

THE SOILS OF ENGLAND AND WALES

By C. P. BURNHAM

Wye College (University of London) Nr. Ashford, Kent.

With an Appendix and 1:2,000,000 map

By B. W. AVERY, D. C. FINDLAY and D. MACKNEY,

Soil Survey of England and Wales

ABSTRACT

Soil variation is great, but not random. Most of it results from relatively few processes, and arises from five factor groups: parent material, climate, relief, biotic factors and time. Examples of their effects are given from South Shropshire, and their wider regional implications are also discussed. The description and classification of soils in standard terms requires a specialised vocabulary, which is explained in the Appendix, facilitating the use of the annexed soil map of England and Wales (1:2,000,000).

INTRODUCTION

MANY field scientists are interested in soils. Geographers, geologists and agricultural scientists all engage in soil studies, while the subject has immediate relevance to ecologists and archaeologists too. Soils are very variable in their properties, and to many their diversity is baffling, yet it is never random because of the interdependence of soil formation and other aspects of the environment. This short account illustrates this interdependence within England and Wales, and will assist in the understanding of more detailed works. A fuller general account of the soils of Britain has been written by Curtis *et al* (1976), the technical description of soil profiles has been described by Hodgson (1974) and detailed maps and reports on many specific areas have been made by officers of the Soil Survey of England and Wales. Lists of Survey publications can be obtained from their headquarters (see References) or from the Annual Report of Rothamsted Experimental Station.

I. SOIL PROCESSES

The soil profile is the basic unit in the study of soils (pedology) and in soil survey work. Exposed in a cutting or pit, it consists of a vertical section through various layers (soil horizons) from the surface down to the relatively unaltered geological material. Soil horizons result from the interactions between a relatively few complex and imperfectly understood physico-chemical processes and the soil parent material.

(1) *Weathering*

Parent materials (i.e. those from which soil is derived) may be disintegrated physically by wetting and drying, freezing and thawing and the wedging action of roots, especially along grain boundaries and natural weaknesses, such as joints. Chemical changes are more drastic, producing new minerals often in very small crystals, notably hydrated ferric oxide and the clay minerals. The resulting soil horizons often have more clay and are of a brighter brown or yellow colour than their parent material.

(2) *The incorporation of organic matter*

The uppermost horizons of a soil profile are generally darker in colour and richer in organic matter than the lower ones, because soil organisms are only able to transform plant material and mix it with the mineral soil near the surface. The rate at which plant remains decompose depends on such environmental conditions as temperature, water content and acidity; In base-rich well-aerated soils it is usually swift, with mineral and organic components thoroughly mixed to form a mull: in strongly acid soils the rate of decomposition appears to be slower, and the organic horizons, more or less clearly separable from the mineral soil, are termed either moder or mor. Peat is characteristic of more or less permanently waterlogged sites where decomposition is slow.

(3) *Leaching, mechanical eluviation and podzolisation*

In Britain, part of the rain arriving at the soil surface is evaporated or, after penetrating a short distance, is taken up and transpired by plants. Part may run off the surface. The remainder soaks through the soil, and may cause leaching, mechanical eluviation and podzolisation (Fig. 1).

Water moving through the soil dissolves and removes soluble components—the process of leaching. The upper soil horizons are, therefore, continually being depleted of bases, such as calcium, magnesium, sodium and potassium, and unless the losses are made good by additions of lime and fertilisers soils tend to become impoverished and acid.

Fine soil particles, such as clay, may also be moved downwards whilst suspended in soil water, and when subsequently deposited, form a layer containing more fine particles than the layers above and below. Clay transported in this way is usually unchanged in composition, and the process is known as mechanical eluviation.

Podzolisation is associated with strongly acid moder or mor; organic compounds liberated by decomposition of plant residues react with iron and aluminium oxides and hydroxides to form complexes that readily move in percolating solutions, so forming a well defined, bleached, subsurface layer depleted of iron, and contrast-

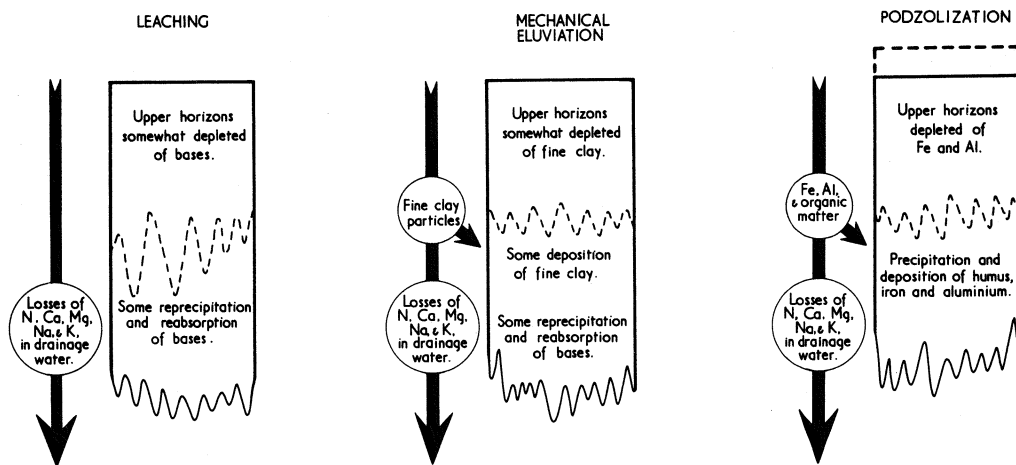


FIG. 1.
Processes connected with the movement of soil water.

ing dark-coloured and/or ochreous layers below where humus and hydrated oxides of iron and aluminium respectively have been precipitated.

