Illustrated Handbook of WRB Soil Classification

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Wrocław 2022

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FOREWORD

Soil classification is a difficult issue and requires many years of study under the guidance of experienced teachers. In the course of long-term studies and field research, soil scientists acquire the skills of recognizing and correctly naming many important features resulting from litho-, anthropo- or pedogenic processes. The problem with learning the secrets of this art is the lack of opportunity to see many examples of different soil features hidden beneath the earth's surface. Visiting many regions of the world for didactic or scientific purposes, we felt the need to share our photographic collections with other people involved in the study and interpretation of the soil environment. It is with great pleasure that we present to the reader a set of several hundred photographs showing the features, properties, soil horizons, as well as examples of interpretation of soil profiles – in accordance with the rules and nomenclature adopted in the international soil naming and classification system – the World Reference Base for Soil Resources (2022).

The book has been divided into several chapters. The photos have been arranged in such a way as to reflect the process of creating a description of the soil profile - from environmental features, through morphological soil features, diagnostic horizons, properties and materials, to specific examples of soil profile classification. In the section with soil profiles, we managed to collect 100 examples from all Reference Soil Groups found in all climatic zones of our planet. In the names of the soils, we have mainly emphasised those features (qualifiers) that are morphologically identifiable in the photos, consciously omitting those that can only be read from the results of laboratory analyses.

We hope that the handbook, developed as one of outcomes of an Erasmus+ project Share Your Soils (SYStem), will be useful in didactic and scientific work and will help to understand what the individual soil characteristics look like, in general and in the context of the nomenclature used in the World Reference Base for Soil Resources.

ILLUSTRATED HANDBOOK OF WRB SOIL CLASSIFICATION – GENERAL CONCEPT

Soil is one of the most important components of the Earth system, providing pivotal ecosystem functions (pollutant filtration, water regimentation, greenhouse gas sequestration, etc.) together with goods and services for all forms of life (Bouma, 2019). As a non-renewable resource, time population and economic growth as major drivers, it is dramatically under threat, with soil erosion, organic carbon decline, compaction, salinization, and soil biodiversity decline representing one of the most critical issues (Montanarella et al., 2016). Despite such a great importance for preserving the possibility of global development, the soil environment is known only to a few people connected to it scientifically or through cultivation and remains unknown to the general public (Charzyński et al., 2022; Urbańska et al., 2022).

Knowledge of natural resources is always important for their proper use and conservation. The soil is specific in such a way that we usually can only see the upper part of it. However, in order to know and assess the soil, it is necessary to look beneath the surface and study it at its entire depth. Soils are usually covered by plants under natural or semi-natural conditions in many climates, or covered by human buildings, and hence are unseen. However, they are sometimes exposed, especially after ploughing, but observers must fit into a fairly narrow time window before the plants sprout and cover the topsoil surface. Urban excavations, related to construction works and the replacement of underground infrastructure, provide insight into the soil. Nevertheless, such opportunities are often missed, due to the misconception of most people: there are no soils in urban areas, soils are a countryside matter. Soils, frequently referred to as 'dirt', 'ground', or simply 'earth', can even be considered dull and unexciting. Most people associate them only with agricultural activities. In part, this may be because soil education at various educational levels is still deficient in many countries. This statement could also be true in the case of university students involved in environmental-related subjects. Very often, soil science courses belong to agricultural, forestry, environmental, geography, or geology degree courses, with limited hours devoted to the study of the pedosphere. This may result in students perceiving the pedosphere as less important than other geospheres (litho-, atmo-, bio-, and hydrosphere), and despite the fundamental role of soils, understanding their importance in sustaining terrestrial life and human existence is still low among the general public (Brevik et al., 2020).

A soil survey has multiple goals that can be achieved simultaneously or in a singular way according to scholars and/or research purposes. Indeed, to give some practical examples, we can: i) describe the characteristics of the soils in a given area; ii) classify them according to a standard system of taxonomy; iii) plot their boundaries on a map; iv) collect their properties in an organised database; v) make predictions about their suitability and limitations for multiple uses, as well as their likely response to management systems. The information collected through a soil survey helps the development of land use plans and management and can be utilised to evaluate and predict the effects of land use on the total environment (Soil Science Division Staff, 2017).

Although new approaches in describing soil properties, such as remote sensing and advanced statistical methods, have recently started to be applied, the traditional field works and soil description by the soil scientist is still the most important tool for understanding soils and their properties. Some properties can be determined by remote sensing, others can be modelled by statistical and spatial analysis. However, soils are below the land surface, so it is very difficult to observe them directly as a whole, even from

a distance. On bare, unvegetated surfaces, we can only see the topmost part. A hole created by an uprooted tree, an eroded gully, or a road cut can give us a closer look at the structure and the general properties of the soil. But only through careful and challenging fieldwork can we discover what a rich and mysterious world lies beneath our feet.

Classification is an important branch of soil science as it integrates knowledge about soils in the process of selecting criteria and limit values and has been one of the cornerstones of pedology since its emergence. Soil names and classes give an overview of multiple soil properties (Kubiëna, 1953). Unlike zoo- and phytotaxonomy (Linnean classification system) or mineralogy (Dana's System of Mineralogy), many classification systems coexist globally in soil science (Krasilnikov et al., 2010) and their number has even been increasing. The type of classification system employed is often not based on multi-aspect analysis of the available classification systems, but rather influenced by historical factors, legal actions, conventions, scientific trends, or present geopolitical atmosphere.

The World Reference Base (WRB) soil classification system, created nearly 30 years ago (FAO, 1994; 1998; IUSS Working Group WRB 2006, 2014), is a thoroughly thought out and useful tool. To find an opportunity for people to freely discuss soils and their properties, regardless of the region, scientists have been trying for several decades to integrate WRB soil classification into a common language at the national soil classification level and to promote a free approach to understanding soil classification (Karklins 2001; 2009; Repe 2006; Świtoniak et al. 2018). The WRB system enables not only the use of uniform nomenclature in relation to entire soil profiles, but it is a universal tool for their detailed description – regardless of the soil science traditions of authors from different countries around the world (Świtoniak and Charzyński 2014, 2018a, b, c, 2022). However, it gets more and more complicated with each edition (IUSS Working Group WRB, 2022). This is common to all classification systems, alienating them from ordinary people and even from non-specialized scholars. Consequently, a great issue arises; being uninterested, common people feel far from science. It could appear as a problem of little interest, but scholars have proved that the more people distance themselves from science, the less importance it is given by the political agenda (Burstein, 2003).

Teaching WRB soil classification may seem a relatively easy task for experienced pedologists. Firstly, the basic terminology of the discipline shall be explained, and then the entire system of taxonomy shall be thoroughly discussed. Eventually, some exercises can complete the programme. But what does it look like from a student's perspective? It is easy to guess that such an approach is considered frightening and boring by most students and favours large memory capacities rather than comprehension of how to deal correctly with the subject (Langohr 2002). It can be stated that soil classification has a poor reputation. Critical remarks are not uncommon. Comments such as 'too many systems', 'changing too often', 'too many features to describe', 'too complex', 'too difficult terminology', 'even specialists disagree on exact names of the soils', are frequently heard. Pronounced by laymen, such opinions could be understandable. Such expressions can, pitifully, also come from numerous soil scientists. In the presence of students or colleagues representing other disciplines, they could negatively influence the status of soil science in general. 'This bad reputation is at least partly responsible for soil classification being absent from many teaching programmes in soil science. Many younger soil scientists do not receive any training in classifying soils and, thus, do not even comprehend a classification system' (Langohr 2002).

The long-term teaching experience reveals difficulties related mainly to complicated terminology and an excessive number of characteristics that must be known, even in the introductory stage of teaching. Another obstacle to the science of soil classification is the limited opportunities for practical observation of soil types due to geographical constraints. A study site facilitates understanding of the surrounding soils but provides no information on soils from remote areas. Such soils often have unique characteristics not found in other regions or look different enough to confuse observers. In addition, many features that are important for the description of the profile are often described in words or presented in textbook figures. However, it is hard to imagine the real picture based on the description or black and white drawing, hence the idea of this album; to show all diagnostics used in the 4th edition of WRB in precisely selected photos and highlight what is important for their correct detection. A challenge that wants to represent a step forward in making soil classification for what it is: one of the most fascinating aspects in the study of a finite and fragile resource on which we all depend, on which the destiny of the entire humanity depends. Nevertheless, we need to name it to properly protect our soils. 'The beginning of wisdom is to call things by their names', the Chinese philosopher and politician Confucius states. Of course, we can name it by using new tools, never experienced before. Tools that can bring new students and young researchers closer to the study of this beautiful discipline, soil science, with particular reference to classification. Indeed, as Certini and Scalenghe (2019) argued, 'unnamed soils, lost opportunities'. It is time to take advantage of the many possibilities that soil classification offers.

In recent years, many studies have been developed to illustrate soil classification systems, e.g., Illustrated Guide to Soil Taxonomy (Soil Survey Staff, 2014), Guidelines for Surveying Soil and Land Resources (McKenzie et al. 2008), or containing a wide range of examples of photos of soils and soil features from around the world (e.g., Zech et al. 2022). It also seems that textbooks, handbooks, or manuals are seldom sufficiently comprehensible for people in training. It could be caused by not taking into account by its authors that the readers are frequently not well acquainted with the classification systems and a large number of specialised terms used. Moreover, it should be considered that the present generation of Gen Z Digital Nomads are more visual oriented and information provided in the form of text is more difficult for them to acquire and thus the idea and form of book you have now in your hands.

Many soil features are difficult to recognize, others are not common in all types of environment; therefore, it is difficult for teachers in particular regions of the world to conduct comprehensive soil science education without appropriate, tangible examples seen in specific cases. Consequently, the aim of this handbook is: i) to help to find all the information needed to classify and correctly name soils presenting diagnostics needed to be detected during fieldwork when soil is observed, measured, and interpreted; ii) gain new insights into the landscape and the pedosphere through further challenging tools.

The presented work is a continuation and development of a simplified student WRB guide published by Świtoniak et al. (2018). In this previous book, nomenclature and examples of soil description and qualifiers were limited to the Central and Eastern Europe environments. The 'Illustrated Handbook of WRB soil classification' contains a collection of photos from different parts of the world, and their selection was intended to show as much as possible the diversity of the world's soil cover. The book opens with Chapter 1 containing examples of environmental and soil surface features with their short descriptions in the context of use in describing the surroundings of a soil pit. In Chapters 2 through 6, the reader

is guided through extensively inventoried examples of detailed soil features and horizons, properties, and diagnostic materials. It should be noted that full definitions of the soil features required in the WRB were not used, but only simplified descriptions aimed at drawing attention to the characteristic morphological features, which facilitate their recognition in the field. The core of the study is Chapter 7 - a list of 100 soil profiles, presented in the order according to the Reference Soil Groups key in the WRB (2022). Each soil photo was accompanied by a thumbnail showing the depth of occurrence of individual features determining the classification position of the soil, both the RSG and the use of main qualifiers. The description of particular parts of the soil names (RSG and qualifiers) have been simplified in order to link the interpretation of a given names with recognizable morphological features of the soil. The book ends Chapter 8 with photos showing the general principles of using specifiers and additional examples of selected qualifiers with their general descriptions. Therefore, the handbook is not able to replace the formal key for soil determination in accordance with WRB, it is only a complementary, additional tool containing a database of photographic examples for wide use by people involved in soil classification.

The authors of this publication hope that the present handbook will contribute to the theoretical and practical development of young researchers' skills on soil classification itself, but also to interpret the soil in terms of its ecological value, sustainable use and protection of soil resources, and how soil types determine our wider environment. The beautiful soil images in the book will help you discover a hidden world of rare beauty. Indeed, what is clear to all soil scientists has been easily explained by Saint-Exupéry's words: 'what is essential is invisible to the eye'.

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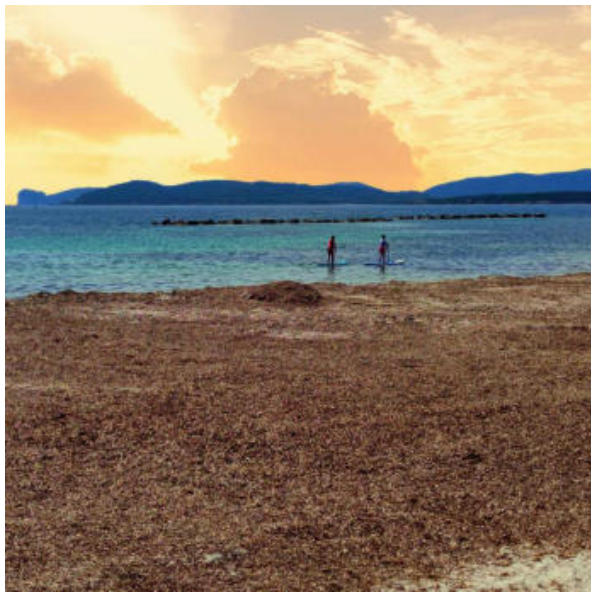
ENVIRONMENT AND SOIL SURFACE FEATURES

VEGETATION TYPE

Algae in fresh or brackish waters

a group of predominantly aquatic, photosynthetic, and nucleus-bearing organisms that lack the true roots, stems, leaves, and specialized multicellular reproductive structures of plants.



Algae in marine waters

marine algae can be deposited on coastline and shores, especially after windy conditions.

Higher aquatic plants

woody or non-woody plants that have adapted for living in aquatic environments.

Biological crust

the community of organisms (bryophytes, lichens, cyanobacteria, algae and/or fungi) living at the surface of soils in a range of environments, from deserts to temperate climates.

VEGETATION TYPE

Lichens

complex life form that is a symbiotic association of a fungi and an algae.

Bryophytes and/or algae (non-peat)

non-vascular land plants limited in size and preferring moist habitats; consists of three groups: the liverworts, hornworts and mosses.

Peat forming plants (non-woody)

peat is formed mainly from bryophytes (mostly sphagnum mosses), herbs and shrubs growing in wet conditions.

Grasses

monocotyledonous flowering plants. The leaves of grasses grow from the base of the blade which is an adaptation allowing it to cope with frequent grazing.

VEGETATION TYPE

Heath

shrublands developed mainly on dry, acidic soils and characterised by open, low-growing woody vegetation. In moderate and high altitudes characteristic of heathland and moorland (photo: Piotr Sewerniak).

Heath in warm climates

heathland is favoured where climatic conditions are typically hard and dry, particularly in summer.

VEGETATION TYPE

Dwarf shrubs

these form of plants, also called chamaephytes, are usually woody, perennial plants whose buds overwinter just above soil level. An example from a cold climate zone is the *Dryas octopetala*.

Dwarf shrubs

in warm climate zones small, low shrubs with e.g. *Armeria sardoa*, *Halimium halimifolium* or *Santolina sp*. are classed as dwarf shrubs or subshrubs.

VEGETATION TYPE

Evergreen shrubs

dwarf mountain pines (*Pinus mugo*) are an example of conifer species of high elevation evergreen shrubs.

Evergreen shrubs

bushes which have green leaves all the year round.

VEGETATION TYPE

Seasonally green shrubs

bushes that shed leaves for a part of the year e.g. in a colder and/or dryer part of season.

Seasonally green shrubs

bushes that shed leaves for part of the year – mainly due to drought.

VEGETATION TYPE

Evergreen trees

occur across a wide range of climatic zones. Among them are rainforest trees in tropical zone.

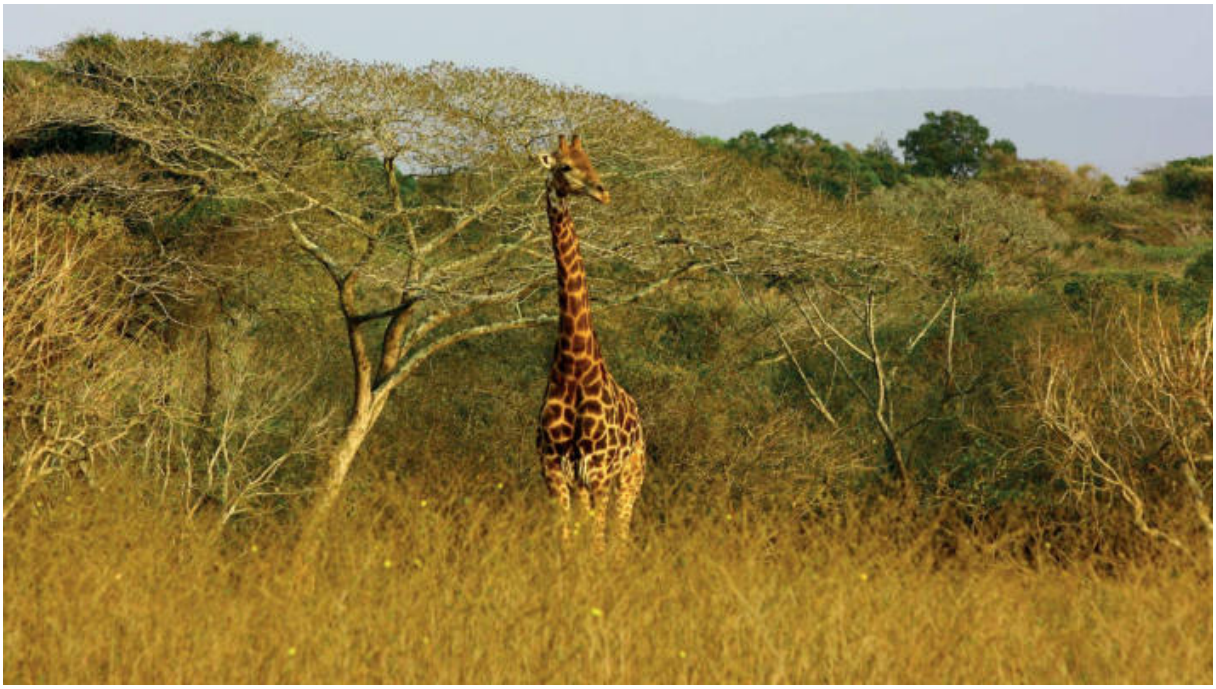
Evergreen trees

coniferous temperate evergreen forests are dominated by pine, cypress or spruce.

VEGETATION TYPE

Seasonally green trees

deciduous forests with oak, lime, maple, hornbeam etc., which shed all of their leaves during the cold part of the year.



Seasonally green trees

tropical, subtropical, or monsoon forests with species which shed some or all of their leaves during the dry season.

VEGETATION TYPE

Plantation forest

not in rotation with cropland or grassland.

Plantation forest

in rotation with cropland or grassland.

VEGETATION TYPE

None (barren)

water bodies – lakes or rivers.

None (barren)

salt-encrusted surfaces (e.g. Salar).

VEGETATION TYPE

None (barren)

deserts – sandy, gravelly, or stony.

None (barren)

glaciers, ice caps, ice sheet.

VEGETATION TYPE

None (barren)

heavily eroded areas.

None (barren)

outcrops of solid rocks.

CULTIVATION TYPE

Agroforestry

simultaneous agroforestry system with trees and annual crops.

Agroforestry

simultaneous agroforestry system with trees and grassland.

CULTIVATION TYPE

Agroforestry

simultaneous managed forest and extensively grazed area.

Pasture

on (semi-) natural vegetation.

CULTIVATION TYPE

Intensively-managed grassland, pastured

extensively or intensively grazed permanent grasslands with presence of farm infrastructure such as: fences, shelters, enclosures, watering places.

Intensively-managed grassland, not pastured

grassland used for serving as a hayfield.

CULTIVATION TYPE

Perennial crop production

crops (cultivated for food, fodder, fuel, fibre production) that do not need to be replanted each year. Grapevine, fruit, olives and nut crops are examples of perennial cultivated plants.

Annual crop production

planted and harvested during the same production season, e.g. corn, wheat, rice, lettuce, peas, watermelon etc.

CULTIVATION TYPE

Fallow, less than 12 months

left without sowing for maximum one year, with spontaneous vegetation.

Fallow, at least 12 months

left without sowing for more than one year, with spontaneous perennial vegetation.

NATURAL SURFACE UNEVENNESS

Unevenness caused by permafrost

different forms like palsa, pingo, mud boils, thufurs or cryo mounds.

Unevenness caused by shrink-swell clays

surface irregularities resulting from swelling-shrinking of clay.

ARTIFICIAL SURFACE UNEVENNESS

Longitudinal elevation

flood embankments.

Longitudinal positive forms

dike surrounding the pond.

ARTIFICIAL SURFACE UNEVENNESS

Rounded elevations

Neolithic kurgan – man-made burial mound.

Rounded elevations

early Medieval kurgan – man-made burial mound.

ARTIFICIAL SURFACE UNEVENNESS

Human-made terraces

graduated terraces built into the slope to maximize the land area for agricultural use and reduce the soil erosion and water loss.

Rounded holes

the 'volcanic ash funnels' for grapevine.

SPECIAL TECHNIQUES TO ENHANCE SITE PRODUCTIVITY

Raised beds

improving drainage and increasing soil temperature at the early part of the growing season.

Others

furrows and ridges for plantation pine growing.

SPECIAL TECHNIQUES TO ENHANCE SITE PRODUCTIVITY

Underground drainage

system of pipes and fittings that is put below ground level to transport water to a soakaway or water course.

Drainage by open canals

surface channels used to intercept and convey excess water across a plot, the water is transported by gravity, in a non-erosive manner.

Wet cultivation

method of farming using the impermeable subsoil and earthen bunds to hold water (10-15 cm in average) in the field for the most of the growing season.

SPECIAL TECHNIQUES TO ENHANCE SITE PRODUCTIVITY

Irrigation

center-pivot irrigation applaying controlled amounts of water to land to assist in the production of crops.

Irrigation

water is distributed by pipes with using overhead high-pressure sprinklers or guns.

SOIL SURFACE CHARACTERISTICS

Litter layer

detritus or dead organic material from plants on the top of soil.

Rock outcrops

visible exposures of hard rock or other geologic formations at the surface of ground.

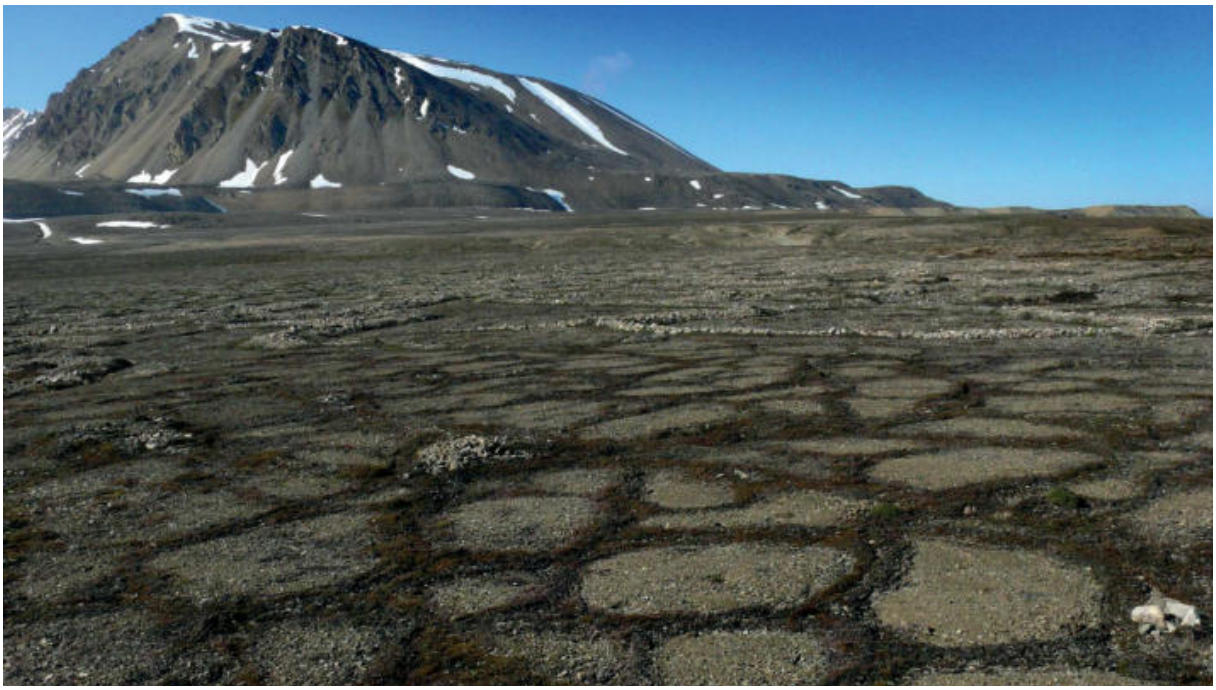
Coarse surface fragments

skeletal fraction (stones, gravels) visible on the soil surface.

Desert features

desert surface covered with closely packed, interlocking angular or rounded rock fragments of pebble and cobble (gravel and stones) size.

SOIL SURFACE CHARACTERISTICS



Patterned ground

distinct and often symmetrical natural pattern of geometric shapes (rings, polygons, stripes) formed by the segregation of ground material in periglacial regions.

Surface cracks

appearing mainly as result of shrinkage of shrink-swell material – clay or organic.

SOIL SURFACE CHARACTERISTICS

Natural surface sealing – physical crust

crust forming a thin layer with higher density, shear strength and lower hydraulic conductivity, than the underlying soil, causing its sealing.

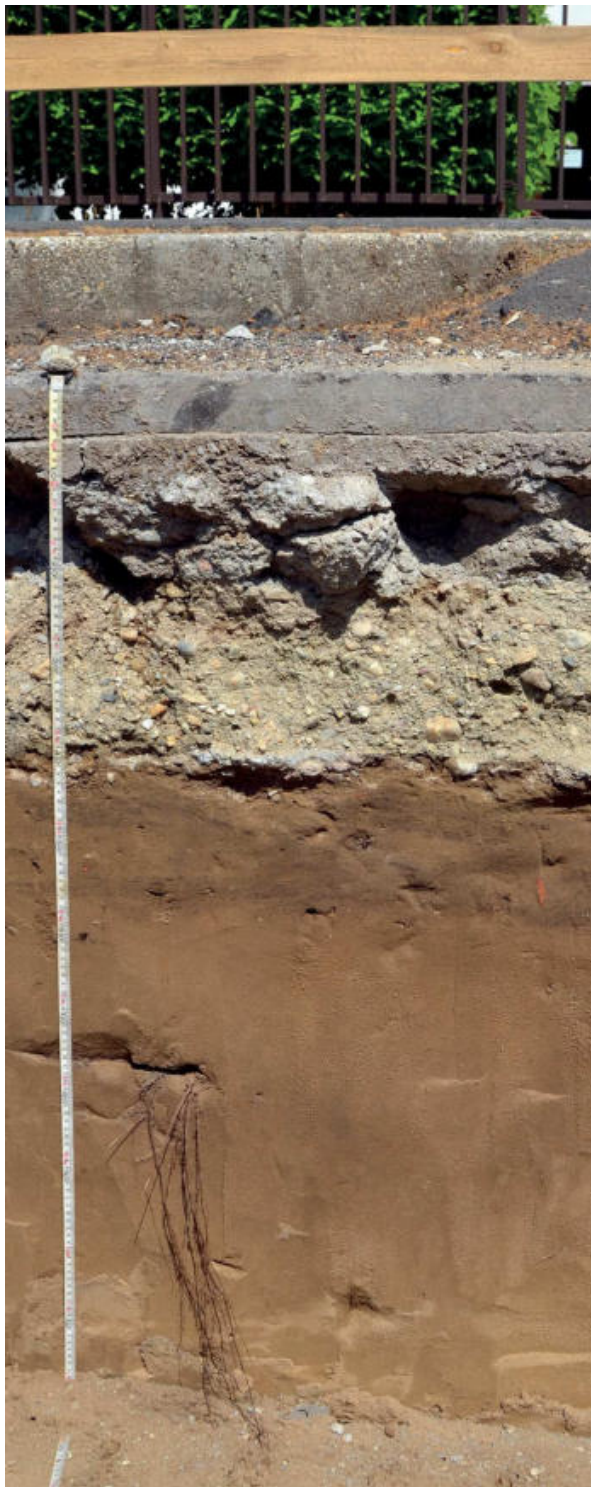
Natural surface sealing – salt crust

layer at the soil surface which are mainly formed by soluble salts crystallizing between soil particles.

SOIL SURFACE CHARACTERISTICS

Technical surface sealing

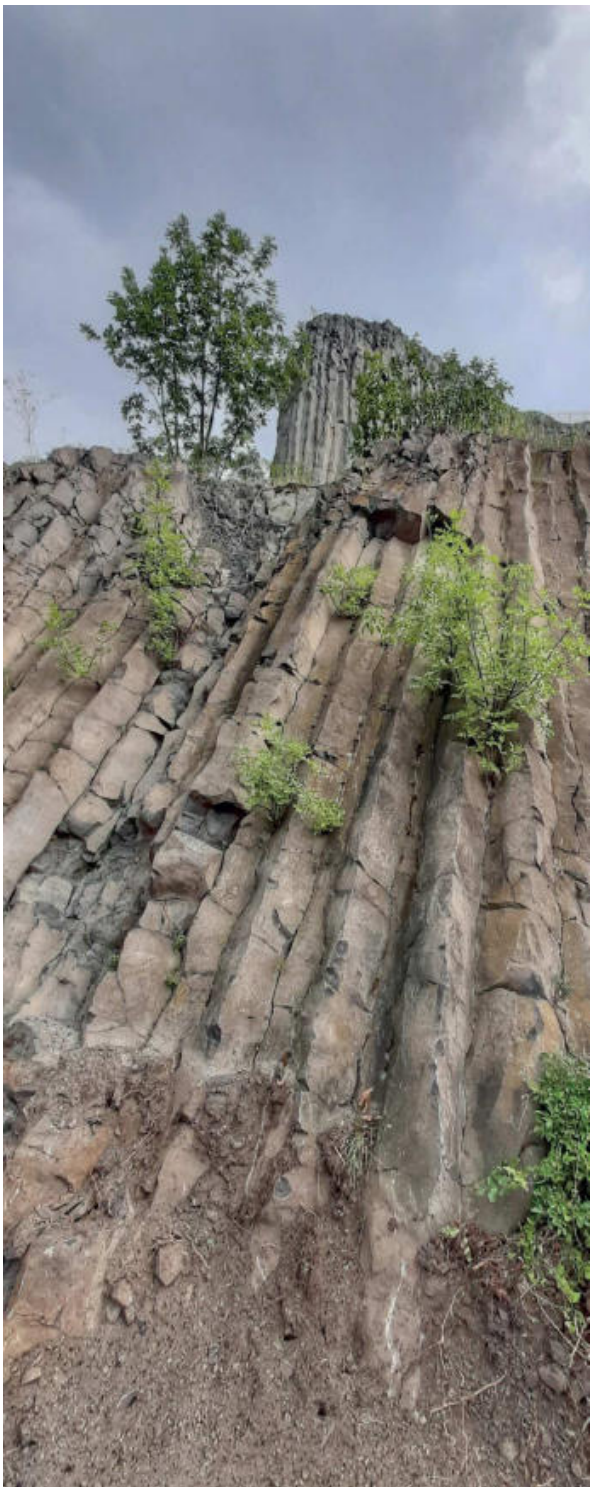
a man-made artificial barrier – such as a concrete slab or asphalt covering the ground.



Technical surface sealing

soils sealed by artificial barrier are called 'ekranosols'.

SOIL SURFACE CHARACTERISTICS



Basalt

volcanic rock outcrops, e.g. in the form of column.

Granite

outcrops are either inselbergs – isolated rock hills or knobs – or monoliths.

Glacial till

unsorted glacial sediment. Larger fractions (gravel, stones) are completely surrounded by the matrix of finer material (mix of clay, silt and sand).

SOIL SURFACE CHARACTERISTICS

Ant mound

mostly relatively small, convex structures formed up by ants.

Termite mound

nest of termites' colony constructed as a heaped pile of earthy materials, gravels, rocks or debris.

SOIL SURFACE CHARACTERISTICS

Sheet erosion

erosion of substrate along a wide area, it implies not canalized flow of water causing the erosion.

Rill erosion

removal of soil by concentrated water flow, it occurs when the water forms small channels in the soil as it flows off site.

SOIL SURFACE CHARACTERISTICS

Gully erosion

is the formation and subsequent expansion and deepening of erosional channels in the soil as a result of concentrated water flow.

Tunnel erosion

the removal of subsoil which form the tunnel beneath the soil surface. It becomes larger and the soil may eventually collapse and form a gully.

SOIL SURFACE CHARACTERISTICS

Erosion cone

accumulation of eroded material (*solimovic material* or in other words 'colluvium') at the foot of the slope – clearly visible in barren lands.

Erosion cone

in cultivated areas, the zone with accumulation of slope material is not clearly visible at first glance.

SOIL SURFACE CHARACTERISTICS

Shifting sands (wind erosion)

the action of the wind causing the move of sand and burying the vegetation.

Mass movement (landslides)

bulk movements of soil and rock debris down slopes in response to the pull of gravity.

PRESENCE OF WATER

Permanently submerged by seawater

the area below the lowest astronomical tides or the lowest mean low water level.

Tidal area

the area where the sea meets the land between mean low and mean high tides.

PRESENCE OF WATER

Occasional storm surges

the area above the highest astronomical tides, sometimes submerged with water due to the abnormal rise in sea level during the storm.

Permanently submerged by inland water

the area within water bodies – lakes, rivers etc.

PRESENCE OF WATER

Submerged by remote flowing inland water at least once a year

mainly areas often flooded by rivers on alluvial plains.

Submerged by remote flowing inland water less than once a year

e.g. areas in alluvial plains protected by embankments.

PRESENCE OF WATER

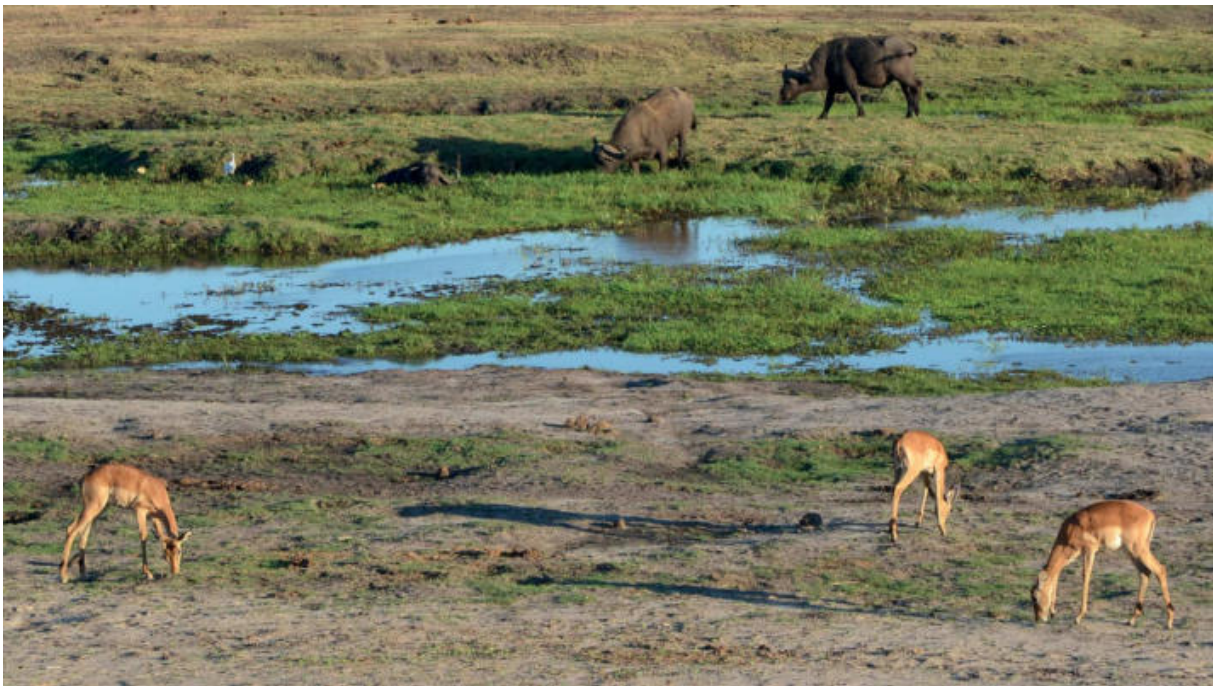
Submerged by rising local groundwater at least once a year

areas with very low drainage or spring areas with outflowing water.

Submerged by rising local groundwater less than once a year

areas with poor drainage – often with low permeability.

PRESENCE OF WATER



Submerged by local rainwater at least once a year

areas in depressions. Seasonally filled by water – especially after heavy rains or during rainy season.

Submerged by local rainwater less than once a year

areas flooded with rainwater every few years, e.g. in semi-arid areas after episodic rains.

MORPHOLOGICAL SOIL FEATURES

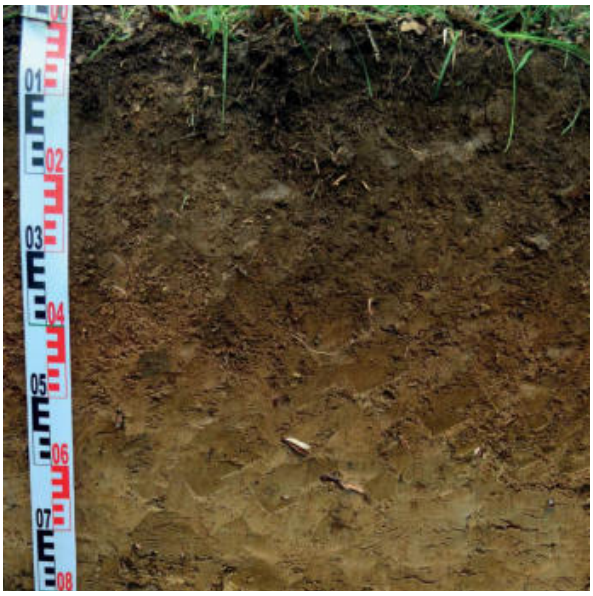
BOUNDARIES (MINERAL AND HYDROMORPHIC ORGANIC LAYERS)

Distinctness – very abrupt

transition ≤0.5 cm, often connected with *lithic discontinuity* or human-made alterations.

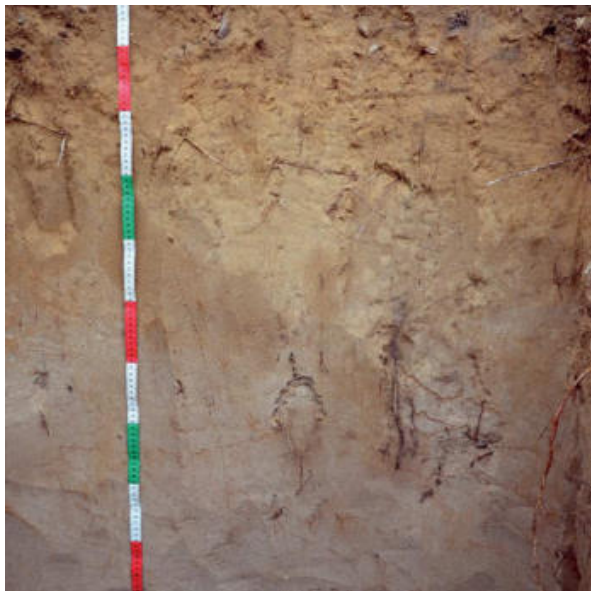
Distinctness – abrupt

transition within 0.5–2 cm.



Distinctness – clear and gradual

clear: transition within 2–5 cm (depth 50–55 cm on photo);
gradual: 5–15 cm (depth 25–35 cm on photo).



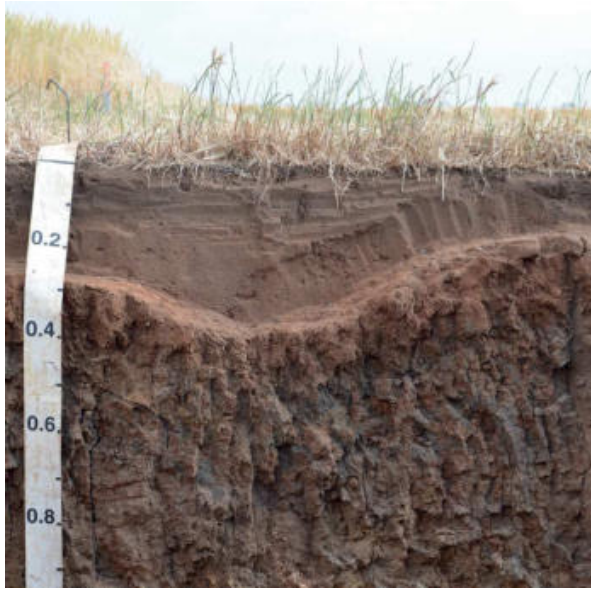
Distinctness – diffuse

transition within more than 15 cm.

BOUNDARIES (MINERAL AND HYDROMORPHIC ORGANIC LAYERS)

Topography – smooth

nearly plane surface.

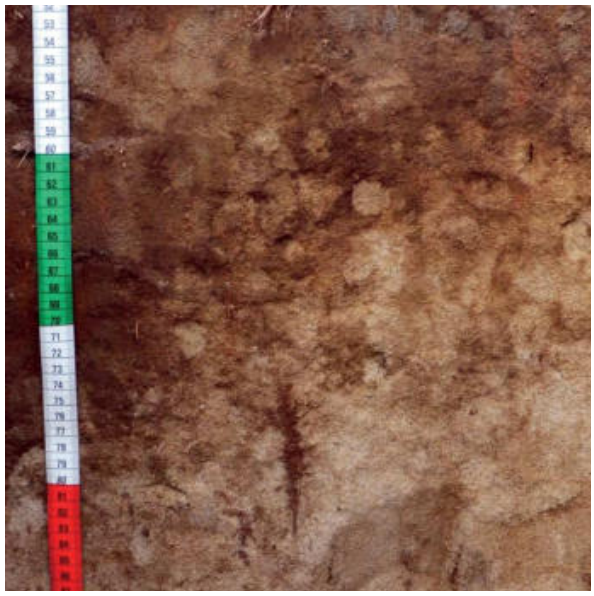


Topography – wavy

pockets where width is larger than depth.

Topography – irregular

pockets where depth is larger than width.



Topography – broken

discontinuous, at different depths.

COARSE FRAGMENTS

Rounded and subrounded

gravels and stones with rounded and subrounded edges – cobble, pebbles.

Angular

gravels and stones with sharp or distinct edges.

WEATHERING OF COARSE FRAGMENTS

Fresh (unweathered)

no or almost no evidences of weathering.

Moderately weathered

surface of the coarse fragment lost the original rock colour and and/or crystal form in the outer parts while its centre remain relatively fresh.

Strongly weathered

almost all minerals are weathered, original rock colour is lost throughout, the coarse fragments tend to disintegrate under only moderate pressure.

Ventifacts

sand-blasted, wind-faceted stones, common in desert environments.

ARTEFACTS

Bitumen (asphalt)

a black, sticky substance, often mixed with small stones or sand, that forms a strong surface when it becomes hard.

Bottom ash

part of the non-combustible residue of combustion in a power plant, boiler, furnace or incinerator.

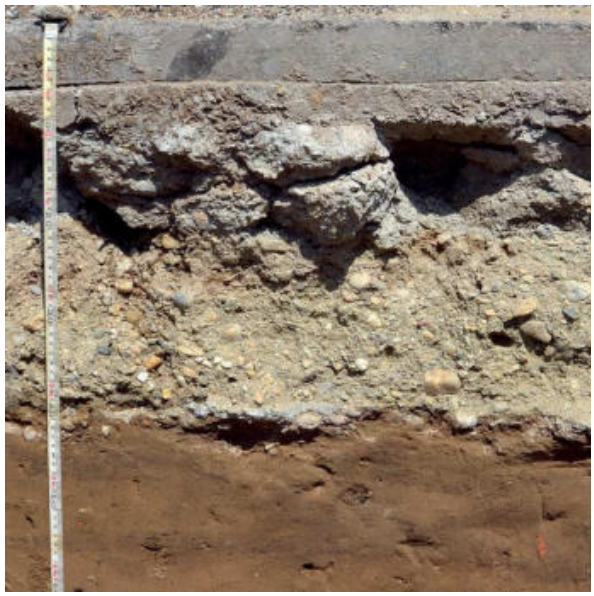
Brick

a handy-sized unit of building or paving material typically being rectangular.

ARTEFACTS

Ceramics, glass, metal

pieces of objects made of ceramics, glass or different metaloids, usually of the coarse fragments size.

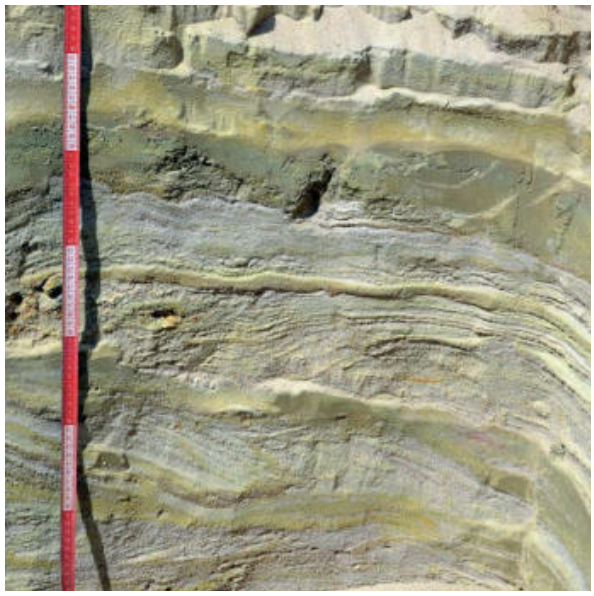


Concrete (fragments)

composite material composed of fine and coarse aggregate bonded together with a fluid cement that hardens over time.

Industrial waste

residual materials that result from industrial operations – metallurgical slag (photo: Łukasz Uzarowicz).



Industrial waste

post-production waste may be in a semi-liquid form, forming layers (yellowish on photo – sulfur) after drying.

ARTEFACTS

Industrial waste

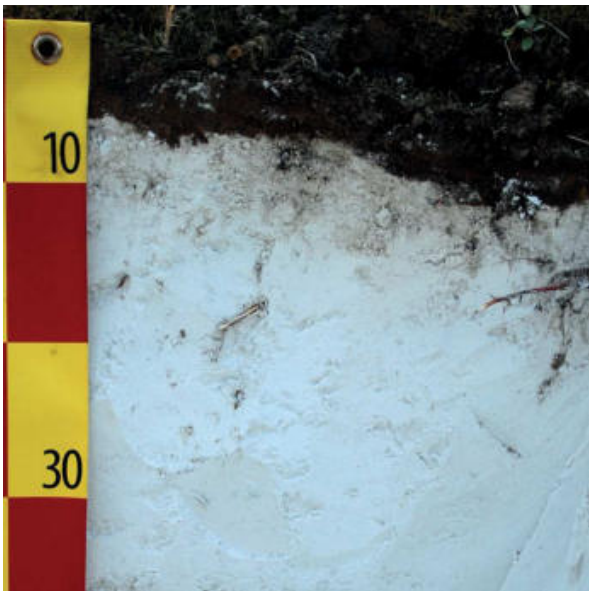
fly ash (in the bottom) and bottom ash (in the top) in soil profile (photo: Łukasz Uzarowicz).

Industrial waste

fresh fly ash from Thermal Power Station (photo: Łukasz Uzarowicz).

Industrial waste

phosphogypsum dump (photo: Łukasz Uzarowicz).



Industrial waste

phosphogypsum in soil profile (photo: Łukasz Uzarowicz).

ARTEFACTS

Mine spoil

a waste byproduct from mining activities.

Dressed or crushed stones

e.g. waste resulting from the extraction of rocks in quarries.

Lumps of applied lime

pieces of carbonate rock e.g. applied to the soil as the fertilizer increasing and stabilising the soil pH.

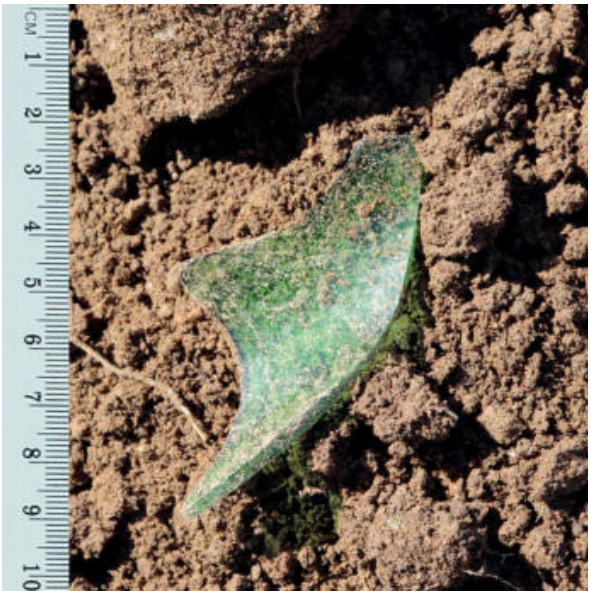
Geomembrane (broken)

very low permeability synthetic liner or barrier used to control fluid (liquid or gas) migration.

ARTEFACTS

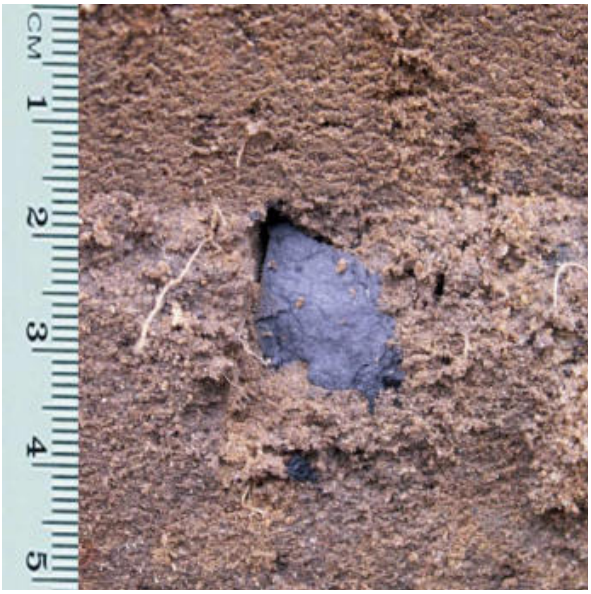
Plastic

plastic bottle – municipal waste.



Glass

fragment of a glass bottle – municipal waste.



Charcoal

fragment of burnt wood.

SOIL STRUCTURES

Granular

common structure in the humus horizons developed under grasslands.

Granular

spheroidal, biogenic, many visible pores, bounded by curved or very irregular faces, limited accommodation to the faces of surrounding aggregates.

SOIL STRUCTURES

Subangular blocky

bounded by undulating rough faces, variable number of faces, many vertices rounded, limited accommodation to the faces of surrounding aggregates.

Mixed structure

smallest rounded aggregates are granular, coarser – subangular and angular.

SOIL STRUCTURES

Angular blocky

bounded by relatively flat, smooth, roughly equal faces, variable number of faces;
most vertices angular; usually much accommodation to the faces of surrounding aggregates.

Angular blocky

often connected with heavy texture.

SOIL STRUCTURES

Wedge-shaped

bounded by flat faces, interlocking wedges or lenses that terminate in pronounced angular vertices, typical for first-level or second-level structure in *vertic horizons*.

Prismatic

bounded by relatively flat faces, vertically elongated units with angular vertices and flat tops, much accommodation to the faces of surrounding aggregates.

Columnar

bounded by relatively flat faces, vertically elongated units with angular to rounded vertices and rounded (domed) tops.

Polyhedral

bounded by relatively flat smooth, unequal faces, more than six faces, most vertices angular, re-entrant angles between adjoining faces (typical for second-level structure in *nitic horizons*).

SOIL STRUCTURES

Cloddy

artificial clods created by disturbance; e.g., ploughing or compaction.

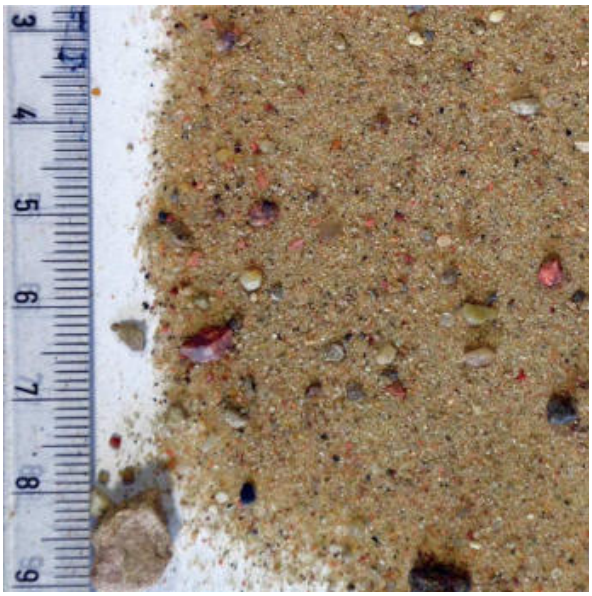
Platy

bounded by relatively flat horizontal faces, much accommodation to the faces of surrounding aggregates.

SOIL STRUCTURES

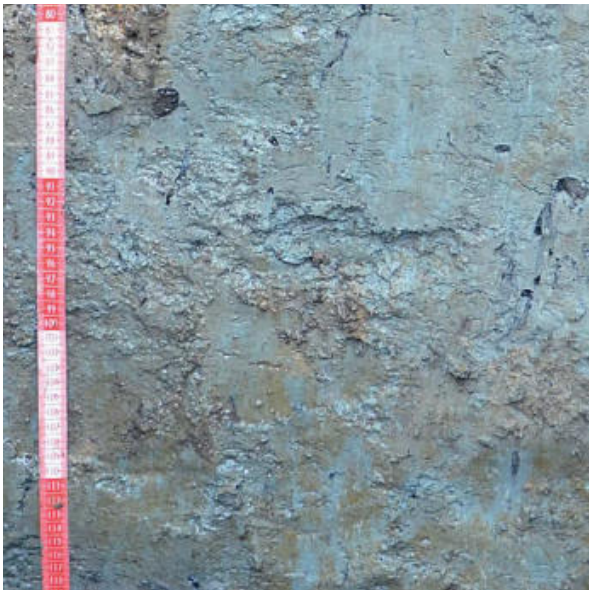
Single grain

entirely non-coherent, e.g. loose sand.



Single grain

typical for coarse-grained soils, with a particle size greater than 0.05 mm.



Massive

material is a coherent mass (not necessarily cemented).

SOIL STRUCTURES

Vesicular

vesicular pores are probably caused by capillary pressure within the air-filled voids surrounded by water.

Wormcasts

created by worms, which are digesting soil material (e.g. organic compounds) and excreting it on the surface or into voids in soil.

STRESS FEATURES

Slickensides

a polished surfaces of the cracks and pedfaces formed when aggregates are sliding past one another due to the increase of pressure in shrink-swell clay rich soils.

Slickensides

cutans are also called clay skins, clay flows, illuviation cutans, or argillans – visible here on concave surface after removing the stone.

CONCENTRATIONS

Clay coatings (cutans)

coatings of oriented clay (more brownish in colour) on the surfaces of peds and mineral grains and lining pores.

Clay coatings (cutans)

cutans can also form a films on stone surfaces. In general, cutans are also called clay skins, clay flows, illuviation cutans, or argillans.

CONCENTRATIONS

Ribbon-like accumulations

have higher iron content than the directly overlying and underlying layers.

Clay-iron lamellae

many clay-iron lamellae have also lithogenic 'background'. Illuviation just increased amount of clay in them.

Fe/Mn lamellae

illuvial concentrations of iron and manganese compounds in form of very thin layers.

CONCENTRATIONS

Fe nodules/concretions (hard)

rounded, cemented concentrations of iron formed due to the changes of redox potential.

Fe/Mn nodules (semi-hard)

containing high concentrations of not only iron but also manganese.

Mn hard nodules

containing high concentrations of manganese.

Fe/Mn soft masses (peppers)

small dark-brown to black spots in profile – effect of Mn and Fe segregation by stagnation of water.

SECONDARY CARBONATES AND GYPSUM

Carbonate nodules/concretions

rounded, at least weakly cemented, concentrations of secondary carbonates in forms of so called loess dolls.

Carbonate nodules/concretions

secondary carbonates concentrations infilling former root channels etc.

Masses (incl. spheroidal white eyes)

bulk concentrations of carbonates.

Pseudomycelia, channel infillings

carbonates concentrations infilling relatively small pores, forming the root-like and spawn- or mycelium-like structures.

SECONDARY CARBONATES AND GYPSUM

Carbonate coatings
on aggregate surfaces.

Carbonate coatings
on undersides of coarse fragments – so-called carbonate "beards".

Gypsum crystals
prismatic, lenticular, fibrous, tubular and granular forms can be found in soils.

Gypsum pendants
crystallized in form of envelopes on the surface of coarse fragments.

CEMENTATION

Fe/Al cementation (ortstein)

iron and manganese cementing the soil particles often forming a continuous layer.

Fe cementation (raseneisen)

bog iron - impure iron deposit developed by the chemical or biochemical oxidation of iron carried in water solution – *limonic horizon*.

