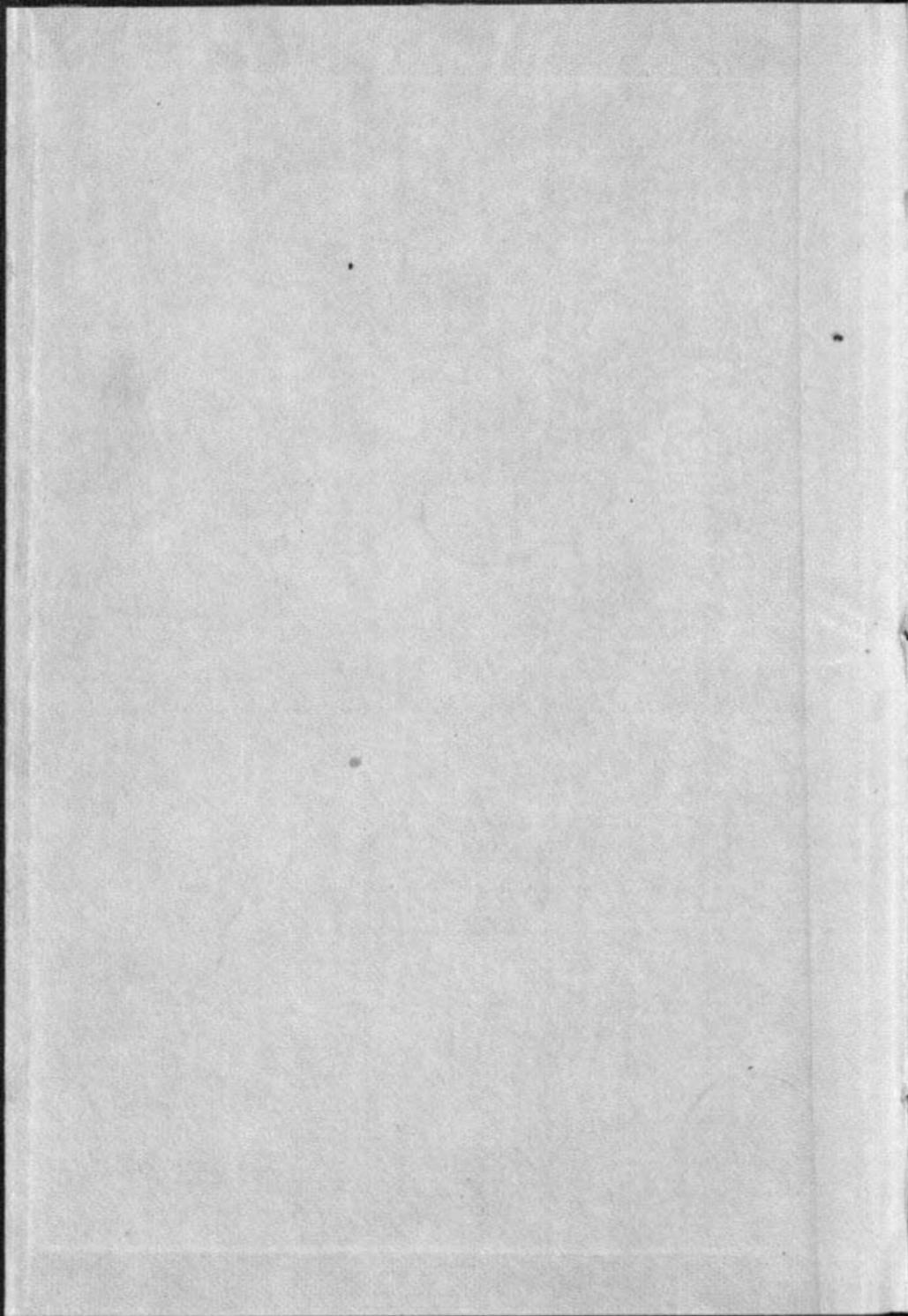


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SOIL SURVEY OF
GREAT BRITAIN

FIELD HANDBOOK



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COMPILED BY THE SOIL SURVEY STAFF

1960

PREFACE

It is now some time since the original Field Handbook was prepared for the Soil Survey by Mr. G. R. Clarke. In the interval older ideas have silently given way to newer and it was felt that a revision of the Handbook was necessary. This has now been done by members of the staff of the Soil Survey with Mr. E. Crompton, who prepared the final version, as convener. This will in future form the basis for soil descriptions appearing in memoirs and other publications of the Soil Survey. In a science that is still relatively young it is to be expected that ideas will continue to change but it is felt that the present Handbook should serve for some years as an aid to uniformity of presentation of soil descriptions that may also prove useful to foresters, ecologists and others needing to describe soils. It should perhaps, be emphasised that the Handbook is meant only as a summary, users wishing further information on the various subjects should refer to G. R. Clarke's "The Study of the Soil in the Field" or to the U.S. Soil Survey Manual.

The main difference of the present from the earlier Handbook is that definitions of the major soil groups have been omitted. It is realized that a revision of the earlier groups is essential, but before this can be done satisfactorily more field and laboratory data are required. In the meantime the soil groups currently used will be defined in the memoirs as required.

The Soil Survey is grateful to Mr. Clarke for allowing this revision of his work to be made and to Mr. E. Crompton for the care he has taken in preparing this new edition.

