AGRICULTURAL RESEARCH COUNCIL

Soil Survey of England & Wales

MAKING 1:25,000 SOIL MAPS

by

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Westbury-on-Trym,
Bristol,
May, 1970.

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INTRODUCTION

The aim of the Soil Survey of England and Wales is to describe, classify and map the many different types of soil in the country. Areas of 38 sq. miles have been chosen in each county for their geomorphological and agricultural interest. These areas correspond to those of the Ordnance Survey 10 km x 10 km Outline Edition 1:25,000 map series, and are being surveyed in an order of priority determined by the interest of map users. Maps are being published at a scale of 1:25,000, and are accompanied by a publication known as a "Soil Survey Record", which describes the soils in words and gives relevant laboratory analyses. The surveyor uses many skills in recognizing soil properties and in accurately describing and mapping different soil types. Such skills are acquired through field experience, and their range and nature are governed by the soil classification system using the definitions and scales set out in the Field Handbook. In pursuing his mapping programme the surveyor aims at the regular production, at comparatively short intervals, of a series of maps and reports.

The production of a 1:25,000 sheet, from early preparation to completion of map and report, employs a number of more or less distinct stages which constitute the work plan. Although applicable in all circumstances this plan can follow somewhat different time schedules depending on local circumstances e.g. seasonal influence of crops on access. It can also follow different patterns depending on experience of staff e.g. early stages can be completed by a senior surveyor and later stages by a trainee under supervision.

This booklet describes the objects, procedure and duration of each stage in current (1970) practice.

1. Preparatory Work

The object is to accumulate and study all relevant publications and maps. The search for existing data embraces a wide range of related disciplines e.g. agriculture, geology, botany, engineering, and involves many sources, including journals and university theses. Government Departments, central and local, particularly planning authorities, can also provide information, as can land use maps. Aerial photographs are examined at an early stage for quality, scale, etc. to determine whether special photography needs to be flown.

This preparatory stage can start a year or so ahead of the intended survey and files opened on all proposed sheets in the programme for each region so that special requirements are known well in advance. These files include geological sketch maps with keys and information sheets giving a brief digest of existing knowledge. References are also accumulated on these sheets, as they come available.

As field work approaches contact is made with MAFF staff of the Ministry of Agriculture, Fisheries and Food concerned with agricultural extension work in the survey area, and if agricultural data is to be collected as part of the survey, questionnaires are prepared and circulated. Local branches of the Country Landowners Association and National Farmers Union are approached, and letters prepared for circulation to landowners and farmers in each parish, asking for permission to enter land.

2. Air Photographs Interpretation (API)

The contribution made by this aid to soil survey in Britain varies according to quality of material and type of country as well as skill of the interpreter and equipment available.

The air photographs used at present include existing prints and those from negatives taken specially for the Survey. Existing cover is held in the Air Photo Library of the Ministry of Housing and Local Government, by the Ordnance Survey, commercial air photo companies and by some local authorities. Photography for the Survey is ordered by the surveyor in time for prints to be available in good time prior to field survey. The order is placed through, and with the advice of, the two Airphoto Units of the Survey; one for the uplands at Leeds and the other for the lowlands at Cambridge.

Study of the photographs taken for other organizations often shows that it can give much useful help. However, quality and scale are often far from ideal and coverage is incomplete. When photographs are taken specially for the Survey they are usually of better quality, at the required scale, and flown at times of the year when tonal patterns are most likely to be visible.

In uplands where soils are often reflected by vegetation it has been shown that a saving in time in field work of up to 40 per cent can be obtained by prior interpretation of photography. In uplands, soils are often well related to the landscape units visible on air photographs, and savings in time can be expected, particularly in surveys at a scale of 1:250,000, envisaged at a later stage in the mapping programme.

There are similar advantages in lowland England, where prominent tonal patterns related to soil differences are known to exist, e.g. in E Anglia. Elsewhere in lowlands, however, particularly in grassland areas, less has so far been achieved and it is hoped that newer types of photography e.g. colour and false colour, may reveal more of soil patterns.

