ROTHAMSTED RESEARCH

Report for 1975 - Part 1

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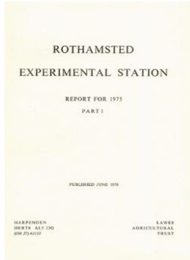
ROTHAMSTED
EXPERIMENTAL STATION
REPORT FOR 1975
PART 1

Soil Survey of England and Wales

K. E. Clare

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SOIL SURVEY OF ENGLAND AND WALES

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Introduction

The very warm summer this year provided many days in which the job of surveying was particularly enjoyable, although at the same time the very dry soil often offered more resistance than usual to the auger. In June we had the pleasure of being hosts to a Visiting Group, whose comments and recommendations have now been received and are being studied with interest. In July, the Soil Science Committee of the Joint Consultative Organisation spent a day with us in Norfolk inspecting work in that county, and later expressed its appreciation of what is being achieved. The year has also seen the publication for us by the Ordnance Survey of a soil map of England and Wales, at a scale of 1:1 million, which is available through Ordnance Survey Agents.

The aims of the Survey are to describe, classify and map the different soils of the two countries. The soils are described in profile, and kinds of soil profile are differentiated at four successive categorical levels, termed major group, group, subgroup and soil series. Classes in the three higher categories are defined partly by the composition and mode of origin of the soil material, and partly by the presence or absence of particular horizons, within specified depths, using properties that can be observed or measured in the field or inferred from field examination by comparison with analysed samples. Soil series are distinguished chiefly by lithologic characteristics. When a map unit is identified by the name of a soil series or other class, it is implied that most of the soil in each delineation on a map conforms to that class. More heterogenous units (complexes or associations) are similarly identified by the names of two or more classes.

The properties of the soils shown on maps are described in accompanying publications, as are the geography, geology, climate and land use of the district surveyed. A soil map and text together are a permanent record of the distribution and properties of the different kinds of soils.

The mapping programme continues, with the surveying of districts in each county chosen for their geomorphological and agricultural interest, and with the compilation of maps at a scale of 1:25 000. Thirty such areas were worked on during the year and some 850 km² were surveyed in detail in 20 of them. Thirty-four maps at a scale of 1:25 000 have now been published, with explanatory publications—usually *Soil Survey Records*—for 30 of them. At the request of the MAFF a start has been made of 1:100 000 scale mapping of the uplands, and in the Northern region 850 km² were surveyed in reconnaissance, aided by air-photo interpretation. Progress in reconnaissance survey also included compilation of maps of soil associations at a scale of 1:250 000 for the counties of Avon, Berkshire, Cheshire, Derbyshire, Kent, Norfolk, South and West Yorkshire, Suffolk and Pembrokeshire.

Northern England

Cheshire

***Sheet SJ 45E/55W* (*Burwardsley*).** The *Record* was completed. (S. J. King)

County map. The *Bulletin* was completed. (Furness)

Cumbria

***Sheet NY 14N/15S* (*Abbey Town*).** A reconnaissance survey was made on selected farms and 15 km² mapped in detail. The district, considered to have under-developed agricultural potential, was chosen in consultation with ADAS.

The soils are from (a) peat, (b) marine, river and estuarine alluvium, (c) loamy reddish till and (d) sandy reddish glaciofluvial drift. Soil series identified so far include Clifton (1), Crannymoor (1), Foggathorpe (2) and Penrith. (Matthews)

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Sheet NY 36 and part of NY 37 (Longtown). The remaining 55 km² have been surveyed and the map completed. Twenty-five soil series and phases have been recognised, in till, river terrace drift, glaciofluvial sands and marine alluvium.

Clifton series is the most extensive on till, with smaller areas of Salop and Salwick series (3). Wick (3) series is very extensive on the river terraces, with lesser areas of Arrow (3) series and a fine loamy gley soil, yet to be named. Newport and Blackwood series (1) are mainly on the glaciofluvial sands, with minor areas of Ollerton (1) series. The marine alluvium is non-calcareous, usually gleyed, with generally large silt (over 70%) and small clay contents. (Kilgour)

Sheet NY 53 (Penrith). A land use capability map was prepared and the *Record* completed. (Matthews)

Humberside

Sheet TA 14 (Brandesburton). This sheet is representative of Holderness, the gently undulating, largely arable, plain between the Yorkshire Wolds and the coast. Soils are entirely on glacial and post-glacial deposits and in a reconnaissance survey they have been subdivided into three broad lithological units of agricultural and topographic significance. Soils on till, the most important of the three divisions, cover much of the gently undulating southern half of the sheet. The till, which is probably equivalent to the Drab Till of the coast and the Marsh Till of Lincolnshire, is reddish; and some argillic stagnogley soils have a superficial resemblance to the Salop and Clifton series of north-west England and the Midlands. At depth, however, the till has a significant chalk content, and more detailed work is required before any correlation can be made.

Sands and gravels form more strongly undulating country and occur particularly around Brandesburton and in a narrow belt from there eastwards to the coast, where they merge into terrace deposits around Hornsea Mere. Elsewhere gravels occur as isolated patches forming small hills and hummocks on the till plain. Soils vary from stony brown sands to stoneless brown sands and brown earths.

Alluvial and organic soils are widespread on the low-lying carr land of the river Hull floodplain; they are associated with shallow peat over grey stoneless silty clay.

The composition of the tills is being studied by the Pedology Department (p. 221) and their hydrology by the University of Hull Geography Department. (Furness)

North Yorkshire

Sheet SE 39 (Northallerton). Reconnaissance was completed and 40 km² mapped. Most extensive is a typical stagnogley soil with clayey Bg horizons in reddish till. Pelo-stagnogley soils of the Denchworth (2) series are in Lower Jurassic shales. Cambic gley soils with mainly fine loamy Bg horizons, and stony argillic brown earths are on glacio-fluvial outwash. Peat soils and alluvial gley soils occur in valleys and in basins, e.g. Ainderby Bottoms. (Hartnup and Allison)

Sheet SE 58 (Rievaulx) with parts of SE 49/59 (Upper Ryedale). The *Record* was completed. An interesting feature of the land use capability assessment is a climatic limit to class 2 soils at 240 m O.D. (Bendelow and Carroll)

Sheet SE 63/73 (Selby/Bubwith). The remaining 22 km² were mapped and the writing of the *Record* begun. (Furness and S. J. King)

Sheets SE 97N/98S (Wykeham Abbey). This sheet represents the eastern Vale of

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Pickering, a complex district of glacial deposits, lacustrine clay, carr land and alluvuim, bounded to the north by the Middle Oolite and to the south by the Upper and Lower Cretaceous. Reconnaissance, aided by air-photo interpretation, was begun late in the year on eight farms, chosen to represent the broad range of parent materials. (S. J. King)

North York Moors. This is the first of a series of 1:100 000 soil maps of the uplands. The remaining 250 km^2 (of approximately 900 km^2) were mapped by reconnaissance survey aided by photo-interpretation methods. The map was compiled from this and from more detailed work in the Pickering Moor/Troutsdale and Rievaulx/Ryedale areas. Mapping by G. D. Anderson and by staff of the Forestry Commission has also been incorporated. A legend has been constructed listing 48 map units, and work has begun on an accompanying text.

During the survey, 41 series were recognised. On the Tabular and Hambleton Hills, the soils are mainly rendzinas, brown earths, paleo-argillic brown earths, podzols and stagnopodzols over Corallian limestones and sandstones. The soils of the central moorlands are raw peat soils, stagnohumic gley soils, stagnopodzols and podzols over clay shales and sandstones of the Middle Jurassic Deltaic Series. In the valleys incised into the moorlands, there are brown earths and stagnogley soils over Lias sandstones, siltstones and shales. On the northern flanks of the north Cleveland moors, brown earths, podzols, stagnogley and stagnohumic gley soils are mapped over glaciofluvial drift and reddish till. (Carroll and Bendelow)

North Yorkshire Pennines. This will be the second 1:100 000 upland soil map and will include mapping done in the former West Riding of Yorkshire before the local government reorganisation. Some 600 km^2 were mapped by reconnaissance survey. The part of the Pennines formerly in the West Riding was completed and work started in Wensleydale and Swaledale. Most soils had already been recognised in other places on the Pennines, but more stony brown earths in glaciofluvial drift and stagnopodzols over chert were found as work progressed. (Carroll and Bendelow)

Northumberland

Sheet NZ 07 (Stamfordham). The legend was finished and the writing of the *Record* begun. (George)

Sheet 19 (Hexham). The *Memoir* was completed. (R. A. Jarvis)

South Yorkshire

Sheet SK 59 (Maltby). A land use capability legend was drawn up in collaboration with ADAS soil scientists, and the *Record* written. (Hartnup and Allison)

East Anglia

Cambridgeshire

Sheet TF 00E/10W (Barnack). The remaining 20 km^2 of this sheet have been mapped. In all thirty-one profile pits have been described and sampled, and a draft 1:25 000 soil map and legend have been prepared. Thirty-one series have been recognised and the map also identifies a further nine phases and variants. Because the district is situated on the only extensive Jurassic limestone outcrop in East Anglia several series new to the region but previously described elsewhere have been recorded. These include Sherborne (4)

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and Marcham (4) on limestone, and Frilford (4) and Langley on sands interbedded with Jurassic limestone or clays. (Burton)

