INTERNATIONAL STANDARD

# ISO 25177

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# Soil quality — Field soil description

*Qualité du sol — Description du sol sur le terrain*



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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 25177 was prepared by Technical Committee ISO/TC 190, *Soil quality*, Subcommittee SC 1, *Evaluation of criteria, terminology and codification*.

This first edition of ISO 25177 cancels and replaces ISO 11259:1998, which has been technically revised.

# Introduction

Traditionally, descriptions of soils and their environment were carried out as parts of soil survey and soil inventories, the purpose of which was to describe the pedogenetic context of the soil and assess applied aspects, principally agronomic potentials.

Today, many soil observations are made as part of much wider environmental studies, and include analysis for objectives such as the following:

— the identification of human influences on the soils, particular attention being paid to the negative effects of these influences (for example, pollution and physical deterioration);

— land protection within the context of “sustainable” agriculture;

— the prediction of the fate of contaminants introduced into the soil;

— the assessment of the consequences resulting from changes in the use of the soil;

— setting up monitoring programmes for specific purposes (observation of changes of soil properties in time);

— the development of spatial data bases (used in the context of GIS) aimed at facilitating the geographical representation of these;

— many other uses.

Therefore, this International Standard is based on aspects of the traditional approach to soil description [for example, the Guidelines for soil description FAO ROME (2006)]. The descriptions of soils and sites alone are not sufficient. Field and laboratory measurements, whether physical, chemical or biological, must accompany this description. Care must be taken in the specification of sites and in the methods of sampling and the number of samples. It is therefore imperative that this International Standard be considered in the context of other International Standards developed within the framework of ISO/TC 190, *Soil quality*.



 

# Soil quality — Field soil description

## 1 Scope

This International Standard is a guide for describing the soil and its environmental context at a given site. Sites can be natural, near-natural, urban or industrial. It is important to realize that a number of soil samples can be taken at a site to support the soil description. The information provided by the descriptions in this International Standard provides the context for the presentation of results from analyses undertaken on soil samples.

NOTE 1 It might not be possible or necessary to record data under all the headings listed in these descriptions.

NOTE 2 Overall guidance for presentation of information from soil surveys is given in ISO 15903.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3166-1:2006, *Codes for the representation of names of countries and their subdivisions — Part 1: Country codes*

ISO 3166-2:2007, *Codes for the representation of names of countries and their subdivisions — Part 2: Country subdivision code*

ISO 14688-2:2004, *Geotechnical investigation and testing — Identification and classification of soil — Part 2: Principles for a classification*



## 3 General references

### 3.1 Site/profile numbers

— Profile number

— Survey number or code

### 3.2 Location

— Country

Country codes according to ISO 3166-1 and ISO 3166-2 shall be used. For historical research, designations according to ISO 3166-3 should be considered, when necessary.

— Administrative division

To be adapted according to the country: (provinces, states, regions, departments, towns, etc.), both uncoded and coded.

### 3.3 Geographical coordinates

- Type of geographical reference system (degrees, Lambert, national reference grid)
- Position within the geographical reference system (longitude in deg/min/s, latitude in deg/min/s)
- Altitude (in metres)

### 3.4 Date of observation

- Year
- Month
- Day
- Time

### 3.5 Author and organization

- Author's name
- Accreditation
- Name of organization
- Department
- Address
- Telephone
- Fax number
- E-mail address

## 4 Profile environment

### 4.1 Previous precipitation

0 No precipitation within the last month

1 No precipitation within the last week

2 No precipitation within the last three days

3 Rainy but no intense precipitation within the last three days

4 Moderate rain for several days or intense rainfall the day before the observation

5 Extreme precipitation or snow melt or inundation just before the observation

6 Not recorded

## 4.2 Land use at plot level (checked by detailed field survey)

01 Buildings and industrial infrastructures

02 Mining site (current or past)

03 Metal processing sites

04 Chemical processing sites

05 Oil and gas production sites

06 Metal manufacturing sites

07 Food processing sites

08 Waste disposal sites

09 Cultivated lands

10 Horticulture

11 Grazing

12 Orchards, fruit plantations or grapevines

13 Forest, woodlands

14 Mixed land use (agroforestry or agropastoral)

15 Gathering/hunting-fishing (exploitation of natural vegetation, hunting or fishing)

16 Nature protection (for example, nature reserve, protected area, erosion control by terracing)

17 Wetland (for example, marsh, swamp, mangrove, etc.)

18 Snow or ice cover

19 Bare rock or rocky surface

20 Natural lands

21 Natural grasslands

22 Recreation land

23 Other type of unutilized and unmanaged site



## 4.3 Type of cultivation or vegetation or human utilization (at the plot level)

Be as clear and precise as possible. For cultivated plants, it may be interesting to note the variety, when known.

EXAMPLE Grazing (natural meadow, planted grassland); metal processing (ferrous, non-ferrous); mining site (iron, deep coal, open-cast coal); cultivated lands (maize, oats, rice); horticulture (flowers, vegetables).

## 4.4 Geomorphology of the site

— The position of the site in the landscape

— The geomorphology of the immediate surroundings of the site (scale: 0,1 km)

## 4.5 Slope length (in metres)

When flat, note 0 (zero).

## 4.6 Slope value

The average slope value is measured in the vicinity of the soil pit (flat = 0).

Slope may be expressed in percent or degrees:

— slope value, in percent;

— slope value, in degrees.

## 4.7 Orientation (aspect) of the slope

The orientation of the slope can be expressed in the following ways:

a) N-S-E-W

NE-SE-NW-SW

with VV = variable and AA = flat; or

b) use degrees with the following convention:

0° = north

90° = east

180° = south

270° = west

with VV = variable and AA = flat.

## 4.8 Nature of the parent material

### 4.8.1 Modified or artificial material

The nature of the parent material may be modified by the use of the site, or artificial materials may be imported to a site. The knowledge of the history of the site may provide information about the modifications of the natural material.

### 4.8.2 Natural material

The natural parent material and/or bedrock should be described as completely as possible, according to local knowledge. For example, glacial tills, marine alluvium, metamorphic bedrock, hard limestone, loessic deposit, etc.



