Report for 1980 - Part 1

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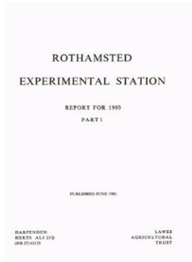
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REPORT FOR 1980
PART 1

Soil Survey of England and Wales

D. Mackney

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SOIL SURVEY OF ENGLAND AND WALES

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Introduction

A long-term programme for the Survey has been the subject of intensive discussions with MAFF. The scientific and practical aspects of the survey's work were reviewed and new proposals for mapping after April 1982 were presented to the Chief Scientist, MAFF. Briefly the proposals combine a national objective to complete general purpose maps at a scale of 1:50 000, with local objectives to survey in detail for specific purposes.

Remaining individual projects in the 1:25 000 map series have been completed and some 30 draft manuscripts await editing at regional centres. It is particularly gratifying to report this progress since staff released from the current national map project in April 1982 will be free to start the new programme referred to above.

A *Soil Suitability Map for Grassland* has been published. This is the fourth of a series of maps of England and Wales at a scale of 1:1 000 000. The classification was developed to aid assessment of the potential of land for grass production and utilisation, and to balance the effects of the Land Use Capability Classification which downgrades much productive grassland.

A *Technical Monograph* on Soil Classification for England and Wales (higher categories) has been published, bringing together in convenient form several internal documents used by staff in applying the classification to subgroup level. The new *Monograph* containing details of differentiating criteria, and definitions of classes, will be a vital companion document to the national *Soil Maps* and *Bulletins* scheduled in the Survey's publication programme.

Progress has been made in planning a common soil information system for several Services of ADAS and the Soil Survey, capable of being interrogated by all participating agencies. A joint working group has identified the data required by the participating agencies and estimated computer costs involved in establishing the system.

Despite the high priority given to the national map programme staff have been involved in many special surveys and consultations with our customers in MAFF and our colleagues in ARC. Consultations with public and private bodies concerned with land use have continued and some have led to contracts. The range of consultancy is illustrated by the following list of co-operating agencies: National Coal Board, County Planning Authorities, Universities, Central Electricity Board, Thamesgro, Severn-Trent Water Authority, Hydraulics Research Institute, and several civil engineering consultants. It is our continuing aim to extend the field of consultations so that soil surveys contribute increasingly in the land use field.

National map programme

Field-work on the 1:250 000 National Map Project continued steadily throughout the year. The mild spring and wet summer provided almost ideal surveying weather except in upland Cumbria where some days were lost by persistent heavy rain. Soils remained moist and easy to dig and auger even in the east where normally work can be difficult during late summer and autumn. Overall the programme is on target but in the South-east and East Anglia Regions progress has been slower than planned partly because of staff moves and commitments to other work. All but two of the field staff have been almost full-time on the project so during the year 312 man/months have been spent on the programme and approximately 32 000 km^2 were surveyed. Altogether, since the programme started in April 1979 49 000 km^2 have been covered, that is 63% of the previously unsurveyed land of England and Wales. Field-work is most advanced in Wales and the North where survey of previously unmapped areas is now almost complete (Fig. 1.) The second stage of survey, the revision of previous reconnaissance, started in south Wales in November.

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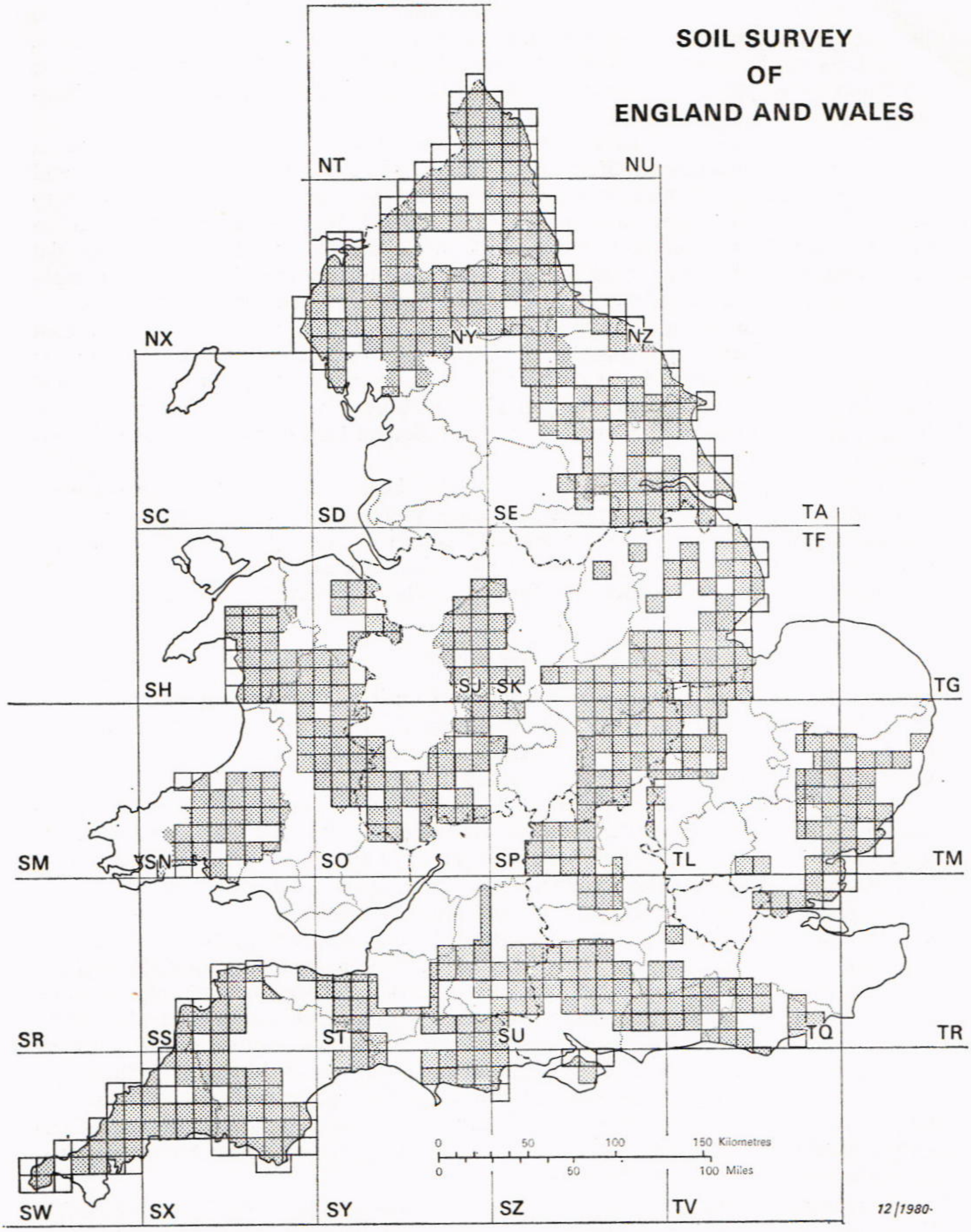

FIG. 1. Progress of the 1:250 000 mapping programme.

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The number of descriptive *Memoirs* with accompanying maps it is intended to publish has been reduced to six to conform with the reorganisation of MAFF into six regions.

Progress on the construction of the Land Classification map has been slow because the Ministry has yet to ratify proposals for a new National Agricultural Land Classification.

The list of provisional map units set up at the beginning of the survey has been a valuable working document. Of the units recognised, 250 cover substantial areas and there are a further 180 minor ones, many of which may prove too small in extent to show on the map at the publication scale of 1:250 000. Working parties on correlation at the annual Survey meeting at Swanwick in January contributed to a substantial reorganisation of the units on the original list, and rationalisation of soil series, currently under consideration, will reduce still further the number of units on the final map.

Areas in Northumberland, Cornwall, the Welsh Borderland and in East Anglia/East Midlands where surveying is complete are being used to test legend format, cartographic style and map symbols. Model drafts of various chapters of the proposed regional memoirs have been written by senior staff. Cross-border correlation of map units has been achieved with the Soil Survey of Scotland, despite the different soil classifications used by the two Surveys.

Samples for the National Soil Inventory have been collected from approximately 2000 of the 6000 proposed sites; these have been pretreated for analysis at Rothamsted and measurement of organic carbon content has started. Computer processing of profile descriptions from inventory sites is now under way. (Hodgson)

The following regional reports give further details of the year's progress.

East Anglia

Field-work started in February and continued until mid-June when standing crops prevented efficient working until harvest. In the autumn the ground was noticeably drier and field-work more difficult on the boulder clays of south Suffolk than in west Cambridgeshire until soils rewetted in October.

Some 3800 km^2 were surveyed during the year. In west Cambridgeshire and Bedfordshire 1250 km^2 were mapped comprising sheets TL06, 16, 18W, 27, 36W, SP85, 86, 95, 96, 97, 92, 93 and 94, the last three being sheets linking previous small-scale surveys in Buckinghamshire with the reconnaissance soil map on the 1 in./1 mile 7th Edition Sheet 147 (Bedford and Luton). In this area the main map unit consists of calcareous pelosols on Chalky Boulder Clay (Hanslope series) although small areas with pelo-stagnogley soils (Ragdale series), especially near the Buckinghamshire boundary, and stagnogleyic argillic brown earths (Ashley series) have been separated. Soils in adjoining vales are more mixed, the most characteristic being a calcareous pelosol on Jurassic clay (Evesham series), but stagnogleyic and gleyic brown soils are as common. Brown rendzinas (Sherborne series) and calcareous pelosols (Evesham series) are co-dominant further west where Jurassic limestone is interbedded with clays. Ferritic brown earths (Tadmarton series) occur on the Jurassic ironstone workings whilst the river floodplains are universally pelo-alluvial gley soils, calcareous in the west (Thames series) but more often non-calcareous (Fladbury series) in the east.

In mid-Suffolk 1500 km^2 have been surveyed between the Essex border along the Stour, and the Waveney and Little Ouse marking the boundary of Norfolk, mainly in areas covered by Chalky Boulder Clay or related weathered products. Sheets TL72E, 73E, 74E, 77E and 78E adjoining previous reconnaissance surveys on 1 in./1 mile 7th Edition sheets 135 (Cambridge and Ely) and 148 (Saffron Walden) together with TL87, 93, 94, 95, 96, 97, 98 (pt), TM03 (pt), 07, 13 (pt), 14, 15, 17, 23 (pt) and 25 have been com-

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pleted. North of the A45 Bury St Edmunds–Ipswich road the Chalky Boulder Clay plateau has typical stagnogley soils (Beccles series) with calcareous pelosols (Hanslope series) on the steeper slopes. South of the A45 the plateau soils are stagnogleyic argillic brown earths (Ashley series) but with some typical stagnogley soils (Beccles series) appearing in the south-east. Again Hanslope series dominates the steeper valley sides. South of a line between Sudbury and Woodbridge the plateau surface carries stagnogleyic paleo-argillic brown earths and paleo-argillic stagnogley soils (Hornbeam and Oak series), occurring in deeply weathered till. On the eastern fringe of Chalky Boulder Clay terrain is a narrow zone of clayey argillic brown earths; a similar zone with argillic brown earths and stagnogleyic argillic brown earths (Ashley series) borders the Little Ouse–Waveney valley at the Norfolk county boundary. In south Suffolk, typical and stagnogleyic paleo-argillic brown earths (Bradfield and Tendring series) occur on flat gravel plateaux overlain with sandy silt loam Coverloam.