(4) *Gleying*

Soils periodically or permanently waterlogged develop horizons variegated or mottled with grey and ochreous colours; these are caused either by reduction and re-oxidation of iron compounds under alternating anaerobic and aerobic conditions, or by partial removal of iron in the more soluble ferrous form.

This process, known as gleying, is largely microbiological. Either observations of soil wetness, or inferences from the extent of gleying and peat formation, can be used to assess whether soils are freely, imperfectly, poorly or very poorly drained.

II. FACTORS OF SOIL FORMATION

Soil horizons result from the modification of parent material by various processes. The extent of modification depends on the nature of parent material, on past and present environmental factors such as climate, vegetation and hydrological conditions, and on the length of time the processes have been acting in more or less stable landscapes. Human influence in particular has greatly disturbed previous equilibria and caused major changes in vegetation and the characters of soil horizons.

(1) *Parent material*

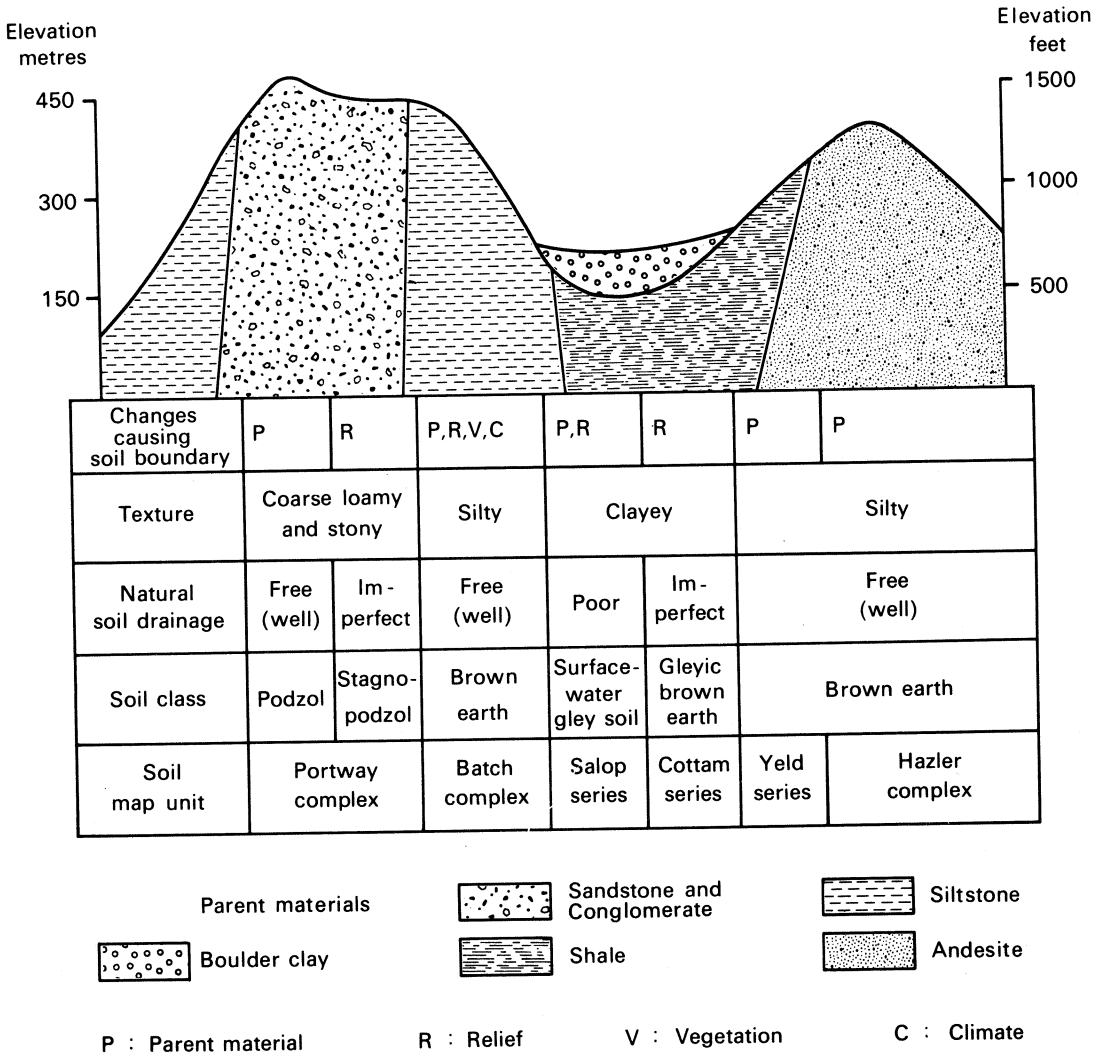
Particularly important properties are permeability, base content and weatherability of the material, together with texture and mineralogy of the weathering product. For example, in Fig. 2, the relatively impermeable boulder clay, which yields clayey soils, is associated with waterlogging and with gleyed soils; the moderately permeable fissured andesite and siltstone with brown earths*; and the very permeable sandstone and conglomerate with podzols. The shale and boulder clay are soft and easily weathered, yielding deep soils, while the relatively hard conglomerates, sandstones, siltstones and andesites give shallow stony soils. Only the boulder clay contains calcium carbonate, giving subsoils near neutrality. The andesite is relatively rich in bases, but weathers so slowly that unlimed soils on it are moderately acid. The conglomerates, sandstones and siltstones lack bases and give strongly acid soils when unlimed. The shale varies in base content so that there is corresponding variability in derived soils. Changes in soil profile type reflecting changes in parent material are marked 'P' on Fig. 2.