 

## 4.9 Presence and depth of water table

### 4.9.1 General

The depth of the water table generally fluctuates during the year, sometimes in relation with the seasons or the tide.

In 4.9.2, note the depth of the water table during the description of the site.

Subclauses 4.9.3 and 4.9.4 are included to describe the variations in water-table depth, when there are some variations in depth and when these variations are known (piezometers, investigations, or as marks on the walls of the profile).

In 4.9.3, the minimum depth of the water table shall be noted (water table at its highest point).

In 4.9.4, the maximum depth of the water table shall be noted (water table at its lowest point).

When the person writing the description does not know these variations in depth, record “unknown” in 4.9.3 and 4.9.4.

When there is no variation in the water-table depth, or when the describer does not know if there are depth variations, do not answer the points in 4.9.3 and 4.9.4.



### 4.9.2 Depth

The depth can be

a) observed or measured,

b) estimated, or

c) not observed.

If it is estimated, observed or measured, the depth is expressed in centimetres.

### 4.9.3 Minimum depth of water table

The minimum depth of the water table can be

a) observed or measured,

b) estimated, or

c) not observed.

If it is estimated, observed or measured, the depth is expressed in centimetres.

### 4.9.4 Maximum depth of water table

The maximum depth of the water table can be

a) observed or measured,

b) estimated,

c) not observed.

If it is estimated, observed or measured, the depth is expressed in centimetres.

#### 4.9.5 Nature of the water

Make a general estimation, without reference to threshold value of soluble salts or of conductivity, or analytical values for pollution or contamination, as follows:

— S = saline;

— B = brackish;

— F = fresh;

— P = polluted or contaminated.

Combinations SP, BP or FP are possible.

## 5 Surface appearance

### 5.1 Percentage of land surface occupied by rock outcrops or surface exposures of "non-natural" material (e.g. on an industrial site)

The following categories are widely used in soil description. (Compare the charts shown in Annex A.):

0 None: 0 %

1 Very few: > 0 % and ⩽ 2 %

2 Few: > 2 % and ⩽ 5 %

3 Common: > 5 % and ⩽ 15 %

4 Many: > 15 % and ⩽ 40 %

5 Abundant: > 40 % and ⩽ 80 %

6 Dominant: > 80 %

7 Not observed

### 5.2 Evidence of erosion

The classes given below are based upon aspects of soil conditions reflecting present erosion (or accumulation) and not past or possible future erosion (or accumulation).

0 No visible evidence of erosion

1 Visible evidence of soil loss

  1 Sheet erosion

  2 Rill erosion

  3 Gully erosion

  4 Wind erosion



 

5 Landslides

2 Visible evidence of accumulation

1 Deposition by water

2 Wind deposition

# 6 General designation – Soil type

## 6.1 General

In describing soils in their environment, it is normal to allocate the soil to a reference base in an established soil classification. These allocations are normally based on the expression of pedogenetic processes in the soil profile. There are many classifications with national origins, but the use of the international soil classification system, the World Reference Base (WRB), is suggested.

Pedogenetic processes result in the formation of different layers in the soil, generally more or less parallel to the topographic surface, which are called “horizons”. In the framework of soils deeply modified by human activity, artificial layers may be due to different kinds of deposits (concrete, bricks, etc.). These kinds of layers are simply called “layers”. Artificial soils and soils in industrial and urban landscapes are not readily classified in most established soil classification systems, including WRB. In these conditions, the layers are described from the surface of the soil as described in Clause 7.

## 6.2 Type of soil classification used

Record which soil classification or which system is used.

Basically, the WRB classification system is recommended.

## 6.3 Soil type with reference to the soil classification used

EXAMPLE Albic luvisol.

Annex B gives a list of reference soils according to the World Reference Base for Soil Resources, 2006.

NOTE The World Reference Base for soil resources is available on the Internet.

## 6.4 Type of horizon designation used

Note which type of horizon designation is used, for example FAO (2006) or other national system.

As an example, the FAO system of horizon designation (2006) is given in Annex C, and can be used as a reference if there is no local or regional system of horizon designation.

## 6.5 Sequence of horizons

Note the succession of horizons described in the profile.

EXAMPLE A/E/B/C (see Annex C).

## 7 Horizon or layer description

### 7.1 General

For each horizon or layer, the following points shall be described.

### 7.2 Horizon or layer number

The horizons or layers are numbered from 1 to $n$ within each site, and should be described from the surface in sequence.

### 7.3 Depth

Note the average depth and range of depths of the appearance and disappearance of each horizon or layer, in centimetres.

Organic horizons or layers of undecomposed litter shall be noted as greater than zero, preceded with the sign +.

### 7.4 Estimation of moisture status

The purpose of this heading is to indicate the conditions under which the other observations are made, and to give some guidelines for field determination of the soil moisture status.

The water content of a soil is difficult to estimate directly in the field, since the same volume of water in different soils results in different behaviour, depending on the nature of the soil material, nature and dimensions of pores, etc.

It is therefore worthwhile to observe the moisture status in the field, which is directly linked with the quantity of soil water. To determine the moisture status, it may be necessary to make inspections to calibrate the moisture analysis.

The soil moisture status is indicated as follows.

a) **Dry**: water content less than the moisture retained at the wilting point.

In the case of cohesive samples (generally more than 17 % clay), this may result in the following soil properties: hard, nonplastic consistency; soil colour darkens when water is added.

In the case of noncohesive samples, generally when the percentage of clay is less than 17 %, this may result in the following soil properties: light soil colour, which becomes much darker when water is added; dusty.

b) **Slightly moist**: water content between field capacity and wilting point.

In the case of cohesive samples (generally more than 17 % clay), this may result in the following soil properties: partially cohesive, but crumbles when forming a roll of 3 mm thickness; soil colour darkens slightly when water is added.

In the case of noncohesive samples, generally when the percentage of clay is less than 17 %, this may result in the following soil properties: soil colour darkens slightly when water is added.

c) **Moist**: moisture content of soil is near the field capacity; absence of free water.

In the case of cohesive samples (generally more than 17 % clay), this may result in the following soil properties: stiff; can be formed into a roll of 3 mm thickness without crumbling, does not darken when adding water; no water freed when squeezed.