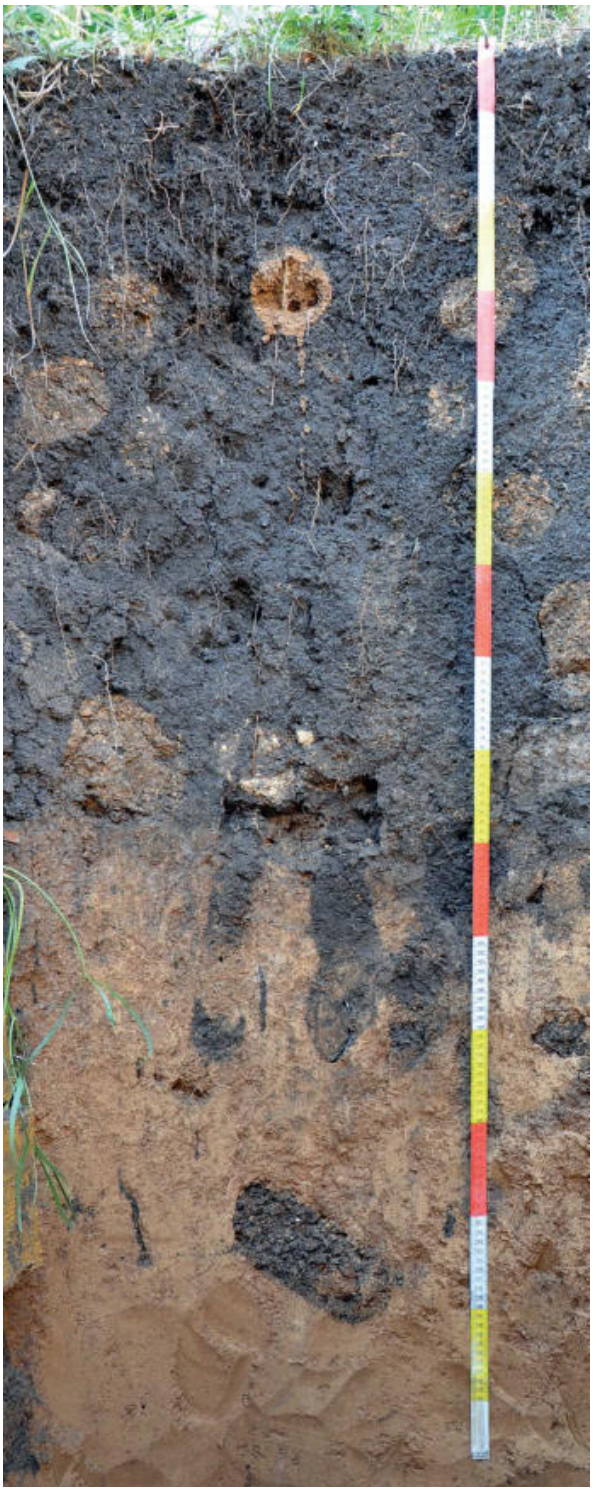
Fe cementation (petroplinthic)

relatively continuously cemented by high contents of Fe oxides, formed in tropical and subtropical regions with humid climate.

Carbonate cementation (petrocalcic)

horizon which is relatively continuously cemented with secondary carbonates.

RESULTS OF ANIMAL ACTIVITY



Infilled large burrows (crotovinas)

a paleoburrow filled with sediments (sands, clays, etc.). For example on this profile they are visible as dark tongues.

Open large burrows (made by mammals)

a hole or tunnel dug by a small animal, mostly by mammals e.g. rabbits, dormice or gophers.

Earthworm channels

tubular channels or burrows. They increase soil porosity which additionally increases the amount of air and water that get into the soil. On the photo infilled by humus material.

RESULTS OF ANIMAL ACTIVITY

Ant craters

relatively small forms build by ants with soil particles, often in gaps between concrete slabs or in asphalt cracks.

Worm casts

created by worms, which digest soil material (e.g. organic compounds) and ejected it on the surface or into voids in soil.

Termite channels and nests

constructed as a nest by a colony of termites mound which is a heaped pile of earth, gravel, sand, rocks or debris.

DIAGNOSIS

Presence of carbonates

checking effervescence with HCl for the presence of carbonates.

Checking soil pH with Hellig

the pH is determined on the basis of colour comparison. Red colours indicate low pH, deep green – high pH values.

DIAGNOSIS

Reducing conditions

checking for reddish/purple colour (indicates *reducing condition*) after spraying with dipirydyl.

Colour

checking soil colour using Munsell charts. Good eye is needed!

HORIZON AND LAYER DESIGNATIONS

ORGANIC HORIZONS OR LAYERS

H

organic material not forming part of a litter layer. Water saturation >30 consecutive days in most years or drained. Generally regarded as peat layer or organic limnic layer.

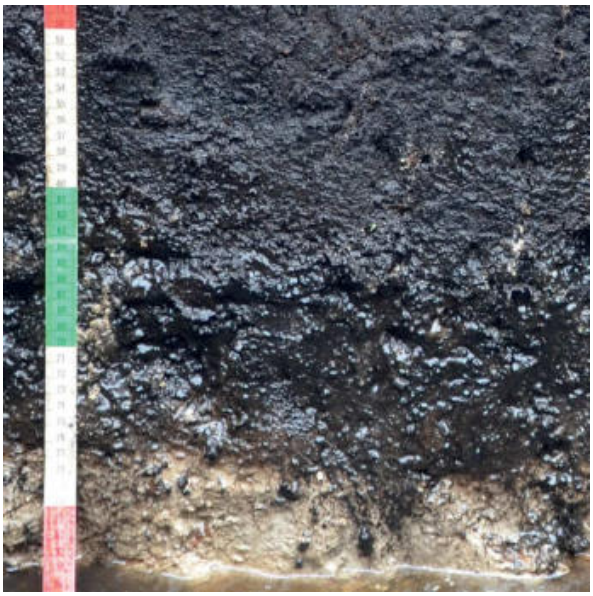
Hi

organic material in an initial state of decomposition. After gently rubbing, > two thirds of the *organic material* consists of recognizable plant tissues.

He

organic material in an intermediate state of decomposition. After gently rubbing, ≤ two thirds and > one sixth of the of the *organic material* consist of recognizable plant tissues.

ORGANIC HORIZONS OR LAYERS

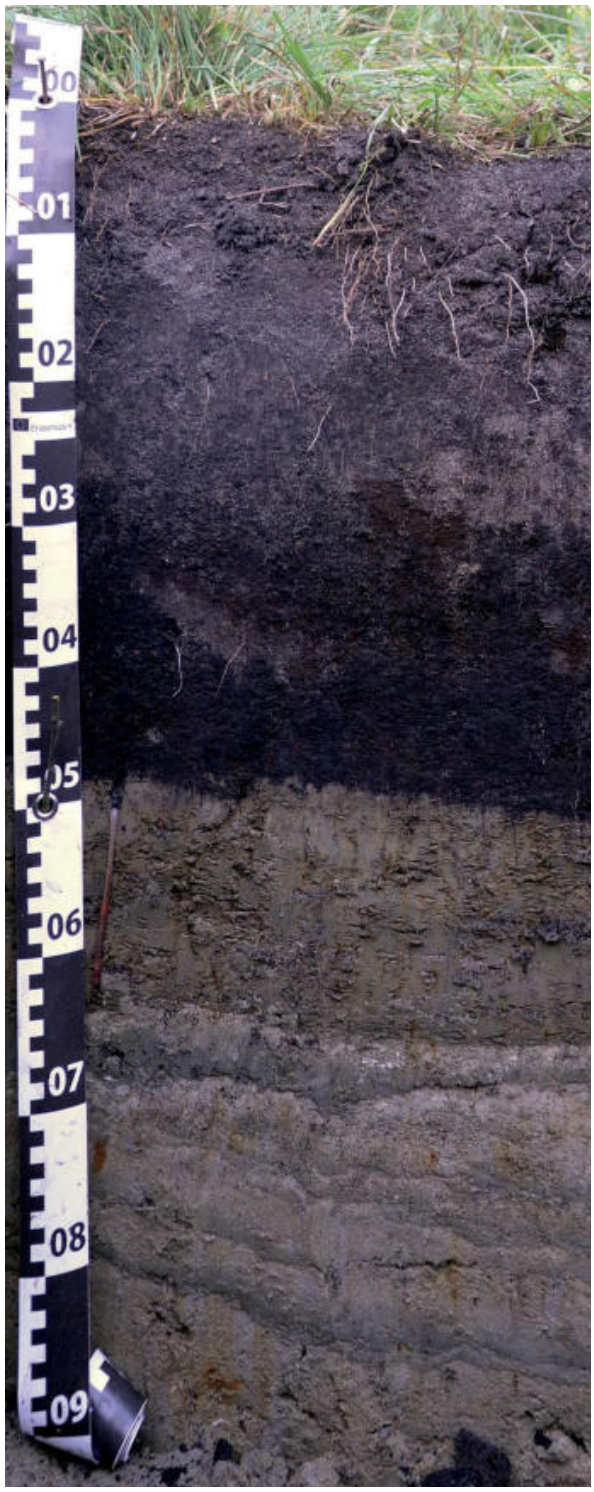


Ha

organic material in an advanced state of decomposition; After gently rubbing, ≤ one sixth of the *organic material* consists of recognizable plant tissues.

Hλ

deposited in a body of water (e.g. in lakes), the examples of such materials are gyttja, coprogenous earth or sedimentary peat.



Hb

buried organic horizon. In many cases covered by mineral colluvial (*solimovic material*) or alluvial (*fluvic material*) deposits.

ORGANIC HORIZONS OR LAYERS

Oi–Oe

organic material accumulated in 'dry' conditions in the initial (upper part) and intermediate (lower part) state of decomposition.

Oi–Oe–Oa

organic material accumulated in 'dry' conditions – all states of decomposition from initial to highly decomposed.

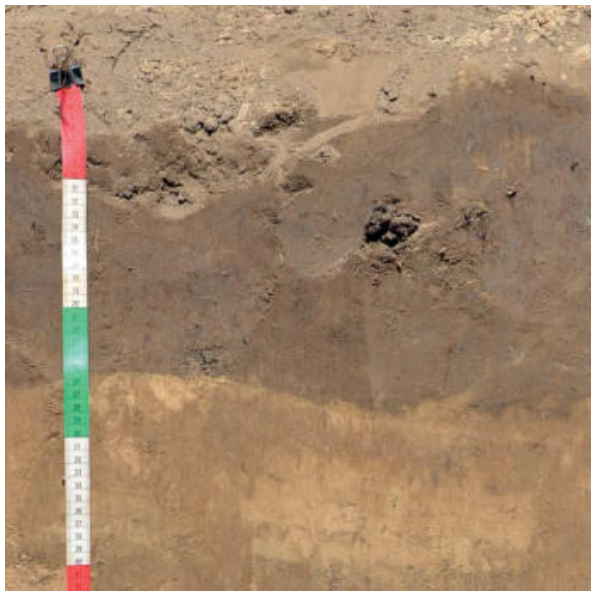
MINERAL HUMUS HORIZONS

A

humus-enriched surface mineral horizon – colour from black to light gray.

Ah

significant amount of organic matter in A horizons, at least partly modified in situ. Mostly with many roots.



Ap

humus horizons modified by cultivation (e.g. ploughing) – in many cases strongly homogenized, deepened and with very abrupt lower boundary.

MINERAL HUMUS HORIZONS

Au

humus horizon containing *artefacts* or consisting of *artefacts*.

Ab

buried humus horizon – covered by younger deposits. Mostly darker than upper and underlying horions. On photo in middle just above eluvial horizon.

Ak

humus horizon with accumulation of secondary carbonates.

MINERAL ELUVIAL HORIZONS

E

eluvial horizon (bleached part of profile) depleted in iron, aluminium compounds and humus as a result of the podzolization.

E

eluvial horizon (bleached part of profile) depleted in clay fraction as a result of the lessivage process.

Eg

eluvial horizon with loss of Fe and/or Mn by water stagnation.

E–EBcg

eluvial horizon with Fe and Mn concretions or nodules in lower part.

ENRICHED MINERAL HORIZONS

Bhs

illuvial accumulation of iron and humus (dark brown part) in the same zone – mostly by podzolization.

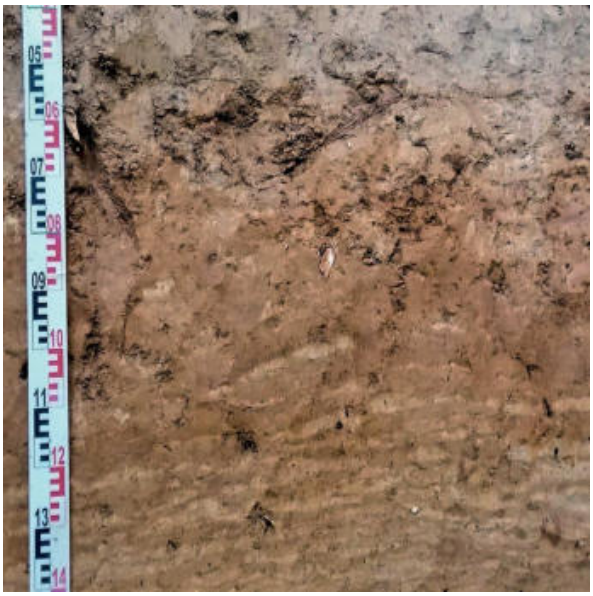
Bh

illuvial accumulation of humus visible as dark gray zone below eluvial horizon. Mostly as a effect of podzolization.

Bs

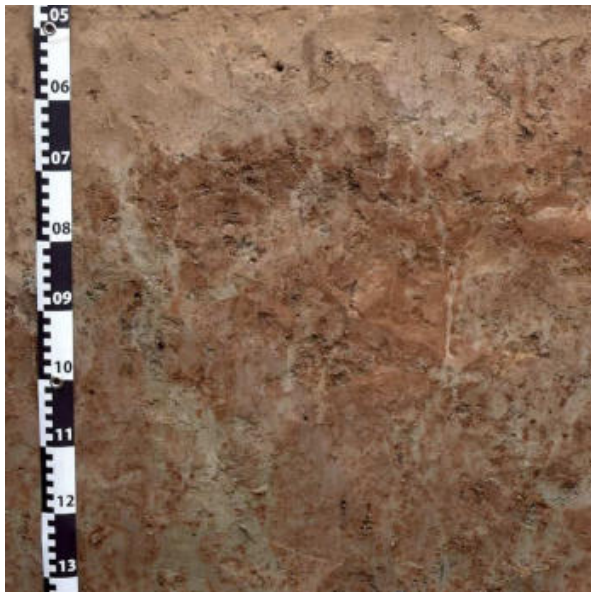
illuvial accumulation of iron visible as brownish zone below eluvial horizon. Mostly as an effect of podzolization.

ENRICHED MINERAL HORIZONS



Bt

illuvial accumulation of clay. In most cases visible as cutans or higher amount of clay fraction.



Btg

illuvial accumulation of clay with features connected with water stagnation.

Btk

illuvial accumulation of clay and accumulation of secondary carbonates.

Btx

presence of aggregates that could not be penetrated by root due to the clay illuviation at the ped faces.

ENRICHED MINERAL HORIZONS

Bi

B horizon with slickensides and/or wedge shaped aggregates.

Bo

residual accumulation of large amounts of pedogenic oxides in strongly weathered horizons.

Bw

formation of soil structure and/or oxides and/or clay minerals.

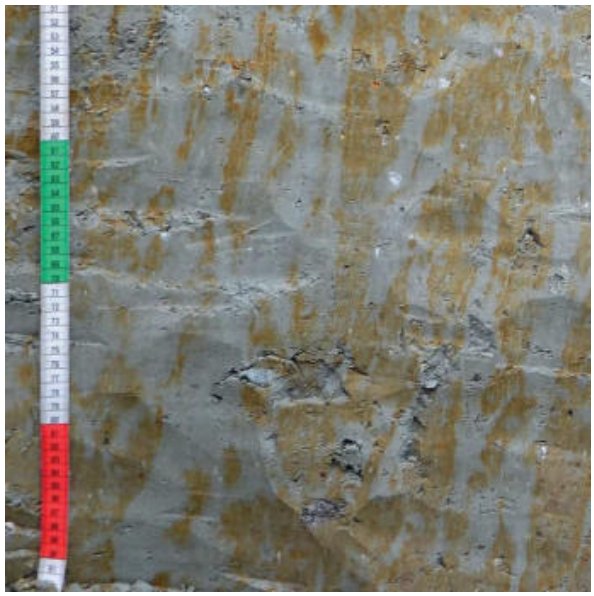
Bw

formation of soil structure and oxides on sand's grains surfaces.

PARENT MATERIALS

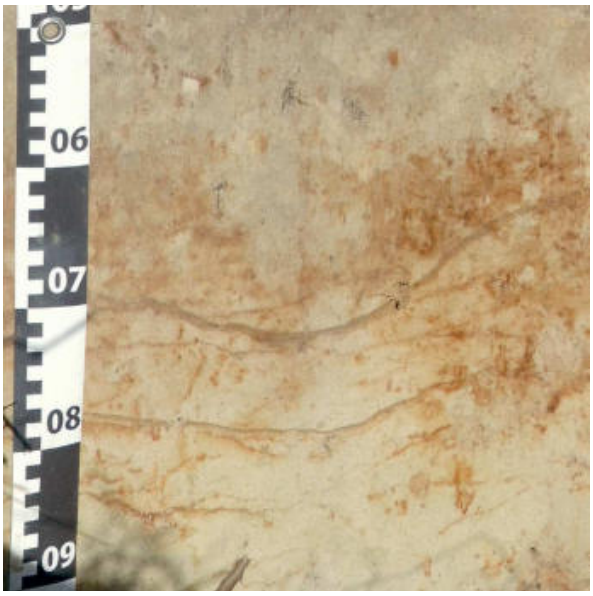
C

material unaltered by pedogenesis.



Cg

parent material with features connected with water stagnation.



Cl

parent material with accumulation of Fe and/or Mn in reduced form by upward-moving capillary water with subsequent oxidation.

Cr

parent material with strong reduction by groundwater.

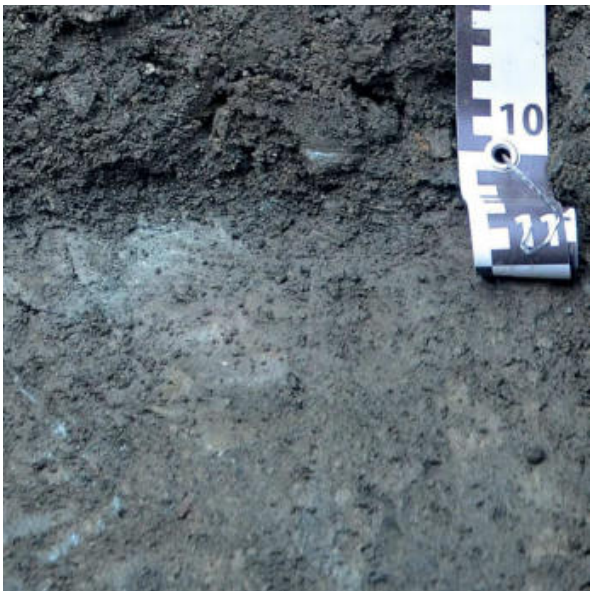
PARENT MATERIALS

Ck

parent material with secondary carbonates.

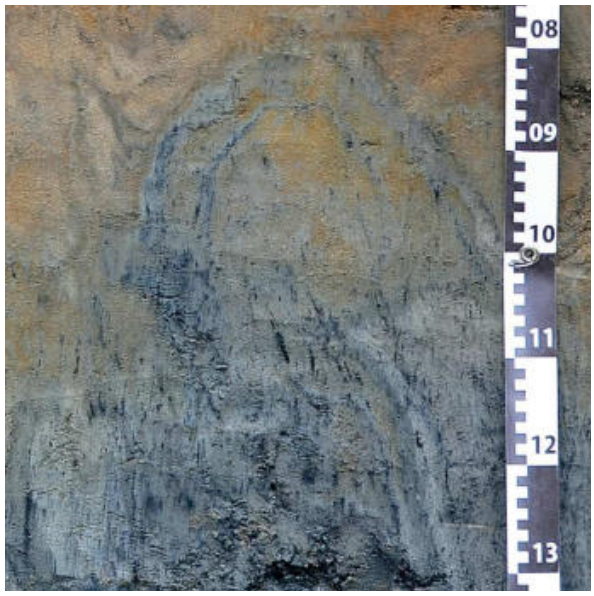
Ckm

parent material in which secondary carbonates accumulation leads to cementation in ≥50% of the volume.



Cf

parent material with permafrost.



Cl@

parent material with cryoturbations and *gleyic properties*.

PARENT MATERIALS

R

consolidated rock.

I

≥75% ice (by volume), permanent, below an H, O, A, E, B, or C layer.

TRANSITIONAL AND MIXED HORIZONS

E/B

example of mixed horizon.

BC

example of transitional horizon.

DIAGNOSTIC HORIZONS

ALBIC HORIZON

Albic horizon

bleached soil material – washed out of iron, aluminium and humus by podzolization process.

Albic horizon

eluvial horizon depleted in the fraction of clay, compounds of iron, aluminium – washed out by lessivage process.

ARGIC HORIZON

Argic horizon

enriched with the clay fraction – often also with iron compounds, which give it a colour browner than the parent material.

Argic horizon

in many cases (e.g. due to erosion) *argic horizon* is directly below the humus horizon

CALCIC HORIZON

Calcic horizon

secondary accumulation of calcium carbonate visible in cracks, pores and on the surface of stones.

Calcic horizon

numerous secondary carbonate concretions of spherical shape.

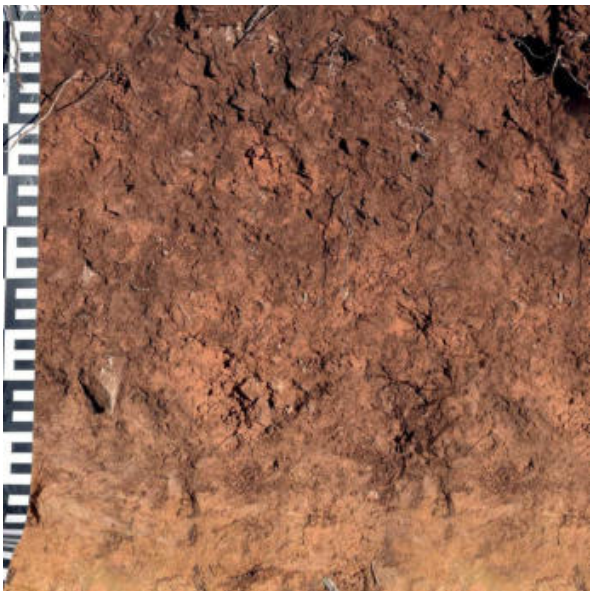
CAMBIC HORIZON

Cambic horizon

increasing colour intensity and development of soil structure in weathered limestones.

Cambic horizon

clay and iron accumulation in-situ in weathered acid rocks.



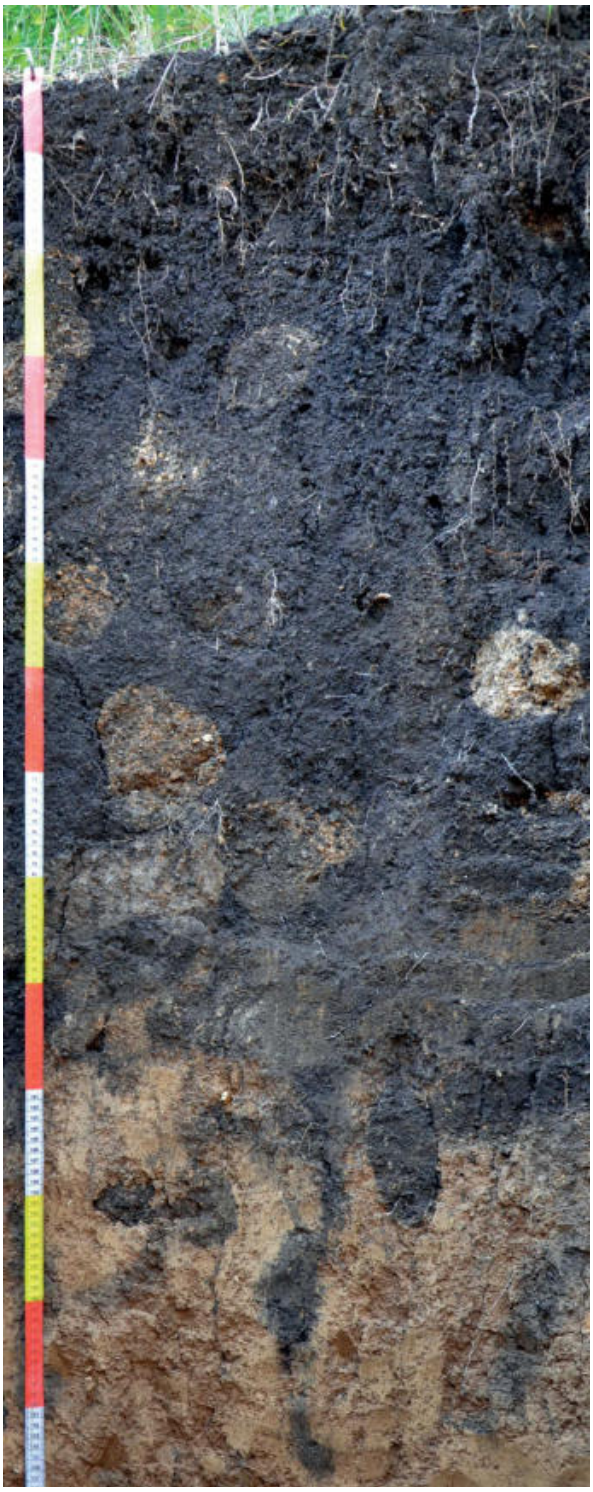
Cambic horizon

pedogenical structure in slope deposits, enriched also with humus.

Cambic horizon

iron compounds accumulation and soil structure development in silty deposits covering pieces of shists.

CHERNIC HORIZON



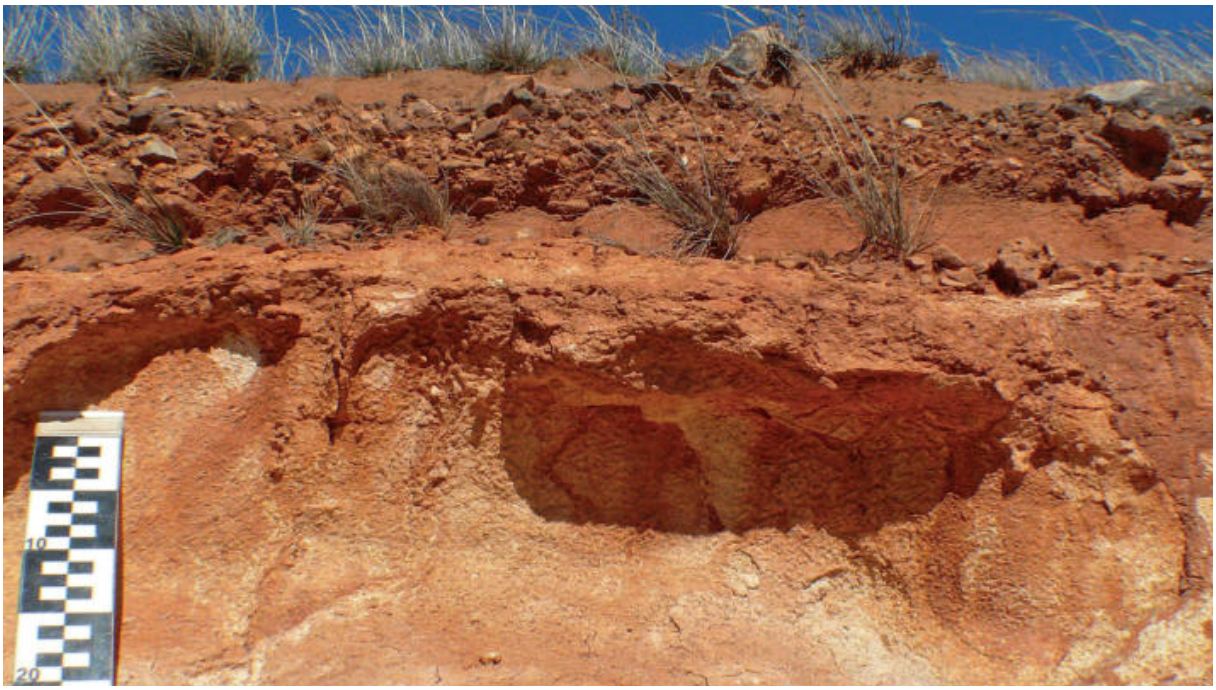
Chernic horizon

thick, dark, well structured humus horizon – often with high biological activity (crotovinas).

Chernic horizon

due to high fertility, soils with *chernic horizon* are often intensively cultivated. Lower plough boundary visible at 50 cm.

COHESIC HORIZON AND CRYIC HORIZON



Cohesic horizon

subsurface horizon dominated by kaolinite. It is found in tropical regions with seasonal climate changes.

Cryic horizon

perennially frozen soil horizon with ice (on photo) or soil temperature permanently below 0°C.

FERRALIC HORIZON

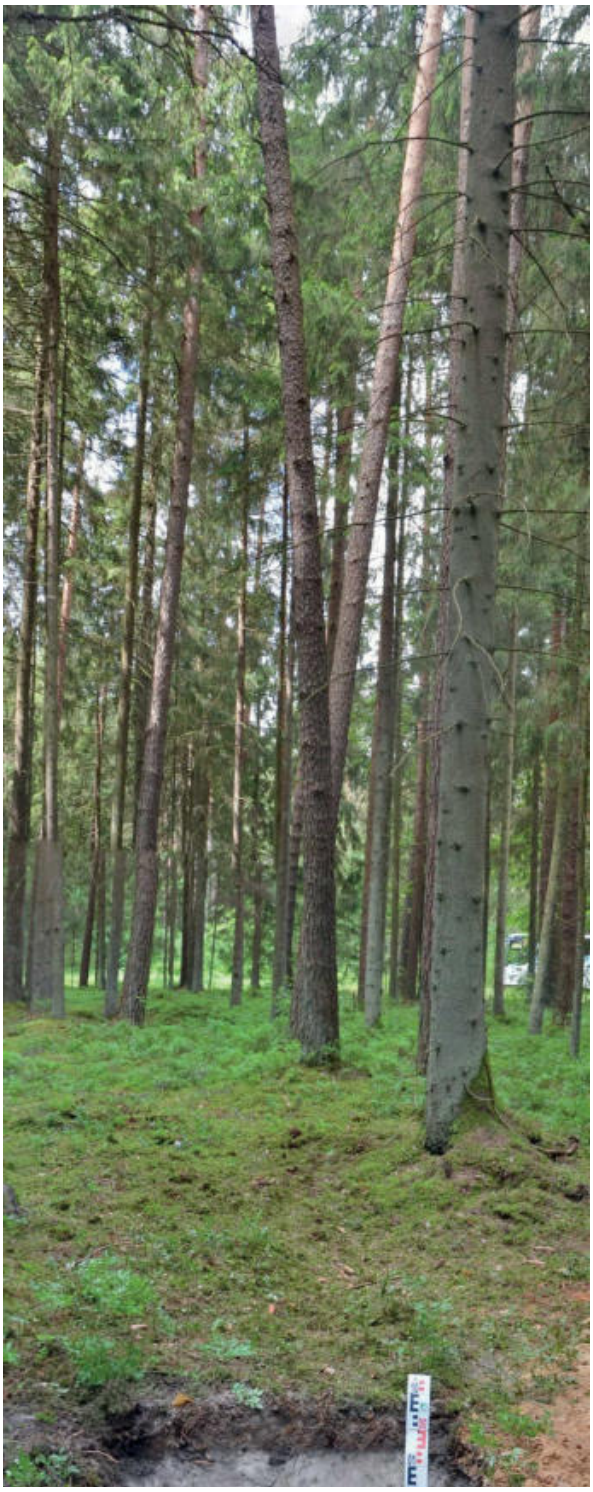
Ferralic horizon

subsurface horizon resulting from long and intense weathering.

Ferralic horizon

if the *ferralic horizon* has less hematite and a more yellowish colour, it typically shows a higher bulk density and a lower porosity.

FOLIC HORIZON



Folic horizon

predominantly occurs where low temperatures inhibit the organic debris (litter) decomposition rate (e.g. mountain areas, taiga etc.).

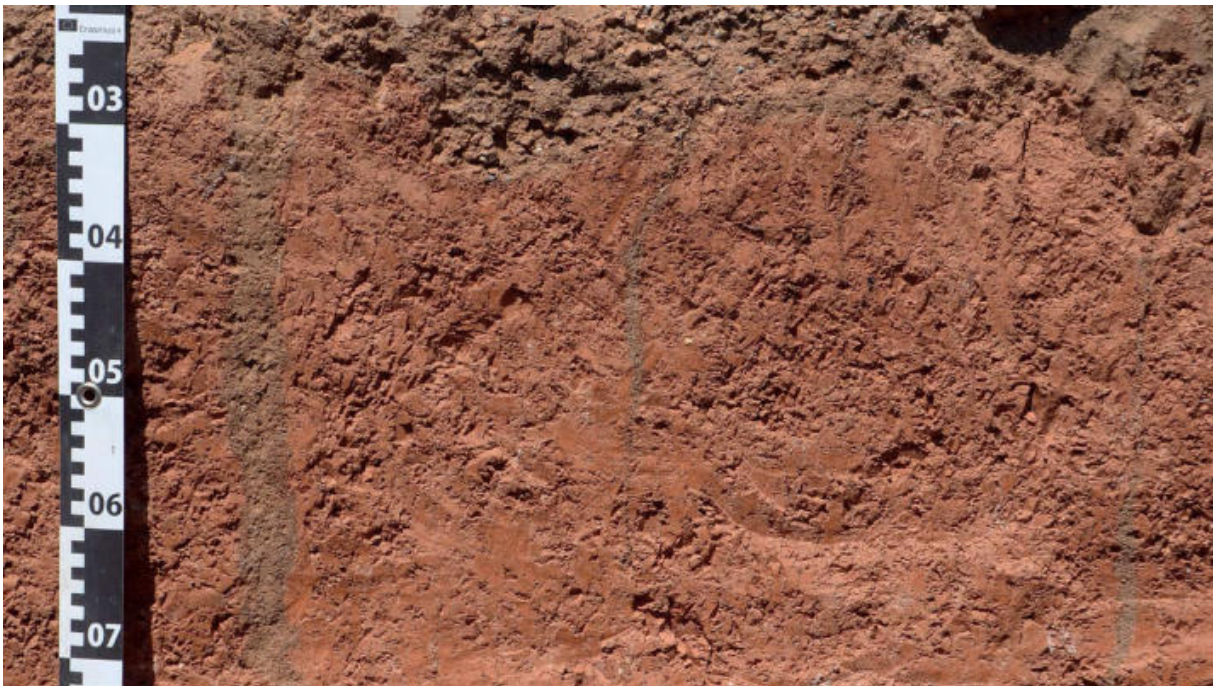
Folic horizon

develops at the soil surface, under relatively 'dry' environmental conditions (is saturated with water for <30 consecutive days in most years).

Folic horizon

has a well-aerated *organic material* with thickness of ≥10 cm.

FRAGIC HORIZON



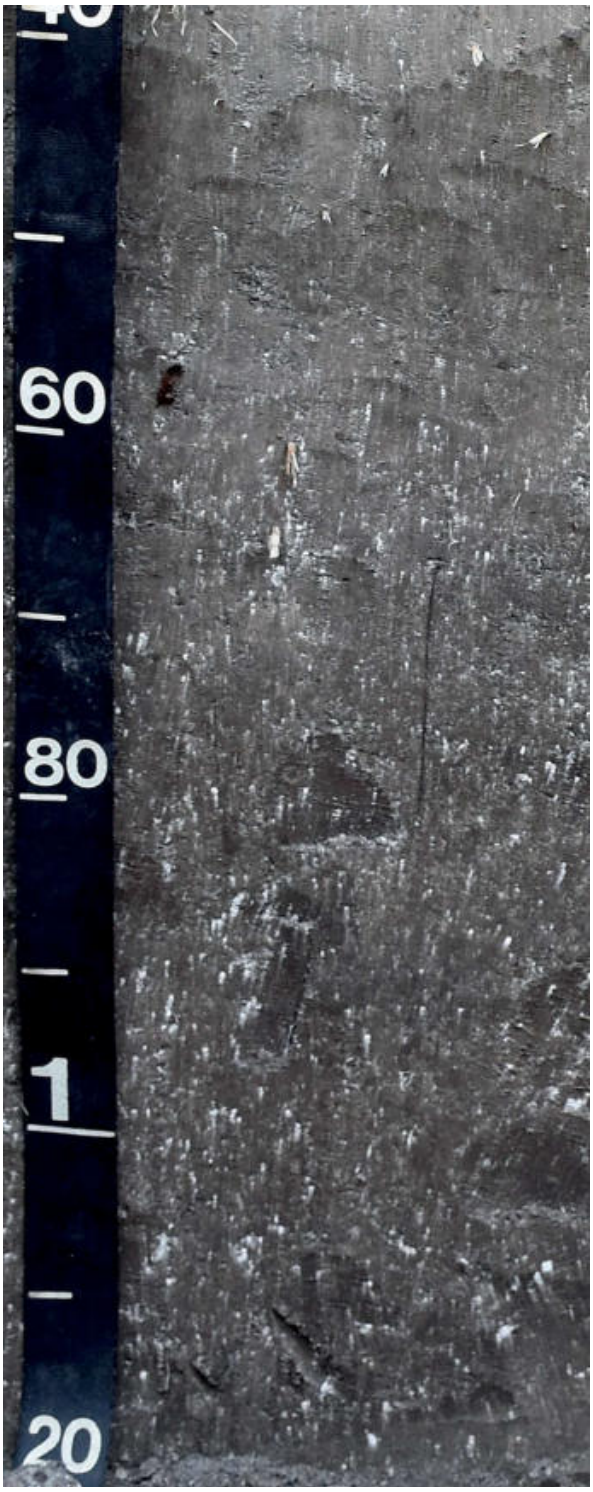
Fragic horizon

non-cemented subsurface horizon with large soil aggregates. Roots and percolating water penetrate the soil only in between these aggregates.

Fragic horizon

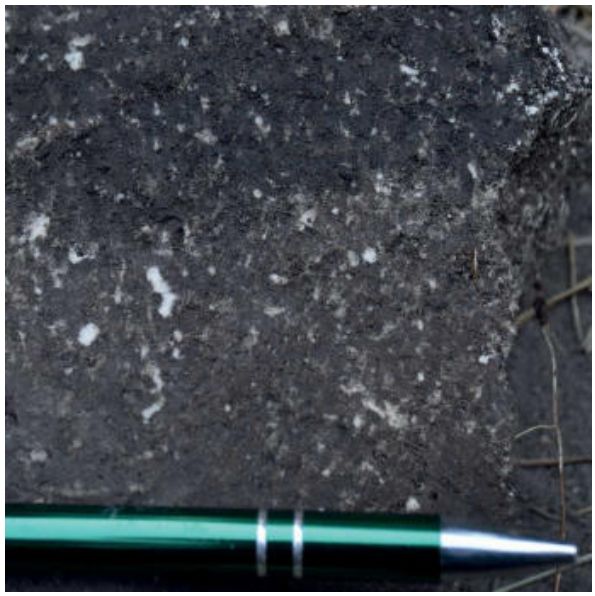
can overlap partly or completely with an *argic horizon*.

GYPSIC HORIZON



Gypsic horizon

non-cemented surface or subsurface horizon containing accumulations of secondary gypsum in various forms.



Gypsic horizon

accumulations of secondary gypsum can be visible in form of light in colour dots – concretions.

Gypsic horizon

has ≥5% gypsum – on photo in form of crystals.

HISTIC HORIZON

Histic horizon

consists of poorly aerated *organic material* with thickness of ≥10 cm accumulated at soil surface.

Histic horizon

its development is associated with waterlogged landscapes – wetlands, bogs, peatlands.

HORTIC HORIZON

Hortic horizon

humus horizon created by the human activities of deep cultivation, intensive fertilization and/or long-continued application of organic residues.

Hortic horizon

is often found in allotment gardens.

Hortic horizon

its development results from intensive agricultural treatments, usually on a small spatial scale.

LIMONIC HORIZON

Limonic horizon

strong accumulation of Fe by capillary rise in groundwater soils cause a cementation of *mineral material* – eg. sand.

Limonic horizon

is traditionally referred to as bog iron. Pieces of it have dark brown colour and behave like soft stones.

MOLLIC HORIZON

Mollic horizon

development of *mollic horizon* is often associated with grass vegetation.

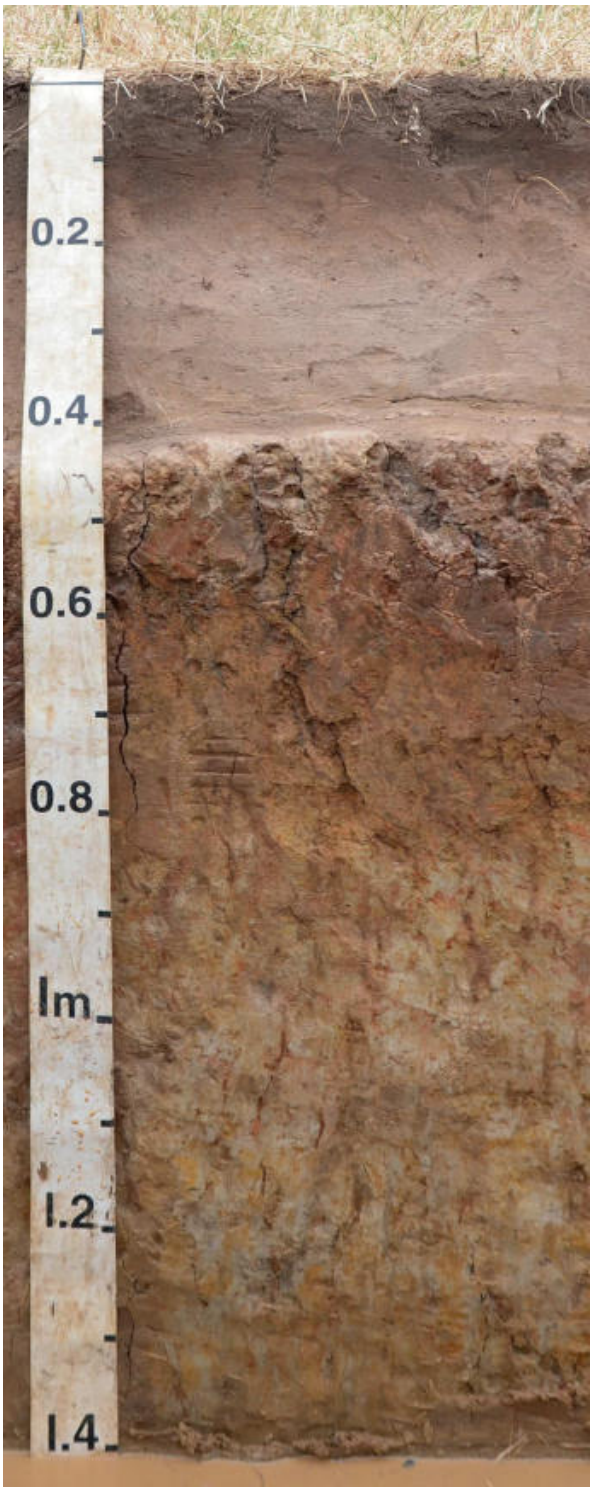
Mollic horizon

well developed thick and dark humus horizon with high base saturation.

Mollic horizon

due to high fertility most of *mollic horizons* are in agriculture use. On photo visible sharp lower boundary made by ploughing.

NATRIC HORIZON



Natric horizon

subsurface layer with distinctly higher clay content than the overlying layer and high content of exchangeable Na.

Natric horizon

apart from illuvial concentration of clay has a columnar or prismatic structure at least in some parts.

PANPAIC HORIZON

Panpaic horizon

is a buried mineral surface horizon with a significant amount of organic matter formed before having been buried. On photo almost black A horizon buried by slope processes on depth of 170–180 cm.

Panpaic horizon

is an expression of soil formation in the past, here buried by volcanic deposits.

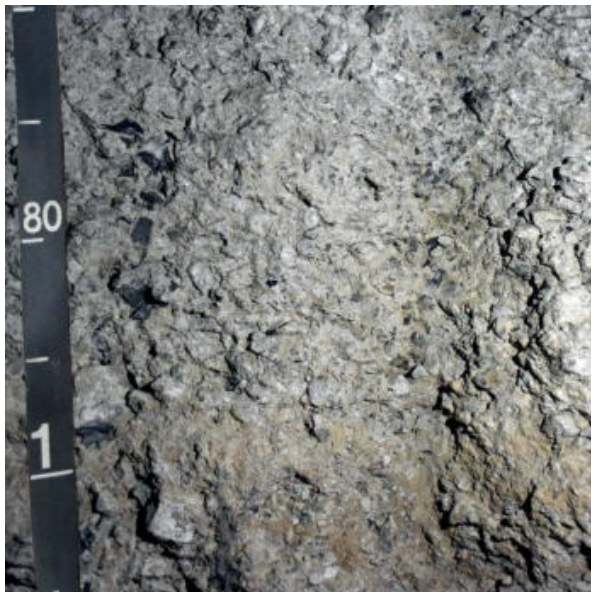
Panpaic horizon

these horizons are common in agriculture landscapes. Some of them were ploughed in the past when they were on soil surface - it is visible by sharp lower boundary.

PETROCALCIC HORIZON

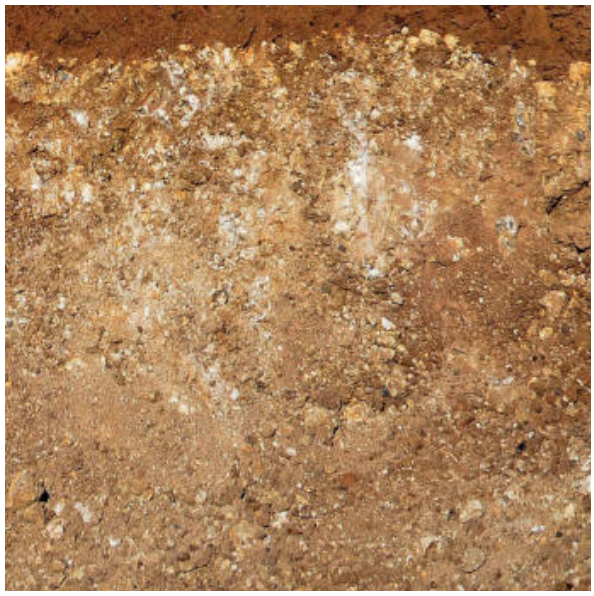
Petrocalcic horizon

cemented by calcium or magnesium carbonate. Its massive or platy structure makes it resistant for penetration.



Petrocalcic horizon

petrified massive calcrete – extremely cemented layers by secondary carbonates.



Petrocalcic horizon

also occurs as non-platy and non-massive nodular calcrete.

PETROGYPSIC HORIZON

Petrogypsic horizon

cemented horizon containing accumulations of secondary gypsum.

Petrogypsic horizon

these horizons are cemented, whitish and composed predominantly of gypsum.

PETROPLINTHIC HORIZON

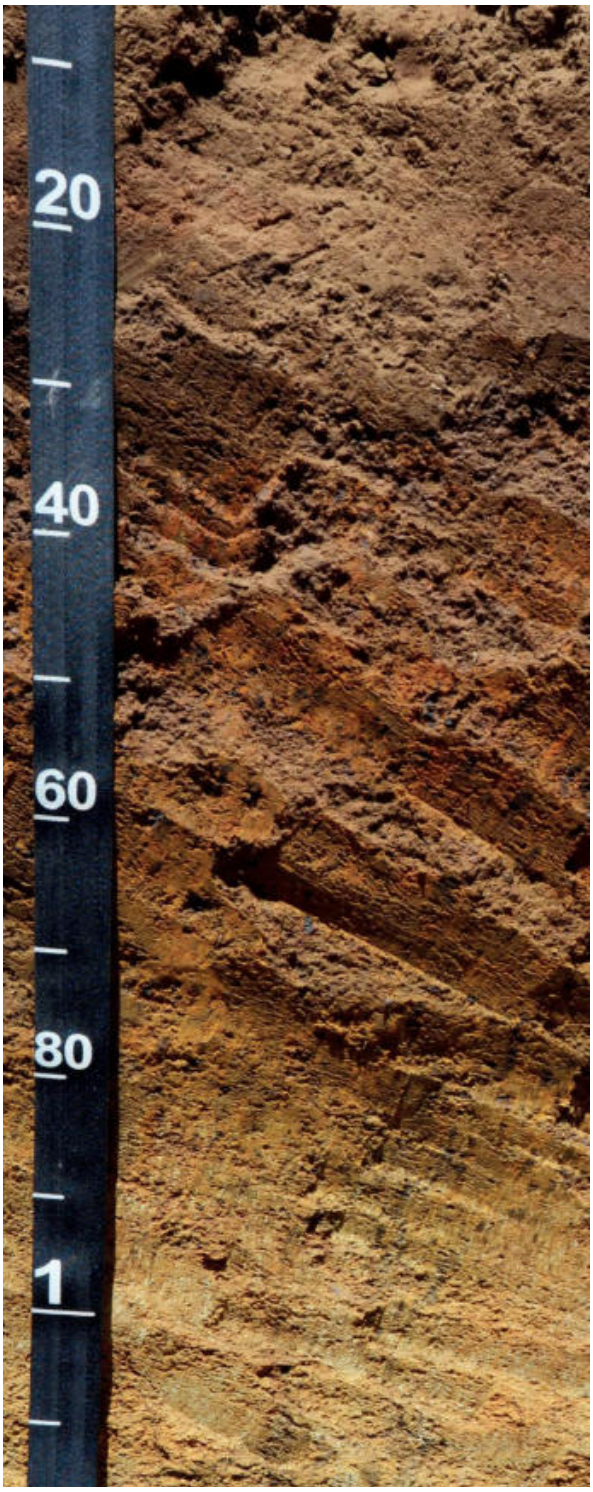
Petroplinthic horizon

is a continuous, fractured or broken layer of material cemented by Fe (and in some cases also Mn) (hydr-)oxides. Evolved in tropical climates.

Petroplinthic horizon

traditional names for such horizons are 'laterite' or 'ironstone'. Fragments of laterite on photo.

PISOPLINTHIC HORIZON



Pisoplinthic horizon
contains a large amount of concretions and/or nodules that are at least moderately cemented by Fe (and in some cases also by Mn).

Pisoplinthic horizon
reddish or blackish concretions and nodules have occupy more than 40% of exposed area but can be hardly visible from distance.

Pisoplinthic horizon
after the rain nodules and concretions of these horizons become more visible – especially in surface horizons and exposed scarps.

PROTOVERTIC HORIZON

Protovertic horizon

has swelling and shrinking clay minerals with some amount of wedge-shaped soil aggregates or some slickensides.

Protovertic horizon

in these horizons some shrink-swell cracks can be visible.

Protovertic horizon

wedge-shaped soil aggregates and slickensides may not be immediately evident if the soil is moist.

SALIC HORIZON

Salic horizon

surface horizon or a subsurface horizon at a shallow depth that contains high amounts of readily soluble salts which can be visible on soil surface as white salt crust.

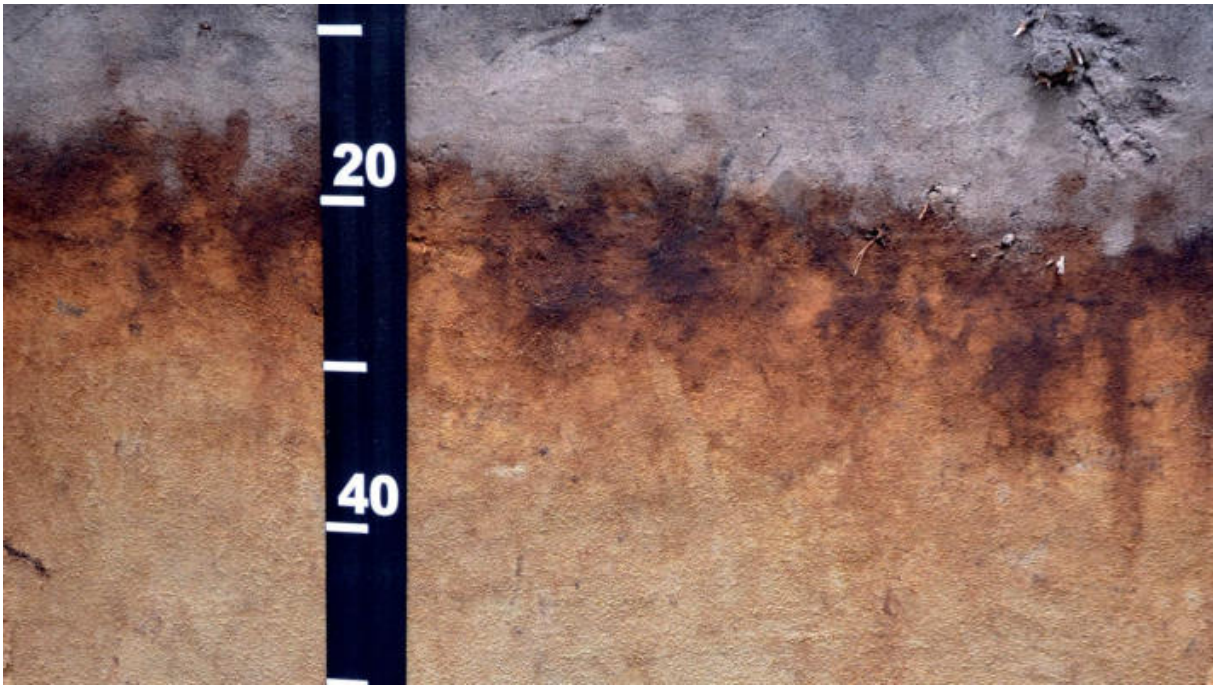
Salic horizon

salt crystal can appear on aggregate surfaces after excavation from soil and exposition to the sun.

SPODIC HORIZON

Spodic horizon

subsurface horizon containing illuvial compounds of iron, aluminium and humus, diagnostic horizon for Podzols.



Spodic horizon

in most of these horizons, the upper part is characterized by dark illuvial organic matter, when lower is more brownish – coloured by illuvial Fe oxides.

TSITELIC HORIZON

Tsitelic horizon

usually found in soils on lower slopes or in depressions. Characterized red colour is due to accumulation of Fe by lateral subsurface waterflow.

Tsitelic horizon

due to the low bulk density and the thixotropy, they may give the impression of *andic properties*, but they have neither a significant amount of allophanes and imogolites nor of Al-humus complexes.

UMBRIC HORIZON

Umbric horizon

well developed thick and dark humus horizon with relatively low base saturation.

Umbric horizon

morphologically is very similar to *mollic horizon* – pH test on field can help with distinguishing it.

VERTIC HORIZON

Vertic horizon

dominated by swelling and shrinking clay minerals, has slickensides and wedge-shaped soil aggregates.

Vertic horizon

wedge-shaped soil aggregates and slickensides may not be immediately evident if the soil is moist.

DIAGNOSTIC PROPERTIES

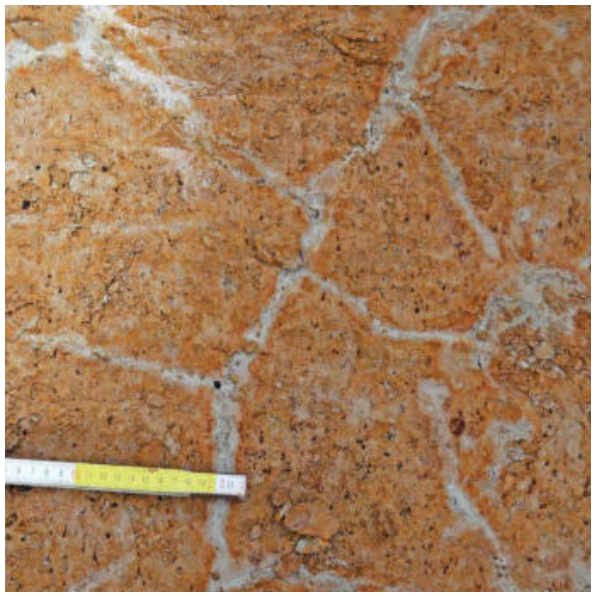
ABRUPT TEXTURAL DIFFERENCE

Abrupt textural difference
is a very sharp increase in clay content within a limited depth range.

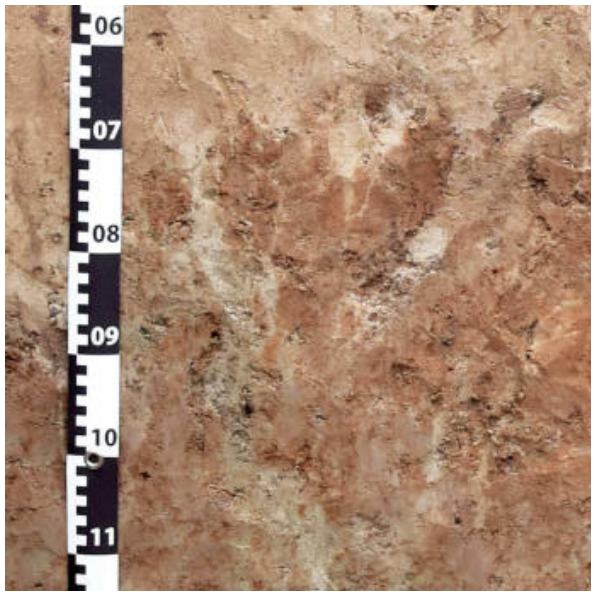
Abrupt textural difference
often is connected with *lithic discontinuity*. Here layered fluvial deposits on glacial till – both gleyed.

ALBELUVIC GLOSSAE

Albeluvic glossae
penetrations of clay- and Fe-depleted material into an *argic horizon*. Occur along soil aggregate surfaces and form vertically continuous tongues.



Albeluvic glossae
in horizontal sections, they exhibit a polygonal pattern.



Albeluvic glossae
special case of *retic properties* (stronger expression): have vertical extension of ≥30 cm; horizontal extension of ≥1 cm; and occupy ≥10 and <90% of the exposed area.

ANDIC PROPERTIES

Andic properties

weathered pyroclastic deposits with the presence of short-range-order minerals and organo-metallic complexes – in humus horizons can be difficult to recognize.

Andic properties

may be identified using the sodium fluoride field test of Fieldes and Perrott (1966).

Anthric properties

mollic or *umbric horizon* is created or heavily transformed by humans.

Anthric properties

light-coloured or humus-poor mineral A horizons may be transformed into *umbric* or *mollic horizons* by long-term cultivation but still have very little animal activity.

