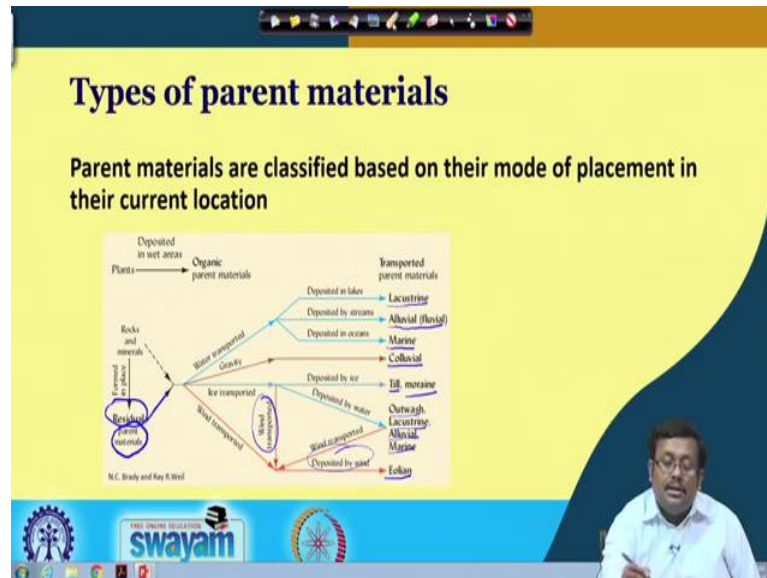


**Soil Science and Technology**  
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**Lecture – 05**  
**Weathering and Soil Formation (Contd.)**

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Hi, friends. Welcome to this lecture of Soil Science and Technology. Today, we will be discussing about different types of parent materials and also we will be discussing about what is soil profile and what are the important soil master horizons.

So, in the last class we stopped here while discussing the influence of parent material for soil formation. And I told you that the parent material is very important for determining the soil physical and chemical characteristics, not only that but also the nature of parent materials shows; nature of parent material governs the rate of soil formation.

Now, types of parent materials while we are talking about the types of parent materials remember that parent materials are classified based on their mode of placement in their current location. So, as you know that all soil forms from rocks and rocks breaks down into the parent materials. So, sometime parent materials develop into the soil at the place of their origin and sometimes these parent materials translocate from one area to another

area with the help of different types of forces physical forces and transporting agents and deposit in other places and therefore form soil in those places.

So, parent material can develop soil either at the place of origin or in some new places. So, depending on their location of origin or placement in their current location they are named in different ways. For example, in this slide you can see that when the rocks and minerals undergo weathering. So, they first forms parent materials and when these parent materials develops soil at the place of origin they are called residual.

Now, when this parent materials transported through different transporting agents to other places depending on the transporting agents we name them differently. For example, when the parent materials are transported through water and deposits in the lake we call it lacustrine. When the transporting agent is streams or river, we call it alluvial or fluvial. When the transporting agent is ocean, we call it marine and when the transportation occurs due to the gravitational action, we call it colluvial parent material. And when the transportation occurs due to the ice or glacier we call it, till or moraine and when this ice melts and further this parent materials deposited by water they will call outwash, lacustrine, alluvial and marine depending on various transporting agents, and when that parent material is transported through air or wind and or deposited by wind we call it either eolian .

So, as you can see based on different types of transporting agents we are naming the parent materials differently. And they are basically named based on the dominant transporting agent.