In the case of noncohesive samples, generally when the percentage of clay is less than 17 %, this may result in the following soil properties: fingers moisten slightly when the sample is touched; no water escapes from soil pores even when the sample is knocked on the drill; does not darken when water is added.

d) **Very wet**: presence of free water, saturating all or a part of the soil pores.

In the case of cohesive samples (generally more than 17 % clay), this may result in the following soil properties: soft; can easily be formed into a roll of thickness more than 3 mm; water freed when the sample is squeezed.

In the case of noncohesive samples, generally when the percentage of clay is less than 17 %, this may result in the following soil properties: fingers get distinctly wet when the sample is touched; visible free water when the sample is compressed.

e) **Saturated**: free water saturates all the soil pores.

In the case of cohesive samples (generally more than 17 % clay), this may result in the following soil properties: muddy, waterlogged; mud passes through the fingers when the sample is squeezed.

In the case of noncohesive samples, generally when the percentage of clay is less than 17 %, this may result in the following soil properties: distinct water escape; sample is often fluid.

f) **Inundated**: soil surface is covered by water.

This concerns only the upper horizon, near the surface of the soil.



## 7.5 Colour of the horizon or layer matrix

Determined by comparison with the Munsell soil-colour chart, the soil being in the moisture status “moist”.

## 7.6 Mottles

### 7.6.1 General

Mottles are spots or patches of different colours which are distinct from the matrix colour and any variation associated with ped surfaces, worm holes, concretions or nodules.

### 7.6.2 Abundance

The abundance of mottles is described in terms of classes indicating the percentage of exposed surface occupied by the mottles. The following categories are widely used in soil description. (Compare the charts shown in Annex A.):

0 None: 0 %

1 Very few: $> 0$ % and $\leqslant 2$ %

2 Few: $> 2$ % and $\leqslant 5$ %

3 Common: $> 5$ % and $\leqslant 15$ %

4 Many: $> 15$ % and $\leqslant 40$ %

5 Abundant: $> 40$ %

#### 7.6.3 Colour

If possible, full Munsell colour coding should be given.

### 7.7 Estimated organic matter content

Although it is difficult to carry out in the field and requires local experience, estimation of the organic content is important, in particular in relation to the interpretation of other soil variables.

0 absent or not detectable

1 sufficient to darken the soil

2 considerable organic matter giving the soil a very dark colour and a low density

3 only organic matter detectable

4 undetermined

### 7.8 Texture

#### 7.8.1 Description of texture diagram

The name of the texture triangle used and the granulometric division scale are given uncoded, including the grain size division between silt and sand (see Annex D and ISO 14688-2).

#### 7.8.2 Estimation

Note that the texture is a manual estimation carried out in the field; it is different from "particle size distribution", which is done in a laboratory. A brief guide for the texture test is presented in Annex E.

This is an estimation of the texture class of the fine earth of the horizon (particle size < 2 mm).

The soil texture class determined manually may differ from the soil texture class determined from the results of particle size analysis (e.g. according to ISO 11277).

### 7.9 Coarse elements

#### 7.9.1 General

Coarse elements correspond to the soil fraction of size > 2 mm (as opposed to fine earth). In natural soils this includes rock fragments. In urban, industrial and artificial soils, this may include other foreign materials, such as metals, concrete, glass, etc.

#### 7.9.2 Abundance (in percent volume fraction)

The following categories are widely used in soil description. (Compare the charts shown in Annex A.):

0 None: 0 %

1 Very few: > 0 % and ⩽ 2 %

2 Few: > 2 % and ⩽ 5 %

3 Common: > 5 % and ⩽ 15 %

4 Many: > 15 % and ⩽ 40 %



 

5 Abundant: $>$ 40 % and $\leqslant$ 80 %

6 Dominant: $>$ 80 %

#### 7.9.3 Maximum size of the most frequently observed coarse elements

The following categories are widely used in soil description:

1 0 cm to $\leqslant$ 2 cm

2 $>$ 2 cm and $\leqslant$ 7,5 cm

3 $>$ 7,5 cm and $\leqslant$ 12 cm

4 $>$ 12 cm and $\leqslant$ 25 cm

5 $>$ 25 cm

Each country may name the classes using local or national terms.

#### 7.9.4 Nature

Write, as clearly as possible, the nature(s) of the coarse elements. In natural soils, the lithological nature of the coarse elements should be described.

### 7.10 Carbonates and effervescence

NOTE This is often an important property in natural soil materials.

#### 7.10.1 Intensity of effervescence

The carbonate content is estimated in the field according to the visible and audible reactions of the $CO_2$ development (effervescence), using a hydrochloric acid solution, diluted to 1/10 (volume fraction). In this context, carbonate means calcium and magnesium carbonates.

0 No effervescence

No visible or audible effervescence.

This corresponds generally to no presence of carbonates.

1 Weak effervescence

Audible effervescence and a few bubbles after several seconds.

Generally, this corresponds to a percentage of carbonates less than 2 %.

2 Moderate effervescence

Visible bubbles often confined to individual grains.

Generally, this corresponds to a percentage of carbonates between 2 % and 7 %.

3 Strong effervescence

Bubbles form a thin, but more or less continuous, froth.

Generally, this corresponds to a percentage of carbonates between 7 % and 25 %.

4 Extreme effervescence

Strong reaction; the bubbles rapidly form a thick froth.

Generally, this corresponds to a context of carbonates over 25 %.

### 7.10.2 Location of effervescence

The following categories are widely used in soil description:

1 Generalized

Both the matrix (particle size < 2 mm) and the coarse elements react to acid.

2 Localized in the matrix

Effervescence limited to the fine material (< 2 µm).

3 Localized on coarse elements

Effervescence limited to coarse elements.

## 7.11 Main categories of structure

Some structures are shown in Annex F.

It is important to record the size of structural elements (in centimetres).

0 Continuous or massive

Coherent without structural aggregates.

1 Single grain

Noncoherent mass of individual particles.

2 Fibrous or layered

Particular structure of organic horizons or layers in which the vegetable residues with fibrous structure (for example, needles) or layered structure (for example, leaves) are still easily identifiable.