CONTINUOUS ROCK

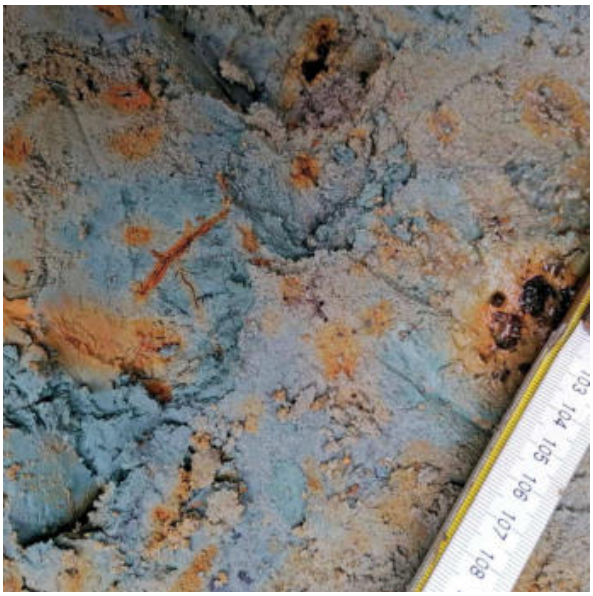
Continuous rock

consolidated material, exclusive of cemented pedogenic horizons.

Continuous rock

cracks occupy <10% (by volume) of the rock with has no significant displacement.

GLEYIC PROPERTIES



Gleyic properties

from Russian folk name gley means wet bluish clay.

Gleyic properties

saturated with flowing or upwards moving groundwater permanently or at least long enough that *reducing conditions* occur.

Gleyic properties

oximorphic features are clearly redder than the surrounding material.

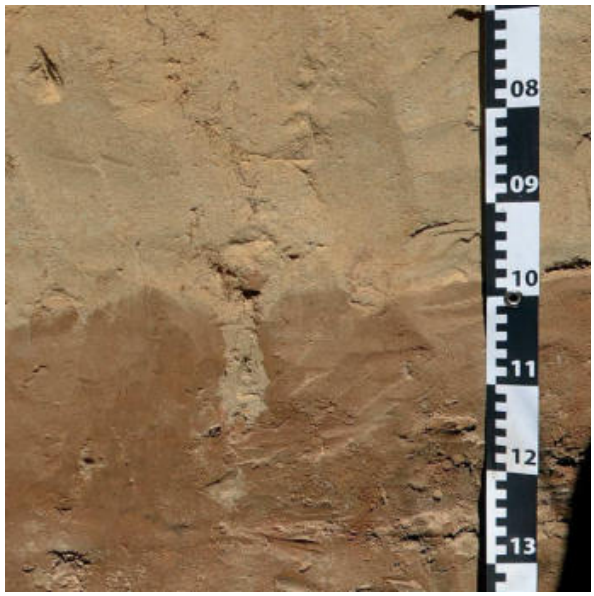
Gleyic properties

oximorphic features cover at least 5% of exposed surface and can occur predominantly on biopore walls.

LITHIC DISCONTINUITY

Lithic discontinuity

significant differences in parent material within a soil – in this case visible as sharp changing of colour on depth 80 and 140 cm.



Lithic discontinuity

can be express by abrupt difference in particle-size distribution (sand on loam on this photo).

Lithic discontinuity

upper part (up to 22 cm) is silty and has almost no coarse fragments, lower – contains mostly gravels and weathered stones.

PROTOCALCIC PROPERTIES

Protocalcic properties

carbonates derived from the soil solution and precipitated in the soil (secondary carbonates) occur across the soil structure or fabric – vertical section.

Protocalcic properties

carbonates derived from the soil solution and precipitated in the soil (secondary carbonates) occur across the soil structure or fabric – horizontal section.

RETIC PROPERTIES

Retic properties

the interfingering of coarser-textured *claric material* (lighter colours) into a finer-textured *argic* or *natric horizon* (brownish).

Retic properties

the interfingering of coarser-textured *claric material* may sometimes show *stagnic properties*.

SHRINK-SWELL CRACKS

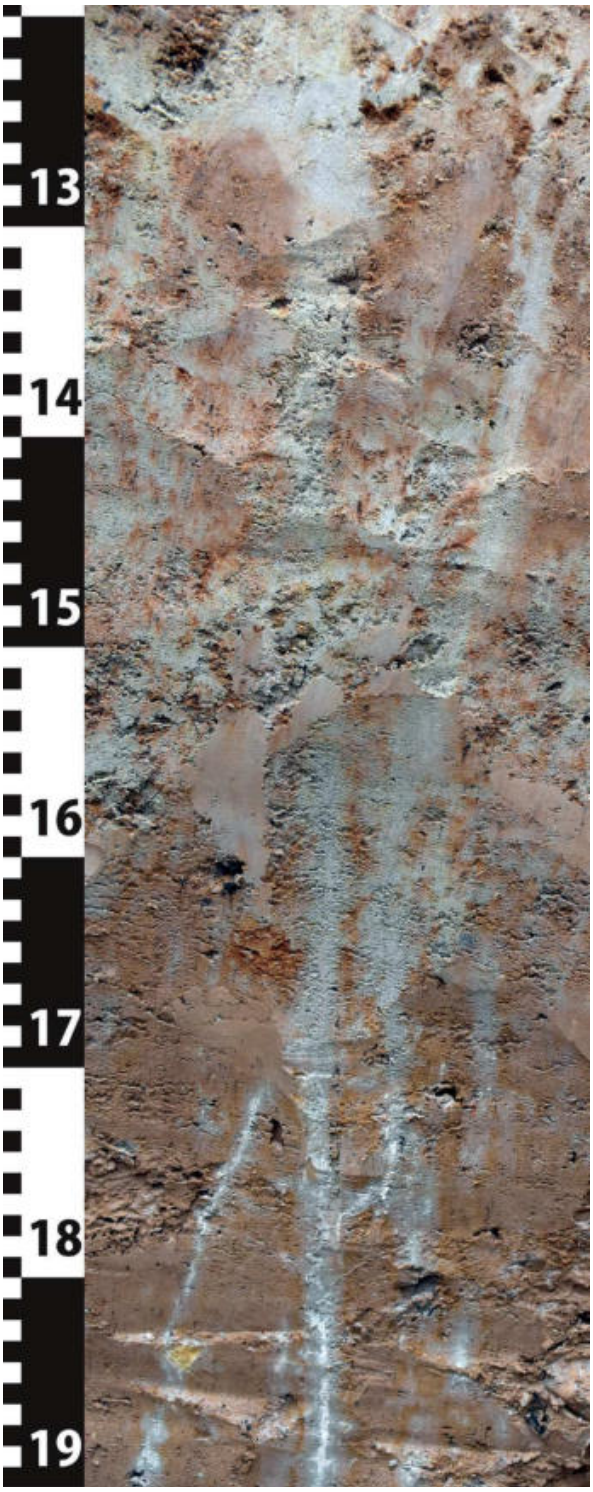
Shrink-swell cracks

vertically open and close due to shrinking and swelling of clay minerals with changing of soil moisture.

Shrink-swell cracks

may be evident also on the soil surface but only when the soil is dry.

STAGNIC PROPERTIES

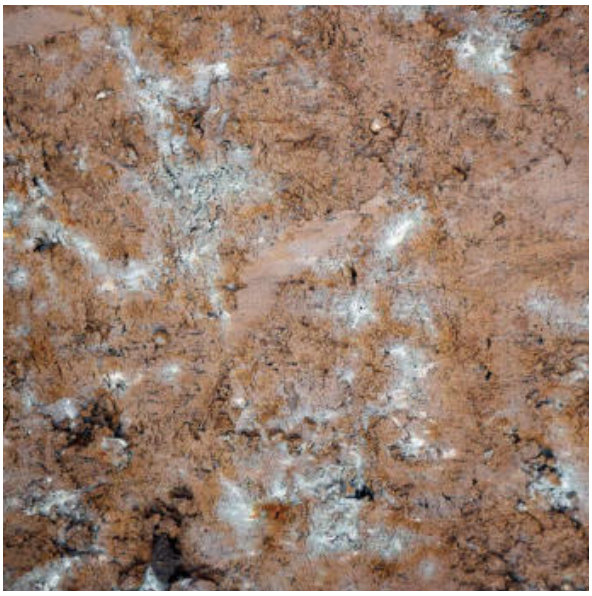


Stagnic properties

stagnation of water is long enough that allows *reducing conditions* to occur. Often visible on soil profile in form of vertical tongues along the surface of the aggregates (in lower part also filled by carbonates).

Stagnic properties

the reductimorphic features are predominantly around biopores and, if soil aggregates are present, predominantly at the outer parts of the aggregates.



Stagnic properties

the horizontal section (flat) shows the reduction of the interior of the cracks/root channels (additionally filled with secondary carbonates – whitish spots).

TAKYRIC PROPERTIES

Takyric properties

fine-textured surface crust with a platy or massive structure which occur under arid conditions in periodically flooded soils.

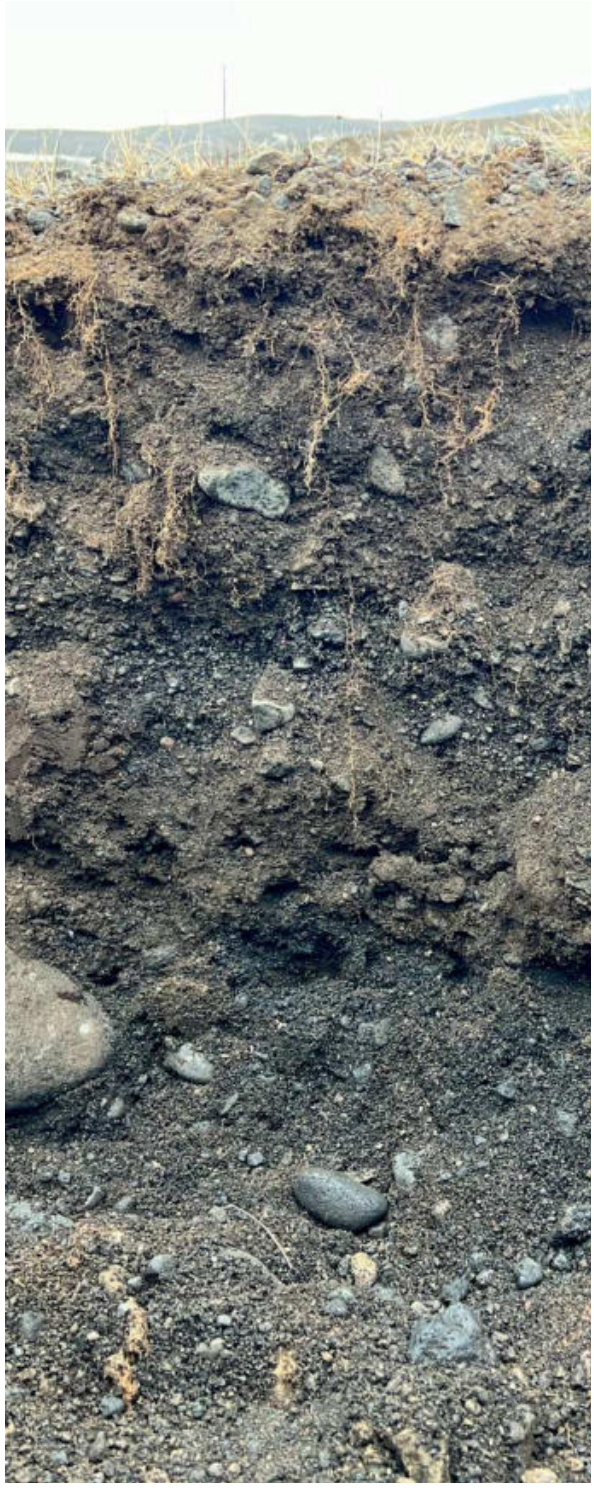
Takyric properties

when the soil is dry polygonal cracks ≥2 cm deep and with an average horizontal spacing of ≤20 cm are visible on soil surface.

VITRIC PROPERTIES

Vitric properties

glass from volcanic or industrial origin is visible (≥5% by grain count) in the fraction between >0.02 and ≤2 mm.



Vitric properties

can occur in a surface layer, have a significant amount of unaltered or slightly altered volcanic glass.

YERMIC PROPERTIES

Yermic properties

occur on the mineral soil surface in deserts where accumulation of coarse surface fragments (some are wind-shaped or varnished) covering ≥20% of the soil surface (desert pavement).

Yermic properties

vesicular pores and platy structure are also characteristic feature of this properties.

DIAGNOSTIC MATERIALS

AEOLIC MATERIAL

Aeolic material

fresh material deposited by wind with low amount of humus (OC >1%) and 10% of the particles of sand (medium and coarse) are rounded or subangular with matt surface.

Aeolic material

is typical in arid and semi-arid environments but can be also found in aeolian active areas in other climates, eg. on dunes.

CALCARIC MATERIAL

Calcaric material

contains ≥2% calcium carbonate equivalent and carbonates are at least partially primary – are inherited from the parent material.

Calcaric material

on photo carbonates are in form of an accumulation of marine molluscs' shells.

CLARIC MATERIAL

Claric material

light-coloured fine earth where sand and coarse silt grains are free of coatings.

Claric material

light colour and lack of coatings on sand grains in upper part of soil is related to the initial phase of podzolization process.

DOLOMITIC MATERIAL

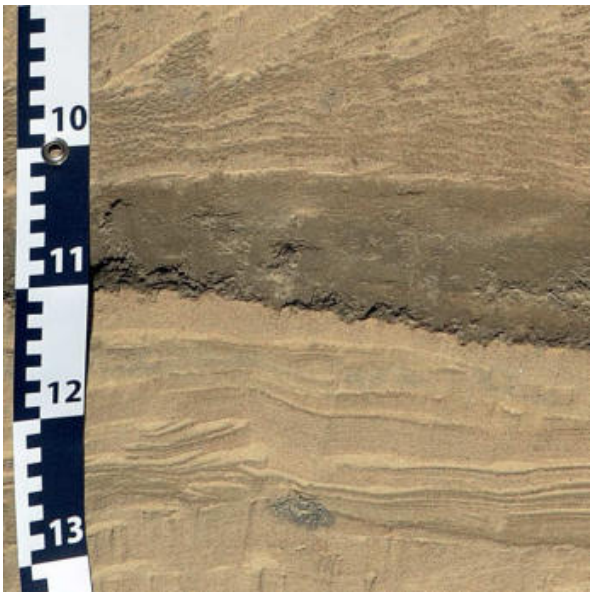
Dolomitic material

shows visible effervescence with heated 1 M HCl throughout the fine earth, with non-heated HCl, it gives only a retarded and poorly visible effervescence.

Dolomitic material

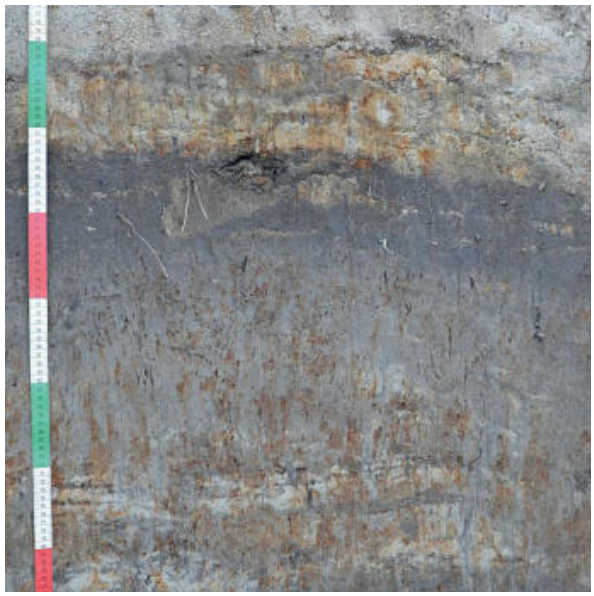
is also very irresistible to mechanical weathering. Visible sharp stones of various size. If exposed, immediately a small scree would form.

FLUVIC MATERIAL



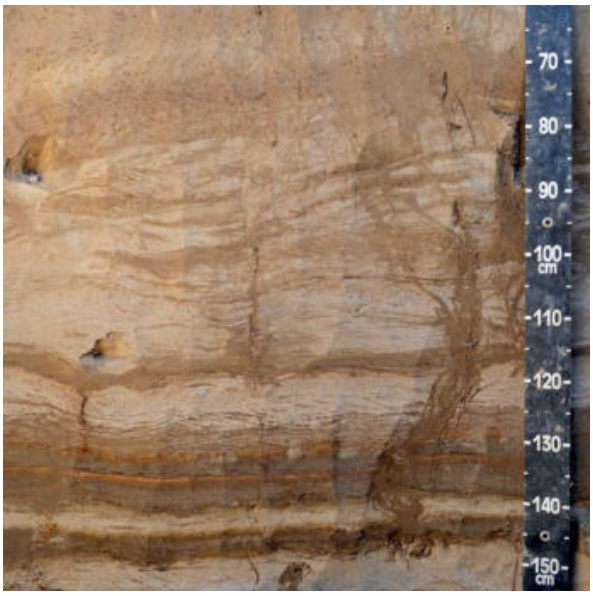
Fluvic material

fluviatile, marine or lacustrine deposits with evident stratification.



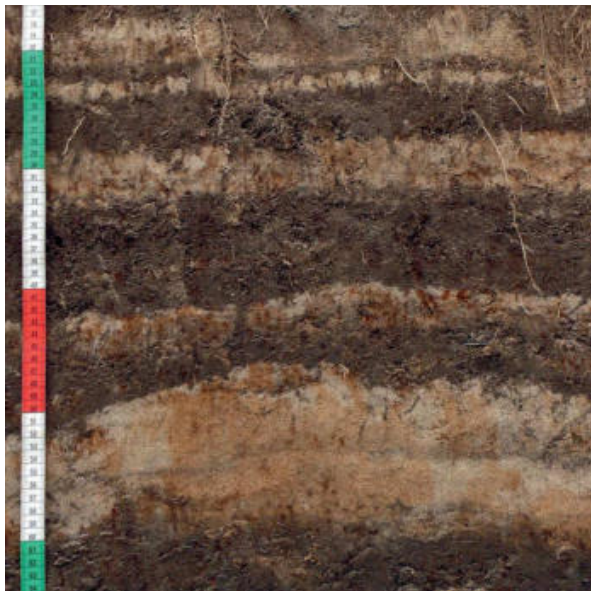
Fluvic material

shows slight soil formation after deposition. On this photo visible influence of ground water.



Fluvic material

stratification is in ≥25% (by volume).



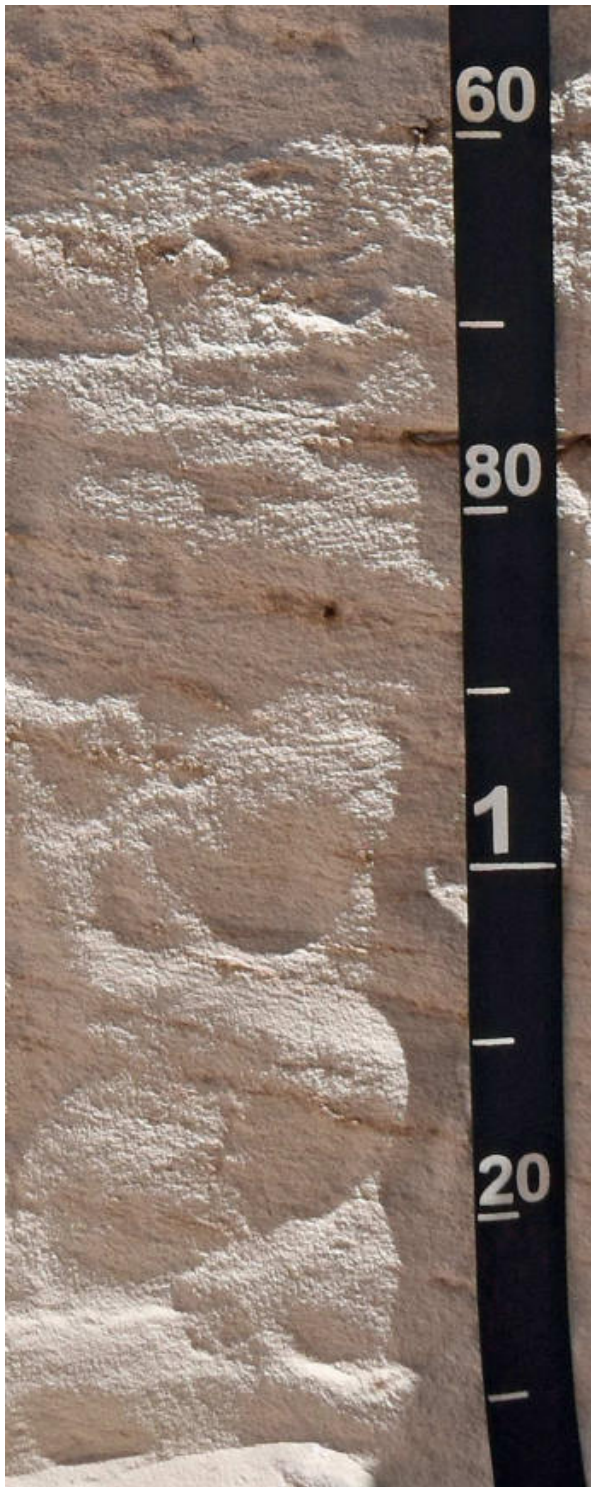
Fluvic material

has a single grain, a massive, a platy, weak subangular blocky structure or in layers with higher amounts of organic carbon (darker on photo) – granular/subangular blocky structure.

GYPSIRIC MATERIAL

Gypsiric material

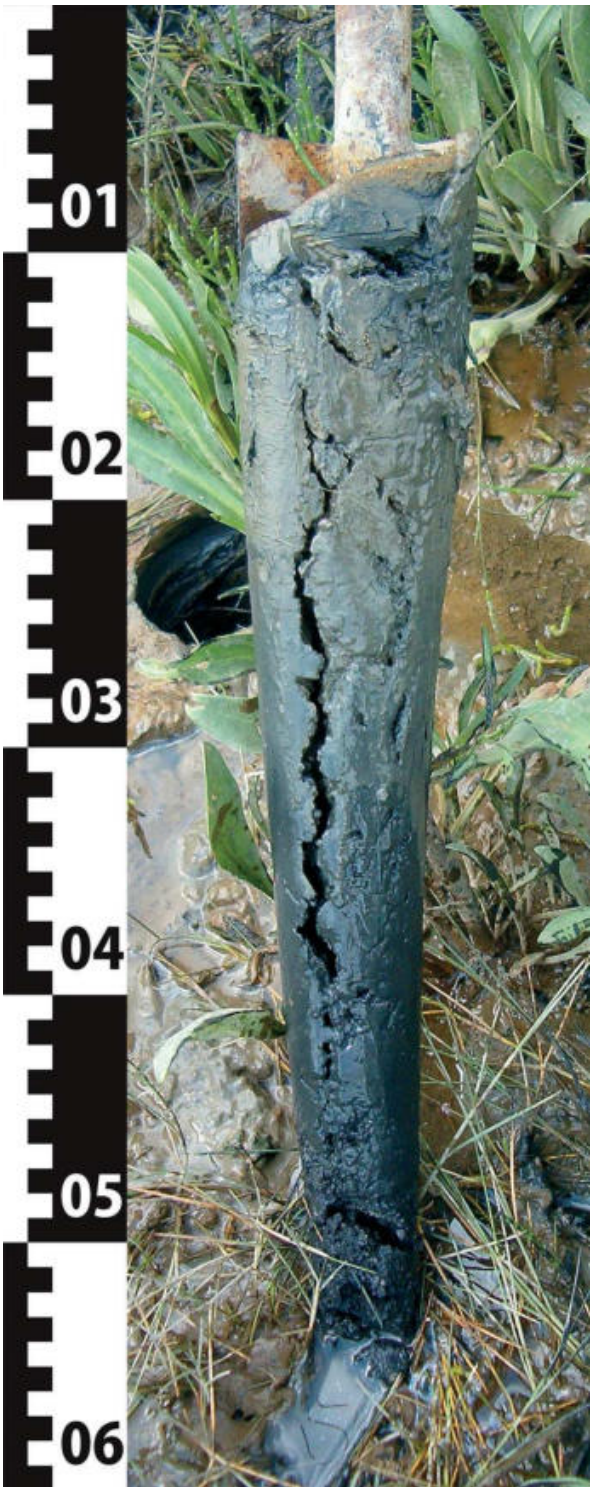
contains ≥5% gypsum that is not secondary gypsum – on photo visible gypsum solid rock.



Gypsiric material

contains ≥5% gypsum that is not secondary gypsum – on photo sand contains mainly gypsum.

HYPERSULFIDIC MATERIAL



Hypersulfidic material
containing sulfides and capable of severe acidification. Darker, lower part of presented material is due to high content of reductimorphic colours of iron sulfide (photo: Piotr Hulisz).

Hypersulfidic material
dark internal part of aggregate contains iron sulfide in *reducing conditions*. Surface is reddish due to oxidized iron compounds (photo: Piotr Hulisz).

Hypersulfidic material
effervescence and odour of hydrogen sulfide (rotten eggs) may be noticed after treated by 1 M HCl (photo: Piotr Hulisz).

LIMNIC MATERIAL

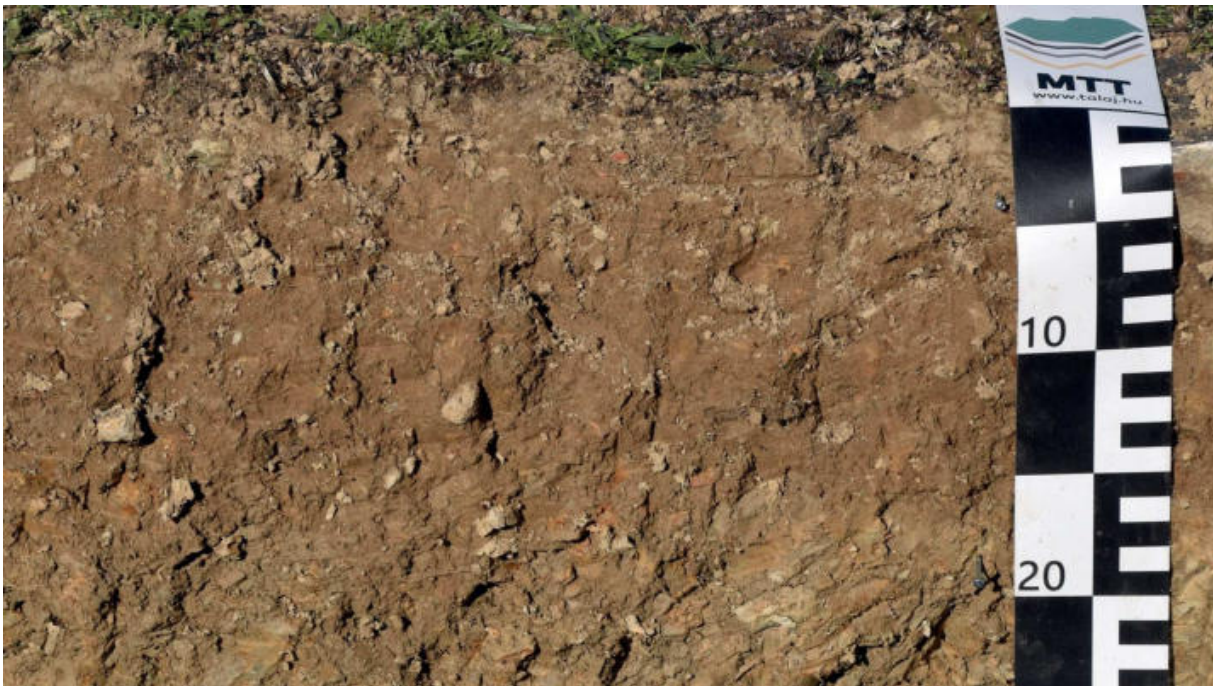
Limnic material

formed as subaquatic deposits and usually stratified – example of silt loam calcareous gyttja.

Limnic material

strongly calcareous, light in colour lacustrine marl.

MINERAL/ORGANIC MATERIAL



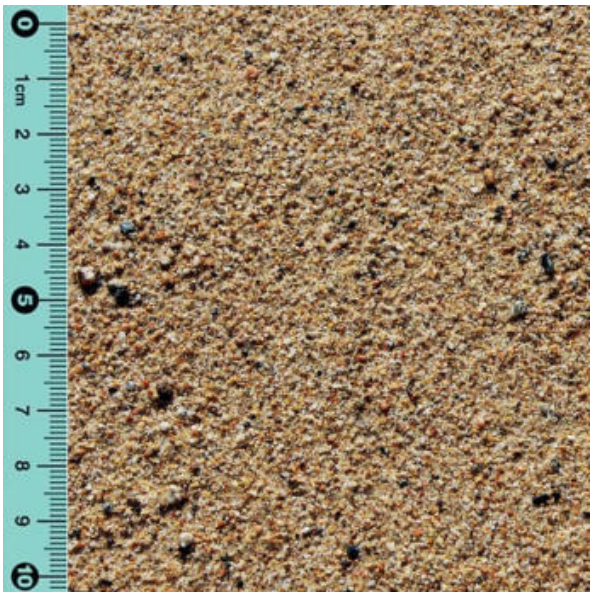
Mineral material

fine earth are dominated by mineral components – contains <20% *soil organic carbon*.

Organic material

has large amounts of organic matter (≥20% *soil organic carbon*) in the fine earth and/or contains many dead thin plant remnants.

TEXTURE CLASSES OF MINERAL MATERIALS



Sandy material

dominated by sand particles, feel gritty. Single grains are visible by naked eye. Sand, loamy sand – **Arenic** qualifier.

Loamy material

mix of sand, silt and clay. Their feel can be described as smooth or silky, and also greasy. Sandy loam, loam, sandy and silty clay loam, clay loam – **Loamic** qualifier.

Clayey material

plastic feel (like plasticine) when moulded, shiny surfaces of aggregates. Sandy clay, silty clay, clay – **Clayic** qualifier.

Silty material

possible to roll a wire of about 3–7 mm in diameter, very floury and not cohesive. Silt, silt loam – **Siltic** qualifier.

MULMIC MATERIAL

Mulmic material

soil organic carbon content eventually (after drainage) falls below 20% but still is high (≥8%).

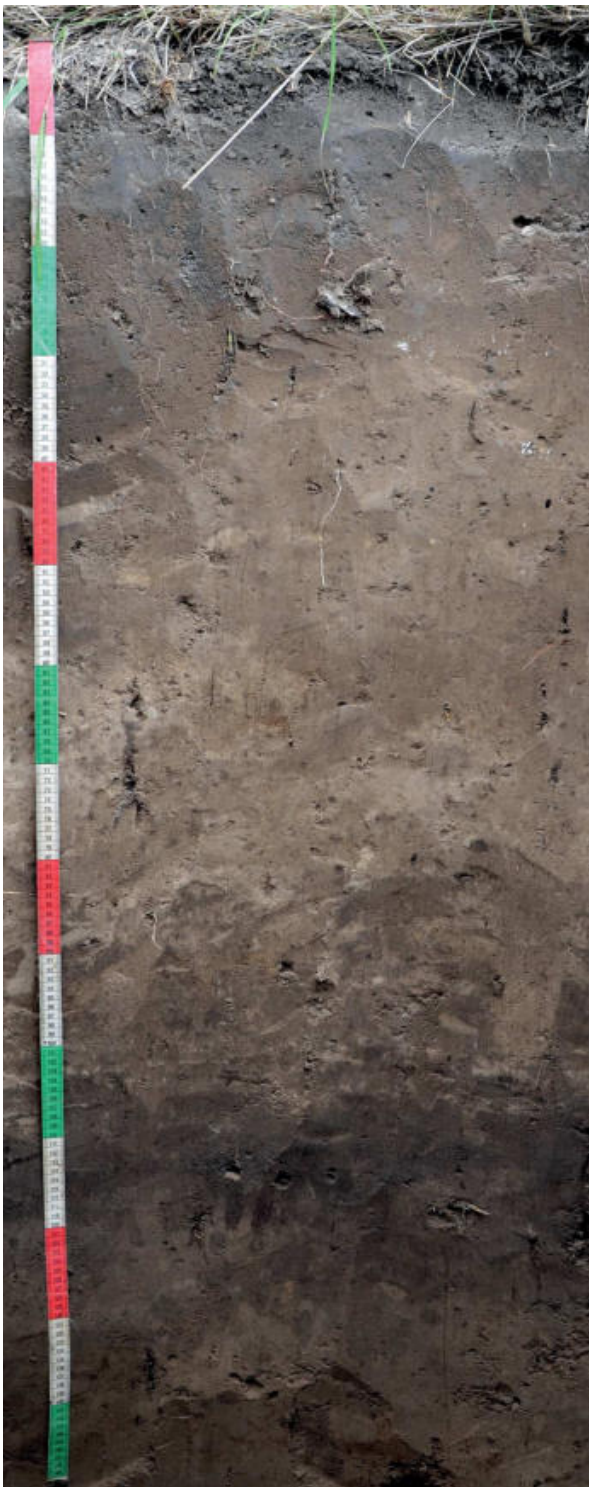
Mulmic material

is *mineral material* developed from *organic material* as a result of decomposition after drainage.

Mulmic material

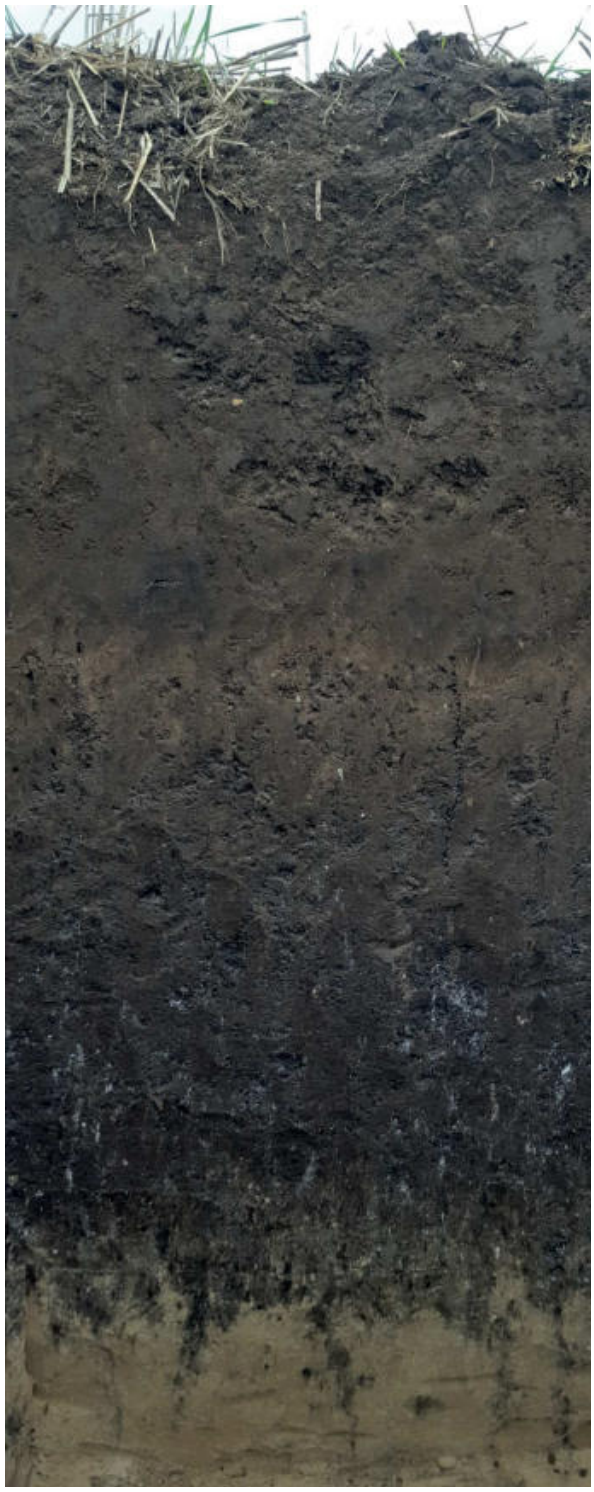
due to high amount of humus is very dark.

SOLIMOVIC MATERIAL



Solimovic material

mixed, heterogeneous material that has moved downslope – mostly by soil erosion (so-called "colluvium").



Solimovic material

often contains humus and has grey – even dark grey colours. In many cases under it buried horizons are visible.

TECHNIC HARD MATERIAL

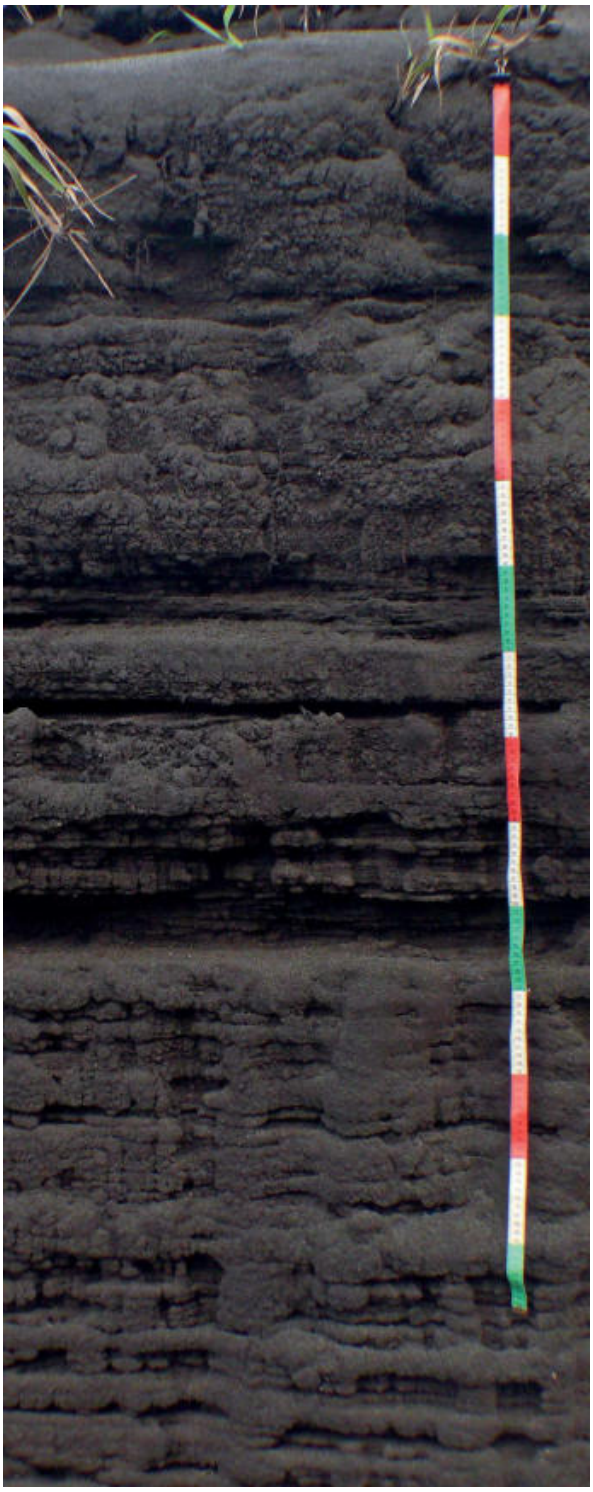
Technic hard material

consolidated material (continuous or has free space covering <5% of its horizontal extension), created or substantially modified by humans – here zone with bricks.

Technic hard material

on photo visible in lower part as concrete slab.

TEPHRIC MATERIAL



Tephric material

word tephra is derived from Greek – where means pile ash.

Tephric material

consists unconsolidated, unweathered or only slightly weathered pyroclastic products of volcanic eruptions – tephra.

Tephric material

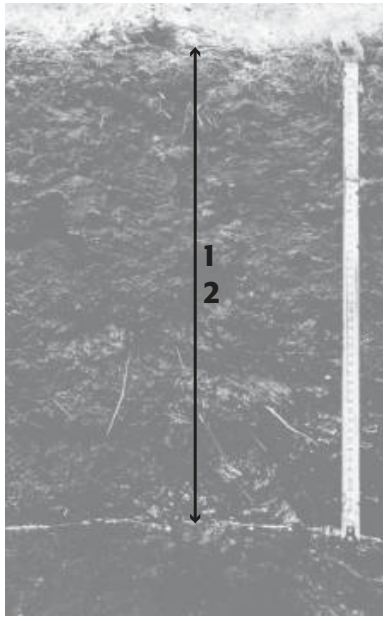
refers to the fine earth, but coarse fragments may also be present e.g. cinders, lapilli, pumice, pumice-like vesicular pyroclasts, blocks and volcanic bombs.

REFERENCE SOIL GROUPS (RSG)

The order of the RSG's in this chapter is in accordance with the Key to Reference Soil Groups:

Histosols	165	Gleysols	192	Chernozems	213	Acrisols	241
Anthrosols	169	Andosols	197	Kastanozems	216	Lixisols	243
Technosols	170	Podzols	200	Phaeozems	219	Alisols	245
Cryosols	175	Plinthosols	205	Umbrisols	226	Luvisols	246
Leptosols	177	Planosols	207	Durisols	229	Cambisols	250
Solonetz	183	Stagnosols	209	Gypsisols	231	Fluvisols	254
Vertisols	186	Nitisols	211	Calcisols	234	Arenosols	256
Solonchaks	189	Ferralsols	212	Retisols	238	Regosols	262

Hemic HISTOSOL



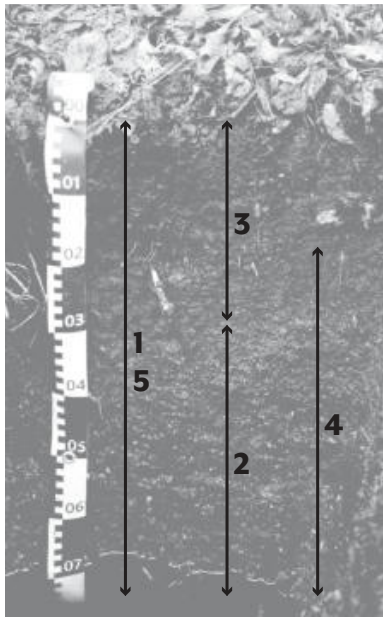
1 – HISTOSOL

organic material starting at the soil surface, having a thickness of ≥40 cm.

2 – Hemic

organic material that, after rubbing, consists of ≤ two thirds and > one sixth (by volume, related to the fine earth plus all dead plant remnants) of recognizable dead plant tissues in one or more layers with a combined thickness of ≥30 cm.

Rheic Murshic Katofibric HISTOSOL (Eutric)



1 – HISTOSOL

organic material starting at the soil surface, having a thickness of ≥40 cm.

2 – Katofibric

organic material that, after rubbing, consists of > two thirds of recognizable dead plant tissues in one or more layers with a combined thickness of ≥30 cm, starts >0 and <50 cm from the (mineral) soil surface and has its lower limit ≥100 cm.

3 – Murshic

drained *histic horizon*, with moderate to strong granular, angular or subangular blocky structure ≥20 cm thick, starting at the soil surface.

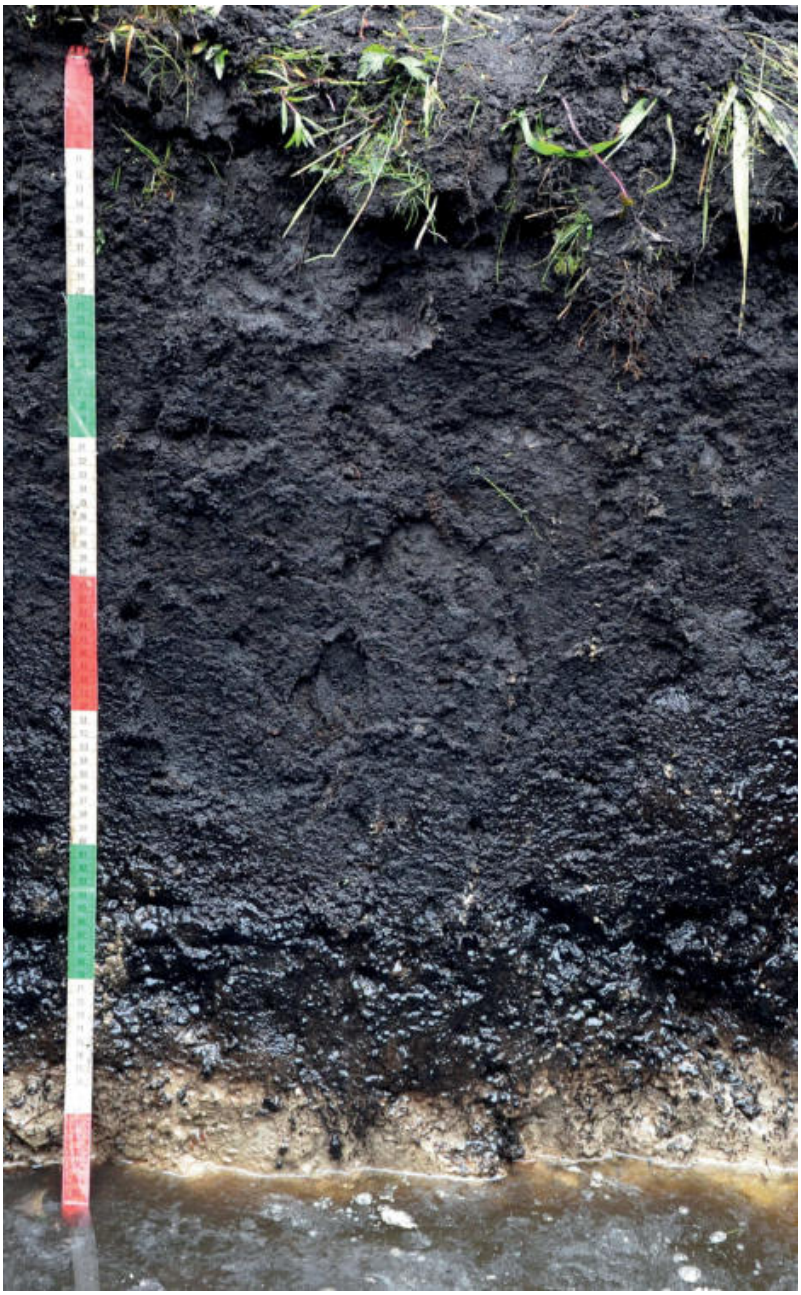
4 – Rheic

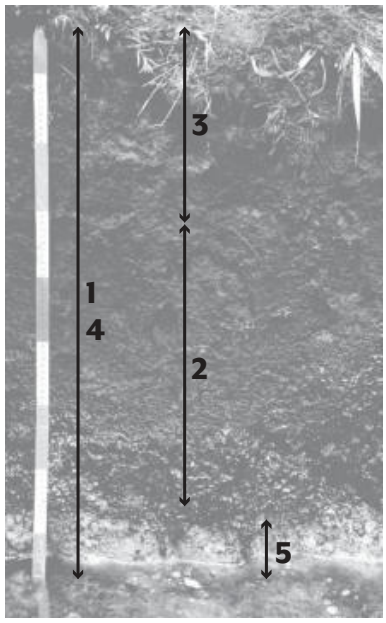
histic horizon, in which groundwater or flowing water ascends to <20 cm of the soil surface.

5 – Eutric

exchangeable (Ca+Mg+K+Na) ≥ exchangeable Al in half or more thickness between 20 and 100 cm of the mineral soil surface. Expressed by relatively high pH values.

Murshic Sapric HISTOSOL (Hypereutric, Limnic)





1 – HISTOSOL

organic material starting at the soil surface, having a thickness of ≥40 cm.

2 – Sapric

organic material that, after rubbing, consists of ≤ one sixth (by volume, related to the fine earth plus all dead plant remnants) of recognizable dead plant tissues in one or more layers with a combined thickness of ≥30 cm.

3 – Murshic

drained *histic horizon*, with moderate to strong granular, angular or subangular blocky structure ≥20 cm thick, starting at the soil surface.

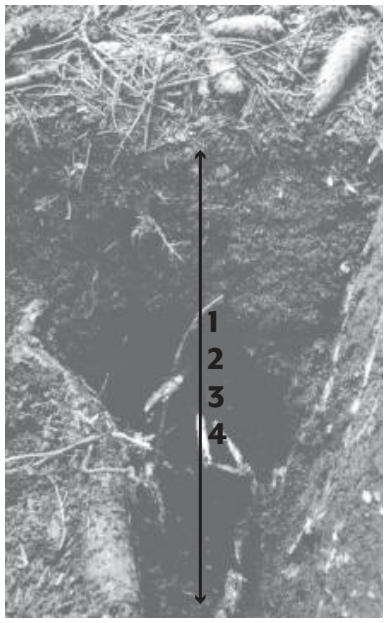
4 – Hypereutric

pH_{water} of ≥5.5 throughout in the *organic material* within 100 cm of the soil surface and ≥6.5 in the major part with *organic material* within 100 cm of the soil surface.

5 – Limnic

limnic material with thickness of ≥10 cm within 100 cm of the soil surface. Subaquatic deposits - here whitish, calcareous marl.

Folic Mawic HISTOSOL (Dystric)



1 – HISTOSOL

organic material starting at the soil surface, having a thickness of ≥40 cm.

2 – Mawic

layer of coarse fragments that, together with *organic material* starts at the soil surface and has a thickness ≥40 cm. Major part of the interstices between the coarse fragments is filled with *organic material*.

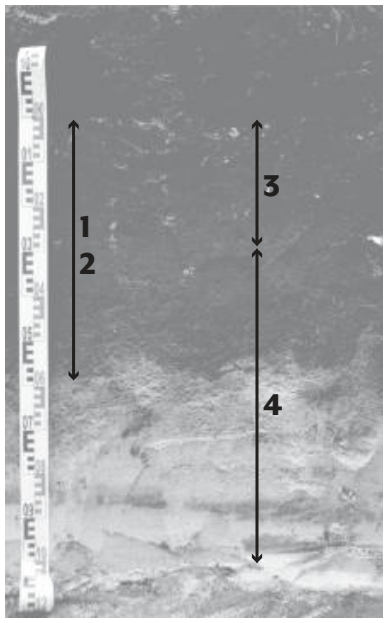
3 – Folic

folic horizon – well-aerated *organic material* (litter) at the soil surface with a thickness of ≥10 cm.

4 – Dystric

exchangeable Al > exchangeable (Ca+Mg+K+Na) in half or more thickness between 20 and 100 cm of the mineral soil surface. Expressed by low pH values.

Terric ANTHROSOL (Epiloamic, Katoarenic)



1 – ANTHROSOL

≥50 cm thick, heavily modified, well developed humus horizon due to long-term cultivation and addition of organic waste.

2 – Terric

human-made humus horizon, has ≥0.6% *soil organic carbon*, high base saturation, evidence of addition of material (land surface has been raised) but with <10% *artefacts*.

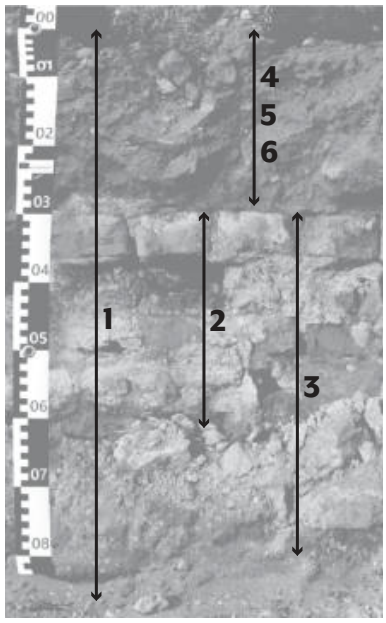
3 – Epiloamic

loamy (loam, sandy loam, clay loam, sandy clay loam or silty clay loam) material with thickness of ≥30 cm with lower limit ≤50 cm of the mineral soil surface.

4 – Katoarenic

sandy (sand, loamy sand) material starts >0 and <50 cm from the (mineral) soil surface and has its lower limit ≥100 cm of the (mineral) soil surface.

Urbic Thyric TECHNOSOL (Arenic, Ochric, Skeletic)



1 – TECHNOSOL

technic hard material – consolidated, created by humans (here brick wall) starting ≤100 cm from the soil surface.

2 – Thyric

technic hard material starting within >5 and ≤100 cm from the soil surface.

3 – Urbic

layer, ≥20 cm thick and within 100 cm of the soil surface, with ≥20% *artefacts*, ≥35% of which consist of rubble and refuse of human settlements (e.g. bricks).

4 – Arenic

texture class of sand or loamy sand in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

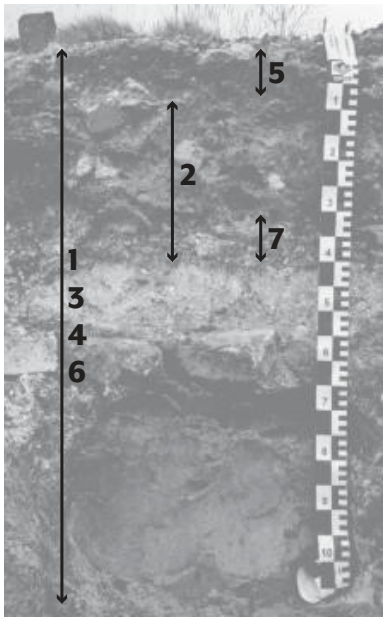
5 – Ochric

not diagnostic (too light colour) humus horizon.

6 – Skeletic

≥40% (by volume, related to the whole soil) coarse fragments averaged from the soil surface to the *technic hard material*.

Spolic TECHNOSOL (Arenic, Hyperartefactic, Ochric, Skeletic, Toxic)



1 – TECHNOSOL

≥20% (by volume, weighted average, related to the whole soil) *artefacts* in the upper 100 cm from the soil surface.

2 – Spolic

layer, ≥20 cm thick and within 100 cm of the soil surface, with ≥20% *artefacts*, ≥35% of which consist of industrial products (e.g. mine spoil, slag).

3 – Arenic

texture class of sand or loamy sand in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Hyperartefactic

≥50% (by volume, weighted average, related to the whole soil) artefacts within 100 cm of the soil surface.

5 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

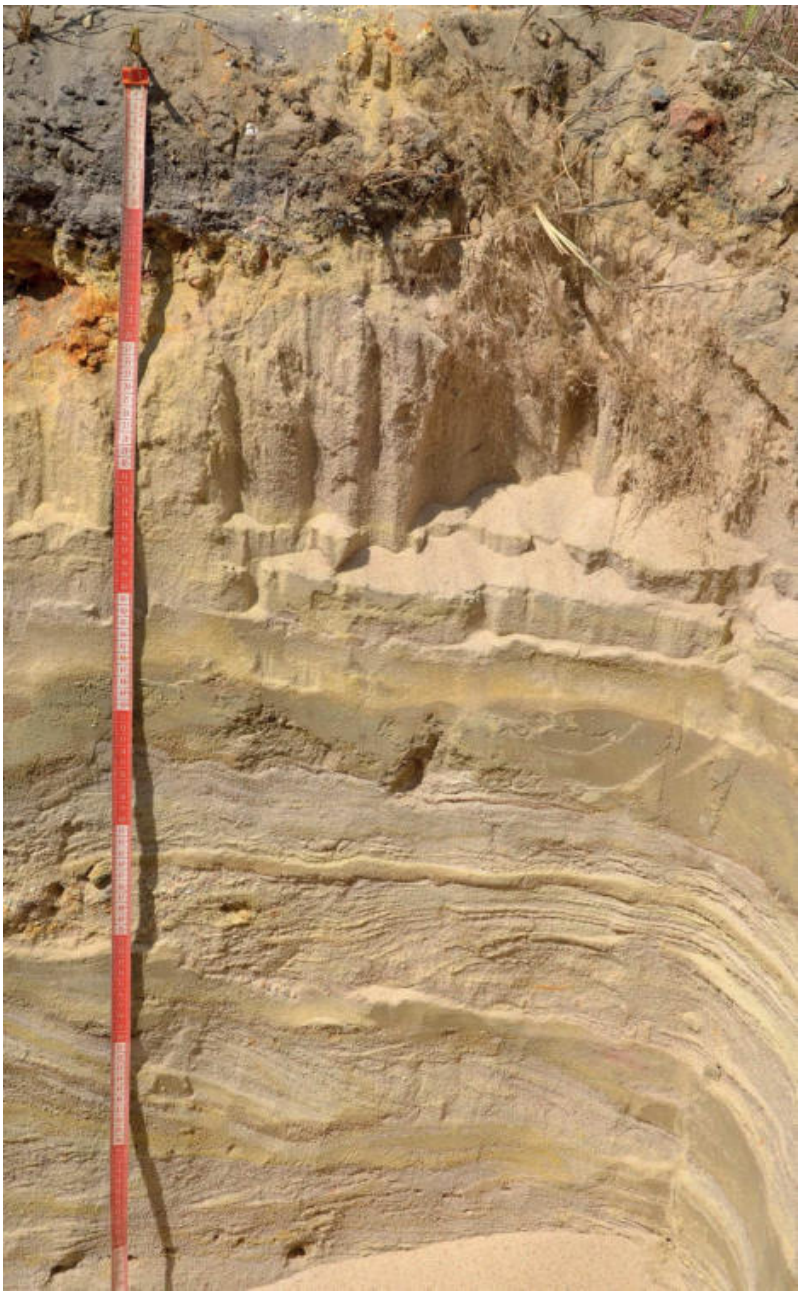
6 – Skeletic

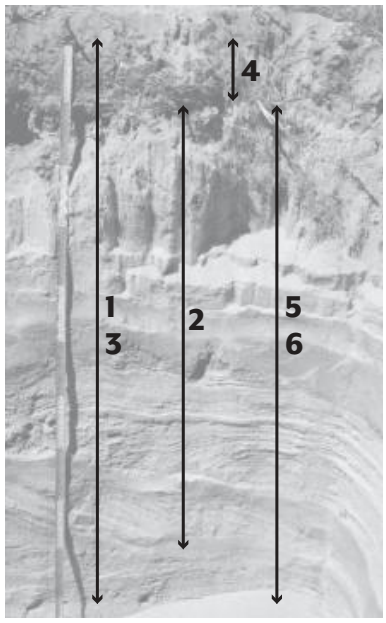
≥40% (by volume, related to the whole soil) coarse fragments averaged over a depth of 100 cm from the mineral soil surface.

7 – Toxic

toxic concentrations of organic, inorganic, or radioactive substances. Yellowish material with sulfur on photo.

