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Second edition
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Soil quality — Field soil description

Qualité du sol — Description du sol sur le terrain

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 190, *Soil quality*.

This second edition cancels and replaces the first edition (ISO 25177:2008), which has been technically revised.

The main changes compared to the previous edition is as follows.

— The 2015 edition of the World Reference Base for soil resources[24] has been adapted.

— References to geotechnical standards ISO 14688-1[3] and ISO 14688-2[4] have been made.

— A new Clause 4 describing how to use this document has been added and subsequent clauses have been renumbered.

— A new Clause 5 describing objectives and methods has been added and subsequent clauses have been renumbered. The aspects to describe and how to do this is more separate from the observations and background information.

— The numbering and encoding have been made more consequent and logical.

— New aspects about coarse anthropogenical elements, oil-water reaction pan and signs of pollution or contamination have been added.

— A new Clause 11 about reporting has been added.

— A new Annex A about landforms has been added and subsequent annexes have been renumbered.

— The former Annex B listing reference soil groups of the WRB[24] has been removed.

— A new Annex G about common coarse elements found in soil and soil surface has been added.

— A new Annex H about recording soil description observations for specific types of soil quality investigations has been added.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Traditionally, description of soils and their environment was carried out as parts of soil surveys and soil inventories, the purpose being to describe the pedogenic context of the soil and assess applied aspects, principally agronomic potentials.

Today, many soil observations are made as part of either much broader, or alternatively more focused, environmental studies, and might include analysis for objectives such as:

— identifying human influences on soils, with, particular attention being paid to the negative effects of these influences (for example contamination with possible hazardous substances, or deterioration of physical soil properties);

— land protection within the context of sustainable agriculture and forestry;

— assessing the fate of contaminants introduced to the soil;

— assessing the consequences arising from changes in the use of the soil;

— setting up monitoring programs for specific purposes (such as observation of changes of soil properties over time);

— developing spatial databases (used in the context of GIS) aimed at facilitating the geographical representation of soils;

— and for many other purposes.

While the general framework of this document has stayed the same in this updated version, additions include references to the ISO 18400 series (see Figure 1), observations for soil contamination, and description of artificial material and soil layers.

The description of soils and sites is often accompanied by field and laboratory measurements, and therefore field measurement observations are included in this document.

The original text was based on aspects of the traditional approach to soil description {for example the "Guidelines for soil description" from the FAO (Rome 2006)[30] and the soil type classification from the World Reference Base for soil resources (WRB)[24]}.

Soil descriptions and associated soil data are used and re-used for a variety of purposes. For wider utilization of data from soil descriptions, this document can be used in conjunction with other (commonly and publicly available) standards. Some types of soil information, specifically soil contamination data and data on anthropogenic and exogenous material, were not available in earlier versions and have been included here.

Depending on the objective/s of an investigation, specific observations of interest will be made and recorded. Even within a particular field of interest, the degree of detail in the soil description in the field will vary, depending on the scope of the project.

The quality of field soil descriptions is strongly dependent on the knowledge and especially the experience of the person making and/or recording the observations in the field, since most field observations are estimations (sometimes with the help of reference materials and devices like colour-charts, magnifiers, sieves, or scatter diagrams).

Soil quality — Field soil description

1 Scope

This document provides guidance on the description of soil in the field and its environmental context. It is applicable to natural, near-natural, urban and industrial sites. The soil observations and measurements can be made on a project site level, on a plot level, on layer or horizon level and on specific soil constituents.

It also provides guidance on how to describe layers of anthropogenic (artificial) material or layers that were not modified by pedogenic processes in the strict sense and how to describe coarse material of natural or artificial origin.

This document can be used in combination with other publications that provide guidance or requirements regarding specific aspects of soil observations and measurements.

NOTE 1 It might not be possible or necessary to record data under all the headings listed in Clauses 4 to 11.

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

NOTE 3 The guidance provided assumes that sampling will be done in accordance with ISO 18400.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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, *Codes for the representation of names of countries and their subdivisions — Part 1: Country codes*

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

ISO 11074, *Soil quality — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11074 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at: http://www.electropedia.org

3.1
observation
act of observing a property, with the goal of producing an estimate of the value of the property

Note 1 to entry: Adapted from ISO 19156.

4 How to use this document

4.1 General

This document describes the most commonly used field observations in soil quality investigations. The observations are recorded at different levels:

— general/site (see Clause 6);

— profile/surface point (see Clause 7 and 8);

— horizon/layer (see Clause 9 and 10).

Pre-defined observations (picklists) are tabulated with their corresponding codes. Where relevant, explanatory text is given before or after the observation to be recorded [e.g. in this subclause (4.1)]. Some observations to be recorded are so commonly understood that they are simply listed, for example in 6.5.

Where possible values associated with observations are pre-defined (picklists) and these values are defined with percentages (%), it is also permissible to record estimated specific percentage values.

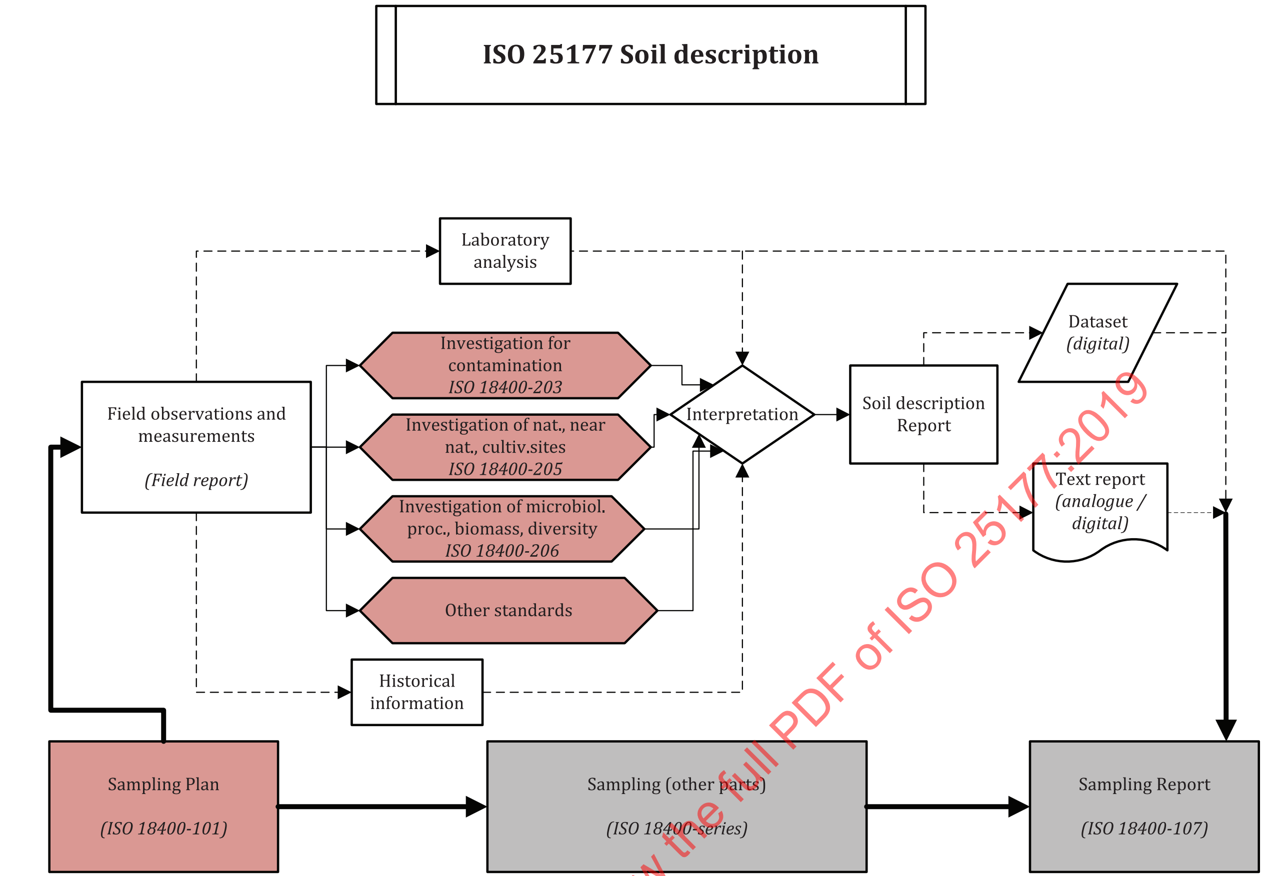
EXAMPLE Recording of a mottle abundance value of 10 % is allowed (see 9.8.2). This can also be recorded as code "3" or as "common".

This means that a more precise estimate can be recorded (e.g. rather than a range), however it does not mean that the estimates are in fact more accurate, since accuracy may depend on both the requirements of the project and skill of the observer.

For soil descriptions in the field and for digital data exchange, only the codes and values can be recorded. In the full field report, the text of the description can also be provided. The full text descriptions belonging to codes shall be available.

NOTE In the digital exchange of data this might be in the form of a hint or link to the table.

The context of the information is important for the application of the results. In Figure 1, the process for soil description is provided.



Key

optional routes (specific part of) soil descriptions

possible purposes soil investigations (can be combined)

soil investigation primary process route

Figure 1 — Soil description process

4.2 Combined use with other description standards

This document can be used separately or in combination with standards that provide further guidance or requirements for specific aspects of soil observations and measurements.

