Report for 1968 - Part 1

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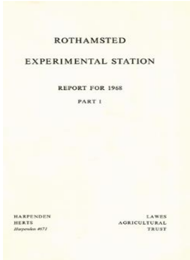
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REPORT FOR 1968

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 types of soils in Great Britain. Classification is mainly on the basis of properties of the soil profile as observed in the field, but also on observations of the parent material from which the soil is thought to come, the environment and the 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 memoirs or bulletins, 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 3 ft) and, with the additional information provided, are of use in agriculture, forestry, land use planning, land drainage, geography and ecology.

The Headquarters Office, the Analytical Laboratories and the Cartographic Section are at Rothamsted Experimental Station, Harpenden, Herts., and surveyors are stationed at 16 centres.

A new principle has been adopted for mapping. Selected areas of 38 sq miles in each county of England and Wales will be surveyed and maps published at a scale of 1 : 25000. The areas, which correspond to the Ordnance Survey 10 km × 10 km Outline Edition 1 : 25000 map series, are chosen for their geomorphological and agricultural interest, and as a basis for later county, regional and national maps. Surveying is now in progress on 18 maps in 15 counties.

Northern England

Yorkshire

Sheet SE 60 **(*Armthorpe*).** A further 10 sq miles were mapped, mainly in Armthorpe and Cantley parishes, in a traverse typical of much of the district. There are a few acres of cultivated deep carr peat at Potteric Carr, south of Doncaster. Farther east a relatively high-lying area of Pleistocene deltaic reddish sands containing scattered Bunter and Coal Measures sandstones, has freely draining acid brown soils similar to the Newport (1) series. Considerable wind blowing of sand was observed during March.

In the east, the land is almost level (10–20 ft O.D.) with sands, sandy loams and clays of late or post-Pleistocene age. Light grey subsoils with pronounced ochreous mottling are common, showing that ground-water used to rise seasonally much nearer to the surface than it does today. Dry ponds and ditches, and local memories confirm this, thought to be

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caused by both extensive regional land drainage schemes and the pumping of water for Doncaster from boreholes. The gleying is therefore not an indicator of present soil drainage.

A belt of deep carr peat runs across the area into Hatfield Moss. The river Thorne follows it to an artificial cut leading to the Trent. Hatfield Moss, at the eastern end of the traverse, is higher than the carr peat of the alluvial depressions and is covered with bracken and mature birch. Much peat has been cut for fuel at the edge, leaving a swampy area of rushes, reeds and bulrushes growing in about a foot of remnant peat over wet sand. (R. A. Jarvis)

Sheet SE 65 (York East). More information on the soil series was obtained and the Soil Survey Record is being written. In March, wind eroded the sandy soils considerably; dunes up to 5 ft high and 10 ft wide formed in the lee of hedges near Upper Helmsley. (Matthews)

Sheet SE 76 (Westow). 18 sq miles were mapped to the south-west of Malton, a quarter over deep Pleistocene and Flandrian deposits and the rest on Triassic clays and Jurassic sandstones, limestones and clay, with a patchy veneer of drift, possibly of Gippingian (Riss) age. Soils closely follow the geology; those on the Jurassic outcrop of the Howardian Hills were partly described earlier. Much of the Estuarine Series limestone carries non-calcareous loamy soils and similar acid brown soils occur on the Calcareous Grit. South of Westow, gley soils of the Evesham (2) and Denchworth (3) series overlie Lower Lias clay. Most of the non-calcareous Denchworth soils are on steeper slopes and have a thin sandy wash where sandstone crops out above the clay. In a few places, e.g. near Leavening, the surface of the calcareous Evesham soils is littered with fossils, especially *Gryphaea* spp. The topsoil contains a few Jurassic limestone and sandstone fragments and quartzite and flint erratics, probably all that remains of pre-Weichselian till.

Very calcareous, silty, green Keuper Marl crops out in the south-west, with surface-water gley soils of the Hurcot (2) series, but east of the river Derwent most of the Marl carries acid soils of the Worcester (2) series.

There are two distinct tills; (*a*) a calcareous clayey till with chalk, flint and Oolitic limestone fragments, which gives soils resembling the Hanslope (4) series, mainly near Howsham and Barton-le-Willows; (*b*) an acid loamy till carrying soils of the Wighill (5) series.

A well-developed sequence of terraces occurs in the Derwent valley, some depositional—formed of gravel and sand, and others erosional—eroded into the Keuper Marl. The acid brown soils and *sols lessivés* on the gravels are soils of the Collingham (5) complex.

Podzols and gley soils are on small areas of Flandrian aeolian sand. Similar soils also occur near Burythorpe on sands of the Kellaways Beds, of similar grain size, but the B horizon of the brown earths is extremely pale because the soil material lacks iron (0·6% iron oxide). Like the Flandrian sands, these soils can be eroded by wind. (Matthews)

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Lancashire

***Sheet 66* (*Blackpool*).** Detailed field mapping of 16 sq miles on the 1 : 25000 scale completed the map, which was prepared for publication. (Hall)

Westmorland

***Sheet SD 58* (*Sedgwick*).** Mapping in Westmorland at the 1 : 25000 scale started in the south of the county and 20 sq miles was surveyed.

Between Kendal and Kirby Lonsdale the country rises from the low alluvial plain of the river Kent in the west, over rolling glacially formed foothills, to open fell land at about 900 ft O.D. in the east. The eastern boundary lies close to the Lune valley and beyond rises the much higher ground of the Barbon Fells, Middleton Fells and the Pennines. To the north lies the main mass of the Howgill Fells, and the south-west is dominated by the steep limestone escarpment of Farleton Fell, rising to 850 ft O.D.

Drainage is mainly to the west and south-west. Most streams rise close to the eastern edge of the area and flow through narrow valleys to join the river Beela, which drains into the Kent estuary.

The topography mainly reflects the deeper geological structure, much modified by glaciation, and land forms are either erosional or depositional. The most striking depositional features are drumlins over most of the land between 150 and 600 ft O.D. and covering almost three quarters of the area. They are of very stony till, almost entirely of Silurian greywacke and grey slatey material in a grey silt loam matrix. The pronounced north-east to south-west orientation of the drumlins and their lithology suggest that much of this material comes from the nearby Howgill Fells known to have had their own ice cap, which would have deflected the main Lake District ice to the west.

Higher, in the centre and east of the district, glacial erosion has produced craggy ground with much bare rock, hollows surrounded by short steep slopes and many small roches moutonées. The area of craggy ground is ill-defined, and is covered in some places by till with drumlin-like topography.

The older rocks are mainly Silurian Kirkby Moor Flags, a series of strongly folded, much cleaved grey flagstones and shales with thin bands of coarse greywacke. They form the highest land, are well seen on the craggy ground, and form the Helm, a prominent steep-sided hogback near Oxenholme. To the west Carboniferous Limestone is down thrown against Silurian strata along the north to south trending Kendal fault, but most of this area is covered by deep drift and there are few exposures. However, the rock is seen again on Farleton Fell in the south-west, where limestone scenery, with pavements dipping to the west and south-west, is well developed. A fault-bounded tongue of limestone extends north into the Silurian strata near Lupton Hall but is also under drift and exposed only in a small disused quarry. Beyond this the two boundary faults converge and there is no evidence of the limestone extending beyond Lupton Row.