***Sheet TL 54* (*Linton*).** The initial reconnaissance of this district has been started with survey of the Chalky Boulder Clay and adjacent soils of the Chalk near Linton and Chesterford. The sheet covers the edge of the Boulder Clay Plateau of south-east Cambridgeshire, the gentle slopes of the Lower and Middle Chalk with associated thin drifts and the terraces of the Granta and Cam. (Burton)

***Sheet 135* (*Cambridge and Ely*).** A soil association map of Ordnance Survey 7th Edition Sheet 135 has been prepared and will accompany a *Special Survey* publication describing the soils. (Seale)

Norfolk

***Sheet TG 11* (*Attlebridge*).** In preparing the survey for publication amendments have been made to the map, legend and *Record* to reflect ideas recently introduced. A new series, the Wensum, has been recognised on the river floodplains as a typical (non-calcareous) humic alluvial gley soil and distinguished from the Midelney (5) which is not humic. The most extensive soil, the Freckenham (5) series, has been resampled to obtain better representation. (Eldridge)

***Sheet TL 99* (*Caston*).** The draft of the map and legend were completed. (Eldridge)

***County map*.** In west Norfolk soil maps of those districts previously mapped for publication at 1:25 000 (Sheets TF 82, TL 99 and TL 88) were redrawn at 1:250 000 scale. This involved the regrouping of the map units into larger units suitable for a 1:250 000 map. Using this legend soil boundaries were then drawn on those remaining 1:25 000 maps of west Norfolk where soil observations had previously been systematically made at 400 points grouped as clusters on a grid. Soil boundaries on these sheets were drawn on the basis of relief and stratigraphy shown on topographic and geological maps and in relation to the available soil information. The boundaries were then checked in the field. Seventeen of the thirty-one 1:25 000 sheet areas in west Norfolk were surveyed in this way.

In east Norfolk the soil boundaries on the six 1:25 000 sheets mapped in detail were reduced to 1:250 000 scale in a similar manner but have not yet been extrapolated into adjoining districts. (Corbett)

Suffolk

***Sheet TL 76E/86W* (*Risby*).** The remaining 35 km² were mapped and the *Record* is in preparation. (Seale)

East Midlands

Derbyshire

***County map*.** To characterise accurately the main map units on the Carboniferous Limestone, six sample farms comprising about 10 km² in total were mapped in detail at scales of 1:10 000 and 1:10 560.

On the plateau, soils of the Malham (6) and Nordrach (7) series were more or less equally widespread, the former being mainly restricted to 5–10° and the latter to 0–5° slopes. The relative amounts for the whole limestone plateau will be assessed by air-photo interpretation.

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The limestone dales have mostly ranker soils: brown rankers of the Crwbin (6) series are most common in the minor dales with slopes of 20° or less, while in steeper sided (20–30°) dales, there are mostly humic rankers of the Wetton (6) series. On slopes greater than 30°, there are locally many humic rendzinas of the Marian (3) series. Rock outcrops are common, especially in the steepest dales where active screes form below them.

Some 70% of the county is now mapped in sufficient detail for publication at 1:250 000 scale. (Thomasson and Reeve)

Lincolnshire

***Sheet SK 99* (*Kirton-in-Lindsey*).** The district is partly in north Lincolnshire and partly in south Humberside and was chosen to represent the Lower and Middle Jurassic deposits of the County. The Lower, Middle and Upper Lias beds all crop out, with the Inferior Oolite series comprising Northampton Sand, Lower Estuarine Series and large areas of Lincolnshire Limestone. Various tills and other drifts are also present.

A reconnaissance survey of the district found soils similar to Hanslope (5) series on chalky till and Salop (3) series on a reddish till. Sherborne (4) soils are on the Lincolnshire Limestone and Denchworth (2), Long Load (7) and Rowsham (4) soils are on the Lias clays. Soils similar to Tadmarton (8) series are on the Northampton Sand. (Heaven)

***Sheet TF 28* (*Donington-on-Bain*).** The *Record* is nearing completion. The complex flinty drift soils of the Wolds have needed further detailed correlation. (Heaven)

***Sheet TF 39* (*Covenham*).** Some 10 km² were surveyed on the reddish Marsh Till deposits. Fine loamy over clayey, typical stagnogley soils similar to Salop (3) series were commonly found. Calcareous alluvial gley soils correlated with the Newchurch (9) series are mapped on clayey marine alluvium. Many extensive silty mounds east of Marshchapel are waste-heaps remaining from salt-making in medieval times. (George)

***Sheet TF 45* (*Friskney*).** Some 10 km² were mapped in detail. Most of the fen soils noted occur in other parts of Lincolnshire (10) but a very fertile, as yet unnamed, gleyic brown calcareous alluvial soil consisting of 60–70 cm of sandy silt loam over peat is present as a strip in Wainfleet St Mary Fen, probably representing a former major creek that flowed east towards Wainfleet.

The marked lateral variation of fen soils in short distances is being examined using 2-m deep proline soil cores.

Some soils on the toft land contain charcoal and possibly burnt layers below 60 cm suggesting disturbance by man.

Here too low mounds on the toft land are possibly waste material from earlier salt-making. (Robson)

Northamptonshire

***Sheet SP 66* (*Long Buckby*).** The remaining 55 km² were mapped. Fine loamy over clayey stagnogleyic argillic brown earths on chalky Wolstonian till were provisionally named Brington series but have now been correlated with the Ashley (5) series. A clayey non-calcareous pelosol on the same deposit has been named Buckby series. The soil map and *Record* are in preparation. (Reeve)

West Midlands

Hereford and Worcester

***Sheet SO 85* (*Worcester*).** A further 50 km² were mapped in detail. A provisional

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legend of 30 soil series has been established, although some series may prove uncommon and of insufficient extent to form map units.

Keuper Marl underlies about 93% of the district, the remaining 7%, in the south-east, being over Lower Lias clays. Whimple (11) and Brockhurst (3) soils with thin fine loamy or fine silty horizons over clayey Keuper Marl are the most extensive whereas Worcester and Spetchley series (11) are important where the Keuper Marl is drift-free.

The glaciofluvial terraces of the rivers Severn, Teme and Salwarpe including the Power Station, Worcester, Main and Kidderminster terraces consist of coarse loamy deposits over sands and gravels giving Wick and Arrow soils (3). Some soil profiles on the 5th (Bushley Green) and 6th (Woolridge) Severn terraces at 60 and 90 m O.D. have paleo-argillic characteristics (12). The deposits in which these profiles are formed are probably Wolstonian in age and consist of coarse loamy material over sandy clay loam or sandy clay horizons having prominent reddish, pinkish and grey mottles with thick clay skins coating stones and lining pores. These paleo-argillic horizons pass downwards into marl or in the deeper deposits into sand and gravel. Soils on the 5th and 6th terraces classified as stagnogleyic paleo-argillic brown earths have been correlated with the Norton (13) series and a new, as yet unnamed, series has been recognised for the paleo-argillic stagnogley soils in similar parent material.

The Bushley Green terrace is more widespread than previously mapped. It had been reported around Broadheath, Hindlip and south of Norton but remnants of these high-level deposits, at about 60 m O.D., have been mapped in Whittington, Warndon and Powick and near Nunnery Wood, Worcester. (Palmer)

Salop/Staffordshire

***Sheet SO 79E/89W* (*Claverley*).** The remaining 60 km^2 were mapped in detail. The final legend includes 20 soil series, five of which were established during the survey. Fourteen soil subgroups have been recognised of which typical brown sands, stagnogleyic argillic brown earths and typical stagnogley soils are most common.

The distribution of soils was discussed in the previous annual report, but completion of the survey allows further interpretation of the soil patten. Soils of the Dodmoor (14) series proved inextensive and usually have thin surface horizons of coarse loamy drift. They have been included in a map unit dominated by an unnamed series belonging to the argillic brown earths and in coarse loamy drift over reddish clayey Upper Carboniferous marl. Similar soils of the Dunnington Heath (3) series in coarse loamy drift over clayey Triassic marl occur near Shipley, Kingslow and Pattingham. Sandy typical (humo-ferric) podzols of the Wanfell series over reddish Triassic sandstone are mapped over a small tract north of Bradney and on part of the Abbot's Castle Hill scarp while the similar podzols of the Crannymoor (1) series in glaciofluvial and colluvial sands occur only around Blackhill Plantation and Whitehouse Farm.

During the summer, a trench at least 2·1 m deep was excavated for a gas pipeline. It crossed the district from near Whitehouse Farm in the south-east, to near Badger Heath Farm in the north and was examined in detail, giving a valuable insight into the distribution of the drift soils and their parent materials. Thick drift deposits ($>$2·1 m) occur only in the river Worfe and Smestow brook valleys, where glaciofluvial sands and gravels possibly linked with the main terrace deposits of the Severn and Stour, give soils mainly of the Newport (1) series, and on relatively flat, featureless low ground at the bottom of the Abbot's Castle Hill, Shipley–Rudge and Rudge–Nurton escarpments, where till and associated glaciofluvial drifts give soils mainly of the Clifton (1), Salwick (3) and Quorndon (3) or Arrow series (3). Elsewhere till and outwash deposits are thinner ($<$2·1 m) giving soils of the Clifton, Salwick, Arrow, Wick (3) and Newport series, and the as yet unnamed

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stagnogley soils, stagnogleyic brown sands and argillic brown sands mentioned in the last report.