Where relevant, this document can be applied with the following references:

— FAO Guidelines for soil descriptions (Rome)[30], for example when describing soils and denoting horizons;

— World Reference Base for soil resources (WRB)[24], for example when determining soil types;

— ISO 14688-1 and ISO 14688-2.

If additional codes, descriptions or requirements from these or other complementary references is used, these shall be recorded (see 6.1).

EXAMPLES

— ISO 25177:2019 FAO

— ISO 25177:2019 ISO 18400-203

4.3 Mandatory or optional observations

Where observations are mandatory, it is explicitly indicated by underlined text in this document. If not mandatory the observations to record are optional.

For a number of common soil investigation types the mandatory observations are listed in Annex H. If optional observations are described, they shall be recorded according to this document.

NOTE National legislation or project rules can demand that optional observations can be mandatory in some contexts.

4.4 Accuracy and units

Because of the very different objectives for most field observations, no minimum accuracy is stipulated. For some observations, the unit to be used is mandatory. The unit specified is generally the most commonly used one and fit for the purpose for most soil descriptions.

EXAMPLE x- and y- coordinate in metres.

Depending on the accuracy required for an investigation, recording the coordinates in whole metres may be sufficient, however, more accuracy is needed at times (for example, plus or minus 0,01 metres). The unit used in the second case is still metres, although the accuracy may be significantly better than a whole metre.

NOTE The units and number of digits output from a given device do not automatically reflect its accuracy. For example, a GPS measurement with 3 digits after comma or point (depending on the convention used) does not mean that the value is accurate to 1 mm.

4.5 Encoding

Field observations can comprise different types of results. For some observations, the result should be one of the results given in the pre-defined in picklists. For other observations, results should be recorded as estimated or measured values. At least at all main levels (site-, profile-, layer/horizon-) there should be capacity for free text for observations that do not match those in the pre-defined picklists.

Numeric codes in this document are defined with the same number of digits. If there are more than 9 and less than 99, a zero is added to the codes 1 until 9 (i.e. 01, 02, 03, etc.). Numeric codes start in principle with 1, unless the first value class is zero or near-zero. In that case, the numeric codes start with zero (0).

EXAMPLE In 8.4, Code 0 = no visible erosion.

If not observed, but a code is needed for an observation, an “X” can be used.

NOTE X does not mean observed with result 0 (zero).

In this document, some descriptions and associated codes are derived from FAO[30] and/or ISO 14688-1. In addition, new observation results have been added, codes from the earlier version of this document might have been changed, and new codes might have been added.

5 Description objectives and methods

5.1 General

The reference for this clause is the FAO Guidelines for soil descriptions[30]. If another complementary reference is used, this shall be clearly stated in the text of the written report, or in the meta-data of the digital data that is reported.

5.2 Investigation objectives

Soil investigations usually have specific objectives. Other standards adapted to various scopes can be combined with this document.

Main investigation types based on project objectives or approaches include:

— investigation for contamination (e.g. according to ISO 18400-203);

— investigation for nature or near-nature management (e.g. according to ISO 18400-205);

— investigation for cultivation management (e.g. according to ISO 18400-205);

— investigation for agricultural management (e.g. according to ISO 18400-205);

— investigation for forestry (e.g. according to ISO 18400-205);

— investigation for archaeology;

— investigation of soil gas (e.g. according to ISO 18400-204);

— biological investigation (e.g. according to ISO 18400-206).

NOTE 1 See Figure 1 for a schema of how this document can be used in combination with other standards.

NOTE 2 Annex H provides a list of the most commonly used observations of soil that can be recorded and the importance of separate types of soil investigations.

5.3 Quality assurance and quality control

The desired accuracy and level of detail is dependent on the project scope and project objectives.

Where aspects of soil description are mentioned or given, ISO 18400-106 can be applied.

Alternatively, or in addition, other guidance on QA/QC can be applicable.

For digital exchange of soil related data ISO 28258 can be applied.

Field estimations depend on the knowledge and experience of the observer. To ensure consistent soil observations, it is recommended to regularly undertake field soil descriptions with experienced personnel.

NOTE 1 Education and training of staff is important. Projects can benefit with staff that has experience with similar soil sites, soil layers and scopes.

NOTE 2 Assessing inexperienced personnel's estimates of texture for example can be done by comparing their results with reference analysis and reference samples, and/or having them working with personnel experienced in field soil description.

NOTE 3 A check for logical and internal consistency of field data can give a first impression of data quality.

5.4 Description structure

Soil is described at different levels.

— General level: references of a soil description, e.g. profile numbers, geographical coordinates. See Clause 5.

— Site level: observations of the location or site. The scale of the location or site is determined in the project. A project can have different sites or locations. A site or location usually has more than one plots. See Clause 6.

— Plot level: observations that can be made on profile level: from the borehole or in a trial pit or trench. See Clause 7 and 8.

— Layer/horizon level: observations that can be made on one spot from the surface down to the parent material. See Clause 9.

NOTE The difference between plot and site (location) is explained in ISO 28258.

6 Description of general references and general information

6.1 General

Record the general reference, using the following codes or descriptions:

Code	Description
1	ISO 25177
2	ISO 25177 and FAO[30]
3	ISO 25177 and ISO 14688-1
4	ISO 25177 and FAO[30] and ISO 14688-1
5	ISO 25177 and other standard(s) – see 4.2

Record, if relevant, (other) reference standard(s) and general information.

6.2 Site/profile numbers

Record the profile number(s) or code(s).

Record the survey number or code.

6.3 Location

Record the 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.

Record the administrative division.

To be adapted according to the country, provinces, states, regions, departments, towns. This can be recorded uncoded and coded. If coded, the definition shall be available, for example, in code lists.

Record the toponym and address of the location.

Place name, street and street number, postal code, local/extra place name.

6.4 Geographical coordinates

Latitude and longitude of the site should be given as accurately as possible in decimal degrees (WGS84). Other reference systems may be used if specified.

Record the type of geographical reference system (degrees, lambert, national reference grid).

Record the position within the geographical reference system (longitude in degree/min/s, latitude in degree/min/s).

Record the altitude (in metres).

6.5 Date and time of observations

Record the year, month and day of the observations.

Record, if relevant, the time of the observations.

6.6 Author and organization

Record the author's name.

Record the accreditation (e.g. reference to the qualification of person and/or organization).

Record the name of organization.

Record, if relevant, the department.

Record the address.

Record the telephone number.

Record the e-mail address.

7 Profile environment

7.1 General

The environmental setting of the profile that is to be described may be recorded using a combination of different standards if necessary (see 4.2).

The reference for this clause is the FAO[30]. If another reference is used, this shall be clearly stated in the text of the written report or in the meta-data of the digital data that is reported.

7.2 Previous precipitation

Record, using the following codes or descriptions.

Code	Description
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
X	Not observed

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

Record, using the following codes or descriptions.

Code	Description
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

Code	Description
06	Metal manufacturing sites
07	Food processing sites
08	Waste disposal sites
09a	Arable lands
09b	Cultivated grasslands
10	Horticulture
11	Grazing
12	Orchards, fruit plantations or grapevines
13	Forest, woodlands
14	Mixed land use (agroforestry or agro-pastoral)
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	Other type of unutilized and unmanaged site
21	Natural lands
22	Natural grass lands
23	Recreation land
X	Not observed

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

Record the type of cultivation or vegetation or human utilization.

Be as clear and precise as possible. For cultivated plants, it may be useful 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).

7.5 Landform of the site

Record the position of the site in the landscape.

Record the geomorphology of the immediate surroundings of the site (scale: 0,1 km).

NOTE See Annex A for a list of landforms.

7.6 Slope length

Record the slope length in metres. When flat, record 0 (zero).

7.7 Slope value (gradient)

The average slope value or slope gradient is measured in the vicinity of the profile/sampling location.

Slope values may be expressed in percent or degrees.

Record the slope value (gradient), in % (100*rise/distance).

Alternatively, record the slope value (gradient), in degrees (0 = flat, 90 = vertical).

NOTE FAO[30] specifies in %.

7.8 Slope orientation (aspect)

The orientation can be recorded as code or degrees.

a) Record the orientation, using one of the following codes.

Code	Description
N	North
E	East
S	South
W	West
NE	North East
NW	North West
SE	South East
SW	South West
VV	Variable
AA	Flat
X	Not observed

or

b) Record the orientation in degrees, use the following convention.

0° = north

90° = east

180° = south

270° = west

with VV = variable and AA = flat

7.9 Nature of natural and anthropogenic soils and materials

7.9.1 Natural material

Natural parent material and/or bedrock should be described as completely as possible (and appropriate) in accordance with ISO 14688-1, ISO 14688-2 and ISO 14689 taking into account published information on geology and local knowledge. The level of detail should be that necessary for the task at hand (i.e. a full geotechnical description might not be required). Complementary information from local knowledge should be recorded where appropriate.

NOTE Natural parent material and/or bedrock might be identified, for example, as glacial till, marine alluvium, metamorphic bedrock, limestone, loessic deposit, surface cracks, surface sealing, or salt, etc. The material could also be identified as loose, firm or hard.

Record, if present, the natural material.

