Horizons, Layers, and Characteristics Diagnostic for the Higher Categories

3

Abstract

This chapter defines the horizons, layers, and characteristics of mineral soils found in the UAE. Soil profiles are described according to the different soil layers that may be identified within each profile. In this chapter "required characteristics" for horizons or features, are arranged as a key. Each major layer, or master horizon, is allocated one or more letter codes, each of which has a specific meaning. The uppercase letters O, L, A, E, B, C, R, M, and W are used within the USDA-NRCS system to represent the master horizons and layers of soils. These letters are the base symbols to which other characteristics are added to complete the designations. Lowercase letters are used as suffixes to designate specific kinds of master horizons and layers. The letters aa, b, c, d, g, k, m, n, p, q, r, w, y, yy, and z are the suffix symbols used for the UAE soils. The use of prime symbol, where appropriate, is placed after the capital-letter horizon B′k and the "caret" symbol (^), for example ^A_^C-Ak, are described. Diagnostic surface (Ochric) and subsurface horizons (Anhydritic, Calcic, Cambic, Gypsic, Petrocalcic, Petrogypsic, Salic), as well as moisture (Aquic, Aridic or Torric) and a temperature regime (Hyperthermic) identified in the UAE are described. The Anhydritic horizon is a new subsurface diagnostic horizon first recognized and defined in the UAE.

Keywords

Aridic • Diagnostic horizons • Suffix letters • Moisture regime • Temperature regime

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3.1 Introduction

This chapter defines the horizons, layers, and characteristics of mineral soils found in the United Arab Emirates. The horizons and characteristics defined below are not in a key format. The "required characteristics" for horizons or features, however, are arranged as a key. Some diagnostic horizons are mutually exclusive, and some are not.

3.2 Master Horizons and Layers

Soil profiles are described according to the different soil layers that may be identified within each profile. Each major layer, or master horizon, is allocated one or more letter codes, each of which has a specific meaning. The capital letters O, L, A, E, B, C, R, M, and W are used within the USDA-NRCS system (Soil Survey Staff 2010) to represent the master horizons and layers of soils. These letters are the base symbols to which other characteristics are added to complete the designations.

Common master horizons used for soils in arid regions are:

A horizons—mineral horizons that show an accumulation of humified organic matter or show signs of cultivation;
B horizons—mineral horizons that show evidence of illuvial concentration of silicate clay, gypsum, carbonates, iron, aluminum, humus, silica, or sesquioxides alone or in combination or have structure other than rock structure;
C horizons or layers—lack the properties of O, A, E, or B horizons and may be little affected by pedogenic processes;
R layers—strongly cemented to indurated bedrock. Granite, basalt, limestone, and sandstone are examples of bedrock designated by the letter R.

Within the UAE, the conditions are generally unsuitable for the occurrence of many pedogenic processes, and thus recognition of A, B, and C horizons can be difficult. B horizons are typically identified in the UAE through the accumulation of gypsum and/or carbonates, while C horizons typically lack this development. Due to the lack of significant amounts of organic matter, the surface layers are generally defined as A horizons. However, within the dune areas, the surface layer has been blown in from elsewhere and is typically the most recent material. In general, these deep sands lack any significant profile development, and thus most of the horizons (including the surface) have been described as C horizons. Lithified layers and bedrock are encountered and are designated as R layers.

3.3 Suffix Symbols

Lowercase letters are used as suffixes to designate specific kinds of master horizons and layers. The term “accumulation” is used in many of the definitions of such horizons to indicate that these horizons must contain more of the material in question than is presumed to have been present in the parent material.

The letters aa, b, c, d, g, k, m, n, p, q, r, w, y, yy, and z are the suffix symbols used for the UAE soils. These suffixes and their meanings are described below:

aa Accumulation of anhydrite†

This symbol is used in mineral soils to indicate an accumulation of anhydrite ($CaSO_4$). Colors associated with horizons that have suffix aa typically have hue of 5Y with chroma (dry and moist) of 1 or 2, and value of 7 or 8. Soil materials containing anhydrite have a fluid manner of failure. The symbol is commonly used in combination with suffix z as “Bzaa”.

b Buried genetic horizon

This symbol indicates identifiable buried horizons with major genetic features (diagonostic horizons) that were developed before burial. Genetic horizons may or may not have formed in the overlying material, which may be either like or unlike the assumed parent material of the buried soil.

c Concretions or nodules

This symbol indicates a significant accumulation of concretions or nodules. Cementation is required. The cementing agent commonly is iron, aluminum, or manganese. It cannot be silica, dolomite, calcite, or more soluble salts.