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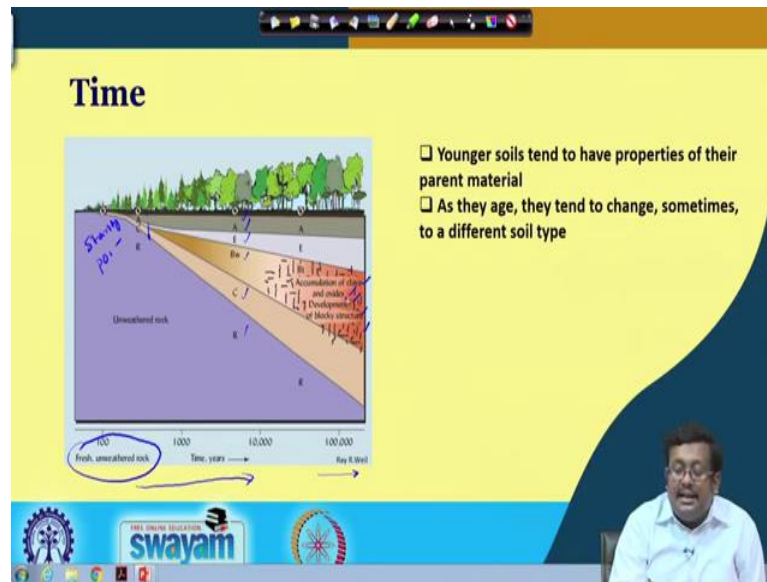
So, as you can see here three important examples of parent materials. First of all you are seeing colluvial parent material which occurs. Now here the parent materials are transported due to the action of gravity. Second is flood plains and third one is alluvial plain both of them are formed due to the transporting action of rivers or streams. So, based on the transporting agents as you can see the soil characteristics or parent material also differs from one soil to another soil.

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Here, some example of glacial till and glacial till occur due to the due to the action of glacier and this loess which formed due to the wind action. So, based on the transporting agents as you can see we are naming them differently.

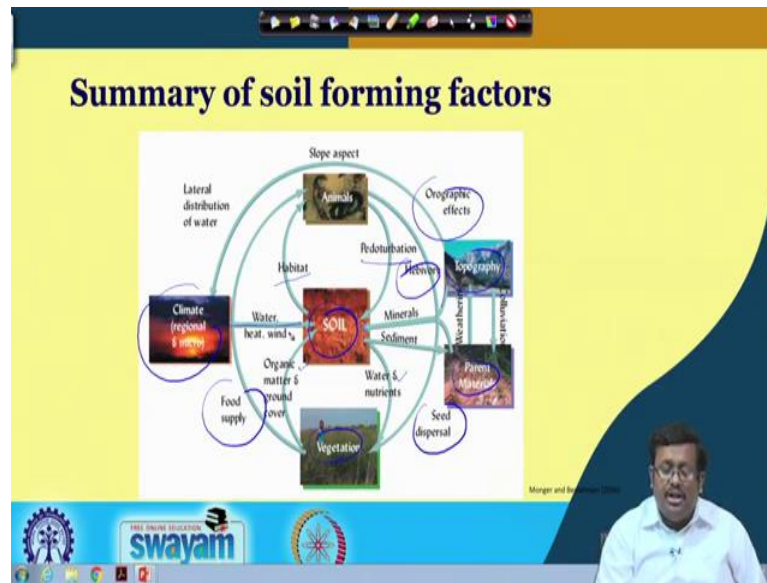
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Final important aspect of factor for soil formation is time. So, you know that younger soils tend to have properties of their parent material and as they age they tend to change sometime to a different soil type. This diagram shows this in a very nice manner. Now, as you can see this is this is a starting point of soil formation. So, obviously, there will be fresh unweathered rock and as the time goes on to 100 to 1000 to 10000 to I mean 100000 and so on so forth. You can see the development of different horizons or layers within the soil like O horizon or the organic horizon, A horizon or mineral horizon, C horizon or unconsolidated horizon and R which is basically the unweathered rock.

And, as the soil formation process further as you can see the development of more horizons in the soil, and further as the soil develops you will see accumulation of clays and oxides development of different types of soil structure and so on so forth. So, these justifies that the younger soils tend to have properties which are which resemble to their parent material and as they age they tend to change and sometime to a different soil type.

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So, let us see the summary of soil forming factors. As you can see this slide shows how this five soil forming factors are intimately interconnected to each other for the formation of soil. For example: here you are seeing that the vegetation is intimately related to the soil because they supply organic matter and ground cover for the soil formation. In turn soil gives them water and nutrients. So, vegetation is an important factor as you know and these parent material gives minerals to the soil as the result of different types of physical chemical weathering and soil also deposited into sediments to form further parent materials.