SOIL PROFILE DESCRIPTION

1. SITE DESCRIPTION.

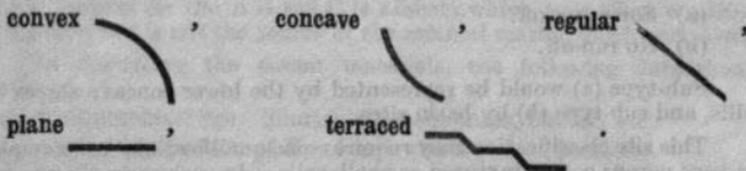
1. **PROFILE No.**
2. **DESCRIBED BY.** Name of the person responsible for the description.
3. **DATE.**
4. **GRID REFERENCE.**
5. **LOCALITY.**

Give a description in words in relation to some features shown on a map (and/or aerial photograph), the number of which should be given; e.g. pit lies some 220x S.S.W. of the S.E. corner of Pickmere Wood, some 12x from left of the stream bank and about 150x from the Terrington—Little Basset road bridge. O.S. Cambs. 45 N.W.

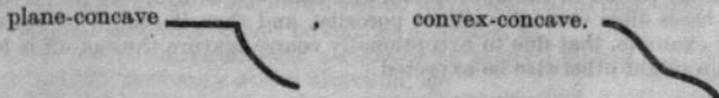
6. **ELEVATION.** In feet O.D.

7. RELIEF.

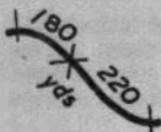
- (a) General description of surrounding countryside and relation of pit to landscape.
- (b) Angle of general slope of site (not micro-relief) in direction of maximum run-off.
- (c) Shape of slope :



Where combinations occur the upper part should be named first : e.g.,



- (d) Position of pit on slope with some idea of scale. A sketch is helpful e.g.



- (e) Aspect : State aspect to nearest $2\frac{1}{2}^{\circ}$ true bearing.
- (f) Micro-relief : e.g. ridge and furrow running NW—SE. Pit half-way between ridge and furrow. Vegetation hummocks, small banks etc. should also be noted.

8. SURFACE DRAINAGE OF SITE.

Although estimates of the probable movements of water over a particular site may be largely an inference from relief, the additional record of the pedologist's judgment on the spot is considered desirable.

As far as possible, therefore, the surface drainage of the site should be recorded, using such of the following headings as are appropriate to the particular case :—

1. **Shedding sites.** Slopes with run-off exceeding the amount of water reaching the site from higher slopes.

Most convex slopes and the upper slopes of hills would belong to this class.

2. **Normal sites.** Slopes on which run-off might be expected to equal approx. the amount of water running down from higher regions onto the site.

This class includes regular slopes and possibly also flat areas except basin sites.

3. **Receiving sites.** Sites receiving more water from the slopes above than is lost by run-off. This type should be sub-divided into :

- (a) Some run-off.
- (b) No run-off.

Sub-type (a) would be represented by the lower concave slopes of hills, and sub-type (b) by basin sites.

This site classification may require some qualification, for example, in very porous coarse-textured or chalk soils. In such cases the run-off may be very slight, even on relatively steep slopes. These sites should first be placed in the appropriate site drainage category as if the soils at these sites were of medium porosity, and then it should be stated, for example, that due to exceptionally coarse texture the run-off is less than might otherwise be expected.

4. **Fresh-water flooding sites.** Soils liable to flooding from a water course. These should be sub-divided into :

- (a) Regular seasonal flooding.
 - (i) short-term flooding : e.g. a few days.
 - (ii) long-term flooding : e.g. several weeks.

- (b) Occasional flooding.
 - (i) short-term flooding.
 - (ii) long-term flooding.
- (c) Springs and flush sites.

A river valley might be included in category 4a (i); a swamp in 4a (ii), and much of the Fens in category 4b, although without artificial drainage the last would be in category 4a (ii).

5. Salt-water flooding sites. These should be sub-divided into :

- (a) Regular flooding.
 - (i) short-term flooding.
 - (ii) long-term flooding.
- (b) Occasional flooding.
 - (i) short-term flooding.
 - (ii) long-term flooding.

6. Irrigated sites. The method, amount and annual duration of irrigation should be stated.

7. Presence and nature of artificial drainage.

9. PARENT MATERIAL.

Parent material may be defined as consolidated or unconsolidated material, relatively little affected by the present weathering cycle, from which the solum has developed, i.e. the C horizon.

In some profiles a D horizon is present ; it is defined as any layer below the C horizon (or the B if the C is absent) which may affect conditions in the solum but is not the source of the mineral matter which comprises it.

In describing the parent materials, the following data should be recorded.

- (a) **Stratigraphical age**—Silurian, Carboniferous, Recent, etc.
- (b) **Angle and direction of dip of rock strata** (where possible).
- (c) **Mode of origin**—This refers mainly to superficial deposits which are products of weathering during and after the Glacial epoch, e.g., lacustrine clays, wind-blown sands, till, Recent alluvium, etc.

Recent alluvium should be further described as

- (i) active alluvium—still accumulating mineral matter,
- (ii) intermittently active alluvium, or
- (iii) stable alluvium—no longer receiving additions of mineral deposits.

It should be further described as river (fresh water) or estuarine (brackish water).

- (d) **Lithological description**—e.g., micaceous sandstone, mudstone, quartzschist, granite, coarse sand, silty fine sand, clay, etc. Under this heading note should be taken of any variability in parent materials, such as stratification, etc.

- (e) **Calcium carbonate content**—(see note on carbonates p. 24).
- | | | |
|--------------|---------------------------|------------------------------------|
| Less than 1 | per cent. CaCO_3 | — non or very slightly calcareous. |
| 1—5 | „ „ | — slightly calcareous. |
| 5—10 | „ „ | — calcareous. |
| More than 10 | „ „ | — highly calcareous. |
- (f) **Any other special parent material features** should be noted. For instance, the presence of large amounts of hydrous ferric oxides may have important effects on the behaviour of a soil, and if the parent material is known to contain unusually high or low amounts of weatherable iron minerals, or of hydrous ferric oxides, the fact should be noted.