There is evidence of a buried channel between Hilton and Sandford, where small deeply dissected dry valleys with steep slopes are cut into thick sand deposits with thin stringers and lenses of coal pebbles. It is not clear what relationship these deposits (up to 15 m thick at Hilton sand pit) have with the sands and gravels of the Worfe valley, which are also deeply dissected by small steep sided valleys, but both are capped in places by thin till remnants supporting soils of the Clifton, Salwick, Wick and Arrow series or an unnamed stagnogleyic brown sand. The deep dissection of these thick sandy drifts gives areas of the steep phase of the Newport series.

A close examination of Devensian till in the pipeline sections showed how complex it is. Basically a reddish brown slightly stony clay loam, it has been extremely cryoturbated since deposition, and frost wedges filled with sandier drift are common. Upper parts of the till have been reworked and partly sorted, giving a coarser, stonier wash of variable thickness, which rests on the contorted surface of the till proper between 30 and 120 cm depth. Profiles in this parent material usually have upper horizons of sandy loam at least 50 cm thick which pass into lower horizons of clay loam within 90 cm, and these soils have been mapped as the Salwick or Clifton series. Because of the thickness of their sandy loam surface horizons however, it is thought that problems associated with late autumn and early spring cultivations were significantly less than on the same soils mapped further north in the Shropshire–Cheshire plain. Clifton and Salwick profiles with more than 50 cm of sandy loam in their upper horizons therefore have been separated as deep sandy loam phases. They dominate the Clifton and Salwick map units in this district.

The moisture release characteristics of a Clifton deep sandy loam phase profile confirm the moderate to large air capacities present to below 50 cm depth, and the change to small air capacities and large packing density between 50 and 100 cm, typical of a surface-water gley soil. A preliminary investigation of the physical properties of gleyed coarse loamy soils mapped as Quorndon series, suggests that some have moisture release characteristics very similar to those of surface-water gley soils. In such cases, the distinction between surface-water and ground-water gley soils would be easier if the criteria included the physical properties of soil profiles. (Hollis)

Staffordshire

Sheet SK 12 (Draycott in the Clay). A further 42 km² were mapped in detail and the legend finalised.

Much of Tatenhill and Yoxall parishes is covered by till with mainly Salop (3) and Crewe (13) soils. Reddish and brownish subsoil phases of both series continue to be distinguished in the field but will not be shown on the published map. In the parishes of Abbots Bromley and Hamstall Ridware, some of the till areas give moderately stony profiles and stony phases of the Flint (3), Clifton and Salop map units have been delineated. In Dunstall where the drift is thinner than farther north, Brockhurst, Whimple, Flint and Worcester soils are found.

On the first or low terrace of the Trent in the south-east and on the Dove floodplain in the north-east pelo-alluvial soils of the Fladbury (3) series are dominant, with Wharfe (3) soils on the natural levees and small patches of gleyic brown alluvial soils of the Trent (3) series behind these banks. The Fladbury map unit contains some reddish profiles which correlate with the Compton (3) series.

In the north, the Tea Green Marl crops out above red marls on the moderately-steeply sloping ground of the Keuper scarp. The greenish-grey marls give Hurcot (7) soils and the reddish marls Worcester soils; steep phases of these soils have been recognised for

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land capability classification. Where the Tea Green Marl is covered by thin clayey drift on level or gently sloping ground, a pelo-stagnogley soil occurs which has been correlated with the Sinfin (3) series. The scarp is capped by Rhaetic shales which are sometimes drift-free giving Belvoir (15) soils but where they are thinly covered by drift, fine loamy or fine silty over clayey, profiles of the Marchington series have been mapped.

The very wet autumn of 1974 made late harvesting of cereal crops very difficult in this marginal arable district. Damage to the structure of Salop, Crewe, Spetchley, Ragdale (3) and Sinfin soils was serious in some places by early December. Late ploughing and drilling when soils were wet produced many poor seed beds and some fields of winter wheat failed to germinate by early spring.

During late April and May, the soils over much of the district dried out rapidly and by mid-June cracks began to appear in fine silty, fine loamy and clayey soils. This dry spell severely retarded the growth of spring barley. Large cracks 4–6 cm wide at the surface had developed in Crewe, Spetchley, Ragdale, Worcester and Salop soils by the end of July. On the floodplain of the Dove, Fladbury soils were also very fissured. The hot dry weather continued until the end of September and gave the best post-harvest conditions for subsoiling for many years. (Jones)

Warwickshire

Sheet SP 29/39 (Nuneaton). About 120 km^2 were mapped in detail. The district includes a large part of the East Warwickshire Plateau, a comparatively simple relief unit between 120–150 m O.D. mainly formed of Middle and Upper Coal Measures and edged in the north by Cambrian shales containing igneous intrusions. This upland is bounded in the west by the Tame valley which contains low gravelly terraces of Devensian age over Keuper Marl, and in the east and north-east by the Anker valley, a Keuper Marl vale with gently rolling relief typical of the Keuper lowlands of the Midlands. Reddish till from the north and west occurs as small cappings to some of the highest ground of the plateau and is widespread in the valleys. There is Chalky Boulder Clay east of Nuneaton.

The reddish beds of the Upper Coal Measures support typical brown earths of the Shifnal (14) series, stagnogleyic argillic brown earths of the Dodmoor series and unnamed typical stagnogley soils with fine loamy over clayey profiles in poorly drained sites. On the Middle and Lower Coal Measures pelo-stagnogley soils of the Dale (6) series and fine loamy over clayey stagnogley soils occur on the clays and clay shales. Typical brown earths of the Swindon Bank (6) series are found on the brown Coal Measure sandstones. The profiles of many stagnogley soils on the Cambrian rocks are similar to those on the Middle and Lower Coal Measures, but no correlation has so far been made. There are small patches of rankers on the intrusive rocks within the Cambrian outcrop and on the Cambrian shales themselves.

The Keuper Marl, where drift-free, has Worcester and Spetchley soils but where there is thin drift, Whimple, Dunnington Heath and Brockhurst soils have been recognised. Wick, Arrow and Quorndon soils occur on the terraces along the Tame and Anker and pelo-(vertic) alluvial gley soils of the Compton series have been mapped along the floodplains. A small tract of Fladbury soils have been mapped in the Anker valley east of Nuneaton on alluvium mainly from Jurassic rocks. The extensive till mainly from Triassic rocks has Flint, Salop, Astley Hall (15) and Rufford (14) series and the small area of Chalky Boulder Clay has Oak (16) and Ragdale (3) soils.

Most of the terraces in the Tame valley have been worked for gravel and are being reclaimed, and much quartzite has been quarried from the Cambrian outcrop. (Whitfield and Beard)

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South-east England

Berkshire

County map. Further data from grid samples were numerically analysed using the Rothamsted computer. Legends for land use capability and winter rain acceptance maps have been constructed. Further substantial work on the accompanying bulletin has been undertaken; completion has been delayed by difficulties in coordinating contributions but is planned for the end of the year. (M. G. Jarvis and Hazelden)

Sheet 268 (Reading). A legend has been constructed for a land use capability map. (M. G. Jarvis)

Essex

Sheet TL 71 (Little Waltham). A further 20 km² have been mapped and 30 profile descriptions made from pits and proline cores representing landscapes and soils on glacial till (Chalky Boulder Clay), glaciofluvial deposits (Glacial Sands and Gravels) and their associated superficial deposits.

While the Chalky Boulder Clay can give calcareous soils it is more usually leached to depths greater than 40 cm or covered by a lithologically distinct deposit. The deposit can be local or occur as thin spreads extending off the till on to valley sides.

The typical soil in Chalky Boulder Clay is a calcareous pelosol of the Hanslope series. More deeply leached argillic pelosols also occur associated with typical pelo-stagnogley soils of the Ragdale (3) series in less well drained ground.

On broader interfluves the Chalky Boulder Clay is covered by spreads of fine silty loess or brickearth. Here typical brown earths of the Hamble (9) series and stagnogleyic brown earths of the Hook (9) series are found.

Head derived partly from this loess and partly from glacial deposits is widespread, filling small hollows in the till surface and as thin spreads and valley side deposits. Fine loamy or fine silty over clayey soils predominate with typical stagnogley soils of the Oak series and stagnogleyic argillic brown earth analogues. Argillic brown earths of the Bengeo series and gleyic analogues occur on valley sides.

The Chalky Boulder Clay is often covered by thicker clayey drifts with prominent red mottling in a strong brown and grey matrix, carrying paleo-argillic stagnogley soils and paleo-argillic stagnogleyic brown earths. (Allen and Sturdy)

Kent

County map. A further 1500 km² were surveyed to complete the map. Reconnaissance of river terraces showing patterned ground near St Mary's, Hoo, was followed by more detailed study, including examination of quarry sections and proline cores; soil variability of the more extensive floodplains was checked. The map and legend were revised to accommodate 23 soil associations. The *Bulletin* is nearly complete. A land use capability map and descriptive key with 34 capability units has been prepared. (Green and Fordham)

Oxfordshire

Sheet SP 30 (Witney South). Water levels were monitored again through the winter at four dipwell sites in Denchworth and four in Langley series. Draw-down tests were also made to assess permeability and the calculations are in hand.