d Physical root restriction

This symbol indicates noncemented, root-restricting layers in naturally occurring or human-made sediments or materials. Examples are dense basal till, plowpans, and other mechanically compacted zones.

g Strong gleying

This symbol indicates either that iron has been reduced and removed during soil formation or that saturation with stagnant water has preserved it in a reduced state. Most of the affected layers have chroma of 2 or less, and many have redox concentrations. The low chroma can represent either the color of reduced iron or the color of uncoated sand and silt particles from which iron has been removed.

k Presence of calcium carbonates

This symbol indicates the presence of calcium carbonate as exhibited by effervescence or as visible accumulations that occur as carbonate filaments, coatings, masses, nodules, disseminated carbonate, or other forms. It was used with horizons that were very slightly to strongly effervescent (formation of bubbles) with application of dilute hydrochloric acid.

***m* Cementation or induration**

This symbol indicates continuous or nearly continuous cementation. It is used only for horizons that are more than 90 % cemented, although they may be fractured. The cemented layer is physically root restrictive. The predominant cementing agent (or the two dominant ones) may be indicated by adding defined letter suffixes, singly or in pairs. The horizon suffix km indicates cementation by carbonates; qm, cementation by silica; yym, cementation by gypsum; kqm, cementation by carbonates and silica; and zm, cementation by salts more soluble than gypsum.

***n* Accumulation of sodium**

This symbol indicates an accumulation of exchangeable sodium. It is used with horizons that have an exchangeable sodium percentage (ESP) of 15 or more or sodium adsorption ratio (SAR) of 13 (mmoles $L^{-1})^{0.5}$ or more.

***p* Tillage or other disturbance**

This symbol indicates a disturbance of the surface layer by mechanical means, pasturing, or similar uses.

***q* Accumulation of silica**

This symbol indicates an accumulation of secondary silica.

***r* Weathered or soft bedrock**

This symbol is used with C to indicate layers of bedrock that are moderately cemented or less cemented. Examples are weathered igneous rock and partly consolidated sandstone, siltstone, or shale. The excavation difficulty is low to high.

***w* Development of color or structure**

This symbol is used only with B horizons to indicate the development of color or structure, or both, with little or no apparent illuvial accumulation of material. It was not used to indicate a transitional horizon.

***y* Accumulation of gypsum**

This symbol indicates an accumulation of gypsum. It was used when the horizon fabric was dominated by soil particles or minerals other than gypsum. Gypsum is present in amounts that do not significantly obscure or disrupt other features of the horizon (generally, 1–50 % or more by volume; or 5–40 % percent or more by weight).

***yy* Dominance of horizon by gypsum**

This symbol indicates a horizon that is dominated by the presence of gypsum. The gypsum content may be due to an accumulation of secondary gypsum, the transformation of primary gypsum inherited from parent material, or other processes. Suffix yy is used when the horizon fabric has an abundance of gypsum (generally, 50 % or more, by volume; or 40 % or more, by weight) and pedogenic or lithologic features are obscured or disrupted by growth of gypsum crystals. Colors associated with horizons that have suffix yy typically are highly whitened, with value of 7 through 9.5 and chroma of 2 or less.

z Accumulation of salts more soluble than gypsum

This symbol indicates an accumulation of salts that are more soluble than gypsum. The suffix z is commonly used when the ECe is more than 4 dS/m (slightly or more saline).

3.4 Conventions for Using Letter Suffixes

Many master horizons and layers that are symbolized by a single capital letter have one or more lowercase letter suffixes. The following rules apply:

1. Letter suffixes should directly follow the capital letter.
2. More than three suffixes are rarely used.
3. If more than one suffix is needed, the following letters, if used, are written first: d, k, r, t, and w. None of these letters are used in combination in a single horizon.
4. If more than one suffix is needed and the horizon is not buried, the following symbols, if used, are written last: aa, c, g, and m (e.g., Bkm or Bzaa).
5. If a horizon is buried, the suffix b is written last (e.g., Bkb).
6. If the above rules do not apply to certain suffixes, such as k, q, or y, the suffixes may be listed together in order of assumed dominance or they are listed alphabetically if dominance is not a concern.

A B horizon that is gleyed or has accumulations of carbonates, sodium, silica, gypsum, or salts more soluble than gypsum or residual accumulations of sesquioxides carries the appropriate symbol: g, k, n, q, y, or z.