3 Spheroidal (crumb or granular)

When a product of soil faunal activity has a low bulk density, the structure may be described as fluffy.

4 Blocklike

Units are blocklike or polyhedral, surfaces are flat or slightly rounded, and the three dimensions are approximately the same.

5 Prismatic or columnar

Units have angular or slightly rounded surfaces, the vertical dimension is greater than the horizontal dimensions.

Where the top of the unit is curved, the structure is described as columnar.

6 Planar or platy

Structures in which parallel planes are predominant.

Where the planes are horizontal, the structure is described as platy.

Where these parallel planes are inherited from initial rock organization, the structure is considered as “rock structure”.

7 Rock

The rock organization is preserved in C or R horizons or layers (e.g. weathered schist or weathered puddingstone).

## 7.12 Compactness

The compactness evaluation by the knife test depends on the moisture status (see 7.4). It is therefore essential that the moisture status be recorded.

1 Loose

Uncompacted material; a knife penetrates easily up to the hilt.

2 Slightly compacted

A slight effort is required to insert a knife into the soil.

3 Compacted

A knife does not penetrate completely, even with considerable effort.

4 Very compacted

It is impossible to insert a knife more than a few millimetres.

## 7.13 Total estimated porosity

The total estimated porosity is an indication of the total volume of voids of all sizes estimated for a surface using the charts given in Annex A.

The total estimated porosity integrates the whole porosity of the soil, including passages made by dead roots or completely decayed roots.

All indicated percentages are by volume.

0 Nonporous: 0 % to $\leqslant$ 2 %

1 Low: $>$ 2 % and $\leqslant$ 5 %

2 Medium: $>$ 5 % and $\leqslant$ 15 %

3 High: $>$ 15 % and $\leqslant$ 40 %

4 Very high: $>$ 40 %

5 Visible porosity, but not quantified

6 Porosity not recorded

## 7.14 Roots

### 7.14.1 Size (diameter) of most frequently observed roots

1 Very fine $\leqslant$ 0,5 mm

2 Fine $>$ 0,5 mm and $\leqslant$ 2 mm

3 Medium $>$ 2 mm and $\leqslant$ 5 mm

4 Coarse $>$ 5 mm

### 7.14.2 Abundance

Abundance is defined on the basis of the mean number of roots per square decimetre (normally this is an average over a number of square decimetres). The observed face shall be smooth and shall represent a vertical plane.

In the case of very thin horizons or layers, where a square-decimetre chart cannot be used, the abundance of roots may be based on the mean number of roots encountered over a 50 cm long horizontal line, over the observed horizon face, and at the median depth between the appearance of the horizon and its disappearance (or the bottom of the pit).

0 No roots

1 Very few: 1 to 20 roots/dm$^2$, or less than 4 on a line 50 cm long

2 Few: 20 to 50 roots/dm$^2$, or 4 to 8 on a line 50 cm long

3 Common: 50 to 200 roots/dm$^2$, or 8 to 16 on a line 50 cm long

4 Many: $>$ 200 roots/dm$^2$, or more than 16 on a line 50 cm long

## 7.15 Density of worm channels (usually an average over a number of square decimetres)

The following categories are widely used in soil description:

0 No worm channels

1 Few: $<$ 1/dm$^2$ on the vertical face of the horizon

2 Common: 1 to 2/dm$^2$

3 Abundant: $>$ 2/dm$^2$

## 7.16 Nature of lower horizon boundary

The following categories are widely used in soil description:

1 Smooth

The boundary is a plane with few or no irregularities.

2 Wavy

The boundary has undulations in which depressions are wider than they are deep.

3 Irregular

The boundary has undulations in which depressions are deeper than they are wide.

4 Broken

One or both of the horizons or layers separated by the boundary are discontinuous and the boundary is interrupted.

# Annex A
(informative)

## Charts for estimating proportions of mottles, coarse elements, etc.

The charts in Figure A.1, expressed in percentage, are used for site estimation of the abundance, in area or in volume, of some elements (in black on the charts) compared to the whole.