The principles of interpreting air photographs in soil survey are being worked out by the two specialist units and there are courses to train surveyors in their use. A primary objective is to obtain from the photographs a clear delineation of the land form units into which the survey area can be divided, and which can be marked on the photographs and/or an overlay sketch map. Patterns seen in drainage conditions, in vegetation and in land use are also treated in the same way.

Air photo study overlaps with field work in that after some time has been spent on the ground the initial interpretation can often be improved. Individual photographs are also valuable at the time of routine survey, both for location where this is difficult on the ground and for accurate tracing of intricate soil boundaries and other relevant features.

3. Field Reconnaissance

The object of preliminary reconnaissance is to make a broad field study of soil parent materials and the relationships between soils and landform, and between land use and soil type. The knowledge of local farmers and NAAS advisory staff can be of value here and visits to key farms with advisers are a first step in public relations as well as in getting to know the district.

Parent materials are inspected and described in existing exposures and occasional pits, a geomorphological sketch map is prepared and transects and areas chosen to respresent each landscape unit and soil. Correlations with soils elsewhere are reviewed. The knowledge obtained in stages 1, 2 and 3, then enables the surveyor to start detailed study of the soils.

4. <u>Soil Identification and legend construction</u>

The object here is to identify all the major soils, and compile a descriptive mapping legend which serves as a basis for the later routine survey. This is perhaps the most important stage as it determines the quality and significance of the survey as a whole. The time spent depends on the range of soils, the surveyor's familiarity with them, the complexity of the pattern and the criteria of the classification used. These in turn regulate the size of sample area necessary to cover the full range of soils.

The soils are identified in borings and pits in selected transects (i.e. strips of country about 1 km wide) or in sample blocks of land chosen by air photo interpretation and field reconnaissance. The average area needed is 5-10 sq km and within this observations are made at an intensity of 50/sq km or more. Data is recorded on cards, notebooks or tape recorders. Borehole inspection is immediately followed by description of the soils in pits from which reference soil samples are also taken for confirmation of texture, etc. Each variety of soil is fully described in pits 90-100 cm. deep.

Because landscape varies, this part of the survey can occupy different proportions of the total survey time in different parts of the country, but in most cases is completed in 8 weeks of field work.

From the data accumulated, a mapping legend is drawn up which provides a key to the symbols to be used in the subsequent stages of the survey, and describes the characters by which the units are recognised. It also relates the mapping units to land form and to air photograph patterns, where these exist, and indicates the nature of the boundaries between units. As well as primary series mapping units it can include phases such as those related to land use or land form, and can also tentatively define complex units, leaving refinement of such units to the later stages of survey.

The preparation of a descriptive mapping legend before survey proceeds further is essential where field survey is by new staff. It is also important that the legend is approved by the senior staff, who are responsible for correlation in and between the different regions of the country. Correlation with existing mapping units elsewhere is thus initiated at this stage. Arbitrary, numerical or letter, symbols for map units are first used to avoid premature correlation.

A new soil classification is now being developed specifically for survey use aimed at providing more uniform standards and more effective correlation.

5. Surveying

In this stage, boundaries are drawn between areas of the map corresponding to the mapping units listed in the legend. The legend is also made more precise by closer definition and separation of the units, particularly of any phases needed. Units are also grouped as complexes if, as survey advances, it becomes clear that the pattern of soil series is too intricate to be separated at the recommended density of observations although most decisions of this kind will have been made at the end of stage 4.

The screw auger is an adequate sampling tool for verifying most soil characteristics used in delineating mapping units. Features like structure and horizon boundaries are examined in soil pits, and some surveyors use a combination of shallow pit and auger hole, although not in arable crops. A larger diameter Dutch auger is being tried as an alternative. 3 ft (90 cm) borings and pits are generally satisfactory for most purposes, while rather deeper holes prove contacts of drift with solid substrata, and in peat borings are deep enough to establish the thickness.