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Recent deposits are widespread; alluvium occurs in all main river valleys and extends into the higher reaches of many tributary streams. Peat is common in enclosed hollows, especially on the craggy ground and also in some poorly drained minor valleys.

The soils were mapped as series and complexes. On the craggy ground with sporadic rock outcrops interspersed with undulating moraines, hollows and networks of marshy channels and occasional small tarns, a hydrologic sequence of soils was grouped into a complex. The craggy summits have outcrops of rock and rankers, the latter where rock or shallow stony head is covered by organic matter rarely more than 6 in. thick. Above 700 ft O.D. peaty gleyed podzols occur over medium textured stony head and moraine on moderate to steep slopes round rocky crags. Brown earths replace peaty gleyed podzols on the short steep slopes below. Ground-water gley soils, peaty gley soils and frequently peat occur in enclosed hollows and meander channels where water stands for long periods.

A second hydrologic sequence of soils occurs on extensive areas of till, where relief is strongly undulating with drumlins and irregular hillocks and hollows. Freely drained brown earths are confined to the steepest sides of the hillocks. Gleyed brown earths on gentle slopes merge into ground-water gley and peaty gley soils in hollows and low-lying sites. Many enclosed hollows contain fine textured alluvium and peat in which the ground water level fluctuates.

On Farleton Fell there are large areas of Carboniferous Limestone exposed as 'limestone pavements', with scree locally on scarp slopes. Clint and scree rendzinas occur on the limestone outcrops but are never extensive. Brown calcareous soils, brown earths and peaty gleyed podzols with thin iron pans were also mapped here.

Narrow deposits of riverine alluvium border streams with soils extremely variable in texture, locally over peat. (Hall and Furness)

Cheshire

***Sheet SJ 65* (*Crewe West*).** The Nantwich centre was opened in July and mapping started on the first of three 1 : 25000 sheets representative of Cheshire.

Nantwich lies at the centre of the Cheshire dairying country. Many of the heavier soils are ideal grassland, but even on lighter land, grass is traditionally the predominant crop. The foot-and-mouth epidemic last winter disturbed the farming pattern, although probably only temporarily, and acreages of cereals were larger in 1968 than for some years past.

Almost the entire area is covered by red or brown till largely from the underlying Keuper Marl, but with many erratic pebbles and boulders from the Lake District. Borehole records show that the boulder clay ranges in thickness between 50 and 125 ft. There are patches of glacial sands and gravels, including the Middle Sands, especially in the west.

The river Weaver flows from south to north and the associated alluvium and terrace deposits are evident topographical features in an otherwise flat or gently undulating landscape. Alluvium and in some places terraces are also associated with many smaller tributary streams. Usually,

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the terraces are narrow, discontinuous remnants, but round Burland to the west of Nantwich, a large area of clayey or silty material suggests a former lake.

Except for a few small exposures of Keuper Marl in the Weaver valley, the solid rocks below are not seen. The Upper Keuper Saliferous Beds underlie boulder clay in the south, and produce a few brine springs and small natural subsidence hollows, some filled with peat or alluvium.

A completed reconnaissance of the area showed that most soils are similar to those on the reddish boulder clay in Lancashire (1) and North Shropshire (6) described previously. Detailed mapping started and 5 sq miles around Burland were covered. (Furness)

Northumberland

***Sheet 19* (*Hexham*).** This map was prepared for publication and the Memoir is being written.

***Sheet NZ 07* (*Stamfordham*).** Some 12 sq miles were surveyed in detail. Most soils are those found near Hexham, but distributed differently. Many are on Glacial drift of local origin but deposited from melt-water rather than by ice. There are many filled-in pro-glacial lakes and more *wiesenböden*. More drift is calcareous at depth and though most soils are gleys and gleyed brown earths, structure is more stable and better developed.

Gley soils and gleyed brown earths are common with a few patches of better drained soils on thin drift over sandstone and limestone. Occasionally these rocks occur at, or near the surface, giving podzols and brown calcareous soils respectively.

The admixture of north-eastern drift in the till increases to the east, but the soils on it cannot be definitely separated from those to the west. Although they contain more bases, the content is still within the range for soils on locally derived Carboniferous drift.

An iron-rich sandstone near Black Heddon carries a ferruginous brown earth with a very stable structure and strong rusty colour, resembling those of Oxfordshire (7). (Ashley)

East Anglia

Cambridgeshire and the Isle of Ely

***Sheet 173* (*Ely*).** The memoir for this sheet is being prepared.

Field work provided additional detail for 30 sq miles near March and Mildenhall. Near Mildenhall soundings were made in deep peat of the Adventurers' (4) series to the west of Lakenheath. The depth of peat and the nature of the mineral substrata were recorded. The Adventurers' series was separated into depth phases, and more than 16 ft of peat was recorded in some places. Near March, areas in the Downholland complex where peat has eroded away were separated from those where it is still present. The eroded areas have only a humose cultivated layer over mineral subsoil.

An extinct watercourse from Shippea Hill south-east to Mildenhall

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Fen was identified from air photographs. The 3 mile course is straight, possibly Roman, and marked on the ground by fresh-water shells and silt patches. (Seale)

Huntingdonshire

Sheet TL 26 **(*Papworth Everard*).** Some 15 sq miles were mapped, mainly on the low Boulder Clay plateau. Two units, the Hanslope series and a Valley Bottom (8) complex, were defined. Air photos exist for part of the area and are useful in mapping the boundary of the intricate Valley Bottom complex. (Hodge)

Norfolk

Sheet TM 49 **(*Beccles North*).** Mapping was completed and the sheet is being prepared for publication.

The Aldeby, Beccles, Hall and Waveney series were established. The Beccles series consists of surface-water gley soils developed in Chalky Boulder Clay with surface and subsurface horizons of sandy clay or sandy clay loam texture. Aldeby soils are similar but with coarser textured surface layers of sandy loam or loamy sand. The two soils occur in complex near Burgh St. Peter, and half a sq mile was mapped on a 75-yd grid to study the detailed distribution of the soils and the range of profile features.

Small areas of Hall series, a brown earth (*sol lessivé*), were mapped round Herringfleet. Surface and subsurface horizons of sandy loam or loam texture about 24 in. thick cover sand, which can contain bands of reddish brown loamy sand.

The greater part of the floodplain of the Waveney has non-calcareous ground-water gley soils of the Waveney series developed in silty clay estuarine alluvium. These poorly, or sometimes imperfectly, drained soils occupy nearly the whole width of the floodplain in the lower reaches below Wheatacre, but upstream the alluvium thins over peat and narrows along the river so that at Beccles organic soils (Adventurers' and Prickwillow (4) series) extend across the valley floor.