In Essex the pelo-stagnogley soils (Windsor series) with non-calcareous pelosols and typical stagnogley soils (Althorne and Wickham series) are associated with London Clay. On adjoining higher ground an argillic brown earth unit and a typical argillic gley soil unit of variable composition occur. The Thames marshes are predominantly pelo-alluvial gley soils (Wallasea series).

Near Southwold on the coast of East Suffolk, soils of the sandland areas are dominantly typical brown sands (Freckenham series) with areas of typical (humo-ferric) podzols (Redlodge series) under heath or woodland. The adjacent Chalky Boulder Clay has a subdued featureless surface and is mainly a typical stagnogley soil unit (Beccles series).

The surveys on either side of the Midlands–East Anglia boundary have been correlated, and a preliminary legend and field boundaries transferred to the 1:50 000 scale for a block of mapping to the north-west of Cambridge. A similar legend and outline map is being prepared from the Norfolk 1:100 000 survey. (Hodge and Regional Staff)

The Midlands

Eighty-five 1:25 000 maps covering 8000 km^2 have been completed. (Areas of sea and previously surveyed land account for 500 km^2.) Approximately 350 National Soil Inventory sites were described and sampled while another 30 soil profiles have been described in detail in order to characterise some of the 1:250 000 map units.

In the western Midlands field-work has again been concentrated in peripheral areas of southern Hereford and Worcester and north Staffordshire where correlation was necessary with established county mapping in adjacent Gwent, Gloucestershire and Derbyshire. Work is now complete in Herefordshire and only southern Staffordshire and parts of north Worcestershire close to the West Midland Metropolitan County remain to be surveyed. Most soil patterns are as described for 1:250 000 mapping 1979 or those encountered in previous detailed surveys. No new soil series have been reported.

The survey of most of southern and eastern Lincolnshire is now complete. Near the coast, high quality land is associated with the silty Wisbech series but further inland clayey Wallasea soils are dominant. The soils in coastal alluvium of north-east Lincolnshire are fringed by the fine loamy Holderness series on Devensian till. Contrasting upland areas of Lincolnshire include (a) the Chalk Wolds where Andover series is dominant, often associated with argillic brown earths in thin clayey Devensian till; (b) Jurassic limestone escarpments in the Wolds dominated by the Murton series but with argillic or typical brown earths on patches of loamy drift; (c) Jurassic Clay vales where loamy over clayey soils exemplified by Rowsham series preponderate especially

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on the borders of Lincolnshire and Leicestershire; (d) areas of Wolstonian (Chalky) till east of Melton Mowbray and north of Lincoln with Beccles and Ragdale series.

With the exception of small areas to the east of Banbury, survey in Northamptonshire is now complete. Work continued adjacent to areas mapped in 1979 on Jurassic rocks to facilitate the correlation of soils on complex geological successions in the Welland valley and the Kettering district. Evesham and Sherborne soils are extensive along the valley sides with subordinate inclusions of coarse loamy soils associated with outcropping sandy beds. The soil pattern on the more extensive Northampton Sand and Ironstone is dominated by the Banbury and Irondown series with coarse loamy Tadmarton soils at higher elevations. Long Load, Belvoir and Martock series occur on the Upper and Middle Lias silt and clay shale outcrops, while in east Warwickshire Denchworth, Rowsham and Lawford soils are prevalent on Lower Lias sediments. Most of the high ground is capped by chalky till where the Hanslope, Ragdale, Beccles and Ashley series are common. To the south and east of Rugby, Salop and Crewe soils developed in reddish till are extensive.

Soils developed in a variety of drift deposits and a wide range of solid lithologies from Pre-Cambrian volcanics to Oxford Clay were also encountered in southern Leicestershire. Most of these have been described but in Charnwood Forest, earlier unpublished mapping and new work indicate a dominance of Abbey and Salop series in drift with subsidiary Iveshead soils on outcrops of volcanic tuff. (Ragg and Regional Staff)

Northern England

During the field season all but about 500 km² of the remaining 12 000 km² of unsurveyed land in the region were mapped in Cumbria, Durham, Cleveland, North Yorkshire and Humberside. The aim of working nearer to the Soil Survey Centres was generally followed, although the exigencies of upland weather and lowland cropping caused divagations.

Of the 200 map units reported so far in the north, 16 are widely distributed, 13 of which reflect patterns of soils in deep drift deposits and three involve soils passing more or less directly to bedrock. Seven of the main map units in deep drift represent patterns of soils in clayey or fine loamy glacial till in the stagnogley, stagnohumic gley and brown earth soil groups. Some are in materials derived from Triassic or Carboniferous red beds, but the majority are more yellowish. Another four map units involve coarse loamy, brown earth and cambic gley soils in glaciofluvial drift. A further unit is in sandy and coarse loamy drift and comprises brown sands with brown earths, and related gley soils. In addition there is an upland map unit consisting almost exclusively of raw peat soils.

Of three map units representing soils developed over bedrock, two have typical brown earths over sandstone dominant. One unit has no important associate but the other is accompanied by a brown podzolic soil over sandstone and a brown earth passing to shale. The third unit is dominated by a stagnopodzol in association with a ranker and a podzol, all on sandstone.

Stagnohumic gley soils in glacial drift and peat soils occupy the high plateaux and upper slopes of the Pennines. Soils over bedrock are mainly on steep slopes near plateau edges and on valley sides. Non-humic soils in glacial drift extend from the foothills to the coast and are overwhelmingly dominant throughout the north-eastern lowland, from Northallerton to the Scottish border. The soils in the coarser, glaciofluvial drifts are confined to depressions within the lowlands.

Less widely distributed but locally important map units in the Lake District and the Cheviots comprise lithomorphic, podzolic and surface-water gley soils over lavas and

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granite or associated drift, and over the chalk of the Yorkshire Wolds rendzinas and brown calcareous earths.

Identification and mapping problems have mainly centred in the north-eastern lowland, where amount of clay, the depth at which it is encountered, the extent to which clay eluviation has occurred and the degree of soil redness vary around critical limits within the soil classification system. (R. A. Jarvis and Regional Staff)

South-east England

A further 3800 km^2 have been surveyed during the year in Oxfordshire, Hampshire, Isle of Wight and East and West Sussex.

The varied lithology and land use in districts over Tertiary strata and related drifts has made differentiation of consistent map units difficult. Drier land associated with the more sandy formations is commonly characterised by typical brown sands (Frilford series) and loamy stagnogleyic argillic brown earths (Bursledon series) where cultivated, or by typical podzols (Shirrell Heath and Southampton series) and stagnogley-podzols (Rapley and Holidays Hill series) on heathland. Wettish low landscape sites have ground-water gley soils. Typical stagnogley and pelo-stagnogley soils predominate where soils develop in strata of mixed or clayey lithology.

Soil patterns of the Hampshire chalklands have proved predictable and uniform over large areas with fine silty brown rendzinas (Andover series) on gentle and moderate slopes, and fine silty over clayey typical paleo-argillic brown earths (Carstens series) on interfluves capped by 'clay-with-flints' being the two most extensive classes. The larger river valleys have earthy eutro-amorphous peat soils (Adventurers' series) and related calcareous humic-alluvial gley soils.

Soils associated with the Upper Greensand have been surveyed in several counties and they are everywhere characterised by a large fine sand and coarse silt fraction. Assessment of their wetness class remains uncertain, however, and dip-wells have been installed near Selborne to monitor height and duration of waterlogging.

Substantial areas of the Lower Greensand outcrop in the Weald are common lands with sandy typical podzols and brown sands; the most frequent soils of cultivated land are coarse loamy over sandy, typical argillic brown earths (Barming series) with finer analogues, typical brown sands and locally wetter soils. Similar associations occur on the Isle of Wight.

The Weald Clay lowlands of the western Weald have moderate relief and the presence of extensive loamy Head and sandstones intercalated between the clays gives map units dominated by typical stagnogley soils and stagnogleyic argillic brown earths as well as pelo-stagnogley soils. Typical argillic gley soils are common in low landscape sites.

In the High Weald, fine silty stagnogleyic (argillic) brown earths (Curtisden series) together with cambic stagnogley soils (Cranbrook series) and typical (argillic) brown earths of similar lithology are developed over Tunbridge Wells and Ashdown sands with typical stagnogley and pelo-stagnogley soils over associated Wealden clays and Head. Stagnogley-podzols are frequent on the heathlands of Ashdown Forest and other similar terrain. (M. G. Jarvis and Regional Staff)

South-west England

Mapping in east Devon extended the patterns of soils established around Honiton to adjoining areas of plateau drift and Upper Greensand. Where Greensand overlies Lias clay around Axminster the narrow springline is replaced by a broader zone of slumped ground in which soils are derived from a mixture of Greensand and soliflucted

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plateau drift and loessic silt. As around Honiton, the Axe valley has loamy stagnogleyic brown earths in thin drift over marl and non-calcareous pelosols in more dissected parts. On the Lias clay, loamy drift is sparse and pelo-stagnogley soils are common.

In south Devon brown earths predominate over slate but brown podzolic soils are sufficiently extensive to map on slopes where valleys converge near the coast, notably between Kingsbridge and Dartmouth. Brown podzolic soils also occupy much of the Dartmoor fringe between Buckfastleigh and Ilsington. On basic igneous rocks, brown earths predominate south of Totnes. Few hydromorphic soils occur in south Devon, but there are ground-water gley soils in a belt of wet land over the Staddon Grits on high ground between Modbury and Morleigh. Around Torbay brown rankers predominate on limestone and brown earths on limestone breccia. On the 130 m coastal platform near Salcombe there are typical argillic brown earths and on surrounding slopes brown earths and rankers.

On eastern parts of Dartmoor, much of which is enclosed farmland, typical and humic brown podzolic soils are dominant in association with granitic rocks. Moorland to the north and east of Widecombe has ferri-humic podzols under either heather or acid grassland often dominated by bristle-leaved bent. Around Moretonhampstead and Chagford, on unenclosed commons where the ground is particularly bouldery, ferri-humic podzols predominate and much is overrun by bracken and gorse. Spring sites have ground-water gley soils with localised flush peats at higher altitudes.

In the Jurassic clay vales of Somerset and Wiltshire loamy over clayey typical stagnogley soils are common in thin drift over clay. The Vale of Taunton Deane includes extensive drift deposits over red mudstones and sandstones; stagnogleyic and gleyic argillic brown earths cover the former and typical argillic brown earths the latter.

Upper Greensand soils are mainly glauconitic loamy gleyic argillic brown earths but non-glauconitic gleyic soils occur south-west of Devizes and Sturminster Newton. Typical brown sands and gleyic argillic brown earths occur over ferruginous rocks around Bromham and Calne. Typical brown earths in Chert Beds around Warminster include patches of paleo-argillic brown earths and podzols.

Over the Lower Chalk outcrop shallow grey rendzinas on knolls give way to fine silty to clayey brown calcareous earths in valley bottoms and on wide benches. Gleyic brown calcareous earths occur on the bench south-west of Swindon and around Warminster, with cambic gley soils by streams in valley bottoms.