Only a minority of British soils are derived from "solid" geological formations, most are from younger superficial ("drift") deposits, some of which are too thin or indeterminate to be indicated on geological maps.

(2) *Climate*

The elements of climate mainly affecting soil development are rainfall and temperature and, although considered separately, they do not operate independently (Burnham & Mackney, 1964). Temperature affects the speed of both chemical and biological changes. The balance between precipitation and evaporation determines the amount of water available to percolate through the soil, and remove constituents by leaching. In Britain striking climatic changes are related to

*See p. 361 for definitions.



NOTES: i) A soil complex consists of two or more series mapped as a single unit
 ii) All solid geological boundaries are faulted or very steeply dipping

FIG. 2.
 Simplified classification of soils along a traverse near Church Stretton, Shropshire.

differences in altitude. The Church Stretton Valley in Shropshire (Fig. 2) has about 850 mm (33 in.) of rain annually, while the Longmynd, 300 m (1,000 ft.) higher, has about 1,150 mm (45 in.). The combination of more rainfall and lower temperature encourages peaty surface layers and podzolic soils on the gentle slopes of the Longmynd summit but they are absent from equivalent sites in the Church Stretton valley, where peat is confined to occasional enclosed hollows.

(3) *Relief*

The shape of the ground surface strongly affects the movement and accumula-

tion of water in and around the soil. If it lies over relatively impermeable parent materials, most water which is not evaporated or transpired runs off. Where flat topography impedes run-off, surface waterlogging will affect the soil especially in winter and spring, producing a pattern of soil distribution such as that shown in Fig. 3a (and the boundaries marked 'R' on Fig. 2). In readily permeable materials water penetrates the subsoil until it reaches the water-table, leaving high flat land well drained (Fig. 3b). In the lower parts of such landscapes a permanently waterlogged substratum normally underlies a mottled layer affected by a rising water-table in winter: such soils are ground-water gley soils. These effects are more fully discussed by Thomasson (1974).

On sloping ground, run-off removes soil particles, especially under cultivation, leaving a shallow soil. The eroded material, called colluvium or hill-wash, is deposited at the foot of slopes, building up deeper soils. Fig. 4 illustrates a particular, but widespread, case where the hill-wash contains comminuted limestone.

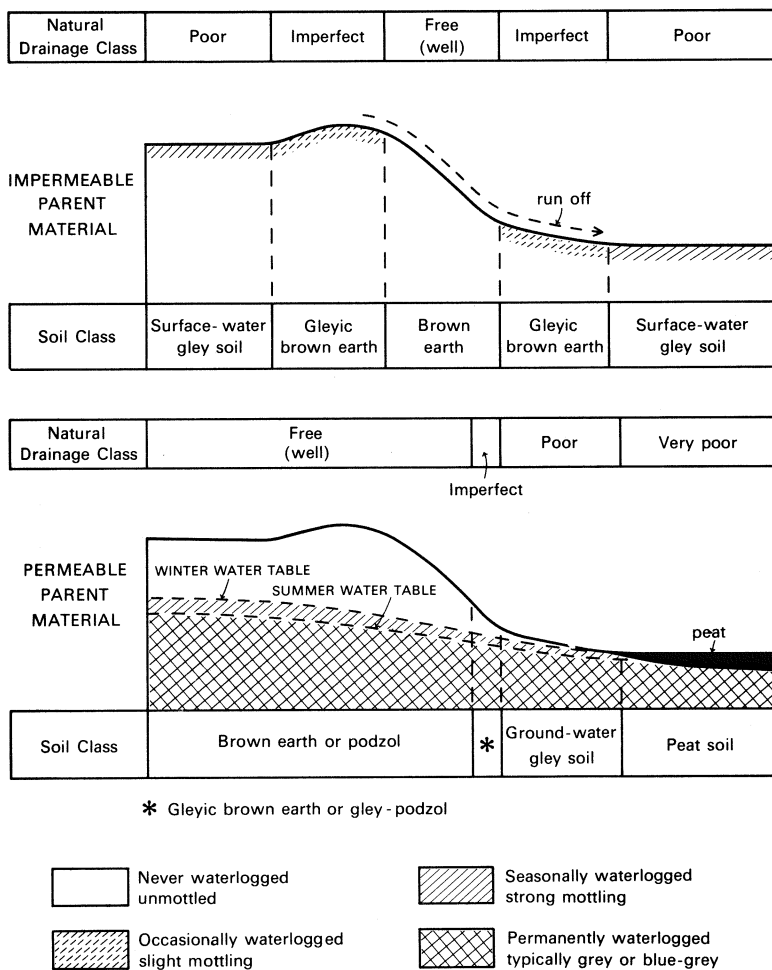


FIG. 3. Effect of relief and hydrology on soil and drainage.