During the winter, watertable levels were observed at sites in the Beccles, Ashley and Waveney series using simple auger holes (9).

A Land Use Capability map (10) was prepared with the soil map, in which the soils of the area were classified after consultation with N.A.A.S. soil scientists. (Corbett and Tatler)

Sheets TG 13 **(*Barningham*)** ***and TG 14*** **(*Sheringham*).** A reconnaissance was made of this combined sheet, representative profiles described, samples and cores taken for analysis and monolith preparation, and a preliminary legend drawn up.

The area covers the Cromer Ridge and includes both the narrow Coastal Plain to the north, and the extensive low Boulder Clay Plateau to the south.

Freckenham (4), Redlodge (4), and Hall series were identified on the slopes of the Cromer Ridge. A brown earth (*sol lessivé*) occurs on flat interfluves of the Ridge where gravel substrata are covered by about two feet of fine sandy loam or silt loam. Similar textured soils occur on interfluves in the Boulder Clay area to the south but often pass downwards

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into brown weathered boulder clay of sandy clay texture. This extensive layer of material blanketing the highest sites and covering varied substrata contains much very fine sand and silt and has probably been wind transported. (Corbett and Tatler)

East Midlands

Derbyshire

***Sheet SK 17* (*Tideswell*).** A further 10 sq miles were surveyed and the sheet more than half completed. No new mapping unit was included. (Johnson)

Nottinghamshire

***Sheet SK 66* (*Ollerton*).** Some 16 sq miles were surveyed in detail on outcrops of Bunter Pebble Beds, Keuper Waterstones and Keuper Marl. Acid brown soils of the Newport (1) series occur widely on Pebble Beds and there is a loamy phase in the remnants of Sherwood Forest. The Waterstones are interbedded siltstones, fine sandstones and thin marls, and carry freely or moderately well drained silty soils of the Hodnet (2) series. There are small areas of locally derived sandy or clayey drift over Keuper outcrops giving imperfectly drained soils of the Dunnington Heath (11) and Brockhurst (12) series. Soils of the Salop (1) series occur on reddish boulder clay on higher parts of the Keuper Marl outcrop. Worcester (2) soils are extensive on drift-free Marl areas, and shallow, greyish clayey soils occur locally over hard skerry bands. (Robson and George)

West Midlands

Shropshire, Herefordshire and Worcestershire

***Sheet 181* (*Ludlow*).** The remaining 35 sq miles of the sheet were completed, early work checked and, where necessary, revised. The final legend is being compiled and the memoir prepared. (Hodgson and Whitfield)

Herefordshire. Survey started on two of the 1 : 25000 sheets chosen in the new mapping programme to represent different parts of the county.

***Sheet SO 52* (*Ross-on-Wye West*).** Soft coarse and moderately coarse sandstones of the Upper Dittonian, Breconian and the Upper Old Red Sandstone Formations dominate, and there are sporadic outcrops of marl. The soils on these rocks are sandy loams of the Ross (13) series with small isolated areas of Bromyard and Eardiston (14) series on Dittonian marls and fine grained sandstones.

The alluvial soils of the Wye floodplain are in silty sediments, and mainly freely drained. Some stony terrace deposits occur above the alluvium, but they are fragmentary and small in area.

12 sq miles were surveyed and recent air photography has helped mapping. (Whitfield)

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Sheet SO 53 (Hereford South). This includes an area of Old Red Sandstone, the Silurian of the Woolhope Dome, the extensive alluvium and river terraces of the Wye and Lugg, and a small area of till deposited by the Wye glacier. 3 sq miles were surveyed and series found include Bromyard, Eardiston, Vernolds, Wootton and Hayton (14). Alluvial soils were also mapped. (Hodgson)

South-east England

Buckinghamshire. A soil map of the county was prepared at a scale of 1 : 250 000. Twenty-four soil associations are grouped in four physiographic regions: the northern plateau, the vales, the Chilterns and the Thames valley. (Mackney)

Essex

Sheet TQ 59 (Harold Hill). Some 11 sq miles were mapped in detail; 746 borings were recorded on field cards and a total of 1674 sites were examined giving an acre: boring ratio of 4·2 : 1. Forty-nine profiles were fully described, mostly from undisturbed cores, and samples from 29 taken for laboratory analysis.

An outlier of sandy and loamy Eocene beds forms high ground above 300 ft O.D., extending in a broad ridge from Warley in the south-east northwards through Brentwood and Kelvedon Hatch, towards Doddinghurst in the north-east. The level plateau surface of the ridge is covered by 4–15 ft of clayey drift, which can be very pebbly around Warley and in small patches farther north. The more pebbly facies is shown on the geological map (Sheet 257) as Pebble Gravel or Warley Gravel.

Surface-water gley soils consisting of pebbly (predominantly smooth grey elongated flint pebbles) loam or sandy loam over strong brown, red, and grey mottled clay or sandy clay, occur on the level surface. The brightly mottled subsoil clay, often with strong reddish colours, rests directly on Bagshot Sands and is never chalky. Such soils resemble the Oak series of the Shenley association of Hertfordshire (15).

Small woods of birch and Spanish chestnut contain well-differentiated podzols in a thick sandy layer over clay.

Yellowish fine sands of Bagshot Beds underlie the drift, and are exposed at the heads of valleys dissecting the plateau margins. The Claygate Beds below are browner and more loamy, with thin alternate laminae of fine sand and clay in the upper part merging downwards to a mottled clay with much fine sand and silt. There is a change to brown weathered London Clay proper at about 200 ft O.D. Shedfield, Bursledon and Curdridge (16) series occur on sandy and loamy parent materials, and Woolhampton (16) series on clays containing much fine sand or silt.

Chalky Boulder Clay (Springfield Till) forms a gently undulating surface between 225 and 275 ft O.D. across the middle of the area. It extends over Navestock Common, and partly over an outlier of Claygate and Bagshot Beds to the south-west round Havering-atte-Bower. Tongues of Chalky Boulder Clay on the eastern edge extend well up the valleys dissecting the western edge of the 300 ft ridge around Coxtie Green and Navestock Side,

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where in some places it is contiguous with the pebbly clayey drift but often separated from it by a distinct zone of Upper Eocene material. Chalky Boulder Clay also abuts against the eastern edge of the ridge, south of Doddinghurst. Hanslope (4) and Ragdale (17) series were mapped.

A thin band of sands and gravels underlies the Chalky Boulder Clay at Stapleford Tawney and Doddinghurst and gives small areas of Chelmer and Bengeo (15) soils.

Windsor (16) series on London Clay is the most common soil in the south where gentle slopes predominate in the valleys of the Paines, Weald, and Bourne brooks. There are also Windsor soils on the mid-valley sides of the Roding in the north-west. In this broad valley, the Fladbury (2) series is developed in grey clayey alluvium of the floodplain and passes into poorly and imperfectly drained stoneless fine sandy and silty soils, often over gravel within 3 ft, on adjacent gentle slopes. Mainly poorly drained sandy or clayey gravelly soils occur on ill-defined terrace remnants some 50 ft above the floodplain.