Excavations for the Witney by-pass have helped to elucidate soil relationships and several sections have been described. The map legend is complete and the map awaits compilation. (Hazelden)

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***Sheet SP 60* (*Tiddington*).** A further 40 km² were mapped, chiefly on the clay land, over Oxford, Ampthill and Kellaways clays in the north and Gault clay in the south-east of the district. Denchworth and Evesham series (2) are common. Much of the northern part of the district is low-lying with very shallow valleys filled with drift, and Rowsham (4) and Podimore (13) series are extensive here; similar soils also occur over thin gravel. There are mostly Fladbury and Thames series (4) in the main river valleys and an unnamed stagnogley soil in fine loamy stony Head occurs on the terraces and inter-terrace slopes around Tetsworth on the eastern edge of the sheet. (Hazelden)

South-west England

Avon

County map. A draft bulletin has been prepared describing the geology of the area, climatological factors affecting agriculture and soil formation and classification. The soils of each map unit are described and their potential for amenity or recreation assessed. Chapters discussing the potential of the soils for agricultural and industrial use are in preparation. (Colborne)

Cornwall

***Sheet SW 53* (*Hayle*).** The map was completed and the *Record* is in preparation.

***Sheet SW 61/62/71/72/81/82* (*Lizard*).** Initial reconnaissance of the Lizard Peninsula is under way. The map covers the whole of the Lizard complex of rocks, with the Meneage Crush Zone and Devonian rocks to the north.

The rocks of the Lizard complex comprise serpentine, gabbro, granite-gneiss and hornblende and mica schists. Unconsolidated deposits include a small area of gravelly clay, the Crousa Gravels, which cap an interfluve on the Lizard Platform, with widespread loess. The loess is most evident on the very gently undulating Lizard Platform where thicknesses of 1 m have been recorded over serpentine. Elsewhere, in more dissected country, the distribution is more sporadic.

The Platform supports a variety of soils, the characters of which are dependent upon position in the landscape. On near flat interfluves loess, often more than 50 cm thick, overlies *in situ* serpentine, which usually has a clay-weathering skin. The soils are mainly coarse silty and usually have marked stagnopodzolic features in the upper 30 cm whilst the subsoil has a gley morphology. Clayey humic gley soils occupy shallow depressions whilst shallow, fine loamy brown earths are on rocky sea cliffs and a few steep rocky valley sides.

The gabbro carries fine loamy brown earths in undulating country with fine loamy and clayey gley and humic gley soils in depressions and on parts of the Lizard Platform. Deep, loamy brown earths and brown podzolic soils are found in the strongly dissected schist country. Loamy brown earths and gley soils occur on granite-gneiss outcrops while the Crousa Gravels, which have a thin loessial covering, support stony paleo-argillic gley soils.

The Meneage Crush Zone, which includes crush breccias, conglomerates, quartzites and basic volcanic rocks, has a wide range of soils. The breccias and conglomerates carry fine loamy brown earths and brown podzolic soils with clayey stagnogley soils while shallow brown earths and rankers are found on volcanic rocks.

Brown earths and rankers of the Highweek (17) and Powys (18) series seem to dominate much of the strongly dissected Devonian slate country and brown podzolic soils similar to the Dartington (17) series are found on many heavily wooded slopes around the Helford river. (Staines)

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Devon

***Sheet SS 61* (*Chulmleigh*).** Mapping was completed and the *Record* is in preparation. Twenty-six dipwells were established on Tedburn (17), Halstow (17) and Brickfield (6) soils to assess their hydraulic conductivity. (Harrod)

***Sheet SS 74/75* (*Lynton*).** An initial reconnaissance was made. The district lies between the Bristol Channel and Exmoor Forest. Soils over Devonian rocks, both slates and the more arenaceous Hangman and Foreland Grits, will be examined. In Exmoor Forest parish the Grits are largely masked by blanket peat. The landscape includes a series of sharply dissected upland surfaces descending from near 490 m O.D. in the south to about 300 m on the cliff tops near Lynton. Ironpan stagnopodzols are widespread and grassland could be improved by subsoiling to disrupt the pan. (Harrod and Hogan)

***Sheet SX 68* (*Fernworthy*).** A brief reconnaissance survey was made to confirm that this district, within the Dartmoor National Park, an area of special importance for nature conservation, scientific study and amenity, contained the range of soils to be expected on the Dartmoor granite. The district represents both enclosed agricultural land mostly below 300 m and open moorland rising to about 600 m O.D. Typical brown podzolic soils of the Moretonhampstead (17) series are widespread on the enclosed land with humic brown podzolic soils of the Moor Gate (18) series under grassy moorland and with ironpan stagnopodzols of the Hexworthy (18) series and ferric stagnopodzols of the Rough Tor (18) series common under heather and *Molinia* moorland and under significant tracts of coniferous forest. Blanket peat occupies some 20% of the sheet at high altitude. (Hogan)

Gloucestershire

***Sheet SO 61* (*Cinderford*).** An initial reconnaissance of the Upper Carboniferous syncline has revealed extensive deep loamy and silty drift deposits on which there are a range of soils from stagnohumic gley soils to argillic brown earths. Upstanding features formed by sandstones within the Suprapennant Measures and the massive Pennant Sandstone itself are also covered by variable depths of drift in which coarse loamy typical brown earths and loamy argillic brown earths are mapped. Much land has been disturbed by mining for coal and iron ore. About 10 km^2 has been mapped in detail. (Colborne)

***Sheet SO 72* (*Newent*).** About 30 km^2 were mapped using some 60–80 borings per km^2. The soils are mainly on Triassic mudstones, sandstones and related drift. In the south-west there are also small patches of soils on Silurian mudstones and sandstones flanking the May Hill inlier, with a tract of soils on Devonian mudstones which extend northwards towards Dymock. In the south-east, slopes on the Lower Lias extend into the Maisemore district.

Soils of the Worcester, Whimple and Spetchley series (13) were mapped over Triassic mudstones, together with small stretches of Dunnington Heath and Brockhurst soils (3) in coarse loamy drift over mudstone. Triassic sandstones around Newent give Bridgnorth, Newport, Bromsgrove soils (3) and locally sand rankers. Soils of the Yeld (19) series occur on Silurian mudstones, and coarse loamy brown earths and coarse loamy over clayey argillic brown earths occur on Silurian sandstones and siltstones. Devonian mudstones give mainly Bromyard (19) soils and in the east Liassic clays and limestones give Evesham, Haselor and Denchworth soils (13). (Cope)

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Wales

Clwyd

Sheet SJ 17 (Holywell). A further 57 km² were mapped and the field work is virtually complete: 160 samples have been collected for analysis of heavy metal contents by ADAS to help assess land use capability in the district.

Thin sections taken from brown soils over limestone have shown argillic brown earths to be more extensive than previously thought. Clay-enriched (Bt) horizons occur directly over limestone or within thicker loamy drift as reddish brown or brownish layers. These appear to be due to current soil-forming processes; the reddish layers contrast markedly in colour with adjacent horizons and contain more clay but are thinner than the less well defined browner layers. (Thompson)

Sheet SJ 24 (Llangollen). Some 40 km² have been surveyed. Analyses show that typical brown podzolic soils of the Manod (14) series are dominant in till from Lower Palaeozoic sediments below 460 m with typical brown earths of the Denbigh (20) series much less widespread. Typical brown earths of the Rheidol (20) series occur on glacio-fluvial terraces along the Eglwyseg river. Slopes above the Carboniferous Limestone escarpment are also covered by till from Lower Palaeozoic sediments and typical brown podzolic soils occur within 0·5 km of the escarpment or within 5 m of limestone outcrops. Elsewhere in this vicinity, there are ferric stagnopodzols of the Hafren (18) series and ironpan stagnopodzols of the Hiraethog (18) series up to 430 m O.D. Stagnohumic gley soils in arenaceous material and blanket peat are on the higher ground, on the Millstone Grit or Ruabon Mountain. (Lea)

Sheet SJ 35 (Wrexham). The *Record* has been completed. (Lea and Thompson)

Dyfed

Sheet SN 13 (Eglwyswrw). The *Record* has been completed. (Bradley)

Sheet SN 24 (Llechryd). A further 50 km² were mapped, proline samples taken and part of the *Record* written. The extent of the sand deposits approximately coincides with previous published limits (21); however, the clays have been mapped in several small separates surrounded by typical brown podzolic soils of the Manod (14) series away from the previously recognised locations on old meanders and plateau surfaces associated with the pro-glacial Lake Teifi. (Bradley)

Sheet SN 62 (Llandeilo). A further 62 km² were mapped and 16 representative profiles described and sampled.

On Lower Palaeozoic rocks the main soils are fine loamy and fine silty cambic stagnogley soils of the Cegin (20) series, occurring in the drift which mantles much of the landscape. A stony phase of this series, associated with outcrops of grit and conglomerate has been mapped extensively south of the river Tywi and in the Taliaris area. On the steeper hills and ridges typical brown earths of the Denbigh (20) series and typical brown podzolic soils of the Manod (19) series with fine loamy textures are widespread.

Over the Old Red Sandstone typical brown earths with fine loamy textures of the Milford (20) series are the commonest soils. Cambic stagnogley soils of the Fforest (20) series and stagnohumic gley soils of the Wenallt (20) series with fine silty textures occur in drift-filled depressions.