Topography governs different types of soil formation, animal also effects soil formation due to the pedoturbation process. We have discussed the pedoturbation process in the last lecture and in turn soil gives the animals habitats. Climate that is regional both regional micro climate provides the water heat and wind required for soil formation or soil chemical weathering. Vegetation is also linked with the animals because vegetation supply food for the animals and animals also help in seed dispersal or herbivore. So, this is another interconnection.

So you can see the all the factors the topography and parent materials are also intimately you know related to each other because of weathering and colluviation. And you can see also the topographic factors or the mountain effects or slope effects we call them orographic effects are responsible for different types of climates which are also you

know which also influences the soil formation. So, you can see there is an intimate relations or inter connections of this five soil formation factors for soil formation.

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The slide features a yellow background with the title "Soil Profile:" in bold black text. To the left of the diagram, there are three bullet points: "Five soil forming factors cause different set of layers (horizons).", "Each soil is characterized by a given sequence of these horizons.", and "A vertical exposure of this sequence is termed a soil profile." The central diagram shows a vertical cross-section of soil with five horizons labeled O, A, E, B, and C. Handwritten blue annotations include "E. Eluvial" next to the E horizon and "Soil Profile" written vertically along the right side of the diagram. The presenter's video feed is visible in the bottom right corner.

**Soil Profile:**

- Five soil forming factors cause different set of layers (horizons).
- Each soil is characterized by a given sequence of these horizons.
- A vertical exposure of this sequence is termed a soil profile.

*E. Eluvial*

*Soil Profile*

So let us see what is soil profile? Now, soil is a 3-dimensional body. So, five soil forming factors cause different state of layers if you go and cut down a soil vertically you will see different soil layers you can visually differentiate them. So, the how they occur basically? They occur because of actions from different five soil forming factors. So, each soil is characterized by a given sequence of this horizon and obviously, vertical section of this sequence is termed as soil profile. So, as you can see here the total as you can see here this total vertical section of a soil is called soil profile. An in a particular soil profile you will see some specific soil horizons or layers.

For examples; O horizons, A horizon, E horizon, B horizon, C horizon and at the bottom unweathered parent material. So, O horizons basically shows loose and partly decayed organic matters. So, remember that O horizon always occur at the top and it is dark in color and it basically composed of decaying organic matter fresh and decaying organic matter. Just beneath the O horizon you will see A horizon which is basically a mineral matter mixed with some humus or in other words mineral matters mixed with some organic matter. So, it is darker in nature.



See in some soil just below the A horizon you will see a light color horizon; we call it E horizon or eluvial horizon. So, E stands for eluvial. Eluvial horizon occurs due to the process of eluviations. Eluviation is basically movement of clay minerals or other compounds from upper layers to the bottom layers of the soil. So, this is the process of eluviation and as a result of movement of clay from upper layers to the deeper layers these resulting horizon is called light colored zone of leaching and we call it E horizon.

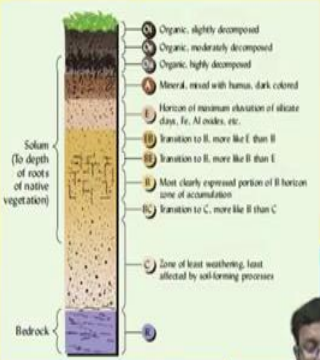
Just below the E horizon you will see a relatively darker horizon we call it B horizon which basically shows accumulation of clay from above. So, the all the eluviated clay from the above horizon they will deposit in the low horizon they will form B horizon. Just below the B horizon you will see C horizon which is basically composed or partially altered parent materials or small parent materials small fractions of parent materials and finally, at the bottom you will see unweathered parent material.

So, these basically shows the different soil horizons which are present within a soil profile.