Soils on the chalk of Salisbury Plain and in Dorset are dominantly brown rendzinas. One map unit on higher interfluves includes patches of humic rendzinas, paleo-argillic brown earths in clay-with-flints, and brown calcareous and argillic brown earths in high-level coombe deposits. Another in more dissected country north and south of Salisbury includes grey rendzinas which also form a map unit on the dissected sides of the main river valleys. Away from settlements there are large areas of humic rendzinas.

Most of the extensive Bagshot Beds country is or was, until recently, heathland and podzolised soils preponderate. Ill-drained sandy gley-podzols and stagnogley-podzols are most frequent whilst many broad depressions have humic-sandy gley and peat soils. Well drained stony paleo-argillic podzols are found on many of the plateau gravels. The London Clay outcrop, often covered by thin loamy drift, is marked mainly by typical stagnogley soils. Better drained stagnogleyic argillic brown earths are common but are rarely sufficiently extensive to separate as a distinct map unit. The sinuous Reading Beds outcrop has a very complex soil pattern; although brown sands are found, typical brown earths and argillic brown earths probably dominate. The chalk outcrop adjacent to the Reading Beds usually carries a thin cover of drift in the thicker parts on which there are loamy argillic brown earths; brown rendzinas and brown calcareous earths predominate where the drift thins.

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Drift deposits are widespread in the Frome valley. Deep soils over low terrace gravels are loamy brown earths near Dorchester whilst around Wareham and Poole brown sands are common. Loamy paleo-argillic brown earths are found on low plateau gravel deposits. Higher up the Frome valley the soils of the higher terraces are silty paleo-argillic brown earths. (Findlay and Regional Staff)

Wales

The survey of all the remaining 1:25 000 maps, covering some 5400 km², has been completed. Pilot studies have also been done to assess the effort needed to update existing soil maps at a variety of scales. The main work was concentrated this year in mid and north Powys, central and southern Dyfed, southern Gwynedd and Clwyd.

In Powys ten sheets were surveyed. On Lower Palaeozoic rocks below about 400 m, fine loamy typical brown earths and brown podzolic soils are most common, whilst above this altitude stagnopodzols and stagnohumic gley soils occur extensively. Smaller areas of peat soils were found on plateaux and in enclosed depressions. Fine loamy stagnogley and stagnohumic gley soils occur widely in the east of the county on thick drift north of Llandrindod Wells. The landscape often shows signs of periglacial activity in the form of kettle holes and pingos in valleys, and solifluction terraces in the uplands and on the flanks of large valleys. Profiles with clayey lower horizons are more common than was expected.

In Dyfed 21 sheets and ten part sheets were surveyed. The soils are derived from rocks of Lower Palaeozoic, Devonian and Carboniferous age and from glacial, fluvio-glacial and recent deposits in valleys and around the coast. Differences were noted in soil patterns from those previously reported: broad interfluves above 200 m near the former Carmarthen–Pembrokeshire border carry cambic stagnohumic gley soils in Head and residuum in close association with humic brown podzolic soils (Parc series). These cambic stagnohumic gley soils are frequently favoured for cereals, having a large available water capacity resulting from the humose topsoil, yet field drainage is not required. The discrepancy between gley morphology and apparent lack of soil wetness is being investigated with dip-wells and core samples. The dipslope of the Black Mountains where Millstone Grit quartzites are extensive carries a complex assemblage of typical podzols, typical gley-podzols, stagnohumic gley soils, humic rankers and bare rock. Much of the Lower and Middle Coal Measures is covered by till, with stagnohumic gley soils (Wilcocks series) and stagnogley soils (Brickfield series); typical brown earths (Neath series) occur on sandstone hills. Clayey drift in the Teifi valley and northwards towards New Quay gives rise to significant areas of pelo-stagnogley soils (Hallsworth soils). Marine alluvium of silty clay loam or silty clay texture with occasional coarser bands is extensive inland from the dunes around Carmarthen Bay. Typical, pelo- and calcareous alluvial gley soils have been identified.

In Gwynedd and Clwyd field-work for 18 sheets was completed. Soil sequences on the Palaezoic rocks are similar to those reported for Powys and Dyfed. The estuarine flats of the Mawddach and the Dysynni have large spreads of peat soils beginning about 1 km from the coast. In the Dysynni estuary, typical sandy gley soils are formed near the coast in blown sand, whilst the marshlands around Fairbourne have mainly pelo-alluvial gley soils (Wallasea series). (Rudeforth and Regional Staff)

1:25 000 mapping programme

Progress with the remaining sheets in this programme is given in Table 1.

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TABLE 1

Progress of 1:25 000 mapping

Region	Map no.	Soil	Land capability
East Anglia	TL34	Complete	To be finalised
	TL54	Complete	To be finalised
	TM06	Complete	
Midlands	SK00/10	Complete	Complete
	SK99	Complete	To be finalised
	SP25/35	Complete	To be finalised
	SP27/37	Complete	Complete
	TF36	Complete	To be finalised
	TF39	Complete	Complete
	TF45	Complete	To be finalised
North	NY14/15	Complete	Complete
	NY56	Complete	Complete
	SE47	Complete	In preparation
	SE85	To be finalised	
	SE97N/98S	To be finalised	
	TA14	Complete	In preparation
South-east	SP60	Complete	Complete
	TL83	Complete	In preparation
	TQ05	Complete	In preparation
	TQ64	Complete	In preparation
South-west	Lizard	Complete	Complete
	SO72	Complete	In preparation
	SS74	Complete	Complete

1: 1 M grassland suitability map

A method of assessing soil suitability for grassland is described in *Soil Survey Technical Monograph* No 13. Interactions of soil conditions with climate are rated as *potential grassland yield category* and as *trafficability/poaching risk category*, the latter being a measure of the ease with which the crops can be managed and used. To do this a small number of properties observed during soil survey, or their derivatives, are applied to place the soil in its appropriate category. Yield category is based on the soil moisture regime which expresses the balance between climatic summer dryness and profile available water. For grassland suitability this assessment is modified in moist western districts of England and Wales and in areas with short growing seasons. Trafficability/poaching risk category assessment involves integration of the retained water capacity of the surface soil with profile properties of wetness class and depth to impermeable layers. An additional climatic modification to express the likelihood of wet conditions during the growing season is then applied. Given yield and trafficability categories, overall suitability is then classified in terms of potential yield and how readily ground conditions permit its utilisation. Classes are as follows:

Class A *Soils well suited to pasture*, high potential yield being readily achieved.
Class B *Soils suited to pasture, with only minor limitations* as small imbalances of yield and trafficability.
Class C *Soils suited to seasonal pasture* with serious imbalance of yield and trafficability.
Class D *Soils ill-suited to pasture* with low potential yield and difficult ground conditions.

During construction of the map, grassland yield and trafficability categories, and hence grassland suitability class were determined for the dominant and associated soils on the legends of the 1:1 M Soil and Land Capability maps of England and Wales.

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The published map is shaded to show the grassland suitability class of the dominant soils of each delineation. Within class C there are five subdivisions. These are: high poaching risk; limited yield; restricted growing season in the uplands; steep slopes; limited yield with high poaching risk.

The country's better grassland soils tend to be on low ground in the west and in the Midlands. Much land in the north, east and south-east has its potential restricted both through soil and climate, while ill-suited land is widespread in the mountains.

Class A land is usually on deep, well drained, loamy and silty brown soils or brown podzolic soils, lowland peats and loamy ground-water gley soils, these being most extensive in traditional grassland areas in the lower parts of Wales, in the south-west and favoured parts of the north-west. The Fens and Humberhead levels form isolated enclaves of high potential in the east. Large areas of long established productive grassland fall into class B on brown soils with slight drought risk, podzolic soils and lithomorphic soils in less droughty districts, as well as many gleyic and stagnogleyic soil subgroups. This class occupies much of the Midlands as well as parts of Yorkshire and southern and south-western counties.

Class C land covers a variety of soils and climatic circumstances. Many traditional pastoral districts in the moist west and north have high potential yields, but being on gley soils have poor trafficability and are susceptible to poaching. These cover much of north-west England and the north Midlands on stagnogley soils over till, as well as areas of similar soils over clayey formations in the south-west. In drier districts, are droughty soils with good trafficability, on which grass growth is sometimes confined to spring and early summer. Included are coarse loamy or stony sandy or shallow brown soils as in East Anglia and the east Midlands, along with rendzinas over chalk in south-eastern counties. Many traditional grassland areas in the drier parts of the country have limited yield potential and poor trafficability; such land is on surface-water gley soils and pelosols with profile available water much less than the summer moisture deficits occurring in the Midlands, east, south-east and north-east of the country. In areas of improvable upland soils, the growing season is short and poaching and trafficability remain as limitations in soils with organic or humose topsoils even after drainage and cultivation. The map unit largely comprises stagnopodzols and loamy stagnohumic gley soils of the Pennines from the Peak District to the Scottish border. Sizeable areas of moderately steep and steep land (11–25°) have brown and brown podzolic soils. Management of such land, which occurs widely in Wales, is inhibited by considerations of both safety and mechanical efficiency of equipment. The ill-suited soils of class D combine limited yield potential with very difficult ground conditions. Soils are upland peats, stagnohumic and humic gley soils in the uplands of Wales, the Lake District and the Pennines.

With the 1:1 M map of Grassland Suitability, maps of ancillary information are published. A generalised map of Potential Grassland Yield at 1:3 M shows part of the data used in assessing Grassland Suitability class for the main map, and there are also maps of Permanent Grassland Distribution, Average Maximum Potential Soil Moisture Deficit (MD) and Autumn Flush at 1:4 M. Comparison of the main map with that of permanent grass (taken to include rough grazing) shows that much pasture is ill-suited to intensive use though grass is still the best of limited options. The MD map summarises data, which along with profile available water, are used to allocate dryness subclass. The map of Autumn Flush indicates the number of days before (or after) the end of the growing season in an average year, that well drained soils will return to field capacity. This identifies favoured western districts with good grass growth in late summer and autumn. The advantage is partly offset by increased susceptibility to damage by stock and vehicles on moist soil. (Harrod)

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Investigations of soil type/liver fluke interactions

The association of fascioliasis (liver fluke disease) in sheep and cattle with wet ground, through the ecology of the host snail (*Limnaea truncatula*) is well known. The purpose of this investigation is to assess the value of soil maps in identifying fluke-prone land. The area of study has been south Wales, south Dyfed in particular.

The snail prefers semi-permanently moist conditions, often in contact zones between wet and dry ground. The fluke, too, in the stages outside the host requires water for survival. The snail feeds on microalgae that grow on moist bare soil and habitats are commonly shallow pools and mud such as are found in wet areas trampled by livestock. Indeed the fact that livestock create favourable ground conditions for the snail is an important factor in the transmission of the disease. Few parts of the British Isles are too cold for the snail but there is a low incidence on acid peat, probably due to poor food supply. It can tolerate slightly brackish water but is absent from land regularly inundated by sea-water at high tide and will not tolerate water with a low oxygen content, as is found in stagnant pools rich in decaying organic matter.