7.9.2 Anthropogenic material

The nature of the parent material may be modified by the land use of the site, or artificial materials that might have been imported to the site. Modified natural parent material and imported soil or other material should be described as completely as possible (and as appropriate) in accordance with ISO 14688-1, ISO 14688-2 and ISO 14689, taking into account published information on geology and local knowledge. The level of detail should be that necessary for the task at hand (i.e. a full geotechnical description might not be required).

NOTE 1 ISO 14688-1 establishes the basic principles for the identification and classification of soils on the basis of those material and mass characteristics most commonly used for soils for engineering purposes. ISO 14688-1 is applicable to natural soils in situ, similar human-made materials in situ and soils redeposited by human activity.

NOTE 2 ISO 18400-104 recognizes "anthropogenic ground" comprising "fill" and/or "made ground" (see ISO 18400-104 or ISO 11074). These are the preferred terms to use when dealing with potentially contaminated and similar sites.

NOTE 3 Knowledge about the history of the site can provide information about the modifications of the natural material and the nature of soil or other materials imported and deposited on the site (see ISO 18400-202).

Record, if present, the anthropogenic material.

7.10 Presence and depth to water table

7.10.1 General

The depth to the water table generally fluctuates during the year. It can sometimes be seasonal or in response to fluctuating tidal levels.

When there is no variation in water table depth, or when the describer does not know if there are depth variations, do not answer points 7.10.3 and 7.10.4.

7.10.3 and 7.10.4 are included to describe the variations in water table depth, when there are variations in depth and when these variations are known (e.g. measurements have been made using piezometers, standpipes, investigations or as marks on the walls of the profile).

In 7.10.3, the minimum depth to the water table should be noted (water table at its highest point) together with the date, and when appropriate the time, the measurement was made.

In 7.10.4, the maximum depth to the water table should be noted (water table at its lowest point) together with the date, and when appropriate the time, the measurement was made.

When the observer does not know these variations in depth, record "not observed" under 7.10.3 and 7.10.4.

7.10.2 Present depth to water table

Note the depth of the present water table in centimetres with date and, if relevant, time.

Add if the value is observed or measured (a), estimated (b) or not observed (X).

Code	Description
a	Observed or measured
b	Estimated
X	Not observed

7.10.3 Minimum depth to water table

Note the minimum depth to water table in centimetres.

Add if the value is observed or measured (a), estimated (b) or not observed (X).

Code	Description
a	Observed or measured
b	Estimated

Code	Description
X	Not observed

7.10.4 Maximum depth to water table

Note the maximum depth to water table in centimetres.

Add if the value is observed or measured (a), estimated (b) or not observed (X).

Code	Description
a	Observed or measured
b	Estimated
X	Not observed

7.10.5 Nature of the water

A general estimation of the nature of the water can be given, without reference to threshold values of soluble salts or of conductivity, or analytical values for pollution or contamination.

Record the nature of the water, using one of the following codes or descriptions.

Code	Description
S	Saline
B	Brackish
F	Fresh
P	Polluted or contaminated
SP	Saline and polluted or contaminated
BP	Brackish and polluted or contaminated
FP	Fresh and polluted or contaminated
X	Not observed

8 Surface appearance

8.1 General

The surface appearance of the intended location of the soil profile that is to be described can be recorded using a combination of different standards if necessary (see 4.2).

8.2 Description of the surface material

Record the surface material.

If relevant, Annex G can be used.

8.3 Percentage of land surface occupied by rock outcrops or surface exposures of “non-natural” material

Record, using the following codes or descriptions.

Code	Description
0	Zero: > 0 %
1	Very low: > 0 % and ≤ 2 %
2	Low: > 2 % and ≤ 5 %

Code	Description
3	Moderate: > 5 % and ≤ 15 %
4	High: > 15 % and ≤ 40 %
6	Very high: > 40 % and ≤ 80 %
7	Extensive/Total: > 80 %
X	Not observed

NOTE Illustrative charts to aid the assessment of rock outcrops/surface exposure are provided in Annex B.

8.4 Evidence of erosion

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

Record, using the following codes or descriptions.

Code	Description
0	No visible evidence
1	Visible evidence of soil loss
1.1	Sheet erosion
1.2	Rill erosion
1.3	Gully erosion
1.4	Wind erosion
1.5	Landslides
2	Visible evidence of accumulation
2.1	Deposition by water
2.2	Wind deposition
X	Not observed

9 Soil profile description

9.1 General

A detailed soil profile description involves the identification of soil horizons/layers and a full description of each layer.

Soil layer or horizon observations like clay (lutum), silt, sand, organic matter) can be determined as percentage (%) or as classes according to specific classification standards. Where relevant, examples for combined use of this document with WRB[24]/FAO[30] and ISO 14688 should be given.

The estimation of percentages (%) of soil constituents is preferred to enable later classification according to different and/or specific standards. Accuracy of estimates and, measurements and determinations when percentages are used can be preferable. If information is to be transferred from one classification system to another classification system, the information is to be reported as “interpreted” with a description of the estimated loss of quality in the text.

Differences in horizon description and layer description are not considered if not necessary. The process of observing and describing is, in essence, the same: if differences in physical appearance of the soil from the top downwards can be recognized, the observed profile can be split up into horizontal sections that all have a top and bottom that is recorded by depth. The choice of describing only horizons, only layers, or combinations of both is dependent on, for example, project objectives, scale, parties involved, etc. For instance, for a contaminated soil, one horizon can have different layers depending on observed signs of contamination.

9.2 Soil descriptions made or changed after the fieldwork

Horizon or layer description is generally made in the field. In projects the result of the field soil description shall be checked by the author of the field description and stored as raw data.

If soil descriptions are made or amended after the fieldwork is completed, the quality could also be changed for the better or worse.

Record if the soil description is done in the field or if the description is made or changed after the fieldwork, using the following codes or descriptions.

Code	Description	Explanation
1	Field soil description	The description occurred in the field using only field tools (sand ruler, code cards, small magnifiers).
2	Improved soil description	The description occurred (or in-field descriptions improved) in a dedicated observation room e.g. in a laboratory, using samples of every horizon or layer and microscopes.
3	Laboratory soil description	The description occurred in a laboratory after testing e.g. sieving of samples of every horizon or layer.
4	Interpreted soil description	The description was changed using laboratory test results or after comparison with results of other investigations in the same region or location.
5	Generalized soil description	The description has been generalized to be able to compare or presented with other soil data.

This field soil description does not always have to be reported in a project report but shall be available upon request.

9.3 Soil layer or horizon description method

For agricultural and fundamental soil investigations, soil horizon descriptions are often made in compliance with the FAO Guidelines[30]. Other guidance could also be used, e.g. the USDA method[28].

An example of a method which focuses on only specific soil observations because of specific project objectives is given in Annex I. This method focuses on investigation for contamination. Other standards can be used in combination, see 4.2.

For a minimum set of (mandatory) observations for different types of soil investigations, see Annex H.

Record the soil layer or horizon description method used.

9.4 Horizon or layer number

Record the horizon or layer number.

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

9.5 Horizon or layer depth

Record the depth of each horizon or layer.

Record the average depth and range of depths of the appearance and disappearance of each horizon or layer, in metres measured from the surface.

However, when appropriate the FAO system[30] in which the zero is the top of mineral soil, may be used.

If the FAO system[30] is used, it should be stated in the report or the meta-data.

According to FAO[30], organic horizons or layers of undecomposed litter should be noted as greater than zero and preceded with the sign +.

9.6 Nature of lower horizon boundary

Record the nature of lower horizon boundary, using the following codes or descriptions.

Code	Description	Explanation
1	Abrupt	0,00 m to 0,02 m
2	Clear	0,02 m to 0,05 m
3	Gradual	0,05 m to 0,15 m
4	Diffuse	> 0,15 m
5	Smooth	The boundary is a plane with few or no irregularities.
6	Wavy	The boundary has undulations in which depressions are wider than they are deep.
7	Irregular	The boundary has undulations in which depressions are deeper than they are wide.
8	Broken	One or both of the horizons or layers separated by the boundary are discontinuous and the boundary is interrupted.

Reference: Derived from FAO[30], Table 24.

9.7 Estimation of moisture status

The estimation of moisture status is not always necessary, depending on the purpose of the investigation.

The purpose of this subclause is to provide guidance on how to indicate the conditions under which the other observations are made, and to provide guidance for field determination of soil moisture status.

The exact amount of 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, for example, the nature of the soil material, nature and dimensions of pores.

NOTE The moisture status can, however, be measured in the field. For field measurements, see Clause 4.

It is 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.

Record the estimated moisture status using the following codes or terms.

Code	Description	Explanation
1	Dry	Water content less than the moisture retained at wilting point. In the case of predominantly fine-grained samples (generally more than 17 % clay), it may result in the following soil properties: hard, non-plastic consistency; soil colour darkens when water is added. In the case of coarse-grained samples, generally when the percentage of clay is less than 17 %, it may result in the following soil properties: light soil colour, which becomes much darker when water is added; dusty.
2	Slightly moist	Water content between field capacity and wilting point. In the case of cohesive samples (generally more than 17 % clay), it 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 non-cohesive samples, generally when percentage of clay is less than 17 %, it may result in the following soil properties: soil colour darkens slightly when water is added.