On the Tywi floodplain typical brown alluvial soils in fine silty (Teme (19) series) and coarse loamy alluvium are the most widespread. Frequently these soils contain bands of

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gravel within 80 cm of the surface. Gleyic brown alluvial soils of the Clwyd series and typical alluvial gley soils of the Conway (20) series in fine silty alluvium are locally common. (Wright)

Pembrokeshire. A further 493 km² were mapped at 1:25 000 from aerial photographs and an additional 116 km² remapped to bring them to the same standard. The first draft for the former county is complete except for about 80 km² in the south for which there are as yet no photographs. The edited hand-coloured reduction to 1:50 000 now covers 837 km², and a draft at 1:250 000 of 521 km² was prepared from this. The 1600 profiles described at 1 km intervals were reclassified according to the new Survey system and finer subdivisions of parent rocks were made for some 900 of these in the north, to help construct legends. (Rudeforth)

Basic research

Soil water regimes

In the period 1963–73, water-tables were monitored at over 300 places in England and Wales. The results of this work will be published later as a *Technical Monograph*, but gley morphology and land use can be related to the number of days per annum that the water-table was within 40 cm (W_{40}), or 70 cm (W_{70}) of the surface (Table 1). Soils with similar gley morphology, particle-size composition and land use are grouped together, groups, 1, 2, 3, 4 and 9 being all stagnogley soils with impeded drainage. Groups 5, 6, 7 and 8 are stagnogleyic profiles (12). 'Red' soils include profiles on red marl (mainly Triassic deposits). Groups 10, 11 and 12 are ground-water gley soils of varying texture. Group 13 consists of gleyic soils without impeding horizons, and group 14 contains soils with no gleying within 70 cm depth. The first two columns give averages of observations for each group or subgroup, while the third and fourth columns are estimates of mean W_{40} and W_{70} from regression analyses. This is necessary to even out observations at individual sites in years which could be much wetter or much drier than the average year. The average year for this purpose is defined in terms of mean Field Capacity Days ($\overline{FC}_m$).

The results show a progressive decline in waterlogging within the stagno groups (1–9). In groundwater situations, the pattern is more complex. Groups 11, 12a and 13 include many sites where drainage has very successfully controlled water-tables and the gley morphology is relic. Group 14 includes one anomalous profile (Dunsford series); exclusion of this would reduce the W_{40} value for 11 sites to eight days. (Robson and Thomasson)

The soil physics laboratory has studied some 260 profiles producing full pore-size and particle-size distribution data, with partial analyses for a further 50, and a *Technical Monograph* is being prepared to develop further the work reported earlier (22). For example, there are now more reliable estimates of available water, retained water capacity and air capacity, for various land uses, soil subgroups and particle-size classes. It is hoped to improve prediction of physical properties from general profile data, at least for classes of soils. (Hall, Reeve and Thomasson)

The resistance of core samples at 50, 100 and 400 mb suction to overburden pressure has been measured using a fall-cone penetrometer to extend tests made last year on remoulded samples. The condition of the sample was found to be very critical. (Hall)

Measurements of water content distribution in Romney, Downholland and Andover soil profiles continued using a neutron probe. By accumulating such measurements it is fairly clear when field capacity begins or ends and actual deficits can be compared with those calculated from climatic data. (Hall and Heaven)

Water level recording wells were sunk in soils formed on glaciofluvial sand on the

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TABLE 1

Average days waterlogging at 40 and 70 cm; (a) from observations, (b) from regression analyses using $\overline{FC}_m$ for each group

	(a) Means of observations		(b) Estimates from regression analyses	
	W_{40}	W_{70}	W_{40}	W_{70}
Group 1, arable mottled within 25 cm				
1a Clayey	135	182	118	170
1b Others	86	150	76	138
Group 2, grassland, mottled within 25 cm				
2a Clayey	125	186	132	193
2b Others	139	180	129	169
Group 3, arable, mottled between 25–40 cm				
3a Clayey	88	126	80	109
3b Others	75	110	79	114
Group 4, grassland, mottled between 25–40 cm				
4a Clayey	84	149	87	154
4b Others	108	152	107	152
Group 5, arable, mottled between 40–70 cm	5	70	No regression	
Group 6, grassland, mottled between 40–70 cm				
6a Clayey	63	102	56	91
6b Others	8	60	10	67
Group 7, arable, 'Red' soils	56	115	No regression	
Group 8, grass and woodland 'Red' soils	43	94	45	85
Group 9, woodland				
9a Mottled within 25 cm	88	156	64	131
9b Mottled between 25–40 cm	59	88	41	65
Group 10, ground-water gley soils, clayey	120	175	126	183
Group 11, ground-water gley soils, humic mottled within 40 cm	0	18	No regression	
Group 12, ground-water gley soils, mottled within 40 cm				
12a Sandy	0	2	No regression	
12b Loamy	20	102	No regression	
Group 13, gleyic soils, mottled within 70 cm	0	8	No regression	
Group 14, ungleyed soils, unmottled within 70 cm	2	20(8)	No regression	

Skipworth Common Nature Reserve near Selby. This is undrained land with significant annual variations in water-table level, and the soil water regimes will be compared with those on similar drained land nearby. The Common lies within the area of the new Selby coalfield and it is hoped to record any future changes brought about by the widespread and severe subsidence expected from the removal of a coal seam 3·3 m thick.

On North Humberside suitable sites were chosen for ADAS Drainage and Water Supply officers to monitor soil water regimes in the Holme Moor, Everingham, Foggathorpe and Spaldington series. Sites on typical Holderness till soils were selected near Brandesburton and in south Humberside suitable water regime sites were chosen on tills near Grimsby and on post-glacial sand (Everingham series) near Scunthorpe. (Furness and S. J. King)

Water levels were recorded at 49 places in Essex during the winter of 1974/75. Of these, 15 were the responsibility of DWSO staff of ADAS and covered the main soil series needing drainage. Seventeen sites were recorded in woodland and arable farmland, by volunteers and the remainder by Soil Survey staff.

Return to field capacity according to Meteorological Office data was between

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23 October and 13 November in 1974 and ended on 2 April 1975 for most of Essex. Field capacity was maintained therefore for between 140 and 160 days. In the previous winter, 1973/74, soil did not return to field capacity.

During the recent wet winter nearly all soils were a class wetter (23) than in the previous year, and, in general, both the period of continuous waterlogging and the height to which the water-table rose were greater. Drainage in Hanslope and Ragdale soils, with moling as a secondary treatment, was effective in keeping the water-table at about the depth of the moles (*c.* 50 cm), compared with undrained soil. Undrained grassland on Oak and Wickham soils was waterlogged to within 10 cm of the surface for between four and seven months from October 1974 and both were placed in wetness class IV (III and II respectively the year before). Oak series in woodland was a class drier than in a drained arable field nearby, but Ragdale series on similar land showed no difference.

The three years 1972–75 included both a very dry and a very wet winter, and an estimate of wetness class from this period represents a fair approximation to that for a 20-year period recommended by the *Field Handbook* (23). The pelo-stagnogley soils, Windsor and Ragdale, under undrained grassland were in class III or wetter, even in the very dry year, and the water regime was probably reliably estimated after the three-year period. Water regimes of the typical stagnogley soils, Oak and Wickham, under similar conditions varied more widely ranging from class I to IV, and were therefore less likely to be reliably estimated after the shorter period. (Sturdy and Allen)

Recording of water levels in five dipwells continued for a second year in the Llandeilo district (Sheet SN 62) in soils of the Cegin, Sannan, Conway and Teme series. Draw-down tests were carried out in the Cegin and Conway profiles. (Wright)

Soil temperature

Grant miniature recorders measured soil temperatures at 10 cm intervals of depth in a stagnogley-podzol and a typical (humo-ferric) podzol, to compare temperature regimes, help characterise soils, and to study the effects of indurated horizons. Preliminary results suggest that indurated layers affect the thermal regime, acting as heat reservoirs during the critical spring germination. The thermal diffusivity of these soils and of those involved in earlier temperature measurements will be calculated in collaboration with the ADAS Field Drainage Experimental Unit, Cambridge.

Cold north-easterly winds had a marked effect on soil temperature. On 20 March 1975 for instance between 08.00 and 16.00 h there was a 3° fall in temperature at 10 cm at the bare stagnogley-podzol site, near Penrith during a sunny day.

Measurements of frost-heave with a continuous pen-arm recorder were continued at a site on the Clifton series. (Matthews)

Physical measurements

In January and August further samples of the Waveney series were taken along a traverse from the river Waveney to the margins of the floodplain in the Beccles district (Sheet TM 49). Soil extract conductivity values were measured in both seasons and exchangeable sodium levels in winter. Salinity increases from the margins of the floodplain towards the river and soils close to field ditches are more saline than those in the centre of fields. Conductivity values are higher in summer than in winter. (Eldridge, with Ahmed and Hyoni, student workers)

The effect of organic matter and particle-size distribution on the available water and retained water capacities of 144 surface and subsurface horizons from 77 west Midland soils was investigated by regression analyses, using the Rothamsted computer. Much of the variance in both available water and retained water capacity was explained by differ-

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ences in organic carbon content. Multiple regression equations using organic carbon, clay and/or silt contents were derived for the prediction of available water and retained water capacity. A paper is in preparation. (Hollis, Jones and Palmer)

Minor element studies

Pembrokeshire. Alternative maps of trace elements in the north-west of the former county have been drawn by computer to illustrate for publication work reported last year. (Rudeforth)

Cardiganshire. Measurement of trace element contents of soils in the Llechryd district (Sheet SN 24) continued. Two groups of samples are being analysed: from representative profiles described for the *Record* and from samples taken at 1-km intervals during reconnaissance. Results suggest that soils from the clay deposits and from the Lower Palaeozoic sediments have the same trace element compositions which differ markedly from those of soils on the sands and gravels. (Bradley)

Carmarthenshire. In cooperation with ADAS, research has begun in the Llandeilo district into copper deficiency in soils derived from Old Red Sandstone. (Wright)

Soil chemistry

In cooperation with ADAS, research has begun on phosphate availability in brown podzolic soils. (Wright)

Organic soils

Samples from 11 lowland and 17 upland peat profiles have been studied and a paper prepared. (Bascomb)

Upper Greensand soils

The mineralogy of the main soil-forming facies of the Upper Greensand in south-west England and of soils developed on them are being studied. Two further profiles, on the Chert Bed facies of Wiltshire, were described and sampled.