In July 1979 a vacation worker was employed to map snail habitats in an area south of Carmarthen for which there is a detailed soil map (Clayden & Evans, 1974). The landscape comprises hills of Lower Palaeozoic and Old Red Sandstone shales, siltstones and sandstones, and lower slopes covered by thick till. Fine textured alluvium forms the river floodplains. Average annual rainfall is 1270 mm and the maximum potential soil moisture deficit 70 mm. Nine sample farms with a range of soil types were selected and each field was traversed at 10 m intervals so that every part of the ground was viewed. Four of the sample areas are depicted, showing soil boundaries and locations of snail habitats (Fig. 2).

Sample area 1 consists predominantly of the Milford series, a freely draining typical brown earth on a hill of Old Red Sandstone, without surface wetness. On a river floodplain the Hollington series is a typical alluvial gley soil with a groundwater-table that is near the surface for much of the year. Adjoining the floodplain on low ground is the Fforest series, a cambic stagnogley soil in impermeable reddish till with a perched water-table near the surface for long periods. No snail habitats were found on the drier Milford series and the greatest concentration was on the Hollington series where the ground was very boggy and the habitats large, occupying half a field or more. On the Fforest series only one habitat was found in a small area of poached, boggy ground.

Sample area 2 consists of the Milford series on hills, with the Fforest series on lower ground. Eleven habitats were found of which ten are on the Fforest series in ditches, flushes and boggy patches. The habitat on the Milford series is in some wet ground bordering a stream, too small to show on the soil map.

Sample area 3 is mainly the Cegin series, a cambic stagnogley soil in impermeable till from Lower Palaeozoic rocks, with a perched water-table similar to the Fforest series. Two low ridges of Old Red Sandstone with freely draining Milford series protrude above the till. Eight habitats were found, all on the Cegin series in ditches, flushes and boggy patches.

Sample area 4 consists mainly of the Sannan series, a stagnogleyic brown earth on Lower Palaeozoic shales which has impeded subsoil drainage but no prolonged surface wetness. Closely associated is the Denbigh series, a freely draining typical brown earth. A belt of wet ground shown as the Cegin series runs through the centre and on a floodplain there is the Conway series, a typical alluvial gley soil with a high groundwater-table similar to the Hollington series in sample area 1. Two small gravel terraces with soils of the Pibwr series rise above the floodplain. Four habitats were found, two on the Cegin series in flushes and two on the Conway series, one in a spring at the base of the gravel terrace and the other in a patch of boggy ground.

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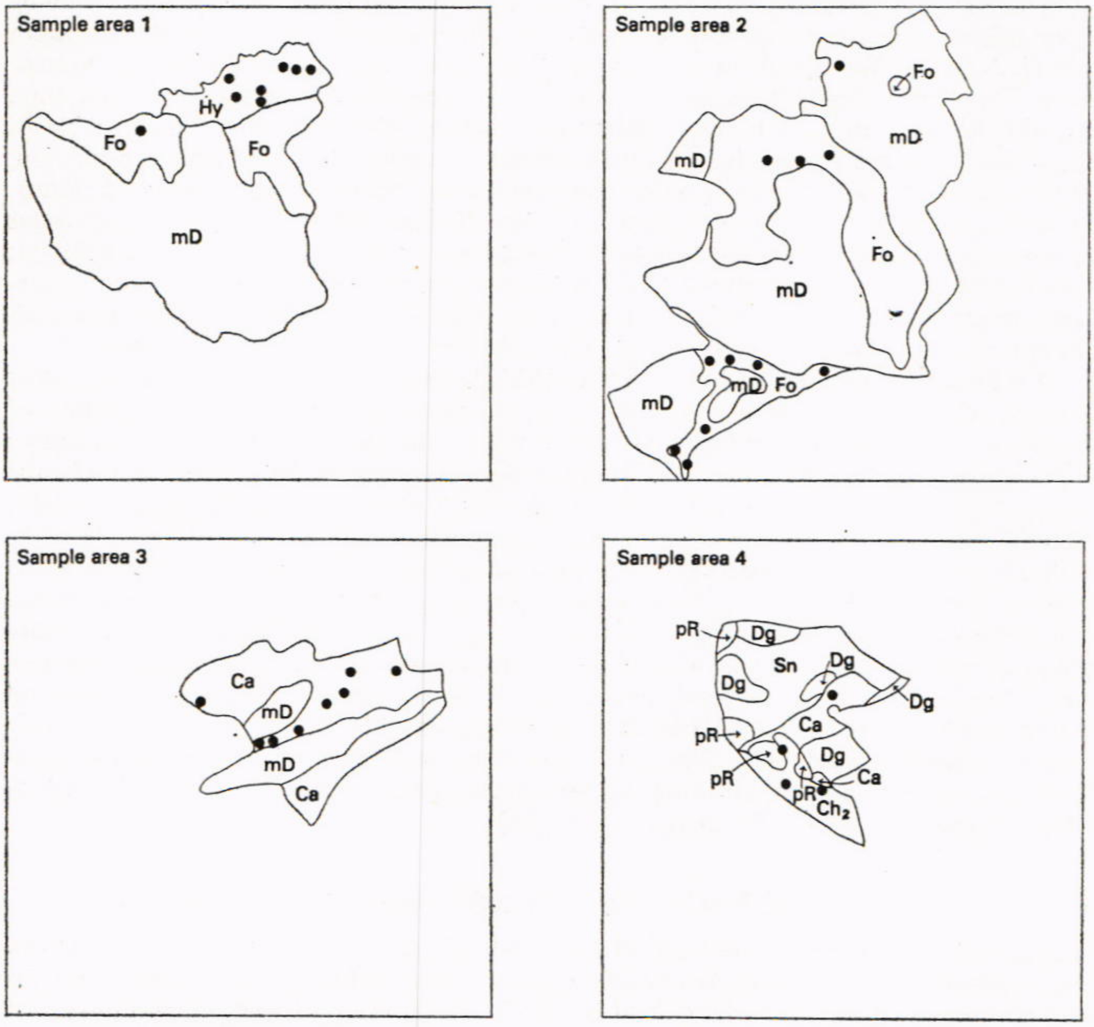

Ca	Cegin		Hy	Hollington
Ch_2	Conway Riverine phase		mD	Milford
Dg	Denbigh		pR	Pibwr
Fo	Fforest		Sn	Sannan

• Habitats

Note: Soil detail taken from SN41 Llangendeirne, soil map

0 1 km

FIG. 2. Habitats of liver fluke in relation to soil series.

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These four sample areas demonstrate a concentration of snail habitats on cambic stagnogley soils (Cegin and Fforest series) and typical alluvial gley soils (Hollington and Conway series). These are soils in wetness classes V (wet within 40 cm for more than 180 days) and VI (wet within 40 cm for more than 335 days) with a very high poaching risk, allowing livestock to create favourable conditions for the snail. It is also apparent that habitats are found only in restricted localities within these areas of wet soils, because lowering of the water-table in summer makes large areas too dry for the snail. Therefore, within the map units, it is only wetter sites (wetness class VI) which are capable of providing permanent snail habitats and effective environments for fluke transmission, although wet summers may provide opportunities for temporary extension of habitats. These wet sites are commonly ditches, springs, flushes, margins of ponds and water courses and other generally boggy patches. Vegetation is a reliable guide to likely habitats; in south Wales, marsh foxtail is a frequent component of habitats as are creeping buttercup, lesser spearwort and rushes. Similarly on drier soils, very localised habitats such as springs and flushes are often easily identifiable by strong vegetation contrasts.

It follows that detailed soil maps are potentially useful in advisory and management aspects of liver fluke control. The sample areas clearly demonstrate a concentration of habitats on the gley soil groups, confirming what is already known about the ecology of snails, but at the same time organising this information visually in terms of landscape relationships. The soil map shows fields and parts of farms at risk, making habitat identification easier and providing a guide for grazing management in periods when infection of livestock is expected to occur. On freely draining soil small localised habitats such as springs will often not appear on the soil map but they are usually easily identified on the ground. The assessment of fluke risk on peaty soils should be treated with more caution as habitats may occur where base status is raised such as by calcareous flushing from limestone outcrops or road foundations or by land improvement. The use of soil maps and techniques of standardised soil description offered in Soil Survey literature would provide research and advisory workers with a uniform method of habitat description and characterisation, allowing greater opportunities for correlation and identification of areas at risk from the disease. (Wright)

Salterns: collaborative work with archaeologists in Lincolnshire

Large tracts of the higher 'silt land' of Lincolnshire have an undulating surface that can be ascribed in part to an extensive medieval salt-making industry. These saltern mounds are composed of silty material (silt loam, sandy silt loam or silty clay loam) discarded after brine extraction and are high and extensive enough to have confused 19th century geologists into mapping them as alluvial terraces.

Co-operation with archaeologists of the South Lincolnshire Archaeological Unit has been of mutual benefit in that soil mapping and investigation has indicated probable additional sites and clarified some aspects of the likely medieval environment, whilst archaeological evidence of buried landscapes has helped to explain some complex soil and alluvial deposition patterns.

Salt-making was a flourishing industry between the 11th and 14th centuries but had declined by the late 16th century. Huge amounts of silty beach deposits were raked up after spring tides from which brine was separated by settling in clay-lined ponds or leaching and then evaporated over peat-fired hearths (Rudkin & Owen, 1960; Healey, 1977). The desalted material was discarded and the large mounds formed were at first the dwelling sites of the salters and later, as the sea receded, used for sheep grazing. Documentary evidence for this activity is abundant and ground or air photograph evidence of dark patches helped to locate the archaeological sites. The patches contain ash and unburnt

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carbon and are in random clusters, or, nearer the sea, in regular linear form. The latter are the sites of the actual, usually later, industry while the former with remains of pottery and sea-food shells are likely dwelling sites near the hearths. Profile pits sometimes show ashy layers covered with stratified alluvium suggesting temporary abandonment of the sites after flooding. However, few of the soils have distinct mottling within 50 cm depth indicating that the mounds were well above marsh level and capable of supporting the salters on the toft or town-land until at least the early 13th century when reclamation of the marsh to the landward of these low islands was necessary owing to population pressures.

The saltern soils are mainly similar to the coarse silty Romney series, characteristically with large available water. The mounds as low islands influenced tidal current velocity and are normally fringed by fine silty Agney soils with coarse silty Wisbech soils to seaward. In north-east Lincolnshire the mounds are mainly fine silty reflecting the different coastal alluvial deposits. Roman and Iron Age salt-making was also extensive in Lincolnshire but these salterns have less topographic expression than those of the Medieval period because different techniques were employed. The Romans tapped tidal creeks and after preliminary treatments evaporated the brine in trough-like moulds. The resulting salt bricks could be removed only by breaking the moulds so this activity is marked by a scatter of briquetage and low mounds of contrasting particle size. Tuition from archaeologists enabled such artifacts to be recognised which helped to explain unusual soil patterns noted during detailed mapping.

The Iron Age industry was concentrated mainly well inland at about 4·5 m OD, although some salterns north of Skegness are near the present coastline. There is some evidence that the Romans worked established Iron Age sites but then had to move at least 3 km eastwards (now 3 m OD) as the sea receded (Simmons, 1977).