3.5 Vertical Subdivision

Commonly, a horizon or layer identified by a single letter or a combination of letters has to be subdivided. For this purpose, Arabic numerals are added to the letters of the horizon designation. These numerals follow all the letters. Within a C horizon, for example, successive layers may be designated C1, C2, C3, etc. If the lower part is gleyed and the upper part is not gleyed, the layers may be designated C1-C2-Cg1-Cg2.

These conventions apply whatever the purpose of the subdivision. In many soils a horizon that could be identified by a single set of letters is subdivided because of the need to recognize differences in morphological features, such as structure, color, or texture. These divisions are numbered consecutively with numerals, but the numbering starts again with 1 wherever in the profile any letter of the horizon symbol changes, e.g., Bk1-Bk2-Bky1-Bky2 (not Bk1-Bk2-Bky3-Bky4). The numbering of vertical subdivisions within consecutive horizons is not interrupted at a discontinuity (indicated by a numerical prefix) if the same letter combination is used in both materials, e.g., Bk1-Bk2-2Bk3-2Bk4 (not Bk1-Bk2-2Bk1-2Bk2).

During sampling for laboratory analyses, thick soil horizons are sometimes subdivided even though differences in morphology are not evident in the field. These subdivisions are identified by numerals that follow the respective horizon designations. For example, four layers of a Bk horizon sampled by 10-cm increments are designated Bk1, Bk2, Bk3, and Bk4. If the horizon has already been subdivided because of differences in morphological features, the set of numerals that identifies the additional sampling subdivisions follows the first numeral. For example, three layers of a Bk2 horizon sampled by 10-cm increments are designated Bk21, Bk22, and Bk23. The descriptions for each of these sampling subdivisions can be the same, and a statement indicating that the horizon has been subdivided only for sampling purposes can be added.

3.6 Discontinuities

Numerals are used as prefixes to horizon designations (preceding the letters A, B, C, and R) to indicate discontinuities in mineral soils. These prefixes are distinct from the numerals that are used as suffixes denoting vertical subdivisions. A discontinuity that can be identified by a number prefix is a significant change in particle-size distribution or mineralogy that indicates a difference in the material from which the horizons have formed and/or a significant difference in age, *unless that difference in age is indicated by the suffix b*.

Symbols that identify discontinuities are used only when they can contribute substantially to an understanding of the relationships among horizons. The stratification common to soils that formed in alluvium is not designated as a discontinuity, unless particle-size distribution differs markedly from layer to layer (i.e., particle-size classes are strongly contrasting), even though genetic horizons may have formed in the contrasting layers.

Where a soil has formed entirely in one kind of material, the whole profile is understood to be material 1 and the number prefix is omitted from the symbol. Similarly, the uppermost material in a profile consisting of two or more contrasting materials is understood to be material 1, but the number is omitted. Numbering starts with the second layer of contrasting material, which is designated 2. Underlying contrasting layers are numbered consecutively. Even when the material of a layer below material 2 is similar to material 1, it is designated 3 in the sequence; the numbers indicate a change in materials, not types of material. Where two or more consecutive horizons have formed in the same kind of material, the same prefix number is applied to all the designations of horizons in that material: A-Bk1-2Bk2-2Bk3-2Ck. The suffix numbers designating vertical subdivisions of the Bk horizon continue in consecutive order across the discontinuity.

However, vertical subdivisions do not continue across lithologic discontinuities if the horizons are not consecutive or contiguous to each other. If other horizons intervene, another vertical numbering sequence begins for the lower horizons: A-C1-C2-2Bk1-2Bk2-2Ck1-2Ck2. If an R layer is present below a soil that has formed in residuum and if the material of the R layer is judged to be like the material from which the soil has developed, the Arabic number prefix is not used. The prefix is used, however, if it is thought that the R layer would produce material unlike that in the solum, e.g., A-Bk-Ck-2R or A-Bk-2R. If part of the solum has formed in residuum, the symbol R is given the appropriate prefix: A-Bk1-2Bk2-2Bk3-2Ck1-2Ck2-2R.

A buried horizon (designated by the letter b) presents special problems. It is obviously not in the same deposit as the overlying horizons. Some buried horizons, however, have formed in material that is lithologically like the overlying deposit. A prefix is not used to distinguish material of such a buried horizon. If the material in which a horizon of a buried soil has formed is lithologically unlike the overlying material, however, the discontinuity is indicated by a number prefix and the symbol for the buried horizon also is used, e.g., A-Bk1-Bk2-C-2Ab-2Bkb1-2Bkb2-2C.