Code	Description	Explanation
3	Moist	Moisture content of soil is near field capacity; absence of free water. In the case of cohesive samples (generally more than 17 % clay), it 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 non-cohesive samples, generally when percentage of clay is less than 17 %, it may result in the following soil properties: fingers moisten slightly when sample is touched; no water escapes from soil pores even when sample is knocked on the drilling apparatus ; does not darken when water is added.
4	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), it may result in the following soil properties: soft; can easily be formed into a roll of more than 3 mm thickness; water freed when sample is squeezed. In the case of non-cohesive samples, generally when percentage of clay is less than 17 %, it may result in the following soil properties: fingers get distinctly wet when sample is touched; visible free water when sample is compressed.
5	Saturated	Free water saturates all the soil pores. In the case of cohesive samples (generally more than 17 % clay), it may result in the following soil properties: muddy, waterlogged; mud passes through fingers when sample is squeezed. In the case of non-cohesive samples, generally when percentage of clay is less than 17 %, it may result in the following soil properties: distinct water escape; sample often fluid.
6	Inundated	Soil surface is covered by water. This concerns only the upper horizon, near the surface of the soil.

9.8 Colour of the horizon or layer matrix

9.8.1 Colour description method

Use the colour description methods below to record the colour of the horizon or layer matrix.

Code	Description	Explanation
1	Munsell soil colour charts	Munsell soil colour charts are the most common to use for a high-quality determination of (soil) colours. A small amount of the horizon or layer material is held next to the colour plates, usually in Munsell field book. Every colour has a specific (Munsell) code. For the determination of soil colour for fundamental scientific soil investigations, e.g. to help determining soil type according to WRB[24], the Munsell Soil Colour Charts shall be used to record Munsell codes.
2	Other soil colour chart system (user method)	Other soil colour charts can be used for e.g. a specific country, region, or soil. The codes can be derived from Munsell or other colour systems. These charts can be used to register colours in codes or names. The user method is comparable with Munsell charts. Other colour charts can only be used if they are publicly available as a standardized method. This method shall be referred to as given in 4.2.
3	Normal colour wording (e.g. ISO 14688-1)	No tools for this method and colour are recorded by the colour names from common knowledge of the language used. If soil colour is indicative and not used to help determine soil types according to WRB[24] or related standards, in every layer or horizon a main colour and if relevant a secondary colour and indication “light” or “dark” is determined.

9.8.2 Colour description

Record the colour of each horizon or layer.

Figure 2 and associated examples can be applied when ISO 14688 is used for layer colour description. This is basically a two-colour system.

NOTE 1 When only one colour is observed, the term "neutral" can be added, for example, neutral brown.

		light/dark/ -	main colour					
			brown	grey	yellow	...	...	...
secondary colour	brown		example 1					
	grey	light	example 2					
	yellow	dark		example 3				
	...							

	normal text	systematic
example 1:	brown	**brown**, -, -
example 2:	light grey **brown**	**brown,** grey, light
example 3:	dark yellow **grey**	**grey,** yellow, dark

Figure 2 — Two colour description system

In all cases it shall be clear if colour is recorded as normal text or systematically.

NOTE 2 The order of two colours as normal text is opposite to systematic descriptions.

NOTE 3 Soil colour charts other than Munsell can be useful for training or daily use.

NOTE 4 When other layer descriptions standards are used, specific soil colour charts might be mandatory.

Both FAO[30] and ISO 14688 are field descriptions and therefore colour is described when soil is under "moist" conditions.

If soil is dry in the field, it should be moistened before determining the colour. If samples are dried, for example in a laboratory, they should also be re-moistened before determining the soil colour.

9.9 Mottles

9.9.1 General

Mottles are spots or patches of different colours that are distinct from the matrix colour, and these colour variations are often associated with ped surfaces, worm holes, concretions or nodules.

Mottles may be caused by a range of physical, chemical and biological pedogenic processes, such as oxidation, reduction, contamination.

When a judgment can be made as to the cause of mottling this should be recorded.

9.9.2 Mottle abundance

The abundance of mottles is recorded in terms of classes indicating the percentage of exposed surface occupied by the mottles. The categories below are widely used in soil description.

NOTE The abundance of mottles can be compared with charts shown in Annex A.

Record the abundance of mottles using the following codes/descriptions.

Code	Description
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 %
X	Not observed

9.9.3 Mottle colour

Record the mottle colour.

The use of the same colour description method as chosen in 9.8 is recommended.

9.10 Estimated organic matter content

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

Record estimates of organic matter content using the following codes/descriptions.

Code	Description
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
X	Not observed

9.11 Texture

9.11.1 Classification system used

Record the reference used to estimate soil texture.

Note that the texture usually is estimated in the field and not all horizons or layers are sampled for laboratory tests. Texture estimation in the field is different from measuring “particle size distribution”, which is done in a laboratory. A brief guide to determine soil texture in the field is provided in Annex E.

Soil texture is estimated for fine soil material only (particle size < 2 mm).

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

The estimation of coarse elements, especially if they might be anthropological, should be done as a percent by volume. The total of these coarse elements is estimated before regular texture classes are recorded using a specific classification system like FAO[30], ISO 14688 or another referenced system.

NOTE For training purposes, comparison can be made between volume estimated in a field and those made in a laboratory on the same material. However, the laboratory results are usually reported on a mass basis.

EXAMPLE The volume mass of concrete/rock differs from glass fibre or polystyrene. Estimation of mass volume won't show the real impact of, for example, polystyrene.

9.11.2 Field determination/ estimation of particle sizes

Record, if relevant, the clay (lutum) fraction of the soil.

Record, if relevant, the silt fraction of the soil.

Record, if relevant, the sand fraction of the soil.

Record, if relevant, the gravel fraction of the soil.

The fractions can be determined/estimated in mass fraction classes (see 9.11.1). The estimation of percentages in the field can be used to be able to present the data following different classification systems later.

NOTE Some soil registration software can for each recorded percentage automatically generate the fraction class of the used classification system.

9.11.3 Field determination/estimation of the coarseness of a sandy soil

Record the sand median if the soil is sandy.

The sand fraction is characterized by the sand median diameter. This is defined as the sand grain diameter to which applies that the weight of the fractions with a larger diameter is equal to that with smaller diameters.

The median of the size fraction (M50 or M63 value) can be determined in percentages or in classes or both.

There are different classification systems (see Figure 3). The method used shall be clearly stated in written reports or in the meta-data of digital data reports.

Numerical determinations allow the estimate to be more precise and the ability to classify (later) according to any classification system. This method allows the highest (relative) quality and makes the field descriptions more flexible to use.

NOTE 1 Determining median classes after determination of median numbers can be done in the field or afterwards.

NOTE 2 Soil description software might automatically determine classes if numerical values are recorded.

Field estimation of the coarseness of sandy soil samples can be carried out by using a sand ruler with selected samples of standard graduations. The average grain size can be judged using a magnifier (e.g. hand lens with 10 × magnification).

Experienced field investigators might estimate the coarseness by sight and feel. It is recommended that they should train themselves at least annually. This training can be done by estimating samples that have already been examined by a laboratory. It can also be done by working with a suitably experienced person, who evaluates and compares estimates from one or more samples among multiple field investigators (thereby assessing accuracy and precision).

Figure 3 presents the classes of particles < 2 mm in FAO[30] and ISO 14688-1. Figure 3 also provides two examples of national classification systems that may be used.

N.B.: An M50 value of 220 µm can be classified as:

— "medium sand" (FAO[30], ISO 14688-1);

— "fine sand" (USDA[28]);

— "coarse sand" (AUS 2017[37]).

Where texture is recorded as classes, the classification system used to determine soil texture shall also be recorded. It is recommended to identify and record M50 as numbers/values first, so classification according to other classification systems is possible later.

More detail and guidance to determine soil texture in the field is provided in Annex E.