All methods needed vast amounts of fuel and the documentary evidence about rights of turbary suggests that the general lack of peat soils can be attributed, at least in part, to peat removal. Unlike most industrial activity in Britain, the waste products of salt-making in Lincolnshire have formed some of the most fertile and flexible, class 1, land in the country capable of double-cropping and producing high quality horticultural crops. (Robson)

Quantification of soil structure

Structure is an important property affecting the strength of soils and the movement and storage of gases, liquids and solids in them, yet because of technical difficulties it has been little studied.

Now rapid methods of characterisation and quantification of structure applicable to both aggregated and non-aggregated material are being developed using the Quantimet 720 image analysing computer.

Preparation of material. Undisturbed samples are impregnated with a polyester resin containing a fluorescent dye and the hardened samples sliced and made into thin sections. Accurate image analysis requires the feature of interest to be clearly differentiated from all others and because consistent recognition of pores in the normal microscopic image is difficult, techniques have been developed to differentiate them from solids. One involves thin section examination under u.v. light, utilising the fluorescent dye in the resin to highlight the voids, another the use of high contrast photographs of thin sections in which the pores appear black and all other material white.

The Quantimet 720 image analysing computer. Full details and the principles of the image analysing computer are given in a number of papers (Cole, 1971; Fisher, 1971).

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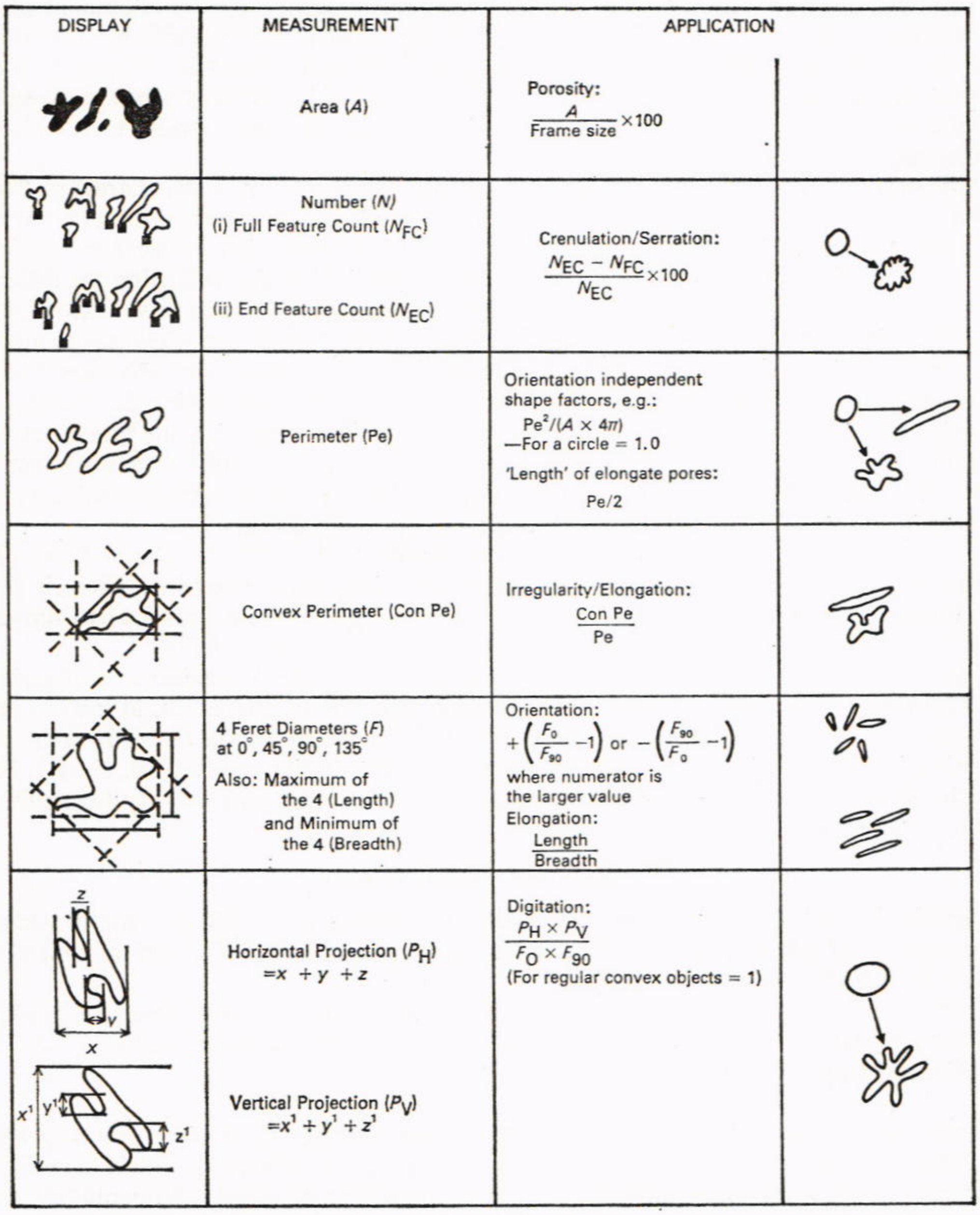

FIG. 3. Basic measurements made by the Quantimet 720 and some derived measurements applicable to pores and aggregates.

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Basically the image obtained from a microscope or an epidiascope is scanned by a plumbicon scanner. The instrument is set to measure features of a grey level corresponding to the particular component to be measured. The screen image is separated into 500 000 picture elements, the grey level of each of which is separately assessed. The instrument is controlled either by Fortran programs or System 23C software run on a PDP 11/04 mini-computer. The mini-computer and the image editor allow a variety of measurements to be made (Fig. 3).

Quantification of aggregates and pore patterns. Well-developed aggregates, i.e. those surrounded by pores on all sides, can readily be characterised by image analysis since they occur as discrete entities. Emphasis is placed on the characteristics of the aggregate itself with measurements of inter- and intra-aggregate pores providing useful additional information. In non-aggregated soils characterisation is based on the nature of the pores and the pattern they form.

Between these two ends of the range is material in which aggregation is only moderately or weakly developed. In such cases, the aggregates are only partially surrounded by pores and thus are not discrete entities. Quantification of such material can be achieved in two ways. The simplest is to treat the material as non-aggregated and characterise it by its pore pattern. This has the disadvantage that continuity with the field in which weak aggregation is observed is lost. The other possibility is to convert moderately or weakly developed aggregates into strongly developed ones, using the image editor to extend the voids until they totally surround the aggregates. The degree of aggregation is then expressed by comparing the inter-aggregate pores before and after editing.

There are a number of attributes by which aggregates and pore patterns can be defined and quantified.

1. Types. Aggregates have been classified into a number of types based on field survey and profile description (Hodgson, 1976) and these terms are also used in laboratory studies. Several types of microscopic pores have been recognised, the most important classes being: packing pores occurring between mineral grains or between small aggregates; vughs and vesicles within aggregates or non-aggregated material; channels and chambers, elongate and more or less circular respectively; and planar pores generally defining aggregates.

Because these pore types have distinctive shapes, they can be distinguished and measured by Quantimet.

2. Sizes. Pores and aggregates can be separated into size classes and distributions obtained for each.

3. Distribution. Statistical techniques including cluster and nearest neighbour analysis can be applied to pore and aggregate distribution measurements. X–Y coordinates are available for the ACP (anti-coincidence point). In the case of more or less circular voids and aggregates, these coordinate points allow the mean free path between each feature to be calculated.

4. Orientation. The most usual reference line for orientation of pores or aggregates is the soil surface. Although in most cases the arrangement is random, in special instances, such as soil compaction, orientation can be important.

5. Irregularity. Pores and aggregates can be characterised by both digitation and crenulation aspects of irregularity. Knowledge of this property aids assessments of the

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routes and speed of water movement through the soil when the soil is wet and fully swollen.

The aim of the work is numerical definition of the different aggregate and pore patterns in our soils. In addition to improving the precision of defining and recognising the different types of soil structure, it can also be used to assess the suitability of soils for rooting, to provide a realistic basis for understanding water movement and retention and soil drainage and to examine the effects of different cultivation treatments on soil structure. (Bullock, Murphy and Waller)

Assessment of soil workability and machinery work days

Soil workability is not a simple concept to handle or define as it is influenced by both transient and intrinsic soil properties, short- and long-term climate and also the type of machinery used. A practical definition of workability is the ease with which field operations, to produce a satisfactory seedbed or to harvest a root crop, can be undertaken (Spoor, 1979). This can be expressed in energy or cost terms, but it is often more convenient to describe workability as the *duration* of good soil conditions for machinery working (Smith, 1977).

Soil properties affecting workability are:

(a) Wetness class, the duration of waterlogging (Hodgson, 1976).
(b) Depth to effectively impermeable horizons (Thomasson, 1978).
(c) Water retention, plasticity and strength properties of the cultivated layer (Hall *et al.*, 1977)

The climatic elements are rainfall and potential transpiration combined to form a meteorological estimate of return to and departure from field capacity (Smith & Trafford, 1976).

TABLE 2

Soil assessment

		Retained water capacity of topsoil			
		Mineral soils			
Wetness class	Depth to impermeable horizon	Low	Medium	High	Humose or peaty soils
I	>80	a	a	a	a
II	>80	a	a	a	a
	40–80	b	b	c	b
III	>80	b	c	c	b
	40–80	c	c	d	c
	<40	c	d	d	d
IV	>80	c	d	d	d
	40–80	c	d	d	e
	<40	d	e	e	f
V	>80	d	e	e	f
	40–80	e	f	f	f
	<40	e	f	f	f
VI	All depths	f	f	f	f

Soil weightings:		Overall	Autumn	Spring
Machinery work days:	a	+30	+20	+10
	b	0	0	0
	c	−25	−20	−5
	d	−40	−30	−10
	e	−55		
	f	−70		

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Table 2 summarises the method of allocating soils to six workability classes from 'a', easy working, to 'f' very difficult, dependent on profile characteristics. The classes are given a 'soil weighting', in terms of machinery work days (MWD), based on examination of farm and soil water regime data. The potential machinery work days for any period is then considered to be the field capacity period, as estimated from meteorological sources, adjusted positively or negatively by use of soil weightings:

$$\text{Potential MWD} = Y - \text{Field capacity days} + \text{Soil weighting}$$

where Y is the assessment period.

Thus if we have a soil of class 'c' in an area with 120 field capacity days (1 December to 1 April) and Y is defined as 15 September to 30 April (225 days) then

$$\begin{aligned}\text{Potential MWD} &= 225 - 120 - 25\\ &= 80\end{aligned}$$

The frequency of late and early return to field capacity can also be used to assess year to year variation in MWD. For individual years, field capacity dates ± 4 days can be extracted from the MORECS output of the Meteorological Office.

The proposed system is useful for comparing year to year and soil to soil differences in workability. It is *not* designed to predict day to day changes in workability, which obviously require on-site assessment. The soil weightings are clearly tentative and will be reviewed as more information accumulates.

The system has been used in land classification. Studies of yield variation on a number of farms suggest that workability is generally less important than droughtiness (crop water supply). However, in difficult years workability can be critical, particularly for spring-sown crops on 'b' and 'c' soils. The effect probably includes both poor tilth and lateness in years with few machinery work days and the converse in years with ample machinery work days.