3.7 Use of the Prime Symbol

If two or more horizons with *identical* numeral prefixes and letter combinations are separated by one or more horizons with a different horizon designation in a pedon, identical letter and number symbols can be used for those horizons that have the same characteristics. For example, the sequence A-Bk-Bkn-Bk-CK identifies a soil that has two Bk horizons. To emphasize this characteristic, the prime symbol (′) is added after the master-horizon symbol of the lower of the two horizons that have identical designations, e.g., A-Bk-Bkn-B′k-Ck. The prime symbol, where appropriate, is placed after the capital-letter horizon designation and before the lowercase suffix letter symbols that follow it: B′k.

The prime symbol is not used unless all letters and numeral prefixes are completely identical. The sequence A-Bk1-Bk2-2Bk1-2Bk2 is an example. It has two Bk master horizons of different lithologies; thus, the Bk horizons are not identical and the prime symbol is not needed. The prime symbol is used for soils with lithologic discontinuities when horizons have identical designations. In the rare cases where three layers have identical letter symbols, double prime symbols can be used for the lowest of these horizons: Bk″.

Vertical subdivisions of horizons or layers (numeral suffixes) are not taken into account when the prime symbol is assigned. The sequence A-Bk-Bkn-B′k1-B′k2-B′k3-C is an example.

3.8 Use of the Caret Symbol

The "caret" symbol (^) is used as a prefix to master horizon designations to indicate layers of human-transported material. This material has been moved horizontally onto a pedon from a source area outside of that pedon by directed human activity, usually with the aid of machinery.

All horizons and layers formed in human-transported material are indicated by a "caret" prefix (e.g., ^A-^C-Ak-Bkb). When they can contribute substantially to an understanding of the relationship of the horizons or layers, numeral prefixes may be used before the caret symbol to indicate the presence of discontinuities within the human-transported material or between the human-transported material and underlying layers (e.g., ^A-^C-2^C-3Bkb).

3.9 Diagnostic Surface Horizons

3.9.1 The Epipedon

The epipedon (Gr. *epi*, over, upon, and *pedon*, soil) is a horizon that forms at or near the surface and in which most of the rock structure has been destroyed. It is darkened by organic matter or shows evidence of eluviation, or both. *Rock structure* as used here and in other places in this taxonomy includes fine stratification (5 mm or less thick) in unconsolidated sediments (eolian, alluvial, or marine) and saprolite derived from consolidated rocks in which the unweathered minerals and pseudomorphs of weathered minerals retain their relative positions to each other.

Any horizon may be at the surface of a truncated soil. These horizons can be covered by a surface mantle of new soil material. If the surface mantle has rock structure, the top of the epipedon is considered the soil surface unless the mantle meets the definition of buried soils. If the soil includes a buried soil, the epipedon, if any, is at the soil surface and the epipedon of the buried soil is considered a buried epipedon and is not considered in selecting taxa unless the keys specifically indicate buried horizons. A soil with a mantle thick enough to have a buried soil has no epipedon if the soil has rock structure to the surface or has an A horizon less than 25 cm thick that is underlain by soil material with rock structure.

A recent alluvial or eolian deposit that retains fine stratifications (5 mm or less thick) or an A horizon directly underlain by such stratified material is not included in the concept of the epipedon because time has not been sufficient for soil-forming processes to erase these transient marks of deposition and for diagnostic and accessory properties to develop. An epipedon is not the same as an A horizon.

3.9.1.1 Ochric Epipedon

The ochric epipedon is the only diagnostic surface horizon recognized in the UAE. It fails to meet any of the definitions for the other epipedons identified in the USDA *Keys to Soil Taxonomy* because it is too thin or too dry, has too high a color value or chroma, contains too little organic carbon, has too high an *n* value or melanic index, or is both massive and hard or harder when dry. The ochric epipedon does not have rock structure and does not include finely stratified fresh sediments, nor can it be an Ap horizon directly overlying such deposits.

3.10 Diagnostic Subsurface Horizons

The horizons described in this section form below the surface of the soil. They may be exposed at the surface by truncation of the soil. Some of these horizons are generally regarded as B horizons, some are considered B horizons by many but not all pedologists, and others are generally regarded as parts of the A horizon. The following diagnostic subsurface horizons have been identified in the UAE.

3.10.1 Anhydritic Horizon†

The anhydritic diagnostic horizon (Abdelfattah and Shahid 2007; Abdelfattah et al. 2008, 2009; Shahid 2010; Shahid and Abdelfattah 2008, 2009; Shahid et al. 2004, 2007, 2009, 2010; Wilson et al. 2013) is in the final stage of approval to be incorporated as part of USDA Soil Taxonomy. The criteria are as follows:

The anhydritic horizon is an illuvial horizon in which secondary anhydrite has accumulated to a significant extent.