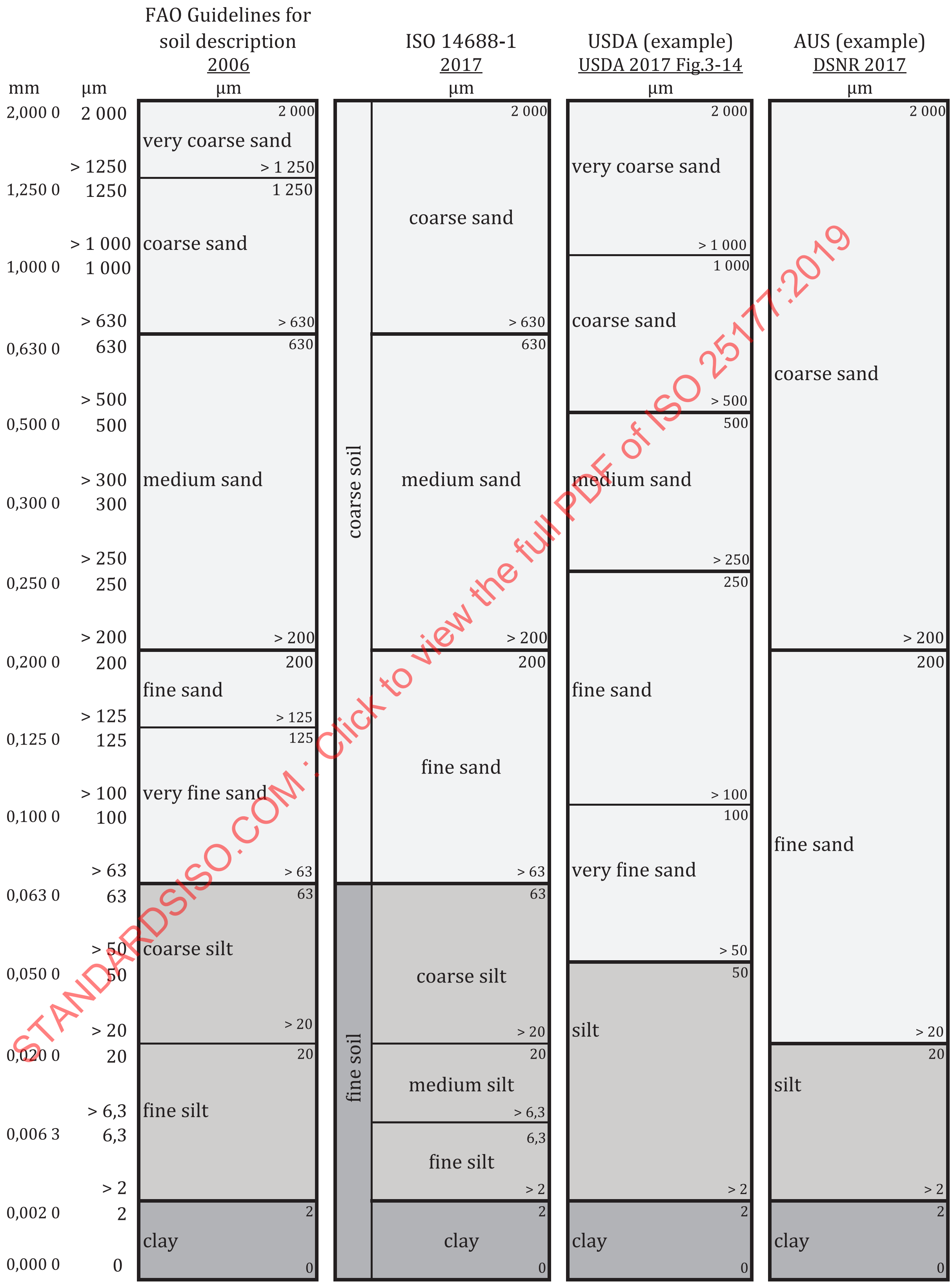


Figure 3 — Particle size classes in different standards (in µm, 1 µm = 0,001 mm)

9.11.4 Sampling for texture analyses

Soil samples can be collected for textural analyses (i.e. particle size distribution) by a laboratory either for quality control of field texture estimations or for greater accuracy.

For the soil sampling procedure see the relevant parts of ISO 18400 series.

For the analyses of organic matter, clay (lutum), silt, sand and gravel see relevant standards.

Analyses of the types of coarse elements are not often conducted and are usually estimated in the field. If the consequences of estimates are large, laboratory analyses might be necessary. The determination shall be conducted by trained and experienced personnel. Depending on the type and properties of the coarse elements, customized sampling methods might be necessary. For general sampling strategy and statistical methods, see ISO 18400-104.

Where qualitative and quantitative laboratory analyses of coarse elements are needed, field and laboratory staff should work closely together.

NOTE For many artificial coarse elements, specifically trained personnel can be involved.

Some coarse elements can be identified as hazardous, such as materials with asbestos. Personnel dealing with hazardous materials should be trained to a level in accordance with national laws and regulations.

9.11.5 Description of texture diagram

The name of the texture triangle used and the granulometric division scale used should be recorded in an uncoded format, including the classification system of sands (see for examples Annex D and ISO 14688-2).

Record the texture triangle and/or granulometric division scale used, if any.

9.12 Coarse elements

9.12.1 General

A list of common coarse elements with their indicative volume-mass-index is presented in Annex G.

Coarse elements correspond to the soil fraction greater than 2 mm in size (as opposed to fine soil materials). In natural soils this includes rock fragments, while in urban, industrial and artificial soils, this may include other foreign materials such as metals, concrete, or glass. For estimating proportions of specific materials, see Annex B.

The soil description should reflect the abundance of the material present in the layer. For example, a layer with > 50 % coarse materials, the soil type of the layer/horizon should be called after the most abundant type of coarse material.

EXAMPLE Brick layer with clay soil.

NOTE Fragments are parts of larger elements. For example, shells are elements that can be found as whole shells or as shell fragments.

9.12.2 Coarse element abundance (in % volume fraction)

Compare with charts shown in Annex B.

Record the abundance of coarse elements using the following.

Code	Description
0	None: 0 %

Code	Description
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 %
X	Not observed

9.12.3 Maximum size of the most frequently observed coarse elements

Record the abundance of coarse elements using the following.

Code	Description
1	0 cm to ≤ 2 cm
2	> 2 cm and ≤ 7,5 cm
3	> 7,5 cm and ≤ 12 cm
4	> 12 cm and ≤ 25 cm
5	> 25 cm
X	Not observed

9.12.4 Nature of the coarse element(s)

Record, as clearly as possible, the nature(s) of the coarse elements.

In natural soils, the lithological nature of the coarse elements should be recorded.

9.12.5 Non-natural or unknown coarse elements

Record, as clearly as possible, the non-natural or unknown coarse elements.

Non-natural or unknown coarse elements can sometimes be recognized in smaller dimensions (<2 mm), such as ash, red brick particles. These particles can be an indication of cultivation, contamination or pollution.

Abundance and maximum size can be observed and recorded as described in 9.12.2 and 9.12.3.

A list of common coarse elements with their indicative volume-mass-index is presented in Annex G.

9.13 Carbonates and effervescence

9.13.1 Intensity of effervescence

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

Record the intensity of effervescence, using the following codes or descriptions.

Code	Description	Explanation
0	No effervescence	No visible or audible effervescence. This corresponds generally to absence of carbonates

Code	Description	Explanation
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 context of carbonates between 2 % and 7 %.
3	Strong effervescence	Bubbles form a thin, but more or less continuous, froth. Generally, this corresponds to a context 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 %.
X	Not observed	

9.13.2 Location of effervescence

Record the location of effervescence, using the following codes or descriptions.

Code	Description	Explanation
1	Generalized	Both the matrix (particle size < 2 mm) and the coarse elements react to acids.
2	Localized in the matrix	Effervescence limited to the fine material.
3	Localized on coarse elements	Effervescence limited to coarse elements.
X	Not observed	

9.14 Main categories of soil structure

Some soil structures types are shown in Figures F.1 to F.3 of Annex F.

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

Record the main categories of soil structure, using the following codes or descriptions.

Code	Description	Explanation
0	Continuous or massive	Coherent without structural aggregates.
1	Single grain	Non-coherent 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 may have a low bulk density the structure may be recorded as fluffy.
4	Block-like	Units are block-like 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 recorded as columnar.
6	Planar or platy	Structures in which parallel planes are predominant. Where the planes are horizontal, the structure is recorded as platy. Where these parallel planes are inherited from initial rock organization, the structure is considered as "rock structure".
X	Not observed	

9.15 Compactness

Soil compactness can be evaluated by trying to cut the soil with a knife, however it depends on the soil moisture status (see 7.4). It is therefore essential that moisture status be recorded.

Record the compactness, using the following codes or descriptions.

Code	Description	Explanation
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.
X	Not observed	

9.16 Total estimated porosity

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 B.

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

Total estimated porosity is described as percentages by volume.

Record the total estimated porosity, using the following codes or descriptions.

Code	Description	Volume percentage of pores
0	Nonporous	0 % to ≤ 2 %
1	Low	> 2 % and ≤ 5 %
2	Medium	> 5 % and ≤ 15 %
3	High	> 15 % and ≤ 40 %
4	Very high	> 40 %
5	Unknown, but visible	Visible porosity, but not quantified
6	Not recorded	Porosity not recorded

9.17 Roots

9.17.1 Root abundance

Root 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 of the soil used to estimate root abundance shall be a smooth 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).

Record the root abundance, using the following codes or descriptions.

Code	Description	Explanation
0	No roots	
1	Very few	1 roots/dm^2 to 20 roots/dm^2, or less than 4 on a line 50 cm long
2	Few	20 roots/dm^2 to 50 roots/dm^2, or 4 to 8 on a line 50 cm long

Code	Description	Explanation
3	Common	50 roots/dm^2 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
X	Not observed	

9.17.2 Size (diameter) of most frequently observed roots

Record the root size, if present, using the following codes or descriptions.

Code	Description	Root diameters
1	Very fine	< 0,5 mm
2	Fine	> 0,5 mm and ≤ 2 mm
3	Medium	> 2 mm and ≤ 5 mm
4	Coarse	> 5 mm
X	Not observed	

9.18 Density of worm channels

Record the density of worm channels, using the following codes or descriptions.

Code	Description	Explanation
0	None	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
X	Not observed	

9.19 Odour

Any odour detected at a site can potentially be dangerous to field investigators. Appropriate safety precautions shall be taken, see ISO 18400-103. Depending on the objectives of the investigation field measurements of volatiles can be conducted.

If an unknown or harmful odour is detected, this shall be recorded. If from this point on, safe observation at layer level is not possible, further observation is not allowed.

Other than smelling, other observations like oil pan and Photo Ionization Detector (PID) should be used until layers are observed without indication of unknown or harmful odours.

From this point on, the observation of odours can be resumed (until a new unknown or harmful odour is detected).

Record the odour, if detected, as explained above.