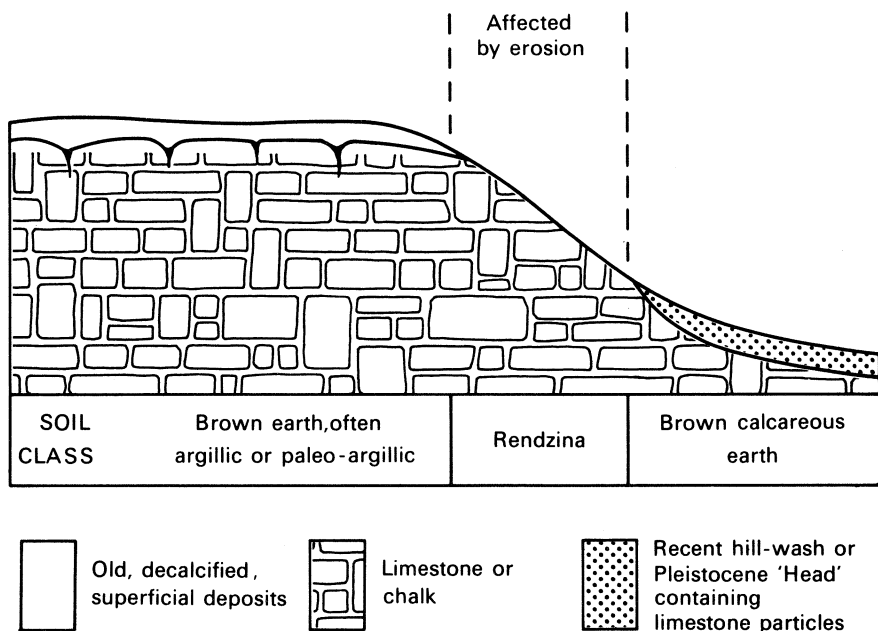


FIG. 4.

Relationship between relief and soil classes in limestone and chalk terrain.

(4) *Biotic factors*

The soil is only one part of an ecosystem that includes the plants and animals dependent upon it. In uncultivated land soil characteristics influence the plants that are found; in the Church Stretton area heather and bilberry are associated with podzols while on brown earths bracken, grasses and deciduous trees occur. Indeed it is generally believed that heather and conifers actively promote podzolisation, while most grasses and broad-leaved trees, in conjunction with earthworms, maintain the well-mixed soil humus characteristic of brown earths, known as mull.

In developing countries particularly, man has profoundly affected the soil. Fertilisers, lime, cultivation and drainage have partly obscured the natural relationships shown in Fig. 5, but without entirely obliterating them.

(5) *Time*

Many soil forming processes are slow, but cumulative in their effect, and one may prepare the way for another; thus extreme leaching of bases precedes podzolisation. The length of time a soil has remained undisturbed by erosion or deposition is an important factor in its evolution, so that soils on slopes or alluvial plains tend to be young, while old soils are often associated with plateaux, especially when over permeable material which discourages run-off and dissection. Thus, the age of a soil is closely connected with relief: Fig. 4 illustrates this with reference to the leaching of soils over limestone. On slopes erosion removes soil material before all its calcium carbonate has been lost. At the foot of slopes calcareous soils are also found resulting from the accumulation of this eroded material and the passage of lime-rich water. In contrast the less disturbed soils on the plateau have suffered deep and complete leaching, and will often contain no calcium carbonate right down to a

limestone surface, itself being dissolved. Such relics of older soils (e.g. the "clay-with-flints") are found in southern England beyond the limits of ice advance during the Pleistocene, although even so the addition of wind-borne materials and disturbance by cryoturbation (front churning) precludes a simple interpretation. In Scotland, Wales and northern England the erosion and deposition associated with recent glaciations have ensured that almost all soils are comparatively young. Even here, however, time sequences occur in soils on alluvium and dune sand.

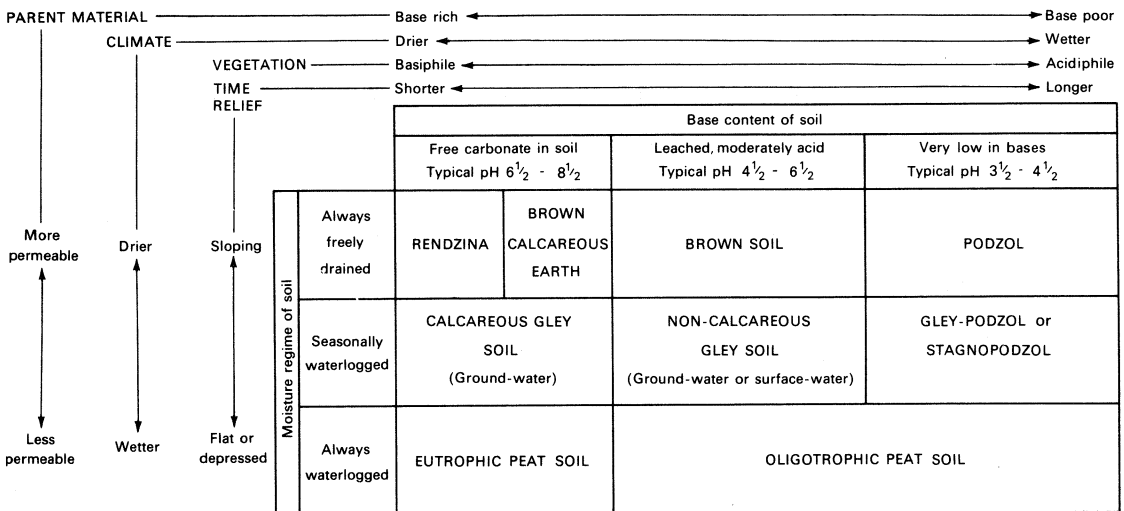
Fig. 5 summarises the most important factors that produce soil differences in Britain and thus control the distribution of soil types. Since the factors are gradational in their effect, soil types also grade one into another, particularly those which adjoin in the Table. Thus gleyic brown earths are intermediate between brown earths and gley soils, and humic gley soils between gley soils and organic soils, while intergrades between brown earths and podzols are also common.

