations of the British Sugar Corporation. (Corbett and Eldridge)

An exhibit of publications and soil monoliths was arranged at the Annual Conference of the Association of Teachers of Geology at Bristol from 15 to 17 September. (Findlay and Colborne)

An exhibit of publications and soil monoliths was arranged at an Environmental Studies Week at Circencester and District Teachers' Centre from 16 to 20 October. (Cope)

A week's course in air photo interpretation for 15 staff members was held at Silsoe in collaboration with Mr. M. Keech of the National College of Agricultural Engineering. (Carroll and R. Evans)

A glossary of English dialect soil terms has been compiled. Copies will be distributed to the Regional Centres and may be consulted by anyone who is interested. (Seale)

Two Memoirs, two Soil Survey Records and one Special Survey have been published. One Memoir, seven Records, two Special Surveys and one Technical Monograph are in

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preparation. Technical Monograph No. 1, Land Use Capability Classification, is being reprinted for the second time. One map at a scale of 1 : 63 360 and five at 1 : 25 000 were published and 18 are in production.

Staff

F. M. Courtney, G. D. Evans and Alison Knowles left and D. J. Briggs, G. J. N. Colborne, W. P. Gibson and P. J. Loveland were appointed.

The office in Newcastle has been closed and a new one opened in Mold, Flintshire.

D. Mackney was invited to join an expert consultation on land evaluation for rural purposes sponsored by FAO, at Wageningen, in the Netherlands.

P. Bullock was invited to participate in a working group set up by the International Society of Soil Science to compile a generally acceptable system of classification and terminology for micromorphological features of soils. Supported by the British Council, he attended a meeting of the group in Seville, Spain, and gave lectures on the micromorphology of humus forms in Madrid, Granada and Murcia. He also attended meetings at the Museum National d'Histoire Naturelle, Brunoy, France, on micromorphological aspects of soil organic matter classification and at the Unesco Building, Paris, on a glossary of micromorphological terms and a minimum descriptive system for this section.

A grant was received from the ARC for six members of staff (Clayden, Bascomb, M. G. Jarvis, Robson, Seale and Thomasson) to attend the Jubilee Spring Meeting of the British Soil Science Society at Wageningen, Netherlands.

A. J. Thomasson and P. D. Smith attended the MAFF Open Conference of Soil Scientists on the theme 'Soil Physical Conditions and Crop Production' and read a paper on soil water movement.

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