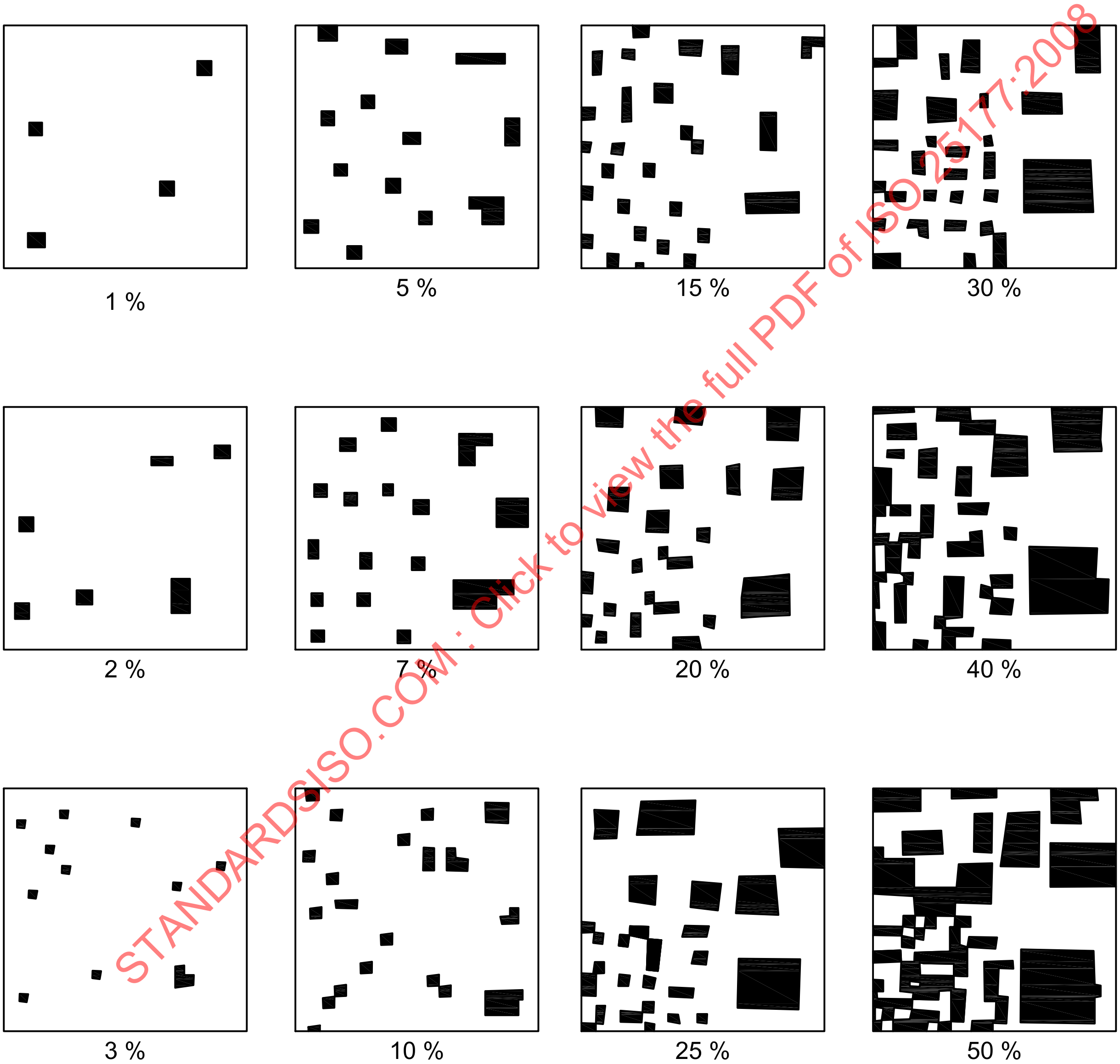




**Figure A.1 — Charts for estimating proportions of mottles, coarse elements, etc.**

# Annex B
(informative)

## Reference soil groups of the World Reference Base for soil resources (FAO, ISRIC and ISSS, 2006)

Table B.1 gives the exhaustive list of the Reference Soil Groups included in the WRB (written in bold characters) with their possible prefix qualifiers used to determine the second-level units.

NOTE 1 The complete document can be found on the Internet.

NOTE 2 Other soil reference systems may be used in accordance with local, regional or national customs.



**Table B.1 — List of the Reference Soil Groups (WRB)**

| **Histosols** | **Cryosols** | **Anthrosols** | **Leptosols** | **Vertisols** |
|---|---|---|---|---|
| Cryic | Histic | Hydragric | Lithic | Thionic |
| Glacic | Lithic | Irragric | Gleyic | Salic |
| Salic | Leptic | Terric | Rendzic | Natric |
| Gelic | Turbic | Plaggic | Umbric | Gypsic |
| Thionic | Salic | Hortic | Yermic | Duric |
| Folic | Natric | Gleyic | Aricic | Calcic |
| Fibric | Gleyic | Stagnic | Vertic | Alic |
| Sapric | Andic | Spodic | Gelic | Gypsiric |
| Ombric | Mollic | Ferralic | Hyperskeletic | Pellic |
| Rheic | Gypsic | Luvic | Mollic | Grumic |
| Alcalic | Calcic | Arenic | Humic | Mazic |
| Toxic | Umbric | Regic | Gypsiric | Chromic |
| Dystric | Yermic | | Calcaric | Mesotrophic |
| Eutric | Aridic | | Dystric | Hyposodic |
| | Glacid | | Eutric | Eutric |
| | Thionic | | Haplic | Haplic |
| | Oxyaquic | | | |
| | Stagnic | | | |
| | Haplic | | | |

**Table B.1** (*continued*)

| **Fluvisols** | **Solonchaks** | **Gleysols** | **Andosols** | **Podzols** |
|---|---|---|---|---|
| Histic | Histic | Histic | Vitric | Gelic |
| Thionic | Vertic | Thionic | Eutrisilic | Gleyic |
| Salic | Gleyic | Anthraquic | Silic | Stagnic |
| Gleyic | Sodic | Endosalic | Gleyic | Densic |
| Mollic | Mollic | Andic | Melanic | Carbic |
| Umbric | Gypsic | Vitric | Fulvic | Rustic |
| Arenic | Duric | Plinthic | Hydric | Histic |
| Takyric | Calcic | Sodic | Pachic | Umbric |
| Yermic | Petrosalic | Mollic | Histic | Entic |
| Aridic | Takyric | Gypsic | Mollic | Placic |
| Gelic | Yermic | Calcic | Duric | Skeletic |
| Stagnic | Aridic | Umbric | Umbric | Fragic |
| Humic | Gelic | Arenic | Luvic | Lamellic |
| Gypsiric | Stagnic | Takyric | Placic | Anthric |
| Calcaric | Hypersalic | Gelic | Leptic | Haplic |
| Sodic | Ochric | Humic | Acroxic | |
| Tephric | Aceric | Alcalic | Vetic | |
| Skeletic | Chloridic | Alumic | Calcaric | |
| Dystric | Sulfatic | Toxic | Arenic | |
| Eutric | Carbonatic | Abruptic | Sodic | |
| Haplic | Haplic | Calcaric | Skeletic | |
| | | Tephric | Thaptic | |
| | | Dystric | Dystric | |
| | | Eutric | Eutric | |
| | | Haplic | Haplic | |

**Table B.1** (*continued*)

| Plinthosols | Ferralsols | Solonetz | Planosols | Chernozems |
|---|---|---|---|---|
| Petric | Plinthic | Vertic | Histic | Chernic |
| Alic | Gleyic | Gleyic | Vertic | Vertic |
| Acric | Andic | Salic | Thionic | Gleyic |
| Umbric | Acric | Mollic | Endosalic | Luvic |
| Albic | Lixic | Gypsic | Plinthic | Glossic |
| Stagnic | Arenic | Duric | Gleyic | Calcic |
| Endoeutric | Gibbsic | Calcic | Sodic | Siltic |
| Geric | Geric | Magnesic | Mollic | Vermic |
| Humic | Humic | Takyric | Gypsic | Hamplic |
| Endoduric | Histic | Yermic | Calcic | |
| Vetic | Mollic | Aridic | Alic | |
| Alumic | Umbric | Stagnic | Luvic | |
| Abruptic | Endostagnic | Albic | Umbric | |
| Pachic | Vetic | Humic | Arenic | |
| Glossic | Posic | Haplic | Gelic | |
| Ferric | Alumic | | Albic | |
| Haplic | Ferric | | Geric | |
| | Hyperdistric | | Petroferric | |
| | Hypereutric | | Alcalic | |
| | Rhodic | | Alumic | |
| | Xanthic | | Ferric | |
| | Haplic | | Calcaric | |
| | | | Rhodic | |
| | | | Chromic | |
| | | | Dystric | |
| | | | Eutric | |
| | | | Haplic | |