III. SOIL PROPERTIES

The recognition and description of soil horizons require a specialised technique for which a scheme is offered in the Soil Survey Field Handbook (Hodgson, 1974) based on colour, texture, structure and organic content. However, a brief guide to the assessment of soil properties in the field follows.

(1) Colour

Munsell Soil Color Charts are used to record soil colours: in this system the soil is compared with a series of standard colours designated by a number and letter notation (e.g. 10YR 5/4) as well as by a description in words (e.g. yellowish brown).



NOTE: pH figures refer to natural soils (unlimed)
Arrows indicate tendencies not all of which apply to a given situation

FIG. 5.

Some effects of formative factors in British soils; arrows indicate tendencies not all of which may apply to a given situation.

(2) *Soil Texture*

Mineral particles less than 2 mm in diameter are grouped in three size fractions: sand (0.06 to 2.0 mm), silt (0.002 to 0.06 mm) and clay (finer than 0.002 mm). Soils can be regarded as containing a mixture of these fractions in proportions which can be determined in the laboratory by sieving and settling in water (mechanical analysis) or estimated in the field by feeling a wetted sample (Table 1). Particles larger than 2 mm in diameter are considered separately as "stones". Sandy soils are rough or gritty and cohere weakly. Farmers describe sandy soils as coarse textured or "light" since they work easily, but their capacity to retain water or plant nutrients

Table 1. *Scheme for finger assessment of soil texture*

1. Does the moist soil form a coherent ball?
Easily . . . (2)
With great care . . . LOAMY SAND but check using tests 2 and 3
No . . . SAND
2. What happens when the ball is pressed between thumb and forefinger?
Flattens coherently . . . (3)
Tends to break up . . . SANDY LOAM but check using tests 3 and 4
3. On slight further moistening can the ball be rolled into a thick cylinder (about 5 mm thick)?
Yes . . . (4)
No, collapses . . . LOAMY SAND
4. On slight further moistening can the cylinder be rolled into a thin thread (about 2 mm thick)?
Yes . . . (5)
No . . . SANDY LOAM
5. Can the thread be bent into a horseshoe without cracking, e.g. around the side of the hand?
Yes . . . (7)
No . . . (6)
6. On remoulding with further moisture what is the general 'feel' of the soil?
Smooth and pasty . . . SILT LOAM
Rough and abrasive . . . SANDY SILT LOAM
7. Can a ring of about 25 mm diameter be formed by joining the two ends of the thread without cracking? (If necessary remould with more moisture and begin again)
Yes . . . (9)
No . . . (8)
8. On remoulding with further moisture what is the general 'feel' of the soil?
Very gritty . . . SANDY CLAY LOAM
Moderately rough . . . CLAY LOAM
Doughy . . . SILTY CLAY LOAM
9. On remoulding without rewetting can a surface be polished with the thumb?
Yes, a high polish like wax with few noticeable particles . . . (10)
Yes, but gritty particles are very noticeable . . . SANDY CLAY
No . . . (8)
10. On wetting thoroughly, how strongly does the soil stick one's fingers together?
Very strongly . . . CLAY
Moderately strongly . . . SILTY CLAY

is small. Clayey soils are sticky when wet and both coherent and pliable when moist. They are "heavy", i.e. difficult to work, and impermeable, tending to become waterlogged in wet seasons, while shrinking to form hard clods when dry. Silty soils are coherent without being sticky, slaking readily to a paste under traffic or the impact of rain. Loamy soils have a mixture of all three grades, and 'coarse loamy' soils in particular, which have a fairly high content of sand, are ideal agricultural soils.

(3) *Soil Structure*

Structure describes the shape and size of aggregates (peds) of soil particles; the aggregates are often small near the surface (crumb or fine blocky) but are larger in fine-textured subsoils, where they may be equidimensional (coarse blocky) or vertically elongated (prismatic). Structure is produced by the natural processes of wetting and drying, freezing and thawing, and by the activities of roots and soil fauna, and is not exactly the same as tilth, which is produced by the fragmentation of peds by cultivation.

(4) *Other properties*

Some other properties, such as depth of root penetration and the activities of the larger soil organisms (e.g. earthworms), can be observed directly. Others can be estimated with reasonable accuracy in the field, e.g. reaction with B.D.H. soil indicator or a portable pH meter. Still others can be placed only in broad categories in the field and are best determined in the laboratory, such as content of moisture and of organic matter, which can be estimated only very roughly from colour and consistence. Calcium carbonate content can be judged by the amount of effervescence with dilute hydrochloric acid. Slight effervescence indicates between 1 and 5 per cent, moderate to strong effervescence more than 5 per cent calcium carbonate. Soils that do not effervesce are considered non-calcareous.