The soil pattern is complicated by a thin smear of boulder clay over the solid formation subsequently entirely removed in places, by erosion, and by minute dissection of Upper Eocene Beds by small, often dry, valleys partly filled with head or colluvium. (Sturdy)

Kent

***Sheet TR 04* (*Ashford*).** Reconnaissance survey was completed, and 33 sq miles mapped in detail. The area is complex with many variations in solid and drift geology and relief, and 33 series were found. The most extensive mapping unit, the Denchworth (3) series occurs over only 10% of the area. Several series are grouped into complexes, e.g. Ford End (3) complex, but others have two or more phases significant in land use, e.g. deep and shallow phases of the Coombe (3) series, and 36 mapping units were used. Soils rich in glauconite occur on the Lower Gault and on several beds of the Lower Greensand Formation. (Green and Fordham)

Berkshire

***Sheet 253* (*Abingdon*).** Nine sq miles were mapped, almost wholly on the Berkshire Downs in the south of the area and no new mapping unit was needed. Soil patterns with a typically asymmetric disposition resemble those found elsewhere in Chalk landscapes. (M. G. Jarvis)

South-west England

Gloucestershire and Wiltshire

***Sheet 251* (*Malmesbury*).** 32 sq miles were mapped on the Tortworth ridge fringing the Bristol Coalfield, and in the scarpland country between Wotton-under-Edge and Chipping Sodbury, completing the survey of this sheet. Checking and correlation of mapping units with those on the adjoining Bath sheet is needed to prepare the Memoir for both sheets.

The synclinal fold of the Bristol Coalfield is enclosed on the north by an arcuate ridge from Tytherington, by Tortworth to Wickwar, south of which it merges into the scarp formed by Rhaetic and Lower Lias strata. The

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outward facing slopes of this ridge are on Upper Old Red Sandstone, Quartz Conglomerate and the Tintern Sandstone Group. The inward facing slopes are Lower Carboniferous strata of shales, limestone and sandstone, passing into Coal Measures. An unusual feature of the drainage is the deep gorge cut by a minor tributary of the Little Avon through the hard Palaeozoic strata along a line approximating to the axis of the syncline.

The Quartz Conglomerate is mostly concealed beneath the same sandy colluvium, which gives the Whitfield (18) series where it overlies Silurian shales. Red marls and siltstones in the Lower Tintern Sandstones give soils of the Bromyard (14) series, and on hard sandstones higher up there are stony loams of variable depth, like the Maesbury (2) series of the Mendips.

Clays in the upper part of the Tintern Sandstone Group give a rather complex pattern of soils with impeded drainage, ranging from deep mottled loams to greyish loams over mottled clay, and are as extensive as the well drained types.

The Lower Limestone Shales usually occupy depressions containing colluvium from nearby sandstone and limestone; small outcrops of Rhaetic Clay are also preserved in these troughs. The soils are imperfectly to poorly drained, of variable surface texture and over mottled, often calcareous clay and shale. From Tytherington to Tortworth Park the Carboniferous Limestone outcrops on steep, usually wooded slopes, but elsewhere the land is flat or gently sloping and shallow loams of the Lulsgate (2) series are used for arable farming. There are small areas of deeper soils of the Nordrach (2) series.

Cromhall Sandstone occurs at three levels at the top of the Lower Carboniferous, but only the upper band is of any great extent. The narrow bands of shallow stony loams on sandstone were included with the Lulsgate (2) series though more sandy than on the Mendips. Soils on the Upper Cromhall Sandstone are very variable. Soils with loamy surface horizons on mottled fine loamy or clayey subsoils over shales are distinguished where possible as Warmley or Yate series. Except for small areas of shallow Nibley (2) series on sandstone, the remaining soils are deep, slightly stony loams with finer textured unmottled subsoils. In places these are derived by deep weathering from the Cromhall Sandstone, but towards Tytherington, below steep limestone slopes, similar soils include limestone and conglomerate rubble in the subsoil, whereas others may overlie Dolomitic Conglomerate rock. The soils resemble the Tickenham (2) series of the western Mendip footslopes and the thin loams over Keuper Marl south of Tytherington and west of Wickwar suggest a widespread distribution of drift with at least some material derived from Cromhall Sandstone.

The scarpland around Wotton-under-Edge, Ozleworth and Kilcott is dissected by valleys, which now carry the head waters of the Little Avon. The upper valley slopes are in Fullers Earth clay that has slipped and flowed on to the narrow shelf formed by the Inferior Oolite, and most of the Fullers Earth outcrop is mapped in the Landslip (7) complex. Between small spurs of Inferior Oolite the clay extends down to the lower valley sides in places. Southwards, the Upper Fullers Earth extends more on to

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the scarp crest and dipslope, probably because the limestone bands are thicker in this direction. Soils on the low ridges and scarps formed by these bands are shallow and often duller coloured and finer textured than the modal Sherborne (2) series, so extensive on neighbouring limestone outcrops.

The steepland unit on the Inferior Oolite is continuous throughout this part of the scarp except above Little Sodbury where the scarp crest is in Cotteswold Sands. In contrast to the wooded slopes to the north, the undissected scarp slopes south of Hillesley are mainly grassland.

The Atrim (19) series on Cotteswold Sands becomes less extensive from Dursley southwards, partly because of the varying thickness of the formation in relation to the structural Bath axis and partly because of the change in apparent thickness of strata brought about by cambering. Around Dursley, where Atrim soils support a significant area of potato growing, slopes are cambered and the Cotteswold Sands are thickest, being close to the Bath axis. South of Hillesley, however, the Sands are thinner, little affected by cambering, and occur mostly on steep land below the Inferior Oolite. Limestone scree, which so frequently mantles part of the Cotteswold Sand in the valleys, is very rare below the undissected scarp.

The lowest slopes are occupied by a strip of the Martock (2) series, but in the Wotton–Sodbury area this mapping unit contains many imperfectly drained soils in fine sandy colluvium, i.e. texturally akin to Atrim soils. This is probably due to absence of a ledge of Marlstone Rock, which farther north has retained or diverted much fine sandy colluvium, and the Dyrham silts there occupy more or less drift-free steep slopes below the ledge. North-east of Sodbury the loamy drift extends on to the Lower Lias Clay outcrop from which it is usually separated by a thin layer of limestone gravel. Superficial deposits of this kind occur only locally on the subedge plain of the Bath and Malmesbury sheets but are more extensive to the north. The drift near Sodbury has probably been preserved because it lies on the watershed between the Little Avon, the Boyd and the Frome. The soils are imperfectly to poorly drained and mapped as Podimore (19) series. (Findlay, Cope and Courtney)

Devonshire

Sheets 325 (Exeter) and 339 (Teignmouth). The two sheets are to be published as one map with a legend of 65 mapping units. Fair copies of the field sheets were drawn and are being prepared for publication by the Cartographic Section. The Memoir was written. (Clayden)

Sheet ST 10 (Honiton). This map was selected to represent the wide areas of East Devon where an intricately dissected, Cretaceous plateau at about 830 ft rises sharply from Keuper Marl vales ranging from 300 to 750 ft. 27 sq miles were mapped. Cretaceous rocks are represented by Upper Greensand, composed of glauconitic fine sands and Chert Beds, which crops out on the plateau-scarps. The plateau surface is mantled with up to 70 ft of Plateau Drift (20), an admixture of clayey Tertiary deposits and insoluble Cretaceous residues, with up to 2 ft of silty drift, probably a

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wind-blown deposit. In the Marl vales, Head deposits, river terrace deposits and alluvium are important parent materials.