 

**Table B.1** (*continued*)

| **Kastanozems** | **Phaezems** | **Gypsisols** | **Durisols** | **Calcisols** |
|---|---|---|---|---|
| Vertic | Leptic | Petric | Petric | Petric |
| Gypsic | Vertic | Leptic | Leptic | Leptic |
| Calcic | Gleyic | Vertic | Vertic | Vertic |
| Luvic | Andic | Endosalic | Gypsic | Endosalic |
| Hyposodic | Vitric | Sodic | Calcic | Gleyic |
| Siltic | Sodic | Duric | Luvic | Sodic |
| Chromic | Luvic | Calcic | Arenic | Luvic |
| Anthric | Albic | Luvic | Takyric | Takyric |
| Haplic | Stagnic | Takyric | Yermic | Yermic |
| | Greyic | Yermic | Aridic | Aridic |
| | Pachic | Aridic | Chromic | Skeletic |
| | Abruptic | Arzic | Hyperochric | Hyperochric |
| | Glossic | Skeletic | Haplic | Hypercalcic |
| | Tephric | Hyperochric | | Hypocalcic |
| | Calcaric | Hypergypsic | | Haplic |
| | Skeletic | Hypogypsic | | |
| | Siltic | Haplic | | |
| | Vemic | | | |
| | Chromic | | | |
| | Haplic | | | |

**Table B.1** (*continued*)

| **Albeluvisols** | **Alisols** | **Nitisols** | **Acrisols** | **Luvisols** |
|---|---|---|---|---|
| Histic | Vertic | Andic | Leptic | Leptic |
| Gelic | Plinthic | Mollic | Plinthic | Vertic |
| Gleyic | Gleyic | Alic | Gleyic | Gleyic |
| Alic | Andic | Umbric | Andic | Andic |
| Umbric | Nitic | Humic | Vitric | Vitric |
| Arenic | Umbric | Vetic | Umbric | Calcic |
| Fragic | Arenic | Alumic | Arenic | Arenic |
| Stagnic | Stagnic | Rhodic | Stagnic | Stagnic |
| Alumic | Albic | Ferralic | Geric | Albic |
| Endoeutric | Humic | Dystric | Albic | Hyposodic |
| Abruptic | Abruptic | Eutric | Humic | Profondic |
| Ferric | Profondic | Haplic | Vetic | Lamellic |
| Siltic | Lamellic | | Abruptic | Ferric |
| Haplic | Ferric | | Profondic | Rhodic |
| | Hyperdystric | | Lamellic | Chromic |
| | Skeletic | | Ferric | Cutanic |
| | Rhodic | | Alumic | Hyperochric |
| | Chromic | | Hyperdystric | Dystric |
| | Haplic | | Skeletic | Haplic |
| | | | Rhodic | |
| | | | Chromic | |
| | | | Hyperochric | |
| | | | Haplic | |

**Table B.1** (*continued*)

| **Lixisols** | **Umbrisols** | **Cambisols** | **Arenosols** | **Regosols** |
|---|---|---|---|---|
| Leptic | Gelic | Gelic | Gelic | Gelic |
| Plinthic | Leptic | Leptic | Plinthic | Leptic |
| Gleyic | Gleyic | Vertic | Gleyic | Gleyic |
| Andic | Arenic | Fluvic | Hypoluvic | Thaptoandic |
| Vitric | Stagnic | Endosalic | Yermic | Thaptovitric |
| Calcic | Albic | Plinthic | Aridic | Arenic |
| Arenic | Humic | Gelistagnic | Ferralic | Takyric |
| Stagnic | Ferralic | Stagnic | Albic | Yermic |
| Geric | Skeletic | Gleyic | Gypsiric | Aridic |
| Albic | Anthric | Andic | Calcaric | Gelistagnic |
| Humic | Haplic | Vitric | Lamellic | Stagnic |
| Vetic | | Mollic | Rubic | Anthropic |
| Abruptic | | Takyric | Fragic | Aric |
| Profondic | | Yermic | Hyposalic | Garbic |
| Lamellic | | Aridic | Tephric | Reductic |
| Ferric | | Sodic | Hypoduric | Spolic |
| Rhodic | | Ferralic | Protic | Urbic |
| Chromic | | Gypsiric | Dystric | Humic |
| Hyperochric | | Calcaric | Eutric | Vermic |
| Haplic | | Skeletic | Haplic | Hyposalic |
| | | Rhodic | | Hyposodic |
| | | Chromic | | Gypsiric |
| | | Hyperochric | | Calcaric |
| | | Dystric | | Tephric |
| | | Eutric | | Skeletic |
| | | Haplic | | Hyperochric |
| | | | | Dystric |
| | | | | Eutric |
| | | | | Haplic |



 

# Annex C
(informative)

# Soil horizon designation — Example of the FAO System (2006)



## C.1 General

The FAO horizon designation consists of one or two capital letters for the master horizon and lower-case suffixes for subordinate horizon distinctions, with or without a numerical suffix. For a full understanding of the soil profile description, it is essential that correct horizon symbols be given.

## C.2 Master horizons and layers

The capital letters H, O, A, E, B, C and R represent the master horizons and layers of soils. The capital letters are the base symbols to which other characters are added to complete the designation. Most horizons and layers are given a single capital-letter symbol, some require two.