Spolic TECHNOSOL (Arenic, Ochric, Hypersulfidic, Toxic)





1 – TECHNOSOL

≥20% (by volume, weighted average, related to the whole soil) *artefacts* and *technic hard material* in the upper 100 cm from the soil surface.

2 – Spolic

layer, ≥20 cm thick with ≥20% *artefacts*, ≥35% of which consist of industrial products (here sulfuric, yellowish dust).

3 – Arenic

texture class of sand or loamy sand in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

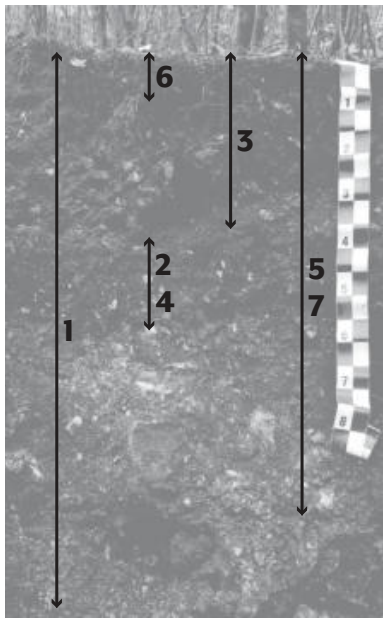
5 – Hypersulfidic

hypersulfidic material is capable of severe acidification as a result of the oxidation, ≥15 cm thick.

6 – Toxic

toxic concentrations of organic, inorganic or radioactive substances. Yellowish material with sulfur on photo.

Spolic TECHNOSOL (Loamic, Densic, Hyperartefactic, Ochric, Skeletic)



1 – TECHNOSOL

≥20% (by volume, weighted average, related to the whole soil) *artefacts* in the upper 100 cm from the soil surface.

2 – Spolic

layer, ≥20 cm thick and within 100 cm of the soil surface, with ≥20% *artefacts*, ≥35% of which consist of industrial products (e.g. mine spoil, slag).

3 – Loamic

loamy material in layer(s) with a combined thickness of ≥ 30 cm, occurring within 100 cm of the mineral soil surface.

4 – Densic

within 50 cm of the mineral soil surface a layer with a bulk density to the extent that roots cannot enter, except along cracks.

5 – Hyperartefactic

≥50% (by volume, weighted average, related to the whole soil) *artefacts* within 100 cm of the soil surface.

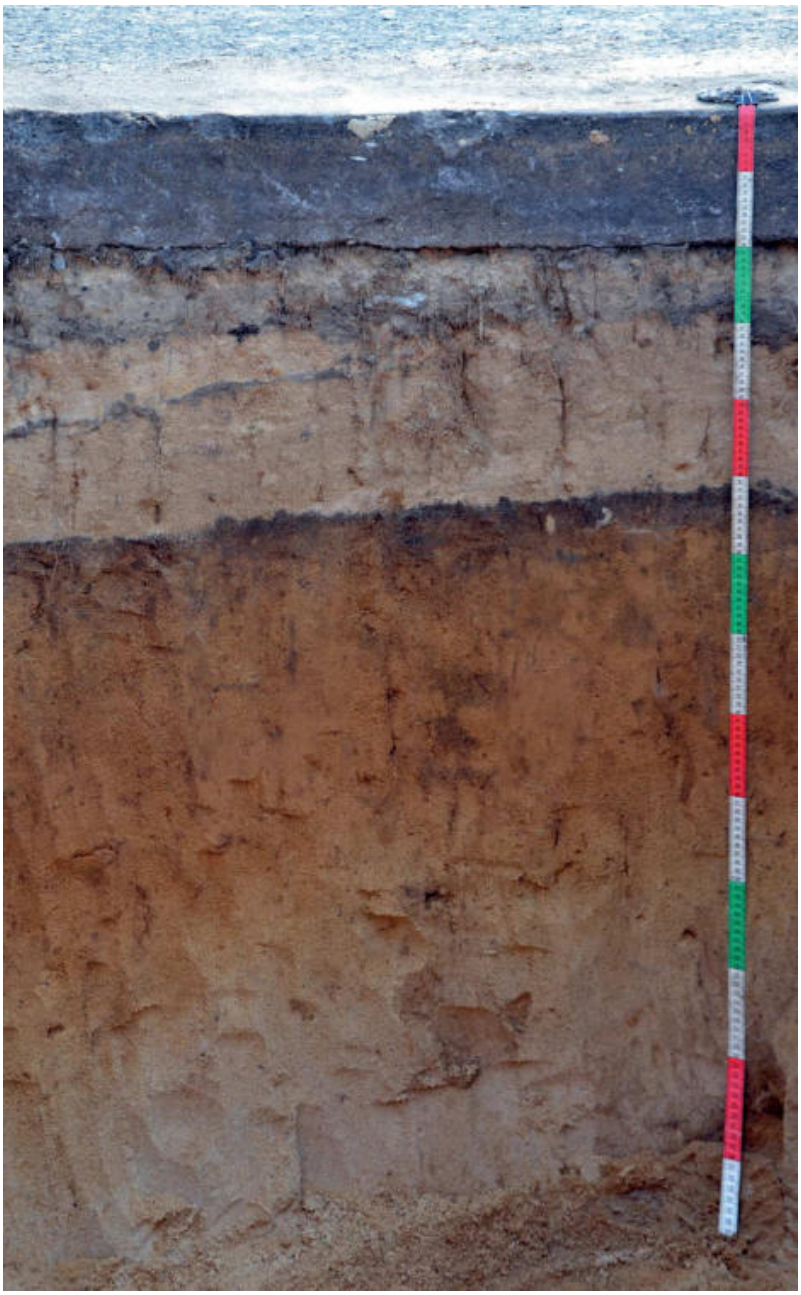
6 – Ochric

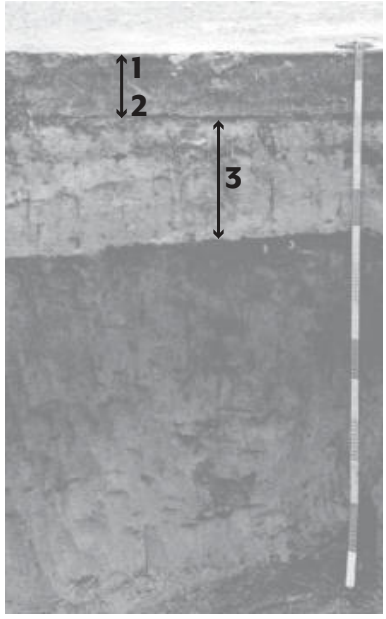
weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

7 – Skeletic

≥40% (by volume, related to the whole soil) coarse fragments averaged over a depth of 100 cm from the mineral soil surface.

Ekranic TECHNOSOL (Arenic) over Brunic ARENOSOL (Ochric)





1 – TECHNOSOL

continuous, very slowly permeable to impermeable, constructed geomembrane or *technic hard material*, starting ≤100 cm from the soil surface.

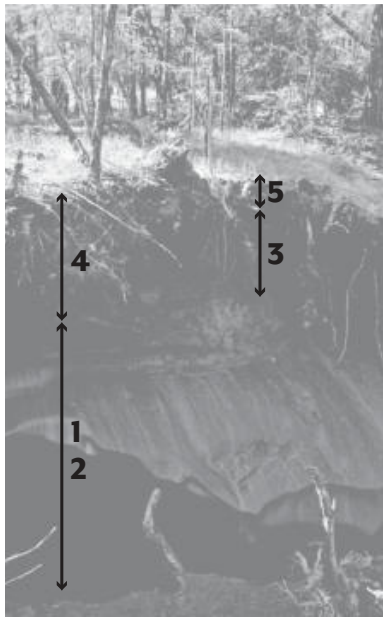
2 – Ekranic

technic hard material (concrete slab in this case) starting ≤5 cm from the soil surface.

3 – Arenic

texture class of sand or loamy sand in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

Cambic Glacic CRYOSOL (Loamic, Ochric)



1 – CRYOSOL

cryic horizon – in this case massive ice, starting ≤100 cm from the soil surface.

2 – Glacic

layer, ≥30 cm thick and starting ≤100 cm from the soil surface, containing ≥75% ice

3 – Cambic

cambic horizon starting ≤50 cm from the mineral soil surface. Higher oxide contents visible by more intensive colour than this underlying layer. Soil aggregate structure at least in half of the volume of the fine earth.

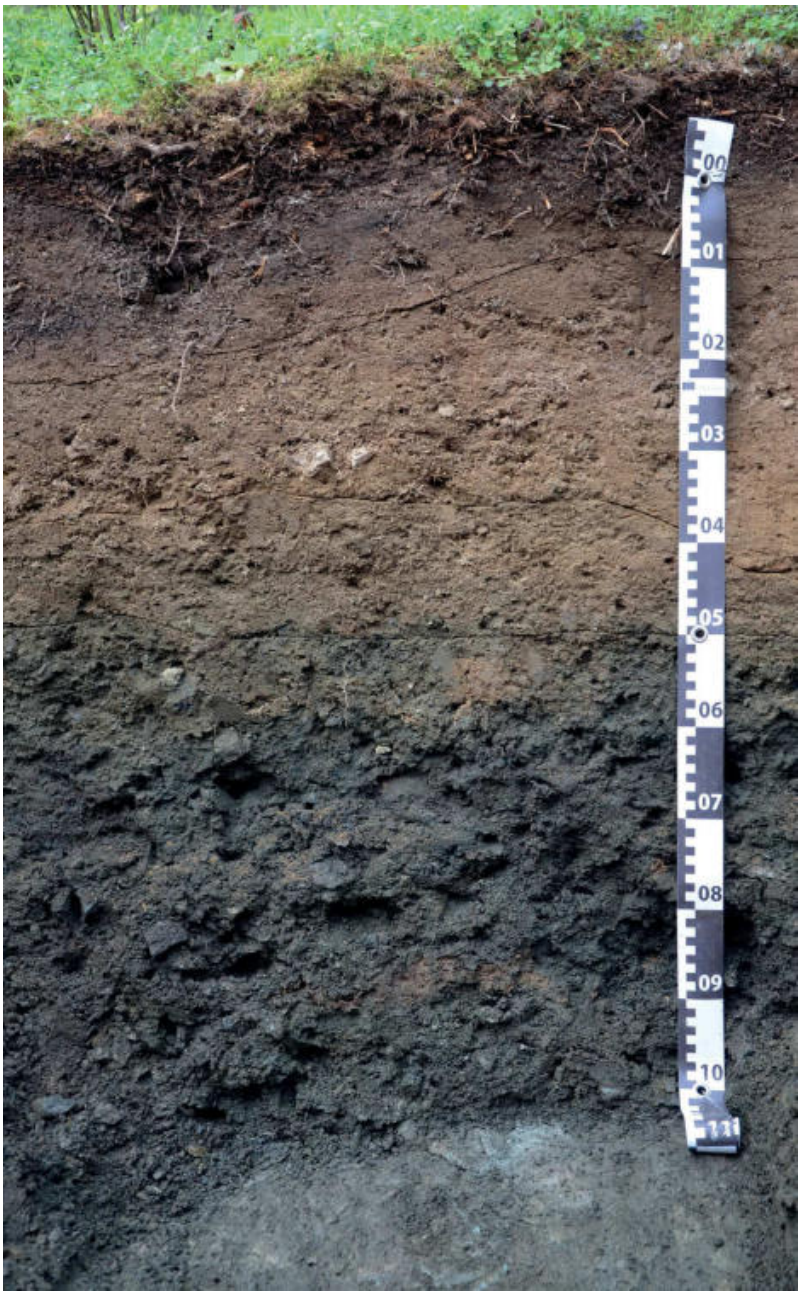
4 – Loamic

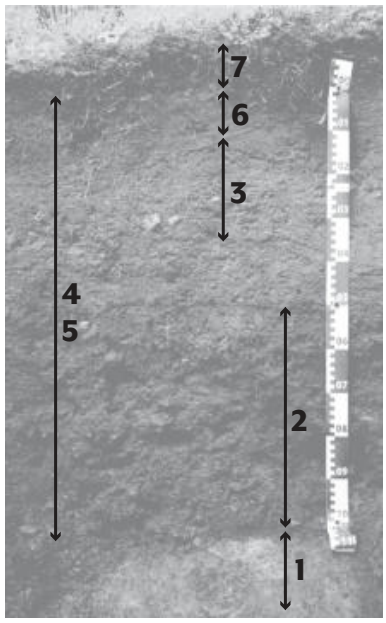
texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

5 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Skeletic Cambic Reductaquic CRYOSOL (Loamic, Folic, Ochric)





1 – CRYOSOL

cryic horizon – in this soil profile *mineral material* cemented by ice, starting ≤100 cm from the soil surface.

2 – Reductaquic

above a *cryic horizon* a layer (≥25 cm thick) that is saturated with water during the thawing period - at some time of the year *reducing conditions*.

3 – Cambic

cambic horizon starting ≤50 cm from the mineral soil surface. Higher oxide contents visible by more intensive colour than this underlying layer.

4 – Skeletic

≥40% (by volume, related to the whole soil) coarse fragments averaged over a depth of 100 cm from the mineral soil surface.

5 – Loamic

loamy material with thickness of ≥30 cm with lower limit ≤50 cm of the mineral soil surface.

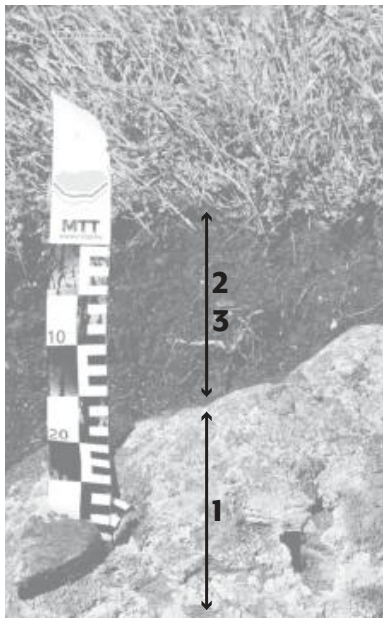
6 – Folic

well-aerated *organic material* (litter) at the soil surface with a thickness of ≥10 cm.

7 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Mollic LEPTOSOL (Loamic)



1 – LEPTOSOL

continuous rock starting ≤25 cm from the soil surface.

REMARK

mollic horizon is overlaying basalt rocks – that is why Somerirendzic qualifier can not be used here.

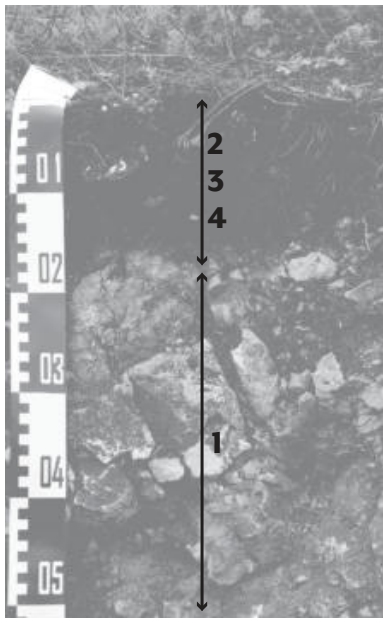
2 – Mollic

mollic horizon – dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and high base saturation. Thickness ≥10 cm is enough because it directly overlies *continuous rock*.

3 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in the major part between the mineral soil surface and a *continuous rock*.

Somerirendzic LEPTOSOL (Siltic, Humic)



1 – LEPTOSOL

continuous rock starting ≤25 cm from the soil surface.

2 – Somerirendzic

mollic horizon, <20 cm thick, that directly overlies calcareous rock containing ≥40% calcium carbonate.

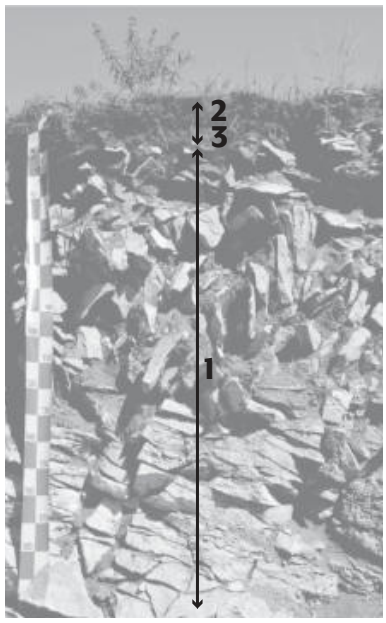
3 – Siltic

texture class of silt or silt loam in the major part between the mineral soil surface and a *continuous rock*.

4 – Humic

≥1% *soil organic carbon* as a weighted average to a depth of 50 cm. In this case it was over 6% in A horizon (0-18 cm).

Rendzic Coarsic LEPTOSOL (Loamic)



1 – LEPTOSOL, Coarsic

having <20% (by volume, related to the whole soil) fine earth, averaged over a depth of 75 cm from the soil surface.

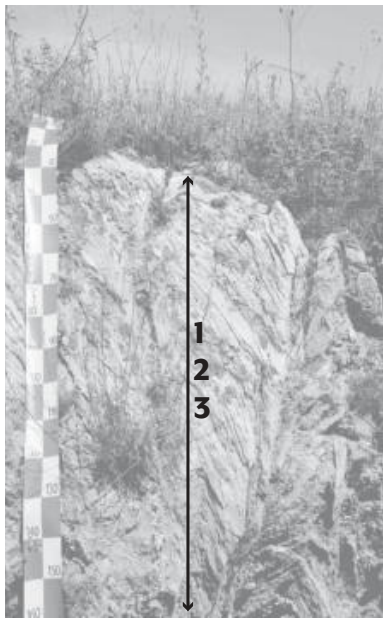
2 – Rendzic

mollic horizon that contains or directly overlies calcareous rock containing ≥40% calcium carbonate equivalent.

3 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in the major part between the mineral soil surface and a *continuous rock*.

Gypsiric Lithic LEPTOSOL



1 – LEPTOSOL

continuous rock starting ≤25 cm from the soil surface.

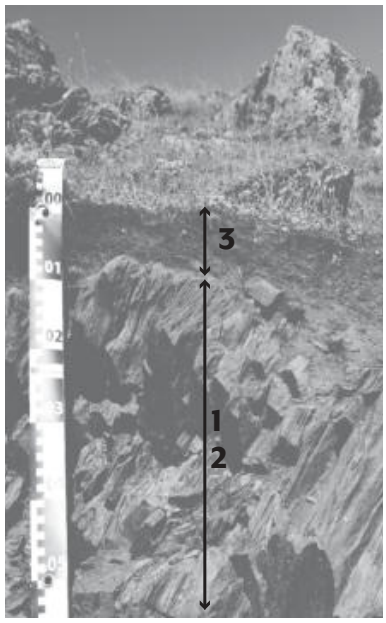
2 – Lithic

continuous rock starting ≤10 cm from the soil surface.

3 – Gypsiric

gypsiric material contains ≥5% gypsum that is not secondary gypsum - here gypsum rock.

Lithic LEPTOSOL (Ochric)



1 – LEPTOSOL

continuous rock starting ≤25 cm from the soil surface.

2 – Lithic

continuous rock starting ≤10 cm from the soil surface.

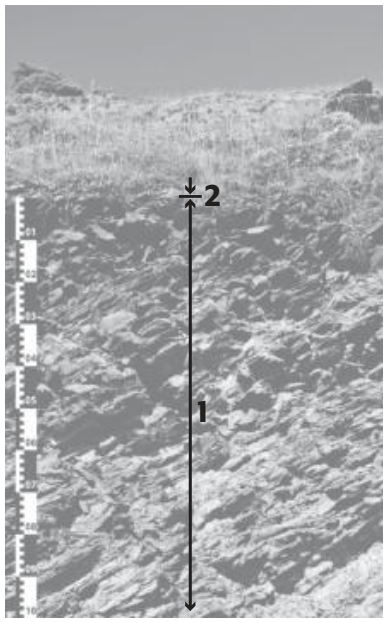
3 – Ochric

weakly developed, thin humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Nudilithic LEPTOSOL

2 – Nudilithic

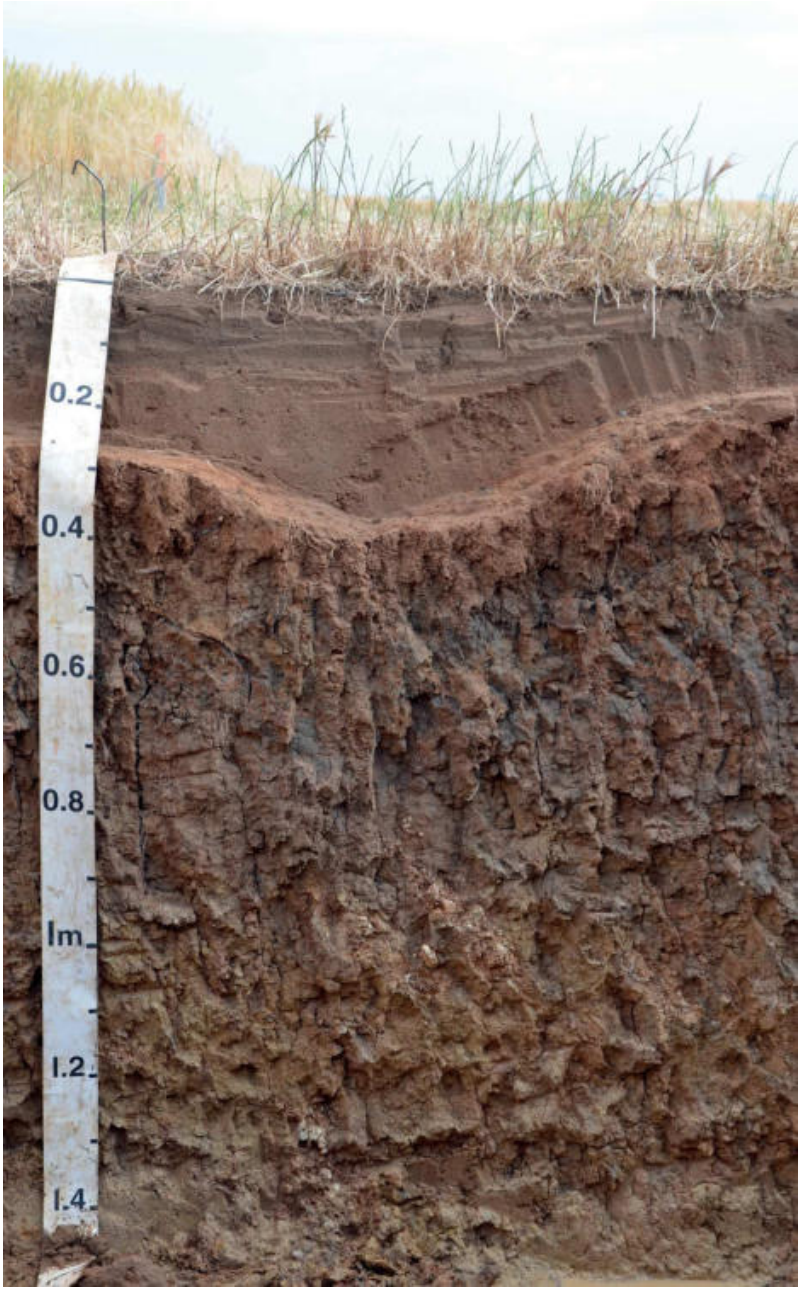
continuous rock at the soil surface.

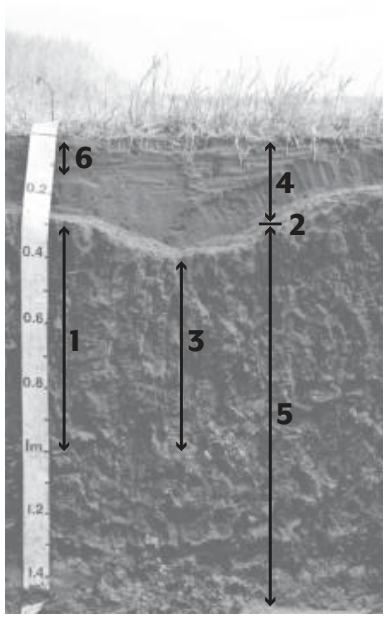


1 – LEPTOSOL

continuous rock starting ≤25 cm from the soil surface.

Vertic Abruptic SOLONETZ (Epiloamic, Katoclayic, Ochric)





1 – SOLONETZ

natric horizon with a distinctly higher clay content than in the overlying horizon and with high content of exchangeable Na, starting ≤100 cm from the mineral soil surface.

2 – Abruptic

abrupt textural difference (here loam on clay) within 100 cm of the mineral soil surface.

3 – Vertic

clay-rich (≥ 30% clay) subsurface *vertic horizon* with thickness ≥25 cm, that, as a result of shrinking and swelling, has slickensides and wedge-shaped soil aggregates. Starting ≤ 100 cm from the mineral soil surface.

4 – Epiloamic

loamy material with thickness of ≥30 cm with lower limit ≤50 cm of the mineral soil surface.

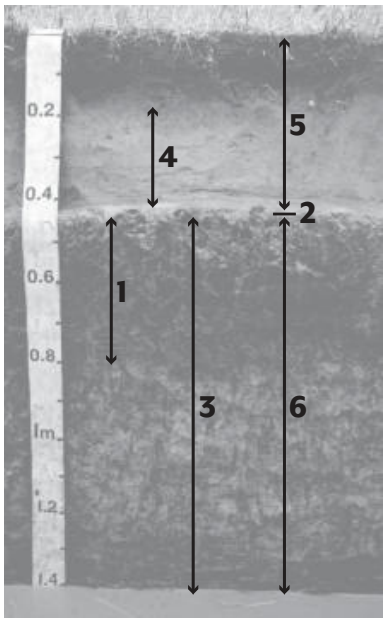
5 – Katoclayic

clayic material starts >0 and <50 cm from the (mineral) soil surface and has its lower limit ≥100 cm of the mineral soil surface.

6 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Albic Stagnic Abruptic SOLONETZ (Epiarenic, Katoclayic)



1 – SOLONETZ

natric horizon with a distinctly higher clay content than in the overlying horizon and with high content of exchangeable Na, starting ≤100 cm from the mineral soil surface. Often has also columnar structure.

2 – Abruptic

abrupt textural difference (here loamy sand on clay) within 100 cm of the mineral soil surface.

3 – Stagnic

layer, ≥25 cm thick and starting ≤75 cm from the mineral soil surface with *stagnic properties* (reductimorphic and oximorphic features ≥25%) and *reducing conditions*.

4 – Albic

light-coloured, eluvial *albic horizon* starting ≤100 cm from the mineral soil surface.

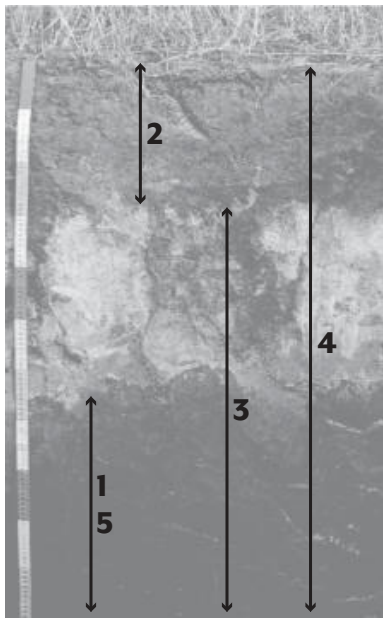
5 – Epiarenic

sandy material with thickness of ≥30 cm with lower limit ≤50 cm of the mineral soil surface.

6 – Katoclayic

clayic material starts >0 and <50 cm from the (mineral) soil surface and has its lower limit ≥100 cm of the mineral soil surface.

Stagnic Mollic SOLONETZ (Loamic, Cutanic)



1 – SOLONETZ

natric horizon with a distinctly higher clay content than in the overlying horizon and with high content of exchangeable Na, starting ≤100 cm from the mineral soil surface.

2 – Mollic

mollic horizon – thick, very dark (≥0.6% soil organic carbon) humus horizon with well developed structure and high base saturation.

5 – Cutanic

evidence of clay illuviation in form of clay coatings on soil aggregates.

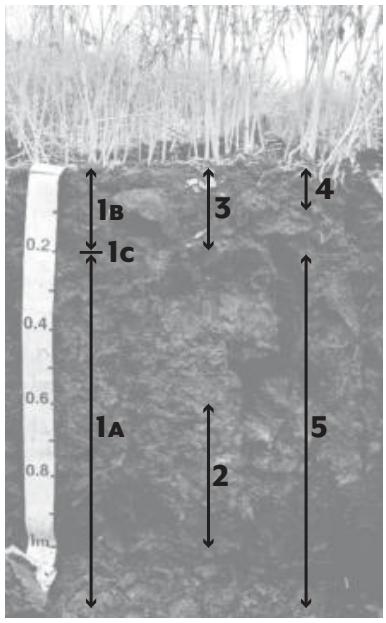
3 – Stagnic

layer, ≥25 cm thick and starting ≤75 cm from the mineral soil surface with *stagnic properties* (reductimorphic and oximorphic features ≥25%) and *reducing conditions*.

4 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

Calcic VERTISOL (Aric, Grumic, Stagnic)



1 – VERTISOL

1A clay-rich (≥30% clay) subsurface *vertic horizon* with thickness ≥25 cm, that, as a result of shrinking and swelling, has slickensides and wedge-shaped soil aggregates. Starting ≤100 cm from the mineral soil surface.

1B ≥30% clay between the mineral soil surface and the *vertic horizon* throughout.

1C *shrink-swell cracks* that start at the base of a plough layer.

2 – Calcic

calcic horizon with calcium carbonate ≥15% and distinct accumulation of secondary carbonates starting ≤100 cm.

3 – Aric

plough layer, ≥10 cm thick – homogenized by ploughing and with very abrupt lower boundary.

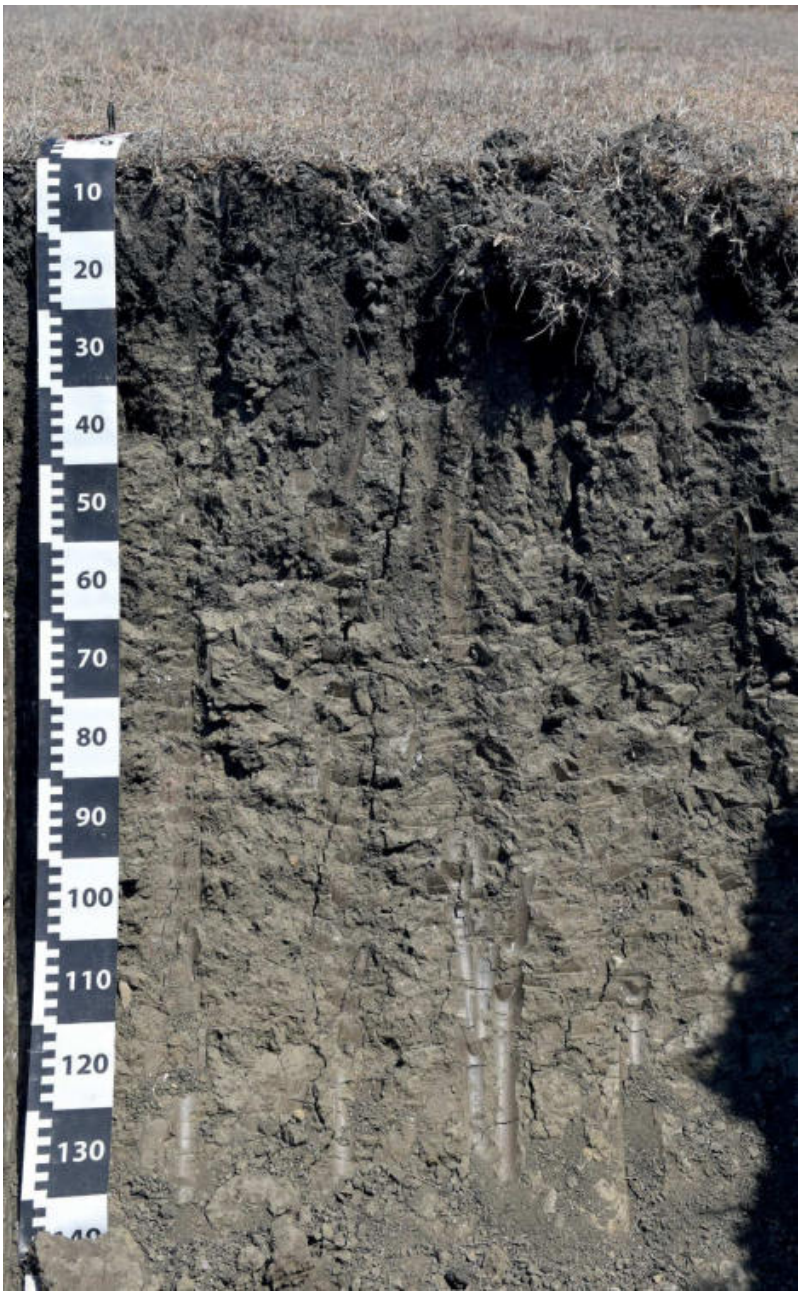
4 – Grumic

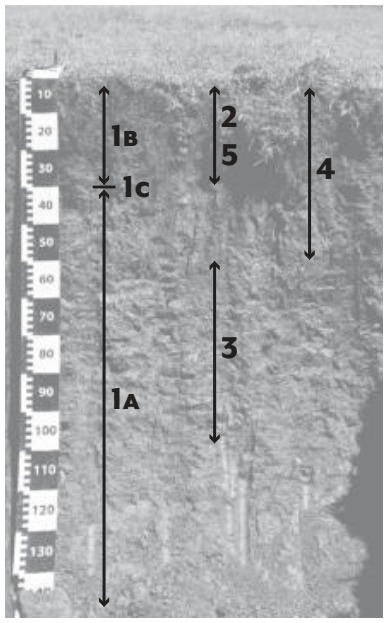
at the mineral soil surface a layer, ≥1 cm thick, with strong granular structure / strong angular or subangular blocky structure with an aggregate size of ≤1 cm, i.e. 'self-mulching'.

5 – Stagnic

layer, ≥25 cm thick and starting ≤75 cm from the mineral soil surface with *stagnic properties* (reductimorphic and oximorphic features ≥ 25%) and *reducing conditions*.

Calcic Pellic VERTISOL (Humic, Mollic)





1 – VERTISOL

1A clay-rich (≥30% clay) subsurface *vertic horizon* with thickness ≥25 cm, that, as a result of shrinking and swelling, has slickensides and wedge-shaped soil aggregates. Starting ≤100 cm from the mineral soil surface.

1B ≥30% clay between the mineral soil surface and the *vertic horizon* throughout.

1C *shrink-swell cracks* that start at the base of a plough layer.

2 – Pellic

very dark in the upper 30 cm of the mineral soil.

3 – Calcic

calcic horizon with calcium carbonate ≥15% and distinct accumulation of secondary carbonates starting ≤100 cm.

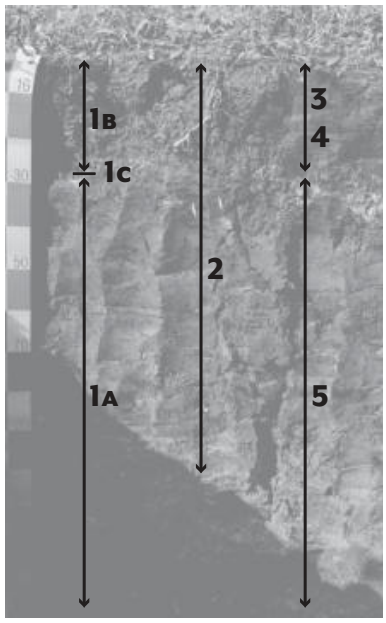
4 – Humic

≥1% soil organic carbon as a weighted average to a depth of 50 cm.

5 – Mollic

mollic horizon - thick, dark (≥0.6% soil organic carbon) humus horizon with well developed structure and high base saturation.

Haplic VERTISOL (Aric, Ochric, Stagnic)



1 – VERTISOL

1A clay-rich (≥30% clay) subsurface *vertic horizon* with thickness ≥25 cm, that, as a result of shrinking and swelling, has slickensides and wedge-shaped soil aggregates. Starting ≤100 cm from the mineral soil surface.

1B ≥30% clay between the mineral soil surface and the *vertic horizon* throughout.

1C *shrink-swell cracks* that start at the base of a plough layer.

2 – Haplic

no other principal qualifier of the respective RSG applies.

3 – Aric

plough layer, ≥10 cm thick – homogenized by ploughing and with very abrupt lower boundary.

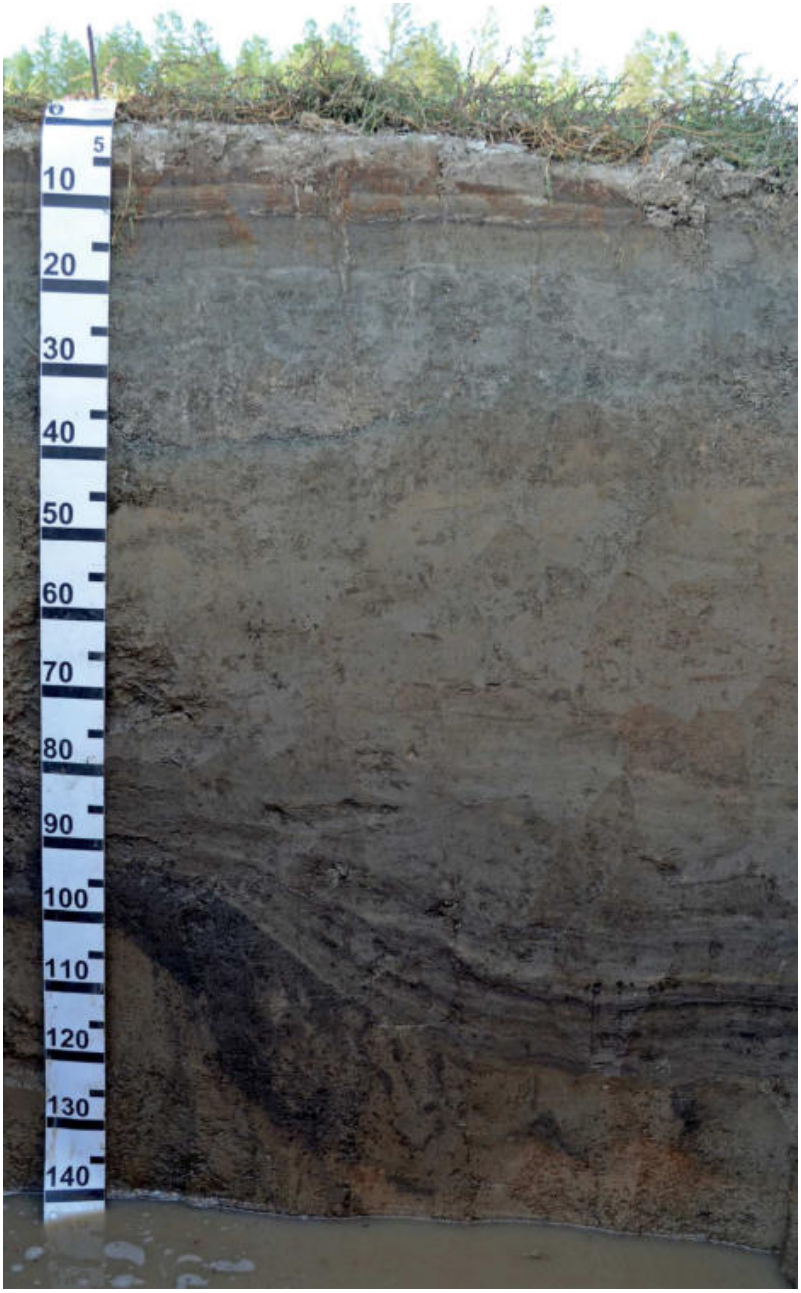
4 – Ochric

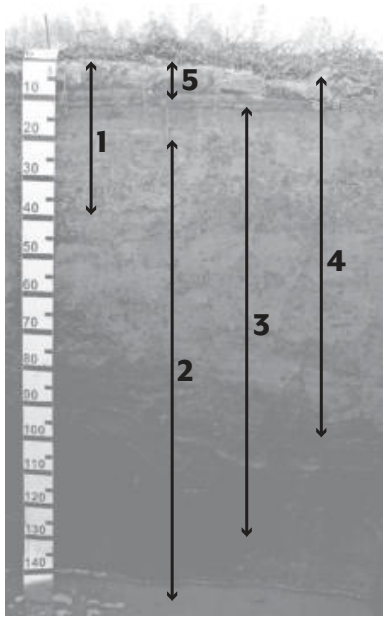
humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil but not well enough developed to be classified as diagnostic (too light in colour in this case).

5 – Stagnic

layer, ≥25 cm thick and starting ≤75 cm from the mineral soil surface with *stagnic properties* (reductimorphic and oximorphic features ≥25%) and *reducing conditions*.

Fluvic Gleyic SOLONCHAK (Loamic, Drainic, Ochric)





1 – SOLONCHAK

salic horizon with high amounts of readily soluble salts (more soluble than gypsum) starting ≤50 cm from the soil surface.

REMARK

drainic – artificially drained soil - drainage can be improved by deep open drains or buried pipe drains – not visible in soil profile.

2 – Gleyic

gleyic properties (≥25 cm thick) and *reducing conditions* start ≥75 cm from the mineral soil surface layer.

3 – Fluvic

fluvic material, ≥25 cm thick and starting ≤75 cm from the mineral soil surface. Fluviatile origin of sediment is recognize by distinct stratification in ≥25% of its volume.

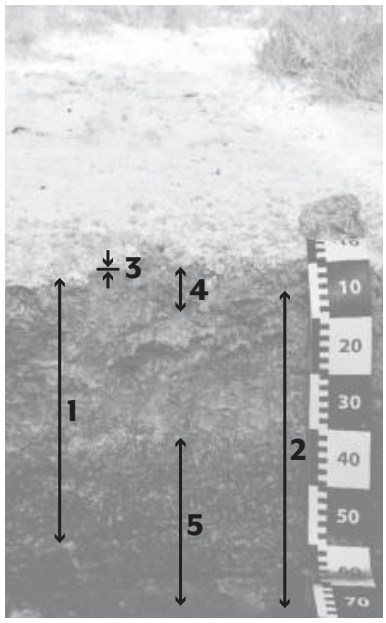
4 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

5 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Gypsic SOLONCHAK (Evapocrustic, Ochric, Oxyaquic)



1 – SOLONCHAK

salic horizon with high amounts of readily soluble salts (more soluble than gypsum) starting ≤50 cm from the soil surface.

2 – Gypsic

gypsic horizon (non-cemented horizon containing accumulations of secondary gypsum) starting ≤100 cm.

3 – Evapocrustic

saline crust (whitish on photo), ≤2 cm thick, on the soil surface.

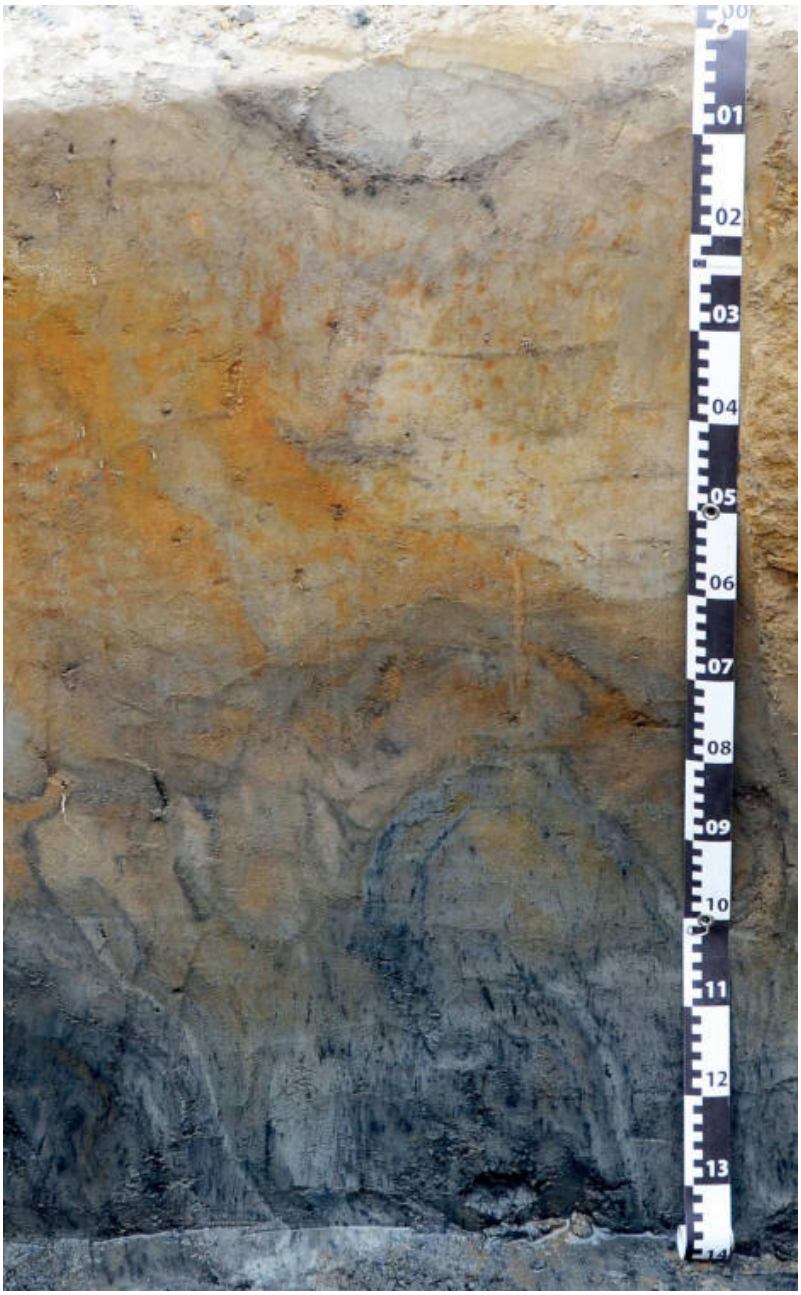
4 – Ochric

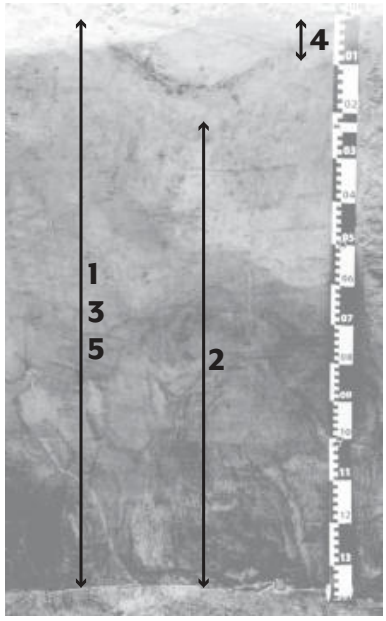
weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

5 – Oxyaquic

layer, ≥25 cm thick and starting ≤75 cm from the mineral soil surface, that is saturated with water during a period of ≥20 consecutive days; and not having *gleyic* and *stagnic properties* within 100 cm of the mineral soil surface.

Gleyic SOLONCHAK (Arenic, Ochric, Turbic)





1 – SOLONCHAK

salic horizon with high amounts of readily soluble salts (more soluble than gypsum) starting ≤50 cm from the soil surface.

2 – Gleyic

gleyic properties (≥25 cm thick) and *reducing conditions* start ≥75 cm from the mineral soil surface layer.

3 – Arenic

texture class of sand or loamy sand in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

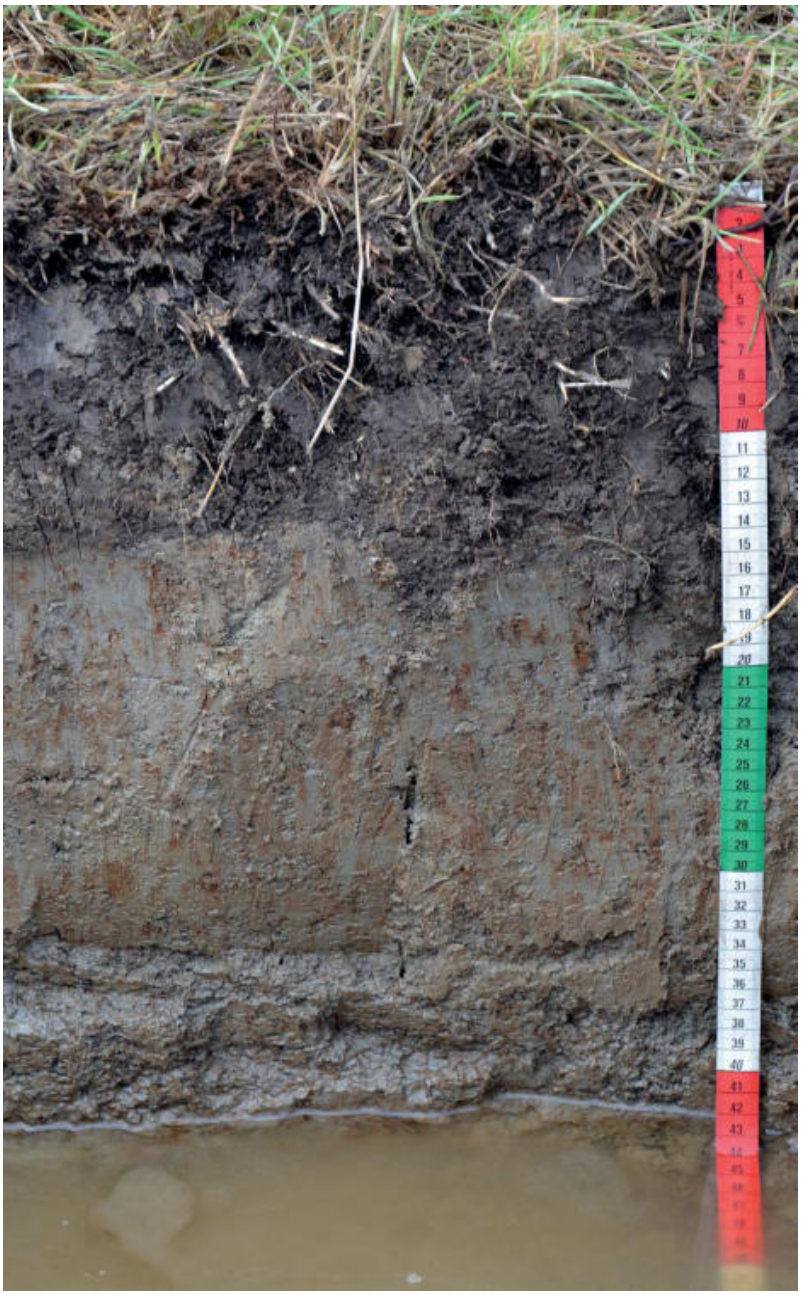
4 – Ochric

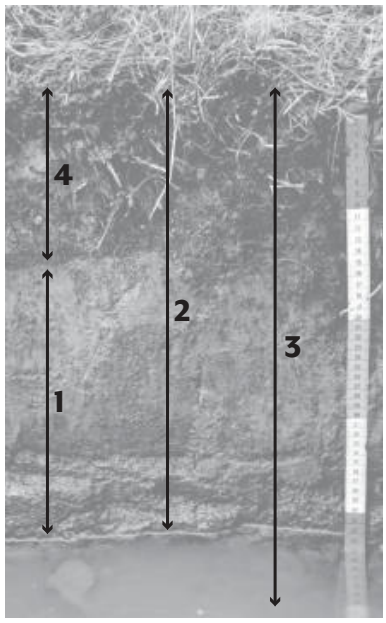
humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil. Structure, soil organic carbon, colour and base saturation fulfil criteria of *mollic horizon* but thickness is too small in this case.

5 – Turbic

cryogenic alteration (e.g. cryoturbation, mixed material, disrupted soil horizons, involutions)

Eutric GLEYSOL (Siltic, Ochric)





1 – GLEYSOL

a layer, ≥25 cm thick and starting ≤40 cm from the mineral soil surface, that has *gleyic properties* throughout; and *reducing conditions* in some parts of every sublayer.

2 – Eutric

exchangeable (Ca+Mg+K+Na) ≥ exchangeable Al in half or more thickness between 20 and 100 cm of the mineral soil surface. Expressed by relatively high pH values.

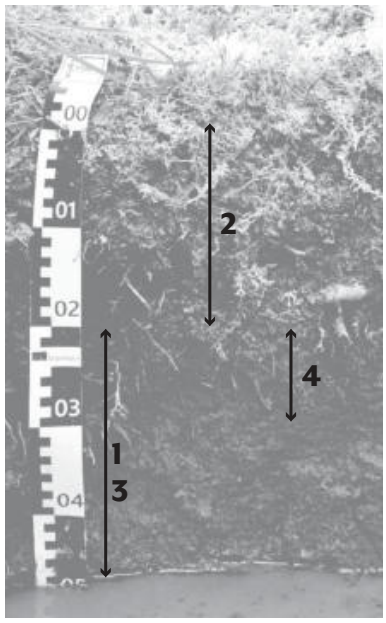
3 – Siltic

texture class of silt or silt loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Ochric

humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil. Structure, soil organic carbon, colour and base saturation fulfill criteria of *mollic horizon* but thickness is to small in this case.

Reductigleyic Histic GLEYSOL (Loamic, Ochric)



1 – GLEYSOL

a layer, ≥25 cm thick and starting ≤40 cm from the mineral soil surface, that has *gleyic properties* throughout; and *reducing conditions* in some parts of every sublayer – in this case it starts at the mineral soil surface.

2 – Histic

histic horizon with thickness <40 cm (20 cm in this profile) consists of poorly aerated *organic material* accumulated e.g. in peatlands. It develops at the soil surface.

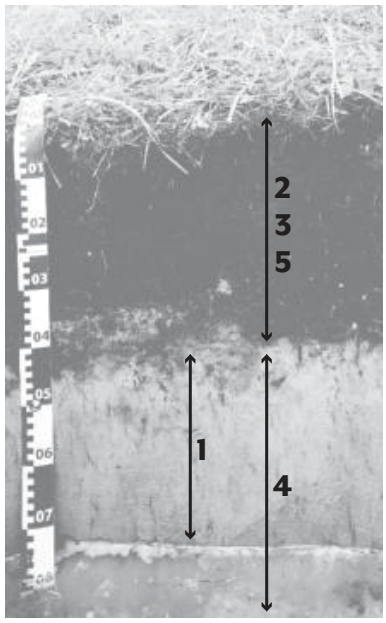
3 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Ochric

weakly developed, thin humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Mollic GLEYSOL (Epiloamic, Katoarenic, Aric, Mulmic)



1 – GLEYSOL

a layer, ≥25 cm thick and starting ≤40 cm from the mineral soil surface, that has *gleyic properties* throughout; and *reducing conditions* in some parts of every sublayer – in this case it starts at the mineral soil surface.

REMARK

humus horizon cannot be classified as *chernic horizon* only due to the presence of *mulmic material*. The other criteria are met.

2 – Mollic

mollic horizon - thick, very dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and high base saturation expressed by relatively high pH values.

3 – Epiloamic

loamy (loam, sandy loam, clay loam, sandy clay loam or silty clay loam) material with thickness of ≥30 cm with lower limit ≤50 cm of the mineral soil surface.

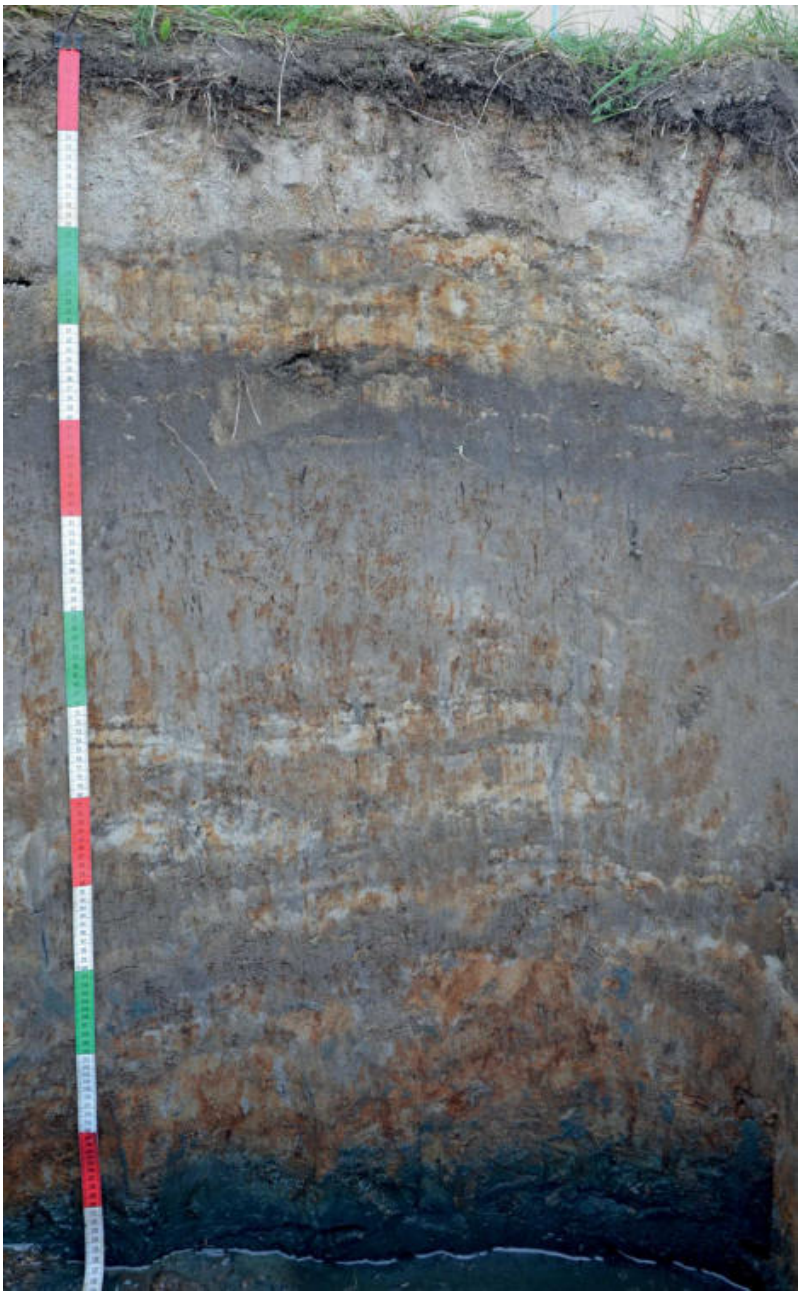
4 – Katoarenic

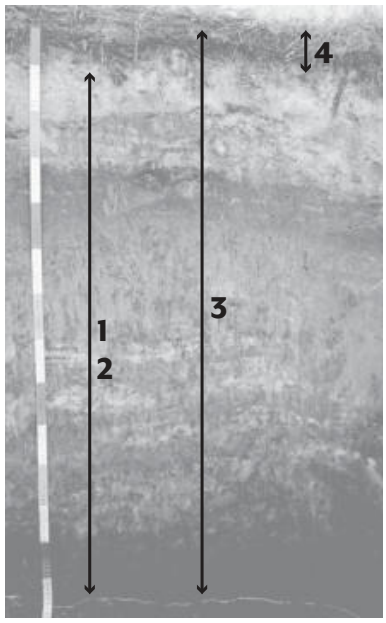
sandy (sand, loamy sand) material starts >0 and <50 cm from the (mineral) soil surface and has its lower limit ≥100 cm of the (mineral) soil surface.