Mineralogical analyses of fine sand (63–212 μm) separates from seven profiles sampled last year were completed, and show large variations in glauconite content within and between profiles. In the Ardington soil (SU 06/4605) it ranges from 5 to 25% and in the Puckshipton soil (SU 05/5595) from 3 to 17%. Amounts of glauconite consistently decreased towards the surface, and various weathering stages were observed in loose mineral preparations and in thin sections. These stages are being characterised. (Loveland and Findlay)

Stagnogley soils

Study of stagnogley soils on till was continued, and a further six profiles were described and sampled for physical, chemical and mineralogical analyses and micromorphological examination. They included Brickfield, Hallsworth and Talog soils on tills from Carboniferous rocks, a Fforest soil on till from Devonian (Old Red Sandstone) rocks and a Cegin soil on till from Lower Palaeozoic rocks. (C. P. Murphy and Bullock)

Methodological research

Particle-size and chemical analyses

Further samples of chalky drifts (Chalky Boulder Clay) from Sheet TF 82 (West

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Raynham) were analysed. (The map number was incorrectly given in the last report.) The carbonate-free clay content of the drift immediately east of the Chalk escarpment is greater on crests than on lower slopes, increases from west to east along the interfluve crests and increases with depth where samples were taken on successive levels. (Corbett and Bascomb)

Particle-size analysis

A commercial pressure transducer tried over a short period has provided an improved means of automatic recording of sedimentation rates over the range 2–100 μm. (Bascomb)

Micromorphometry

Progress was made in measuring peds and voids in soil thin sections using the image analysing computer (Quantimet). In addition to individual measurements of area, perimeter, intercept, full count (total number of particular features) and end count (number of downward protuberances of the features); the measurements can now be combined to evaluate the shape and orientation of peds and voids, tortuosity of voids and rugosity of peds.

Thin sections were made of soil from artificially compacted and uncompacted plots at Brooms Barn. That of the uncompacted soil revealed a random, unimodal distribution of voids, mainly vughs and channels. In the compacted soil the distribution was bimodal, with many large ($>$250 μm) horizontal planar voids separating platy peds in which voids are very small ($<$30 μm). Downward penetration of roots could well be inhibited in soil in this condition. (C. P. Murphy and Bullock)

Mineralogical analysis

The heavy mineral investigation of samples from the Burwardsley district of Cheshire (Sheet SJ 45/55) and the Penrith district of Cumbria (Sheet NY 53) was completed. (Kilgour)

Soil classification

The use of systematic symbols and related acronymic codes to name profile classes has been studied, partly in conjunction with field work. Data handling concepts, particularly ambifeatures to indicate tolerance subclasses, can allow flexibility in field classification and map making. A theory has been developed to adjust field classification to the soil classification currently developing. A suitable field record card is being developed and two papers are being prepared. Observations of quantity/intensity classes for hydromorphism made during the High Weald survey in 1972 were analysed and their use in defining profile classes reviewed. (Green)

Data management

Programs for screening and decoding soil profile descriptions were developed further to process text comment, and now provide routine service to Survey staff. (Webster and Mrs. C. M. Lessells, Computer Department)

Details of 705 published soil series were transferred to a punched feature card system to answer requests for information from surveyors and external users. The system, now called LINDAT, is a modification of that described elsewhere (24) and flexible enough to answer a wide range of queries. Information about provisional series used in current mapping is also recorded. (Heaven and Robson)

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Automated cartography

CAMAP (Finch and Hotson), the mapping program on the Edinburgh Regional Computing Centre's (ERCC) IBM 370/158 machine and a special line-printer was used to present results of the soil survey of the Ivybridge district (Sheet SX 65), and maps made of most of the properties originally recorded. Other maps were produced by combining several properties, and include simple binary and Boolean maps, maps of land quality and land capability, average texture, and of non-soil features like potential solar radiation. Pre-processing for these maps is carried out on the 370 computer by programs written for the purpose in Fortran. Access to the program through EMAS, the ERCC multi-access system, from the remote terminal at Oxford, has proved very satisfactory. (Webster)

A new set of computer-drawn symbols was devised to display trace element distributions clearly on automatic maps without the need for colour. Alternative maps are readily produced with different ranges of values for the symbols so that the best can be chosen for illustrations. (Bradley and Rudeforth)

Remote sensing

False colour and multispectral photography. In a study of parts of upland Yorkshire and Cumbria multispectral photography had no advantage over conventional panchromatic photography for surveying soil. The use of an additive colour viewer and densitometers gave no significant extra information, and the basis of the 'spectral signature' theory is thus open to question. Neither type of photography could distinguish soils of varying wetness on the same parent material under grassland, where interpretation was often confused by different management practices.

False colour photographs of moorland taken at different seasons were compared. Plant associations were more rapidly and confidently recognised with this film than with panchromatic, although in some cases they covered a wide range of soils. It is suggested that photography at 1:20 000 scale taken in October is ideal for this work. It was concluded, however, that neither false colour nor multispectral photography is sufficiently superior to panchromatic photography for them to be used generally for soil survey photointerpretation. (Carroll, with Miss E. V. Brack, Remote Sensing Unit, University of Aston)

Norfolk silt fenland. A further 10 km of clean ditch section was surveyed in Clenchwarton parish, and the soil profiles taken in 1974 along a traverse from the coastline to Clenchwarton were drawn. These show that land enclosures and the soils within them are related to their position within the former tidal marsh. To landward the marsh built up over a long period of time, and fine loamy and clayey deposits were laid down to a depth of 1·6–20 m over coarse loamy and sandy deposits. North of this was a deep lagoon in which over 3 m of clayey sediments were deposited. Seaward, later enclosures were made of rapidly silting marshland which have only 40–60 cm of finer deposits. The latest enclosure has a more variable depth of finer deposits with a trend toward deeper clayey deposits in this and the present-day tidal marsh. These depositional units correlate well with air photo-interpretation units. (Evans)

Photography of pastoral land. Analysis of a series of air photos taken at different times in 1973 over parts of Devon suggest that timeliness is important for recording heath vegetation patterns, differences in grass growth related to steepness of slope, and field drains. Spring is best for recording vegetation patterns, and June for field drains.

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Further work is needed to relate patterns of land use and field drains to particular soils. (Evans)

Photography of bare ground. On photographs of bare soil patterns taken at ground level in 1973, tonal densities were related to soil and surface properties. Photos are best taken when soils have dried from field capacity, as colour contrasts are then greatest. Colours of dark soils change little on drying; it is the light coloured soils which change most and govern the visibility of the soil patterns. Stony soils are best photographed in spring after the soil surface has weathered. Tonal contrasts are reduced, regardless of the actual colour contrasts between soils, as visibility decreases; this is related to the greater atmospheric aerosol content. On black-and-white photos exposed in different parts of the visible wavelength (0·4–0·7 μm) tonal contrast is related, therefore, to amounts of scattering (both Rayleigh and Mie types) of light, even from distances as small as 1–1·5 m. Hence, photo-tone can not be directly related to soil properties. Because aerosol content varies with airmass and local conditions, and may not be predictable, multiband air photography is not a promising tool for identifying soil types. This is confirmed by examining air photos of sites taken within a few days when soil properties had barely changed, but visibility was different. Tonal contrasts were reduced when visibility was poorer. (Evans)

Crop patterns. For several years, extensive crop marks in the parish of Fisherwick, Staffordshire, have been photographed from the air; they are on the first or low terrace of the river Tame, a tributary of the Trent. Many terraces have been worked for sand and gravel and several archaeological sites lost. Of those remaining the crop-marks site at SK 187082 near Fisherwick Park Farm has been excavated and yielded much information over the last three years, and it has provisionally been assigned to the Iron Age. Detailed studies of the crop-marks in relation to soils and meteorological data were made to clarify the factors influencing differential growth. A contribution is being made to the archaeologist's report on Fisherwick. (Jones and Evans, with Mr. C. Smith of the Department of Classical and Archaeological Studies, Nottingham University)

Following this work fields were selected in the parish of Maxey, Cambridgeshire, where crop patterns related to soil depth have often been recorded on air photos next to land where patterns have not been recorded and soil depth is relatively uniform. The accuracy of predictions of pattern occurrence was tested and differences in crop growth and yield within parts of the same field were measured. Plant and tiller numbers, crop height, leaf width and ground cover of winter wheat and spring barley were measured at frequent intervals from April to harvest and related to rainfall, evaporation and soil depth. The first appearance of pattern was accurately predicted. Yield, height and ground cover were significantly and directly related to soil depth, but plant and tiller numbers were dependent on cultivation and fertiliser practices. Within the patterned field, yields on the deepest soils were 17 times greater than those on the shallowest stoniest soil. Generally, soils with less than 30 cm of soil above horizons containing more than 20–25% stones yielded about half of those deeper than 115 cm. Air photos were taken at intervals through the growing season and photo-tone will be related to crop density and yield. (Evans)