Gleyed brown earths of the Batcombe (3) series predominate on the plateau but, in contrast to those of the Chilterns, pass locally into surface-water gley and humic gley soils on nearly level or depressed sites. These soils are developed in similar parent materials, silt loam over silty clay, and those with humose A horizons have well-developed bleached Eg horizons. Locally, the silty drift is thicker giving deep silty soils resembling the Hook (21) series. Soils comparable with the Batcombe eroded phase occur where there is no drift.

The principal soils of the Greensand scarps are brown earths of sandy loam texture developed in a stony drift over stoneless sand. Nearly all the ground is included in the steep phase (>12°) of the mapping unit. Podzols were mapped on patches of unimproved land. Extremely stony, loamy brown earths on the Chert Beds occur in a narrow belt above the steepest ground on slopes mostly less than 12°. The base of the scarps has a pronounced zone of seepage occupied by peat, peaty gley and humic gley soils over thick Greensand Head.

The Keuper outcrop is partly covered by thin sheets of loamy Head, with a variable stone content, derived from Greensand. Where these are very thin or lacking on relatively broken ground, the Worcester (2) series occurs with surface-water gley soils of the Spetchley (2) series on wetter sites. A variant of the Worcester series occurs on grey marls in the Otter valley. The Whimple (18) series occurs widely where the loamy Head is thicker than 18 in. and soils with stronger gleying are grouped as the Brinsea (2) series. There are smaller areas of thicker superficial deposits in the Marl vales and the associated soils lack Bt horizons. The most widespread mapping unit is a gleyed brown earth, brown loam or silt loam with a mottled B horizon 3 ft or more in depth.

A Land Capability map and text are being developed to supplement the soil map, in co-operation with local N.A.A.S. officers, who are also making a survey of cereal yields. It is difficult to exploit the relative long growing season because the high rainfall softens gley soils. The susceptibility of the main soils to poaching is being studied by observations of moisture content, water levels in auger holes and soil strength, using a penetrometer. (Harrod and Staines)

Wales

Cardiganshire. Preparation of the Aberystwyth and Llanilar Memoir was completed. (Rudeforth)

Pembrokeshire

Sheets SM 80 (Angle) and SR 99 (Castlemartin). A further 29 profiles were described in the south of the county mainly over Devonian Red Marls and Carboniferous Limestones. Depths of freely drained soil are less than farther north (57% of profiles on the Limestone have more than 40 cm of freely drained soil and 46% on the Marl, compared with 76% and 60% respectively to the north).

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Grid pattern sampling for laboratory analysis at 4 km intervals, to supplement profile descriptions at 1 km intervals, began using the proline corer, to determine the range and frequency of the main chemical and physical properties of soils in the county. (Rudeforth and Lea)

Supporting investigations

Identification. Investigations into soil identification often need measurements made in the laboratory on samples of soil typical of England and Wales. In choosing the kinds and numbers of such samples it is of interest to know the extent to which major soil groups occur.

The areal proportions of six major soil groups were calculated (Table 1)

TABLE 1

Percentages of major soil groups in lowland areas of England and Wales

	Southern England							N. England and Wales								
Major soil groups	Aylesbury	Reading	Glastonbury	Wells	Cambridge	Derby	C. Stretton	Preston	Southport	Leeds	Bangor	Denbigh	Anglesey	Bridgend	Cardiff	National averages
Brown earths	60	29	20	48	25	43	72	17	6	20	38	81	66	74	34	42
Gley soils	14	38	34	42	32	32	10	55	35	45	16	12	14	8	23	27
Calcareous soils[1]	15	13	33	3	30	2	1	—	—	15	1	—	1	—	—	8
Organic soils	—	1	12	3	13	—	—	14	25	1	3	1	1	—	—	5
Podzols	—	5	—	1	—	1	2	1	15	1	29	5	5	—	—	4
Alluvial soils[2]	3	—	—	1	—	—	11	1	8	1	2	1	7	4	1	3
Miscellaneous[3]	8	14	1	2	—	22	4	12	11	17	11	—	6	14	42	11

[1] Includes rendzinas. [2] Includes Dune sand. [3] Includes built-up areas.

from areas covered by series in 15 Memoirs published or in the press. Brown earths are the most important, especially in southern England, and cover more than two-fifths of the area. Gley soils come next, especially in the wetter environment of northern England and Wales. (Clare)

Micromorphology. Study of fine and coarse textured bands in Boyn Hill Terrace deposits between 1 and 2·5 m shows that some bands are cross bedded. Thin sections of several bands, including cross bedded types, show that most of the clay is moderately to strongly oriented, occurring as free grain and void cutans and as bridges between grains. The degree of orientation increases with depth and is greatest in the cross-bedded structures. Such clay orientation was associated in the past with clay translocation and stress effects produced by shrinking and swelling, but it now seems that such clay orientation patterns may result from geological processes.

To study clay translocation quantitatively, the particle size distribution within clay fractions of representative soils was determined and linear measurements made of microfabric characters.

Thin sections of Bridgnorth, Bromyard and Ragdale series soils show evidence of clay translocation, but those of the Dunsford series do not. In

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the first three, the coarse clay (1–2 μ) remains constant or decreases from Eb to Bt horizons, whereas the medium (0·1–1 μ) and fine (<0·1 μ) clay content increases. In the Dunsford profile, all the clay fractions decrease in amount from the B1 to the B2 horizons and the fine/coarse clay ratio is approximately constant (Table 2).

TABLE 2

Clay ratios from four soil series

Series	Horizon	Fine clay/ coarse clay ratio
Dunsford	B1	0·69
	B2	0·62
Bridgnorth	Eb	1·47
	Bt	4·23
Bromyard	Eb	1·77
	Bt	2·12
Ragdale	Ebg/B1tg	3·05
	B2tg	6·75

Linear measurements of the main *s*-matrices, cutans and voids for the Bt horizon of a Bromyard profile were converted to volume per cent, to assess the relative effects of stress and illuviation on clay orientation. Strongly separated masepic *s*-matrix and void argillans, comprising 4% by volume, are considered to be unequivocally of illuvial origin (Table 3).