10. VEGETATION, etc.

1. (a) Describe the vegetation of the general area, stating, where possible, the type of plant formation (e.g. deciduous woodland, heath, reedswamp, etc.) and association (e.g. Ash/Oak woodland, *Festuca/Agrostis* grassland, etc.).
- (b) Indicate the presence of trees, whether natural or planted, their approximate age, state of growth, and whether regenerating. An indication of the depth and pattern of root development should be given where possible.
- (c) For areas with trees the canopy should be described within a scale as follows:—
 - 0=absence of canopy.
 - 10=no sky visible.
- (d) Where trees, shrubs or tall bushes are growing the total density should be described as follows:—
 - V1 Impenetrable thicket necessitating the cutting of a path.
 - V2 Thicket dense but penetrable without the cutting of a path.
 - V3 Still so thick that a compass traverse is impossible without cutting a path. Open ground about 10 per cent.
 - V4 Visibility better. Open ground about 20 per cent.
 - V5 Easy to traverse with compass. Open ground about 30 to 50 per cent.
 - V6 Open ground exceeding land covered by bush.
 - V7 Scattered trees in otherwise open land.
 - V8 Open land.
- (e) At soil level, indicate the proportion of ground covered by vegetation, describing the nature and size of bare patches.
- (f) Record signs of past vegetation.
- (g) Record signs of flush effects.

(h) Record signs of human or biotic influence :—

i.e., terracing, draining, ploughing, liming, marling, grazing (whether by cattle, sheep, rabbits, etc.).

2. Identify the vegetation occurring within 15 yards of the soil pit, giving some indication of relative proportions of species.

11. WEATHER CONDITIONS.

Some features of profile morphology are a reflection of the weather prevailing during the period prior to sampling. This should be recorded especially when it has been unusual, as, for instance, "abnormally dry for three months, followed by heavy rain during last three days", or, "showery weather for several weeks followed by extremely hot weather during the last two days."

II. DESCRIPTION OF PROFILE.

12. SOIL SURFACE.

In some circumstances bare soil may be exposed on the surface. The soil surface should then be described, and note should be made of such features as patina, unusual concentration or alignment of stones, surface capping or puddling, animal footmarks, wormcasts, mechanical treads etc.

13. LAYER NUMBER OR HORIZON SYMBOL.

Each layer to be described should be numbered, in arabic numerals, consecutively from the surface and these numbers should be used for soil samples.

14. DEPTH.

The upper and lower average depth of each layer measured upwards and downwards from the surface of the mineral soil should be expressed in centimetres or inches. Where the boundary is undulating or irregular the limits should be noted, e.g. 12 (10-14) cm. to 21 (17-25) cm.

15. THICKNESS.

The thickness of each horizon should be noted as this cannot be precisely deduced from the depth figures. (See U.S. Manual p. 186).

16. BOUNDARY TO NEXT HORIZON.

Describe as :—

(a) Sharp—change to next horizon within 2 cm.

(b) Narrow— " " " " " 2 to 5 cm.

(c) Merging— " " " " " more than 5 cm.

Also state whether boundary is :—

- (1) **Even**—at same depth across the described face.
- (2) **Undulating**—relatively small and regular depth variations.
- (3) **Irregular**—marked and irregular variations in depth.

17. MOISTURE.

Dry (+).

Soil darkens or assumes a lower colour value (Munsell notation) when the soil is moistened. In the dry state the soil will not bind, and, when broken, dust may be produced amongst other fragments.

Slightly moist (1).

Soil darkens slightly when wetted. When broken the soil falls into fragments with little or no dust produced. The fragments cannot be moulded.

Moist (Damp) (2).

Soil does not change colour on moistening. The soil does not moisten the fingers immediately but by prolonged working will do so. All except sandy soils can be moulded fairly easily.

Very moist (3).

Soil just below field capacity. On working the soil the fingers are quickly moistened and the soil will stick to the fingers when moulded and show a slight cohesion.

Wet (4).

Soil immediately wets or sticks to the fingers but water does not readily drip out.

Waterlogged (5).

All fissures and pores appear to be completely filled with water. Water drips away and sandy soils especially tend to flow on handling.

18. COLOUR.

The most important record of colour is the colour number from the Munsell Soil Colour Charts, given for the soil as recorded in the field. An additional record of the colours in the dry and moist conditions is also desirable.

Colours should also be described in common colour terms avoiding as far as possible essentially non-colour names such as "mousy", "chocolate" etc. Such terms might be used occasionally as qualifying adjectives to bring out subtle differences between horizons which cannot be adequately expressed in other ways.

In recording soil colour, care must be taken to obtain a freshly broken aggregate, and to avoid a smeared surface. (A smeared soil surface which appears brown may sometimes be seen in a broken soil aggregate to be essentially grey but with abundant rusty mottling.)

In some soils the colour is uniform but in others various colours may be found. Each colour should be recorded where possible and the pattern of the mottling described. For instance, some soils are speckled with a very fine random mixture of colours, perhaps related to individual sand grains. In others certain colours may be associated with root channels and present a veined appearance, whilst some may occur as isolated spots, such as the dark concretions of MnO_2 . Wherever possible it is of the utmost importance to describe the relationship of colour to other morphological features such as structure and root channels.

The pattern of mottling can be conveniently described by three properties contrast, abundance and size :—

Contrast. Contrast may be described as faint, distinct or prominent as follows :—

Faint. Indistinct mottles are evident and recognizable only with close examination. Soil colours in both the matrix and mottles have closely related hues and chromas.

Distinct. Although not striking, the mottles are readily seen. The hue, value and chromas of the matrix are easily distinguished from those of the mottles. They may vary by as much as one or two hues or several units in chroma or value. The pattern may be one of a continuous matrix with mottles or one of mixtures of two or more colours.