Although the main emphasis is that excessive wetness is the chief limitation to workability, the system does identify soils where excessive dryness can restrict autumn workability. (Thomasson)

Basic research

Acid brown soils. Total contents of Co, Cu, Mn, Zn and Se were determined in topsoil (0–8 cm) and subsoil (30–35 cm) samples obtained at 1 km intervals in the Llangadog district (SN72). Correlations between the amounts of any one of these elements and amounts of any of the others in either topsoil or subsoil samples are generally moderately significant ($P<0{\cdot}02$), but weak ($r<+0{\cdot}25$). The exception is the moderately strong, highly significant correlation between contents of Zn and Mn in the topsoils ($r=0{\cdot}758$, $P<0{\cdot}001$). Subdivision of the data on the basis of the two principal source rocks (Lower Palaeozoic and Old Red Sandstone), the three principal soil subgroups (typical brown earth, cambic stagnogley and cambic stagnohumic gley soils) and the principal soil series (Denbigh, Milford, Cegin, Fforest, Wenallt) failed to improve the correlations.

There were highly significant ($P<0{\cdot}001$) strong correlations between the nitrogen contents of the topsoils and their Zn ($r=0{\cdot}813$) and Se ($r=0{\cdot}952$) contents, and a moderately strong correlation between topsoil organic matter and Cu contents ($r=0{\cdot}758$). The Zn/N and Se/N correlations probably reflect the incorporation of these metals into proteins (Anderson *et al.*, 1961; Price *et al.*, 1971).

In the same set of samples, statistical analysis showed poor ($r<0{\cdot}7$) though highly significant ($P<0{\cdot}001$) correlations between the phosphate sorption index (Bache & Williams, 1971) and contents of pyrophosphate and oxalate extractable Fe and Al, the strongest being with pyrophosphate Fe ($r=0{\cdot}681$) in the subsoils. Stratification of the

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data into subsets in the same manner as for the minor elements did not alter the nature of the correlations. This work casts doubt on the common generalisation that the principal element responsible for P sorption in acid soils is Al. Moreover, the poor correlation between pyrophosphate Fe and P sorption, limits the value of the former as a predictor of the latter. (Loveland, Wright, with Mr M. R. Dight, ADAS Trawsgoed)

Cation exchange capacity of peat soils. Forty-seven samples of organic horizons from a wide range of peat soils were analysed for CEC by the current Soil Survey method (Avery & Bascomb, 1974). In a preliminary investigation using eight soils, subsamples air-dried at 30°C and ground mechanically gave values up to 33% lower than those obtained on thoroughly mixed, field-moist subsamples. Results for air-dried samples ranged from 60 to 210 mmol (1) 100 g^{-1} oven-dry soil, or 130 to 300 mmol (1) 100 g^{-1} oven-dry organic matter as determined by loss on ignition. (Thanigasalam)

Methodological research

Soil classification. The classification currently used by the Survey to identify soils and soil maps unit is a hierarchial system with classes in four categories—major soil groups, soil groups, soil subgroups and soil series—defined by progressive division. Soil series are the classes chiefly used to identify map units at scales of 1:63 360 or larger. Classes in the three higher categories serve to convey more generalised information about soil properties and relationships, to systematise differentiation of soil series, and to characterise map units at smaller scales.

A more detailed explanatory text, bringing together definitions and background information needed by staff and other users to apply the system to subgroup level, has been compiled and published this year as a *Technical Monograph*. It includes specifications of diagnostic horizons and other differentiating characteristics, followed by definitions of major soil groups, groups and subgroups. In accordance with the decision to use the 1973 system in the 1:250 000 mapping programme, the original class structure and nomenclature have been retained with only minor revisions at subgroup level. Certain of the differentiating criteria have also been slightly modified. (Avery)

Series differentiation. Building on the work of a Classification Working Group, existing soil series concepts have been re-examined in order to introduce a nationally consistent system for the definition of classes identified in the 1:50 000 mapping programme.

A paper outlining proposals for rationalisation has been circulated to staff which introduces a framework of substrate types as a basis for class definition. It proposes to abandon separations based on the stratigraphic age or assumed derivation of the soil parent material, and to adopt a more consistent approach to differentiation by particle-size classes, the presence of bedrock or very stony layers, and mineralogical or ancillary criteria. Regional meetings are being held to examine the implications of the proposals. After these consultations work will begin on preparing both a monograph explaining how classes are differentiated within subgroups and a fully documented calatogue of soil series. (Clayden)

Micromorphology. Four hundred and eighty-two thin sections were made. Of these, 327 were made and described to aid characterisation and classification of soils in the current mapping programme. The remainder were prepared mainly for research projects, particularly the quantification of soil structure.

Samples from 33 profiles to be demonstrated during excursions arranged in connection with a meeting of the International Society of Soil Science Sub-Commission on Soil

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Micromorphology in London in August 1981 were collected for micromorphological examination. (Bullock, Murphy and Waller)

Data management. Discussions have continued with members of the staff of the Computer Department in order to try to satisfy the Soil Survey's database management system (DBMS) requirements. Following advice from the Netherlands Soil Survey Institute, the Computer Department agreed to mount GRASP—an interactive DBMS used by the US Geological Survey.

Purposive and National Soil Inventory (NSI) field data cards from a trial area in the Welsh Borderland have been punched and verified. A conversion program has been written for these data to render them suitable for trial manipulation by GRASP. At the time of writing the trial is incomplete but the relatively small core store available on the MULTIJOB operating system has necessitated changes to the GRASP program which has reduced its operational capabilities. It is also apparent that a DBMS designed to operate on large databases in batch mode will also be required for future work.

A computer system has been designed and programmed to validate profile descriptions and amendments and to update 'on-line' files. Copies of the updated files are held on magnetic tape for security. An office procedure has been established so that all new or changed profile descriptions and laboratory results are handled centrally. New or changed profile descriptions are automatically distributed to those requiring them.

Additional programs have been added to the LINDAT system to produce the catalogue of soil series in alphabetic and subgroup sequence. The files have been brought up-to-date as at the end of September 1980 and now contain a total of 988 series.

A new catalogue (NATCAT) has been initiated with information on 15 soil series. NATCAT is at present in an experimental stage of development and is designed primarily as a comprehensive information system to replace LINDAT. Like LINDAT it contains subgroup and lithology files together with a library of source data. The new catalogue will also hold text describing the nature, distribution and agronomic characteristics of soil series, definitive characteristics, typical profile descriptions, analytical and bioclimatic data.

An office procedure has been organised to record the receipts of all NSI data cards so that missing areas can be easily identified. Text translations of the NSI records can now be produced using DECODE which is being modified in order to include bioclimatic information. These extra data have been derived from recently published maps and now form part of the environmental information in the NSI database. (Ragg and Proctor)

Estimation of sulphate. A method based on the rate of decolourisation of barium rhodizonate paper from red to white was developed to estimate sulphate in moist soil samples and turbid solutions. It can detect 100 mg ml^{-1} and 0·05% SO_4^{2-} in solution and moist soil respectively. (Thanigasalam)

Particle-size analysis. Preliminary results showed that a reduction in sampling depth for clay determination from 9 to 7 cm in the Soil Survey method (Avery & Bascomb, 1974) caused no significant change in the clay contents obtained for 21 soils of widely differing mineralogy and organic matter status. (Loveland and Williams)

Supporting work

Soil water regimes. The soil moisture regimes of five soils in the Abbots Bromley district were monitored for a further year. The area around the Worcester site was trampled by cattle and was abandoned early in the year, although the profile has since been described in detail and fully sampled. A paper has been prepared comparing the

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moisture regimes of the Salop, Worcester and Rudge soils highlighting the different patterns of moisture extraction with respect to their soil physical properties. (Hall and Jones)

Dip-wells and neutron probe access tubes have been installed on six common soil series near Shardlow (Abbey, Arrow, Hodnet, Staunton, Ticknall and Worcester) having a range of moisture regimes and particle-size classes.

Detailed descriptions, together with disturbed and undisturbed samples, have been taken in an attempt to improve the qualitative assessment of structure. Hydraulic conductivity measurements will be made in the field when moisture conditions are suitable and compared with similar measurements using a falling head permeameter in the laboratory.

Sampling for engineering tests are under discussion with staff of the Department of Civil Engineering, University of Technology, Loughborough, in an effort to correlate pedological taxa with properties commonly employed by engineers. (Wilde, DSIR, New Zealand, and Hall)

Soil water retention. Soil water retention properties have been measured on over 700 cores from nearly 80 profiles over the last year. In response to requests made last year many of the soils sampled have been from groups for which there is little soil physical information (e.g. podzolic and lithomorphic soils). (Hall and Bembridge)

Special surveys

Detailed soil and land capability surveys of nine proposed opencast coal sites, comprising 1650 ha, have been made in Derbyshire, Leicestershire and Staffordshire. Reports on these sites include brief descriptions of the soils encountered, advice on the bulk handling of topsoils and subsoils and statistics on their physical properties. (George, Hollis, Jones and Reeve)

Detailed surveys were made of the East Pit and Glyn Glas Remainder opencast sites in south Wales, prior to coal working. (Wright)

The proposed Packsaddle opencast coal site at Bersham near Wrexham was surveyed for the Agricultural Land Service (1·7 km^2) and a preliminary report with a soil map prepared. More detailed observations, sampling and laboratory analyses will form the basis for soil and land capability maps and a report giving advice on restoration. (Lea)

At the request of MAFF, High Mowthorpe Experimental Husbandry Farm (437 ha) and 190 ha of recently leased land next to Great House Experimental Farm were mapped. (Furness, S. J. King and R. A. Jarvis)

Sites at Newcastle University's Cockle Park Farm, with soils typical of much of northern England, were selected at the request of the Research Division of British Gas, who are investigating the transmission of variable frequency radar pulses through soil profiles. (Carroll and Allison)

A soil survey of 600 ha of farmland in Northamptonshire was interpreted for land drainage, soil workability and soil droughtiness. (Thomasson and Reeve)

A soil map at a scale of 1:10 000 was drawn for Callingwood Hall and Callingwood Gale Farms (150 ha), near Burton-on Trent, at the request of the managers of Lord Burton's estate. (Jones)

Soil maps at a scale of 1:10 000 for Hanbury Park Farm, Hanbury (SK12) and Marlpit House, Marchington (SK02) were provided for the ADAS Drainage Arm, Crewe Division. (Jones)

About 1·4 km^2 of Milton Keynes new town has been surveyed at the request of the Development Corporation to demonstrate the utility of soil surveys to urban planners. (Evans, Seale and Hodge)

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A preliminary survey of the peatland of the Norfolk Broads and surrounding marshes in Norfolk carried out with the aid of students has shown that acid sulphate or potentially acid sulphate soils are widespread adjacent to the limits of the marine alluvium in the lower river valleys. Draining of these areas could lead to extreme acidity in places which would be harmful to both crops and natural fauna and flora. (Price with Jan Bart Kool and R. Brown, students)

The soils of the Tillingbourne catchment (1·5 km^2) near Dorking were mapped and four profiles described for the Central Electricity Research Laboratory. (Moffat and M. G. Jarvis)

Maps predicting trafficability of a further 3200 km^2 of land near London were prepared for Thamesgro, Thames Water Authority. (Moffat and M. G. Jarvis)

Soils and trafficability of a corridor of land between Henley and Nuffield, Oxfordshire, were described and evaluated for Dames and Moore, consultant engineers. (Fordham and Hazelden)

Requests for information on the soils of the Lake Vyrnwy catchment were received from both the Severn-Trent River Authority (the owners) and from the Royal Society for the Protection of Birds, who lease part of the catchment. Both are developing management plans and see soil characteristics as essential elements of their studies. (Lea and Thompson)

Clwyd County Council Planning Department used part of the Holywell land capability survey in forming their case for a preferred bypass route. Advice and explanation were given at the preparatory stage and a further request for information in the Wrexham area has been received. (Lea and Thompson)

Copies of the soil and land capability surveys of Arddleen (Sheet SJ21) were used by the Agricultural Land Service in the preparation of a report concerning a road modernisation scheme north of Welshpool. (Thompson)

A revised 1:1 000 000 soil map of England and Wales was compiled as a collaborative contribution to a map of the EEC countries being prepared at the University of Ghent. The 67 map units are soil associations defined in accordance with the legend of the FAO-Unesco (1974) *Soil Map of the World*. (Avery)

Staff

R. D. Green transferred to Rothamsted to take over the Publications section and the Wye office closed. The publications and cartographic sections moved to new accommodation. An Italian version of the *Field Handbook*, prepared by Dr G. Sanesi, has been published in Florence.