Records of observations are made in the field on 1:10,560 O.S. map sheets which are durable and provide plenty of space for notes. Quartered sheets are used and map cases are available specifically for this size of map. Field sheets are photo-copied as soon as they are completed, and a copy sent to Headquarters to cover possible loss of or damage to the original. Methods and detail of recording vary at this stage, depending on the experience of the surveyor, and to provide a check on interpretation of the legend and to gain experience in describing soils, new staff record descriptions in notebooks or on profile cards (Fig. 1, 2). Symbols and notes on the map sheets often only need augmenting with additional notes where new

Drainage Class & Moisture Status: Poor : moist throughout	Date	Map ref.	Obs. no.
Series: Hanslope	5.3.68	TQ 59 / 57	14.

Depth in.	Depth cm.	Colour: Matrix	Colour: Mottle	Texture	Stoniness	Ca CO_3	Sec. Min.	Struct.	Consist.
6 – 10"	15	Dark gr. br. to v. dk. gr. br. (10YR 4/2 - 3/2)	none	C (contains much c.s.)	slightly stony	none		~	
12 – 18	30 – 45	Light olive brown (2.5Y 5/4)	+ fine y. br. (10YR 5/8) & gr. br. (2.5Y 5/2) mottles	C ↓	none ↓	calc.	a few black speckles of Mn		firm ↓
18 – 24	45 – 60			↓	↓	calc. + common small chalky frags.			↓
24 – 36	60 – 90	Dk. gr. brown to olive brown (2.5Y 4/2 - 4/4)	+ y. br. & grey (5Y 6/1) mottles	↓	↓	↓			↓

Fig.1. Front of completed field card.

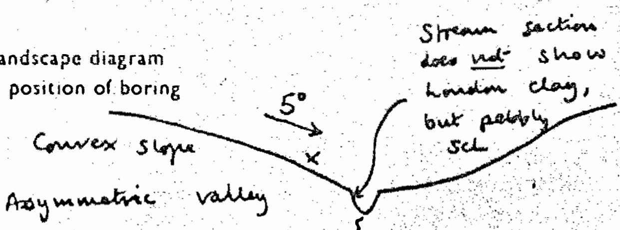
Site	Office use
Landscape diagram & position of boring 	
Slope 5° (measured)	
Aspect S.W.	
Microrelief Smooth	
Vegetation Ploughed	
Surface Stones Rounded flint pebbles and subangular flint fragments, many gravel-sized; also quartz and quartzites.	
Parent Material Chalky boulder clay	
Other observations Remnant of silty drift (loessial?) on opposite slope gives rise to soil of Hatfield Series.	

Fig.2. Reverse side of completed field card.

units or further definition of mapping units is necessary. Detail of recording greatly influences rate of progress, full recording of data is perhaps 30 per cent slower than brief though systemmatic and informative symbols on field sheets (20-25 borings per day as against 30-35 per day). At some centres records are made on punched cards to aid data retrieval.

The density of borings is related to time available and rate of progress, and also determines the minimum area mapped. The average boring intensity is 45/sq km, to allow completion of 1:25,000 sheets in 8-10 months, although with very detailed recording of data this can be as long as 12-14 months. A range of 30-60/sq km allows for variation in the homogeneity of soil cover, the first figure relating to areas of simple topography and geology and the second being more appropriate to intricate or small areas of soil down to 2 hectares, the proposed minimum separation.

Borings and pits are located to confirm the surveyor's intuitive placing of soil boundaries where they coincide with changes in parent material, slope, aspect and other environmental factors; they can also be indicated by air photograph tonal patterns. Where clues to soil distribution are few, observations on a grid pattern are useful, the density varying according to the local conditions.

After locating boundaries between mapping units, the range of variability within major mapping units is assessed, some of which can be accounted for by mapping phases. Elsewhere, symbols or notes are used to determine the proportion of other kinds of soil included within the mapping unit as well as the range covered by each of the properties used in defining the unit.