Prominent. The conspicuous mottles are obvious and mottling is one of the outstanding features of the horizon. Hue, chroma, and value of mottles and matrix may be several units apart. The pattern may be one of a continuous matrix with contrasting mottles or one of mixtures of two or more colours.

Abundance. Abundance of mottles can be indicated in three general classes as : few, common, and many, based upon the relative amount of mottled surface in the unit area of the exposed soil horizon as follows :—

Few—Mottles occupy less than about 2 per cent. of the exposed surface.

(+)=less than 2 per cent.

Common—Mottles occupy about 2 to 20 per cent. of the exposed surface.

(1)—2 to 5 per cent.

(2)—5 to 20 per cent.

Many.—Mottles occupy more than 20 per cent. of the exposed surface. This last class can be further sub-divided according to whether (a) the mottles are set in a definite matrix or (b) there is no clear matrix colour.

(3)=20 to 50 per cent.

(4)=50 to 75 per cent.

(5)=75 per cent. +

Categories (4) and (5) should be used only where the genesis of such dominant mottling is clearly apparent. For instance, where pale grey clearly associated with root channels and structure faces is so extensive as to exceed in amount the recognisable matrix colour.

Size. Measured along greatest diameter except in linear forms.

Five relative size classes can be used as follows :—

Extremely fine : less than 2 mm.

Very fine : 1 to 2 mm.

Fine : 2 to 5 mm.

Medium : 5 to 15 mm.

Coarse **Large :** Greater than 15 mm.

19. SOIL TEXTURE.

To determine texture, the soil is moistened until it reaches its maximum stickiness or plasticity. The determination is made by working a small amount of moistened soil between the fingers and thumb. It is very important to work the soil down thoroughly to eliminate the effects of structure and consistence. In effect, an attempt is made to assess the relative proportions of coarse sand, fine sand, silt and clay, and the soil given its texture name according to the proportion of these groups present.

Certain special difficulties arise in soils high in organic matter or calcium carbonate, or where there is a high proportion of exchangeable sodium. In making this texture estimate in the field the pedologist should record the "feel" as though it were a normal mineral soil. He may note in addition any possible cause of discrepancy.

The properties of the fractions which determine the texture of a soil are as follows :—

Coarse Sand—consists of grains between 2 mm. and 0.2 mm. diameter. These are large enough to grate against each other and can be detected individually by both feel and sight.

Fine Sand—consists of grains between 0.2 mm. and 0.05 mm. and the grating is therefore much less obvious; individual grains can still be detected but are not easily distinguished by either feel or sight.

Silt—individual grains of silt (50—2 μ) cannot be detected, but silt feels characteristically smooth and soapy, and only very slightly sticky.

Clay—is characteristically sticky, although some dry clays require a great deal of moistening and working between the fingers before they develop their maximum stickiness.

High organic matter tends to make both sandy soil and clay soil feel more loamy. Finely divided calcium carbonate also gives a silk-like feeling to the soil.

SOIL TEXTURE CLASS DESCRIPTIONS.

(NOTE—Qualifying adjectives may be added to certain of the descriptions below, e.g., loamy **coarse** sand, loamy **fine** sand, etc., see U.S. Manual, page 210).

Sand—Soil consisting mostly of coarse and fine sand, and containing so little clay that it is loose when dry and not sticky at all when wet. When rubbed it leaves no film on the fingers.

Loamy sand—Consisting mostly of sand but with sufficient clay to give slight plasticity and cohesion when very moist. Leaves a slight film of fine materials on the fingers when rubbed.

Sandy loam—Soil in which the sand fraction is still quite obvious, which moulds readily when sufficiently moist but in most cases does not stick appreciably to the fingers. Threads do not form easily.

Loam—Soil in which the fractions are so blended that it moulds readily when sufficiently moist, and sticks to the fingers to some extent. It can with difficulty be moulded into threads but will not bend into a small ring.

Silt loam—Soil that is moderately plastic without being very sticky, and in which the smooth soapy feel of the silt is the main feature.

Sandy clay loam—Soils containing sufficient clay to be distinctly sticky when moist, but in which the sand fraction is still an obvious feature.

Clay loam—The soil is distinctly sticky when sufficiently moist, and the presence of sand fractions can only be detected with care.

Silty clay loam—This contains quite subordinate amounts of sand, but sufficient silt to confer something of a smooth soapy feel. It is less sticky than silty clay or clay loam.

Silt—Soil in which the smooth, soapy feel of silt is dominant.

Sandy clay—The soil is plastic and sticky when moistened sufficiently, but the sand fraction is still an obvious feature. Clay and sand are dominant, and the intermediate grades of silt and very fine sand are less apparent.

Medium clay—The soil is plastic and sticky when moistened sufficiently and gives a polished surface on rubbing. When moist the soil can be rolled into threads. With care a small proportion of sand can be detected.

Heavy clay—Extremely sticky and plastic soil, capable of being moulded when moist into any shape and taking clear fingerprints.

Silty clay—Soil which is composed almost entirely of very fine material but in which the smooth soapy feel of the silt fraction modifies to some extent the stickiness of the clay.

Soils containing appreciable amounts of organic matter.

Slightly humose—Soils with the feel of the mineral texture grades but containing about 8 to 13 per cent. organic matter.

Humose—Soils with the feel of the mineral texture grades but containing about 13 to 25 per cent. organic matter.

Very humose—Soils with a loamy feel which are moderately plastic when moist and will roll into short threads. Containing about 25 to 40 per cent. organic matter.

Organic soil—Dark-coloured soil without plasticity and incapable of forming threads when rolled between the fingers. Smooth, light and often powdery to the feel. More than about 40 per cent. organic matter.