Indexing soil horizons

As an aid to classification soil scientists use a letter notation to refer to soil horizons. The notation used in Britain usually includes a capital letter and a lower case letter. The significance of the capital letter is as follows:

L—Little decomposed litter

F—Comminuted litter with some plant structure [F for fermenting]

H—A thoroughly decomposed organic layer, often with some mineral particles [H for humus]

O—Organic layer (i.e. peat) formed under poorly drained conditions

A—A mainly mineral surface horizon with well incorporated organic matter. When ploughed Ap is used

E—Subsurface horizons depleted of clay or sesquioxides (iron and/or aluminium) [E for Eluviated]

B—Other altered subsoil horizons

C—Soft or unconsolidated, comparatively unaltered substratum

R—Bedrock too hard to dig with a spade even when moist [R for Rock]

G—An intensely gleyed horizon which changed colour on exposure to air (normally used with C, i.e. CG) [G for Gley]

The lower case letters are often indicative of processes, e.g.

h—added humus

s—added sesquioxides

t—added clay

g—features indicating gleying etc.

“Mull” is a characteristic A horizon which may be covered by a thin L horizon, but F and H horizons are scanty or absent. “Moder” characteristically has an H horizon thicker than the L and F combined. “Mor” (raw humus) has thick L and F layers.

IV. SOIL CLASSIFICATION

The user is aware of soil diversity, whether he be a farmer, a civil engineer or a potato merchant. By allowing for the differences in a familiar area one unconsciously classifies soils. Most farmers could make some sort of soil map of their holdings. To put the classification and mapping of soils on a uniform scientific basis is much more difficult, for no two places have soils identical in every respect. Moreover soils have many properties, some of which can be assessed in the field and others only in the laboratory. Different users will not agree about the priority attaching to these properties: to the lime merchant acidity, or to the gas engineer liability to corrode pipes, may be all-important; while the ecologist or agricultural adviser concerns himself with a wider range of soil properties. To find a single classification suitable for everyone is impracticable.

In classifying plants and animals much emphasis is given to characters believed to indicate evolutionary relationships. Soils are formed by physical, chemical and biological processes and classifications which emphasise properties indicating the nature and extent of these processes have been called natural or genetic. A number of genetic classifications have been proposed, with considerable variation in nomenclature.

The soil classification hitherto used by the Soil Survey of England and Wales has been set out with slight variations in many memoirs and by Burnham and Mackney (1964) and includes three levels; major groups, subgroups and soil series. A revised classification (Avery 1973) has recently come into use which recognises four levels: major groups, groups, subgroups and soil series. A summary of Avery's classification is given in the Appendix.

Subgroups of the genetic classification are divided by texture and parent material into soil series. Soil series are named after localities where examples are known to occur. For example, the Salop series is a typical stagnogley soil in “Irish Sea” boulder clay. While thus defined as a profile class, soil series are commonly used as mapping units on detailed soil maps though within the area delimited as occupied by one soil series there are always small inclusions of others.

V. GEOGRAPHICAL DISTRIBUTION OF SOILS IN ENGLAND AND WALES

(1) *Regional tendencies*

Examination of the coloured soil map of England and Wales appended to this paper will reveal a pattern of soil distribution reflecting regional climatic differences.

The brown soil of drier lowlands (less than 1,000 mm (40 in.) rain per year) are commonly moderately acid argillic brown earths. Eluviation of clay into subsoils, a process encouraged by warm dry summers, is quite marked in south-east England but diminishes northwards and westwards. The small rainfall of the drier lowlands also limits leaching and, as many parent materials contain calcium carbonate, calcareous soils are common. Because much of the landscape is flat surface-water (stagno-) gley soils are common too, but dry summers confine peat to depressions. Limited leaching acts again to make many of these gley soils calcareous, and most of the peat is in fens. Podzols are confined to sandy or gravelly materials. The wetter lowlands (over 1,000 mm (40 in.) rain per year) have brown earths which lack appreciable clay eluviation, and are quite strongly acid when unlimed. Calcareous soils are rare. Despite more undulating topography, the wetter climate gives some gley soils, but these are almost always non-calcareous. Although peat is again confined to hollows, it is generally oligotrophic (i.e. acid).

The uplands are both cold and wet. Peat formation is a regional tendency and most flat land is blanketed with thick acid peat, which thins into stagnohumic gley soils and stagnopodzols on gentle slopes. On steeper slopes podzols and brown podzolic soils (intergrading between brown earths and podzols) form on silty and loamy as well as sandy materials. Steep slopes have shallow stony soils that are often rankers, interspersed with bare rock, and somewhat deeper stony brown podzolic soils.

(2) Soil maps

Maps at scales of 1:25,000 and 1:63,360 showing soil series have been produced by the Soil Survey of England and Wales for a number of areas, but the cover will remain incomplete for some years. These maps are usually accompanied by Soil Survey Records (1:25,000 series) or memoirs (1:63,360 series), giving detailed information about the soils including their utilisation and their Land Use Capability in terms of a system described by Bibby and Mackney (1969). A form for the practical application of this system in the field has been published by Burnham and McRae (1974).

Smaller scale maps use more generalised mapping units known as soil associations. The Soil Survey has published a soil map of England and Wales at 1:1,000,000 and a series at 1:250,000 is in preparation. Lancashire, Cheshire, Hertfordshire and Berkshire already have published soil maps at 1:250,000.