Fig. 3.1 Well developed anhydritic horizon

Required Characteristics
An anhydritic horizon has *all* of the following properties:

1. A thickness of 15 cm or more; *and*
2. 5 % or more (by weight) anhydrite; *and*
3. Has hue of 5Y with chroma (dry and moist) of 1 or 2, and value of 7 or 8; *and*
4. A product of thickness, in cm, multiplied by the anhydrite content (percent by weight) of 150 or more. Thus, a horizon 30 cm thick that is 5 % anhydrite qualifies as an anhydritic horizon, *and*
5. Anhydrite should be the predominant mineral, with gypsum either absent or occurring only in minor amounts (Fig. 3.1).

3.10.2 Calcic Horizon

The calcic horizon is an illuvial horizon in which secondary calcium carbonate or other carbonates have accumulated to a significant extent.

Required Characteristics
The calcic horizon:

1. Is 15 cm or more thick; *and*
2. Has *one or more* of the following:
   or
   (a) 15 % or more (by weight) $CaCO_3$ equivalent and 5% or more (by volume) identifiable secondary carbonates; *or*
   (b) 5 % or more (by weight) calcium carbonate equivalent and:
   (1) Has less than 18 % clay in the fine-earth fraction; *and*
   (2) Meets the criteria for a sandy, sandy-skeletal, coarse-loamy, or loamy-skeletal particle-size class; *and*
3. Is not cemented or indurated in any part by carbonates, with or without other cementing agents, or is cemented in some part and the cemented part satisfies *one* of the following:
   (a) It is characterized by so much lateral discontinuity that roots can penetrate through noncemented zones or along vertical fractures with a horizontal spacing of less than 10 cm; *or*
   (b) The cemented layer is less than 1 cm thick and consists of a laminar cap underlain by a lithic or paralithic contact; *or*
   (c) The cemented layer is less than 10 cm thick.

3.10.3 Cambic Horizon

A cambic horizon is the result of physical alterations, chemical transformations, or removals or of a combination of two or more of these processes.

Required Characteristics
The cambic horizon is an altered horizon 15 cm or more thick. In addition, the cambic horizon must meet all of the following:

1. Has a texture class of very fine sand, loamy very fine sand, or finer; *and*
2. Shows evidence of alteration in the following forms:
   (a) Has soil structure, *or*
   (b) The absence of rock structure, including fine stratifications (5 mm or less thick), in more than one-half of the volume and one or more of the following properties:
   (1) Higher chroma, higher value, redder hue, or higher clay content than the underlying horizon or an overlying horizon; *or*

   (2) Evidence of the removal of carbonates or gypsum; *and*
3. Has properties that do not meet the requirements for a calcic, gypsic, petrocalcic, or petrogypsic; *and*
4. Is not part of an Ap horizon.

3.10.4 Gypsic Horizon

The gypsic horizon is a horizon in which gypsum has accumulated or been transformed to a significant extent. It typically occurs as a subsurface horizon, but it may occur at the surface in some soils.

Required Characteristics
A gypsic horizon meets all of the following requirements:

1. Is 15 cm or more thick; *and*
2. Is not cemented by gypsum, with or without other cementing agents; is cemented and the cemented parts are less than 5 mm thick; or is cemented but, because of lateral discontinuity, roots can penetrate along vertical fractures with a horizontal spacing of less than 10 cm; *and*
3. Is 5 % or more (by weight) gypsum and has 1 % or more (by volume) visible secondary gypsum that has either accumulated or been transformed; *and*
4. Has a product of thickness, in cm, multiplied by the gypsum content (percent by weight) of 150 or more. Thus, a horizon 30 cm thick that is 5 % gypsum qualifies as a gypsic horizon if it is 1 % or more (by volume) visible gypsum and any cementation is as described in 2 above (Fig. 3.2).

3.10.5 Petrocalcic Horizon

The petrocalcic horizon is an illuvial horizon in which secondary calcium carbonate or other carbonates have accumulated to the extent that the horizon is cemented or indurated.