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**The Master horizons and layers:**

- Six **master** soil horizons are commonly recognized and are designated using the capital letters
- O, A, E, B, C, and R.
- Subhorizon horizons may occur within a master horizon these are designated by lowercase letters following the capital master horizon letter
- e.g., Bt, Ap, or Oi



The diagram illustrates a soil profile with various horizons. From top to bottom, the horizons are: O (Organic), A (topsoil), E (eluvial), B (clay accumulation), C (partially altered parent material), and R (bedrock). The O horizon is divided into Oi (slightly decomposed), Oe (moderately decomposed), and Oa (highly decomposed). The A horizon is divided into Ap (mineral mixed with humus, dark colored) and Aq (horizon of maximum absorption of silicate, clay, Fe, Al oxides, etc.). The E horizon is divided into E1 (transition to B, more like E than B) and E2 (transition to B, more like B than E). The B horizon is divided into B1 (most clearly expressed portion of B horizon zone of accumulation) and B2 (transition to C, more like B than C). The C horizon is divided into C1 (zone of least weathering, least affected by soil-forming processes) and C2 (zone of least weathering, least affected by soil-forming processes). The R horizon is the bedrock.

Soilum (To depth of roots of native vegetation)

Bedrock

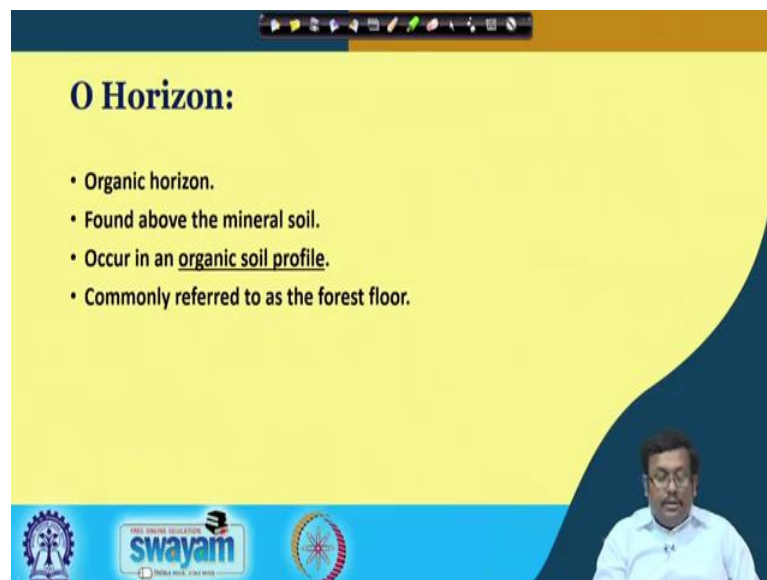
THE HINDU UNIVERSITY swayam

So, let us see what are the master horizon. Obviously, there are six master horizons and this six master horizons are commonly recognized and designated using the capital letters like O horizon, A horizon, E, B, C and R, R is basically the parent bedrock. So, this six are the basically the master horizon. Subhorizons may occur within a master

horizon and these are designated by lower letters following the capital master horizon letter; for example, Bt, Ap or Oi we will discuss them later on. As you can see in the picture also if you know all this sub horizons are given for example, Oi which basically stands for slightly decomposed organic horizon, Oe stands for moderately decomposed organic horizon and Oa stands for highly decomposed organic horizon.

So, like that all the master horizon can be sub divided into sub horizons. And this sub horizons are basically indicated by lower case letters following the capital master horizon letter.

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**O Horizon:**

- Organic horizon.
- Found above the mineral soil.
- Occur in an organic soil profile.
- Commonly referred to as the forest floor.

So, let us discuss them one by one. So, O horizon is basically the organic horizon which is found above the mineral soil and it basically occurs in organic soil profile and commonly referred as the forest floor. So, the thickness of the O horizon basically differs from one soil to another soil. Obviously, in case of forest soil the thickness of the O horizon will be more as compared to the soil which develops in the desert region and this O horizon is darker in color and it occurs just above the A horizon.