9.20 Field detection of mineral oil in soil samples (oil-water reaction pan)

9.20.1 General

Field detection of mineral oil in soil samples can be carried out by visual assessment of the liquid phase hydrocarbon layer formation. Put some soil in the oil-water reaction pan filled with clean water.

9.20.2 Oil floating on water

Record any floating oil in to the pan. If possible, use the following codes and descriptions.

Code	Description
0	no oil slicks observed
1	traces of oil with three to five small oil slicks or an oil streak (<30 % of the surface of the compartment)
2	several oil streaks or oil slicks (maximum degree of cover 30 % of the surface of the compartment).
3	oil slick(s) with a degree of cover of 30 % to 75 %
4	oil slick with a degree of cover of 75 % to 100 %
X	Not observed

Visual assessment should be done in good light. A correct assessment of the floating layer is only possible under a specific angle of view. It is essential to search for this angle of view.

9.20.3 Other oil observations

A detailed description of oil observed during a field investigation (including the nature of the pollution if known) should be made.

Record, if relevant and possible any other indicators of oil.

Description	Explanation
Colour	— rainbow effect: petrol, turpentine, condensate (aromatics) — dominance of blue: diesel oil, crude oil — green tints: tar oil, hydraulic oil
Dullness	the duller the floating layer, the older the oil (decomposition)
Vapour effects	benzene, e.g. older types of petrol, crude oil, condensate, fresh petrol ("jumping eyes")
Forming of balls	drilling and cutting oil, such as grease
Foam forming	detergents
Black floating particles	coal dust (e.g. former local gas works).

The field measurement can be combined with gas testing glass tubes or PID measurements.

10 General designation

10.1 General

Reference for this clause are FAO[30] and WRB[24]. If another reference is used this shall be clearly stated in the text of the written report or the meta-data of the digital data that is reported.

If determination of the soil type according to WRB[24] is needed, the FAO[30] can be used to describe field observations and measurements. All field observations needed to classify soil according to WRB[24] are mentioned in the FAO[30].

Where reference to geo(hydro)logical and geotechnical descriptions are relevant, ISO 14688 or another commonly and publicly available standard can be used to determine the soil type.

The used classification system used (FAO[30], ISO 14688 or other) shall be clearly stated in the text of the written report or the meta-data of the digital data that is reported.

10.2 Type of soil profile classification used

When describing soils in situ, it is normal to allocate the soil to a reference base in an established soil classification system. These allocations are normally based on the expression of pedogenic processes in the soil profile. There are many classifications with national origins, but the use of the international soil classification system, the WRB[24] is recommended.

Pedogenic processes result in the formation of different layers in the soil, generally roughly parallel to the topographic surface, which are called “horizons”. In the context of soils deeply modified by human activity, artificial layers may be due to different kinds of deposits (e.g. concrete, bricks). These kinds of layers are simply called “layers”.

Record which soil classification system is used.

The classification according, for example, to WRB[24] is usually not done in the field. It is important though to know what soil observations should be made and how these should be recorded to provide enough information to classify according to, for example, WRB[24].

10.3 Soil type with reference to the soil classification system used

Record the soil type according to the soil classification system used.

EXAMPLE WRB[24] Albic Luvisol.

NOTE The WRB [24] for soil resources is available in http://www.fao.org/soils-portal/soil-survey/soil-classification/world-reference-base/en/.

The classification according to, for example, WRB[24] is usually not done in the field. It is imported though to know what soil observations should be made and how these should be registered to provide enough information to classify according to, for example, WRB[24].

10.4 Type of horizon designation used

Record which type of horizon designation system is used.

EXAMPLE FAO[30] or other national or regional system.

In Annex C, the FAO system of horizon designation[30] is given and can be used as reference if there is no local, regional or national system of horizon designation available.

10.5 Sequence of horizons

Record the sequence of horizons recorded in the profile.

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

11 Reporting

11.1 General

Field soil descriptions can be reported in different ways. The presentation of reports is explained in 11.2. One specific presentation type is a scaled diagram of a soil profile. In or next to the diagram a textual boring log can be presented, see 11.3.

After the data are reported, the raw field data and the reports shall be stored, see 11.4.

11.2 Presentation of field soil descriptions

The field soil description can be reported as raw data in written text, in spreadsheets, or as a digital data set, depending on the project requirements.

The field soil description can be reported in a format different from field observations that is more suitable for further use, e.g. in an interpreted report with explanatory texts (e.g. context of project, fieldwork, circumstances, etc.). The data or part of the data can be presented in figures, lists, data sets, etc.

If field data are generalized or changed, this shall be clearly stated according to 9.2. This can be done in the text of a written report (analogue or digital) or in the meta-data of a digital data set.

For digital exchange of soil related data ISO 28258 is recommended. For a minimum set of data for soil quality projects to be reported, the use of ISO 15903 and ISO 18400-107 is recommended.

11.3 Profile diagram

Soil profile data can be represented in profile diagrams. Usually, the soil texture is presented for every horizon/layer and depths should be indicated. Additional information can be presented depending on the specific use of the profile drawings. The profile drawings can be presented next to each other with the soil surface as the zero reference, or with all tops of the drawings at the same scale at a general or local reference level (e.g. global sea level).

If profile drawings are used, a complete legend of the colours, patterns, signs and codes that are used should be available, preferably presented with the profile drawings themselves.

11.4 Documented information

The following information shall be archived and remained available for comparison with interpreted reports of (part of) the field description:

— author and author's organization;

— client and project objectives;

— all raw field data checked by the author;

— dates of fieldwork, author's approval of data, archiving.

Annex A
(informative)

Landform

The information in this annex is derived from FAO[30]. The most differentiating landform observation is the dominant slope, followed by the relief intensity. Complementary to 7.5 to 7.8 the following information can be observed and, if relevant, recorded.

MAJOR LANDFORMS

Code	Description	Gradient (%)	Relief intensity (m/km)
LP	Level land – plain	< 10	< 50
LL	Level land – plateau	< 10	< 50
LD	Level land – depression	< 10	< 50
LV	Level land – valley floor	< 10	< 50
SE	Sloping land – medium-gradient escarpment zone	10–30	50–100
SH	Sloping land – medium-gradient hill	10–30	100–150
SN	Sloping land – medium-gradient mountain	15–30	150–300
SP	Sloping land - dissected plain	10–30	50–100
SV	Sloping land – medium-gradient valley	10–30	100–150
TE	Steep land – high-gradient escarpment zone	> 30	150–300
TH	Steep land – high-gradient hill	> 30	150–300
TM	Steep land – high-gradient mountain	> 30	> 300
TV	Steep land – high-gradient valley	> 30	> 150

COMPLEX LANDFORMS

Code	Description
CU	Cuesta-shaped
RI	Ridged
IN	Inselberg covered (occupying > 1 % of level land)
IM	With intermontane plains (occupying > 15 %)
WE	With wetland (occupying > 15 %)
DO	Dome-shaped
TE	Terraced
DU	Dune-shaped
KA	Strong karst

Annex B
(informative)

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

The charts shown in Figure B.1, expressed in percentages, 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. See Reference [32].

NOTE These charts can also be used to estimate proportion of rock outcrops.