Required Characteristics
A petrocalcic horizon must meet the following requirements:

1. The horizon is cemented or indurated by carbonates, with or without silica or other cementing agents; *and*

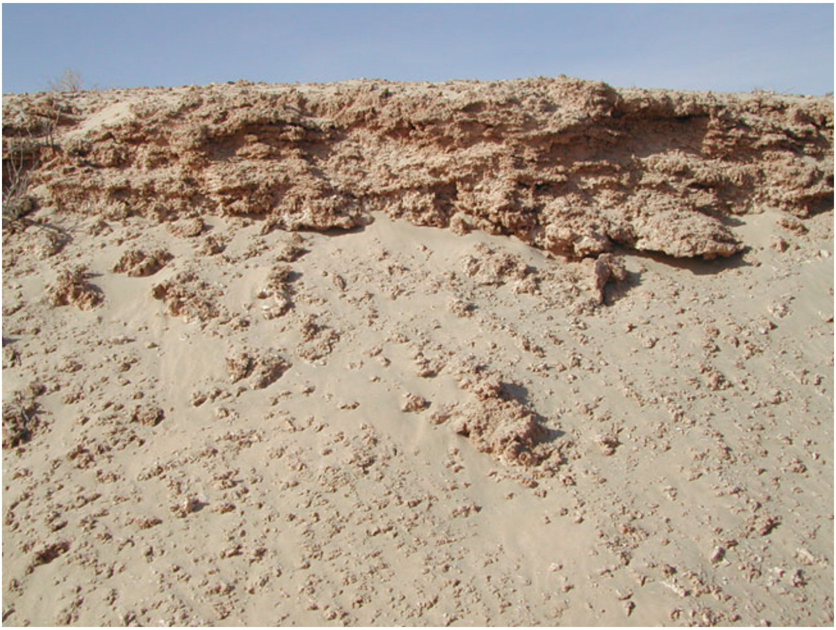

Fig. 3.2 Example of gypsic horizon

2. Because of lateral continuity, roots can penetrate only along vertical fractures with a horizontal spacing of 10 cm or more; *and*
3. The horizon has a thickness of:
   (a) 10 cm or more; *or*
   (b) 1 cm or more if it consists of a laminar cap directly underlain by bedrock (Fig. 3.3).

3.10.6 Petrogypsic Horizon

The petrogypsic horizon is a horizon in which visible secondary gypsum has accumulated or has been transformed. The horizon is cemented (i.e., extremely weakly through indurated cementation classes), and the cementation is both laterally continuous and root limiting, even when the soil is moist. The horizon typically occurs as a subsurface horizon, but it may occur at the surface in some soils.

Fig. 3.3 Example of petrocalcic horizon

Required Characteristics

A petrogypsic horizon meets *all* of the following requirements:

1. Is cemented or indurated by gypsum, with or without other cementing agents (Fig. 3.4); *and*
2. Because of lateral continuity, can be penetrated by roots only along vertical fractures with a horizontal spacing of 10 cm or more; *and*
3. Is 5 mm or more thick; *and*
4. Is 40 % or more (by weight) gypsum.

3.10.7 Salic Horizon

A salic horizon is a horizon of accumulation of salts that are more soluble than gypsum in cold water.

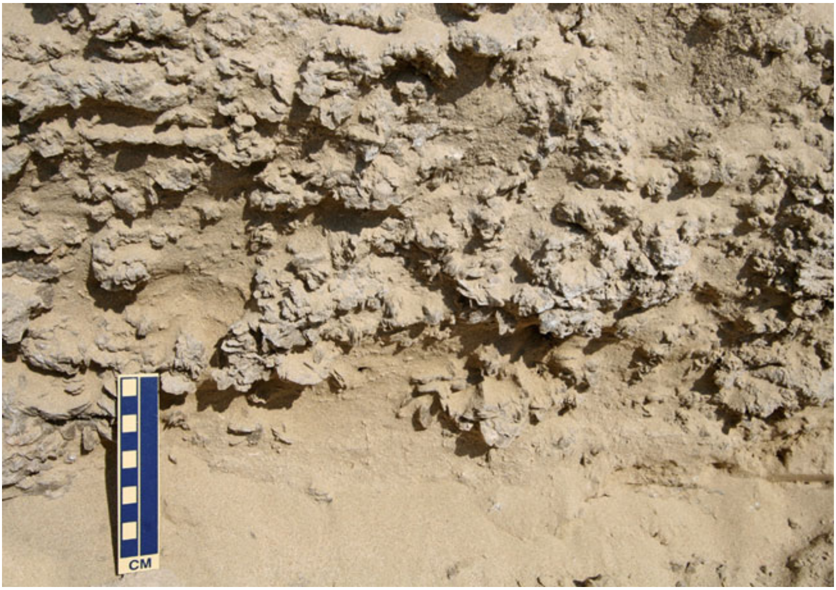

Fig. 3.4 Example of strongly cemented petrogypsic horizon

Required Characteristics
A salic horizon is 15 cm or more thick and has, for 90 consecutive days or more in normal years:

1. An electrical conductivity (EC) equal to or greater than 30 dS/m in the water extracted from a saturated paste; *and*
2. A product of the EC, in dS m^{-1}, and thickness, in cm, equal to 900 or more.