5 – Mulmic

very dark *mineral material* with ≥8% *soil organic carbon* developed from *organic material* as a result of its fast decomposition after drainage.

Fluvic GLEYSOL (Arenic, Ochric)





1 – GLEYSOL

a layer, ≥25 cm thick and starting ≤40 cm from the mineral soil surface, that has *gleyic properties* throughout; and *reducing conditions* in some parts of every sublayer.

REMARK

although a clear stratification of fluvial sediments is visible in almost whole soil profile – due to the relatively advanced post-depositional pedogenesis (gleyic process), the soil is not classified as Fluvisol.

2 – Fluvic

fluvic material, ≥25 cm thick and starting ≤75 cm from the mineral soil surface. Fluviatile origin of sediment is recognized by distinct stratification in ≥25% of its volume.

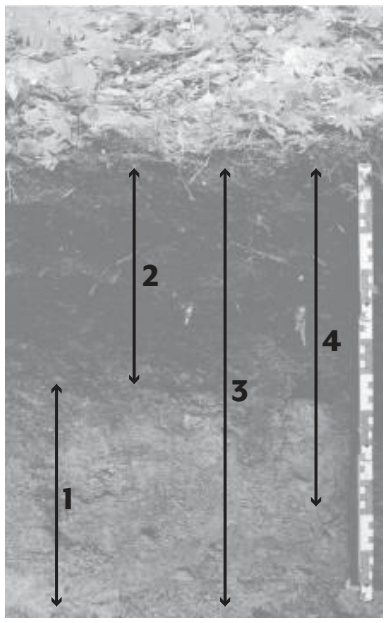
3 – Arenic

texture class of sand or loamy sand in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Ochric

weakly developed, thin humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Umbric GLEYSOL (Loamic, Humic)



1 – GLEYSOL

a layer, ≥25 cm thick and starting ≤40 cm from the mineral soil surface, that has *gleyic properties* throughout; and *reducing conditions* in some parts of every sublayer.

2 – Umbric

umbric horizon – thick, very dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and low base saturation.

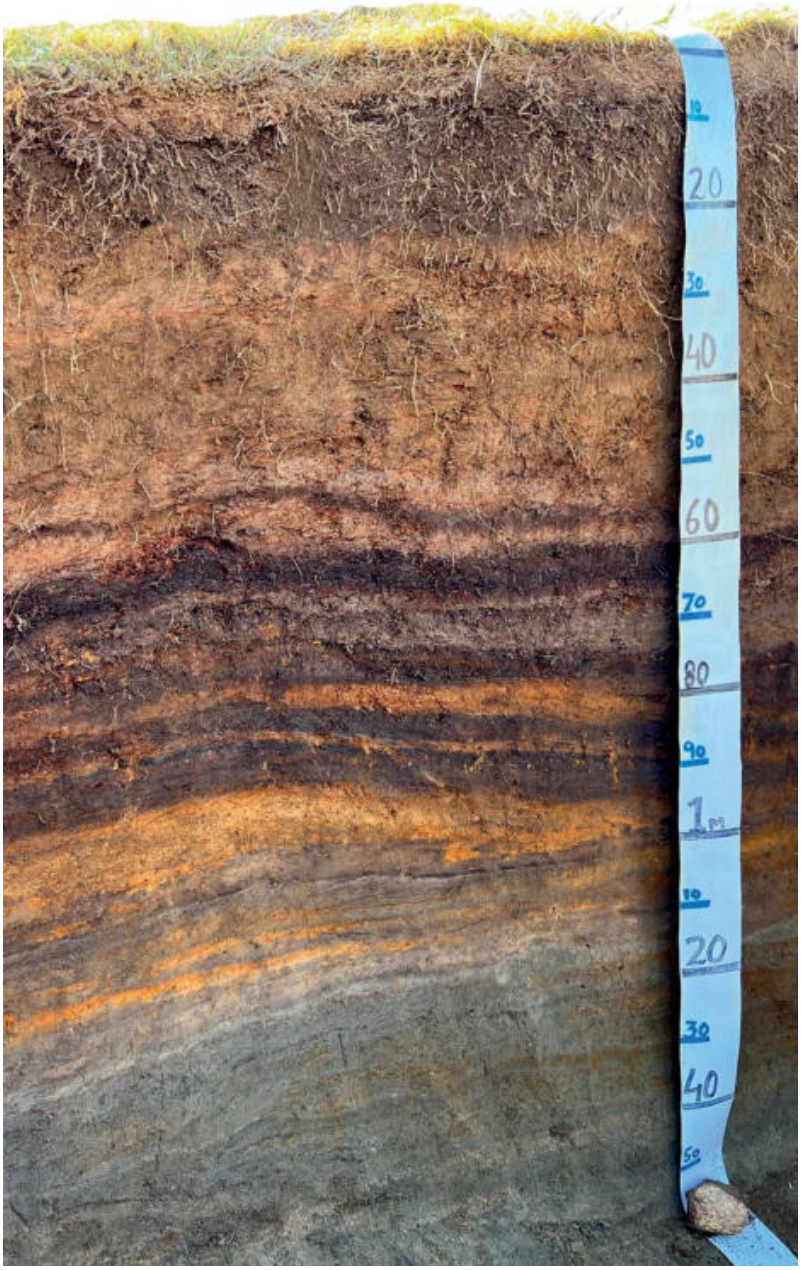
3 – Loamic

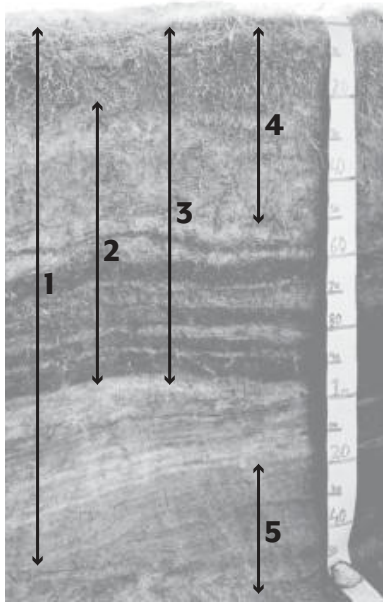
loamy material in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Humic

having ≥1% *soil organic carbon* as a weighted average to a depth of 50 cm.

Silandic ANDOSOL (Loamic, Humic, Bathygleyic)





1 – ANDOSOL

andic properties (moderate weathering of mainly pyroclastic deposits) starting ≤25 cm from the soil surface and has thickness ≥30 cm.

2 – Silandic

lighter in colours layers (combined thickness of ≥15 cm) with silicon-containing material.

3 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

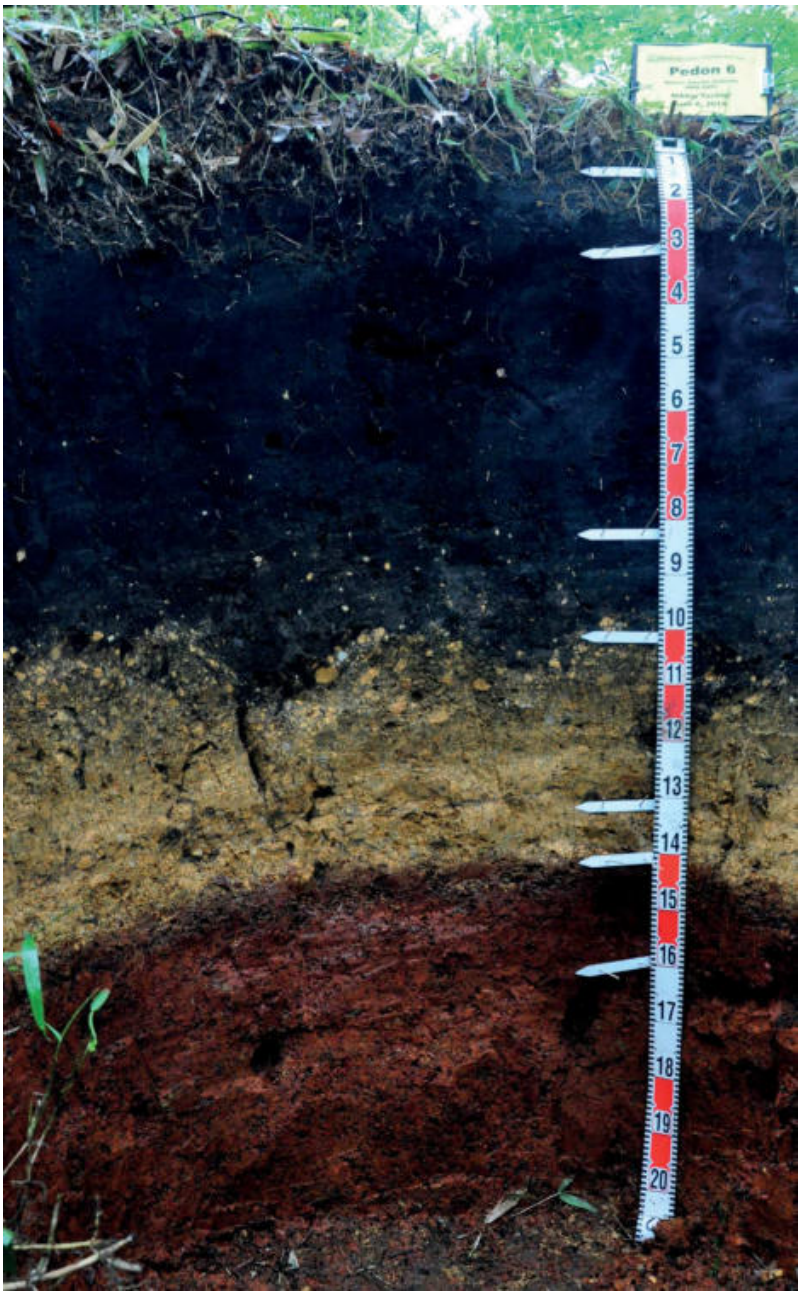
4 – Humic

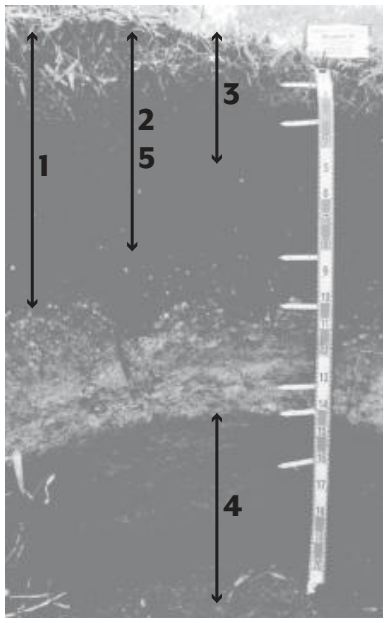
having ≥1% *soil organic carbon* as a weighted average to a depth of 50 cm.

5 – Bathygleyic

gleyic properties and *reducing conditions* start ≥100 cm from the mineral soil surface.

Chernic ANDOSOL (Humic, Bathyargic, Pachic)





1 – ANDOSOL

andic properties (moderate weathering of mainly pyroclastic deposits) starting ≤25 cm from the soil surface and has thickness ≥30 cm.

2 – Chernic

chernic horizon - thick, very dark (≥1% *soil organic carbon*) humus horizon with well developed structure and high base saturation.

3 – Humic

≥1% *soil organic carbon* as a weighted average to a depth of 50 cm.

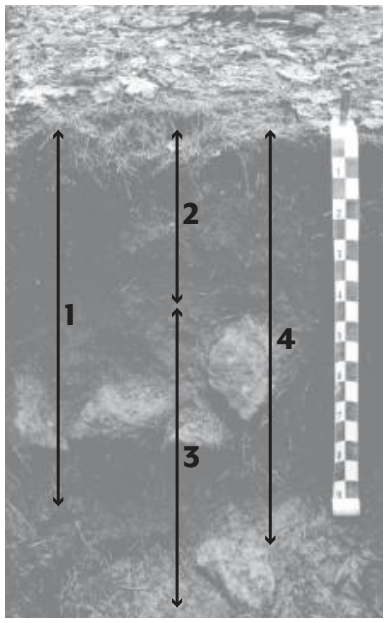
4 – Bathyargic

argic horizon start ≥100 cm from the mineral soil surface.

5 – Pachic

chernic horizon ≥50 cm thick.

Skeletic Umbric ANDOSOL (Loamic)



1 – ANDOSOL

andic properties (moderate weathering of mainly pyroclastic deposits) starting ≤25 cm from the soil surface and has thickness ≥30 cm.

2 – Umbric

umbric horizon - thick, very dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and low base saturation.

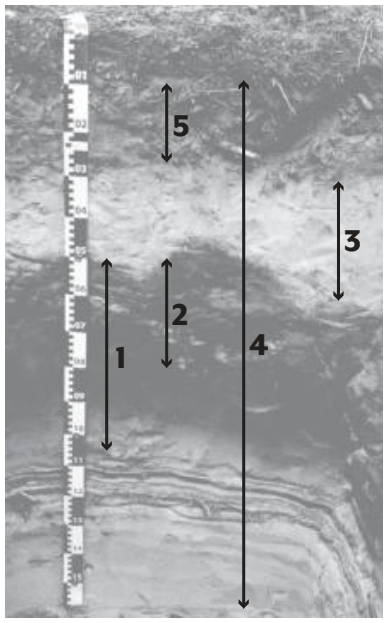
3 – Skeletic

≥40% (by volume, related to the whole soil) coarse fragments averaged over a depth of 100 cm from the mineral soil surface.

4 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

Albic Ortsteinic PODZOL (Arenic, Ochric)



1 – PODZOL

spodic horizon – contains illuvial substances: organic matter (dark) and Fe oxides (intensely brown) and Al oxides. Starting ≤200 cm from the mineral soil surface.

REMARK

well-aerated *organic material* is visible at the soil surface. It has 9 cm – relatively thick but not enough for *folic horizon*.

2 – Ortsteinic

at least moderately cemented *spodic horizon* in ≥50% of its horizontal extension.

3 – Albic

light-coloured, eluvial *albic horizon* starting ≤100 cm from the mineral soil surface.

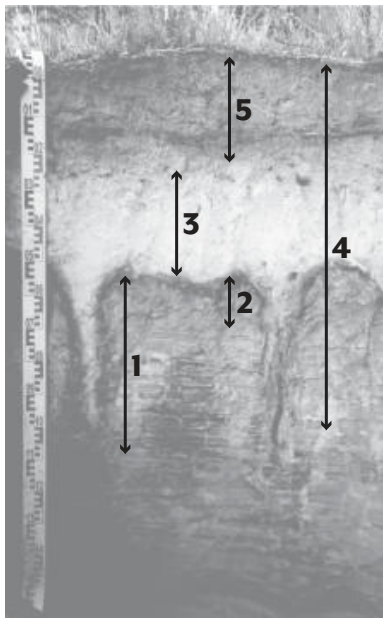
4 – Arenic

texture class of sand or loamy sand in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

5 – Ochric

humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil but not well enough developed to be classified as diagnostic (too light in colour in this case).

Albic Ortsteinic PODZOL (Arenic, Ochric)



1 – PODZOL

spodic horizon – contains illuvial substances: organic matter (dark) and Fe oxides (intensely brown) and Al oxides. Starting ≤200 cm from the mineral soil surface.

2 – Ortsteinic

at least moderately cemented *spodic horizon* in ≥50% of its horizontal extension.

3 – Albic

light-coloured, eluvial *albic horizon* starting ≤100 cm from the mineral soil surface.

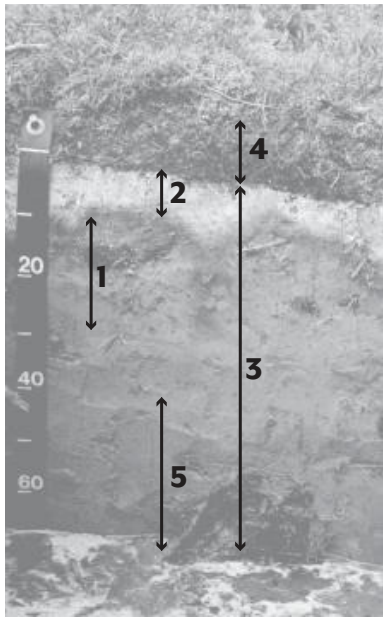
4 – Arenic

texture class of sand or loamy sand in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

5 – Ochric

humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil but not well enough developed to be classified as diagnostic (too light in colour in this case).

Albic PODZOL (Arenic, Folic, Oxyaquic)



1 – PODZOL

spodic horizon – contains illuvial substances: organic matter (dark) and Fe oxides (intensely brown) and Al oxides. Starting ≤200 cm from the mineral soil surface.

REMARK

strong podzolization led to the complete eluviation of humus substances from upper, mineral part of soil.

2 – Albic

light-coloured, eluvial *albic horizon* starting ≤100 cm from the mineral soil surface.

3 – Arenic

texture class of sand or loamy sand in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

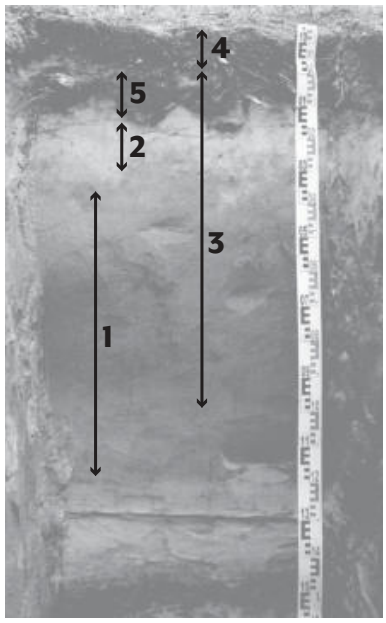
4 – Folic

well-aerated *organic material* (litter) at the soil surface with a thickness of ≥10 cm.

5 – Oxyaquic

layer, ≥25 cm thick and starting ≤75 cm from the mineral soil surface, that is saturated with water during a period of ≥20 consecutive days; and not having *gleyic* and *stagnic properties* within 100 cm of the mineral soil surface.

Albic PODZOL (Arenic, Folic, Ochric) over Dystric GLEYSOL (Arenic)



1 – PODZOL

spodic horizon – contains illuvial substances: organic matter (dark) and Fe oxides (intensely brown) and Al oxides. Starting ≤200 cm from the mineral soil surface.

REMARK

material above buried horizon at the dept of 150 cm, have greenish colour inherited from glauconite – not gleyic process.

2 – Albic

light-coloured, eluvial *albic horizon* starting ≤100 cm from the mineral soil surface.

3 – Arenic

texture class of sand or loamy sand in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

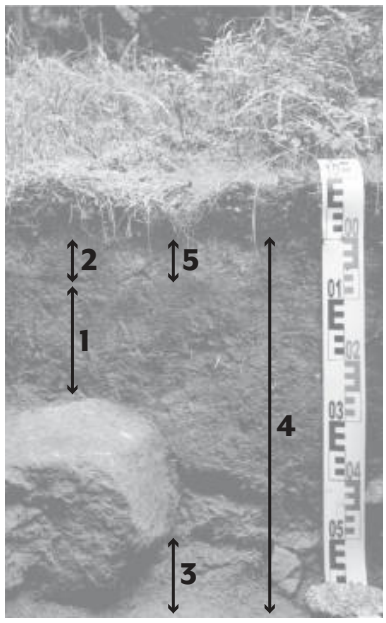
4 – Folic

well-aerated *organic material* (litter) at the soil surface with a thickness of ≥10 cm.

5 – Ochric

humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil but not well enough developed to be classified as diagnostic (too light in colour in this case).

Endoskeletic Entic PODZOL (Loamic)



1 – PODZOL

spodic horizon – contains illuvial substances: organic matter (dark) and Fe oxides (intensely brown) and Al oxides. Starting ≤200 cm from the mineral soil surface.

REMARK

well-aerated, dark in colour *organic material* is visible at the soil surface. It has 8–9 cm – relatively thick but not enough for *folic horizon*.

2 – Entic

lack of *albic horizon* above *spodic horizon*.

3 – Endoskeletic

≥40% (by volume, related to the whole soil) coarse fragments averaged in the depth 50–100 cm from the mineral soil surface.

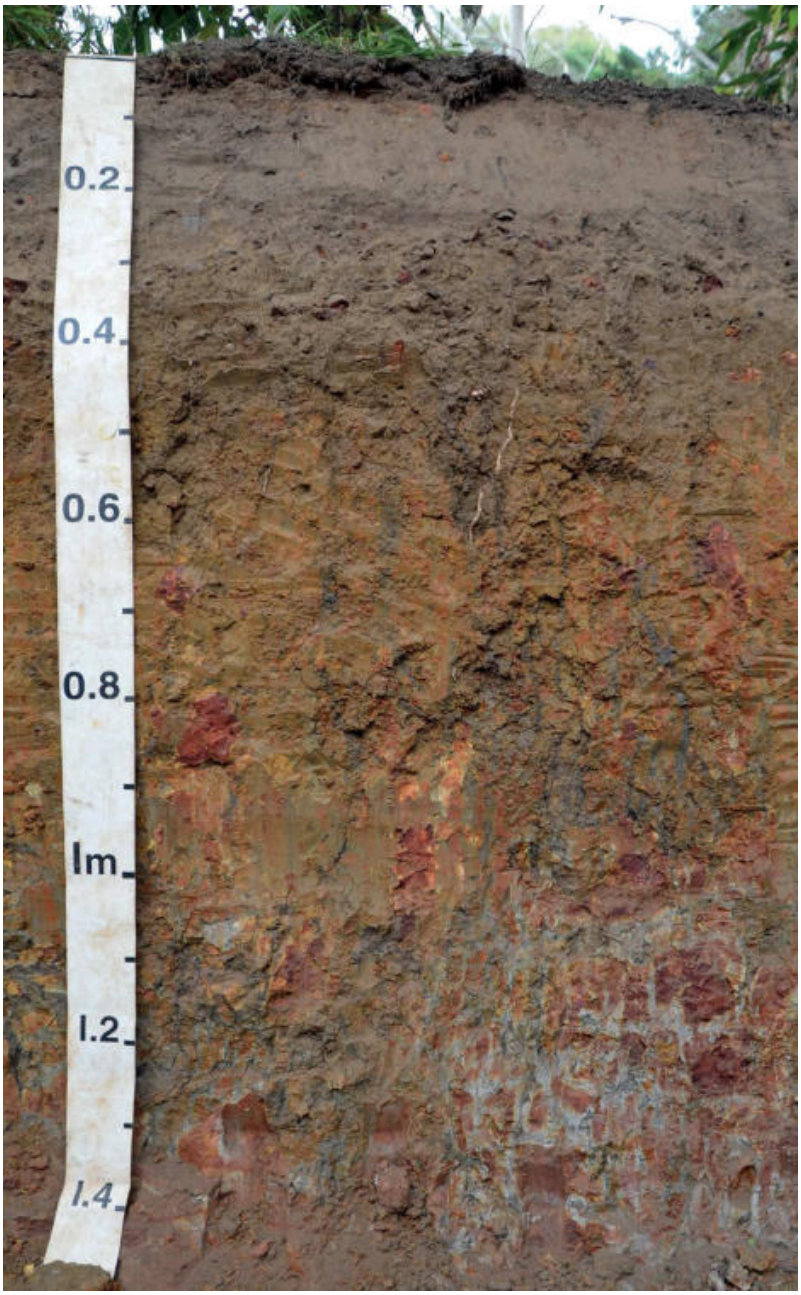
4 – Loamic

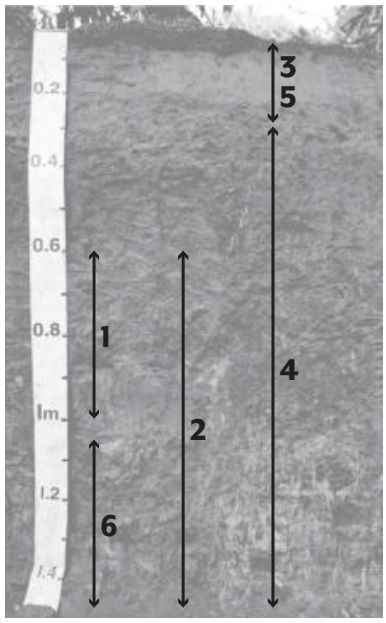
texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

5 – Ochric

humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil but not well enough developed to be classified as diagnostic (too light in colour in this case).

Stagnic PLINTHOSOL (Epiloamic, Katoclayic, Ochric, Bathypetric)





1 – PLINTHOSOL

plinthic horizon rich in Fe (hydr-) oxides and poor in humus, shows redoximorphic features. The clay fraction is dominated by kaolinite.

2 – Stagnic

layer, ≥25 cm thick and starting ≤75 cm from the mineral soil surface with *stagnic properties* (reductimorphic and oximorphic features ≥ 25%) and *reducing conditions.*

3 – Epiloamic

loamy material with thickness of ≥30 cm with lower limit ≤50 cm of the mineral soil surface.

4 – Katoclayic

clayic material starts >0 and <50 cm from the (mineral) soil surface and has its lower limit ≥100 cm of the (mineral) soil surface.

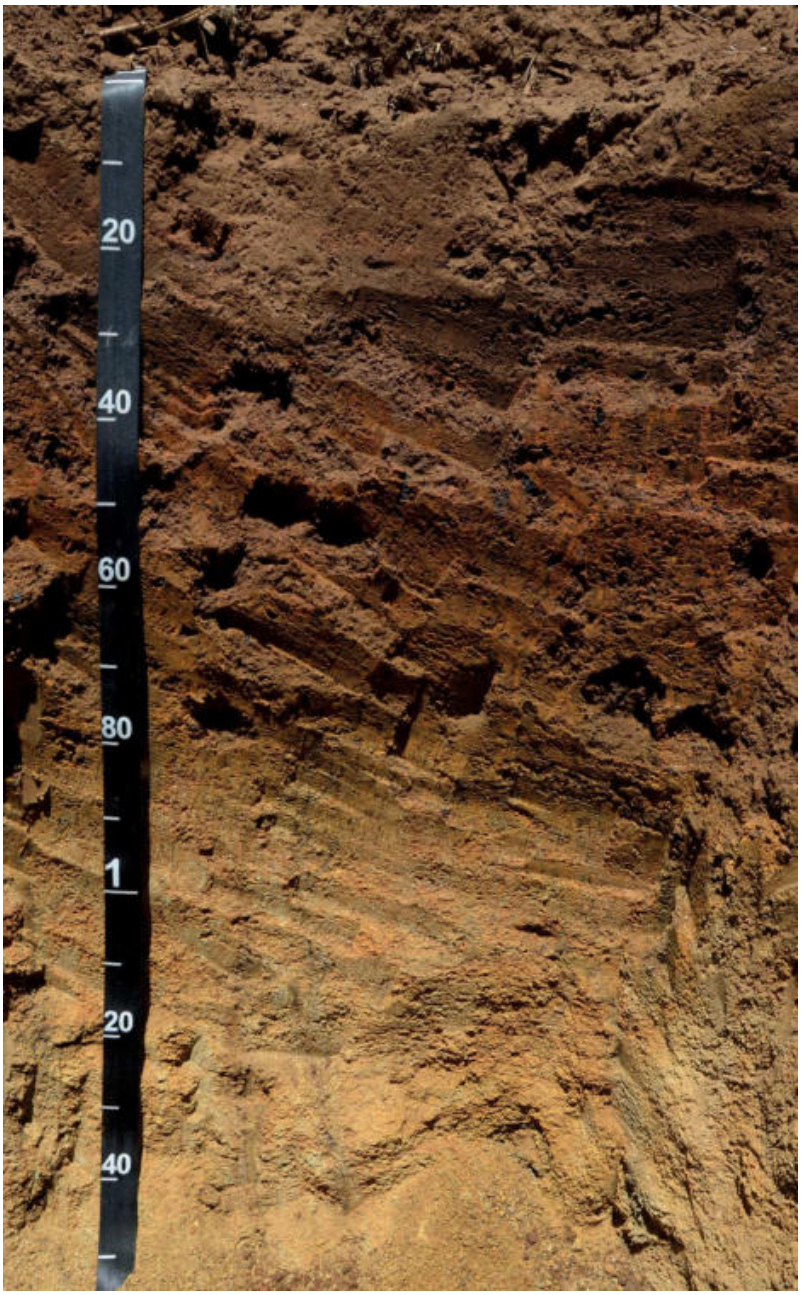
5 – Ochric

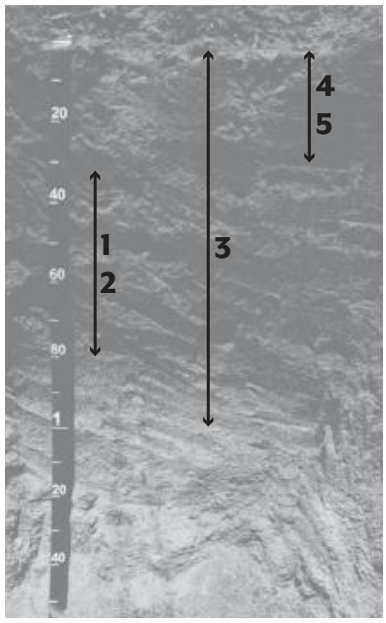
not diagnostic (too light colour) humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

6 – Bathypetric

petroplinthic horizon – cemented by Fe (and in some cases also Mn) (hydr-)oxides. Starts deeper than 100 cm.

Pisoplinthic PLINTHOSOL (Loamic, Aric, Ochric)





1 – PLINTHOSOL

pisoplinthic horizon with large amount of concretions and nodules that are at least moderately cemented by Fe and Mn (hydr-)oxides.

2 – Pisoplinthic

pisoplinthic horizon starting ≤100 cm from the mineral soil surface.

3 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

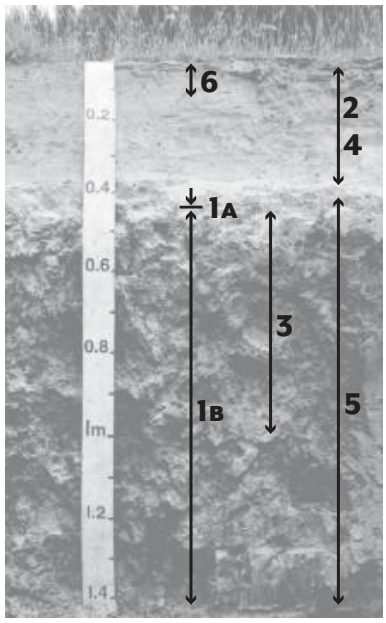
4 – Aric

plough layer, ≥10 cm thick – homogenized by ploughing and with very abrupt lower boundary.

5 – Ochric

humus horizon with ≥ 0.2% soil organic carbon (weighted average) in the upper 10 cm of the mineral soil but not well enough developed to be classified as diagnostic (too light in colour in this case).

Alic Albic PLANOSOL (Epiloamic, Katoclayic, Ochric)



1 – PLANOSOL

1A *abrupt textural difference* ≤75 cm from the mineral soil surface and having within the range of 5 cm from it (above or below) *stagnic properties* in which the area of reductimorphic and oximorphic features is ≥50% of the total area.

1B *reducing conditions* for some time during the year in some parts of the soil volume that has the reductimorphic features.

2 – Albic

light-coloured, eluvial *albic horizon* starting ≤100 cm from the mineral soil surface.

3 – Alic

argic horizon with evidence of clay illuviation, high-activity clays and low base saturation starting ≤100 cm from the mineral soil surface.

4 – Epiloamic

loamy material with thickness of ≥30 cm with lower limit ≤50 cm of the mineral soil surface.

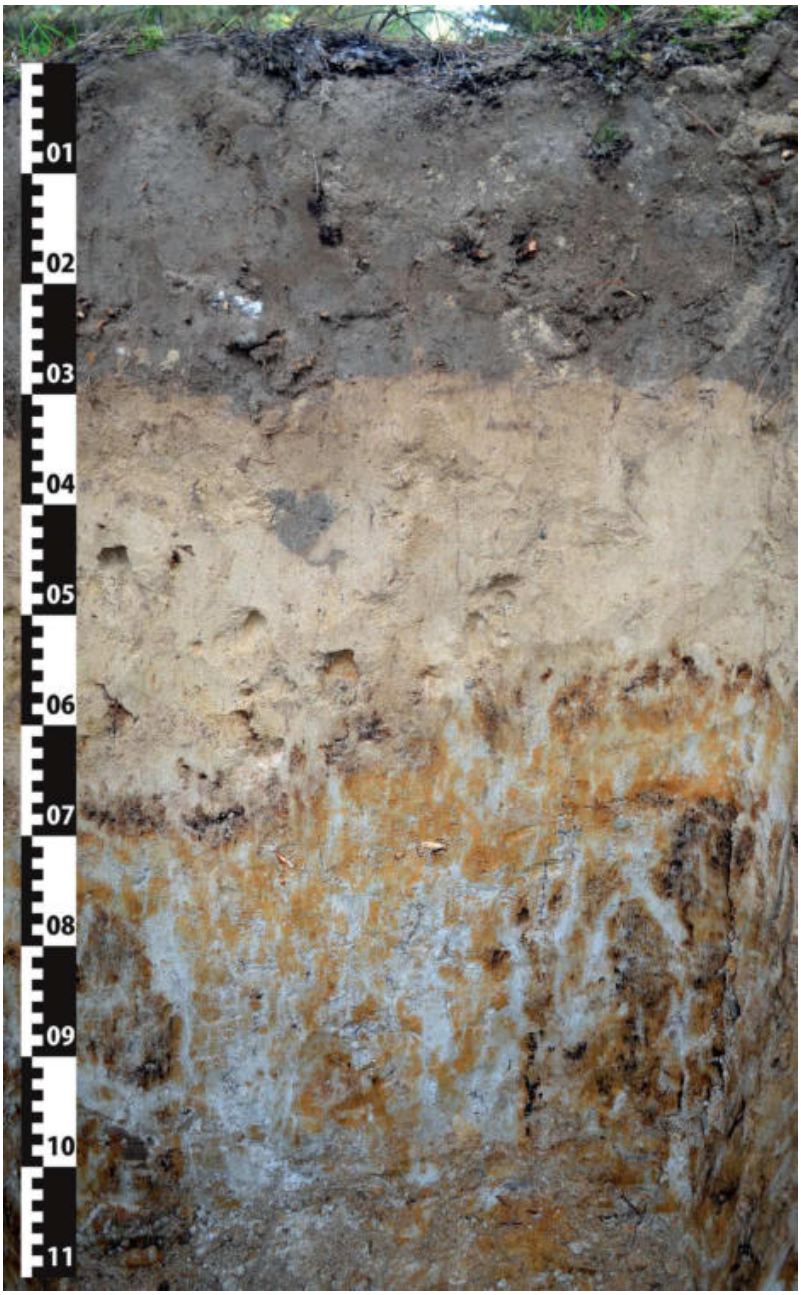
5 – Katoclayic

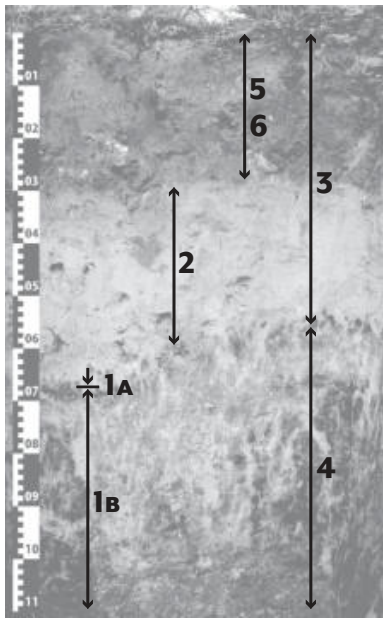
clayic material starts >0 and <50 cm from the mineral soil surface and has its lower limit ≥100 cm of the mineral soil surface.

6 – Ochric

weakly developed, thin humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Albic PLANOSOL (Anoarenic, Endoloamic, Aric, Ochric)





1 – PLANOSOL

1A *abrupt textural difference* ≤75 cm from the mineral soil surface and having within the range of 5 cm from it (above or below) *stagnic properties* in which the area of reductimorphic and oximorphic features is ≥50% of the total area.

1B *reducing conditions* for some time during the year in some parts of the soil volume that has the reductimorphic features.

2 – Albic

light-coloured, eluvial *albic horizon* starting ≤100 cm from the mineral soil surface.

3 – Anoarenic

sandy material (sand, loamy sand) starts at the mineral soil surface and has its lower limit >50 and <100 cm.

4 – Endoloamic

loamy material with thickness of ≥30 cm starts ≥50 cm from the mineral soil surface.

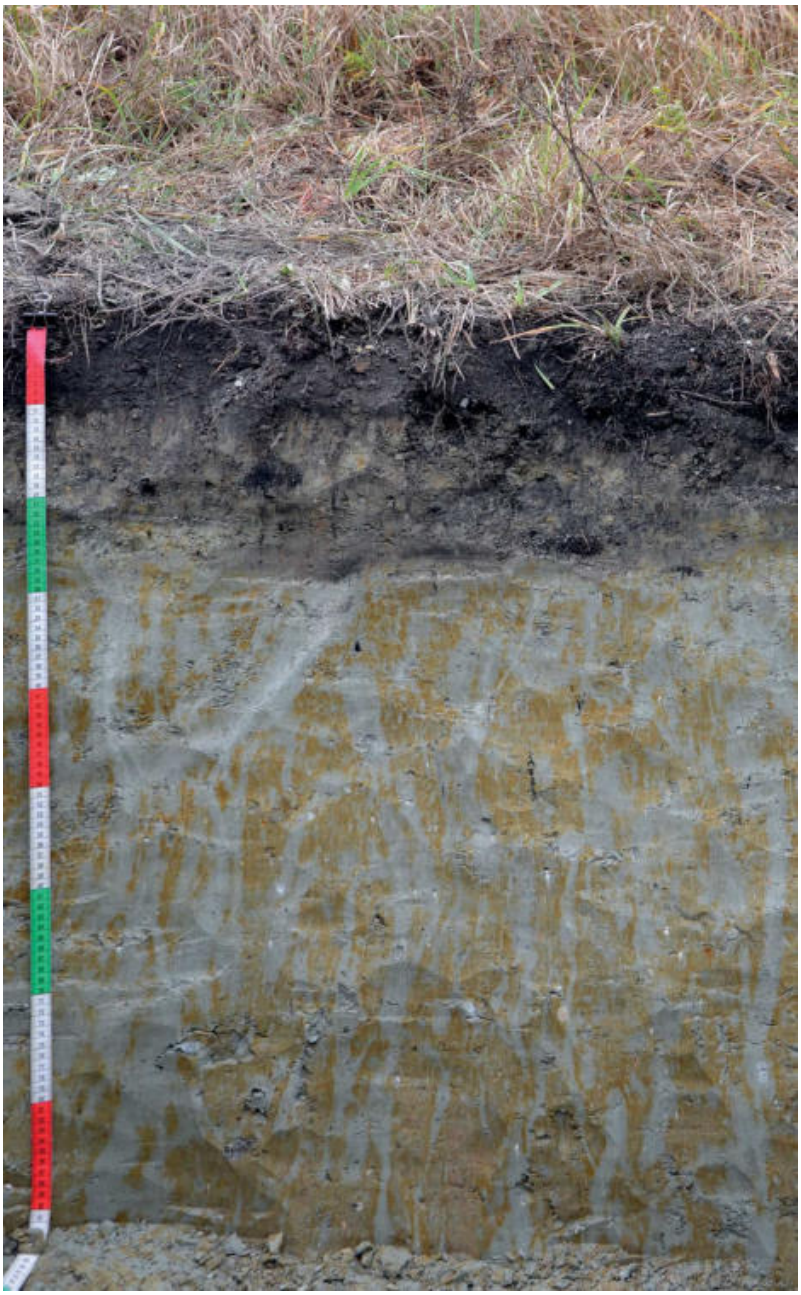
5 – Aric

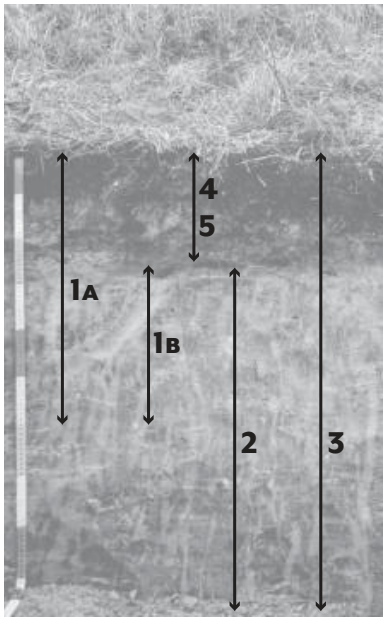
plough layer, ≥10 cm thick – homogenized by ploughing and with very abrupt lower boundary.

6 – Ochric

not diagnostic (too light colour) humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Calcaric STAGNOSOL (Loamic, Aric, Ochric)





1 – STAGNOSOL

1A *stagnic properties*, with reductimorphic and oximorphic features covering ≥ one third (weighted average) of the area from the mineral soil surface to a depth of 60 cm.

1B *reducing conditions* for some time during the year in some parts of the soil volume that has the reductimorphic features within 60 cm from the mineral soil surface.

2 – Calcaric

≥2% calcium carbonate equivalent. The carbonates are at least partially primary (inherited from the parent material).

3 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

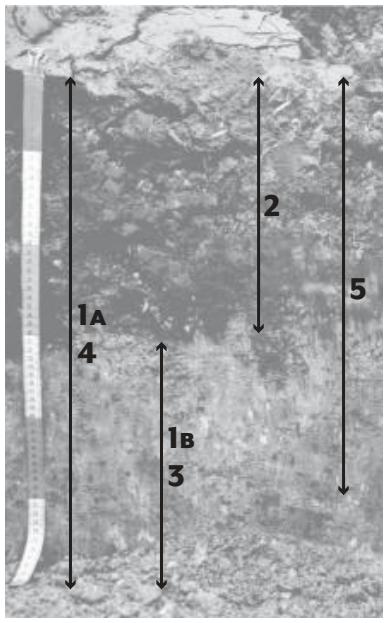
4 – Aric

plough layer, ≥10 cm thick – homogenized by ploughing and with very abrupt lower boundary.

5 – Ochric

humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil but not well enough developed to be classified as diagnostic (too light in colour between 10-25 cm).

Calcic Mollic STAGNOSOL (Loamic, Humic)



1 – STAGNOSOL

1A *stagnic properties*, with reductimorphic and oximorphic features covering ≥ one third (weighted average) of the area from the mineral soil surface to a depth of 60 cm.

1B *reducing conditions* for some time during the year in some parts of the soil volume that has the reductimorphic features within 60 cm from the mineral soil surface.

2 – Mollic

mollic horizon – dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and high base saturation.

3 – Calcic

calcic horizon with calcium carbonate ≥15% and distinct accumulation of secondary carbonates starting ≤100 cm.

4 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

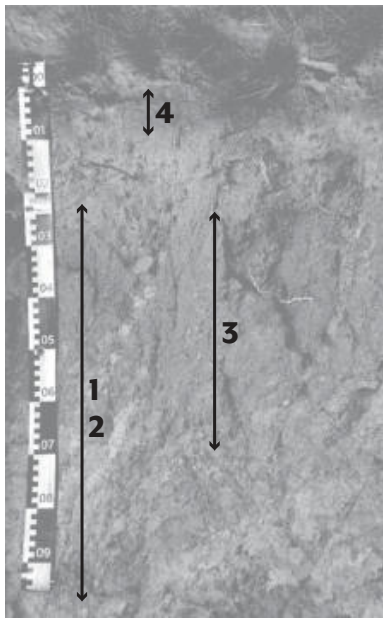
5 – Humic

≥1% *soil organic carbon* as a weighted average to a depth of 50 cm.

REMARK

blackish spots (30-60 cm) are 'manganese peppers' – feature also connected with stagnation of water.

Acric Rhodic NITISOL (Ochric)



1 – NITISOL

clay-rich (≥30% clay) subsurface *nitic horizon* with moderately to strongly developed blocky structure breaking to polyhedral or flat-edged elements with many shiny pressure faces.

2 – Rhodic

evidence of pedogenesis and very intensively red colour in zone with at least 30 cm.

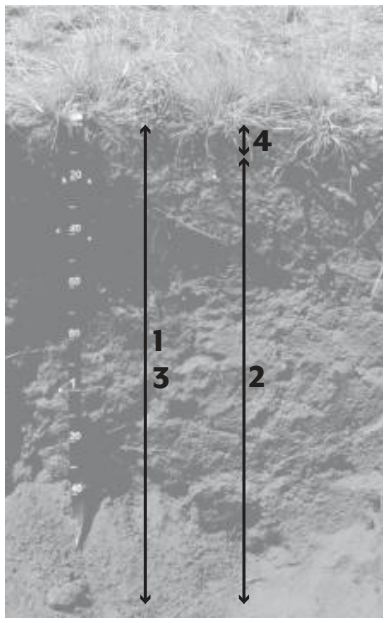
3 – Acric

argic horizon with evidence of clay illuviation, low-activity clays and low base saturation starting ≤100 cm from the mineral soil surface.

4 – Ochric

weakly developed, thin humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Ferritic FERRALSOL (Loamic, Ochric, Eutric)



1 – FERRALSOL

ferralic horizon starting ≤150 cm from the mineral soil surface, strongly weathered, dominated by kaolinites and Fe oxides (hematite - red colour).

2 – Ferritic

layer, ≥30 cm thick and starting ≤100 cm from the mineral soil surface, with ≥0% Fe_{dith} and not forming part of a *petroplinthic*, *pisoplinthic* or *plinthic horizon*.

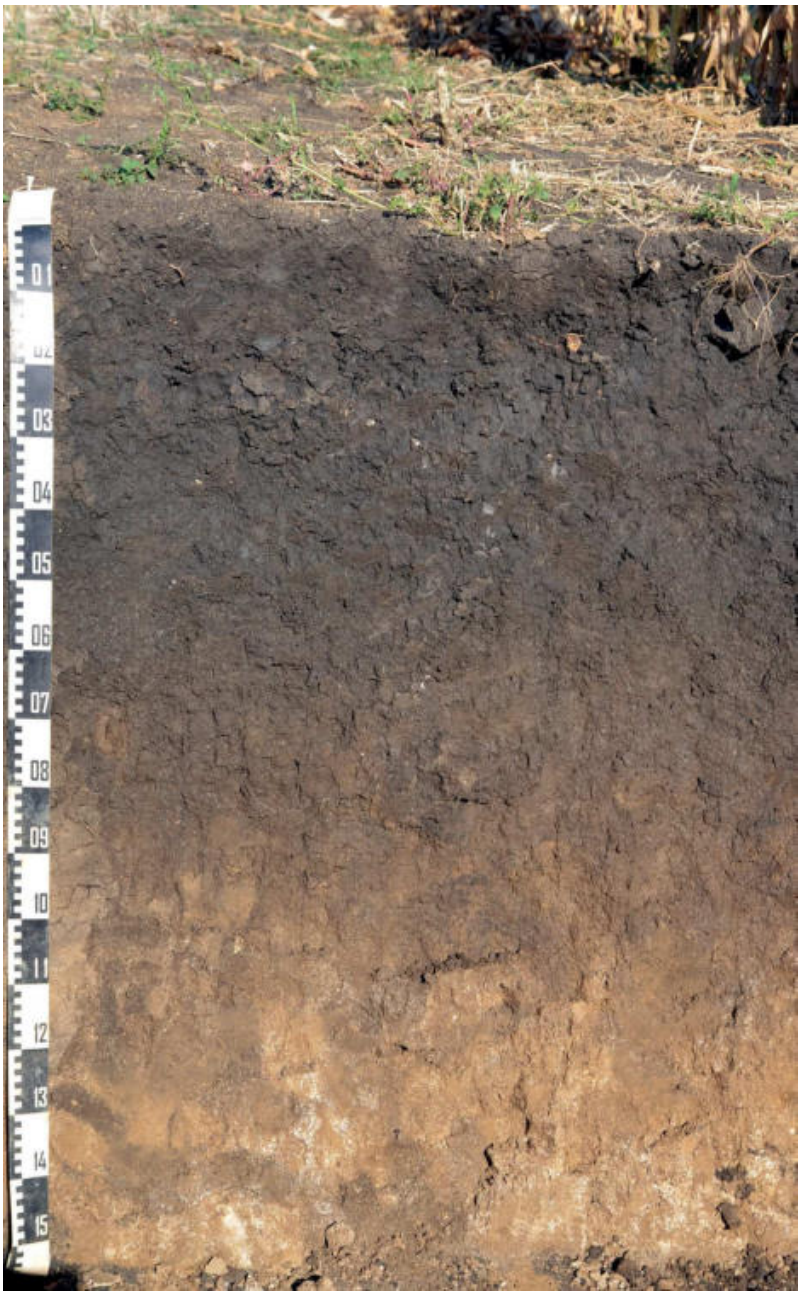
3 – Loamic

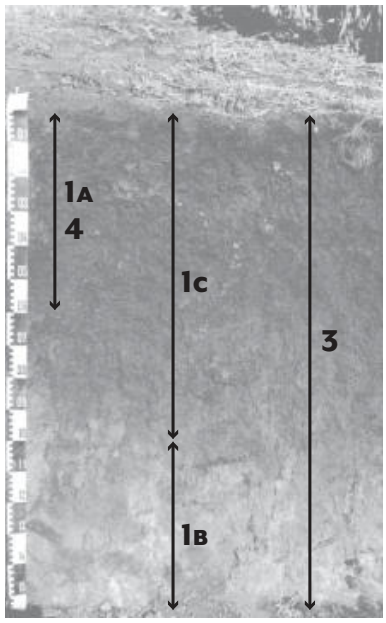
texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Calcic CHERNOZEM (Siltic, Pachic)





1 – CHERNOZEM

1A *chernic horizon* – thick, very dark (≥1% *soil organic carbon*) humus horizon with well developed structure and high base saturation.

1B *calcic horizon* starting ≤50 cm below the lower limit of the *mollic/chernic horizon*.

1C base saturation ≥50% from the mineral soil surface to the *calcic horizon*.

2 – Calcic

calcic horizon with calcium carbonate ≥15% and distinct accumulation of secondary carbonates starting ≤100 cm.

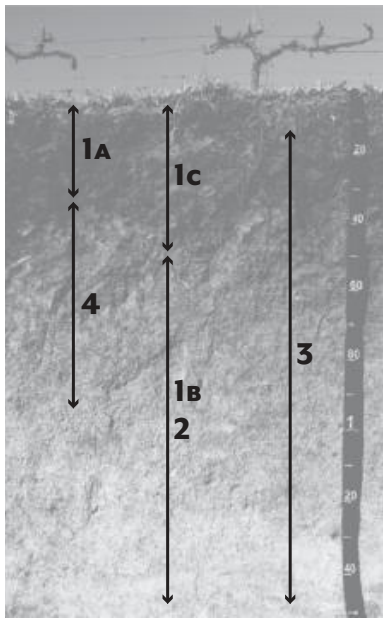
3 – Siltic

texture class of silt or silt loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Pachic

chernic horizon ≥50 cm thick.

Calcic CHERNOZEM (Clayic, Protovertic)



1 – CHERNOZEM

1A *chernic horizon* – thick, very dark (≥1% *soil organic carbon*) humus horizon with well developed structure and high base saturation.

1B *calcic horizon* starting ≤50 cm below the lower limit of the *chernic horizon*.

1C base saturation ≥50% from the mineral soil surface to the *calcic horizon*.

2 – Calcic

calcic horizon with calcium carbonate ≥15% and distinct accumulation of secondary carbonates starting ≤100 cm.

3 – Clayic

texture class of clay, sandy clay or silty clay in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

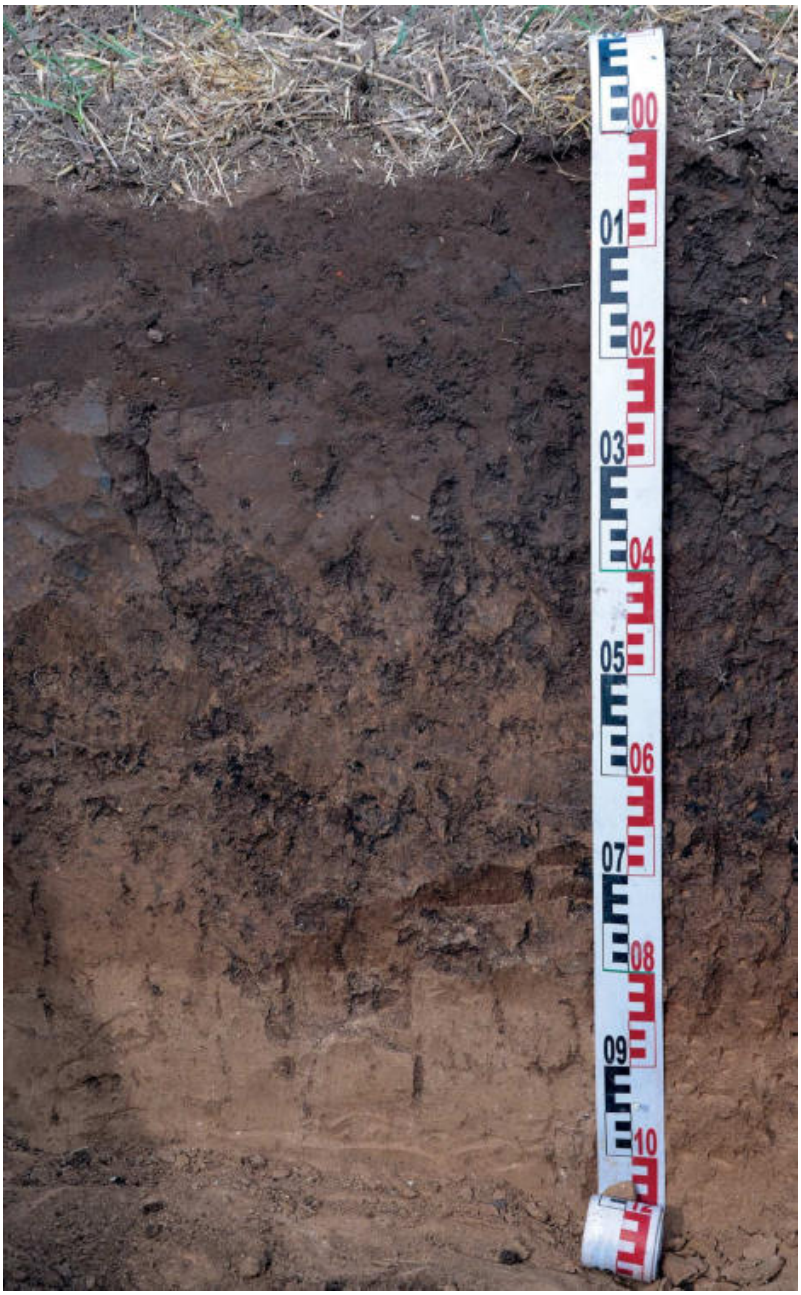
4 – Protovertic

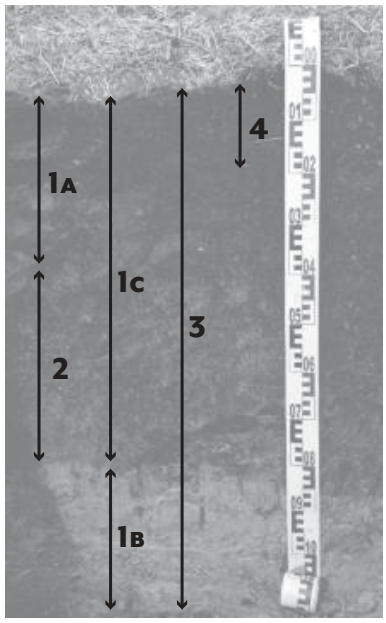
protovertic horizon with ≥30% clay, some wedge-shaped soil aggregates and slickensides, starting ≤100 cm from the mineral soil surface.

REMARK

this soil is similar to Vertisol but swelling and shrinking process is a little to 'weak' here (not enough amount of slickensides and wedge-shaped soil aggregates for *vertic horizon*).

Luvic CHERNOZEM (Siltic, Aric)





1 – CHERNOZEM

1A *chernic horizon* – thick, very dark (≥1% *soil organic carbon*) humus horizon with well developed structure and high base saturation.

1B *protocalcic properties* starting ≤50 cm below the lower limit of the *mollic/chernic horizon*.

1C base saturation ≥50% from the mineral soil surface to the *protocalcic horizon*.

2 – Luvic

argic horizon with evidence of clay illuviation, high-activity clays and high base saturation starting ≤100 cm from the mineral soil surface.