Slope phases (e.g. steep slopes, exceeding 11°) are separated on all maps. This is done in the field by direct measurement, often supplemented by information from the contoured 1:25,000 O.S. map and from air photographs.

Some surveys are made by boring on a strict grid pattern or at randomly selected points; systemmatic recording of data from grid sampling enables soil characteristics to be expressed numerically and variability given on a statistically sound basis. Where the grid is wide (1 km spacing or more), the location of soil boundaries is very dependent on their appearance and accurate interpretation on air photographs. On the other hand, a dense grid (100 m spacing) allows field boundaries to be located accurately and at the same time supplies the data necessary for calculating variability. Pattern sampling methods need to be integrated with the intuitive sampling used in free survey, and a grid of pits is useful to assess the variability of more extensive mapping units.

6. Soil Sampling and Laboratory Analysis

Representative profiles are dug by hand or Proline auger, described, and sampled for laboratory analysis. This is done after the soils have been identified, a legend prepared, and a reasonable assessment made of their distribution, i.e. towards the end of field survey. Whole horizons are sampled, and sample intervals are the same as the vertical distances between horizons. Samples are taken from one profile of each soil series or phase covering more than 1 per cent (1 sq km) of the map sheet. Undisturbed samples are also taken for micro-morphological and soil physical measurements, either by small portable corer or from the larger Proline cores.

Samples for analysis are sent to the Headquarters laboratory, with two typed copies of the soil profile and site description, including the grid reference. Field identification is confirmed by analyses of particle size distribution, organic carbon, calcium carbonate equivalent, dithionite extractable iron, and pyrophosphate extractable iron, aluminium and carbon. Determinations are also made of loss-on-ignition and pH (in water and 0.01 M $CaCl_2$), and of cation-exchange capacity on selected samples.

Variability studies, with statistically adequate sampling, can also be made of soil chemical properties in certain cases.

The Survey's Soil Moisture Unit at Derby measures the moisture release characteristics of undisturbed samples from selected soil series. Determinations are made on triplicate core samples from each horizon of four representative profiles in each series.

7. Preparation of Final Map Key

This key summarizes the data obtained in the survey, classifies the taxonomic units and identifies the mapping units to be shown on the final soil map. The preparation involves the final comparison and correlation of units with existing soils where possible and the setting-up of new unit names for others.

The key provides the means of circulating information about the completed survey to other staff to aid correlation and is the framework for the written account. Apart from selection of final symbols for new units the key at this stage is in the form to be used on the published map. The map and key are then passed to the cartographers for stage 8. Recommendations are also made for the colours to be used when hand colouring the black and white published maps.

8. Preparation of Text and Illustrations

The text accompanying each map reviews briefly the physical geography, climatic environment, geology and geomorphology of the area. The soils are then described in detail, in general terms as well as representative profiles. The results of laboratory analyses are given with each profile for which they are available. The overall objective is to characterize every relatively homogeneous tract of land sufficiently to allow accurate assessment of its fundamental nature and practical usefulness.

In certain areas, the text also includes a brief assessment of the agricultural capability of the different soils, prepared by a local panel of experts under the guidance of the National Agricultural Advisory Service. This supplementary account is accompanied by a second map at a scale of 1:25,000 showing the distribution of land in the different classes of agricultural capability recognized in the scheme used by the Survey. In all probability this practice will be extended to all sheets in the programme. In some cases, a third 1:25,000 map derived from the soil map, is prepared to show the distribution of other single soil factors, for example soil drainage classes.

Texts are edited by senior staff, conformity being ensured by the Publications Group who also deal with the printers.

Block diagrams play an increasingly important role in illustrating the texts of Soil Survey publications. The 1:25,000 map sheets included in the Survey's mapping programme are chosen to represent landscapes typical of substantial areas in each county. They therefore represent one or more recurrent patterns of soil distribution or soil associations. These landscape units are recognized during the survey, and block diagrams prepared to illustrate them in the publication accompanying the map. The technique at present is to prepare a three-dimensional model in plastic of part or the whole of a survey area selected by the surveyor. The soil distribution is marked with boundary lines and symbols, and the model photographed.