3.11 Horizons and Characteristics-Diagnostics for Mineral Soils

Following are descriptions of the horizons and characteristics that are diagnostic for mineral soils of the Unites Arab Emirates.

3.11.1 Aquic Conditions

Soils with aquic (L. *aqua*, water) conditions are those that currently undergo continuous or periodic saturation and reduction. The presence of these conditions is indicated by redoximorphic features and can be verified by measuring saturation and reduction, except in artificially drained soils. Artificial drainage is defined here as the removal of free water from soils having aquic conditions by surface mounding, ditches, or subsurface tiles or the prevention of surface or ground water from reaching the soils by dams, levees, surface pumps, or other means. In these soils water table levels and/or their duration are changed significantly in connection with specific types of land use. Upon removal of the drainage practices, aquic conditions would return. In the keys, artificially drained soils are included with soils that have aquic conditions.

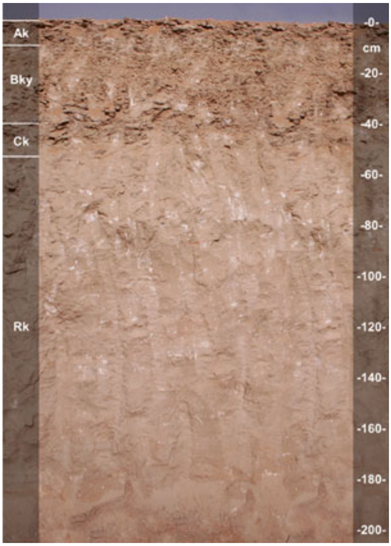

Fig. 3.5 Profile showing lithic contact at 45 cm depth (AD113)

3.11.2 Lithic Contact

A lithic contact is the boundary between soil and a coherent underlying material (Fig. 3.5). The underlying material must be virtually continuous within the limits of a pedon. Cracks that can be penetrated by roots are few, and their horizontal spacing is 10 cm or more. The underlying material must be sufficiently coherent when moist to make hand-digging with a spade impractical, although the material may be chipped or scraped with a spade. The material below a lithic contact must be in a strongly cemented or more cemented rupture-resistance class. Commonly, the material is indurated. The underlying material considered here does not include diagnostic soil horizons, such as a duripan or a petrocalcic horizon. A lithic contact is diagnostic at the subgroup level if it is within 50 cm of the surface for the soils which occur in the UAE.

3.11.3 Paralithic Contact

A paralithic (lithic-like) contact is a contact between soil and paralithic materials (defined below) where the paralithic materials have no cracks or the spacing of cracks that roots can enter is 10 cm or more.

3.11.4 Paralithic Materials

Paralithic materials are relatively unaltered materials (do not meet the requirements for any other named diagnostic horizons or any other diagnostic soil characteristic) that have an extremely weakly cemented to moderately cemented rupture-resistance class. Cementation, bulk density, and the organization are such that roots cannot enter, except in cracks. Paralithic materials have, at their upper boundary, a paralithic contact if they have no cracks or if the spacing of cracks that roots can enter is 10 cm or more. Commonly, these materials are partially weathered bedrock or weakly consolidated bedrock, such as sandstone, siltstone, or shale. Paralithic materials can be used to differentiate soil series if the materials are within the series control section. Fragments of paralithic materials 2.0 mm or more in diameter are referred to as pararock fragments.

3.11.5 Soil Moisture Regimes

The term "soil moisture regime" refers to the presence or absence either of ground water or of water held at a tension of less than 1,500 kPa in the soil or in specific horizons during periods of the year. Water held at a tension of 1,500 kPa or more is not available to keep most mesophytic plants alive. The availability of water is also affected by dissolved salts. If a soil is saturated with water that is too salty to be available to most plants, it is considered salty rather than dry. Consequently, a horizon is considered dry when the moisture tension is 1,500 kPa or more and is considered moist if water is held at a tension of less than 1,500 kPa but more than zero. A soil may be continuously moist in some or all horizons either throughout the year or for some part of the year. It may be either moist in winter and dry in summer or the reverse. In the Northern Hemisphere, summer refers to June, July, and August and winter refers to December, January, and February.