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• Often has three subhorizons:

1. Oi horizon - fibric materials—recognizable plant and animal parts.
2. Oe horizon - hemic materials—finely fragmented residues intermediately decomposed.
3. Oa horizon - sapric materials—highly decomposed, smooth, amorphous residues.

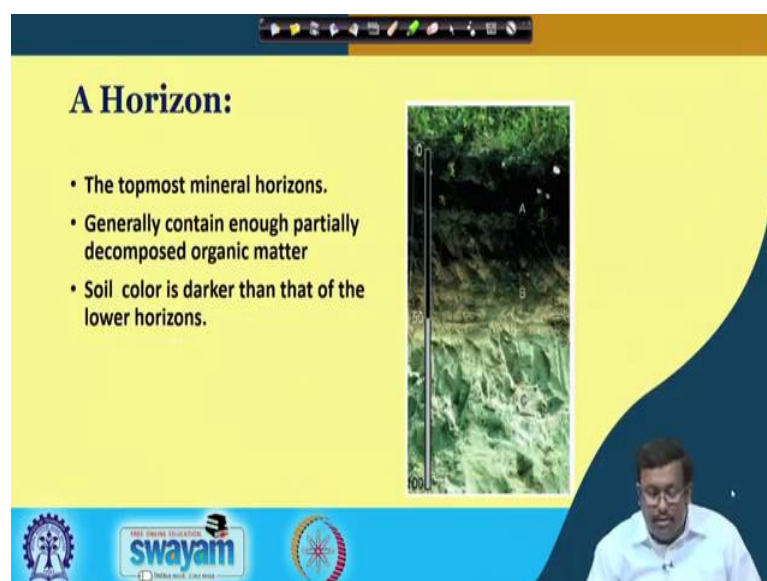


The slide features a yellow background with a blue header and footer. The footer contains logos for 'swayam' and other educational institutions. A small inset photograph shows a soil profile with three distinct layers labeled Oi, Oe, and Oa. The Oi layer is the topmost, showing fibric materials with recognizable plant and animal parts. The Oe layer is the middle, showing hemic materials that are finely fragmented and intermediately decomposed. The Oa layer is the bottom, showing sapric materials that are highly decomposed, smooth, and amorphous.

So, often this O horizon has three subdivisions Oi is fibric. So, it basically in the fibric horizon or fibric material means you can see recognizable plant and animal parts. The second important is Oe horizon we call it hemic materials which is basically composed of finely fragmented residues intermediately decomposed and finally, Oa horizon or sapric materials which consists of highly decomposed smooth amorphous residues.


So, based on the phase of decomposition or I would say the stages of decomposition we can differentiate o master horizon into three sub horizons that is fibric, hemic and sapric.

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**A Horizon:**

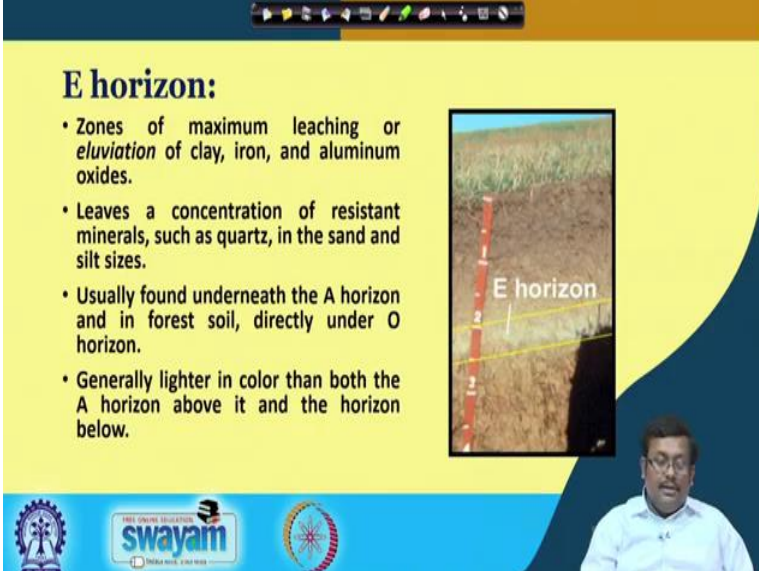
- The topmost mineral horizons.
- Generally contain enough partially decomposed organic matter
- Soil color is darker than that of the lower horizons.