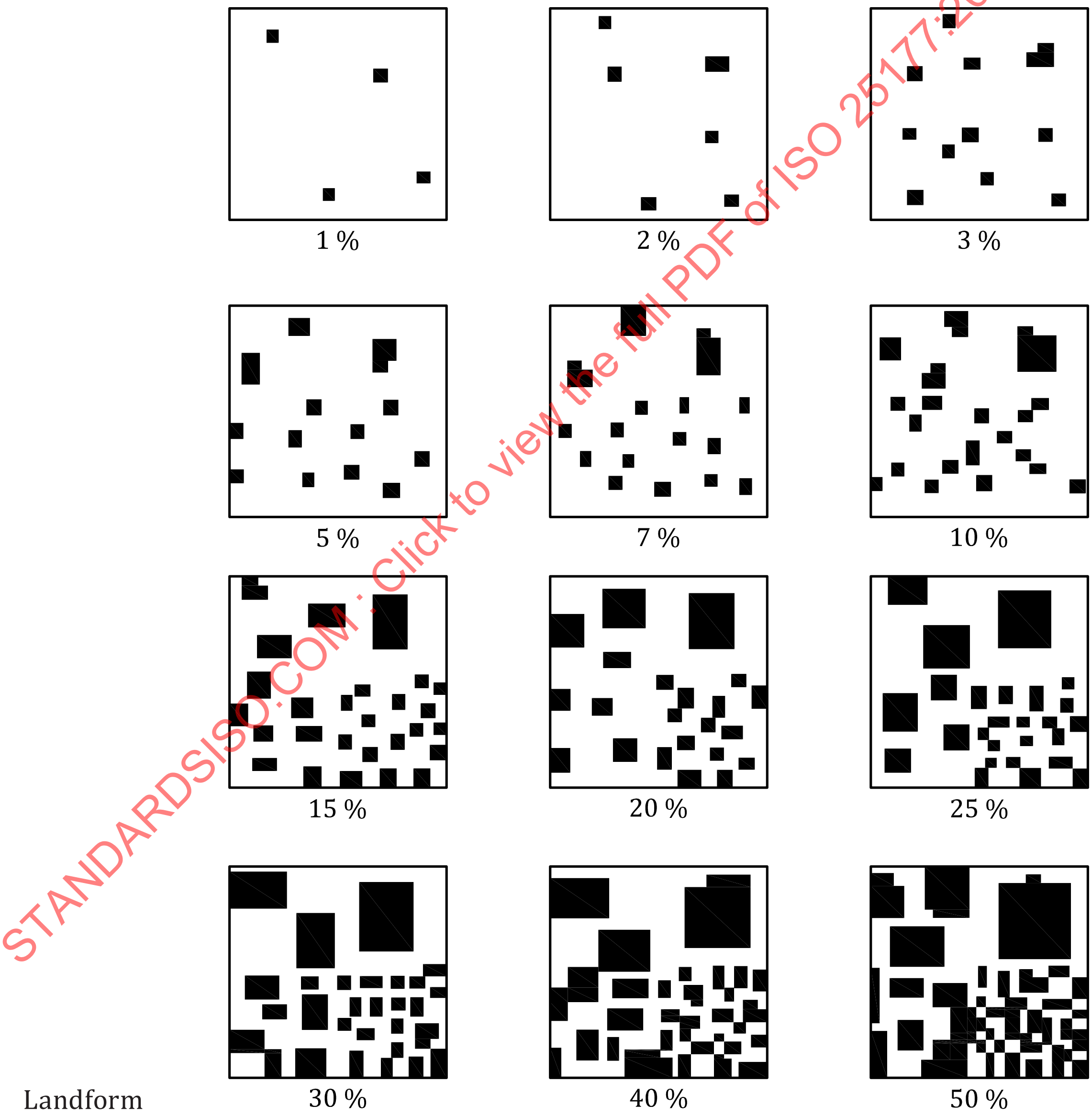


Figure B.1 — Charts for estimating proportions of mottles, coarse elements, etc.

Annex C
(informative)

Soil horizon designation — Example of the FAO System[30]

C.1 General

The FAO[30] 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 can be 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 as follows.

a) H horizons or layers

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

b) O horizons or layers

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 much organic matter.

c) A horizons

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 b) and c)];

— 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 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, though the mineral fraction may be unaltered or only slightly altered by weathering. Such a horizon is designated 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 cultivated.

d) E horizons

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 colour of higher value or lower chroma, or both; by 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

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 conspicuously 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 kind 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 pedogenic processes (these layers may or may not be cemented) and brittle layers that have other evidence of alteration, such as 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 illuvation; layer into which carbonates have been illuviated but are not contiguous to an overlying genetic horizon, and layers with gleying but no other pedogenic changes.

f) C horizons or layers

Horizons or layers, excluding hard bedrock, that are little affected by pedogenic processes and lack properties of H, O, A, E or B horizons. Most 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 hours 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 C. Changes not considered pedogenic 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 pedogenic processes; then it is a B horizon.

g) R layers

Hard bedrock underlying the soil.

Granite, basalt, quartzite and indurated limestone or sandstone are examples of bedrock that are designated R. Air-dry or drier chunks of an R layer when placed in water will not slake within 24 hours. 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 characteristics of both an overlying A horizon and an underlying B horizon, but is more like the A than the B.

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)

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 from a mineral layer.

b) Concretions or nodules (c)

Indicates 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)

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)

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 permanent character throughout the year, whatever the moisture condition at the time of observation.

e) 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)

Indicates the presence of a very acid environment (example former mangrove).

g) Accumulation of carbonates (k)

Commonly calcium carbonate.

h) Cementation or induration (m)

Indicates continuous or nearly continuous cementation and is used only for horizons that are more than 90 % cemented, though 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)

Indicates an accumulation of sodium.

j) 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)

Indicates disturbance of the surface layer by ploughing or any tillage practice. A disturbed organic horizon is designated Op or Hp. A disturbed mineral horizon is designated Ap, Ep, Bp, etc.

l) 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)

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 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 ≤ 2;

— some horizons are temporarily re-oxidized 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”, pedogenic change in addition to reduction is implied; if no other change has taken place, the horizon is designated Cr.

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

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 ≤3. (t)

o) Accumulation of silicate clay (v)

Used with B or C to indicate an accumulation if silicate clay that either has formed in the horizon or has been moved into it by illuviation, or both. A least some part can 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)

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)

Used with “B” to indicate development of colour or structure, or both. It cannot be used to indicate a transitional horizon.

r) Fragipan character (x)

Used to indicate genetically developed firmness, brittleness or high bulk density. These features are characteristic of fragipans, but some horizons designated “x” do not have all properties of a fragipan.

s) Accumulation of gypsum (y)

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

Annex D
(informative)

Examples of texture diagrams

Traditionally the texture, as estimated on-site, is illustrated graphically as a triangle using the following convention:

— clay proportion + silt proportion + sand proportion = 100 % of fine earth.

The triangle can be either equilateral or right-angled. The grain size division between silt and sand can be at 50 µm or at 60 µm.

This annex provides various examples of texture diagrams as shown in Figures D.1 to D.3. No translations of the texture class names are provided. It is important to indicate the texture triangle used in reports.

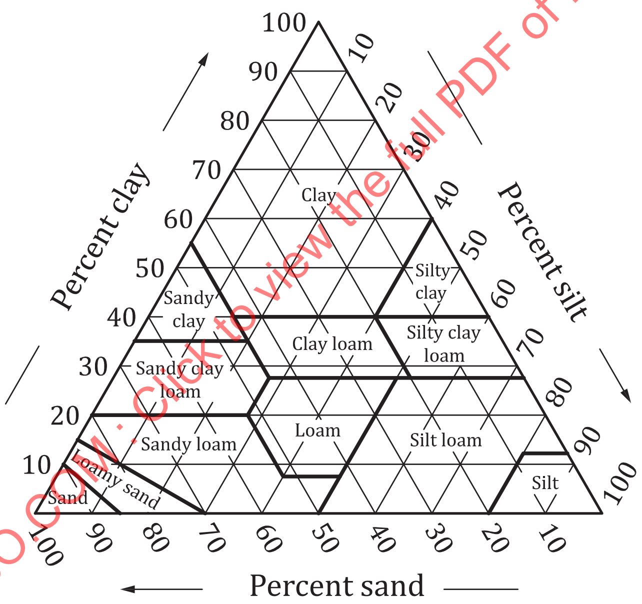


Figure D.1 — Example of an equilateral triangle with division between silt and sand at 50 µm (USDA - USA)

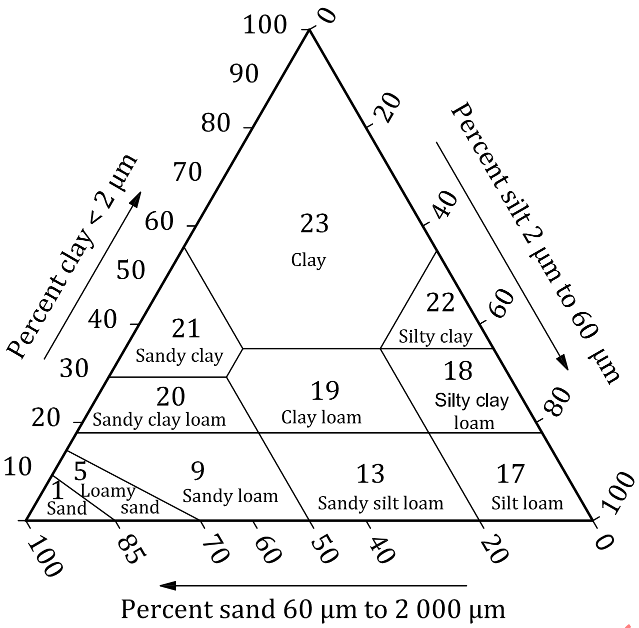
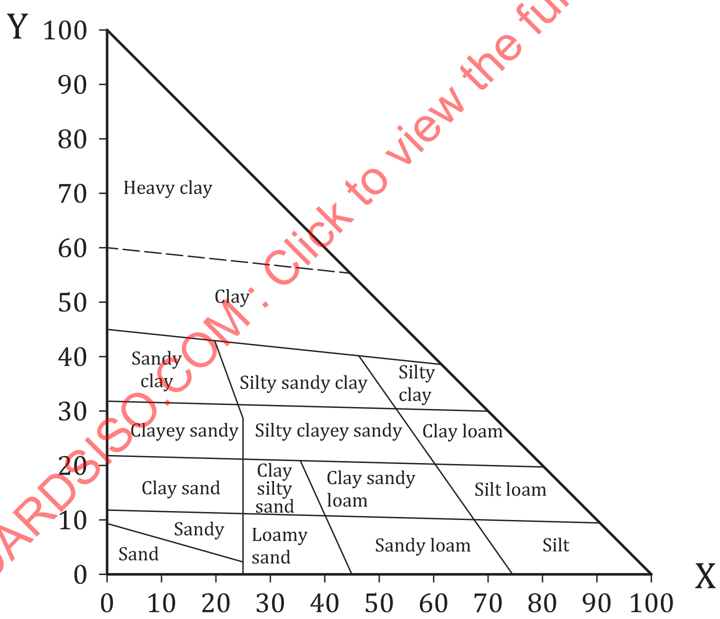


Figure D.2 — Example of an equilateral triangle with division between silt and sand at 60 µm (USDA - USA)



Key

Y clay

X silt

Figure D.3 — Example of a right-angle triangle with division between silt and sand at 50 µm (GEPPA - FRANCE)

Annex E
(informative)

Determination of soil texture in the field

E.1 Definition

The terms “texture” and “texture class” allow a designation of soil corresponding to classification by size of the mineral elements (clay, silt, sand) following manual estimation in the field. It can be determined in the field for each horizon or layer by a finger test or according to visible characteristics. It is quite different from “particle size distribution” which is derived from the laboratory-based particle size analysis.