9. Preparation of the Soil Map

A 1:25,000 map showing boundaries to appear on the published 1:25,000 scale map is prepared by the surveyor from the 1:10,560 scale field sheets, and a clean copy sent, with the field sheets to the Cartographic department. It is accompanied by a legend explaining the mapping units, for printing on the map sheet. The 1:25,000 map prepared by the surveyor need not be exact but it ensures that boundaries coincide on adjacent field sheets and that all separates carry symbols identified on the legend. Copies of this map retained by the surveyor are useful in writing the account of the map and for use at the centre in the period before the final printed map is available.

In the Cartographic department the 10,560 field sheets are redrawn, photographed and reduced on stabilized film at a scale of 1:25,000.

The reduced copies are then scribed on sheets of Stabilene "Scribe Coat", a stable, rust-coloured material which is keyed to a blue printed impression of Ordnance Survey topography. Soil symbols, produced on strips of transparent film by a photo lettering machine, are fixed to a separate transparent sheet by wax adhesive. The fair drawing stage is completed by the construction of the key for the map. Photo-copies are returned to the surveyor for checking.

The completed soil map, with legend, is then sent to the Ordnance Survey for printing. Proof copies and the published map are usually available within three to six months of fair drawing.

MEMOIRS OF THE SOIL SURVEY OF ENGLAND AND WALES

Soils of the Preston district of Lancashire (Sheet 75) by E. Crompton (with map) (1966)

Soils of the South-west Lancashire Coastal Plain (Sheets 74 and 83) by B.R. Hall and C.J. Folland (with 2 maps) (1967)

The County of Anglesey - Soils and Agriculture (Sheets 93, 105 and parts of 92, 94, 106, 118 and 119) by E. Roberts (with map) (1958)

The soils and land use of the district around Bangor and Beaumaris (Sheets 94 and 106) by D.F. Ball (1963)

The soils and land use of the district around Rhyl and Denbigh (Sheets 95 and 107) by D.F. Ball (1960)

The soils and land use of the district north of Derby (Sheet 125) by E.M. Bridges (with map) (1966)

The soils of the Wem district of Shropshire (Sheet 138) by E. Crompton and D.A. Osmond (with map) (1954)

The soils of the Church Stretton district of Shropshire (Sheet 166) by D. Mackney and C.P. Burnham (with 2 maps) (1966)

The soils of the district around Cambridge (Sheet 188) by C.A.H. Hodge and R.S. Seale (with map) (1966)

The soils and land use of the district around Aylesbury and Hemel Hempstead (Sheet 238) by B.W. Avery (with map) (1964)

Soils of the Reading district (Sheet 268) by R.A. Jarvis (with map) (1968)

The soils of the Mendip district of Somerset (Sheets 279 and 280) by D.C. Findlay (with 2 maps) (1965)

The soils of the Glastonbury district of Somerset (Sheet 296) by B.W. Avery (with map) (1955)

Soils of the Leeds district (Sheet 70) by A. Crompton and B. Matthews (with map) (1970)

Soils of North Cardigan (Sheets 163 and 178) by C.C. Rudeforth (with 2 maps) (1970)

Soils of the Melton Mowbray district (Sheet 142) by A.J. Thomasson

BULLETINS OF THE SOIL SURVEY

Soils of the Middle Teign Valley district of Devon by B. Clayden (with map) (1964)

The soils of the West Midlands by D. Mackney and C.P. Burnham (with map) (1964)

Soils of the West Sussex Coastal Plain by J.M. Hodgson (with 4 maps) (1967)

Soils of Romney Marsh by R.D. Green (with map) (1968)

Soils of Lancashire by B.R. Hall and C.J. Folland (with map) (1970)