TABLE 3

Linear fabric analysis

Bt horizon of Bromyard series

		Volume
s-matrices	Lattisepic with strong body colour	35
	Lattisepic	46
	Masepic	5
	Strongly separated masepic	1
Cutans	Void Argillans	3
Voids	Voids > 0·08 mm and unclassified	10

The horizon would be classed as argillic in the classification of the soils of Britain now being prepared. (Bullock and Mackney)

Classification. A system of soil classification for Great Britain was developed in which soil series and broader classes are defined by intrinsic characteristics. These include: (*a*) diagnostic horizons (e.g. gleyed or texture B horizons) identifiable in the field; (*b*) gross composition (lithology) including texture, organic-matter content, amount and nature of stones and texturally contrasting substrata. A separate climatic classification was devised for use in small-scale maps. Letter symbols denote specific attributes, and each series is defined by a combination of symbols, showing characteristics shared with other series. The classification has been circulated for testing and comment. (Avery)

A land use capability classification is being developed in co-operation with the National Agricultural Advisory Service. With help from local groups set up by the Service, land use capability maps are being prepared

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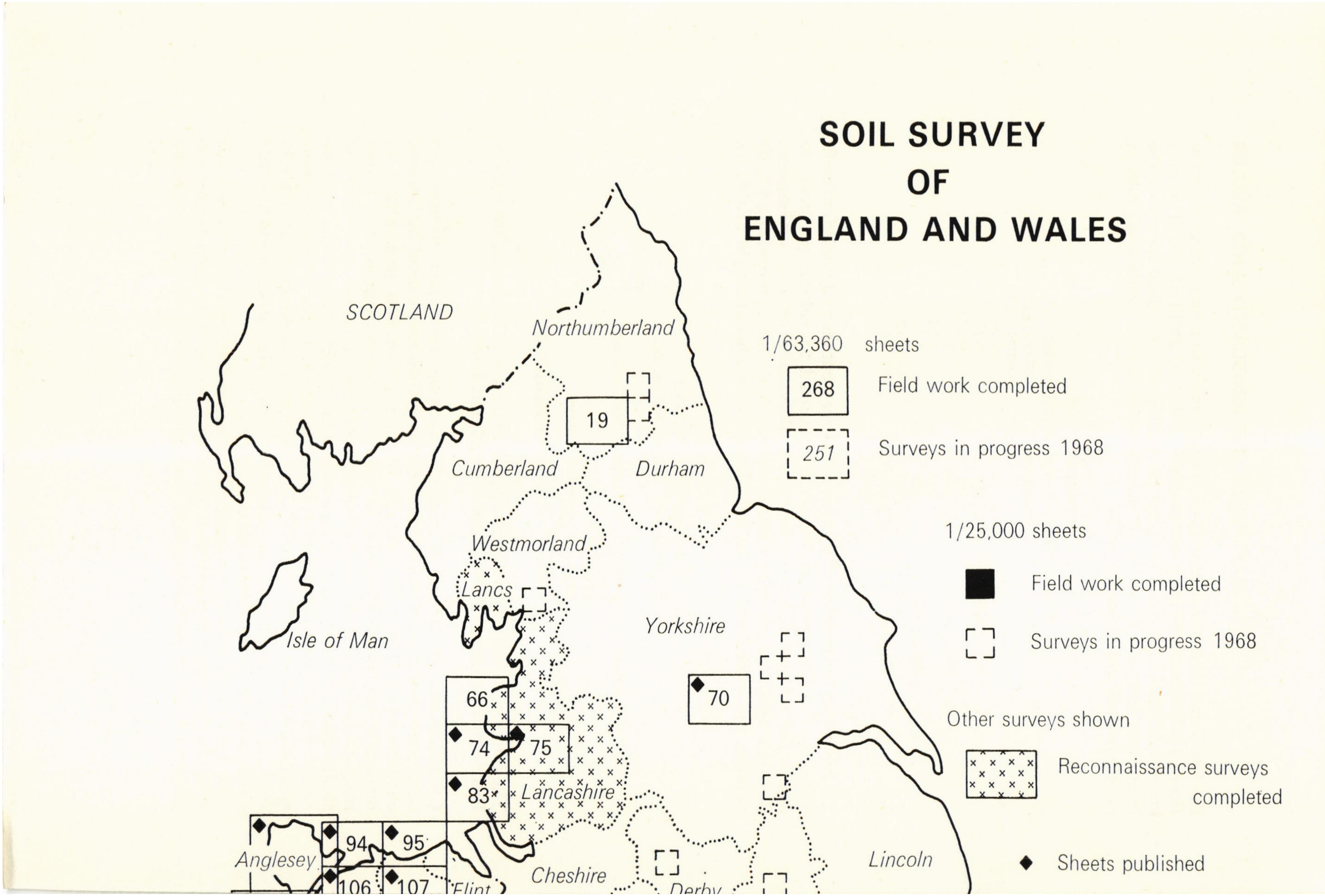
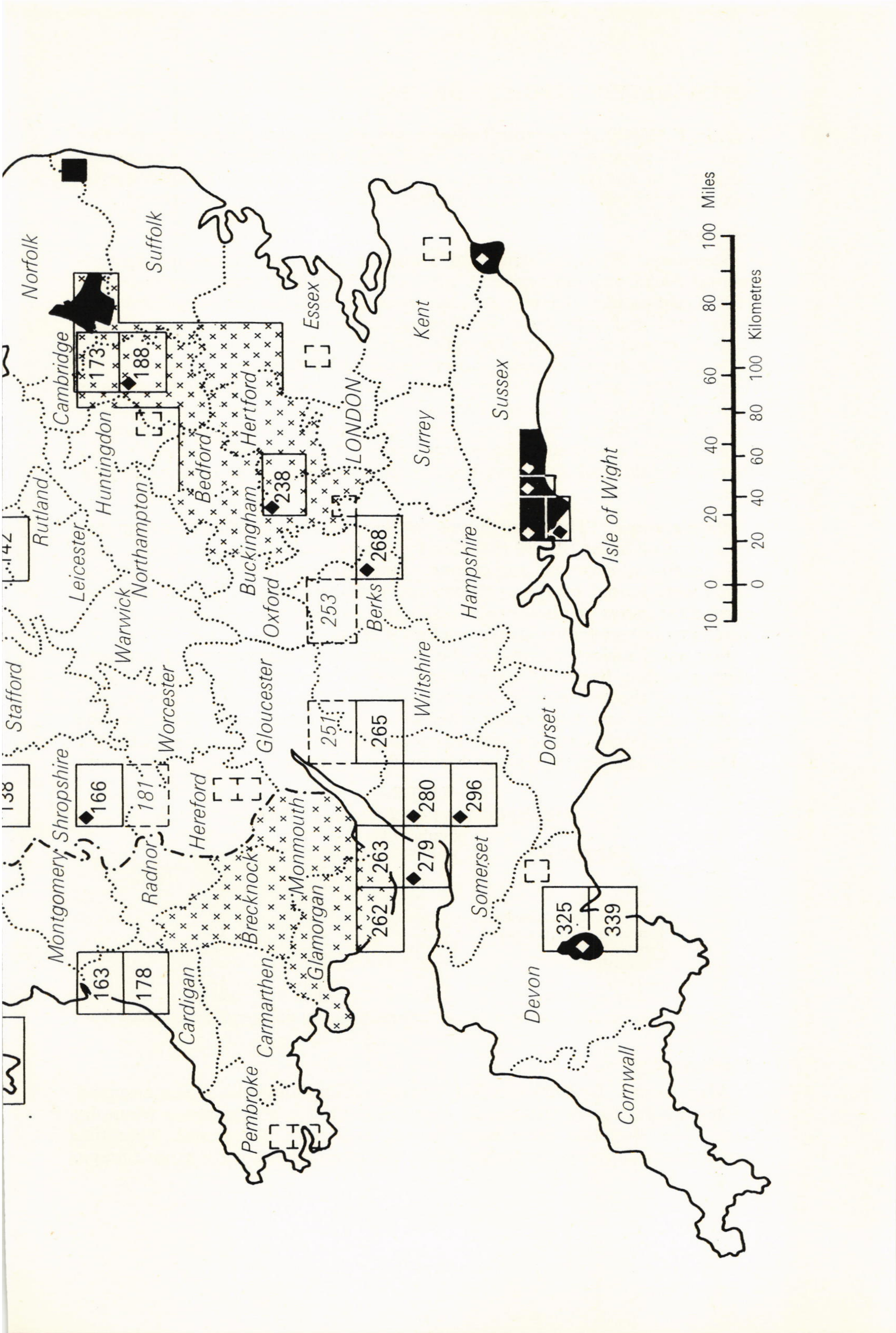