The Oxfordshire and Essex offices closed and J. Hazelden and R. G. Sturdy will open an office at East Malling in the new year.

J. M. Ragg visited the Land Resources Research Institute, Ottawa; the Soil Conservation Service, US Department of Agriculture, Washington; the US Geological Survey, Washington, and attended the International Symposia on Machine Processing of Remotely Sensed Data, Soil Information Systems and Remote Sensing and Soil Survey at Purdue University, Indiana.

T. R. E. Thompson visited Jamaica with a short-term study grant from the Commonwealth Foundation to investigate applications of soil surveys.

P. Bullock chaired a meeting of the International Society of Soil Science Sub-commission of Soil Micromorphology at Ghent, Belgium.

A. J. Thomasson accompanied by Mr G. Spoor (NCAE, Silsoe) visited Yugoslavia as guests of the Croatian government to advise on drainage techniques and experimental trials on State farmland.

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P. J. Loveland attended the fourth meeting of European Clay Groups at Freising, West Germany, and visited the International Soils Museum, Wageningen.

J. M. Ragg (Chairman) and Mary E. Proctor served on the joint ADAS/Soil Survey Working Party concerning a common database. A report on a proposed common information system capable of interrogation by MAFF Land, Land Drainage and Agricultural Science Services and the Soil Survey has been prepared.

Dr R. H. Wilde (Soil Bureau, DSIR, New Zealand) joined us for a period of 15 months' study leave. After 3 months' work on the National Mapping programme he commenced work on soil physical properties at the Shardlow laboratories.

Jane Price, Elaine Avis, Helen Garthwaite, Avani Shah and D. Watson resigned. K. Thanigasalam who joined the Survey in 1968 has retired to start a career in teaching. Barbara Scott retired after 7 years faithfully attending to the secretarial duties of our Cambridge Office.

Mary Proctor, Rosemary Haggerty, Amanda Jenkins, Mathews Parkes and Geraldine Warnes were appointed.

References cited in Report

ANDERSON, M. S., LAKIN, H. W., BEESON, K. C., SMITH, F. F. & THACKER, E. (1961) Selenium in agriculture. *United States Department of Agriculture Handbook* No. 200.

AVERY, B. W. & BASCOMB, C. L. (Eds) (1974) Soil Survey laboratory methods. *Soil Survey Technical Monograph* No. 6.

BACHE, B. W. & WILLIAMS, E. G. (1971) A phosphate sorption index for soils. *Journal of Soil Science* **22,** 289–301.

CLAYDEN, B. & EVANS, G. D. (1974) Soils in Dyfed I: Sheet SN41 (Llangendeirne). *Soil Survey Record* No. 20.

COLE, M. (1971) Instrument errors in quantitative image analysis. *The Microscope* **19,** 87–103.

FISHER, C. (1971) The new Quantimet 720. *The Microscope* **19,** 1–20.

HALL, D. G. M., REEVE, M. J., THOMASSON, A. J. & WRIGHT, V. F. (1977) Water retention, porosity and density of field soils. *Soil Survey Technical Monograph* No. 9.

HEALY, R. H. (1977) Medieval salt-making. *South Lincolnshire Archaeology* **1,** 4–5.

HODGSON, J. M. (Ed.) (1976) Soil Survey field handbook. *Soil Survey Technical Monograph* No. 5.

PRICE, C. A., CLARK, H. G. & FUNKHAUSER, E. A. (1971) Functions of micronutrients in agriculture. *Soil Science Society of America Congress Report.*

RUDKIN, E. H. & OWEN, D. M. (1960) The medieval salt industry in the Lindsey marshland. *Lincolnshire Agricultural and Archaeological Society Report and Papers* **8,** 76–84.

SIMMONS, B. B. (1977) Ancient coastlines around the Wash. *South Lincolnshire Archaeology* **1,** 6–9.

SMITH, C. V. (1977) Work days from weather data. *Agricultural Engineer* **32,** 95–97.

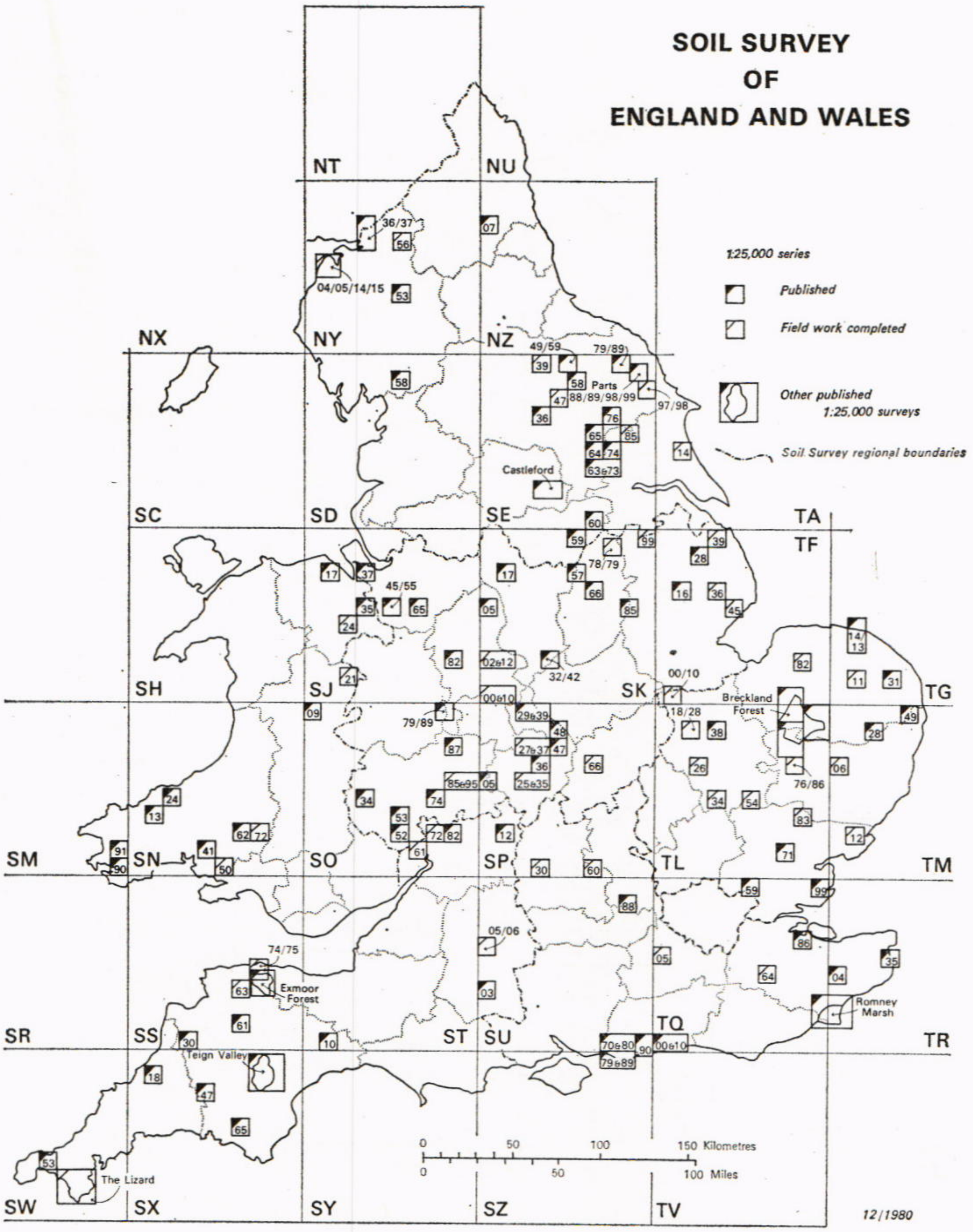
SMITH, L. P. & TRAFFORD, B. D. (1976) Climate and drainage. *Ministry of Agriculture, Fisheries and Food Technical Bulletin* No. 34.

SPOOR, G. (1979) Soil type and workability. In: Soil survey applications. *Soil Surveys Technical Monograph* No. 13.

THOMASSON, A. J. (1978) Towards an objective classification of soil structure. *Journal of Soil Science* **29,** 38–46.