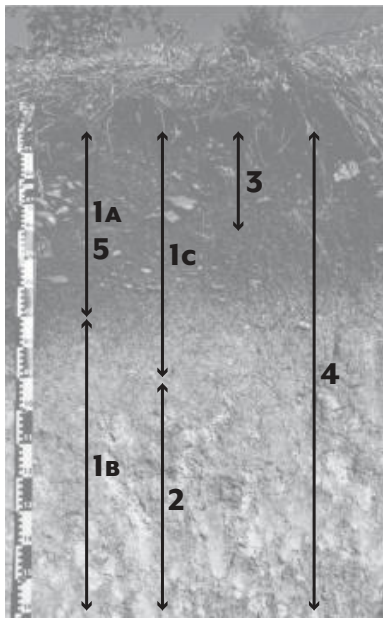
3 – Siltic

texture class of silt or silt loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Aric

layer, ≥10 cm thick and starting at the soil surface, that is homogenized by ploughing and that has an abrupt or very abrupt lower boundary.

Episkeletic Calcic KASTANOZEM (Loamic, Pachic)



1 – KASTANOZEM

1A *mollic horizon* – thick, dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and high base saturation.

1B *calcic horizon* starting ≤70 cm of the mineral soil surface.

1c base saturation ≥50% from the mineral soil surface to the *calcic horizon*.

2 – Calcic

calcic horizon with calcium carbonate ≥15% and distinct accumulation of secondary carbonates starting ≤100 cm.

3 – Episkeletic

≥40% (by volume, related to the whole soil) coarse fragments averaged over a depth of 50 cm from the mineral soil surface.

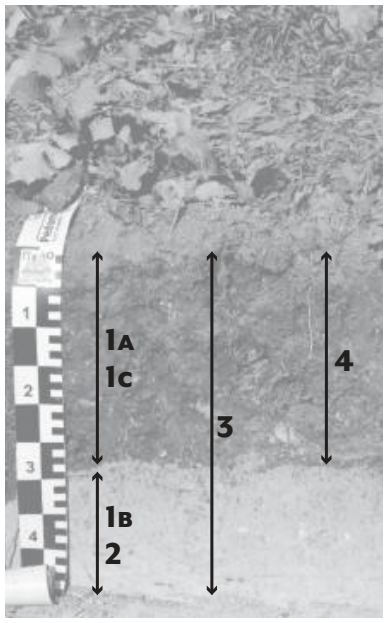
4 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

5 – Pachic

mollic horizon ≥50 cm thick.

Calcic KASTANOZEM (Siltic, Aric)



1 – KASTANOZEM

1A *mollic horizon* – thick, dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and high base saturation.

1B *calcic horizon* starting ≤70 cm of the mineral soil surface.

1C base saturation ≥50% from the mineral soil surface to the *calcic horizon*.

2 – Calcic

calcic horizon with calcium carbonate ≥15% and distinct accumulation of secondary carbonates starting ≤100 cm.

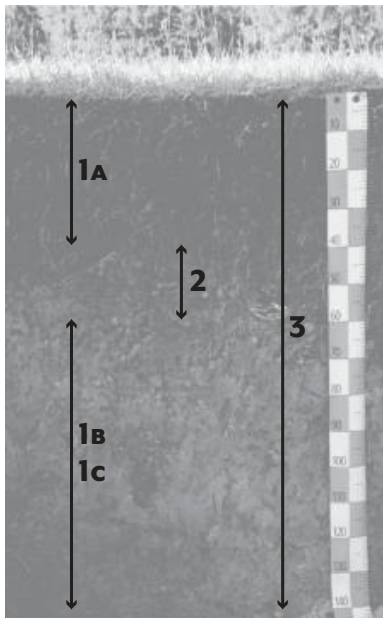
3 – Siltic

texture class of silt or silt loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Aric

plough layer, ≥10 cm thick – homogenized by ploughing and with very abrupt lower boundary.

Cambic KASTANOZEM (Loamic)



1 – KASTANOZEM

1A *mollic horizon* – thick, dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and high base saturation.

1B *protocalcic properties* starting ≤70 cm of the mineral soil surface.

1C base saturation ≥50% from the mineral soil surface to the *protocalcic horizon*.

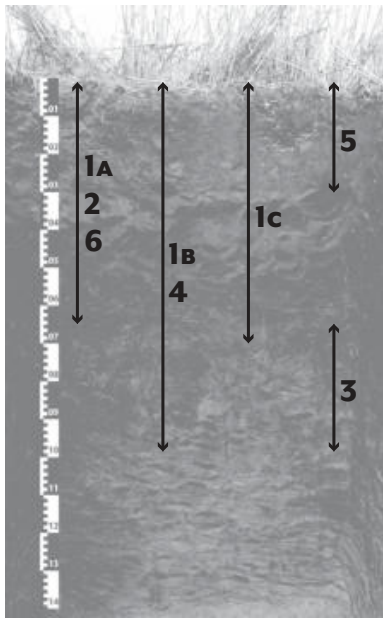
2 – Cambic

cambic horizon starting ≤50 cm from the mineral soil surface. Higher oxide contents visible by more intensive colour than in underlying layer. Soil aggregate structure at least in half of the volume of the fine earth.

3 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

Luvic Chernic PHAEOZEM (Siltic, Aric, Solimovic)



1 – PHAEOZEM

1A *chernic horizon* – thick, very dark (≥1.0% *soil organic carbon*) humus horizon with well developed structure and high base saturation.

1B high base saturation (relatively high pH values) to a depth of 100 cm from the mineral soil surface.

1C no *calcic horizon* or *protocalcic properties* starting ≤70 cm of the mineral soil surface.

2 – Chernic

chernic horizon.

3 – Luvic

argic horizon with evidence of clay illuviation, high-activity clays and high base saturation starting ≤100 cm from the mineral soil surface.

4 – Siltic

texture class of silt or silt loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

5 – Aric

plough layer, ≥10 cm thick – homogenized by ploughing and with very abrupt lower boundary.

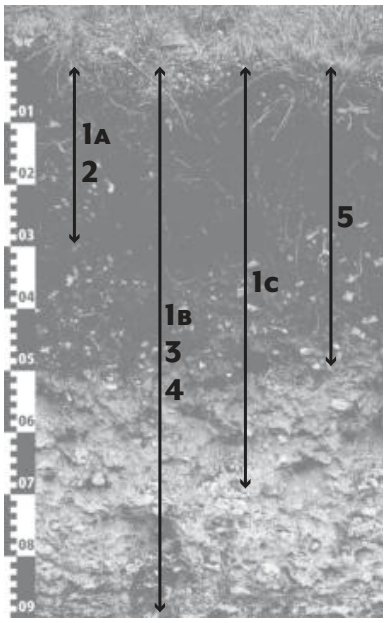
6 – Pachic

chernic horizon ≥50 cm thick.

7 – Solimovic

heterogeneous mixture of material that has moved downslope and accumulated in lower part of slope.

Skeletic Rendzic PHAEOZEM (Loamic, Humic)



1 – PHAEOZEM

1A *mollic horizon* – thick, dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and high base saturation.

1B high base saturation (relatively high pH values) to a depth of 100 cm from the mineral soil surface.

1C no *calcic horizon* or *protocalcic properties* starting ≤70 cm of the mineral soil surface.

2 – Rendzic

mollic horizon that contains or directly overlies calcareous rock containing ≥40% calcium carbonate equivalent.

3 – Skeletic

≥40% (by volume, related to the whole soil) coarse fragments averaged over a depth of 100 cm from the mineral soil surface.

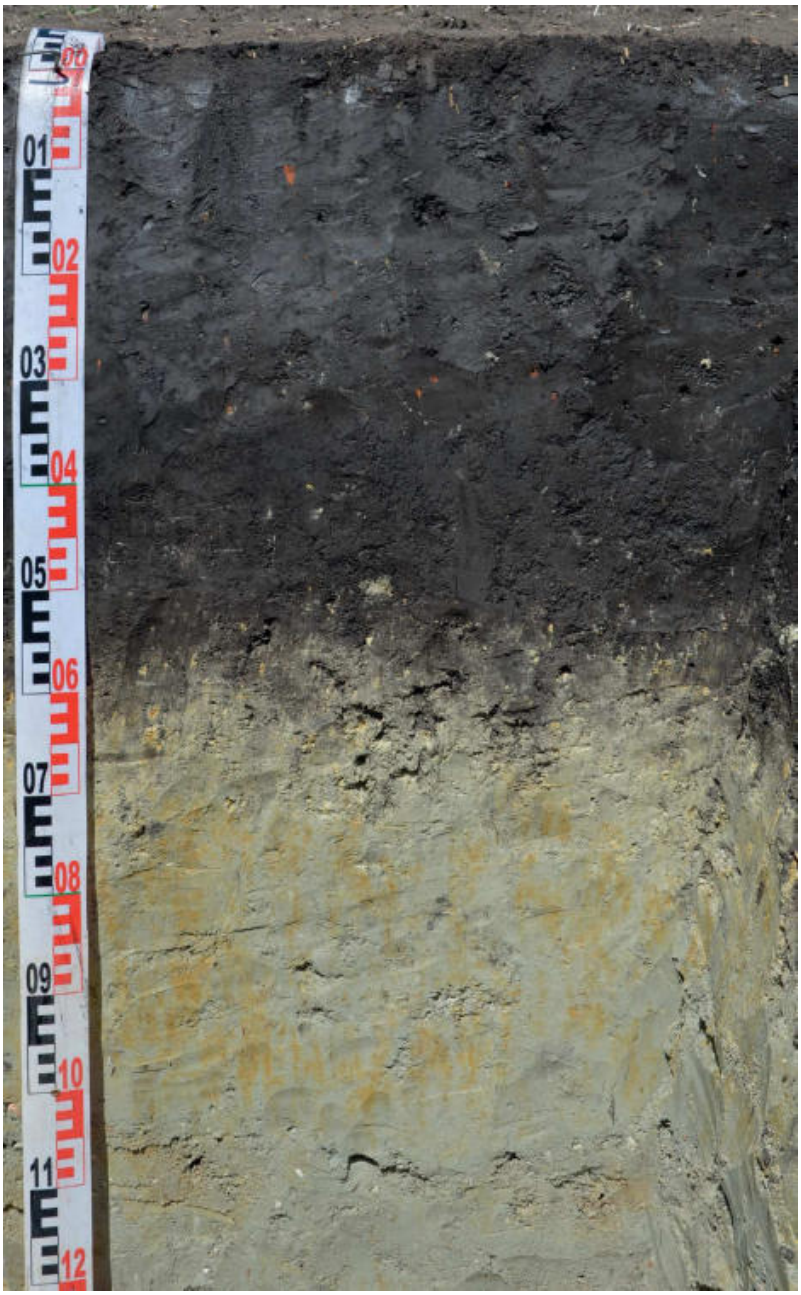
4 – Loamic

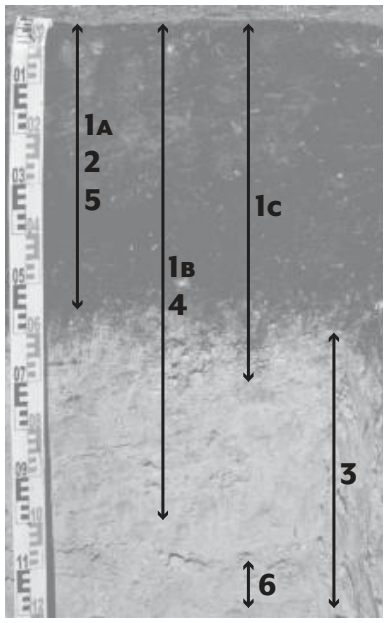
texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

5 – Humic

≥1% *soil organic carbon* as a weighted average to a depth of 50 cm.

Endogleyic Chernic PHAEOZEM (Siltic, Pachic, Bathycalcaric)





1 – PHAEOZEM

1A *chernic horizon* – thick, very dark (≥1.0% *soil organic carbon*) humus horizon with well developed structure and high base saturation.

1B high base saturation (relatively high pH values) to a depth of 100 cm from the mineral soil surface.

1C no *calcic horizon* or *protocalcic properties* starting ≤70 cm of the mineral soil surface.

2 – Chernic

chernic horizon.

3 – Endogleyic

gleyic properties and *reducing conditions* start ≥50 cm from the mineral soil surface.

4 – Siltic

texture class of silt or silt loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

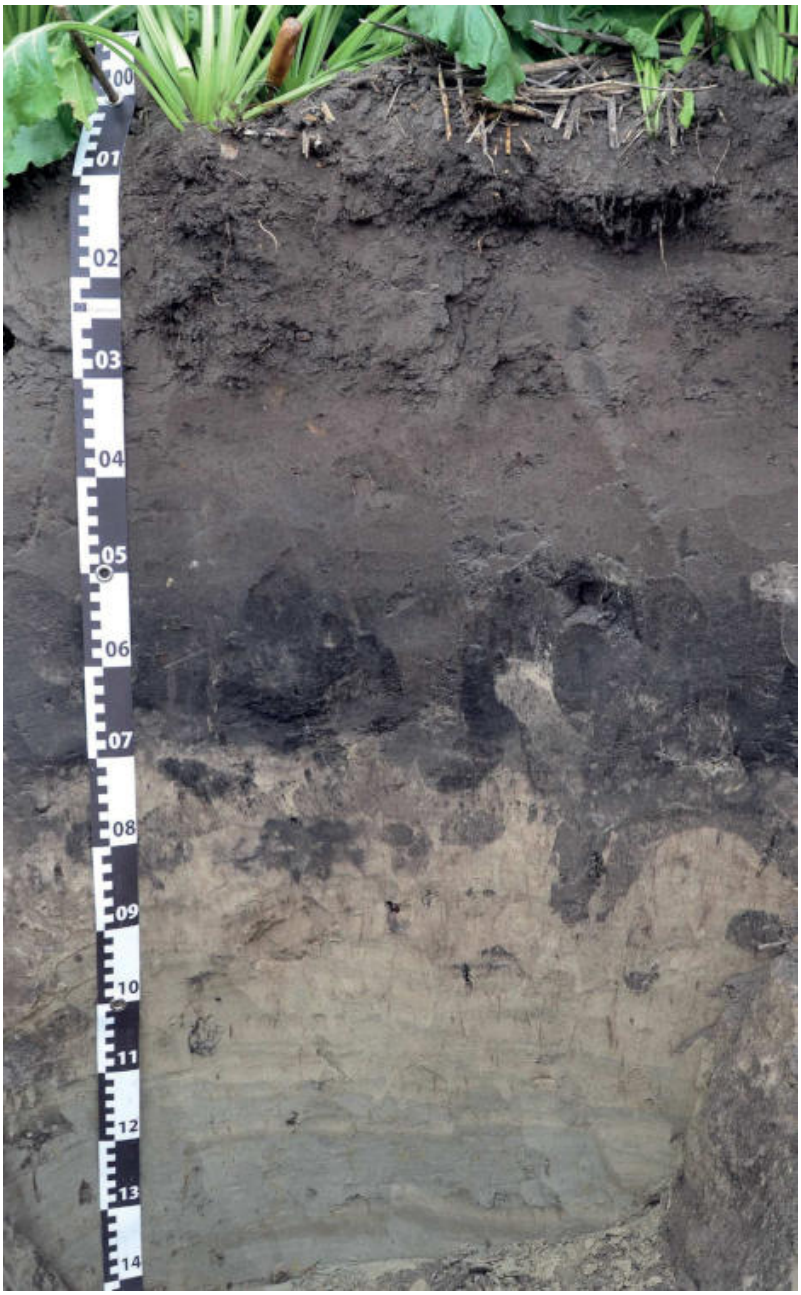
5 – Pachic

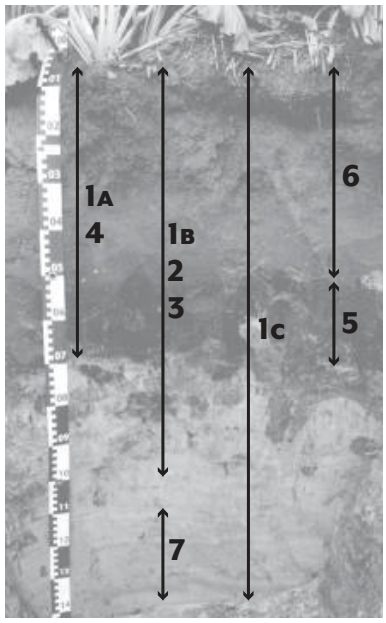
chernic horizon ≥50 cm thick.

6 – Bathycalcaric

calcaric material with ≥2% calcium carbonate equivalent. The carbonates are at least partially primary (inherited from the parent material). Starts >100 cm of the mineral soil surface Small withe spots on photo are pieces of calcareous rocks.

Haplic PHAEOZEM (Siltic, Pachic, Panpaic, Solimovic, Bathygleyic)





1 – PHAEOZEM

1A *mollic horizon* – thick, dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and high base saturation.

1B high base saturation (relatively high pH values) to a depth of 100 cm from the mineral soil surface.

1C no *calcic horizon* or *protocalcic properties* starting ≤70 cm of the mineral soil surface.

2 – Haplic

no other principal qualifier of the respective RSG applies.

3 – Siltic

texture class of silt or silt loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Pachic

mollic horizon ≥50 cm thick.

5 – Panpaic

buried mineral surface horizon with a significant amount of organic matter formed before having been buried.

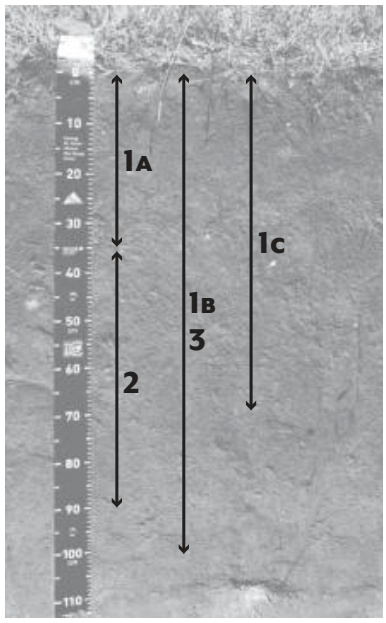
6 – Solimovic

material that has moved down-slope and accumulated in depression. Here has a distinctly brighter colour than buried A horizon.

7 – Bathygleyic

gleyic properties and *reducing conditions* start ≥100 cm from the mineral soil surface.

Calcaric PHAEOZEM (Arenic)



1 – PHAEOZEM

1A *mollic horizon* – thick, dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and high base saturation.

1B high base saturation (relatively high pH values) to a depth of 100 cm from the mineral soil surface.

1C no *calcic horizon* or *protocalcic properties* starting ≤70 cm of the mineral soil surface.

2 – Calcaric

≥2% calcium carbonate equivalent. The carbonates are at least partially primary (inherited from the parent material). Small withe spots on photo are pieces of calcareous rocks.

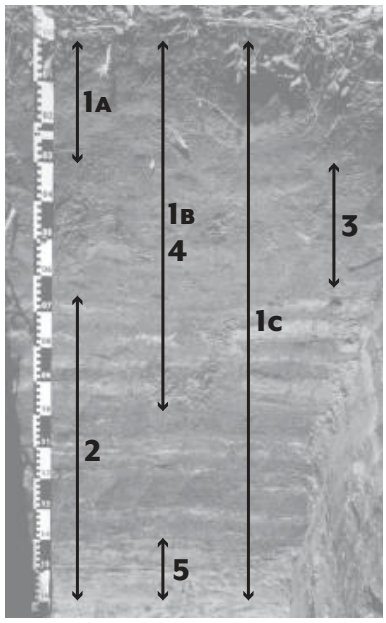
3 – Arenic

texture class of sand or loamy sand in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

REMARK

humus horizon is very thick but only upper 35 cm fulfil criterion of dark colour – necessary for *mollic horizon*.

Cambic Fluvic PHAEOZEM (Siltic, Bathygleyic)



1 – PHAEOZEM

1A *mollic horizon* – thick, dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and high base saturation.

1B high base saturation (relatively high pH values) to a depth of 100 cm from the mineral soil surface.

1C no *calcic horizon* or *protocalcic properties* starting ≤70 cm of the mineral soil surface.

2 – Fluvic

fluvic material, ≥25 cm thick and starting ≤75 cm from the mineral soil surface. Fluviatile origin of sediment is recognize by distinct stratification in ≥25% of its volume.

3 – Cambic

cambic horizon starting ≤50 cm from the mineral soil surface. Higher oxide contents visible by more intensive colour than in underlaying layer. Soil aggregate structure at least in half of the volume of the fine earth.

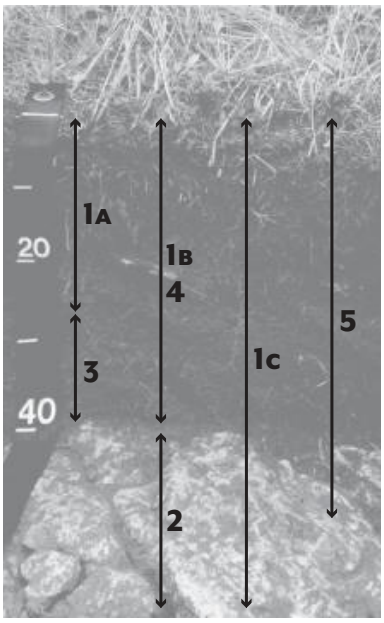
4 – Siltic

texture class of silt or silt loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

5 – Bathygleyic

gleyic properties and *reducing conditions* start ≥100 cm from the mineral soil surface.

Cambic Epileptic PHAEOZEM (Loamic, Hyperhumic)



1 – PHAEOZEM

1A *mollic horizon* – thick, dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and high base saturation.

1B high base saturation (relatively high pH values) to a *continuous rock*.

1C no *calcic horizon* or *protocalcic properties* starting ≤70 cm of the mineral soil surface.

2 – Epileptic

continuous rock starting >25 cm and ≤50 cm from the soil surface.

3 – Cambic

cambic horizon starting ≤50 cm from the mineral soil surface. Higher oxide contents visible by more intensive colour than in overlaying layer. Soil aggregate structure at least in half of the volume of the fine earth.

4 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in the major part between the mineral soil surface and a *continous rock*.

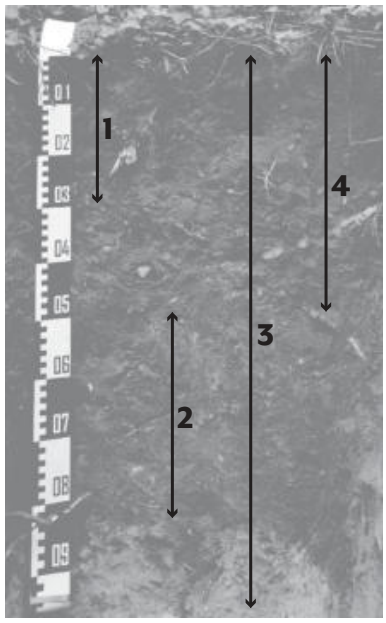
5 – Hyperhumic

≥5% *soil organic carbon* as a weighted average to a depth of 50 cm from the mineral soil surface

REMARK

due to the *continuous rock* – the colour of the *cambic horizon* is compared with the overlaying material.

Luvic UMBRISOL (Loamic, Humic)



1 – UMBRISOL

umbric horizon – thick, dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and low base saturation.

2 – Luvic

argic horizon with evidence of clay illuviation, high-activity clays and high base saturation starting ≤100 cm from the mineral soil surface.

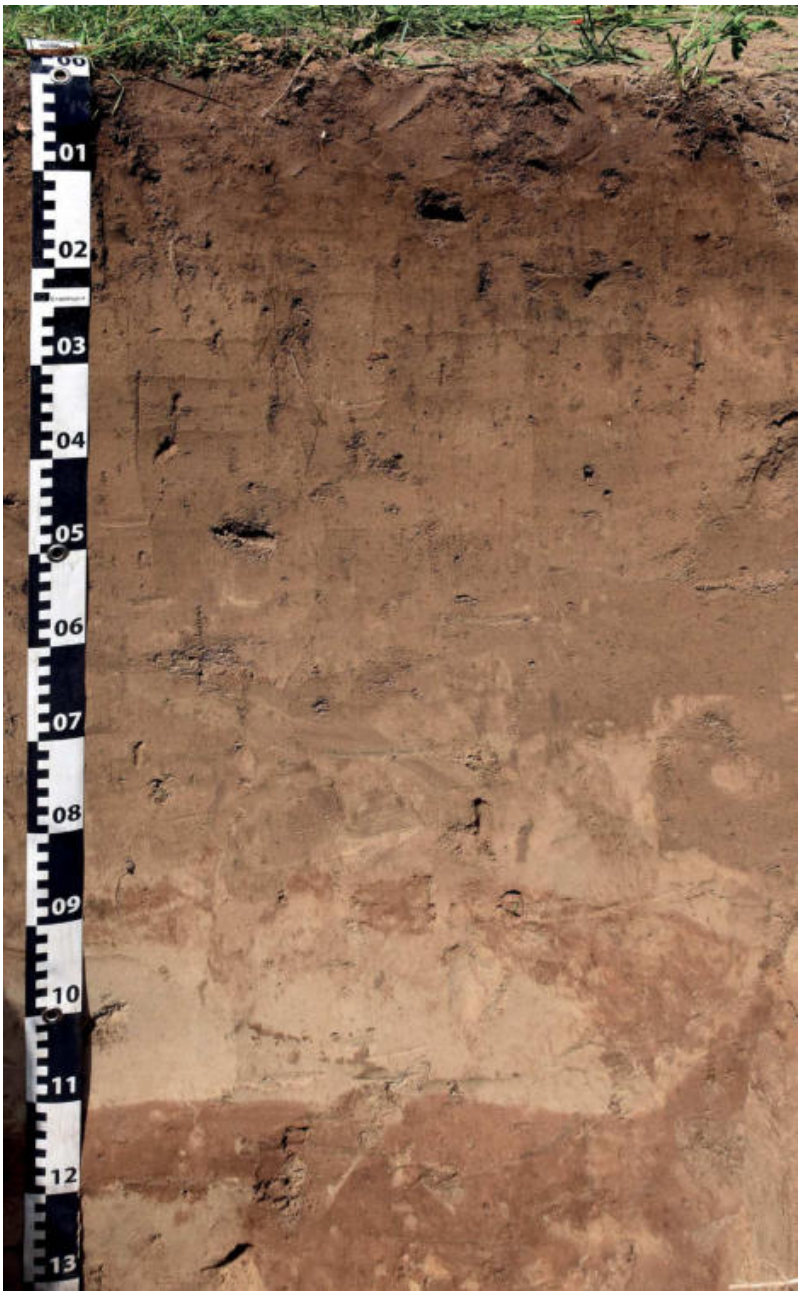
3 – Loamic

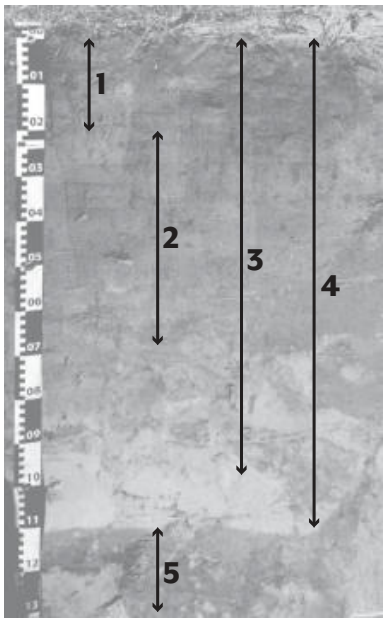
texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Humic

≥1% *soil organic carbon* as a weighted average to a depth of 50 cm.

Brunic UMBRISOL (Arenic, Relocatic, Bathyloamic)





1 – UMBRISOL

umbric horizon – relatively thick, dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and low base saturation.

2 – Brunic

Bw horizon with material which has a texture class of sand, pedogenetic structure, alteration of colour - brownish compared to the directly underlying layer, does not form part of other diagnostic horizon or plough layer.

3 – Arenic

texture class of sand or loamy sand in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

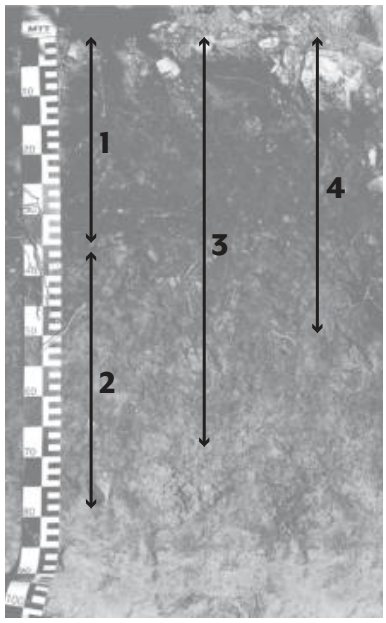
5 – Bathyloamic

loamy material starts ≥100 cm from the mineral soil surface.

4 – Relocatic

being remodelled *in situ* or within the immediate vicinity by human activity to a depth of ≥100 cm (e.g. by deep ploughing, refilling soil pits or levelling land).

Cambic UMBRISOL (Loamic, Humic)



1 – UMBRISOL

umbric horizon – thick, dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and low base saturation.

2 – Cambic

cambic horizon starting ≤50 cm from the mineral soil surface. Higher oxide contents visible by more intensive colour than in underlaying layer. Soil aggregate structure at least in half of the volume of the fine earth.

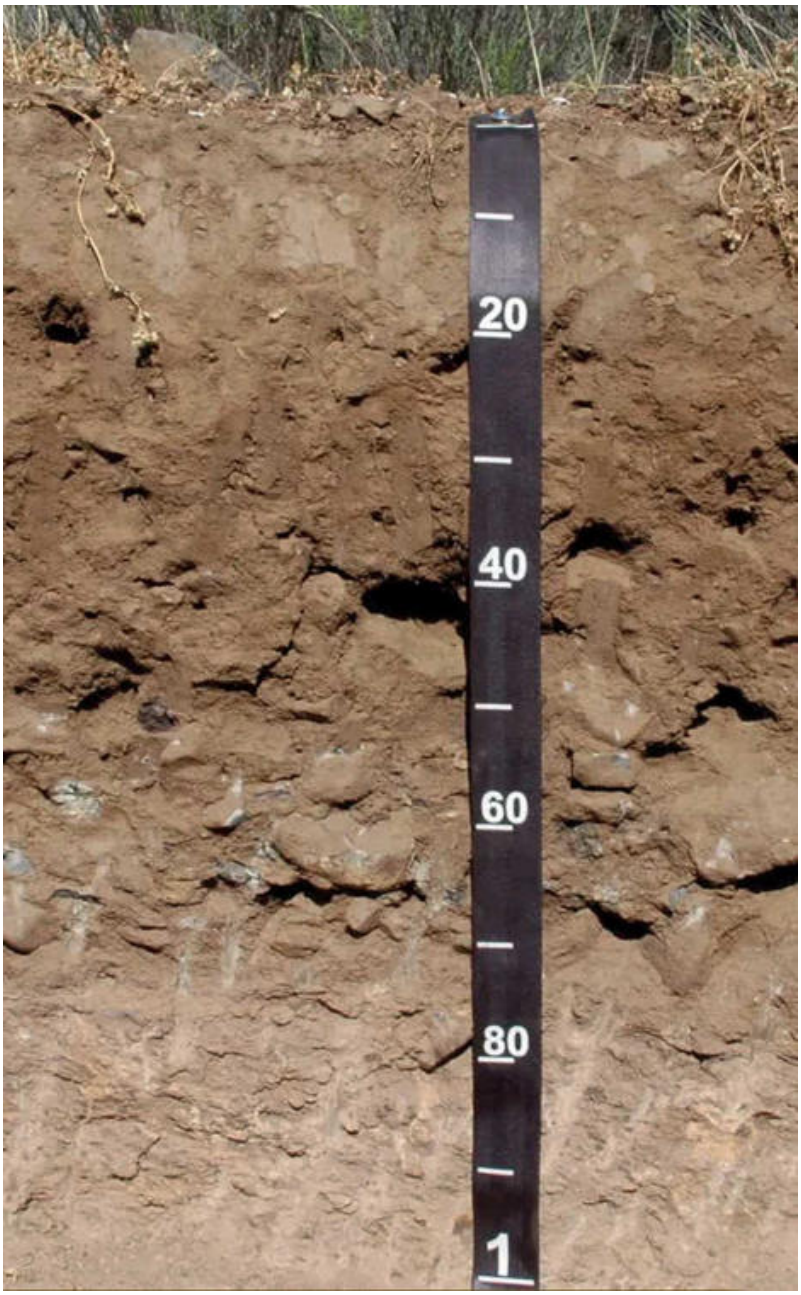
3 – Loamic

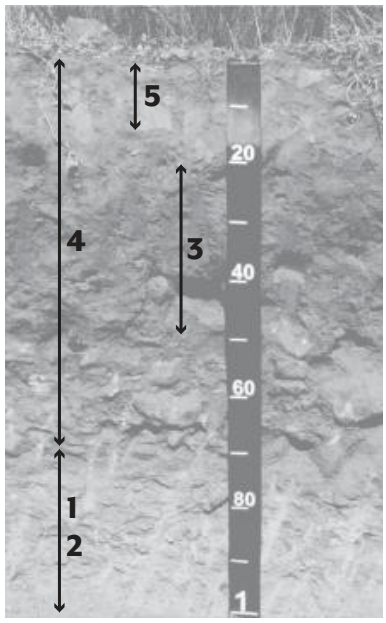
texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Humic

≥1% *soil organic carbon* as a weighted average to a depth of 50 cm.

Lixic Petric DURISOL (Loamic, Ochric)





1 – DURISOL

petroduric horizon also known as duripan (United States) or dorbank (South Africa), reddish brown in colour, cemented mainly by illuvial secondary silica, starting ≤100 cm from the mineral soil surface (photo: Peter Schad).

2 – Petric

cemented diagnostic horizon starting ≤100 cm from the mineral soil surface.

3 – Lixic

clay-illuvial *argic horizon* with low-activity clays and high base saturation.

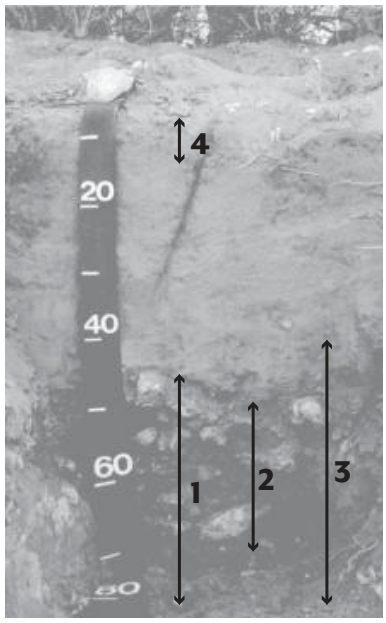
4 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

5 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Luvic DURISOL (Loamic, Ochric)



1 – DURISOL

duric horizon contains fragments of a broken-up *petroduric horizon* – visible on photo cemented by illuvial silica stone-like pieces, starting ≤100 cm from the mineral soil surface (photo: Peter Schad).

2 – Luvic

argic horizon with evidence of clay illuviation, high-activity clays and high base saturation starting ≤100 cm from the mineral soil surface.

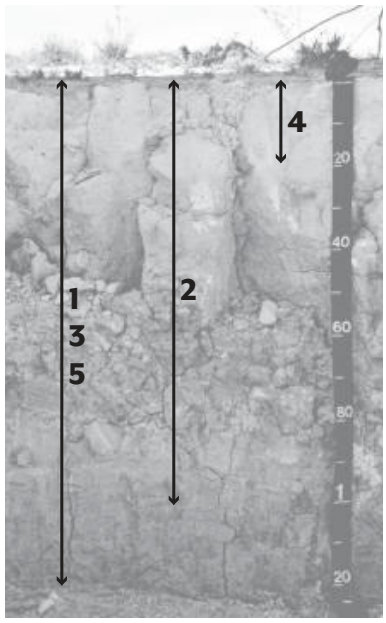
3 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Haplic GYPSISOL (Siltic, Ochric, Gypsiric)



1 – GYPSISOL

gypsic horizon (non-cemented horizon containing accumulations of secondary gypsum) starting ≤100 cm and mostly without other diagnostic horizons above it.

2 – Haplic

no other principal qualifier of the respective RSG applies.

3 – Siltic

texture class of silt or silt loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

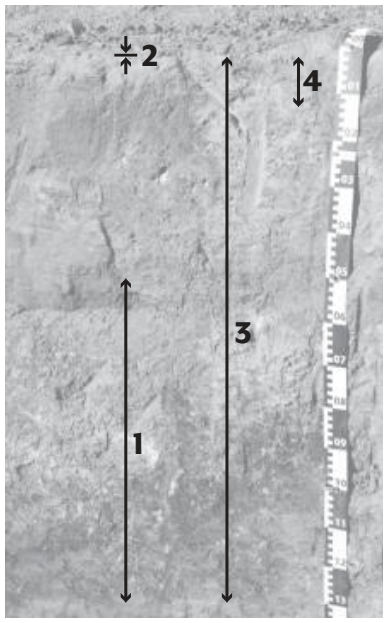
4 – Ochric

weakly developed, thin humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

5 – Gypsiric

gypsiric material contains ≥5% gypsum that is not secondary gypsum.

Yermic GYPSISOL (Loamic, Ochric)



1 – GYPSISOL

gypsic horizon (non-cemented horizon containing accumulations of secondary gypsum) starting ≤100 cm and mostly without other diagnostic horizons above it.

2 – Yermic

yermic properties with desert pavement, desert varnish, ventifacts (windkanters), a platy structure and vesicular pores.

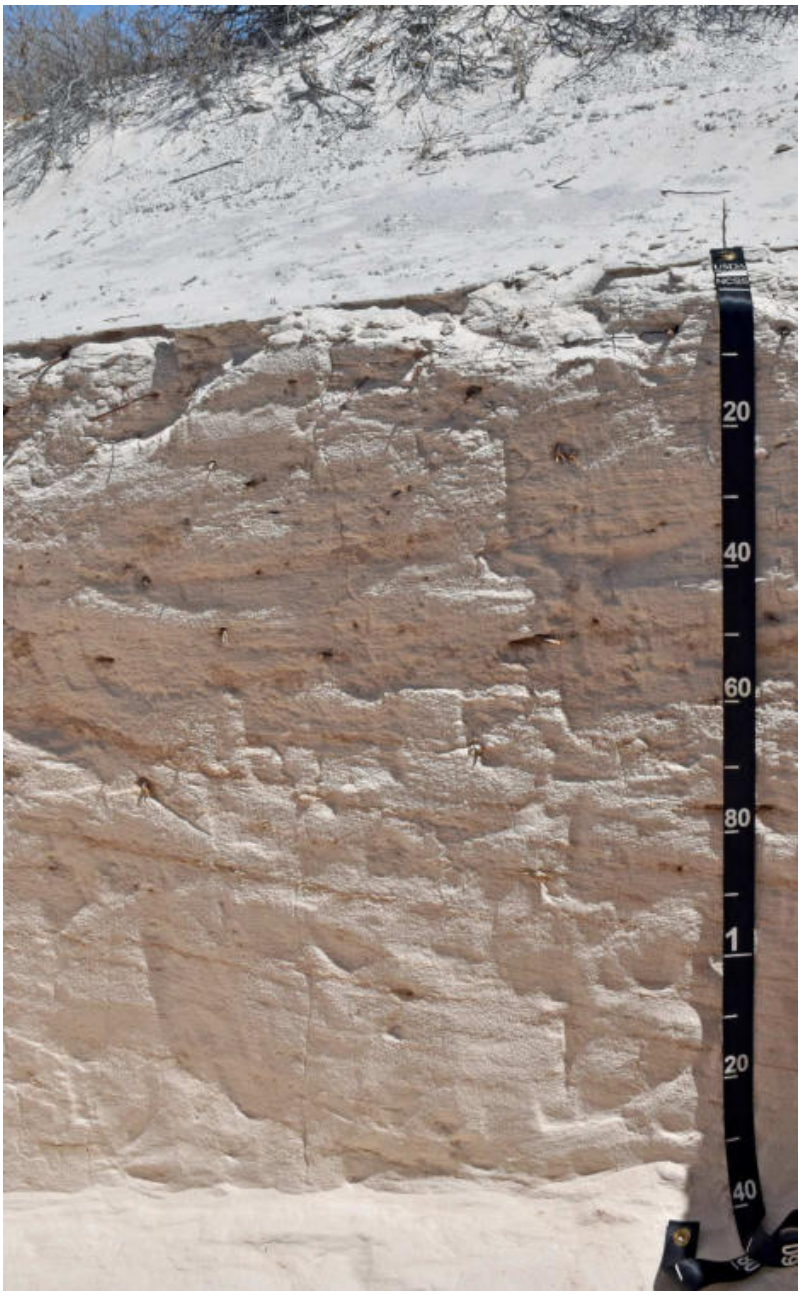
3 – Loamic

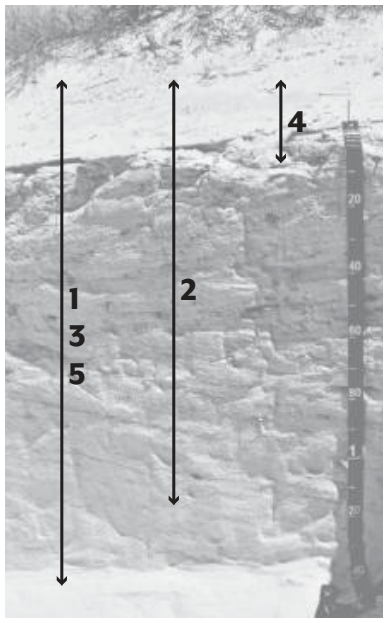
texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Ochric

weakly developed, thin humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Haplic GYPSISOL (Arenic, Aeolic, Gypsiric)





1 – GYPSISOL

gypsic horizon (non-cemented horizon containing accumulations of secondary gypsum) starting ≤100 cm and mostly without other diagnostic horizons above it.

REMARK

this soil is made of gypsum sand in which secondary forms of gypsum accumulation have been formed.

2 – Haplic

no other principal qualifier of the respective RSG applies.

3 – Arenic

texture class of sand or loamy sand in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

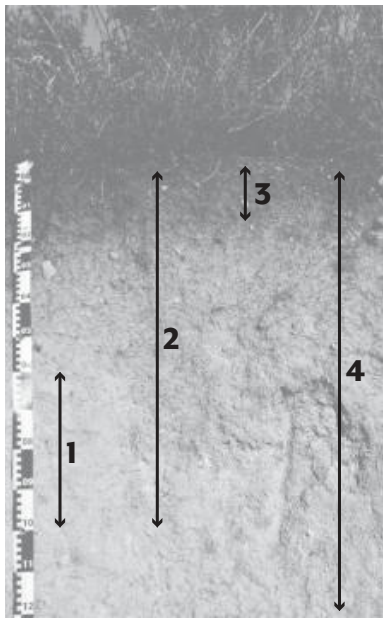
4 – Aeolic

aeolic material with low amount of humus (<1% *soil organic carbon* from the mineral soil surface to a depth of 10 cm) deposited by wind, typical in arid and semi-arid environments. Sand grains are often rounded or subangular and have a matt surface.

5 – Gypsiric

gypsiric material contains ≥5% gypsum that is not secondary gypsum.

Haplic CALCISOL (Ochric, Siltic)



1 – CALCISOL

calcic horizon (calcium carbonate ≥15% and distinct accumulation of secondary carbonates) starting ≤100 cm and mostly without other diagnostic horizons above it.

2 – Haplic

no other principal qualifier of the respective RSG applies.

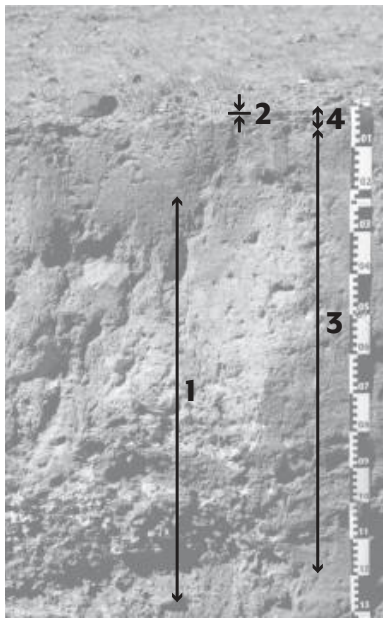
3 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

4 – Siltic

texture class of silt or silt loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

Yermic CALCISOL (Loamic, Ochric)



1 – CALCISOL

calcic horizon (calcium carbonate ≥15% and distinct accumulation of secondary carbonates) starting ≤100 cm and mostly without other diagnostic horizons above it.

2 – Yermic

yermic properties with desert pavement, desert varnish, ventifacts (windkanters), a platy structure and vesicular pores.

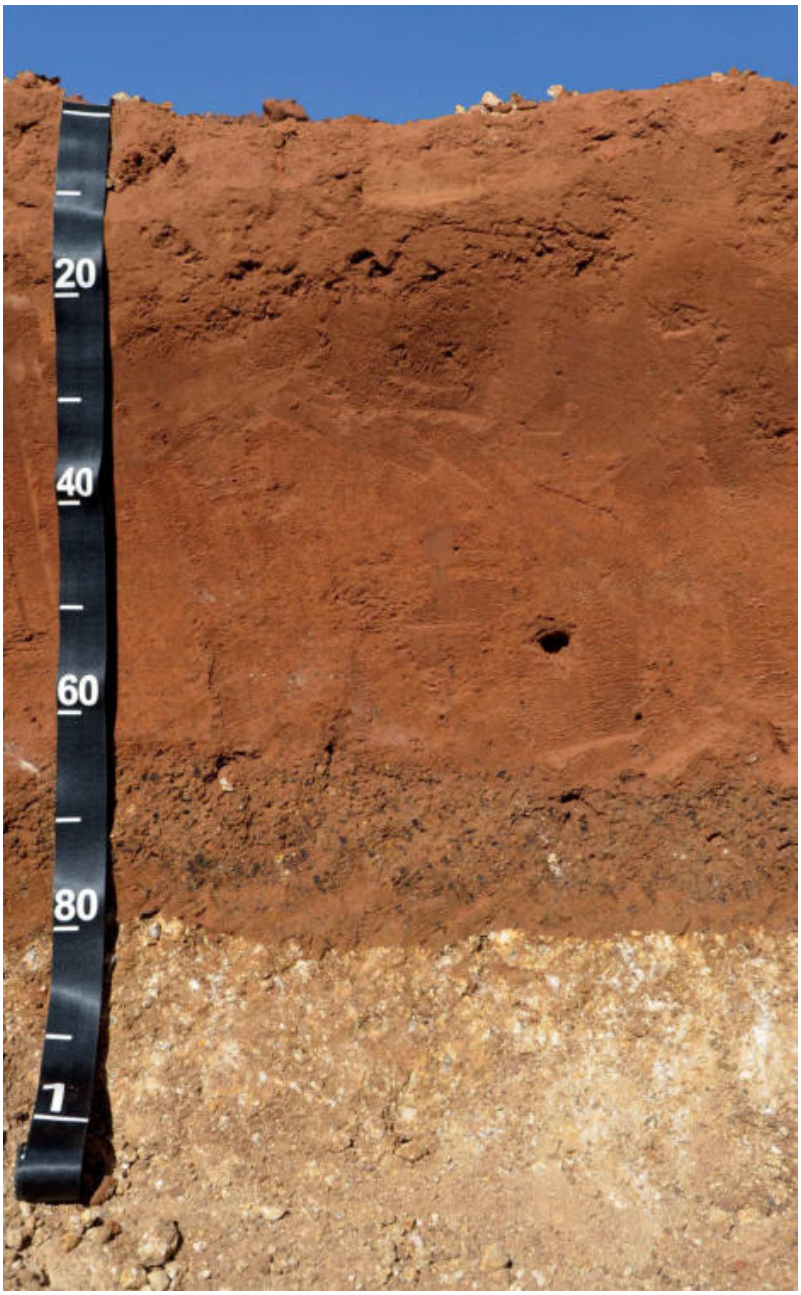
3 – Loamic

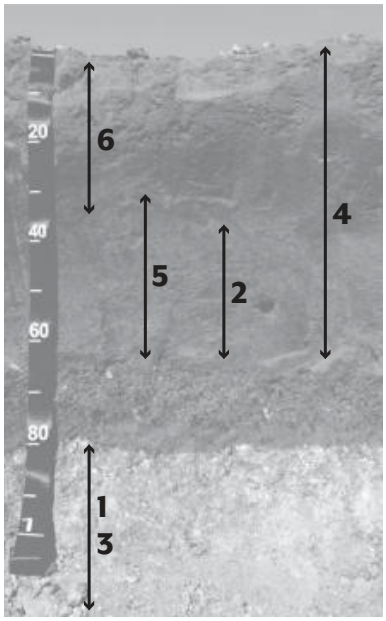
texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Luvic Petric CALCISOL (Loamic, Chromic, Ochric)





1 – CALCISOL

petrocalcic horizon cemented, at least partially by secondary carbonates starting ≤100 cm and mostly without other diagnostic horizons above it (except B-*in situ* developed horizons typical for Cambisols).

REMARKS

1) at depth 65-75 cm is a layer with high concentration of nodules that are at least moderately cemented by Fe. Only the thickness is not enough for *pisoplinthic horizon*.

2) *argic horizon* has secondary carbonates, throughout. If not – the soil could not be classified as Calcisol.

2 – Petric

cemented diagnostic horizon starting ≤100 cm from the mineral soil surface.

3 – Luvic

argic horizon with high-activity clays and high base saturation. In this case it contains secondary carbonates, throughout.

4 – Loamic

loamy material in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

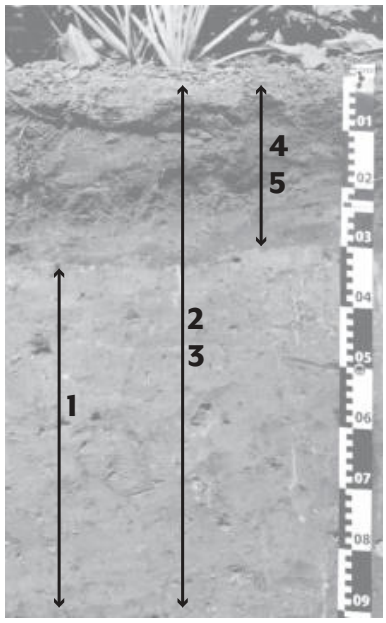
5 – Chromic

evidence of pedogenesis and intensively red colour in zone with at least 30 cm.

6 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Haplic CALCISOL (Loamic, Aric, Ochric)



1 – CALCISOL

calcic horizon (calcium carbonate ≥15% and distinct accumulation of secondary carbonates) starting ≤100 cm and mostly without other diagnostic horizons above it.

REMARK

such Calcisols can be found in wet climate as a result of soil erosion and truncation of soil profiles.

2 – Haplic

no other principal qualifier of the respective RSG applies.

3 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

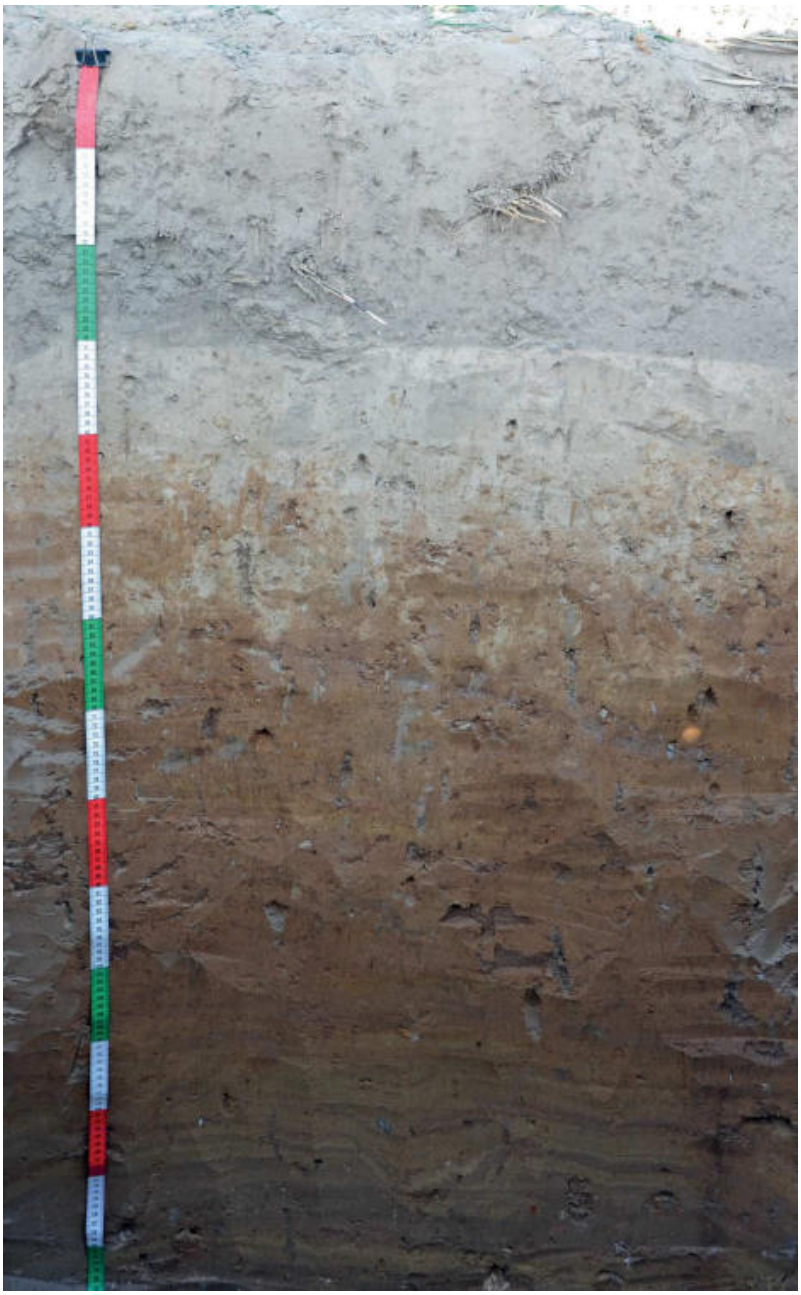
4 – Aric

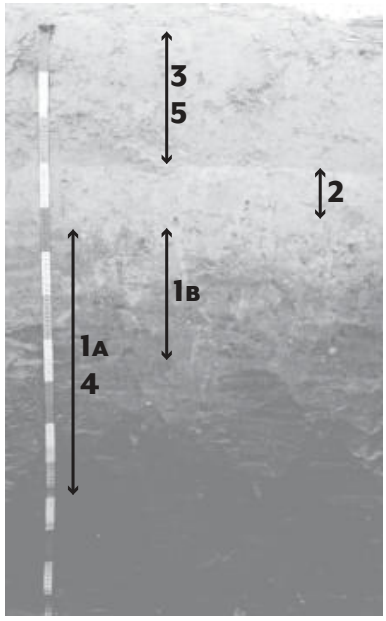
layer, ≥10 cm thick and starting at the soil surface, that is homogenized by ploughing and that has an abrupt or very abrupt lower boundary.

5 – Ochric

humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil but not well enough developed to be classified as diagnostic (too light in colour in this case).

Albic RETISOL (Epiarenic, Endoloamic, Aric, Cutanic, Ochric)





1 – RETISOL

1A *argic horizon* starting ≤100 cm from the mineral soil surface.

1B interfingering of coarser--textured, bleached *claric material* into (30 cm deep) a finer-textured *argic horizon*.

2 – Albic

light-coloured, eluvial *albic horizon* starting ≤100 cm from the mineral soil surface.

3 – Aric

plough layer, ≥10 cm thick.

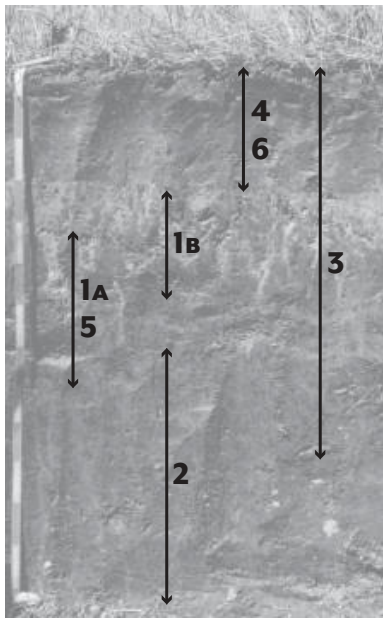
4 – Cutanic

evidence of clay illuviation in form of coatings on soil aggregates and biopore walls.

5 – Ochric

not diagnostic (too light in colour) humus horizon.

Endostagnic RETISOL (Loamic, Aric, Cutanic, Ochric)



1 – RETISOL

1A *argic horizon* starting ≤100 cm from the mineral soil surface.

1B interfingering of coarser--textured, bleached *claric material* into (30 cm deep) a finer-textured *argic horizon*.

2 – Endostagnic

layer, ≥25 cm thick and starting >50 and ≤75 cm from the mineral soil surface with *stagnic properties* (reductimorphic and oximorphic features ≥25%) and *reducing conditions*.

3 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Aric

plough layer, ≥10 cm thick.