REFERENCES

- AVERY, B. W. (1973). Soil classification in the Soil Survey of England and Wales. *Journal of Soil Science*, **24**, 324-38.
- AVERY, B. W., FINDLAY, D. C. and MACKNEY, D. (1974) *Soil Map of England and Wales, 1: 1,000,000*. Ordnance Survey. Southampton.
- BIBBY, J. S. and MACKNEY, D. (1969). *Land Use Capability Classification*. Soil Survey Technical Monograph No. 1 Harpenden.
- BURNHAM, C. P. and MACKNEY, D. (1964). Soils of Shropshire. *Field Studies*, **2**, 83-113.
- BURNHAM, C. P. and McRAE, S. G. (1974). Land Judging. *Area*, **6**, 107-111.
- CURTIS, L. F., COURTNEY, F. M. and TRUDGILL, S. (1976). *Soils in the British Isles*, Longman, London.
- HODGSON, I. M. (1974). *Soil Survey Field Handbook*. Soil Survey Technical Monograph. No. 5, Harpenden.
- MACKNEY, D. (1974) *Soil type and land capability*. Soil Survey Technical Monograph No. 4, Harpenden.

MUNSELL SOIL COLOUR CHARTS. Available from Tintometer Ltd., Waterloo Road, Salisbury, SP1 2JY.
THOMASSON, A. J. (1974). Soil type, water conditions and drainage. In *Soil type and land capability*. ed. D. Mackney. Soil Survey Technical Monograph No. 5, Harpenden.

NOTE: Publications of the Soil Survey of England and Wales are available from:
Rothamsted Experimental Station,
Harpenden,
Herts. AL5 2JQ.

APPENDIX

SOIL MAP OF ENGLAND AND WALES, 1:2,000,000

B. W. Avery, D. C. Findlay and D. Mackney
Soil Survey of England and Wales

This map is based on detailed and reconnaissance soil surveys, geological and relief maps. Soil maps at 1:25,000 and 1:63,360, cover some 20 per cent of the land including parts of most counties. Extrapolation of boundaries into unmapped terrain relies chiefly on inferred relationships between soil pattern and geology or relief.

The 22 map units shown are geographic soil associations identified by dominant (most frequently occurring) soil groups. Associated soils (sub-dominant soils) are indicated and the important agricultural properties of both dominant and associated soils listed. In most map units the dominant soil is associated with differing combinations of sub-dominant soils, reflecting variations in lithology and relief. This method of grouping has allowed the construction of a map which is simple in having a small number of units. More detailed information is presented on the soil map of England and Wales at the scale 1:1,000,000 (Avery *et al* 1974), which displays 71 units.

SOIL CLASSIFICATION

The soil groups are differentiated primarily by observable or measurable characteristics of the soil profile, including distinctive surface and subsurface horizons resulting from alteration of the original material by pedogenic processes, and proportions of organic matter, calcium carbonate and differently sized mineral particles within specified depths.

Soil materials containing more than 20-30 per cent organic matter, depending on clay content, are classed as organic. Mineral or organo-mineral soil materials, containing less organic matter, and less than 70 per cent by volume of stones (2-200 mm), are classed as sandy, clayey or loamy according to mass-percentages of sand (2,000-60 μm), silt (60-2 μm) and clay sized particles (<2 μm) in the inorganic fraction (<2 mm), as follows:

- Sandy: percentage silt+twice percentage clay less than 30
- Clayey: more than 35 per cent clay,
- Loamy: other materials of intermediate composition.

Loamy soils with less than 18 per cent clay and more than 20 per cent sand are differentiated as coarse loamy and those with less than 20 per cent sand as silty.

Soil materials containing 5-35 per cent by volume of stones are described additionally as stony, those with 35-70 per cent stones are very stony and water-sorted materials with more than 70 per cent stones as gravel or shingle.

Organo-mineral materials with more than 8-12 per cent organic matter, depending on clay content, are further distinguished as humose.

Soil profiles are also classed as organic, sandy, clayey, etc with the general implication that at least the upper 40 cm, or a similar thickness starting directly below the topsoil or most of the profile if bedrock supervenes, has the composition named. Similarly, a predominantly mineral profile is considered to have a humose topsoil if at least the upper 15 cm is humose, and a peaty topsoil if it has a superficial organic layer 7.5-40 cm thick, formed under wet conditions.

Characteristics of the soil groups recognised are summarised below, and are described in greater detail by Avery (1973).

Raw soils. These have no distinct pedogenic horizons other than a superficial organo-mineral or organic layer less than 7.5 cm thick, or a buried horizon below 30 cm depth. They are usually sparsely vegetated and of negligible value for agriculture or forestry.

Raw sands. Raw sandy soils, chiefly dune sands.

Raw Skeletal soils. Extremely stony and/or very shallow raw soils, including screes, mountain-top detritus and shingle beaches.

Lithomorphic (A/C) soils. These have a distinct organo-mineral A or occasionally organic surface horizon and bedrock or little altered unconsolidated material at 30 cm or less.

Rendzinas. Calcareous soils normally well drained and usually shallow, over shattered limestone, chalk or soft, extremely calcareous (>40 per cent CaCO_3) material.

Rankers. Non-calcareous soils, normally well drained and usually shallow, over non-calcareous rock or massive limestone.

Brown soils. Well drained or moderately well drained soils with an altered subsurface B horizon, usually brownish, that has soil structure rather than rock structure and extends below 30 cm depth.