Satellite imagery. An enlarged satellite image, at a scale of 1:250 000 of a large part of eastern and southern England was examined. This was taken in March 1973, the best time for recording tonal differences between bare ground and cropped land. Although useful as a basis for identifying reconnaissance soil association units for small scale

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mapping, these differences confirmed information from geological, land use and soil maps rather than furnished fresh evidence. (Evans)

A *Technical Monograph* on air photo interpretation for soil survey, based on a lecture course for Survey staff, has been prepared. (Carroll, Evans and Bendelow)

Soil variability

Profiles 10 m apart at Pwllpeiran Experimental Husbandry Farm were compared, to measure short distance variability within vegetation map units and judge how vegetation can guide soil mapping in the uplands of mid-Wales. Almost half the profile pairs had the same thickness of peat (within 10 cm) and one-eighth had contrasting thicknesses (more than 30 cm difference). Considerable variations between profile pairs were noted in soil series (Table 2). With only a 17% chance of finding a similar profile a Powys map unit based on vegetation would be unsatisfactory. However, Hafren and Hiraethog soils combined in a single unit of stagnopodzols would be about 60% pure, while corresponding figures for Ynys and Peat are 66 and 86% respectively. Improvements in map unit purity can be expected when slope facets as well as vegetation are delineated from aerial photographs. (Bradley and Rudeforth)

TABLE 2

Soil series variation within vegetation map units at Pwllpeiran Experimental Husbandry Farm

Soil at first site	Percentage of series at second site (10 m distant in the same vegetation unit)
Powys	Powys 17; Hafren 33; Hiraethog 33; Peat 17
Hafren	Hafren 37; Hiraethog 37; Powys 18; Peat 8
Hiraethog	Hiraethog 0; Hafren 50; Powys 20; Ynys 10; Peat 20
Ynys	Ynys 66; Hiraethog 17; Peat 17
Peat	Peat 86; Powys 3; Hafren 3; Hiraethog 5; Ynys 3

Field and laboratory data on horizon samples from ten cores extracted at 0·4 km intervals within each of three mapping delineations identified as Denchworth series were used to measure intra-unit variability. Papers have been prepared for publication. (Bascomb, M. G. Jarvis and Banfield, Statistics Department)

Applications research

Land capability

Eight weeks were spent touring England and Wales to assess and map the degree of exposure to wind, using the technique of Birse and Robertson (25). (Hartnup)

The monitoring of exposure by means of tatter flags in the Hayle district of Cornwall (Sheet SW 53) continued and a good relationship was established between the degree of tatter, windrun and the openness of country as measured by 'topex'. A map has been compiled showing a series of exposure zones and assessment of crop yield on similar soils in different zones is in hand. (Staines)

A climatic assessment was made of England and Wales based on accumulated temperature above 5·6°C and on moisture deficit (23), using techniques developed in Scotland by Birse and Dry (26). (Bendelow)

Sugar beet and soil

The survey of sugar beet fertiliser experiments carried out between 1957 and 1970 was thoroughly analysed. There was a steady increase in yield of sugar from the experiments during the period, matching the increase in the national average. There were also big

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fluctuations in yield from year to year, again matched by compatible fluctuations in the national average, and this is attributed to differences in weather, especially to the amount of sunshine. The two most important properties of soil that affect yield are its drainage and the texture of the subsoil. Moderately well drained soil yielded most (7·2 t ha^{-1}), about 1 t ha^{-1} more than poorly drained or droughty soil on average. Of the mineral soils, those with most silt in the subsoil gave largest yields (silt loam, 7·9 t ha^{-1}), those with most sand (sand, 6·3 t ha^{-1}) or much chalk (5·9 t ha^{-1}) least. The peat soils (average 7·1 t ha^{-1}) also yielded well, and especially those soils with thin peat (Adventurers' series shallow phase, 7·8 t ha^{-1}). Soil on Chalky Boulder Clay (Hanslope series) also yielded well (7·2 t ha^{-1}). Although topsoil texture did not significantly affect mean experimental yield it did influence response to additions of both nitrogen (N) and potassium (K) fertiliser. Least responsive were fine silty soil and peat. (Webster, and Hodge, with Draycott and Durrant, Broom's Barn)

Supporting laboratory work

Particle-size and chemical analyses

Approximately 900 horizon samples from 200 profiles sampled in current mapping and basic research projects were analysed in the Headquarters laboratory using the methods given in *Soil Survey Technical Monograph* No. 6. (Bascomb and Thanigasalam)

Mineralogical analyses

The constitution of 141 clay (<2 μm) separates was determined using X-ray diffraction, cation-exchange capacity and non-exchangeable K_2O measurements, as detailed in *Soil Survey Technical Monograph* No. 6. Most samples were from current mapping areas: others were analysed for the Stagnogley project or to extend information on the mineralogy of widespread argillaceous parent materials. (Bullock and Mrs. P. C. Murphy)

Micromorphology

One thousand thin sections of soil samples were made, of which 250 were described in detail and the remainder added to the reference collection. Most descriptions were made to aid soil identification in current mapping projects, and others for basic research projects. (Bullock, C. P. Murphy and Tipping)

Water release characteristics

Water release characteristics were determined for 540 core samples from 48 profiles, including many important soil subgroups, and representing most regions of the country.

Data for many soil series and subgroups can now be provided in both tabular and diagrammatic form. (Hall and Ward)

Special surveys

A soil survey of the Duchy of Lancaster Needwood Forest Estate, 2914 ha, was made as part of the detailed soil survey of the 1:25 000 Sheet SK 12 (Draycott in the Clay). At the request of the Surveyor of Lands for the Duchy, a hand coloured soil map at a scale of 1:10 560 was prepared from the field sheets and a report written describing all the borings made on the estate, as well as the soils in relation to agriculture, and making recommendations for amelioration and potential use. (Jones)

Soil mapping has started on the Bishop Burton College of Agriculture farms, which lie at the foot of the chalk dipslope where the Holderness tills feather out on to the Wolds. Soils range from fine loamy over clayey argillic stagnogley soils on till to shallow brown

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earths and stony rankers on chalk. The map should be useful in planning long-term experiments on typical soil of both the Wolds and Holderness. (Furness and S. J. King)

About 23 km² of alluvial lowland was mapped around Oldbury-on-Severn, Avon. This area has recently been extensively improved by drainage financed by a European Economic Community grant, and it is thought that this will lead to changes in land use. The soil map provides additional physical information for formulating a new agricultural policy in the district. (Colborne)

A map and account of the soils and their land use capability were prepared as part of a management plan for Dartington Hall Estate, Totnes. The most widespread soils are Highweek, Dartington and Ivybridge series over Devonian slate and Ogwell and Torbryan series on limestone. It was from Dartington that the first soil survey work in Devon was carried out by J. B. E. Patterson in the 1930s. In the present survey his units in unpublished work were related to current concepts of soil description and classification. (Harrod)

Other work

The soils at an experimental farm waste disposal site at Colomendy Farm, Caerleon, Gwent, were examined at the request of the Divisional DWSO. Two profiles were described and sampled for bulk density determinations. (Wright)

Trench profiles were examined along the eastern part of the Shell Almwch–Ellesmere Port oil pipeline. (Thompson)

Pipeline trenches excavated by the Wrexham and East Denbighshire Water Co. near Wrexham also provided useful information for soil reconnaissance. (Lea)

The first of a series of deep borehole transects across the Vale of Pickering was made in conjunction with the University of Hull. It is hoped that the information obtained will add to the glacial history of the Vale, in particular the extent of the Wykeham moraine beneath post-glacial deposits. (S. J. King, with Mr. A. Edwards, University of Hull)

The stratigraphy of the Little Ouse rodham near Shippea Hill, Cambridgeshire, representing a previous bed of the river, was recorded and sampled from a drain section. (Seale)

Four meetings concerning the soils and agriculture of Downlands, High Weald, Low Weald and Marshlands of Kent were arranged by ADAS to discuss land capabilities, advisory and research problems with farmers, and to promote understanding and use of soil surveys. Annotated monoliths, maps and other visual aids were used to outline general features and explain the classification, occurrence and relationships of the main soils. Each farmer provided information about the principal soils and their proportions on his farm. (Green and Fordham)

Field excursions were arranged and conducted for the British Soil Science Society meeting at Bangor, the Soil Science Committee of the Joint Consultative Organisation, a party from Heidelberg University and for many MAFF officers in all regions.

Exhibitions of the work of the Survey were prepared and shown at the Great Yorkshire Show, the National Sugar Beet Spring Demonstration, the Conference of the Association of Teachers of Geology and the Chelmsford and Essex Museum. Advice and assistance was given to many organisations including:

1. ADAS Regional Geochemical Liaison Committee
2. Broom's Barn Experimental Station
3. Grassland Research Institute
4. Letcombe Laboratory
5. Weed Research Organisation

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6. Scottish Horticultural Research Institute
7. British Sugar Corporation
8. Rural Environment Studies Association
9. Rural Planning Services Ltd
10. Forestry Commission
11. Department of the Environment
12. Cheshire County Planning Department
13. Worcester and Hereford County Council
14. Severn-Trent River Authority
15. Southern Gas Board Scientific Service Unit
16. Building Research Establishment
17. Geochemical Reconnaissance Group, Imperial College
18. York Archaeological Trust
19. Humberside Archaeological Committee
20. Exeter University Archaeology Department
21. Oxford Archaeological Unit.