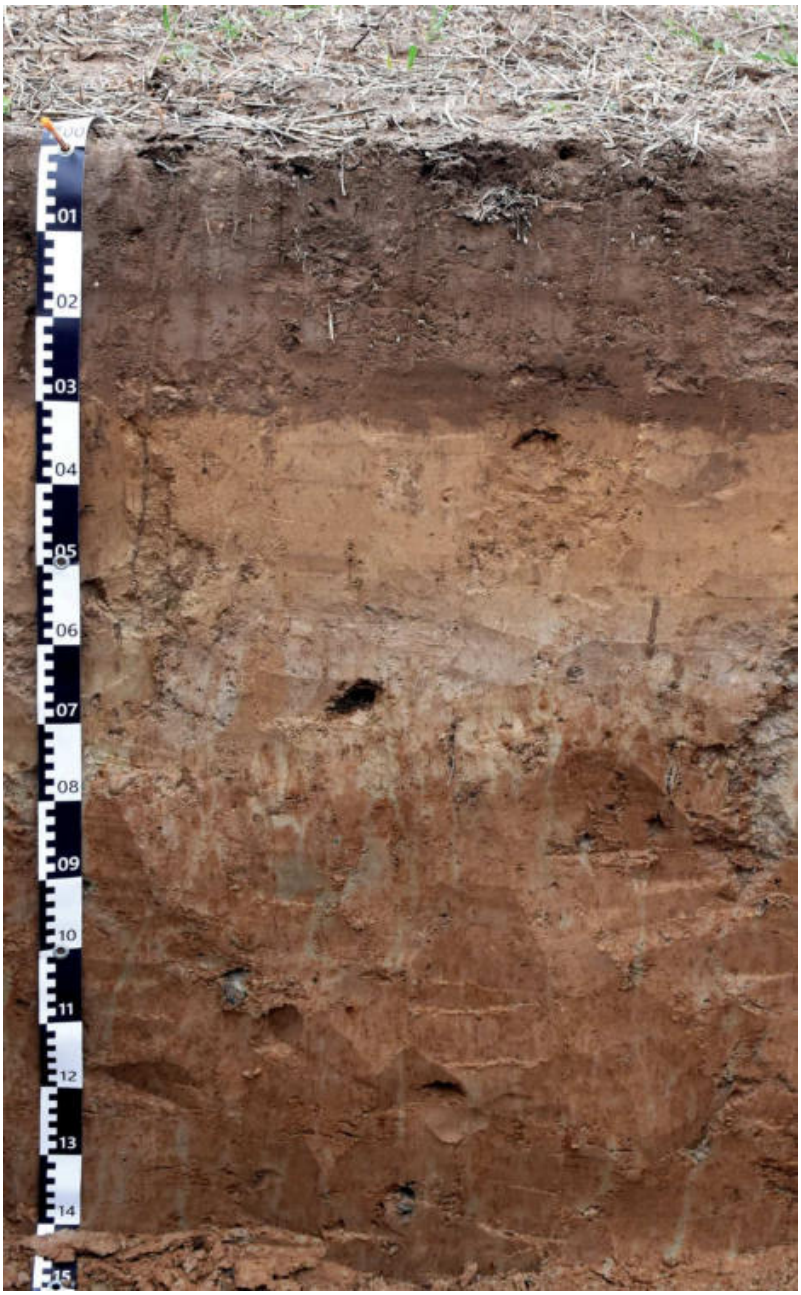
5 – Cutanic

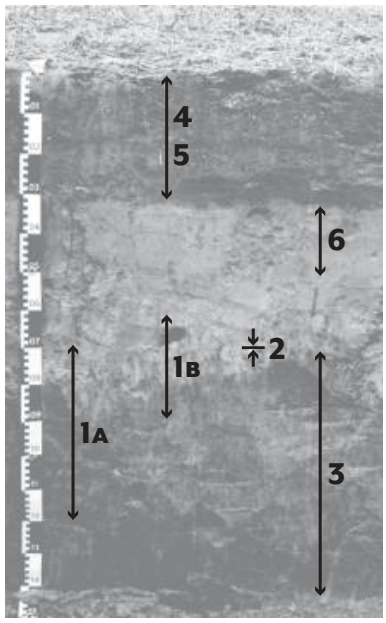
evidence of clay illuviation in form of coatings on soil aggregates and biopore walls.

6 – Ochric

not diagnostic (too light in colour) humus horizon.

Endostagnic Abruptic RETISOL (Anoarenic, Endoloamic, Aric, Cutanic, Ochric)





1 – RETISOL

1A *argic horizon* starting ≤100 cm from the mineral soil surface.

1B interfingering of coarser--textured, bleached *claric material* into (30 cm deep) a finer-textured *argic horizon*.

REMARK

similar to Planosol but oxi/reductimorphic features near to abrupt textural are vvtoo weakly expressed.

2 – Abruptic

abrupt textural difference (here sand on loam) within 100 cm of the mineral soil surface.

3 – Endostagnic

layer, ≥25 cm thick and starting >50 cm and ≤75 cm from the mineral soil surface with *stagnic properties* (reductimorphic and oximorphic features ≥25%) and *reducing conditions*.

4 – Aric

plough layer, ≥10 cm thick.

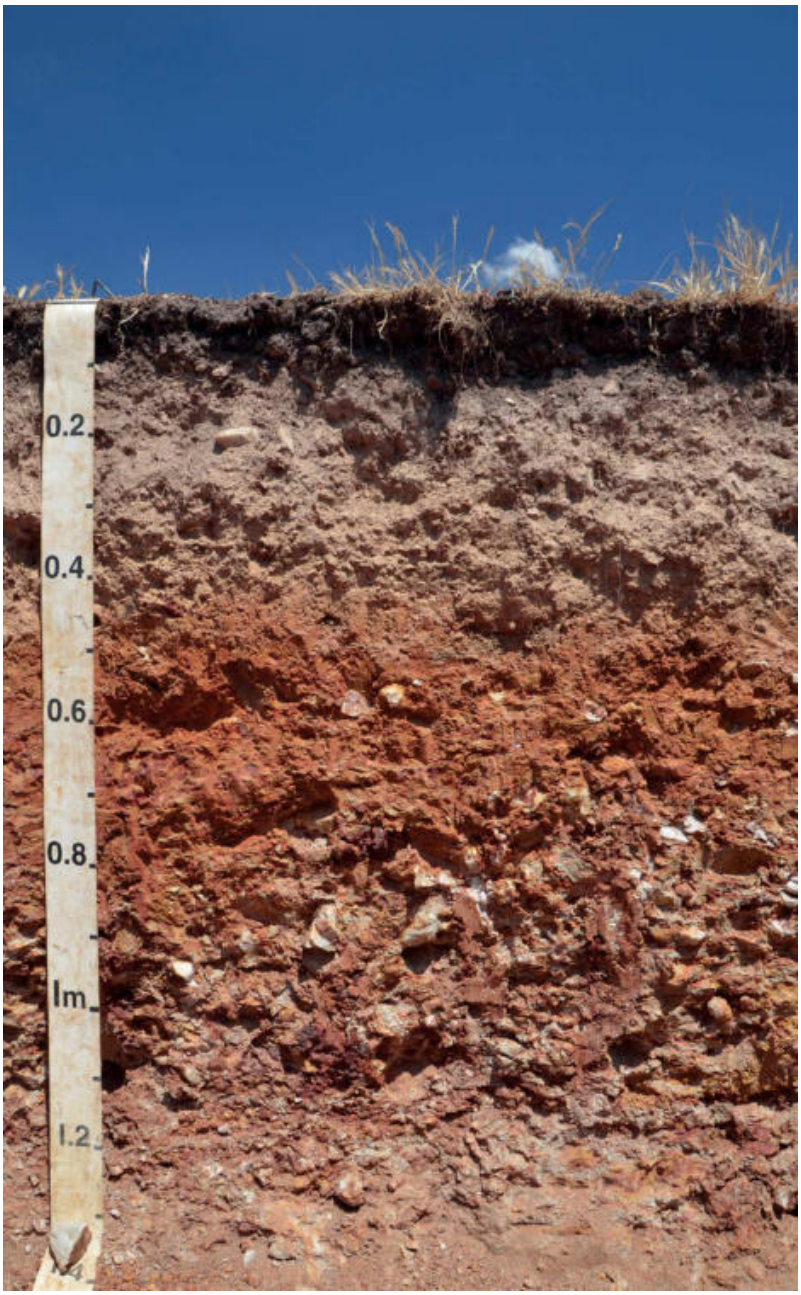
5 – Ochric

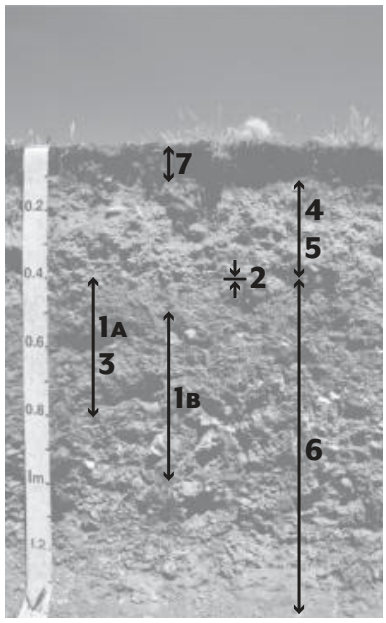
not diagnostic (too light in colour) humus horizon.

6 – Brunic

Bw horizon - similar to *cambic horizon* but sandy.

Albic Chromic Abruptic ACRISOL (Epiloamic, Katoclayic, Ochric)





1 – ACRISOL

1A clay-illuvial *argic horizon* with low-activity clays (developed from highly weathered, old materials).

1B low base saturation (low pH values) in half of more of the depth of 50-100 cm.

2 – Abruptic

abrupt textural difference (here loam on clay) within 100 cm of the mineral soil surface.

3 – Chromic

shows evidence of pedogenesis and intensively red colour in zone with at least 30 cm.

4 – Albic

albic horizon starting ≤100 cm from the mineral soil surface

5 – Epiloamic

loamy material with thickness of ≥30 cm with lower limit ≤50 cm of the mineral soil surface.

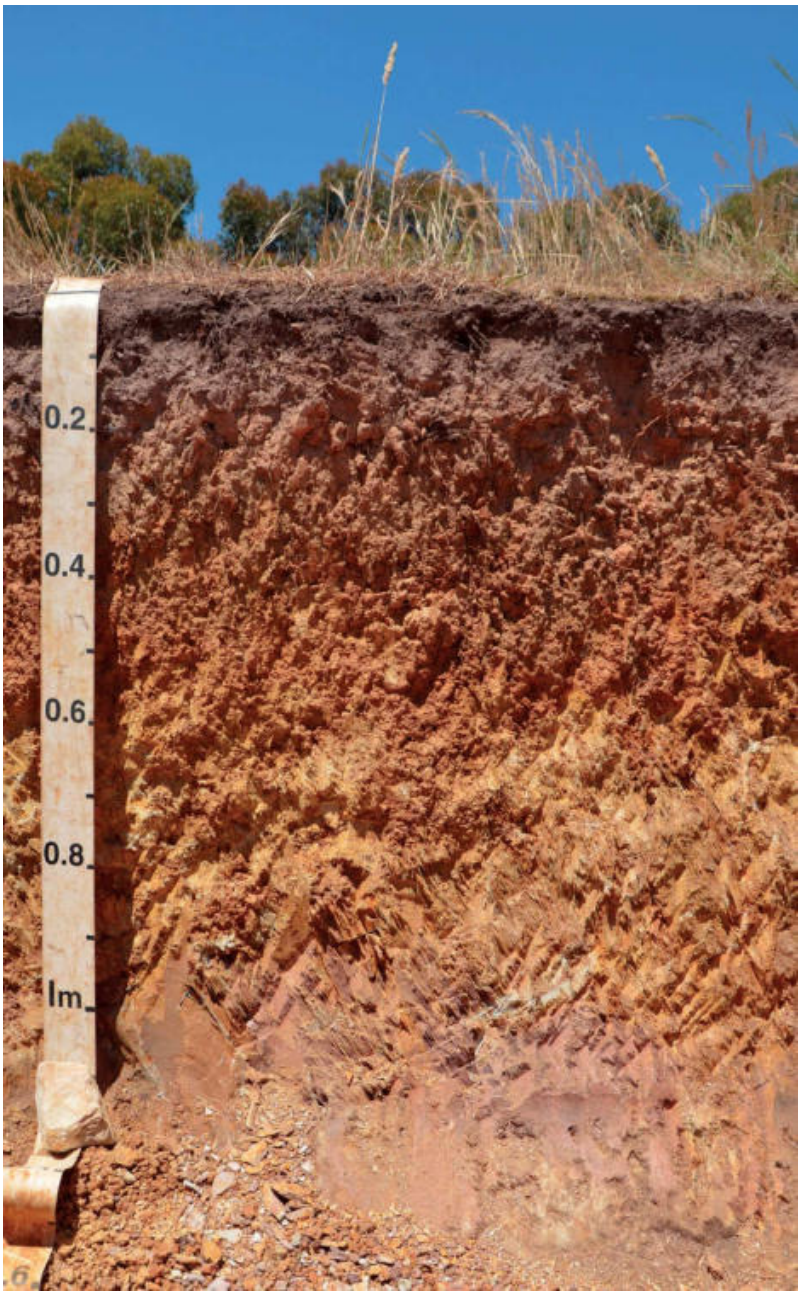
6 – Katoclayic

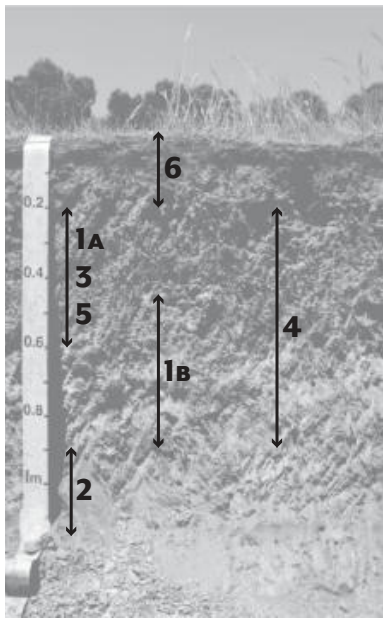
clayic material starts >0 and <50 cm from the (mineral) soil surface and has its lower limit ≥100 cm of the (mineral) soil surface.

7 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Chromic Leptic ACRISOL (Clayic, Cutanic, Ochric)





1 – ACRISOL

1A clay-illuvial *argic horizon* with low-activity clays (developed from highly weathered, old materials).

1B low base saturation (low pH values) in half of more of lower half of the mineral soil above a continuous rock (here at 90 cm).

2 – Leptic

continuous rock starting >25 cm and ≤100 cm from the soil surface.

3 – Chromic

evidence of pedogenesis and intensively red colour in zone with at least 30 cm.

4 – Clayic

texture class of clay, sandy clay or silty clay in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

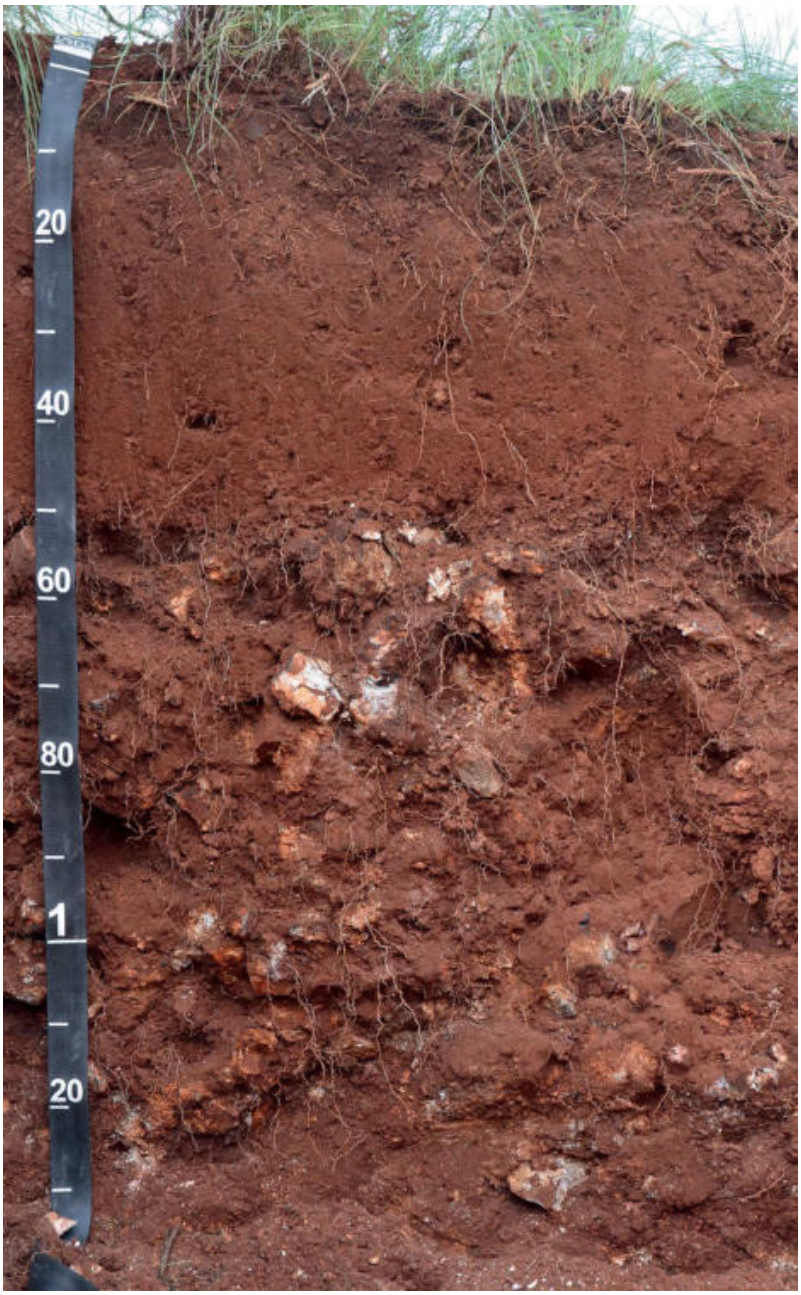
5 – Cutanic

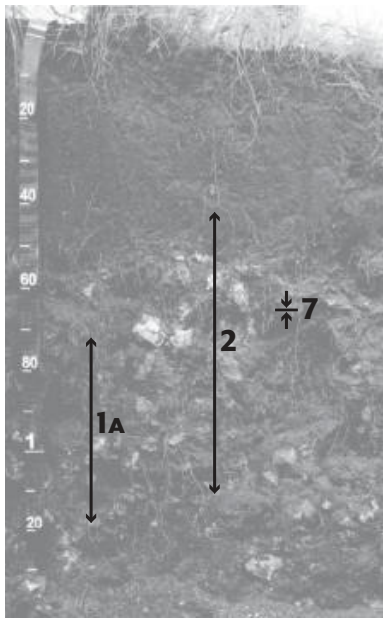
evidence of clay illuviation in form of clay coatings on soil aggregates.

6 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Endoskeletic Chromic LIXISOL (Loamic, Humic, Raptic)





1 – LIXISOL

1A clay-illuvial *argic horizon* with low-activity clays (developed from highly weathered, old materials).

1B high base saturation (relatively high pH values) in half of more of the depth range between 50 and 100 cm of the mineral soil surface.

2 – Chromic

evidence of pedogenesis and intensively red colour in zone with at least 30 cm.

3 – Endoskeletic

≥40% (by volume, related to the whole soil) coarse fragments averaged in the depth 50–100 cm from the mineral soil surface.

4 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

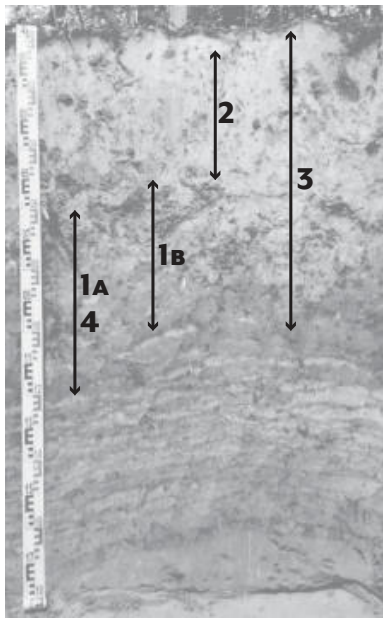
5 – Humic

≥1% *soil organic carbon* as a weighted average to a depth of 50 cm.

6 – Raptic

lithic discontinuity – differences in parent material.

Albic ALISOL (Siltic, Cutanic)



1 – ALISOL

1A clay-illuvial *argic horizon* with high-activity clays (developed from not highly weathered materials).

1B low base saturation (low pH values) in half of more of the depth 50-100 cm.

2 – Albic

light-coloured, eluvial *albic horizon* starting ≤100 cm from the mineral soil surface.

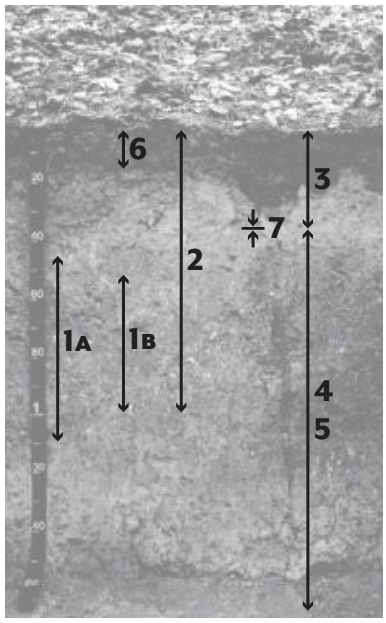
3 – Siltic

texture class of silt or silt loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Cutanic

evidence of clay illuviation in form of clay bridges connecting sand grains, coatings on soil aggregates and biopore walls.

Haplic ALISOL (Episiltic, Katoclayic, Cutanic, Humic, Raptic)



1 – ALISOL

1A clay-illuvial *argic horizon* with high-activity clays (developed from not highly weathered materials).

1B low base saturation (low pH values) in half of more of the depth 50-100 cm.

REMARK

whitish spots (below 45 cm) are pieces of siltstone and are not calcareous!

2 – Haplic

no other principal qualifier of the respective RSG applies.

3 – Episiltic

silty (silt or silt loam) material with thickness of ≥30 cm with lower limit ≤50 cm of the mineral soil surface.

4 – Katoclayic

clay material starts >0 and <50 cm from the (mineral) soil surface and has its lower limit ≥100 cm of the (mineral) soil surface.

5 – Cutanic

evidence of clay illuviation in form of clay coatings on soil aggregates.

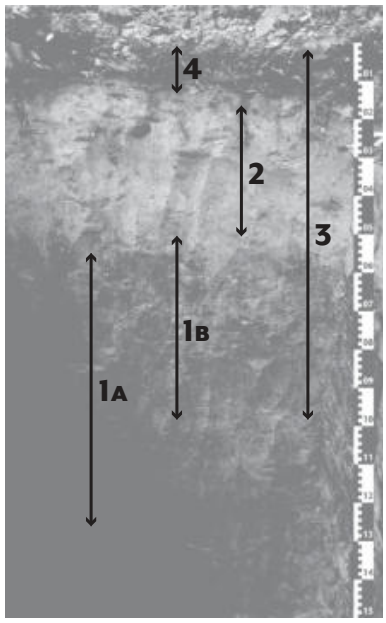
6 – Humic

≥1% *soil organic carbon* as a weighted average to a depth of 50 cm. In this case it was almost 5% in A horizon (0-18 cm).

7 – Raptic

lithic discontinuity.

Albic LUVISOL (Siltic, Ochric)



1 – LUVISOL

1A clay-illuvial *argic horizon* with high-activity clays (developed from not highly weathered materials).

1B high base saturation (relatively high pH values) in half of more of the depth range between 50 and 100 cm of the mineral soil surface.

2 – Albic

light-coloured, eluvial *albic horizon* starting ≤100 cm from the mineral soil surface.

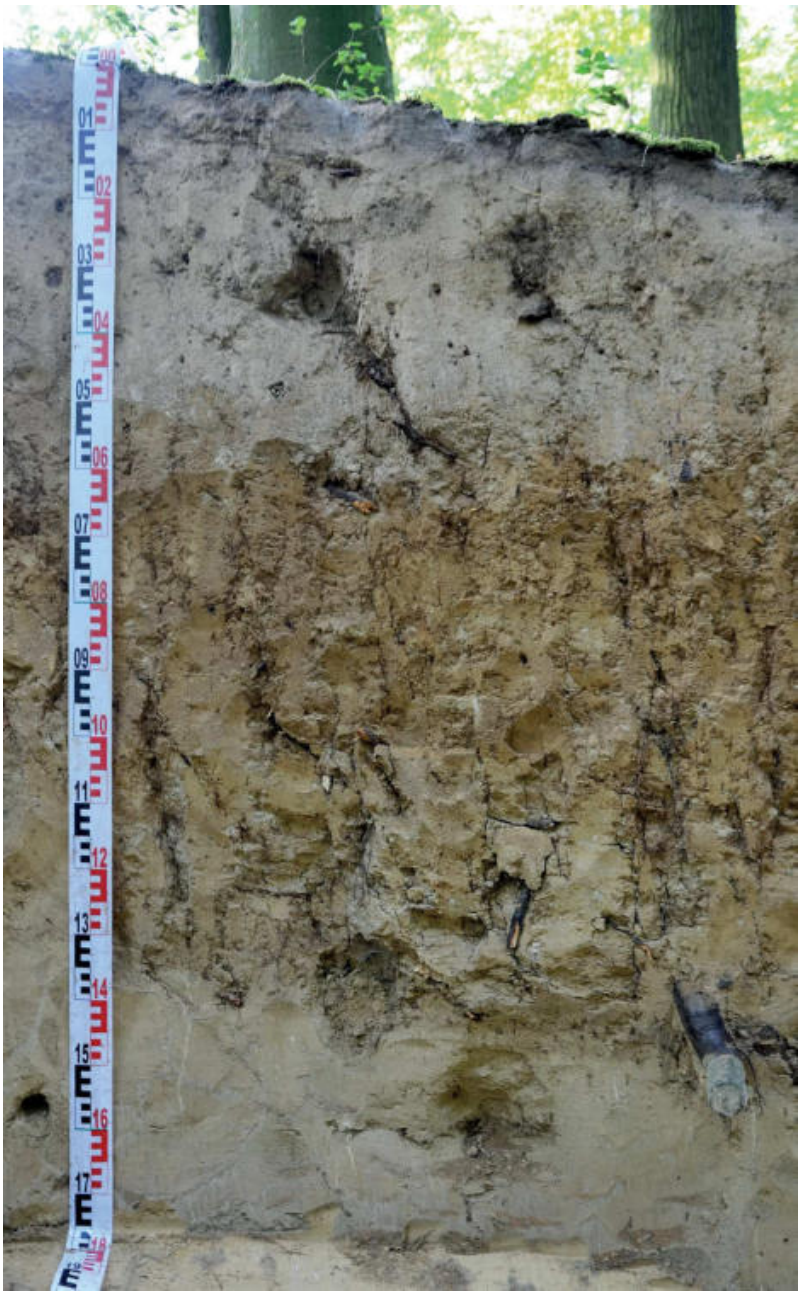
3 – Siltic

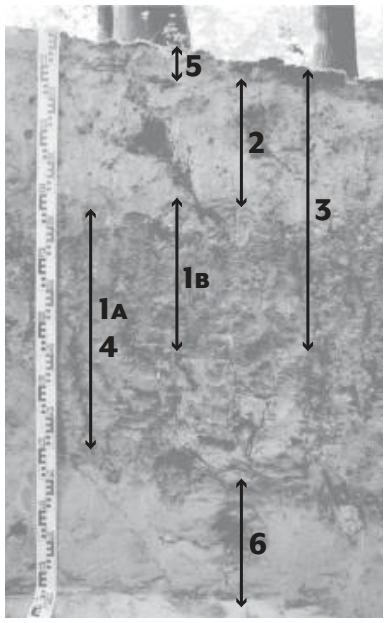
texture class of silt or silt loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Ochric

weakly developed, thin humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Albic LUVISOL (Siltic, Ochric)





1 – LUVISOL

1A clay-illuvial *argic horizon* with high-activity clays (developed from not highly weathered materials).

1B high base saturation (relatively high pH values) in half of more of the depth range between 50 and 100 cm of the mineral soil surface.

2 – Albic

light-coloured, eluvial *albic horizon* starting ≤100 cm from the mineral soil surface.

3 – Siltic

texture class of silt or silt loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Cutanic

evidence of clay illuviation in form of coatings on soil aggregates and biopore walls.

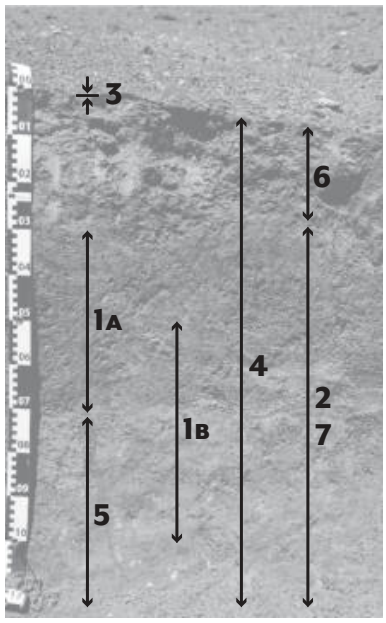
5 – Ochric

weakly developed, thin humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

6 – Bathycalcic

calcic horizon (calcium carbonate ≥15% and distinct accumulation of secondary carbonates) starting >100 cm from the mineral soil surface.

Yermic Chromic LUVISOL (Clayic, Protocalcic, Ochric, Protovertic)



1 – LUVISOL

1A clay-illuvial *argic horizon* with high-activity clays (developed from not highly weathered materials).

1B high base saturation (relatively high pH values) in half of more of the depth range between 50 and 100 cm of the mineral soil surface.

2 – Chromic

evidence of pedogenesis and intensively red colour in zone with at least 30 cm.

3 – Yermic

yermic properties with desert pavement, desert varnish, ventifacts (windkanters), a platy structure and vesicular pores.

4 – Clayic

texture class of clay, sandy clay or silty clay in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

5 – Protocalcic

secondary carbonates accumulation (e.g. nodules, concretions or filaments) less pronounced than in *calcic horizon*.

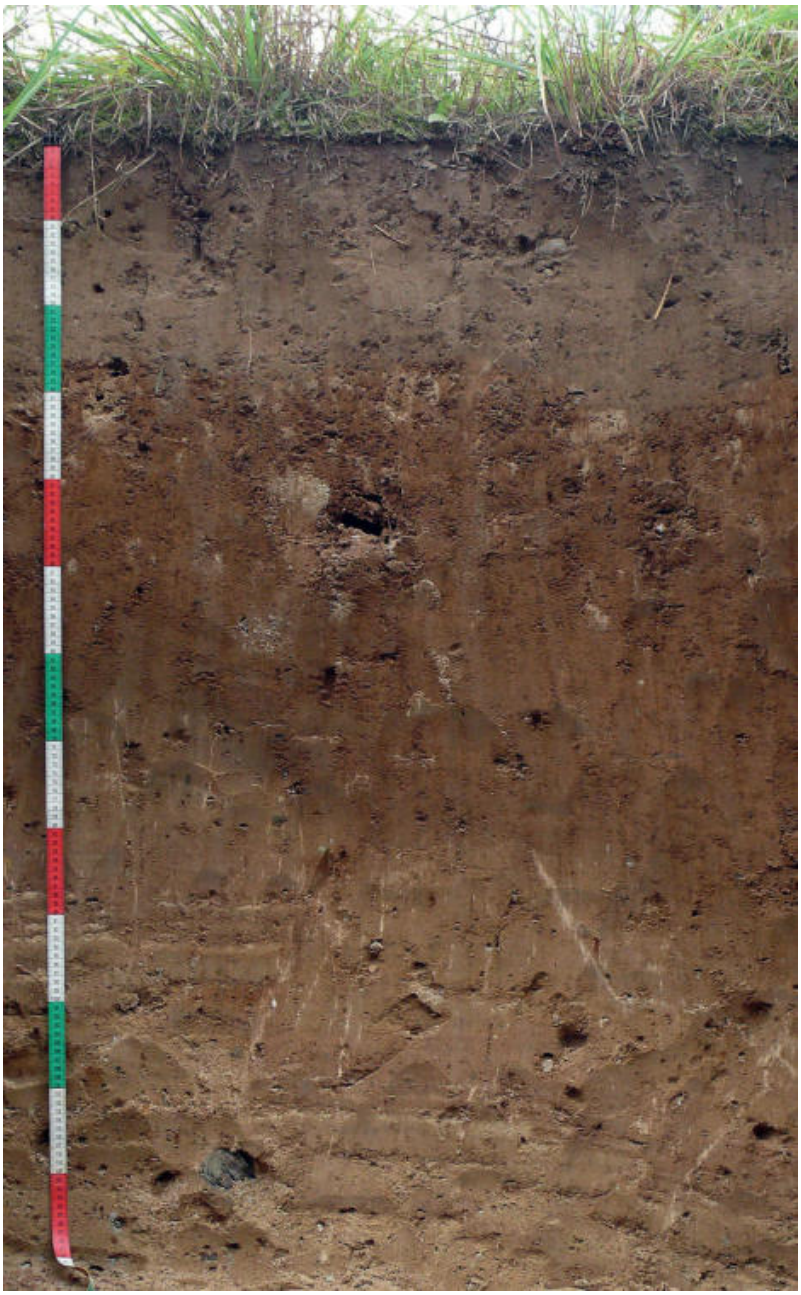
6 – Ochric

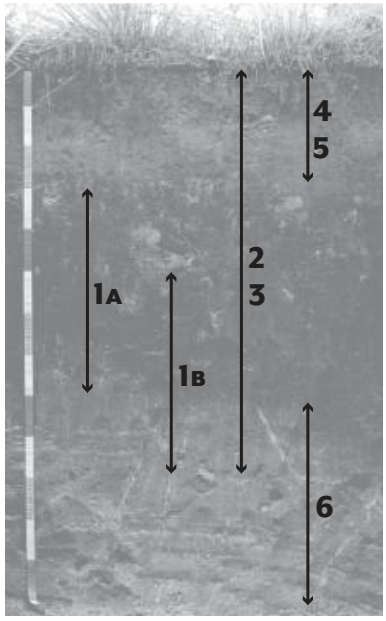
weakly developed, thin humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

7 – Protovertic

≥30% clay, some wedge-shaped soil aggregates and slickensides – in this case also visible cracks filled by humus material.

Haplic LUVISOL (Loamic, Aric, Ochric, Protocalcic)





1 – LUVISOL

1A clay-illuvial *argic horizon* with high-activity clays (developed from not highly weathered materials).

1B high base saturation (relatively high pH values) in half of more of the depth range between 50 and 100 cm of the mineral soil surface.

2 – Haplic

no other principal qualifier of the respective RSG applies.

3 – Loamic

loamy material in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Aric

plough layer, ≥10 cm thick – homogenized by ploughing and with very abrupt lower boundary.

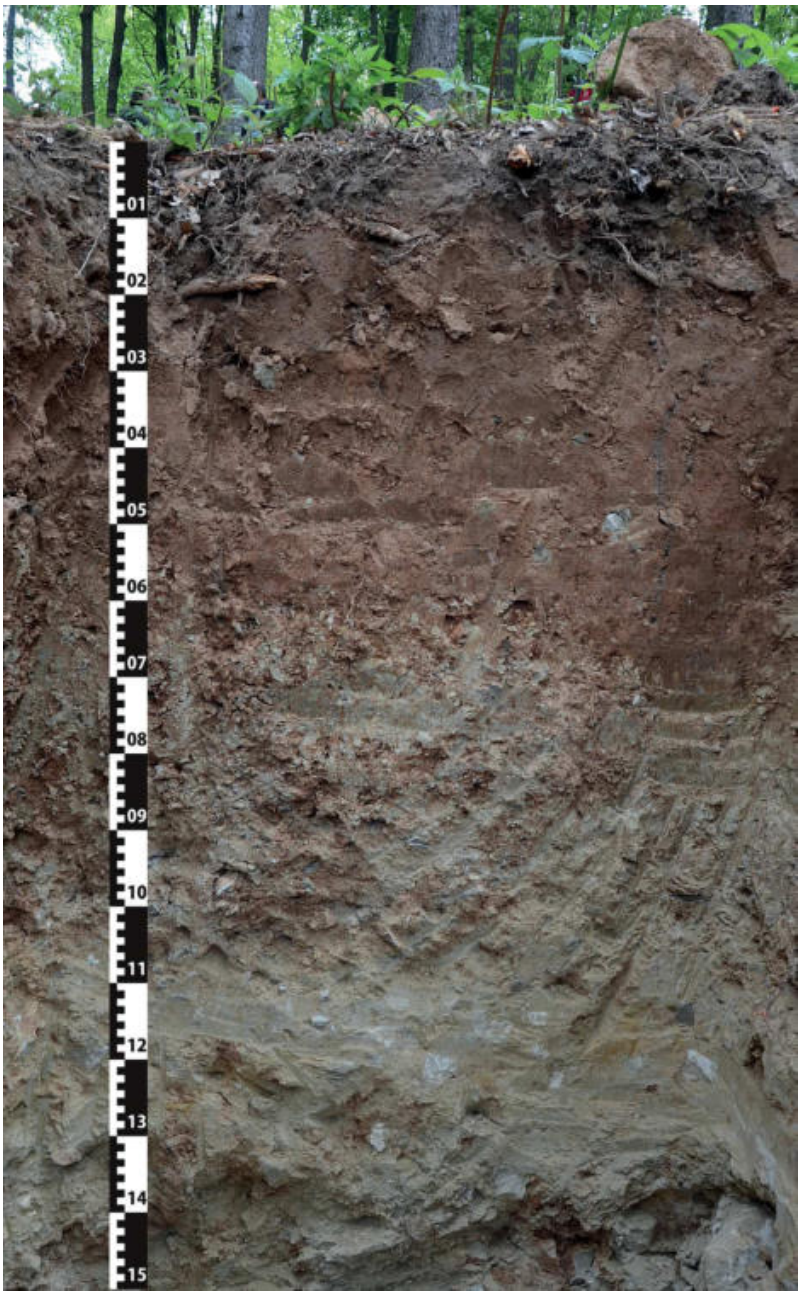
5 – Ochric

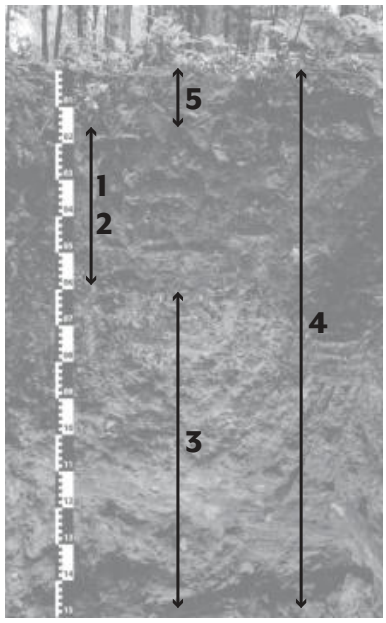
not diagnostic (too light colour) humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

6 – Protocalcic

secondary carbonates accumulation (like masses, nodules, concretions, or filaments, films on surfaces of soil aggregates or biopore walls, underside surfaces of coarse fragments) less pronounced than in *calcic horizon*.

Calcaric Chromic CAMBISOL (Loamic, Ochric)





1 – CAMBISOL

cambic horizon starting ≤50 cm and having its lower limit ≥25 cm from the mineral soil surface. In this case it has higher oxide and/or clay contents visible by more intensive colour than this underlying layer and soil aggregate structure at least in half of the volume of the fine earth.

2 – Chromic

evidence of pedogenesis and intensively red colour (concentration of oxides) in zone with at least 30 cm.

5 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* in the upper 10 cm of the mineral soil.

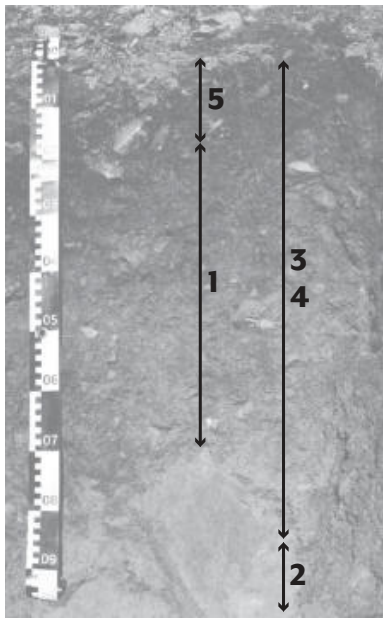
3 – Calcaric

≥2% calcium carbonate equivalent. The carbonates are at least partially primary (inherited from the parent material). Visible on photo as whitish spots – pieces of calcareous rocks.

4 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

Skeletic Leptic CAMBISOL (Loamic, Ochric)



1 – CAMBISOL

cambic horizon starting ≤50 cm and having its lower limit ≥25 cm from the mineral soil surface. In this case it has higher oxide and/or clay contents visible by more intensive colour than this underlying layer and soil aggregate structure at least in half of the volume of the fine earth.

2 – Leptic

continuous rock starting >25 cm and ≤100 cm from the soil surface.

5 – Ochric

humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil but not well enough developed to be classified as diagnostic (too light in colour in this case).

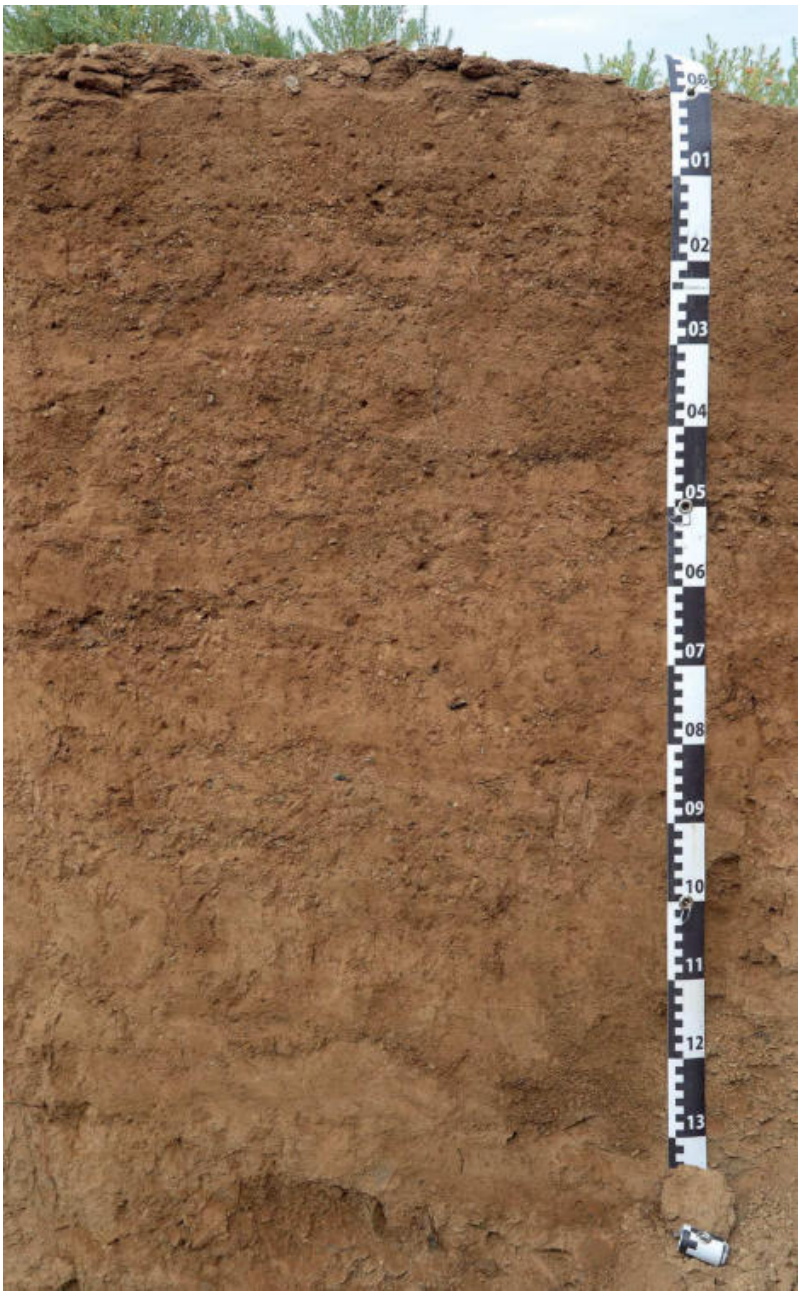
3 – Skeletic

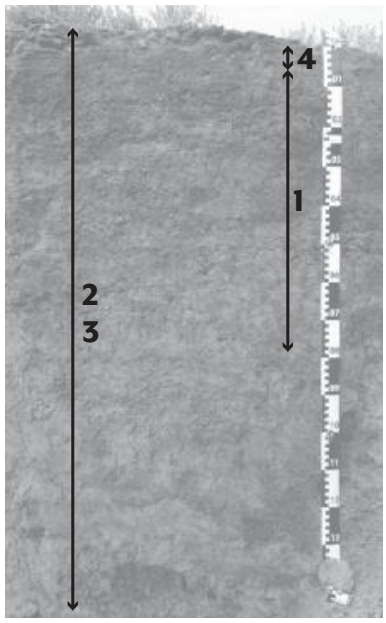
≥40% (by volume, related to the whole soil) coarse fragments averaged from the mineral soil surface to a *continuous rock*.

4 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

Eutric CAMBISOL (Loamic, Ochric)





1 – CAMBISOL

cambic horizon starting ≤50 cm and having its lower limit ≥25 cm from the mineral soil surface. In this case it has higher oxide and/or clay contents visible by more intensive colour than this underlying layer and soil aggregate structure at least in half of the volume of the fine earth.

2 – Eutric

exchangeable (Ca+Mg+K+Na) ≥ exchangeable Al in half or more thickness between 20 and 100 cm of the mineral soil surface. Expressed by relatively high pH values.

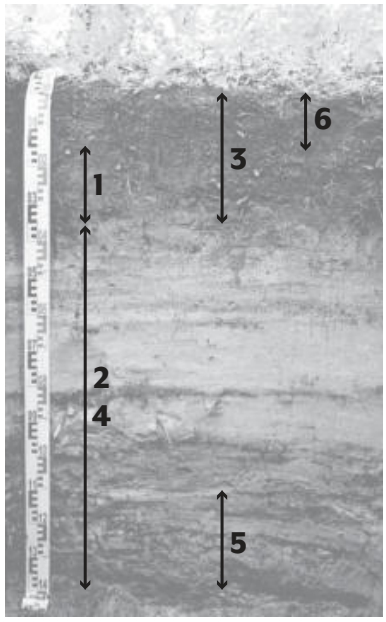
3 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Fluvic CAMBISOL (Epiloamic, Katoarenic, Ochric, Bathygleyic)



1 – CAMBISOL

cambic horizon starting ≤50 cm and having its lower limit ≥25 cm from the mineral soil surface. In this case it has higher oxide and/or clay contents visible by more intensive colour than this underlying layer and soil aggregate structure at least in half of the volume of the fine earth.

2 – Fluvic

fluvic material, ≥25 cm thick and starting ≤75 cm from the mineral soil surface.

3 – Epiloamic

loamy material with thickness of ≥30 cm with lower limit ≤50 cm of the mineral soil surface.

4 – Katoarenic

sandy (sand, loamy sand) material starts >0 and <50 cm from the (mineral) soil surface and has its lower limit ≥100 cm of the (mineral) soil surface.

5 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* in the upper 10 cm of the mineral soil.

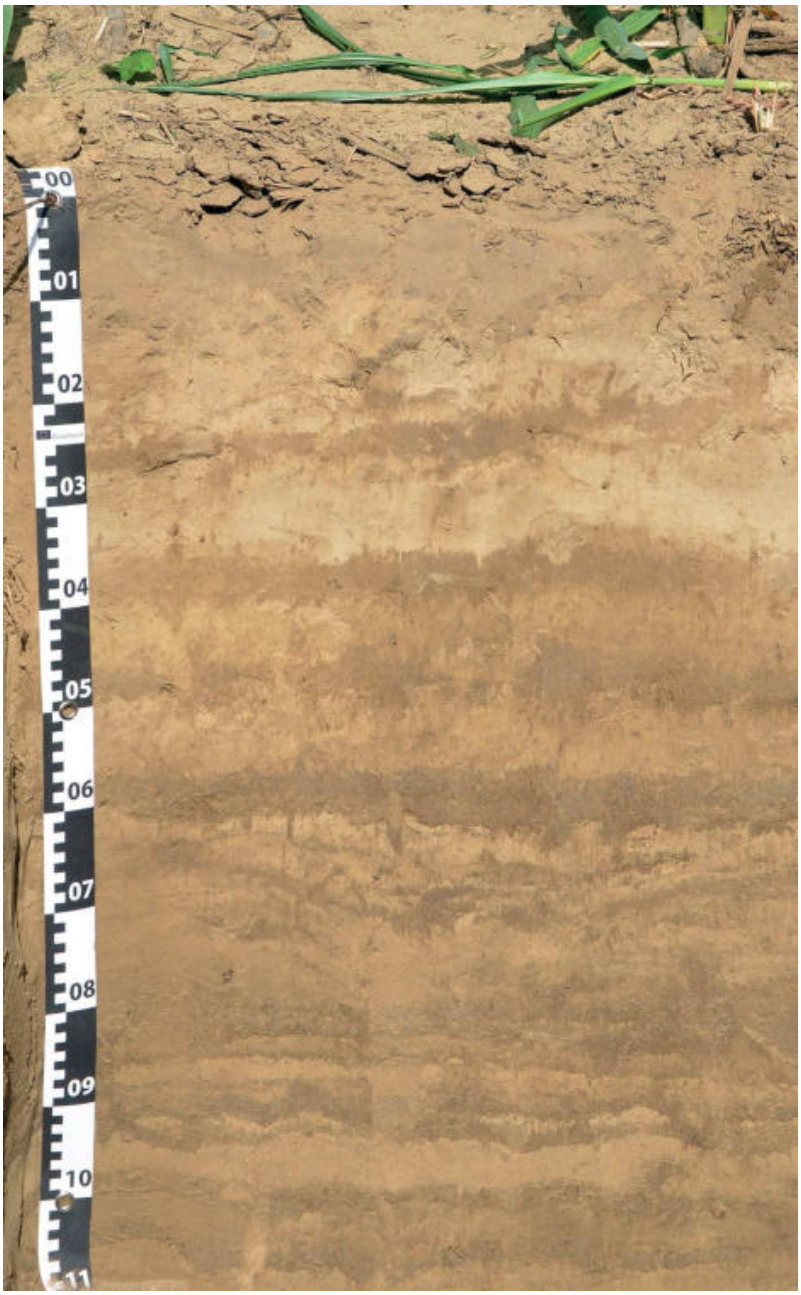
6 – Bathygleyic

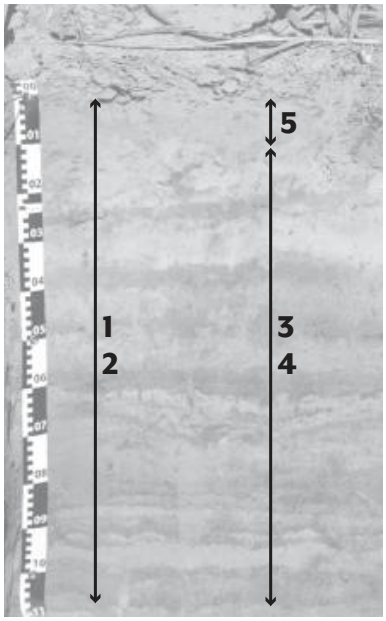
gleyic properties and *reducing conditions* start ≥100 cm from the mineral soil surface.

REMARK

due to the relatively advanced pedogenesis (cambic horizon), the soil is not classified as Fluvisol.

Pantofluvic FLUVISOL (Polyarenic, Polysiltic, Ochric)





1 – FLUVISOL

fluvic material ≥25 cm thick and starting ≤25 cm from the mineral soil surface. Fluviatile origin of sediment is recognize by distinct stratification in ≥25% of its volume.

2 – Pantofluvic

fluvic material starts at the (mineral) soil surface and has its lower limit ≥100 cm of the (mineral) soil surface.

3 – Polyarenic

many layers with sandy texture (lighter in colour) interstratified by silty layers.

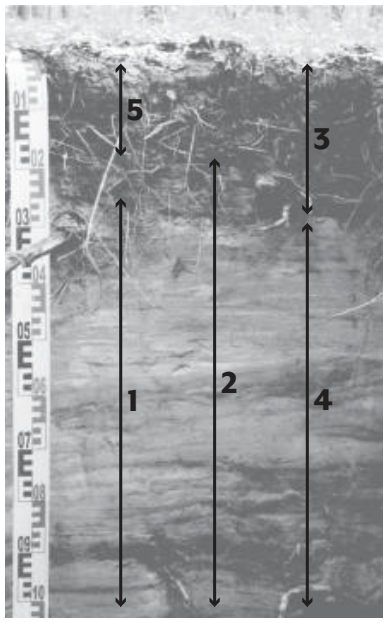
4 – Polysiltic

many layers with silty texture (darker in colour) interstratified by sandy layers.

5 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Eutric FLUVISOL (Epiloamic, Katoarenic, Ochric)



1 – FLUVISOL

fluvic material ≥25 cm thick and starting ≤25 cm from the mineral soil surface. Fluviatile origin of sediment is recognize by distinct stratification in ≥25% of its volume.

REMARK

under humus horizon, Bw horizon with accumulation of oxides is visible. It meets most of the criteria of *cambic horizon* – except thickness.

2 – Eutric

exchangeable (Ca+Mg+K+Na) ≥ exchangeable Al in half or more thickness between 20 and 100 cm of the mineral soil surface.

3 – Epiloamic

loamy (loam, sandy loam, clay loam, sandy clay loam or silty clay loam) material with thickness of ≥30 cm with lower limit ≤50 cm of the mineral soil surface.

4 – Katoarenic

sandy (sand, loamy sand) material starts >0 and <50 cm from the (mineral) soil surface and has its lower limit ≥100 cm of the (mineral) soil surface.

5 – Ochric

not diagnostic humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Dystric ARENOSOL (Claric, Ochric)

1 – ARENOSOL

texture class of loamy sand or sand to a depth of 100 cm from mineral soil surface. Layers of finer texture (e.g. loam) or with ≥40% coarse fragments (stones, gravels) have thickness less than 15 cm.

REMARK

well-aerated *organic material* is visible at the soil surface. It has 9 cm – relatively thick but not enough for *folic horizon*.

2 – Dystric

exchangeable Al > exchangeable (Ca+Mg+K+Na) in half or more thickness between 20 and 100 cm of the mineral soil surface. Expressed by low pH values.

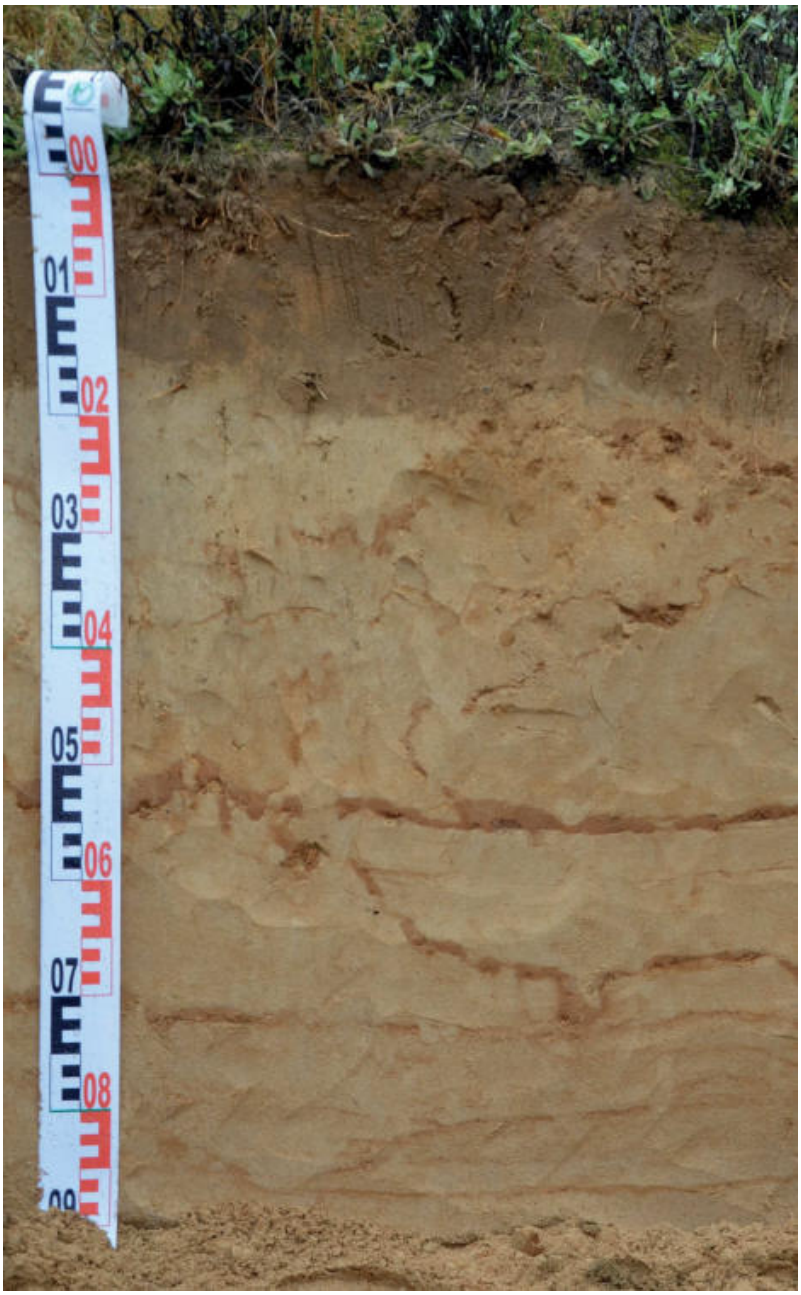
3 – Claric

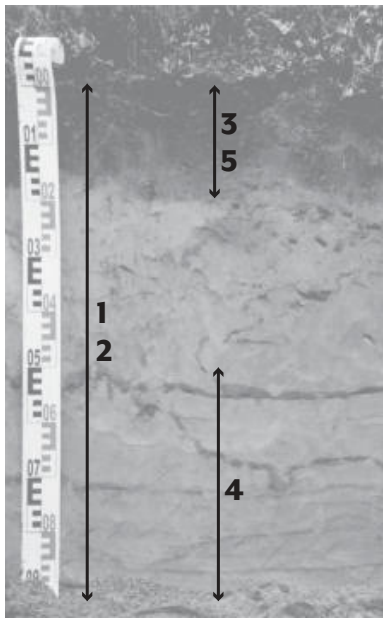
between 25 and 100 cm of the mineral soil surface a layer, ≥30 cm thick, that consists of light-coloured *claric material* – sand grains are free of coatings.

4 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Eutric ARENOSOL (Aric, Cordic, Ochric)





1 – ARENOSOL

texture class of loamy sand or sand to a depth of 100 cm from mineral soil surface. Layers of finer texture (e.g. loam) or with ≥40% coarse fragments (stones, gravels) have thickness less than 15 cm.

REMARK

ribbon-like accumulations are similar to lamellae but are generally thinner and have mostly accumulatio of iron without clay fraction.