Currently, seven master horizons and layers and seven transitional horizons are recognized. Descriptions of the master horizons are the following.

a) H horizons or layers

H horizons or layers are layers dominated by organic material, formed from accumulations of undecomposed or partially decomposed organic material at the soil surface, which may be under water. All H horizons are saturated with water for prolonged periods, or were once saturated if they are now artificially drained. An H horizon may bed on top of mineral soils or at any depth beneath the surface if it is buried.

b) O horizons or layers

O horizons or layers are layers dominated by organic material, consisting of undecomposed or partially decomposed litter, such as leaves, needles, twigs, moss and lichens, which has accumulated on the surface; they may be on top of either mineral or organic soils. O horizons are not saturated with water for prolonged periods. The mineral fraction of such material is only a small percentage of the volume of the material, and generally is much less than half of the mass.

An O layer may be at the surface of a mineral soil or at any depth beneath the surface if it is buried. A horizon formed by illuviation of organic material into a mineral subsoil is not an O horizon, though some horizons formed in this manner contain a large quantity of organic matter.

c) A horizons

A horizons are mineral horizons which formed at the surface or below an O horizon, in which all or much of the original rock structure has been obliterated and which are characterized by one or more of the following:

— an accumulation of humified organic matter intimately mixed with the material fraction and not displaying properties characteristic of E or B horizons [see d) and e)];

— properties resulting from cultivation, pasturing, or similar kinds of disturbance;

— a morphology which is different from the underlying B or C horizon, resulting from processes occurring at the surface.

If a surface horizon has properties of both A and E horizons but the dominant feature is an accumulation of humified organic matter, it is designated as an A horizon.

In some places, such as warm arid climates, the undisturbed surface horizon is less dark than the adjacent underlying horizon and contains only small amounts of organic matter. It has a morphology distinct from the C layer, although the mineral fraction may be unaltered or only slightly altered by weathering. Such a horizon is designated as A because it is at the surface.

Examples of soils which may have a different structure or morphology due to surface processes are vertisols, soils in pans or playas with little vegetation, and soils in deserts. However, recent alluvial or aeolian deposits that retain fine stratification are not considered to have an A horizon unless they are cultivated.

d) E horizons

E horizons are mineral horizons in which the main feature is loss of silicate clay, iron, aluminium or some combination of these, leaving a concentration of sand and silt particles, and in which all or much of the original rock structure has been obliterated.

An E horizon is usually, but not necessarily, lighter in colour than an underlying B horizon. In some soils, the colour is that of the sand and silt particles, but in many soils, coatings of iron oxides or other compounds mask the colour of the primary particles. An E horizon is most commonly differentiated from an underlying B horizon in the same soil profile by the colour of higher- or lower-value chroma, or both; by a coarser texture; or by a combination of these properties.

An E horizon is commonly near the surface below an O or A horizon and above a B horizon, but the symbol E may be used without regard to position in the profile, for any horizon that meets the requirements and that has resulted from soil genesis.

e) B horizons

B horizons are horizons that formed below an A, E, O or H horizon and in which the dominant features are the obliteration of all or much of the original rock structure, together with one or a combination of the following:

— illuvial concentration, alone or in combination, of silicate clay, iron, aluminium, humus, carbonates, gypsum or silica;

— evidence of removal of carbonates;

— residual concentration of sesquioxides;

— coatings of sesquioxides that make the horizon colour conspiciously lower in value, higher in chroma, or redder in hue than overlying and underlying horizons without apparent illuviation or iron;

— alteration that forms silicate clay or liberates oxides, or both, and that forms a granular, blocky or prismatic structure if volume changes accompany changes in moisture content;

— brittleness.

All kinds of B horizons are, or were originally, subsurface horizons. Included as B horizons are layers of illuvial concentration of carbonates, gypsum, or silica that are the result of pedogenetic processes (these layers may or may not be cemented) and brittle layers that have other evidence of alteration, such as a prismatic structure or illuvial accumulation of clay.

Examples of layers that are not B horizons are layers in which clay films either coat rock fragments or are on finely stratified unconsolidated sediments, whether the films were formed in place or by illuviation; layers into which carbonates have been illuviated but are not contiguous to an overlying genetic horizon, and layers with gleying but no other pedogenetic changes.

f) C horizons or layers

C horizons or layers are horizons or layers, excluding hard bedrock, that are little affected by pedogenetic processes and lack the properties of H, O, A, E or B horizons. Most of them are mineral layers, but some siliceous or calcareous layers, such as shells, coral and diatomaceous earth, are included. The material of C layers may be like or unlike that from which the solum presumably formed. A C horizon may have been modified even if there is no evidence of pedogenesis. Plant roots can penetrate C horizons, which provide an important growing medium.

Included as C layers are sediments, saprolite, and unconsolidated bedrock and other geological materials that commonly slake within 48 h when air-dry (or drier) chunks are placed in water and, when moist, can be dug with a spade.

Some soils form in material that is already highly weathered, and such material that does not meet the requirements of A, E or B horizons is designated as C. Changes that are not considered pedogenetic are those not related to overlying horizons. Layers having accumulations of silica, carbonates, or gypsum, even if indurated, may be included in C horizons, unless the layer is obviously affected by pedogenetic processes; then it is a B horizon.

g) R layers

R layers are hard bedrock underlying the soil.

Granite, basalt, quartzite and indurated limestone or sandstone are examples of bedrock that are designated as R. Air-dry (or drier) chunks of an R layer, when placed in water, will not slake within 24 h. The R layer is sufficiently coherent when moist to make hand digging with a spade impractical, although it may be chipped or scraped. Some R layers can be ripped with heavy power equipment. The bedrock may contain cracks, but these are so few and so small that few roots can penetrate. The cracks may be coated or filled with clay or other material.

## C.3 Transitional horizons

There are two kinds of transitional horizons: those with properties intermediate between two horizons, and those with properties of two horizons appearing in separate volumes.

For horizons dominated by properties of one master horizon but having subordinate properties of another, symbols with two capital letters are used, such as AB, EB , BE and BC. The master-horizon symbol given first designates the horizon whose properties dominate the transitional horizon. An AB horizon, for example, has the characteristics of both an overlying A horizon and an underlying B horizon, but is more like the A than the B horizon.