20. STONES.

Quantity, size, shape and kind of stones present.

(a) **Quantity.**

Stoneless

- (+) Very rare stones Less than 1 per cent.
- (1) Slightly stony 1 to 5 per cent.
- (2) Stony 5 to 20 per cent.
- (3) Very stony 20 to 50 per cent.
- (4) Extremely stony 50 to 75 per cent.
- (5) Stones or rock dominant More than 75 per cent.

(b) **Size.**

- (i) Gravel 2 mm. to 1 cm.
- (ii) Small stones 1 to 5 cm.
- (iii) Medium 5 to 10 cm.
- (iv) Large stones 10 to 20 cm.
- (v) Very large stones More than 20 cm.

(c) **Shape.**

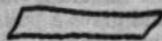
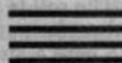
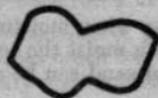
Angular

Sub-angular

Rounded

Shaley

Tabular.



(d) **Kind of stones**—as for parent material—sandstone, limestone, granite, etc.

Where a variety of stones occurs some indication of the proportions of different kinds, shapes and sizes should be given.

21. STRUCTURE.

(a) Degree of structural development.

This is distinguished in the field by the proportion of the soil appearing as aggregates and by the development of aggregate faces. Peds which are stable and persistent show faces that are well formed and are usually smoother than the interior when the aggregate is broken across, and they sometimes have a different hue. The faces may be stained with a coating of other material or have an abundance of roots running along them. Very well formed aggregates may possess smooth shiny faces.

Terms for the grade or degree of structural development are as follows:—

- (a) 0. **Structureless.** No observable aggregation or no definite orderly arrangement of natural lines of weakness. **Massive** if coherent; **single grain** if non-coherent. (11)
1. **Weakly developed.** Poorly formed indistinct peds that are barely observable in place. When disturbed, the soil breaks into a mixture of few entire peds, many broken peds, and much unaggregated material. If necessary for comparison, this grade may be sub-divided into **very weak** and **moderately weak**. (2)
- (c) 2. **Moderately developed.** Well formed distinct peds that are moderately durable and evident but not distinct in undisturbed soil. The soil material, when disturbed, breaks down into a mixture of many distinct entire peds, some broken peds, and little unaggregated material. (3)
- (d) 3. **Strongly developed.** Durable peds that are quite evident in undisturbed soil, adhere weakly to one another, and that withstand displacement and become separated when the soil is disturbed. The soil material consists very largely of entire peds and includes a few broken peds and little or no unaggregated material. If necessary for comparison, this grade may be sub-divided into **moderately strong** and **very strong**. (4)

(b) **Kind of Structure.**

TABLE 6—Types and classes of soil structure.

		TYPE (Shape and arrangement of pedis.)						
Class	Platelike with one dimension (the vertical) limited and less than the other two; arranged around a horizontal plane; faces mostly horizontal.	Prismlike with two dimensions (the horizontal) limited and considerably less than the vertical; arranged around a vertical line; vertical faces well defined; vertices angular.		Blocklike; blocks or polyhedrons having plane or curved surfaces which are castis of the moulds formed by the faces of the surrounding pedis.		Blocklike; polyhedronlike, or spheroidal, with three dimensions of the same order of magnitude, arranged around a point.		
		Without rounded caps.	With rounded caps.	Faces flattened; most vertices sharply angular.	Mixed rounded and flattened faces with many rounded vertices.	Relatively non-porous pedis.	Spheroids or polyhedrons having plane or curved surfaces which have slight or no accommodation to the faces of surrounding pedis.	
	Platy	Prismatic	Columnar	(Angular) Blocky ¹	Subangular blocky ²	Granular	Crumb	
Very fine or very thin.	Very thin platy; <1 mm.	Very fine prismatic; <10 mm.	Very fine columnar; <10 mm.	Very fine angular blocky; <5 mm.	Very fine subangular blocky; <5 mm.	Very fine granular; <1 mm.	Very fine crumb; <1 mm.	
Fine or thin	Thin platy; 1 to 2 mm.	Fine prismatic; 10 to 20 mm.	Fine columnar; 10 to 20 mm.	Fine angular blocky; 5 to 10 mm.	Fine subangular blocky; 5 to 10 mm.	Fine granular; 1 to 2 mm.	Fine crumb; 1 to 2 mm.	
Medium	Medium platy; 2-5 mm.	Medium prismatic; 20 to 50 mm.	Medium columnar; 20 to 50 mm.	Medium angular blocky; 10 to 20 mm.	Medium subangular blocky; 10 to 20 mm.	Medium granular; 2 to 5 mm.	Medium crumb; 2 to 5 mm.	
Coarse or thick	Thick platy; 5 to 10 mm.	Coarse prismatic; 50 to 100 mm.	Coarse columnar; 50 to 100 mm.	Coarse angular blocky; 20 to 50 mm.	Coarse subangular blocky; 20 to 50 mm.	Coarse granular; 5 to 10 mm.		
Very coarse or very thick	Very thick platy; >10 mm.	Very coarse prismatic; >100 mm.	Very coarse columnar; >100 mm.	Very coarse angular blocky; >50 mm.	Very coarse subangular blocky; >50 mm.	Very coarse granular; >10 mm.		

¹ (a) Sometimes called nut. (b) The word "angular" in the name can ordinarily be omitted.

² Sometimes called nuciform, nut, or subangular nut. Since the size connotation of these terms is a source of great confusion to many, they are not recommended.

22. CONSISTENCE.

Consistence refers to the strength and stability of soil aggregates or fragments, or, in other words, to the magnitude and kind of cohesion.