Brown alluvial soils. Loamy or clayey soils in recent alluvium with a brown or reddish subsurface horizon. Lower horizons are often seasonally wet but the water-table seldom rises to within 40 cm of the surface.

Brown calcareous sands. Sandy soils with a brownish, moderately calcareous subsurface horizon.

Brown sands. Sandy soils with a brown or reddish non-calcareous subsurface horizon.

Brown calcareous earths. Loamy or clayey soils, excluding pelosols (see below), with a brownish, friable, moderately calcareous, subsurface horizon in materials other than recent alluvium.

Brown earths (in the strict sense). Loamy soils with a brown or reddish, friable, non-calcareous subsurface horizon, normally similar in texture to the topsoil, in materials other than recent alluvium.

Argillic brown earths. Loamy or loamy over clayey soils with a subsurface horizon of clay accumulation, normally brown or reddish.

Paleo-argillic brown earths. Loamy, loamy over clayey, or clayey soils with a strong brown to red subsurface horizon of clay accumulation, normally attributable to pedogenic alteration of the original material before the last (Weichselian) glacial period.

Podzolic soils. Well drained to poorly drained soils with black, dark brown or ochreous subsurface B horizons, often partly cemented, in which aluminium and/or iron have accumulated in association with organic matter. An overlying bleached E horizon depleted of iron, a peaty topsoil, or both, may or may not be present.

Brown podzolic soils. Loamy or sandy soils, normally well drained, with a dark brown or ochreous, friable subsurface horizon and no overlying bleached horizon or peaty topsoil.

Podzols (in the strict sense). Sandy or coarse loamy soils, normally well drained, with a bleached horizon and/or a dark brown or black compact subsurface horizon enriched in humus, and no immediately underlying grey or mottled (gleyed) horizon, or peaty topsoil.

Gley-podzols. Podzolic soils, normally with sandy or coarse loamy upper horizons, affected by fluctuating groundwater or impeded drainage. They have a dark brown or black subsurface horizon enriched in humus, over a grey or mottled (gleyed) horizon. A bleached horizon, a peaty topsoil, or both, may also be present.

Stagnopodzols. Podzolic soils, usually loamy, with a peaty topsoil, a periodically wet (gleyed) bleached horizon, or both, over a thin iron-pan and/or a brown or ochreous, relatively permeable subsurface horizon.

Pelosols. Clayey soils, usually calcareous or over a calcareous substratum, in materials other than recent alluvium. They crack deeply in dry seasons and have a brown, greyish or reddish, blocky or prismatic sub-surface B horizon, often slightly mottled. These soils are slowly permeable when wet, but a strongly mottled (gleyed) horizon is absent or occurs only below 40 cm depth.

Calcareous pelosols. These have a calcareous subsurface horizon normally similar in texture to the topsoil.

Argillic pelosols. These have a subsurface horizon of clay accumulation, usually decalcified.

Gley soils. Soils with grey and brown mottled or uniformly grey (gleyed) subsurface horizons in which the original material has evidently been altered by reduction, or reduction and segregation, of iron caused by periodic or permanent saturation with water in the presence of organic matter. Horizons characteristic of podzolic soils are absent or, incompletely developed.

1. Gley soils without a humose or peaty topsoil. These are seasonally wet in the absence of effective artificial drainage.

Alluvial gley soils. Loamy or clayey soils in recent alluvium, affected by fluctuating groundwater and often slowly permeable.

Sandy gley soils. Permeable sandy soils affected by fluctuating groundwater.

Cambic gley soils. Loamy or clayey soils in materials other than recent alluvium, with a relatively permeable substratum affected by fluctuating groundwater.

Argillic gley soils. Loamy or loamy over clayey soils with a subsurface horizon of clay accumulation and a relatively permeable substratum affected by fluctuating groundwater.

Stagnogley soils. Non-calcareous loamy, clayey or loamy over clayey soils in which drainage is impeded at moderate depths by a relatively impermeable subsurface horizon or substratum.

2. Gley soils with a humose or peaty topsoil. These are normally wet for most of the year in the absence of effective artificial drainage.

Humic-alluvial gley soils. Loamy or clayey soils in recent alluvium.

Humic-sandy gley soils. Permeable sandy soils affected by a high groundwater table.

Humic gley soils (in the strict sense). Loamy or clayey soils in materials other than recent alluvium, affected by a high ground-water-table.

Stagnohumic gley soils. Non-calcareous loamy, clayey or loamy over clayey soils in which drainage is impeded at moderate depths by a relatively impermeable subsurface horizon or substratum.

Peat soils. These have an organic layer at least 40 cm thick, starting at the surface or at less than 30 cm depth.

Raw peat soils. Peat soils that remain permanently waterlogged (unripened) and/or contain more than 15 per cent of recognisable plant remains within the upper 20 cm.

Earthy peat soils. Peat soils with a relatively firm (drained) surface horizon, normally black containing few or no recognisable plant remains.

ACKNOWLEDGEMENTS

The 1:2,000,000 map was compiled from information supplied by regional Soil Survey staff and drawn by the Cartographic Section. The Clarendon Press Atlas was an invaluable aid in the preparation of the map.

The diagrams and much of the rest of the text have been drawn from previous publications (Burnham and Mackney, 1964, Mackney 1974) with kind permission from D. Mackney, Head of the Soil Survey of England and Wales.