Normal Years

A normal year is defined as a year that has:

1. Annual precipitation that is plus or minus one standard deviation of the long-term (30 years or more) mean annual precipitation; *and*
2. Mean monthly precipitation that is plus or minus one standard deviation of the long-term monthly precipitation for 8 of the 12 months.

For the most part, normal years can be calculated from the mean annual precipitation; however, when catastrophic events occur during a year, the standard deviations of the monthly means should also be calculated. The term "normal years" replaces the terms "most years" and "6 out of 10 years," which were used in the 1975 edition of *Soil Taxonomy* (USDA, SCS 1975). When precipitation data are evaluated to determine if the criterion for the presence of aquic conditions, or number of days that the moisture control section is moist, or number of days that some part of the soil is saturated has been met, it is permissible to include data from periods with below normal rainfall. Similarly, when precipitation data are evaluated to determine if the criterion for the number of days that the moisture control section is dry has been met, it is permissible to include data from periods with above normal rainfall. It is assumed that if the criteria are met during these periods, they will also be met during normal years.

3.11.5.1 Classes of Soil Moisture Regimes

The soil moisture regimes are defined in terms of the level of ground water and in terms of the seasonal presence or absence of water held at a tension of less than 1,500 kPa in the moisture control section. It is assumed in the definitions that the soil supports whatever vegetation it is capable of supporting, i.e., crops, grass, or native vegetation, and that the amount of stored moisture is not being increased by irrigation or fallowing. These cultural practices affect the soil moisture conditions as long as they are continued.

Aquic soil moisture regime.—The aquic (L. *aqua*, water) soil moisture regime is a reducing regime in a soil that is virtually free of dissolved oxygen because it is saturated by water (Fig. 3.6). Some soils are saturated with water at times while dissolved oxygen is present, either because the water is moving or because the environment is unfavorable for micro-organisms (e.g., if the temperature is less than 1°C); such a regime is not considered aquic.

It is not known how long a soil must be saturated before it is said to have an aquic soil moisture regime, but the duration must be at least a few days, because it is implicit in the concept

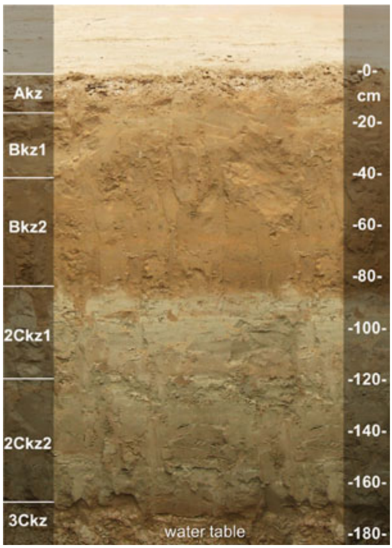

Fig. 3.6 Profile showing aquic moisture regime (AD147)

that dissolved oxygen is virtually absent. Because dissolved oxygen is removed from ground water by respiration of microorganisms, roots, and soil fauna, it is also implicit in the concept that the soil temperature is above biologic zero for some time while the soil is saturated. Biologic zero is defined as 5°C in this taxonomy.

Aridic and torric (L. *aridus*, dry, and L. *torridus*, hot and dry) soil moisture regimes.—These terms are used for the same moisture regime but in different categories of the taxonomy. In the aridic (torric) soil moisture regime, the moisture control section is, in normal years:

1. Dry in all parts for more than half of the cumulative days per year when the soil temperature at a depth of 50 cm below the soil surface is above 5°C; *and*
2. Moist in some or all parts for less than 90 consecutive days when the soil temperature at a depth of 50 cm below the soil surface is above 8°C.

Soils that have an aridic (torric) soil moisture regime normally occur in areas of arid climates. A few are in areas of semiarid climates and either have physical properties that keep them dry, such as a crusty surface that virtually precludes the infiltration of water, or are on steep slopes where runoff is high. There is little or no leaching in this soil moisture regime, and soluble salts accumulate in the soils if there is a source.

3.11.6 Soil Temperature Regime

Following is a description of the soil temperature regime identified in the UAE and used in defining the hyperthermic soil temperature class which is used at the family categorical level of soil taxonomy.

Hyperthermic.—The mean annual soil temperature is 22°C or higher, and the difference between mean summer and mean winter soil temperatures is 6°C or more either at a depth of 50 cm below the soil surface or at a densic, lithic, or paralithic contact, whichever is shallower.

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Field kit used to establish soil taxa

Greening the desert to combat desertification in UAE