SOIL SURVEY
OF
ENGLAND AND WALES
1/63,360 sheets
268
Field work completed
251
Surveys in progress 1968
1/25,000 sheets
Field work completed
Surveys in progress 1968
Other surveys shown
Reconnaissance surveys completed
Sheets published
SCOTLAND
Northumberland
19
Cumberland
Durham
Westmorland
Lancs
Isle of Man
Yorkshire
70
66
74
75
83
Lancashire
Anglesey
94
95
106
107
Flint
Cheshire
Lincoln


Norfolk
Suffolk
Cambridge
Essex
Kent
Sussex
Surrey
LONDON
Hertford
Bedford
Huntingdon
Rutland
Leicester
Northampton
Buckingham
Oxford
Berks
Hampshire
Isle of Wight
Warwick
Stafford
Worcester
Gloucester
Wiltshire
Dorset
Shropshire
Hereford
Radnor
Montgomery
Brecknock
Monmouth
Glamorgan
Carmarthen
Cardigan
Pembroke
Somerset
Devon
Cornwall
173
188
238
268
253
251
265
166
181
280
296
263
279
262
163
178
325
339
142
138
Miles
Kilometres
10 0 20 40 60 80 100
0 20 40 60 80 100

for six 1 : 25000 sheets now being surveyed; soil and land use capability maps will appear in the appropriate Soil Survey Records. Agronomic information relevant to the soil and land of each sheet is being collected to describe the farming and to give basis for classification. (Mackney)

Surveying

Sampling. The uniformity of mapping units on Trawscoed Experimental Farm was measured. A total of 137 profiles were described on a 165 m grid pattern. There is little evidence for separating soils by derivation from hard and soft shale, confirming conclusions reported earlier (22). Soils from soft shales were thought to be greyer, finer textured and deeper (23), but statistical analysis shows a significant difference in depth only. The need to include mull and mor phases within the Denbigh series is confirmed (24). Both phases have similar means and standard deviations of depths (Table 4). The Powys unit is deeper than provided by the definition hitherto accepted, because one deep site lies within the unit; conformity would probably have been greater had more sites been examined. (Lea)

Data storage. The storage and retrieval of data collected in mapping 25 sq km of Sheet SU 88 (Marlow) was studied. Texture, stoniness, calcium carbonate content and colour, taken from more than 800 soil record cards were stored by type of horizon on feature cards; further cards recorded the series or phases to which soil cards had been allocated, and the depths to impenetrable layers or chalky brash.

For each series and phase the frequency of occurrence of property classes within horizons were calculated as percentages. The extent of overlap of the taxonomic units was examined, and the analysis proved useful where new taxonomic units were being considered. However, the recording of field data, on feature cards is laborious (1 man/month for the 800 cards), and a system more economical in labour is needed. (Mackney)

TABLE 4

Soil depths (cm) on Trawscoed Farm

Mapping Unit	Number of profiles*	Mean	Standard deviation
Cegin	8	54	13
Clwyd	6	67	20
Conway	8	55	16
Denbigh (mull phase)	39	54	21
Denbigh (mor phase)	34	54	20
Powys	(3)	(48)	(30)
Rheidol	23	55	14
Sannan	7	45	13
Valley complex	(2)	(53)	(38)

* Seven sites occurred on boundaries between mapping units and are excluded from the table.

Cartography

Map users. In 1964, the Soil Survey of England and Wales assumed responsibility for publishing its own material. Since then seven Memoirs and three Bulletins have been issued, and costs cheapened. Tentative conclusions can now be drawn about the users of publications and maps.

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A thousand of each Memoir or Bulletin are printed, with a free governmental distribution of a hundred, thirty going to the National Agricultural Advisory Service (M.A.F.F.). Between 150 and 190 copies are sold in the first year after publication, and between 40 and 90 during the second. Sales of older Memoirs, published by H.M.S.O. drop fairly rapidly in succeeding years but on average 26 copies of each of the oldest (Wem 1954, Glastonbury 1955 and Anglesey 1958) are still sold annually. Present editions should therefore last 20 to 30 years.

Sales (1964–66) are to:

	%
Bookshops	38
Universities	18
Other educational establishments	10
Public libraries	12
Central Ministries	6
Local Authorities	3
Industry	3
Individuals	7
Overseas	3

Including free distribution, the proportion going to Government Departments, chiefly the M.A.F.F., is 9%.

Soil maps are also sold separately from the publications describing them. The number sold this way is now 1000 annually whereas ten years ago it was about 40. For individual maps the annual rate of sale either remains constant or increases after it has been available for some years (Fig. 1).