Depending on the texture classification system that is used, the particle size boundaries of sand might differ. Figure 3 in 9.11.3 a table with some classification systems are presented.

E.2 Application

Determination of the texture class of the fine soil materials, facilitates interpretation as to properties of the soil.

E.3 Procedure

E.3.1 General

Fine soil materials (particle size < 2 mm) and coarse particles (stones) (particle size > 2 mm) can be determined in accordance with E.3.2 and E.3.3.

E.3.2 Fine soil material

Texture classes can often be located on a texture diagram indicating the respective percentages of clay, silt and sand. The texture classes given in Table E.4 are examples only, since each type of texture diagram has its own thresholds that define texture classes (see Annex D).

E.3.3 Characteristics and properties of particle fractions

Depending on their proportions in the soil, the particle fractions have the following tangible and visible characteristics.

a) Clay (particle size < 0,002 mm)

   When the clay content is in the region of 17 % (by mass) in wet conditions, it is cohesive and sticky; at higher proportions (from 35 % by mass) it becomes more plastic and sticks to fingers and thumb when pressed between them, and the surface becomes smoother and shinier. From 45 % by mass, other particle fractions are only distinguished as secondary components.

b) Silt (particle size 0,002 mm to 0,050 mm or 0,063 mm depending on classification system)

   A smooth silky feel, “soapy” when moist; sticks to fingers and thumb when pressed between them. Particles are visible at proportions of about 10 % (by mass), and clearly visible at proportions above 30 % when clay is present at less than 25 % (by mass).

c) Sand (particle size 0,050 mm or 0,063 mm to 2 mm depending on classification system)

Coarse particles, clearly visible, do not stick to fingers even when moist.

E.3.4 Notes for the determination of texture class

The sample can be investigated only under moist or plastic conditions. Samples that are too dry can be moistened and samples that are too moist can be dried by rubbing them between the fingers. See Table E.1.

It should be taken into consideration that samples that are dry are often estimated to be a little coarser-textured than they actually are, and samples that are wet a little finer-textured. The coarser a sandy fraction, the more easily the sandy proportion is overestimated. If in the fine-sand fraction components of 0,050 mm up to 0,125 mm prevails, and if these components predominantly consist of foliated particles (e.g. mica), it will be difficult to distinguish them from the coarse-silt fraction.

Higher proportions, of $CaCO_3$ in the particle size fractions result in reduced cohesion and overestimation of the silt proportion.

Higher humus content often leads to an overestimation of the clay proportion, but also can lead to an underestimation of the clay proportion when the clay proportion is over 30 % or 40 % by mass.

E.3.5 Coarse elements

The coarse particle fractions can be determined according to ISO 14688-2:2017, Table 1, either from a sample or from a soil profile pit base or wall.

E.4 Determination of the texture class of soil

Table E.1 — Determination of soil texture class in naturally moist condition by finger test in the field

Cohesion — Plasticity	Visible characteristics	Texture class
Not cohesive; does not stick to the finger; not plastic	Individual particles clearly visible and tangible; rough (the finer the particles, the less rough the texture)	Sand
Not cohesive; powdery-blunt; some fine substance sticks in finger grooves; not plastic	Individual particles well visible and tangible; also some fine substance	Silty sand
Slightly cohesive; slightly greasy, fine substance sticks to the finger; not easily moulded; splits and breaks during moulding	Individual particles clearly visible and tangible	Loamy sand
Slightly cohesive to cohesive; (stiff-) plastic; not easily moulded	Individual particles clearly visible and tangible	Sandy clay loam to sandy clay
Not cohesive; sticks distinctly to the finger grooves; not or not easily moulded	Powdery, like silk; individual particles nor or almost not visible and tangible	Silt
Slightly to moderately cohesive; slightly sticky, sticks distinctly to finger grooves	Individual particles of the sandy fraction not or only slightly visible and tangible; a lot of fine substance; powdery when dry	Loam
Slightly to moderately cohesive; sticky; plastic; can be rolled as thick as a pencil, then becomes crackled	Sandy particles clearly visible and tangible; a lot of fine substance	Sandy loam
Cohesive; sticky; plastic; cracks when rolled into a thread	Individual particles of the sandy fraction not or only slightly visible and tangible; a lot of fine substance; a little powdery	Silty loam

Table E.1 *(continued)*

Cohesion — Plasticity	Visible characteristics	Texture class
Cohesive; stiff-plastic sticky; plastic and rolls easily into a thread when moist; will take a slight polish	Only a few or no sandy particles visible and tangible; a lot of fine substance	Clayey loam
Cohesive; stiff-plastic sticky; plastic and rolls easily into a thread when moist; will take a slight polish but sand grains stand out on the surface	A few sandy particles visible and tangible; a lot of fine substance	Sandy clay
Very sticky with a silty/soapy feel	Sandy particles not or hardly visible and tangible; a lot of fine substance	Silty clay
Cohesive; very stiff-plastic; sticky; will roll to a very fine thread; surface will readily polish	No sandy particles tangible	Clay

NOTE The table is derived from FAO[30].

According to the classification or national systems, or different contexts (e.g. pedology, geotechnics), different limits are used to separate silt and sand, e.g. 0,050 mm and 0,063 mm.

Annex F
(informative)

Some types of soil structure

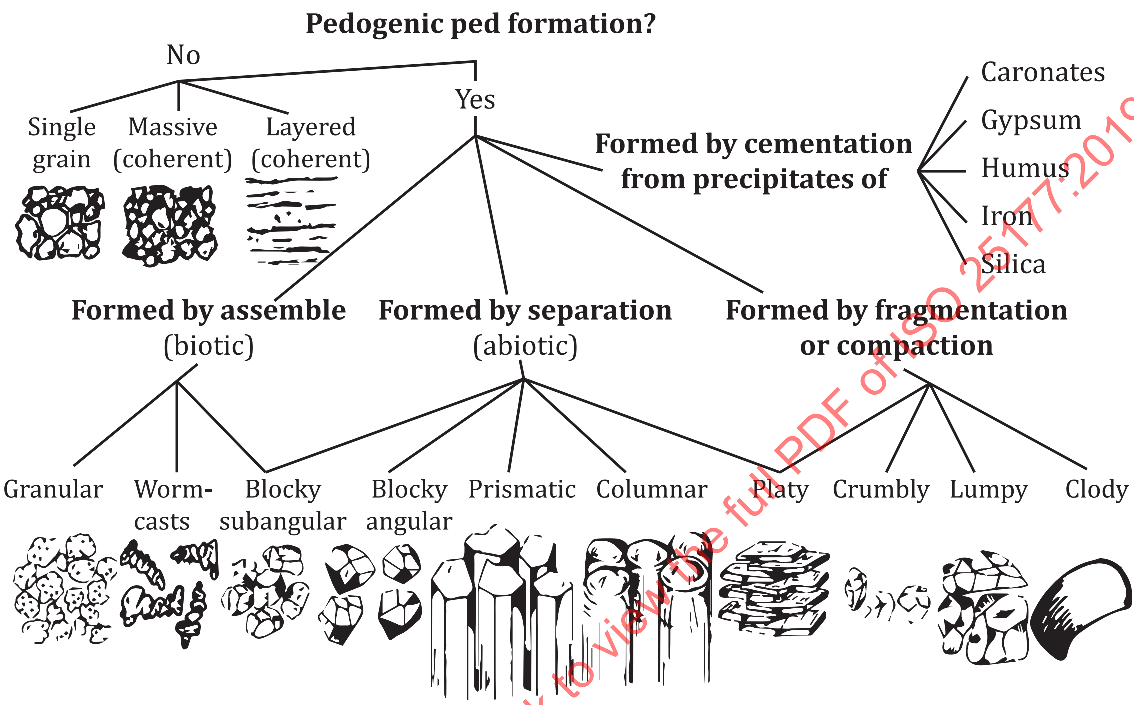


Figure F.1 — Soil structure types and their formation

Reference: Guidelines for soil description, FAO[30].

Classification of structure of pedal soil materials

WE	Weak	Aggregates are barely observable in place and there is only a weak arrangement of natural surfaces of weakness. When gently disturbed, the soil material breaks into a mixture of few entire aggregates, many broken aggregates, and much material without aggregate faces. Aggregate surfaces differ in some way from the aggregate Interior.
MO	Moderate	Aggregates are observable in place and there is a distinct arrangement of natural surfaces of weakness. When disturbed, the soil material breaks into a mixture of many entire aggregates, some broken aggregates, and little material without aggregates faces. Aggregates surfaces generally show distinct differences with the aggregates interiors.
ST	Strong	Aggregates are clearly observable in place and there is a prominent arrangement of natural surfaces of weakness. When disturbed, the soil material separates mainly into entire aggregates. Aggregates surfaces generally differ markedly from aggregate interiors.

Combined classes may be constructed as follows :

WM Weak to moderate
MS Moderate to strong

Figure F.2 — Classification of structure of pedal soil materials