A set of 48 monoliths representing the major soils in England Wales, each identified in accordance with the current classification system, were collected and prepared for exhibition, in the first instance for a meeting of Survey staff at Silsoe in December. Field and laboratory data relating to each soil were compiled for easy reference. (Avery, Bascomb, Loveland with Regional Staff)

Twelve maps were published including a *Soil Map of England and Wales* at 1:1 000 000, the last of the 1:63 360 series, that for Malmesbury and Bath and the first of the new County series, that for Berkshire. Thirty maps are in preparation.

In addition, approximately 600 miscellaneous drawings were completed for Survey publications, scientific journals and magazines. Many photographic prints were supplied and display material for agricultural shows and scientific meetings prepared. (Thomson)

Nine *Records*, one *Memoir*, one *Special Survey* and one *Technical Monograph* were published. Two *Memoirs*, 12 *Records*, one *Special Survey* and one *Technical Monograph* are being published.

Staff

P. Bullock attended a meeting of the International Working Group on Soil Micromorphology at the University of Poitiers and led a session on the micromorphology of soil organic matter.

B. Clayden visited West Germany for three weeks to study German soil survey organisations.

R. Webster visited Wageningen, Netherlands, to study the application of general data base management systems to soil survey data and to take part in the International Working Group on Soil Information Systems.

The Regional Office for South-west England has been moved to Long Ashton Research Station, in a sense a home-coming since the station was one of the original centres of soil survey in Britain.

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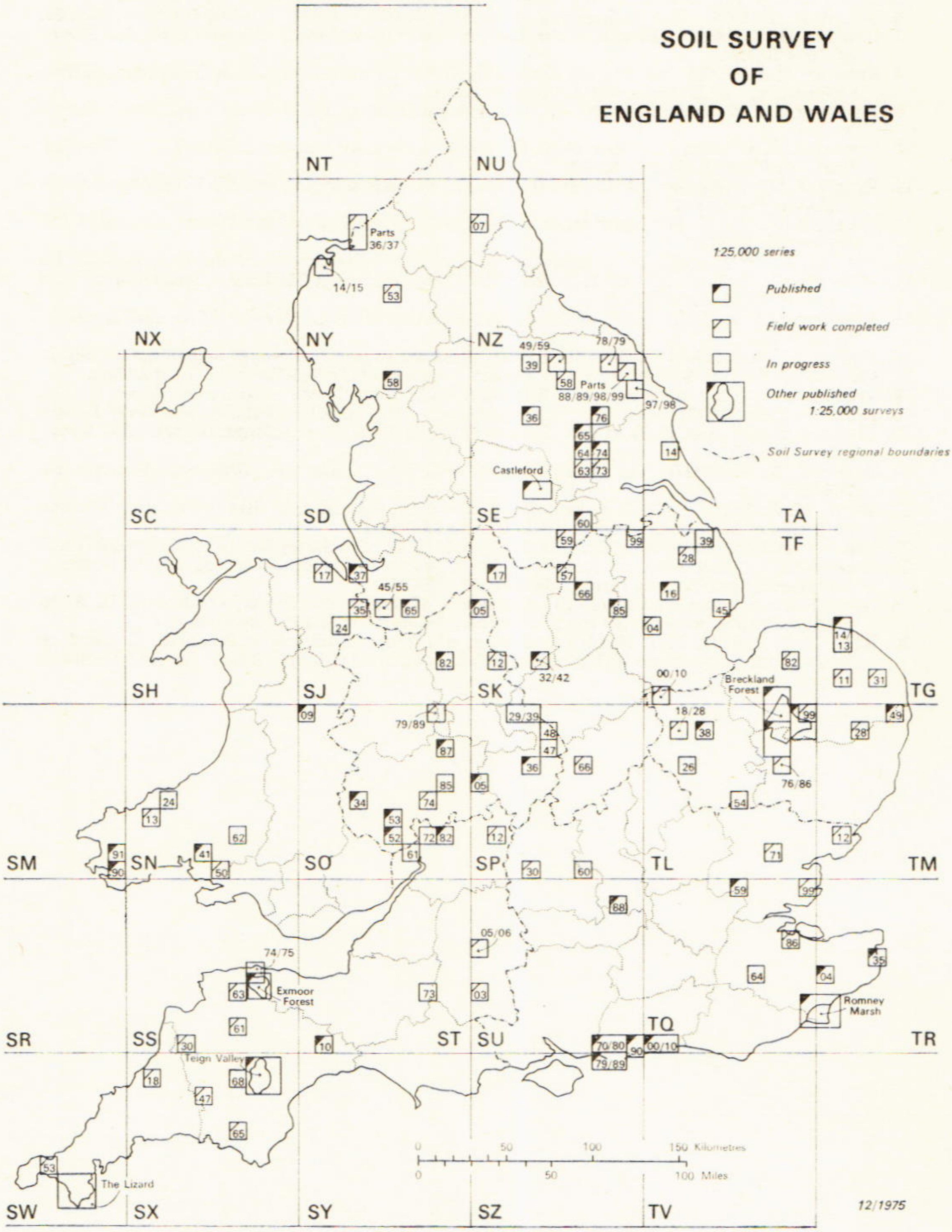

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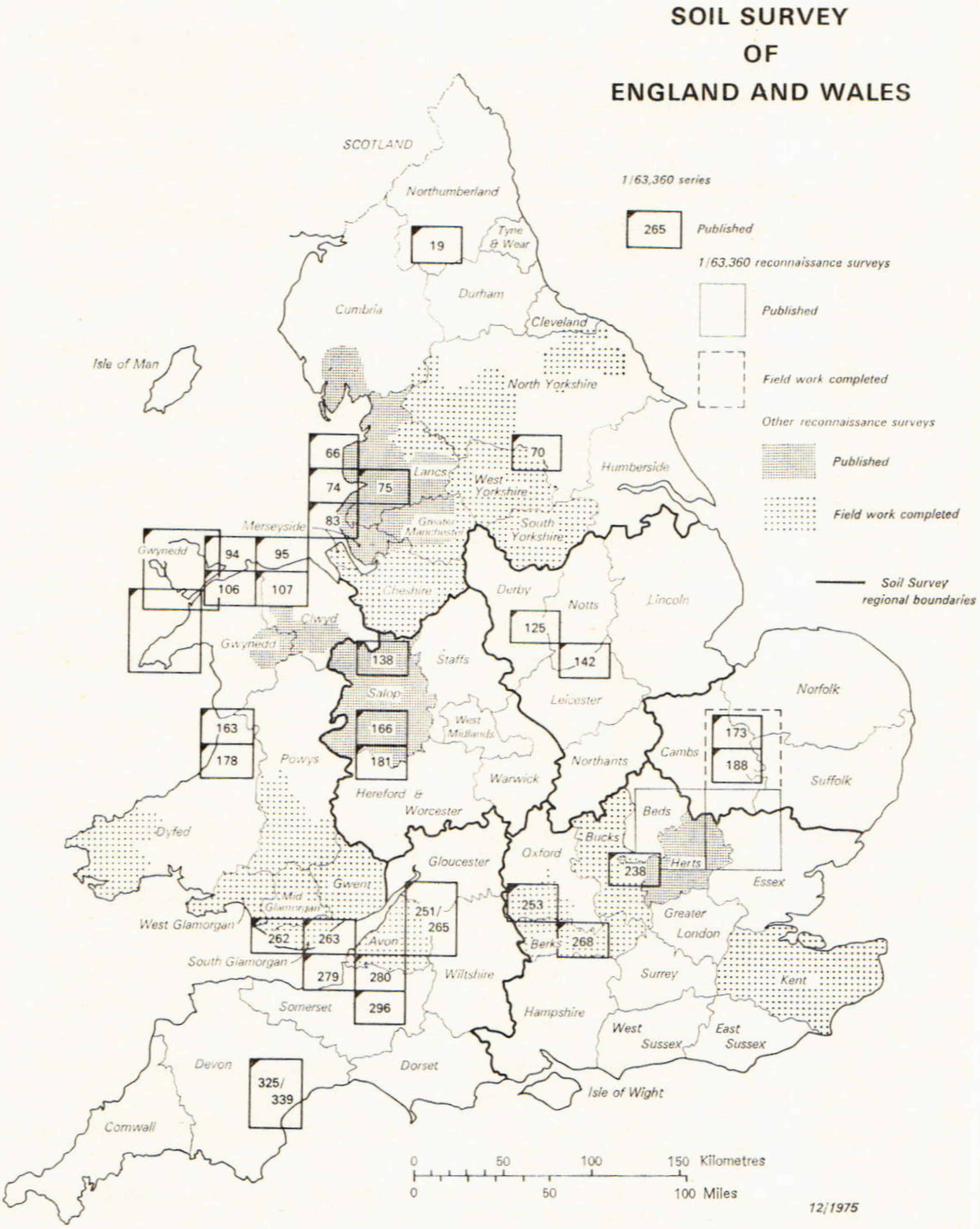

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