Two schemes of consistence description are given below; scheme A is taken from the U.S. Manual, page 231, and scheme B is a modified form of the system developed by B. E. Butler (Aus. Journ. of Agric. Sci. Vol. 21, No. 4).

Scheme A.

1. Consistence when wet.

Consistence when wet is determined at or slightly above field capacity.

(a) **Stickiness**—Stickiness is the quality of adhesion to other objects. For field evaluation of stickiness, soil material is pressed between thumb and finger and its adherence noted. Degrees of stickiness are described as follows:—

0. **Non-sticky**—After release of pressure, practically no soil material adheres to thumb or finger.

1. **Slightly sticky**—After pressure, soil material adheres to both thumb and finger but comes off one or the other rather cleanly. It is not appreciably stretched when the digits are separated.

2. **Sticky**—After pressure, soil material adheres to both thumb and finger and tends to stretch somewhat and pull apart rather than to pull free from either digit.

3. **Very sticky**—After pressure, soil material adheres strongly to both thumb and forefinger and is decidedly stretched when they are separated.

(b) **Plasticity**—Plasticity is the ability to change shape continuously under the influence of an applied stress and to retain the impressed shape on removal of the stress.

0. **Nonplastic**—No wire is formable.

1. **Slightly plastic**—Wire formable but soil mass easily deformable.

2. **Plastic**—Wire formable and moderate pressure required for deformation of the soil mass.

3. **Very plastic**—Wire formable and much pressure required for deformation of the soil mass.

II. Consistence when moist.

Consistence when moist is determined at a moisture content approximately midway between air-dry and field capacity.

0. **Loose. Non-coherent.**

1. **Very friable**—Soil material crushes under very gentle pressure but coheres when pressed together.
2. **Friable**—Soil material crushes easily under gentle to moderate pressure between thumb and forefinger, and coheres when pressed together.
3. **Firm**—Soil material crushes under moderate pressure between thumb and forefinger but resistance is distinctly noticeable.
4. **Very firm**—Soil material crushes under strong pressure; barely crushable between thumb and forefinger.
5. **Extremely firm**—Soil material crushes only under very strong pressure; cannot be crushed between thumb and forefinger and must be broken apart bit by bit.

The term **compact** denotes a combination of firm consistence and close packing or arrangement of particles and should be used only in this sense.

III. Consistence when dry.

0. **Loose**—Non-coherent.
1. **Soft**—Soil mass is very weakly coherent and fragile; breaks to powder or individual grains under very slight pressure.
2. **Slightly hard**—Weakly resistant to pressure; easily broken between thumb and forefinger.
3. **Hard**—Moderately resistant to pressure; can be broken in the hands without difficulty but is barely breakable between thumb and forefinger.
4. **Very hard**—Very resistant to pressure; can be broken in the hands only with difficulty; not breakable between thumb and forefinger.
5. **Extremely hard**—Extremely resistant to pressure; cannot be broken in the hands.

Cementation.

Cementation of soil material refers to a brittle hard consistence caused by some cementing substance other than clay minerals, such as calcium carbonate, silica, or oxides or salts of iron and aluminium. Typically the cementation is altered little if at all by moistening.

1. **Weakly cemented**—Cemented mass is brittle and hard but can be broken in the hands.
2. **Strongly cemented**—Cemented mass is brittle and cannot be broken in the hand but is easily broken with a hammer.
3. **Indurated**—Very strongly cemented; brittle, does not soften under prolonged wetting, and is so extremely hard that for breakage a sharp blow with a hammer is required; hammer generally rings as a result of the blow.

Scheme B.

Ideally, consistence measurements should be made at a number of moisture levels, but this is rarely practicable at one time in the field. It is assumed, therefore, unless otherwise stated, that the moisture content at which the consistence is estimated is that stated at the beginning of the horizon description (item 17, above).

The observations to be made are :—

- (a) the degree of force required to cause rupture or deformation in a soil block.
- (b) the kind of consistence.
- (c) the kind and degree of change produced.

Scale of force.

Scale of force applied using about $\frac{1}{4}$ in. cube of soil taken from the profile and manipulating between thumb and fingers, noting the force which is just sufficient to cause rupture or deformation in the soil block.

Force 1—a very small, almost nil force. Sometimes it is convenient to employ force zero to indicate actual separation, as in loose sands.

Force 2—a small but significant force.

Force 3—a moderate force.

Force 4—a strong force, but conveniently within the power of thumb and fingers.

Force 5—a very strong force, at and passing beyond the capability of thumb and fingers.

Force 6—Cannot be broken in hands but easily broken by hammer.

Force 7—A sharp blow by hammer is required. Hammer or pick rings.

Nos. 6 and 7 are mainly for cemented materials.

Kind of consistence.

1. **Plastic**—the material bends and does not break.
2. **Labile**—the soil first breaks into pieces and then these pieces reform or coalesce into balls or rods which are of plastic consistence.
3. **Crumbly**—breaks into a fairly uniform population of structural aggregates.
4. **Brittle**—fragmentary if the material breaks into fragments of odd shapes and sizes, and **pulverescent** if the materials breaks into ultimate soil particles.

Pulverescence and Coalescence.

The concepts of pulverescence and coalescence refer to the changes in soil materials as a result of work done on them. The result may be either their breakdown to smaller and smaller pieces until finally the ultimate particles are separated, or a coherent plastic mass.

Pulverescence is the tendency of a soil material to break down to fragments or to its ultimate particles (other than smaller structural aggregates) when the specified amount of work is done on it, i.e., using for some two seconds just the force required to cause rupture or deformation of the soil block.