https://doi.org/10.23637/ERADOC-1-137

SOIL SURVEY OF ENGLAND AND WALES



https://doi.org/10.23637/ERADOC-1-137

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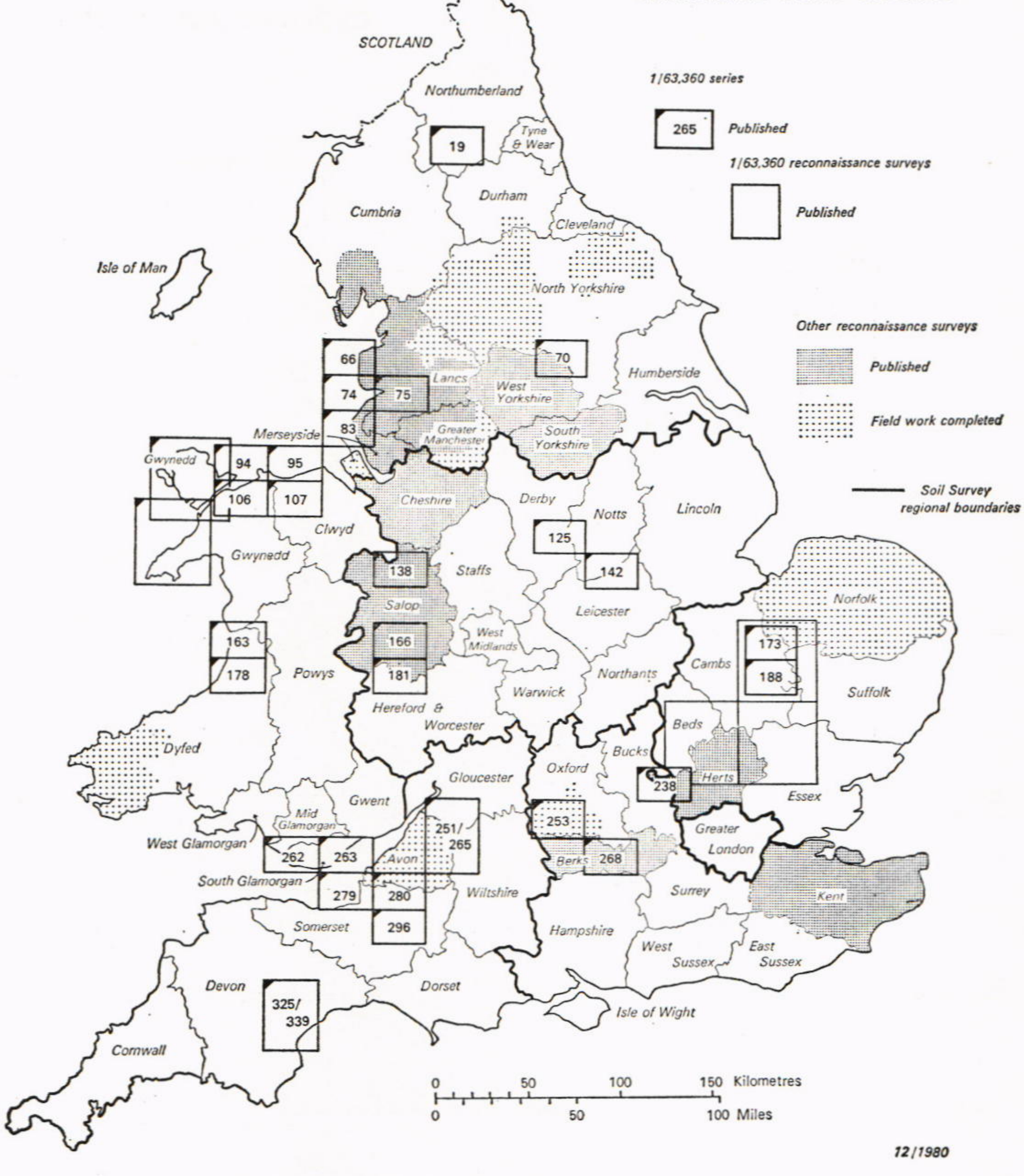

https://doi.org/10.23637/ERADOC-1-137

SOIL SURVEY OF ENGLAND AND WALES

Publications

Books

1 Allen, R. H. & Sturdy, R. G. (1980) *Soils in Essex III: Sheet TL71 (Little Waltham).* Harpenden: Rothamsted Experimental Station, viii, 172 pp.

2 Avery, B. W. (1980) *Soil classification in England and Wales: higher categories.* Harpenden: Rothamsted Experimental Station, vi, 67 pp.

3 Bradley, R. I. (1980) *Soils in Dyfed V: Sheet SN24 (Llechryd).* Harpenden: Rothamsted Experimental Station, viii, 89 pp.

4 Eldridge, D. J. (1980) *Soils in Norfolk V: Sheet TG11 (Attlebridge).* Harpenden: Rothamsted Experimental Station, viii, 161 pp.

5 Fordham, S. J. & Green, R. D. (1980) *Soils of Kent.* Harpenden: Rothamsted Experimental Station, xii, 206 pp.

6 Whitfield, W. A. D. & Beard, G. R. (1980) *Soils in Warwickshire IV: Sheet SP29/39 (Nuneaton).* Harpenden: Rothamsted Experimental Station, x, 186 pp.

7 Wright, P. S. (1980) *Soils in Dyfed IV: Sheet SN62 (Llandeilo).* Harpenden: Rothamsted Experimental Station, x, 171 pp.

Thesis

8 Johnson, N. E. G. (1979) The utility of soil survey in land use planning and engineering. Ph.D. thesis; University of London.

General Papers

9 Allen, R. H. & Sturdy, R. G. (1980) The environmental background. In: *Archaeology in Essex to AD 1500.* Ed D. G. Buckby. *Council for British Archaeology Research Report* No. 34, 1–7.

10 Evans, R. (1980) Mechanics of water erosion and their spatial and temporal controls: an empirical viewpoint. In: *Soil erosion.* Ed. M. J. Kirby & R. P. C. Morgan. Chichester: John Wiley & Sons Ltd, 109–128.

11 Evans, R. & (Mostyn, E.) (1980) Stratigraphy and soils of a fenland gas pipeline. *MAFF, ADAS, Land Service*, 26 pp.

12 Jarvis, M. G. (1980) Soil surveys in Hampshire and the Isle of Wight. *Newsletter, Geological section of the Hampshire Field Club and Archaeological Society*, No. 2, 1–2

13 Price, J. R. (1980) Soils of Redgrave and Lopham Fens. *Transactions of the Suffolk Naturalists Society* **18,** 104–111.

14 Staines, S. J. (1979) Environmental change on Dartmoor. *Proceedings of the Devon Archaeology Society* **37,** 21–47.

Paper in Rothamsted Report, Part 2

15 Catt, J. A., Weir, A. H., Norrish, R. E., Rayner, J. H., King, D. W., Hall, D. G. M. & Murphy, C. P. (1980) The soils of Woburn Experimental Farm. III. Stackyard. *Rothamsted Experimental Station. Report for 1979*, Part 2, 5–39.

Research Papers

16 Bendelow, V. C. & Hartnup, R. (1980) Climatic classification of England and Wales. *Soil Survey Technical Monograph* No. 15, 27 pp.

https://doi.org/10.23637/ERADOC-1-137

17 BRADLEY, R. I. (1980) Trace elements in soils around Llechryd, Dyfed, Wales. *Geoderma* **24,** 17–23.

18 BULLOCK, P. & MURPHY, C. P. (1980) Towards the quantification of soil structure. *Journal of Microscopy* **120,** 317–328.

19 BURGESS, T. M. & WEBSTER, R. (1980) Optimal interpolation and isarithmic mapping of soil properties. I. The semi-variogram and punctual kriging. *Journal of Soil Science* **31,** 315–331.

20 BURGESS, T. M. & WEBSTER, R. (1980) Optimal interpolation and isarithmic mapping of soil properties. II. Block kriging. *Journal of Soil Science* **31,** 333–341.

21 CATT, J. A. & MOFFAT, A. J. (1980) An occurrence of Hertfordshire puddingstone in Reading Beds at St Albans. *Transactions of the Hertfordshire Natural History Society* **28,** 12–16.

22 JONES, R. J. A. & (COURT, M. N.) (1980) The measurement of mean temperatures in plant and soil studies by the sucrose inversion method. *Plant and Soil* **54,** 15–31.

23 JONES, R. J. A. & (TINSLEY, J.) (1980) Hill land in the Grampian Region of Scotland. I. Effects of soil parent material, altitude and aspect on the herbage yields, composition and responses to fertiliser treatments in the upper Don basin. *Journal of Soil Science.* **31,** 343–370.

24 LOVELAND, P. J. (1980) Zoned glauconite from the Upper Greensand. *Mineralogical Magazine* **43,** 682–684.

25 REEVE, M. J., HALL, D. G. M. & BULLOCK. P, (1980) The effect of soil composition and environmental factors on the shrinkage of some clayey British soils. *Journal of Soil Science* **31,** 429–442.

26 SEALE, R. S. (1980) Ancient courses of the Great and Little Ouse in Fenland. *Proceedings of the Cambridge Antiquarian Society* **69,** 1–19.

27 WEBSTER, R. & BURGESS, T. M. (1980) Optimal interpolation and isarithmic mapping of soil properties. III. Changing drift and universal kriging. *Journal of Soil Science* **31,** 505–534.

MAPS

28 ALLEN, R. H. & STURDY, R. G. (1980) Soil map, 1:25 000 Sheet TL71 (Little Waltham). Southampton: Ordnance Survey.

29 ALLEN, R. H. & STURDY, R. G. (1980) Land use capability map, 1:25 000 Sheet TL71 (Little Waltham). Southampton: Ordnance Survey.

30 BENDELOW, V. C. & HARTNUP, R. (1980) Accumulated temperature (for England and Wales), 1:1 000 000. Southampton: Ordnance Survey.

31 BENDELOW, V. C. & HARTNUP, R. (1980) Average maximum potential cumulative soil moisture deficit (for England & Wales), 1:1 000 000. Southampton: Ordnance Survey.

32 BENDELOW, V. C. & HARTNUP, R. (1980) Wind exposure (for England & Wales), 1:1 000 000. Southampton: Ordnance Survey.

33 BRADLEY, R. I. (1980) Soil map, 1:25 000 Sheet SN24 (Llechryd). Southampton: Ordnance Survey.

34 BRADLEY, R. I. (1980) Land use capability map. 1:25 000 Sheet SN24 (Llechryd). Southampton: Ordnance Survey.

35 ELDRIDGE, D. J. (1980) Soil map, 1:25 000 Sheet TG11 (Attlebridge). Southampton: Ordnance Survey.

36 ELDRIDGE, D. J. (1980) Land use capability map, 1:25 000 Sheet TG11 (Attlebridge). Southampton: Ordnance Survey.

37 FORDHAM, S. J. & GREEN, R. D. (1980) Soils of Kent, 1:250 000. Southampton: Ordnance Survey.

38 FORDHAM, S. J. & GREEN, R. D. (1980) Kent. Land use capability classification, 1:250 000. Southampton: Ordnance Survey.

39 FORDHAM, S. J. & GREEN, R. D. (1980) Kent. Types of soil water regime, 1:250 000. Southampton: Ordnance Survey.

40 FORDHAM, S. J. & GREEN, R. D. (1980) Kent. Ease of cultivation classes, 1:250 000. Southampton: Ordnance Survey.

41 FORDHAM, S. J. & GREEN, R. D. (1980) Kent. Winter rain acceptance potential, 1: 250 000. Southampton: Ordnance Survey.

42 HARROD, T. R. (1980) Soil map, 1:25 000 Sheet SS61 (Chulmleigh). Southampton: Ordnance Survey.

43 HARROD, T. R. (1980) Land use capability map, 1:25 000 Sheet SS61 (Chulmleigh). Southampton: Ordnance Survey.

44 HARROD, T. R. & THOMASSON, A. J. (1980) Grassland suitability (for England & Wales), 1:1 000 000. Southampton: Ordnance Survey.

45 SEALE, R. S. (1980) Geological map, solid and drift edition, Sheet 173 (Ely), 1:50 000. Southampton: Ordnance Survey.

46 STURDY, R. G., ALLEN, R. H. & KRUL, H. A. (1980) Soil map, 1:25 000 Sheet TM12 (Weeley). Southampton: Ordnance Survey.

47 WHITFIELD, W. A. D. & BEARD, G. R. (1980) Soil map, 1:25 000 Sheet SP29/39 (Nuneaton). Southampton: Ordnance Survey.

48 WHITFIELD, W. A. D. & BEARD, G. R. (1980) Land use capability map, 1:25 000 Sheet SP29/39 (Nuneaton). Southampton: Ordnance Survey.

https://doi.org/10.23637/ERADOC-1-137