A horizon can be designated as transitional even if one of the master horizons to which it is apparently transitional is not present. For example, a BE horizon may be recognized in a truncated soil if its properties are similar to those of a BE horizon in a soil in which the overlying E horizon has not been removed by erosion. An AB or a BA horizon may be recognized where bedrock underlies the transitional horizon. A BC horizon may be recognized even if no underlying C horizon is present: it is transitional to the assumed parent material. A CR horizon can be used for weathered bedrock which can be dug with a spade, even though roots cannot penetrate except along fracture planes.

Horizons in which distinct parts have recognizable properties of two kinds of master horizons are indicated as above, but the capital letters are separated by a slash (/), as E/B, B/E, B/C or C/R. Commonly, most of the individual parts of one of the components are surrounded by the other.

## C.4 Subordinate characteristics within master horizons and layers

Designations of subordinate distinctions and features within the master horizons and layers are based on profile characteristics observable in the field and are applied during the description of the soil at the site. Lower-case letters are used as suffixes to designate specific kinds of master horizons and layers, as well as other features.

a) Buried horizon **(b)**

A buried horizon (b) is used in mineral soils to indicate identifiable buried horizons with major genetic features that were formed before burial. These genetic horizons may or may not have formed in the overlying material, which may be either like or unlike the assumed parent materials of the buried soil. The symbol is not used in organic soils nor to separate an organic layer from a mineral layer.

b) Concretions or nodules **(c)**

Concretions or nodules (c) indicate a significant accumulation of concretions or of nodules. The nature and consistency of the nodules is specified by other suffixes and in the horizon description.

c) Frozen horizon **(f)**

Frozen horizon (f) designates horizons or layers that contain permanent ice or are perennially colder than 0 °C. It is not used for seasonally frozen layers or for bedrock layers (R).

d) Gleying **(g)**

Gleying (g) designates horizons in which a distinct pattern of mottling occurs which reflects alternating conditions of oxidation and reduction of sesquioxides (caused by seasonal waterlogging).

This corresponds to iron segregation (impoverished or enriched areas) of a permanent character throughout the year, whatever the moisture condition at the time of observation.

e) Accumulation of organic matter **(h)**

Accumulation of organic matter (h) designates the accumulation of organic matter in mineral horizons. The accumulation may occur in surface horizons, or in subsurface horizons through illuviation.

f) Jarosite mottles **(j)**

Jarosite mottles (j) indicates the presence of a very acid environment (example: former mangrove).

g) Accumulation of carbonates **(k)**

Accumulation of carbonates (k) commonly indicates calcium carbonate.

h) Cementation or induration **(m)**

Cementation or induration (m) indicates continuous or nearly continuous cementation and is used only for horizons that are more than 90 % cemented, although they may be fractured. The layer restricts roots which do not enter, except along fracture planes.

The single predominant or codominant cementing agent may be indicated using defined letter suffixes singly or in pairs. If the horizon is cemented by carbonates, “km” is used, by silica “qm”, by iron “sm”, by gypsum “ym”, by both lime and silica “kqm”, by salts more soluble than gypsum “zm”.

i) Accumulation of sodium **(n)**

j) Residual accumulation of sesquioxides **(o)**

Residual accumulation of sesquioxides (o) indicates residual accumulation of sesquioxides and differs from the use of the symbol “s”, which indicates illuvial accumulation of organic matter and sesquioxide complexes.

k) Ploughing or other disturbance **(p)**

Ploughing or other disturbance (p) indicates disturbance of the surface layer by ploughing or any tillage practice. A disturbed organic horizon is designated as Op or Hp. A disturbed mineral horizon is designated as Ap, Ep, Bp, etc.

l) Accumulation of silica **(q)**

Accumulation of silica (q) indicates an accumulation of secondary silica. If silica cements the layer and cementation is continuous or nearly continuous, “qm” is used.

m) Strong reduction **(r)**

Strong reduction (r) predominance of iron reduction and mobilization processes under conditions of permanent or near-permanent saturation. The appearance can vary noticeably in the course of the year in the case of a large variation of water table depth. Two facies can be differentiated.

— Some horizons correspond to conditions of permanent saturation by water; the colours are more or less uniformly bluish green or uniformly white to black or grey, with a chroma $\leqslant 2$.

— Some horizons are temporarily reoxidized if the saturation by water is interrupted for some time. Ochreous mottles (yellowish red, brownish red) are locally observable at contact with voids, with roots and on some aggregate surfaces. If “r” is used with “B”, pedogenetic change, in addition to reduction, is implied; if no other change has taken place, the horizon is designated as Cr.

n) Illuvial accumulation of sesquioxides and organic matter **(s)**

Illuvial accumulation of sesquioxides and organic matter (s) is used with “B” to indicate the accumulation of illuvial, amorphous, dispersible organic sesquioxide complexes, if the value and chroma of the horizon are more than 3. The symbol is also used in combination with “h” as Bhs, if both the organic and sesquioxide components are significant and both value and chroma are $\leqslant 3$.

o) Accumulation of silicate clay **(t)**

Accumulation of silicate clay (t) is used with B or C to indicate an accumulation of silicate clay that either has formed in the horizon or has been moved into it by illuviation, or both. At least some part should show evidence of clay accumulation in the form of coating on ped surfaces or in pores, as lamellae, or as bridges between mineral grains.

p) Occurrence of plinthite **(v)**

Occurrence of plinthite (v) indicates the presence of iron-rich, humus-poor material that is firm or very firm when moist and that hardens irreversibly when exposed to the atmosphere. When hardened, it is no longer called plinthine but hardpan, ironstone, or a petroferric or skeletic phase.

q) Development of colour or structure **(w)**

Development of colour or structure (w) is used with “B” to indicate the development of colour or structure, or both. It should not be used to indicate a transitional horizon.

r) Fragipan character **(x)**

Fragipan character (x) is used to indicate genetically developed firmness, brittleness or high bulk density. These features are characteristic of fragipans, but some horizons designated as “x” do not have all the properties of a fragipan.

s) Accumulation of gypsum **(y)**

t) Accumulation of salts more soluble than gypsum **(z)**