Pulverescence 1—less than 10 per cent. of the material occurs in the form of irregular fragments and/or ultimate particles. Pulverescence zero is sometimes used if the material consists of 100 per cent. natural aggregates. This is the ideal crumbly material.

Pulverescence 2—between 10 and 30 per cent of the material occurs as fragments and particles.

Pulverescence 3—between 30 and 60 per cent. of the material occurs as fragments and particles.

Pulverescence 4—between 60 and 90 per cent. of the material occurs as fragments and particles.

Pulverescence 5—more than 90 per cent. of the material occurs as fragments and particles. This approximates to the ideal brittle form.

Coalescence is the tendency of an unsmearred soil material to assume plastic properties when the specified amount of work is done on it, i.e., using for two seconds just the force required to cause rupture or deformation of the soil block.

Coalescence 1—less than 10 per cent. of the material occurs as plastic balls or rods, after working.

Coalescence 2—10—50 per cent. of the material occurs as plastic balls or rods after working.

Coalescence 3—50—90 per cent. of the material occurs as plastic balls or rods after working.

Coalescence 4—more than 90 per cent. of the material occurs in the coalesced form after working, but some sub-division of the primary piece results from working.

Coalescence 5—all of the material occurs in the coalesced form after working and there is no sub-division of the primary pieces, but some fracturing can be seen at the commencement of the operation.

The ideal plastic material would correspond to coalescence 6 and the criterion for this state is that there is no fracturing to be seen at the commencement of the work being done on it.

Stickiness.

Plastic materials vary to some extent in stickiness—i.e., the degree to which they adhere to other objects. Stickiness may be described in terms taken from the U.S. Manual quoted above.

23. POROSITY.

When a profile is examined by eye, small holes and fissures are apparent. They may be considered under three headings :—

(a) **Quantity** (measured in number of pores per square decimetre) :—

- (+) = Very rare less than 1
- (1) = Rare 1 to 5
- (2) = Few 5 to 10
- (3) = Common 10 to 100
- (4) = Abundant 100 to 500
- (5) = Extremely abundant more than 500.

(b) **Fissures** (between structural aggregates) :—

- (i) Very fine fissures less than 1mm. wide.
- (ii) Fine fissures 1 to 3 mm. wide.
- (iii) Medium fissures 3 to 5 mm. wide.
- (iv) Large fissures 5 to 10 mm. wide.
- (v) Very large fissures more than 10 mm. wide.

(c) **Pores** (within the structural aggregate or within the whole soil mass) :—

- (i) Very fine pores less than 0.5 mm. diameter.
- (ii) Fine pores 0.5 to 1 mm. diameter.
- (iii) Medium pores 1 to 3 mm. diameter.
- (iv) Large pores 3 to 5 mm. diameter.
- (v) Very large pores More than 5 mm.

The main direction or pattern of fissures and pores should be indicated where possible.

24. PERMEABILITY.

Soil permeability is that quality of the soil which permits it to transmit water or air. It can be measured in terms of percolation rates under specified conditions, but in the absence of precise measurements, soil horizons may be placed in relative permeability classes through studies of structure, texture, porosity, arrangement of cracks and other characteristics observable in the profile. The permeability class of each horizon should be stated.

For practical purposes five categories should be sufficient.

1. Very slow e.g. puddled clay.
2. Slow e.g. normal clay loam.
3. Moderate e.g. loam and well structured clay loam.
4. Rapid e.g. sandy loam and very well structured clay loam.
5. Very rapid e.g. very coarse sandy loam and thin chalk soil.

From the practical point of view, permeability is a property of a horizon as a whole and not only of the individual aggregates; fissures and cracks must be recognised as playing their part. Permeability tends to vary with the seasons especially in the case of clay soils which may be better structured after frosty weather or long period of drying.

25. SOIL ORGANIC MATTER.

Organic matter occurs in various forms and positions in soil profiles. A decision should first be made as to which of the following three categories is appropriate.

- (a) Surface accumulations :
 - (i) Thick forms, usually described as peat.
 - (ii) Thin forms, usually described as mor, moder, etc.
- (b) Mixed mineral and organic matter :—
 - (i) Intimate humus.
 - (ii) Mechanically mixed humus and mineral particles.
- (c) Local concentrations of organic matter in essentially mineral horizons.

Description of these organic matter forms should be as follows :—

(a) (i) Thick Forms.

For a profile consisting wholly or with a considerable thickness of organic matter, as many of the following details as possible should be recorded for each horizon.

1. **Thickness, clarity, moisture, colour.**
2. **Botanical composition** of peat-forming remains.
3. **Structural Properties.**

Fibrous—Plant remains easily recognisable, original structure and some of the mechanical strength of plant materials maintained.

Pseudo fibrous—Plant remains recognisable but fibrous in appearance only; when moist, peat is soft and plastic in character.

Amorphous—absence of recognisable plant remains. May be :

- (a) sub-aquatic sediments.
- (b) humified layers.

4. **Degree of humification.**

A. Slightly Humified Peat.

H1 Completely non-humified and free of dy*. Yields only colourless water when squeezed.

H2 More or less unhumified and free of dy. Yields yellow-brown water when squeezed.

H3 Very slightly humified with a small amount of dy. Yields muddy water when squeezed, but the peat substance itself does not pass through the fingers.

H4 Slightly humified peat and weakly dy-charged. Yields very muddy water when squeezed. Residue slightly plastic.

H5 Humified peat with a considerable amount of dy. Plant structure quite evident. Yields very muddy water when squeezed and some of the peat substance escapes through the fingers. Residue quite plastic.

B. Medium Humified Peat.

H6—H7. Well humified peat and strongly dy-charged. Visible plant structures insignificant. Up to $\frac{2}{3}$ of mass passes through the fingers on squeezing. Residue consists chiefly of root fibres and wood, etc., and is strongly plastic.