2 – Eutric

exchangeable (Ca+Mg+K+Na) ≥ exchangeable Al in half or more thickness between 20 and 100 cm of the mineral soil surface. Expressed by relatively high pH values.

3 – Aric

layer, ≥10 cm thick and starting at the soil surface, that is homogenized by ploughing and that has an abrupt or very abrupt lower boundary.

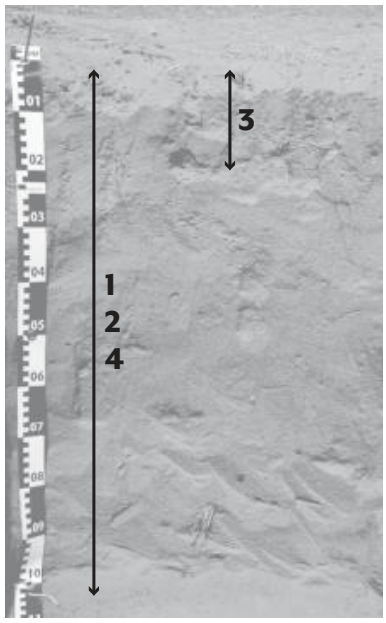
6 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

4 – Cordic

two or more ribbon-like accumulations, ≥0.5 and <2.5 cm thick (have a combined thickness of ≥2.5 cm within 50 cm), that are not cemented, have higher contents of Fe oxides and/or organic matter than the directly overlying and underlying layers.

Protic ARENOSOL (Aeolic, Rubic)



1 – ARENOSOL

texture class of loamy sand or sand to a depth of 100 cm from mineral soil surface. Layers of finer texture (e.g. loam) or with ≥40% coarse fragments (stones, gravels) have thickness less than 15 cm.

2 – Protic

lack of soil horizons. Parent material starts at the soil surface.

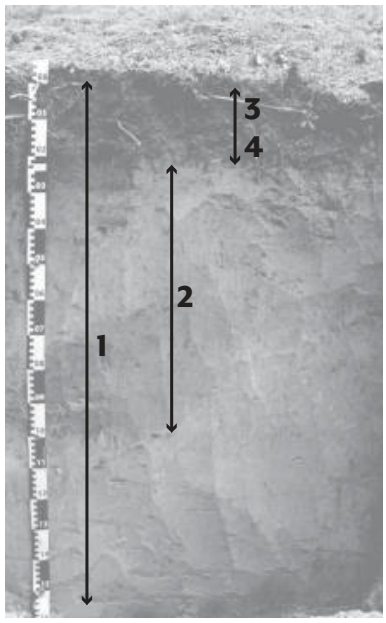
3 – Aeolic

aeolic material with low amount of humus (<1% *soil organic carbon* from the mineral soil surface to a depth of 10 cm) deposited by wind, typical in arid and semi-arid environments. Sand grains are often rounded or subangular and have a matt surface.

4 – Rubic

reddish colour in ≥90% of exposed area.

Brunic ARENOSOL (Aric, Ochric)



1 – ARENOSOL

texture class of loamy sand or sand to a depth of 100 cm from mineral soil surface. Layers of finer texture (e.g. loam) or with ≥40% coarse fragments (stones, gravels) have thickness less than 15 cm.

2 – Brunic

Bw horizon with material which has a texture class of sand, pedogenetic structure, alteration of colour – reddish compared to the directly underlying layer, does not form part of other diagnostic horizon or plough layer.

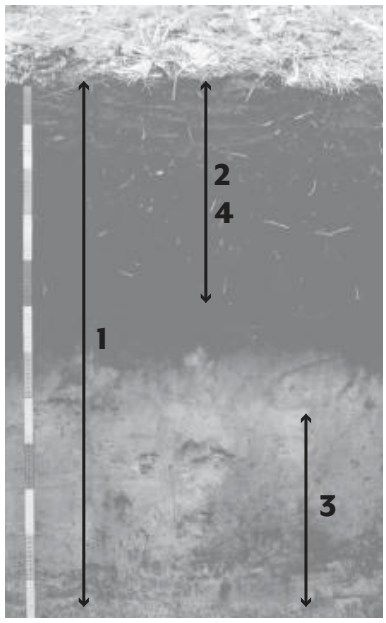
3 – Aric

layer, ≥10 cm thick and starting at the soil surface, that is homogenized by ploughing and that has an abrupt or very abrupt lower boundary.

4 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Endogleyic Tsitelic ARENOSOL (Humic)



1 – ARENOSOL

texture class of loamy sand or sand to a depth of 100 cm from mineral soil surface. Layers of finer texture (e.g. loam) or with ≥40% coarse fragments (stones, gravels) have thickness less than 15 cm.

2 – Tsitelic

tsitelic horizon starting ≤ 50 cm from the mineral soil surface - reddish colour is caused by accumulation of Fe (≥ 1% Fe_{ox}) by subsurface flow. Not cemented and does not show reductimorphic features.

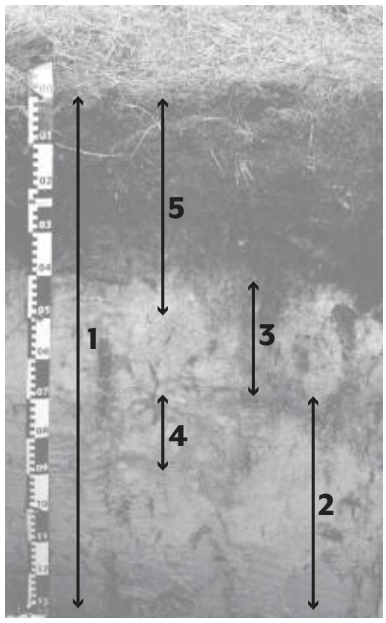
3 – Endogleyic

gleyic properties and *reducing conditions* start ≥50 cm from the mineral soil surface.

4 – Humic

≥1% *soil organic carbon* as a weighted average to a depth of 50 cm. In this case, the humus, dark gray colour is masked by iron compounds. A large amount of humus is evidenced, among others, by numerous, small roots visible to a great depth.

Calcaric Gleyic ARENOSOL (Cordic, Humic, Nechic)



1 – ARENOSOL

texture class of loamy sand or sand to a depth of 100 cm from mineral soil surface. Layers of finer texture (e.g. loam) or with ≥40% coarse fragments (stones, gravels) have thickness less than 15 cm.

REMARK

humus horizon can not be classified in this case as *Chernic* due to many (≥10% of the exposed area) uncoated, white sand grains.

2 – Endogleyic

gleyic properties and *reducing conditions* start ≥50 cm from the mineral soil surface.

3 – Calcaric

≥2% calcium carbonate equivalent. The carbonates are at least partially primary (inherited from the parent material).

4 – Cordic

two or more (many in this case) ribbon-like accumulations, ≥0.5 and <2.5 cm thick, that are not cemented, have higher contents of Fe oxides and/or organic matter than the directly overlying and underlying layers.

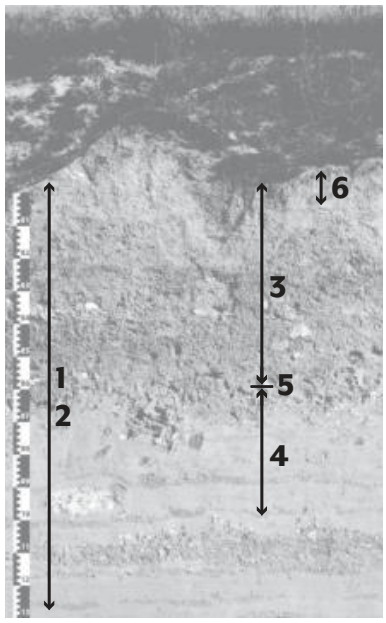
5 – Humic

≥1% *soil organic carbon* as a weighted average to a depth of 50 cm.

6 – Nechic

pH_{water} of <5 and uncoated mineral grains of sand in a darker matrix.

Calcaric REGOSOL (Anoarenic, Endoloamic, Geoabruptic, Ochric)



1 – REGOSOL

soil which does not fulfil criteria of any other Reference Soil Group.

2 – Calcaric

≥2% calcium carbonate equivalent. The carbonates are at least partially primary (inherited from the parent material).

3 – Anoarenic

sandy material (sand, loamy sand) starts at the mineral soil surface and has its lower limit >50 and <100 cm.

4 – Endoloamic

loamy material with thickness of ≥30 cm starts ≥50 cm from the mineral soil surface.

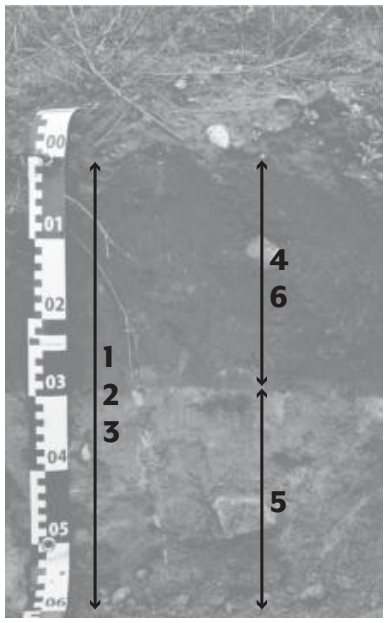
5 – Geoabruptic

lithogenic (not connected with clay illuviation) *abrupt textural difference* within 100 cm of the mineral soil surface.

6 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Eutric REGOSOL (Loamic, Aric, Protocalcic, Ochric)



1 – REGOSOL

soil which does not fulfil criteria of any other Reference Soil Group.

2 – Eutric

exchangeable (Ca+Mg+K+Na) ≥ exchangeable Al in half or more thickness between 20 and 100 cm of the mineral soil surface (high pH values).

3 – Loamic

loamy material in layer(s) with a combined thickness of ≥30 cm, occurring within 100 cm of the mineral soil surface.

4 – Aric

plough layer, ≥10 cm thick – homogenized by ploughing and with very abrupt lower boundary.

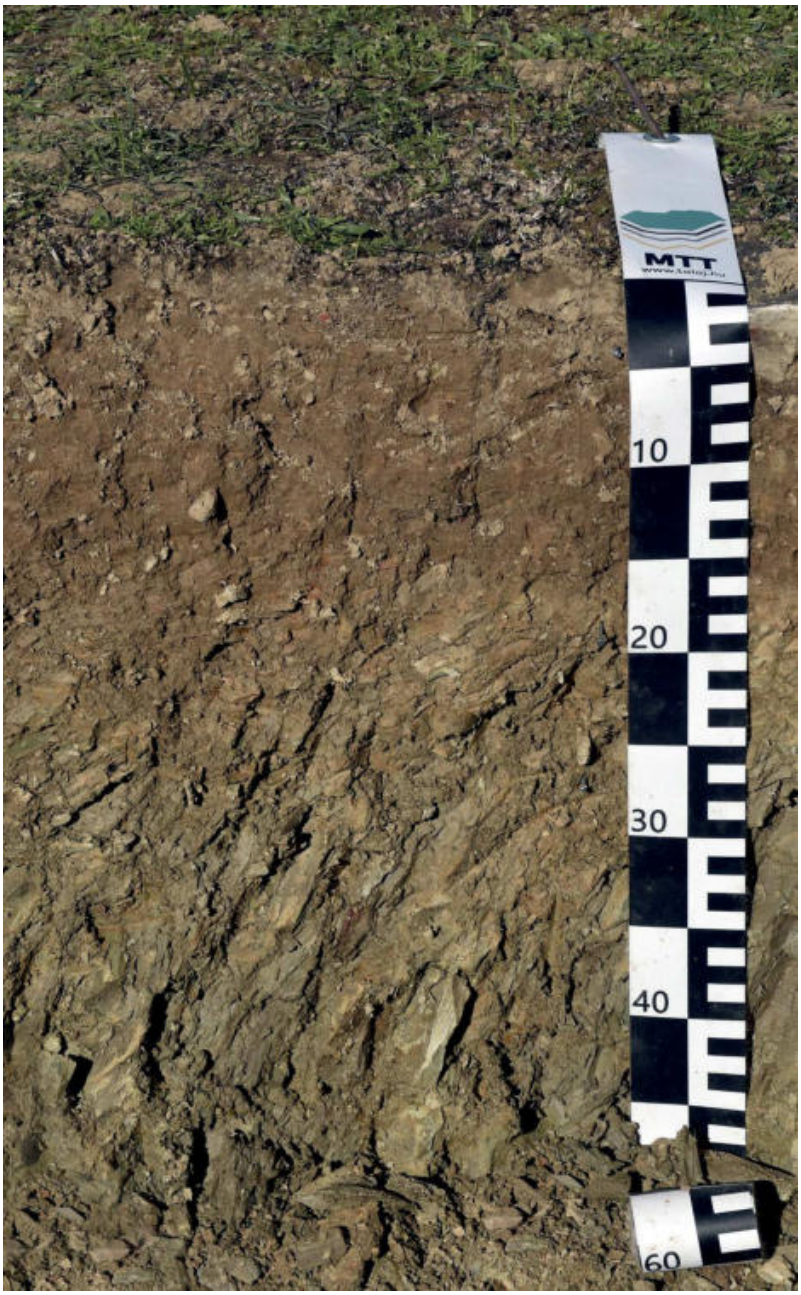
5 – Protocalcic

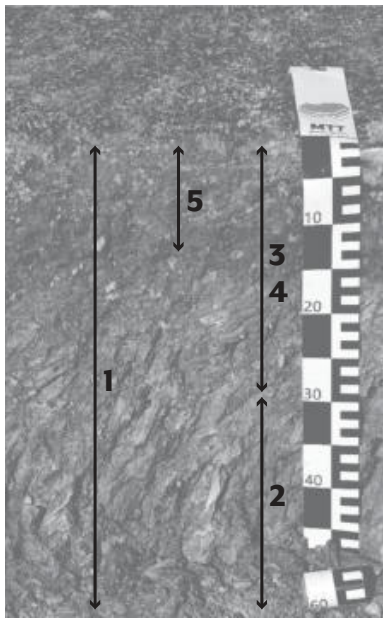
secondary carbonates accumulation (like masses, nodules, concretions or filaments, films on surfaces of soil aggregates or biopore walls, underside surfaces of coarse fragments) less pronounced than in *calcic horizon*.

6 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

Skeletic Epileptic REGOSOL (Loamic, Ochric)





1 – REGOSOL

soil which does not fulfil criteria of any other Reference Soil Group.

2 – Epileptic

continuous rock starting >25 cm and ≤50 cm from the soil surface.

3 – Skeletic

≥40% (by volume, related to the whole soil) coarse fragments averaged over a depth of 100 cm from the mineral soil surface.

4 – Loamic

texture class of loam, sandy loam, clay loam, sandy clay loam or silty clay loam in layer(s) with a combined thickness of ≥30 cm, in the major part between the mineral soil surface and an *continous rock*.

5 – Ochric

weakly developed humus horizon with ≥0.2% *soil organic carbon* (weighted average) in the upper 10 cm of the mineral soil.

SPECIFIERS

SPECIFIERS

Amphi- (1)

the characteristic occurs at a specific point of depth and is present two or more times, once or more times somewhere: a) ≤50 cm, b) >50 and ≤100 cm of the (mineral) soil surface. Here – **Amphiraptic** (47 and 80 cm).

Amphi- (2)

the layer starts >0 and <50 cm and has its lower limit >50 and <100 cm of the (mineral) soil surface. On photo **Amphilimnic** – 40–85 cm.

SPECIFIERS

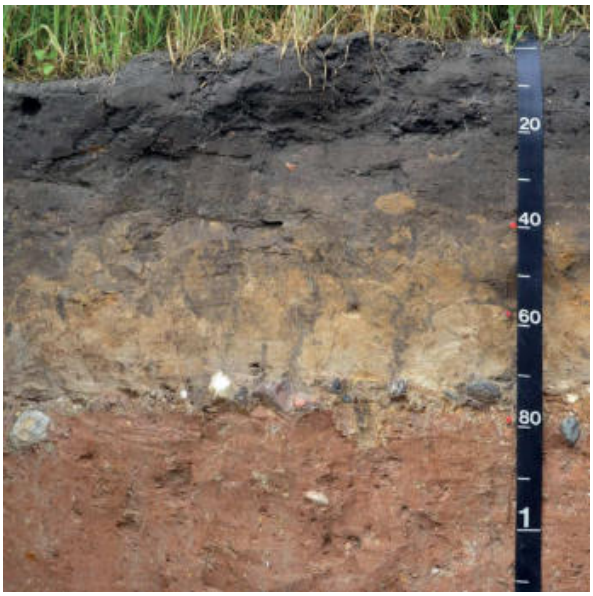
Ano- (2)

the layer starts at the (mineral) soil surface and has its lower limit >50 and <100 cm of the (mineral) soil surface. In this profile – **Anosiltic** (0–65 cm).

Bathy- (6)

the layer starts at a depth of >100 cm of the (mineral) soil surface. **Bathyarenic** on photo visible (135–180 cm).

SPECIFIERS



Endo- (1)

characteristic occurs at a specific point of depth somewhere >50 cm and is absent ≤50 cm of the (mineral) soil surface. Here – **Endoraptic** (75 cm).

Endo- (2)

the layer starts ≥50 cm from the (mineral) soil surface; and no such layer occurs <50 cm of the (mineral) soil surface. On photo **Endocalcic** – starts at 90 cm.

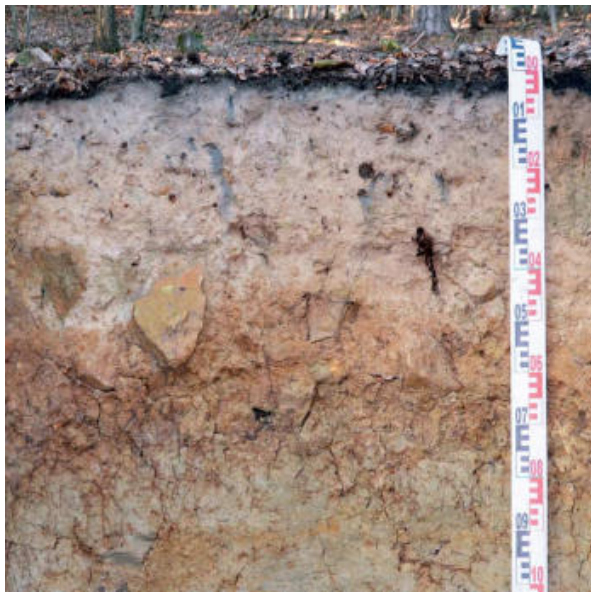
Endo- (5)

the characteristic refers to a percentage is present between 50 and 100 cm of the (mineral) soil surface. Here **Endoskeletic**.

SPECIFIERS

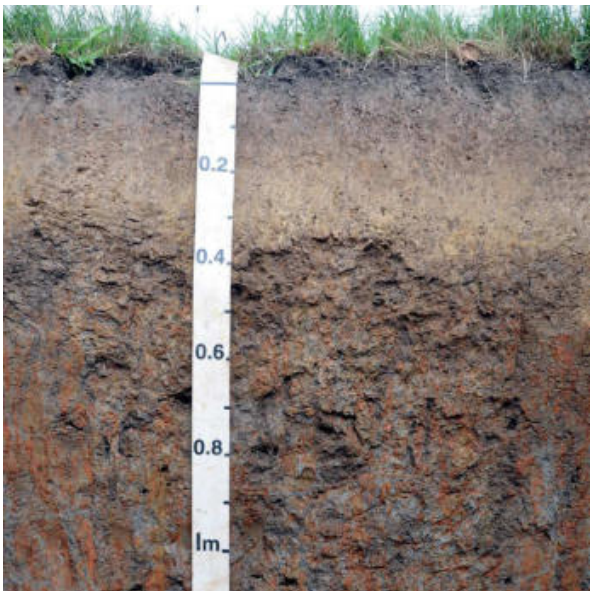
Epi- (1)

characteristic occurs at a specific point of depth somewhere ≤50 cm and is absent >50 cm and ≤50 cm of the (mineral) soil surface. Here – **Epiraptic** (35 cm).



Epi- (2)

the layer has its lower limit ≤50 cm of the (mineral) soil surface; and no such layer occurs between 50 and 100 cm of the (mineral) soil surface. On photo **Epiloamic** – ends at 40 cm.



Kato- (2)

the layer starts >0 and <50 cm and has its lower limit ≥100 cm of the (mineral) soil surface. **Katoclayic** on photo – Clay material is between 40–110 cm.

Panto- (2)

the layer starts at the (mineral) soil surface and has its lower limit ≥100 cm. Example with **Pantoarenic**.

SPECIFIERS

Poly- (2)

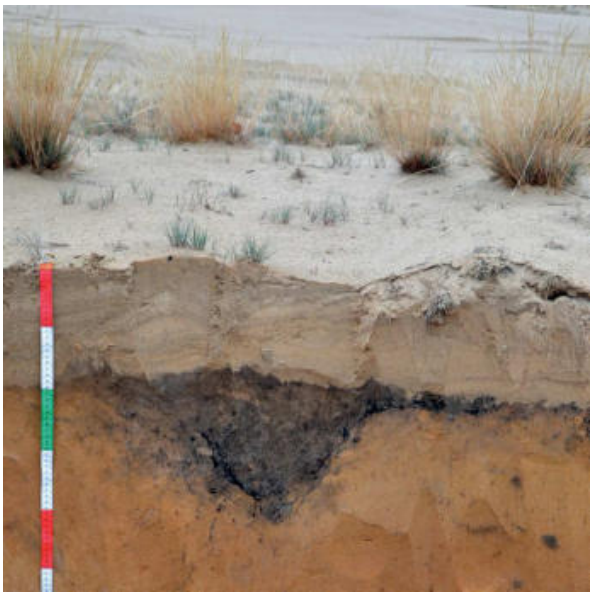
two or more layers within 100 cm of the (mineral) soil surface fulfil the criteria of the qualifier, interstratified by layers that do not fulfil the criteria of the respective qualifier (here darker layers – **Polysiltic**).

Thapto-

diagnostic horizon or a layer with a diagnostic property belongs to a buried soil – on photo very dark, buried **Thaptomollic**.

SELECTED QUALIFIERS

QUALIFIERS



Aeolic

aeolic material – deposited by wind, with *soil organic carbon* <1% and thickness at least 20 cm.

Akromineralic

within 100 cm of the soil surface, one or more layers of *mineral material* (but not *mulmic*) ≥10 cm thick combined thickness of <20 cm. On photo 25–40 cm.

Anthric

mollic horizon made by long-term cultivation (ploughing, liming, fertilization etc.) with abrupt lower boundary, lumps of applied lime and <5% (by exposed area) of animal pores, coprolites or other traces of soil animal activity in depth range of 5 cm below the plough layer.

Biocrustic

biological soil crust – soil particles at the soil surface are aggregated by a community of some organisms.

QUALIFIERS

Calcic

calcic horizon with calcium carbonate ≥15% and distinct accumulation of secondary carbonates starting ≤100 cm from the mineral soil surface.

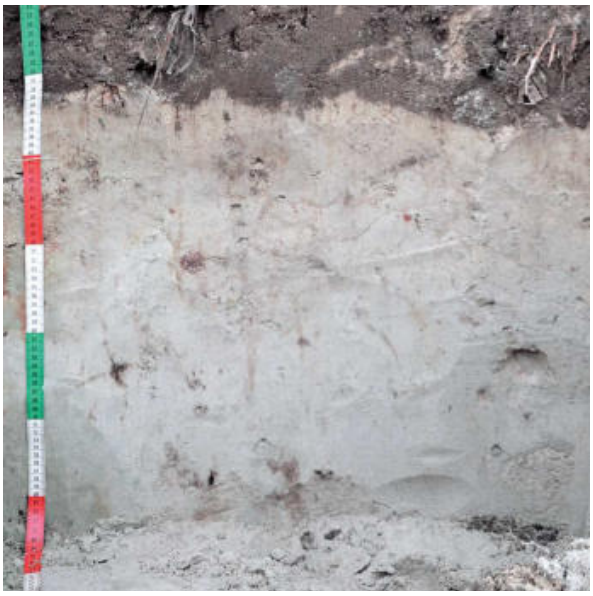
Calcic

calcic horizon with calcium carbonate ≥15% and distinct accumulation of secondary carbonates (here ≥10% of the underside surfaces of coarse fragments) starting ≤100 cm from the mineral soil surface.

QUALIFIERS

Columnic

layer, ≥15 cm thick and starting ≤100 cm from the mineral soil surface, that has a columnar structure.



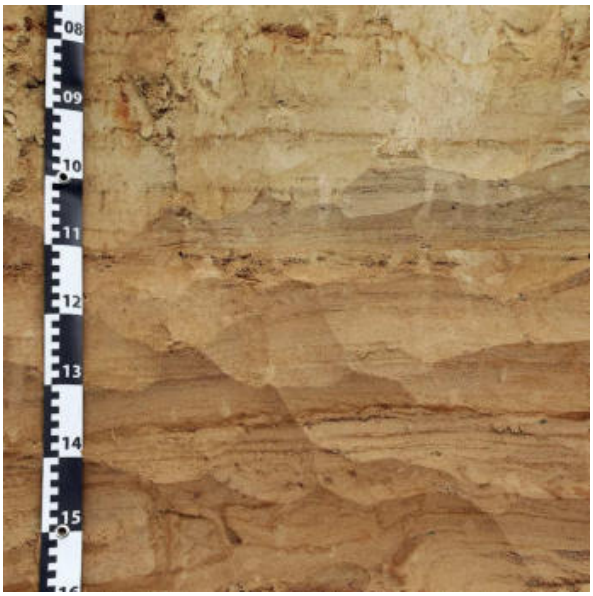
Claric

between 25 and 100 cm of the mineral soil surface a layer, ≥30 cm thick, that consists of light-coloured fine earth – *claric material*.

Coarsic

absolute dominance of the skeletal fraction, <20% (by volume, related to the whole soil) fine earth, averaged over a depth of 75 cm from the soil surface.

QUALIFIERS



Cordic

two or more ribbon-like and not cemented Fe oxides and/or organic matter accumulations, ≥0.5 and <2.5 cm – have a combined thickness of ≥2.5 cm within 50 cm and starting ≤200 cm from the mineral soil surface.

Cryic

cryic horizon starting ≤100 cm from the soil surface. Here silt cemented by permafrost under 50 cm of *organic material* (Cryic Histosol).

Cutanic

argic or *natric horizon* with visible clay illuvial accumulations e.g. on surface of peds, biopores. Here visible as more brownish surface of aggregate than its intersection.

Dolomitic

dolomitic material often very irresistible to mechanical weathering. Visible sharp stones of various size. If exposed, immediately a small scree would form.

QUALIFIERS

Drainic

artificially drained – on photo visible underground drainage 'pipes'.

Ekranic

technic hard material starting ≤5 cm from the soil surface.

Entic

not having an *albic horizon* above the *spodic horizon*.

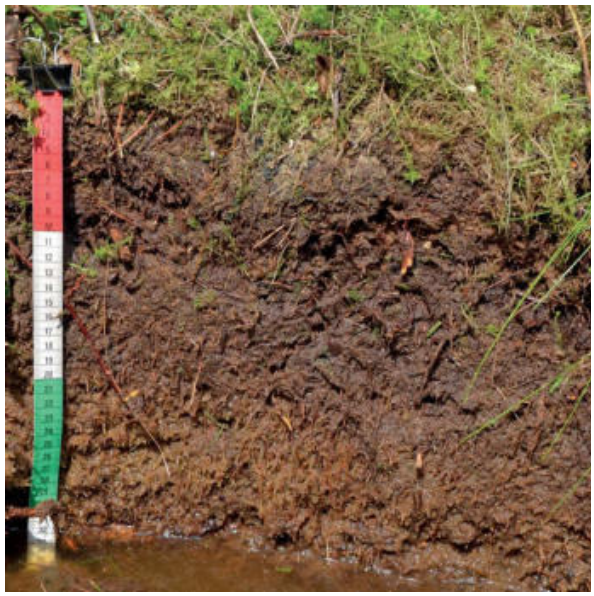
Escalic

soil has been truncated and/or locally transported to form human-made terraces. On the photo Luvisol mixed to the depth of 70 cm.

QUALIFIERS

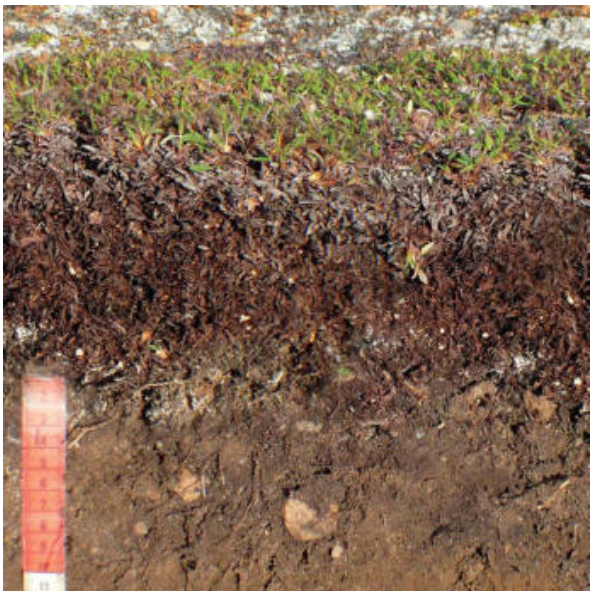
Evapocrustic

saline crust, ≤2 cm thick, on the soil surface.



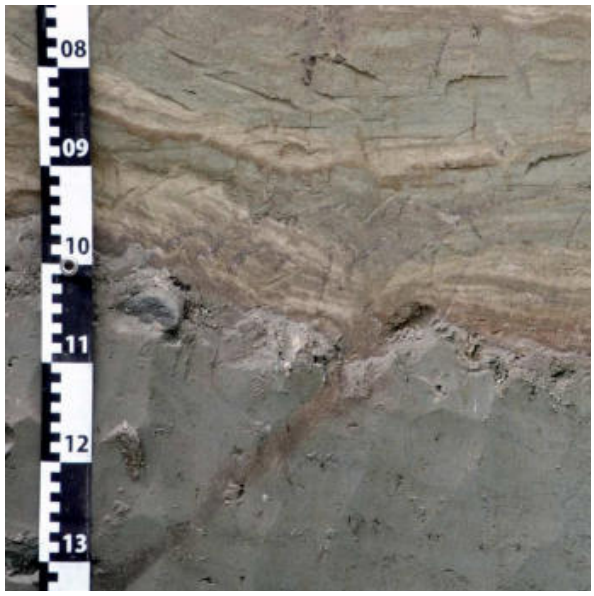
Fibric

layer with a thickness of ≥30 cm, having *organic material* in an initial state of decomposition (consists of > two thirds of recognizable dead plant tissues).



Folic

folic horizon – organic layer ≥ 30 cm thick, not water-saturated and not drained. On photo accumulated on the soil surface *Dryas octopetala* leaf remnants.



Geoabruptic

abrupt textural difference within 100 cm of the mineral soil surface that is result of lithogenesis and not associated with pedogenic translocation of fine fractions (clay illuviation or podzolization).

QUALIFIERS

Gleyic

layer, ≥25 cm thick and starting ≤75 cm from the mineral soil surface, that has *gleyic properties* throughout and *reducing conditions* in some parts of every sublayer. Here within *fluvic material*.

Gleyic

gleyic properties expressed by oximorphic, reddish colours visible along root channels in reductimorphic greyish matrix.

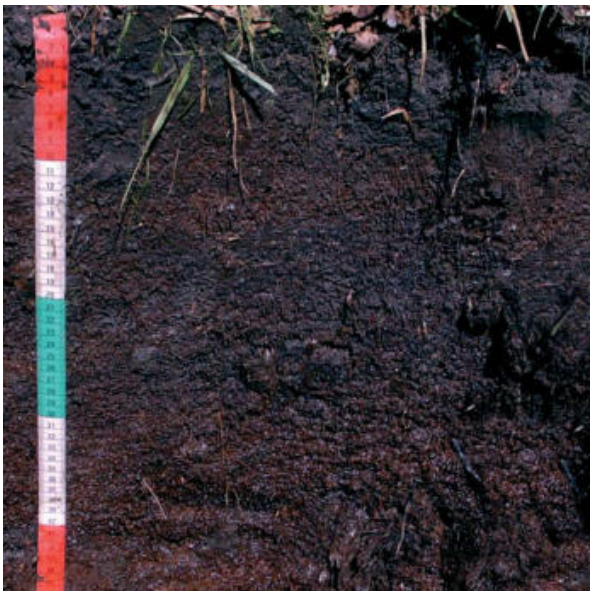
QUALIFIERS

Glossic

albeluvic glossae – coarser-textured and lighter-coloured material forming vertically continuous tongues interfingering into an *argic horizon*, starting ≤100 cm from the mineral soil surface.

Grumic

surface layer, ≥1 cm thick, with strong granular structure or strong angular or subangular blocky structure (aggregate size of ≤1 cm), i.e. 'self-mulching'.



Hemic

layer with a thickness of ≥30 cm, having *organic material* in an moderate state of decomposition (consists of ≤ two thirds and > one sixth of recognizable dead plant tissues).

Histic

histic horizon starting at the soil surface, very often thin (≥10 and <40 cm) peat on *mineral material*.

QUALIFIERS

Hortic

hortic horizon – intensive fertilization and/or long-continued application of organic residues led to development of thick, dark humus horizon.

Isolatic

above *technic hard material*, geomembrane or continuous layer of *artefacts* starting ≤100 cm, soil material containing fine earth without any contact to other soils (e.g. soils on roofs or in pots).

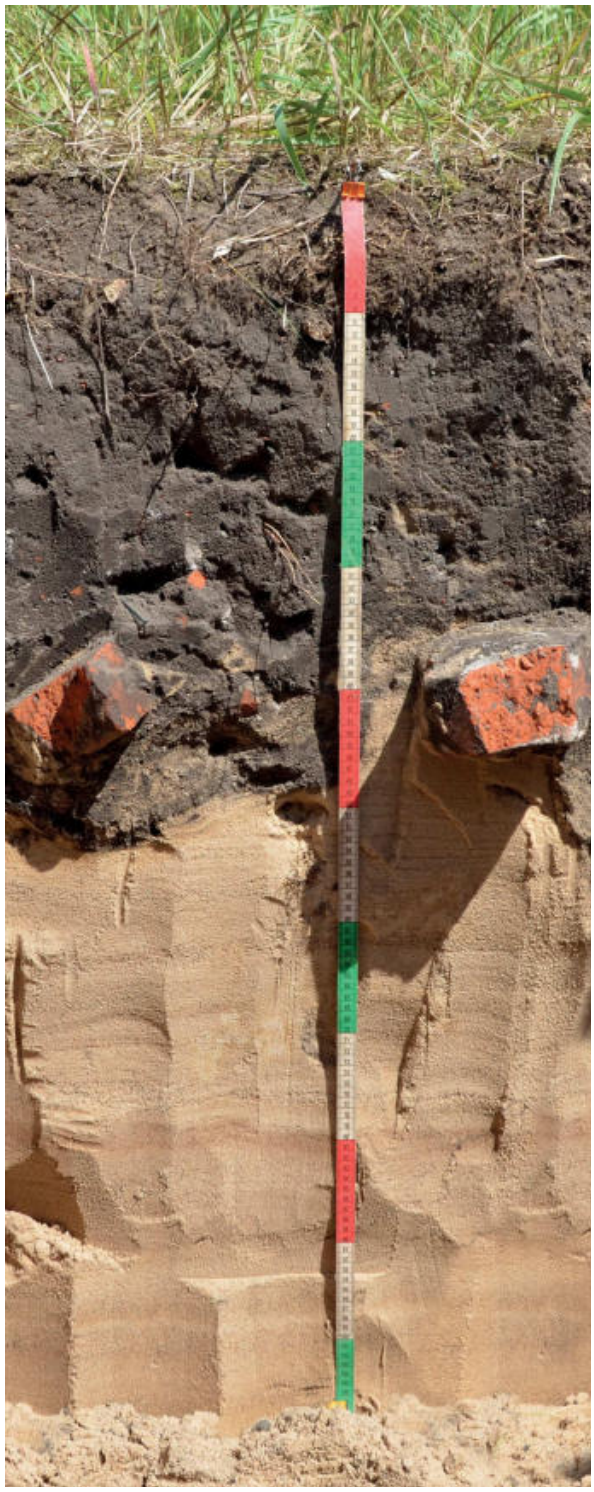
Hyperartefactic

≥50% (by volume, weighted average, related to the whole soil) *artefacts* within 100 cm of the soil surface or to a limiting layer.

QUALIFIERS

Kalaic

layer, ≥10 cm thick and starting ≤90 cm from the soil surface, with ≥50% *artefacts* (total content of *artefacts* in profile not enough for Technosol).



Protokalaic

layer, ≥10 cm thick and starting ≤90 cm from the soil surface, with ≥25% *artefacts* (total content of *artefacts* in profile not enough for Technosol).

QUALIFIERS

Lamellic

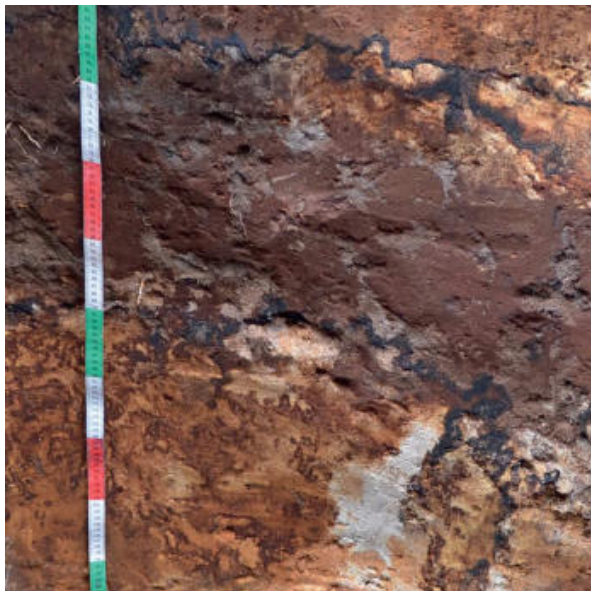
two or more lamellae, ≥0.5 and < .5 cm thick (combined thickness of ≥5 cm) with higher clay contents (accumulated by illuviation) than the directly overlying and underlying layers.

Limnic

layers with *limnic material* (subaquatic deposits) – combined thickness of ≥10 cm within 100 cm of the soil surface. On photo stratified gyttja – with mursh on uppermost 15 cm and in cracks.

Limnic

limnic material (subaquatic deposits) – combined thickness of ≥10 cm within 100 cm of the soil surface. On photo sedimentary black peat/mud at depth 30–50 cm.



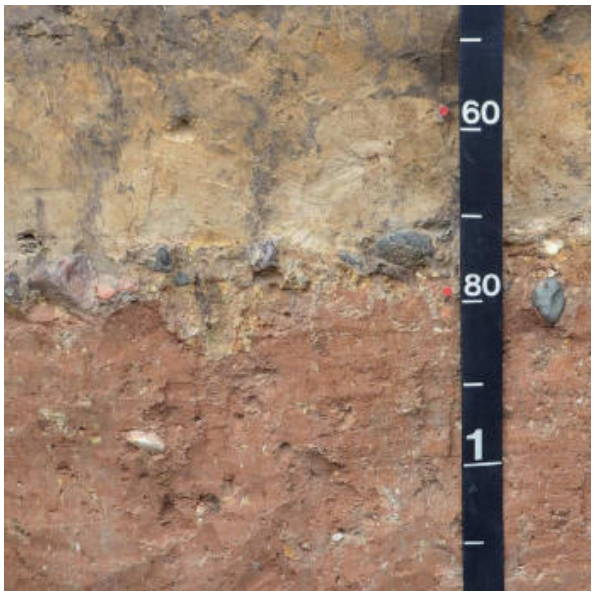
Limonic

limonic horizon – partially cemented by high amount of Fe and/or Mn accumulated by groundwater, starting ≤100 cm from the soil surface.

QUALIFIERS

Lithic

continuous rock starting ≤10 cm from the soil surface.



Litholinic

stone line, ≥2 and ≤20 cm thick and starting ≤150 cm from the mineral soil surface, that has ≥40% coarse fragments. In the layers above and below stones and gravels <10%.

Mineralic

within 100 cm of the soil surface, one or more layers of *mineral material*, not consisting of *mulmic material*, with a combined thickness of ≥20 cm, above or in between layers of *organic material*.

QUALIFIERS

Mulmic

layer, ≥10 cm thick, consisting of *mulmic material* and starting at the mineral soil surface. *Mineral material* (with *soil organic carbon* >8%) developed from *organic material* as a result of decomposition after drainage.

Murshic

having a drained *histic horizon* (mostly black, with moderate to strong granular, angular or subangular structure or cracks), ≥20 cm thick, and starting often at the soil surface.

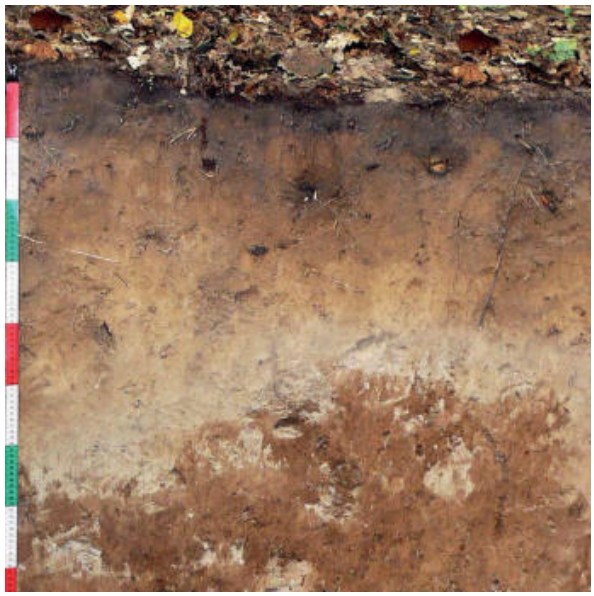
Muusic

organic material starting at the soil surface that directly overlies ice.

QUALIFIES

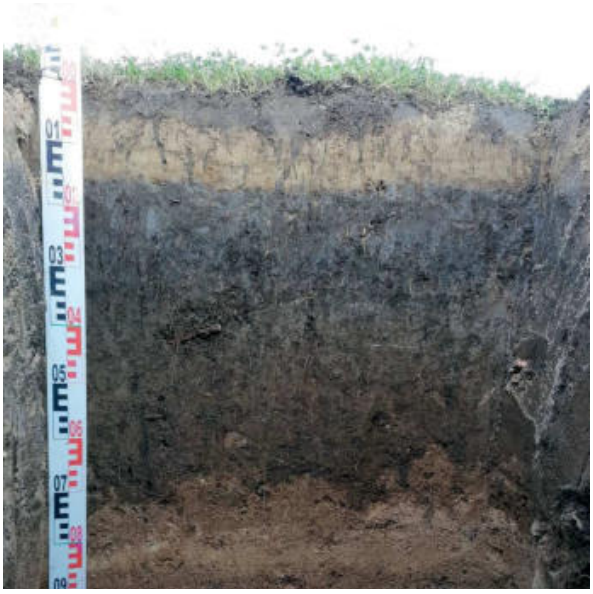
Nechic

pH_{water} of <5 and uncoated mineral grains of sand and/or coarse silt size in a darker matrix somewhere within 5 cm of the mineral soil surface and no *spodic horizon* starting ≤200 cm.



Neocambic

cambic horizon occurs starting ≤50 cm from the mineral soil surface in upper part of eluvial zone above *claric material* and *argic/natric horizon*.



Novic

layer, ≥5 and <50 cm thick, overlying a buried soil that is classified with preference – here new surface material (on Phaeozem) has texture of loamy sand – **Areninovic**.

Novic

layer, ≥5 and <50 cm thick, overlying a buried soil that is classified with preference – here new surface material (on Phaeozem) has texture of loam – **Loaminovic**.

QUALIFIERS

Nudilithic

continuous rock at the soil surface.

Ortsteinic

partly cemented (≥50% of its horizontal extension) *spodic horizon* with a moderately cementation class. Traditionally called 'ortstein'.

Panpaic

panpaic horizon (buried mineral humus surface horizon) starting ≤100 cm from the mineral soil surface.

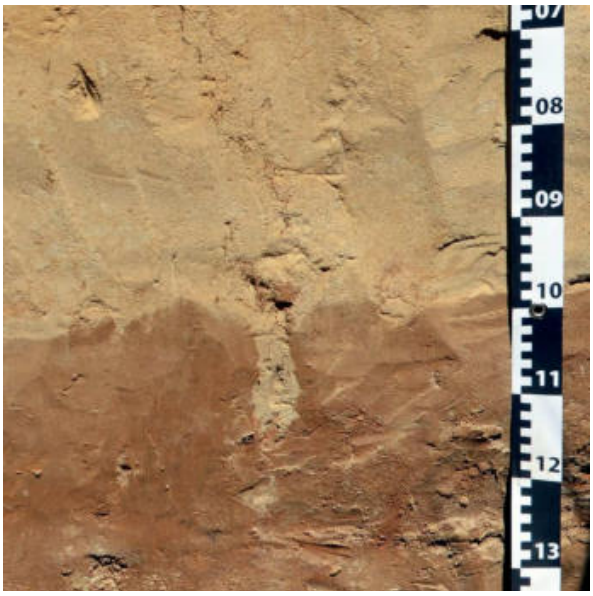
QUALIFIERS

Placic

layer, ≥0.1 and <2.5 cm thick and within 100 cm of the mineral soil surface, that is at least weakly cemented by Fe oxides.

Protic

no soil horizon development – often in young soils within landscapes characterized by active geomorphological processes.



Raptic

lithic discontinuity (lithological change in sediments) at some depth ≤100 cm from the mineral soil surface.

Relictistagnic

layer, ≥25 cm thick and starting ≤75 cm from the mineral soil surface with *stagnic properties* (oximorphic features ≥ 10%) and no *reducing conditions*.

QUALIFIERS

Relocatic

remodelled in situ or within the immediate vicinity by human activity to a depth of ≥100 cm (e.g. refilling soil pits or levelling land) and no formation of diagnostic horizons after remodelling (except a *mollic* or *umbric horizon*).

Rhodic

evidence of pedogenesis and very intensively red colour in zone with at least 30 cm between 25 and 150 cm of the mineral soil surface.

Rubic

evidence of pedogenesis and visible reddish color in zone with at least 30 cm between 25 and 150 cm of the mineral soil surface.

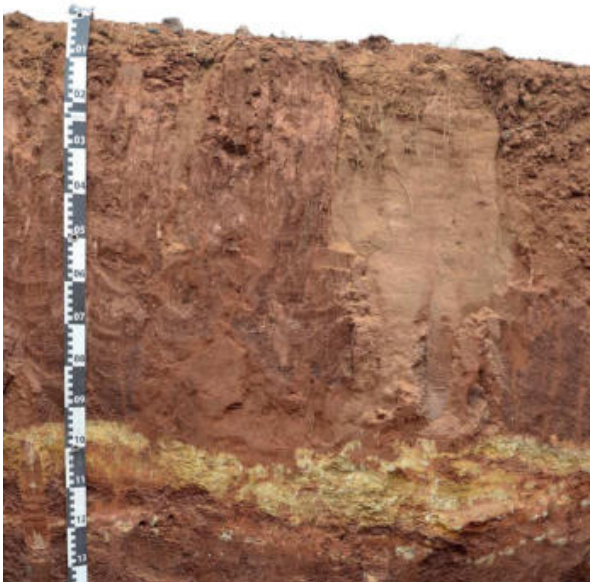
Sapric

layer with a thickness of ≥30 cm, having *organic material* most decomposed – consists of ≤ one sixth of recognizable dead plant tissues.

QUALIFIERS

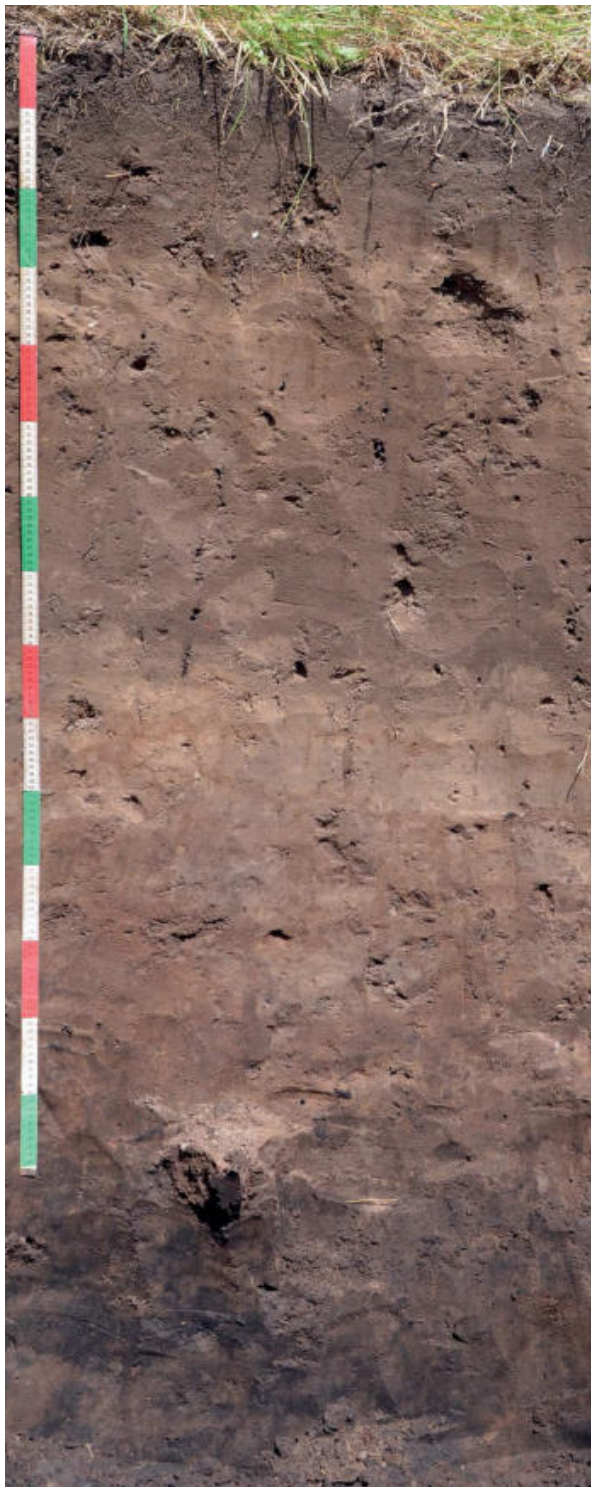
Skeletic

≥40% (by volume, related to the whole soil) coarse fragments averaged over a depth of 100 cm from the mineral soil surface or to a limiting layer.



Sodic

layer, ≥20 cm thick and starting ≤100 cm from the mineral soil surface, that has ≥15% Na plus Mg and ≥ 6% Na on the exchange complex.



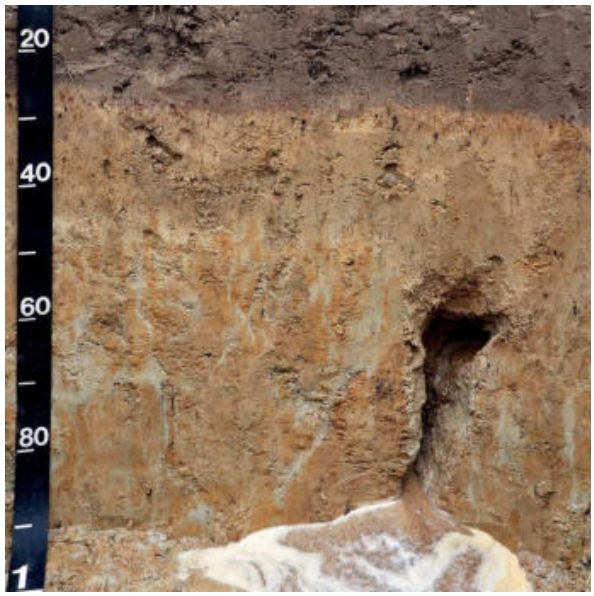
Solimovic

mixture of material that has moved downslope and accumulated in foot slope position or depression. In this profile it has a high thickness.

QUALIFIERS

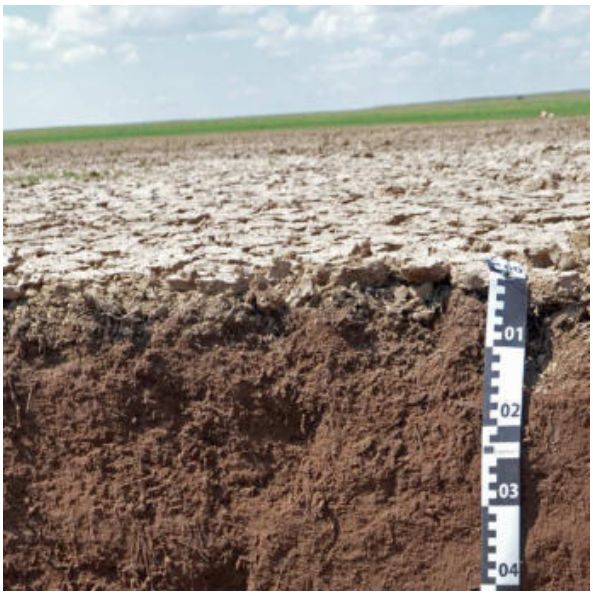
Spodic

spodic horizon – containing illuvial compounds of iron, aluminium, and humus. Starting ≤200 cm from the mineral soil surface. On photo Spodic Gleysol.



Stagnic

layer, ≥25 cm thick and starting ≤75 cm from the mineral soil surface, with *stagnic properties* (reductimorphic features plus the oximorphic features ≥25%) and *reducing conditions*. Preferential flow of water along *albeluvic glossae* visible on photo.



Takyric

takyric properties – fine-textured surface crust with a platy or massive structure in periodically flooded soils under arid climates.

Technic

≥10% (by volume, weighted average, related to the whole soil) *artefacts* in the upper 100 cm from the soil surface or to a limiting layer.

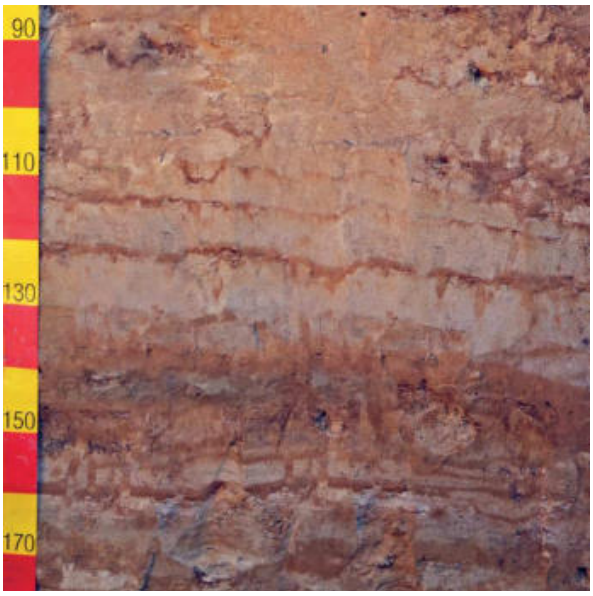
QUALIFIERS

Tidalic

affected by tidal water, i.e. located between the line of mean high water springs and the line of mean low water springs.

Tonguing

tonguing of well developed humus horizon – *chernic*, *mollic* or *umbric horizon* into an underlying layer.



Totilamellic

argic horizon that consists entirely of lamellae starting ≤100 cm from the mineral soil surface.

Transportic

at the soil surface layer ≥20 cm thick, with material containing <10% (if any) *artefacts*; and that has been moved from a source area outside the immediate vicinity by intentional human activity, usually with the aid of machinery.

QUALIFIERS

Tsitelic

tsitelic horizon rich in oxalate-extractable Fe (accumulated by lateral subsurface water flow), and associated with this a homogeneous reddish colour starting ≤50 cm from the mineral soil surface.

Turbic

cryogenic alteration (cryoturbation, mixed material, disrupted soil horizons, involutions, organic intrusions, etc.) in some layer within 100 cm of the soil surface.

Umbric

umbric horizon – thick, very dark (≥0.6% *soil organic carbon*) humus horizon with well developed structure and low base saturation.

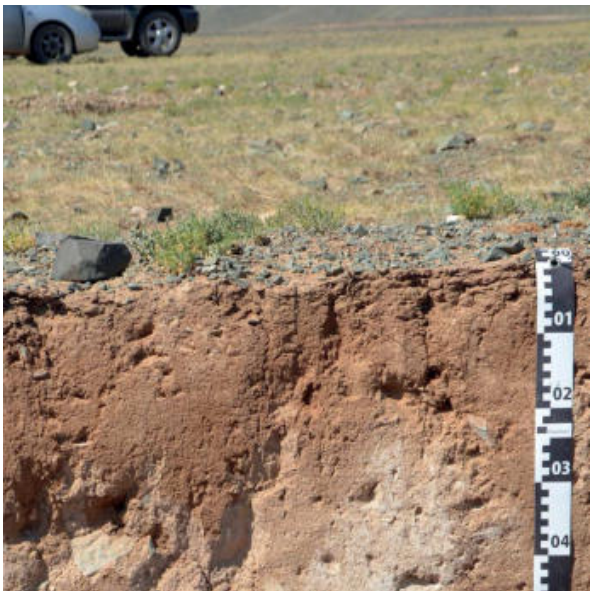
Urbic

layer, ≥20 cm thick and within 100 cm of the soil surface, with ≥20% *artefacts*, ≥35% of which consist of rubble and refuse of human settlements (e.g. bricks).

QUALIFIERS

Vitric

vitric properties – glass from volcanic or industrial origin is visible (≥5% by grain count) in the fraction between >0.02 and ≤2 mm.



Yermic

occur on the mineral soil surface in deserts where coarse surface fragments (some are wind-shaped or varnished) covering ≥20% of the soil surface (desert pavement). Underlain soil layer have half or less than half of coarse fraction in comparision with surface.

Xanthic

ferralic horizon that has in a subhorizon, ≥30 cm thick and starting ≤75 cm from the upper limit yellowish colour.

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