Sales (1964–65) are to:

	%
Educational establishments	65
Bookshops	30
Central Ministries	5

Present practice is to print 500 copies of maps in addition to those needed to accompany publications, so present printings are expected to last only a maximum of 5 years Soil maps are obtainable from Ordnance Survey Agents and all other publications from The Librarian, Rothamsted Experimental Station (see p. 384). (King)

Special surveys

A survey was made of 36 acres at Occombe Wood, Paignton, for the Torquay Natural History Museum. The wood is on Staddon Grits, a major lithological unit of South Devon not hitherto covered in soil survey. (Harrod)

Parr Moss near Bold Colliery, St. Helen's, was surveyed in detail for the National Coal Board. The Liverpool–Manchester Railway runs along-

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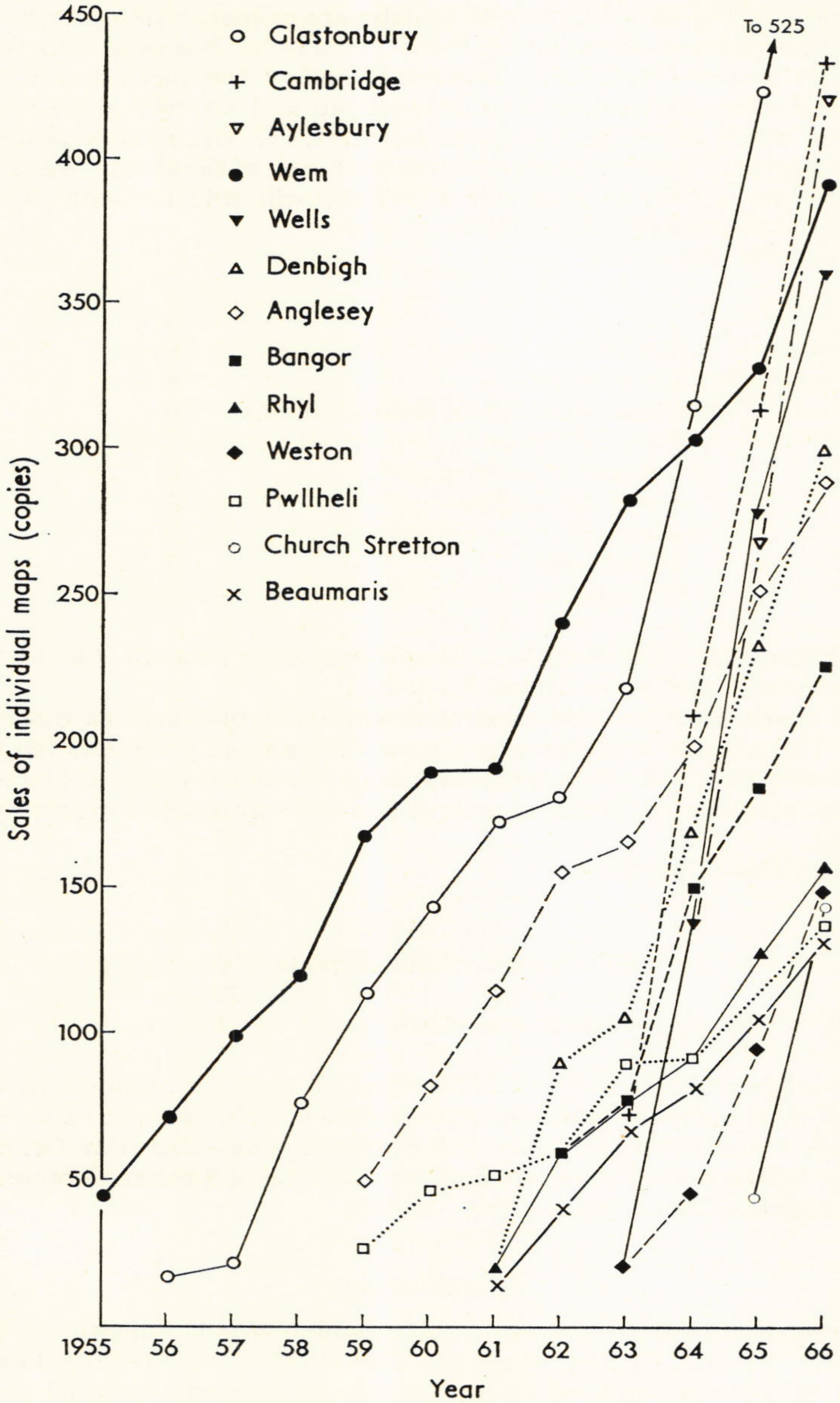

FIG. 1 SALES OF INDIVIDUAL SOIL MAPS (1955 – 1966)

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side and there was concern that continued tipping of spoil on the Moss might cause displacement of the line. Types and thickness of the peat were recorded by traverses and borings. (Hall and Furness)

Broadbalk field (Rothamsted Experimental Station) was surveyed in detail, and 6 representative profiles described and sampled for micro-morphological studies and particle-size, chemical and mineralogical analyses in co-operation with the Pedology Department. (Avery)

Other work

The biennial Field Meeting of the combined Survey of England and Wales and of Scotland was held at Church Stretton in Shropshire. The soils of south Shropshire and north Herefordshire were studied and one day was given to a Conference on Micromorphology.

Information was supplied to the National Agricultural Advisory Service, the Agricultural Land Service, the Ministry of Public Buildings and Works, the Ministry of Transport, the Forestry Commission, the Institute of Hydrology, Agricultural Research Stations, University Departments and industrial firms.

Many lectures and demonstrations were given, and several field excursions arranged and conducted, including one for a party of 45 students and members of staff from the University of Wageningen.

A Memoir, *Soils of the Reading District*, and Bulletin No. 4, *Soils of Romney Marsh*, were published, both with accompanying maps.

In the Cartographic Section work continued on nine 3rd Edition Sheets at a scale of 1 : 63360 and on six maps at other scales.

Staff

B. W. Avery was awarded a Royal Society and Nuffield Commonwealth Bursary to study the work at the Commonwealth Scientific and Industrial Research Organisation (Australia) Soils and Land Research Divisions for 4 months. While in Australia he presented a paper in Commission 5 of the 9th International Congress of Soil Science, and attended a Symposium on Land Evaluation organised by C.S.I.R.O. Land Research Division in co-operation with UNESCO.

P. Bullock rejoined the Survey as mineralogist after three years in the Agronomy Department of Cornell University, where he was awarded a Ph.D. degree for a thesis entitled 'The zone of degradation at the eluvial–illuvial interface of some New York soils'.

B. Matthews was awarded a Ph.D. degree by McGill University for a thesis entitled 'Late Quaternary events in Northern Ungava, Quebec' and P. A. Johnson an M.Sc. degree by Reading University. R. Webster, D. M. Carroll, D. C. Greenway, R. Evans, P. D. Smith, R. C. Palmer, D. M. Pepper, F. M. Courtney, S. J. Staines, G. D. Evans, J. W. Lea and K. Thanigasalam were appointed.

The Welsh office was transferred from Cardiff to Swansea University. New subcentres were opened near Lincoln and near Nantwich in Cheshire. The Reading subcentre was transferred to Oxford, to start survey in that

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county. Two units were set up to explore the use of air photography in soil surveying. One at the Northern Regional Headquarters will deal with Upland soils and the other at Cambridge will concentrate on the Lowlands.

A unit was set up at Oxford to develop new concepts and apparatus for soil cartography, in collaboration with the National Environment Research Council Unit of Experimental Cartography.

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