C. Strongly Humified Peat.

H8—H10. Very strongly humified and almost completely dy-charged. No vegetable structure visible (in field); $\frac{1}{3}$ to the whole of the mass squeezes through the fingers.

* Dy: brown or yellow-brown flocculent material that can be squeezed out with the water from coherent peats.

(a) (ii) **Thin forms.**

For mainly mineral profiles, with an Ao horizon—distinct layer of mainly organic material at the surface—describe the L, F, and H layers or any sub-division as far as possible as follows :—

- (2) Few—5 to 10.
- (3) Common—10 to 100.
- (4) Abundant—100 to 500.
- (5) Extremely abundant—more than 500.

(b) **Size.**

- (i) Fine—less than 1 mm. diameter.
- (ii) Small—1 mm. to 3 mm. diameter.
- (iii) Medium—3 mm. to 10 mm. diameter.
- (iv) Large—10 mm. to 30 mm. diameter.
- (v) Very large—more than 30 mm. diameter.

(c) **Nature.**

- (i) Woody.
- (ii) Fibrous.
- (iii) Fleshy.
- (iv) Rhizomatous.

(d) **Condition**—Should be noted as living, dead, or indeterminable.

Any other features of interest concerning the root system should be recorded in additional notes. It is very important to indicate any observable relationships of roots to other soil characters such as structures, faunal channels, etc.

27. FAUNA.

Describe any soil fauna observed or any evidence of casts, burrows, droppings, etc.

28. CONCENTRATIONS MAINLY OF PEDOGENIC ORIGIN.

Local concentrations of mineral materials arising mainly as a result of the process of soil formation should be described in terms of form, abundance and chemical nature.

Form.

First state whether the concentrations appear to be primary (residual from parent material) or strictly pedogenic.

Efflorescences—Extremely finely divided surface coatings—occasionally forming a "hairy" bloom.

Crusts—A form of efflorescence or coating on the surface which can generally be separated from the underlying soil.

Dendrites—having appearance of a branching plant or veining of a leaf.

Veins and Tubes—e.g., around root channels or around burrows.

Concretions—Nodules, or concentrations of compounds which cement the soil particles together.

Streaks and interlayers—Thin deposits, more or less parallel with soil surface.

Coatings—Thin continuous films on structure faces.

Abundance.

Except in the case of diffuse depositions it should be possible to describe the amount of materials present as:—

- | | |
|----------------|--|
| (i) Few | (0) =less than 2 per cent. of horizon. |
| (ii) Common | (1) =2 to 5 per cent. of horizon. |
| | (2) = 5 to 20 ,, ,, ,, ,, |
| (iii) Abundant | (3) =20 to 50 per cent. of horizon. |
| | (4) =50 to 75 ,, ,, ,, ,, |
| | (5) =More than 75 ,, ,, ,, |

Chemical nature.

Carbonates Using 10 per cent. HCl some indication of the amount of carbonate present can be derived by reference to the following table.

Field Description.	%CaCO ₃	Auditory effects.	Visible effects.
Non-calcareous (less than 0.5%)	0.1	None.	None.
Very slightly calcareous (0.5—1%)	0.5	Faintly audible increasing to slightly.	None.
Slightly calcareous (1—5%)	1.0	Faintly audible increasing to moderately.	Slight eff. confined to individual grains, just visible.
	2.0	Moderately to distinctly audible; heard away from ear.	Slightly more general eff.; visible on close inspection.
Calcareous (5—10%)	5.0	Easily audible.	Moderate eff.; easily visible, bubble to 3 mm. diam.
Highly calcareous (more than 10%)	10.0	Easily audible.	General strong eff.; ubiquitous bubbles to 7 mm. diam. Easily visible.

Gypsum.

Calcium sulphate or gypsum may occur as fine crystals or as a powder on structure faces etc. These deposits or efflorescences are formed at places where water evaporates and are most easily seen following long dry periods. Gypsum may also look like fungal mycelia, and very occasionally may occur as small nodules.

Treatment with dilute acid, as above, will normally serve to distinguish it from the carbonate; the presence of sulphate can also be checked by its property of decolouring barium rhodizonate test paper in the presence of dilute acid. To carry out the test, mix the soil with a little dilute hydrochloric acid and then add a small piece of test paper. If gypsum is present the paper is decolourised rapidly. As hydrochloric acid will decolourise the test paper very slowly it will sometimes be necessary to do a blank.

Gypsum crystals visible to the naked eye sparkle and can be crushed to a white powder between the finger-nails. They can be split into thin flakes like mica but when bent retain the angle of shape to which bent.

Compounds of iron and manganese.

Varying mixtures of the oxides, hydrated oxides and hydroxides of these two metals can occur in concretionary form. Together with organic matter these compounds also act as a cementing medium for other soil components, giving rise to both concretions and pans. Pans may be **diffuse**, occurring as a relatively broad zone of deposition, or they may be very hard and **thin**, generally not more than $\frac{1}{4}$ " thick. They may follow a roughly horizontal line round the profile or may take irregular detours, and are sometimes discontinuous.

Black manganiferous concretions are a common if very irregularly distributed feature of soils that are or have been subjected to intermittent waterlogging. They can normally be distinguished from elementary carbon and humus by the following tests.

- (a) Manganiferous concretions can usually be crushed only between the finger-nails with a certain degree of force. Elementary carbon can readily be crushed to a black powder between the fingers.
- (b) Manganiferous material reacts in the cold more violently than humus with hydrogen peroxide.

In the lower horizons of marshy soils, black streaks or concretions of ferrous sulphide (associated with the smell of H_2S) are quite commonly seen and occasionally blue concretions of an iron phosphate, vivianite.