The slide features a yellow background with a blue header and footer. The footer contains logos for 'swayam' and other educational institutions. A small inset photograph shows a soil profile with a dark A horizon at the top, followed by lighter B and C horizons. A vertical scale bar is visible on the left side of the photograph.

Now, let us see what is A horizon? A horizon is basically the top most mineral horizon. In a horizon you will see there it generally contains enough partially decomposed organic material. So, it is darker in color and soil color I mean it is darker in color than the lower horizons and it is one of the most important master horizon.

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**E horizon:**

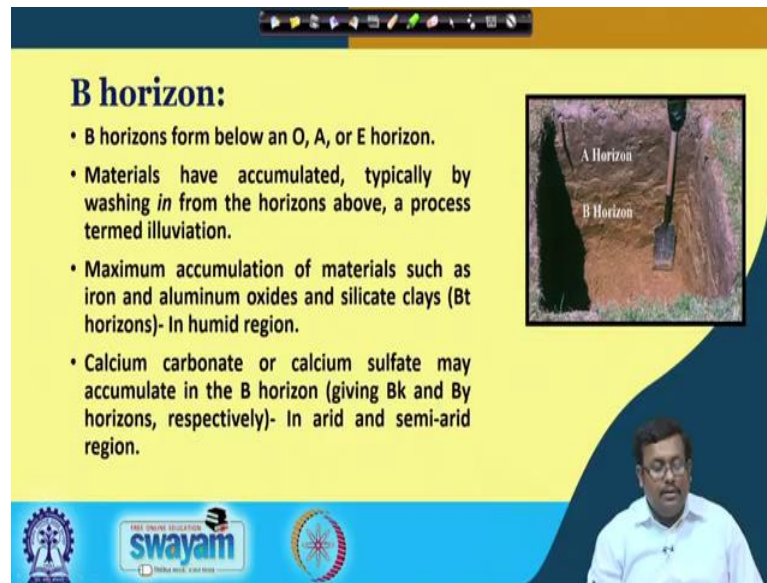
- Zones of maximum leaching or *eluviation* of clay, iron, and aluminum oxides.
- Leaves a concentration of resistant minerals, such as quartz, in the sand and silt sizes.
- Usually found underneath the A horizon and in forest soil, directly under O horizon.
- Generally lighter in color than both the A horizon above it and the horizon below.

The slide includes a photograph of a soil profile with a red measuring tape. A yellow line marks the boundary of the E horizon, which is a lighter-colored layer. The text 'E horizon' is overlaid on the image. At the bottom of the slide, there are logos for Swayam and other educational institutions, along with a small video inset of a man speaking.

E horizon: so zones of maximum leaching or eluviation of clay iron aluminum oxides. Remember that, again this E horizon occurs due to the process of eluviation of clay iron aluminum and it leaves as a result of a this eluviation of clay iron aluminum it leaves a concentration of resistance minerals such as quartz and sands and silt. And, it usually found underneath the A horizon and is the forest soil directly under the O horizon.


And, it is generally lighter in color than both the A horizon above it and the horizon below because all the clay which are darker in color have been already moved downwards. So, that is why it is also called bleach horizon. So, as you can see in this soil there is a clear bleached E horizon which is lighter in color and this is called E horizon or eluvial horizon.

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**B horizon:**

- B horizons form below an O, A, or E horizon.
- Materials have accumulated, typically by washing *in* from the horizons above, a process termed illuviation.
- Maximum accumulation of materials such as iron and aluminum oxides and silicate clays (Bt horizons)- In humid region.
- Calcium carbonate or calcium sulfate may accumulate in the B horizon (giving Bk and By horizons, respectively)- In arid and semi-arid region.

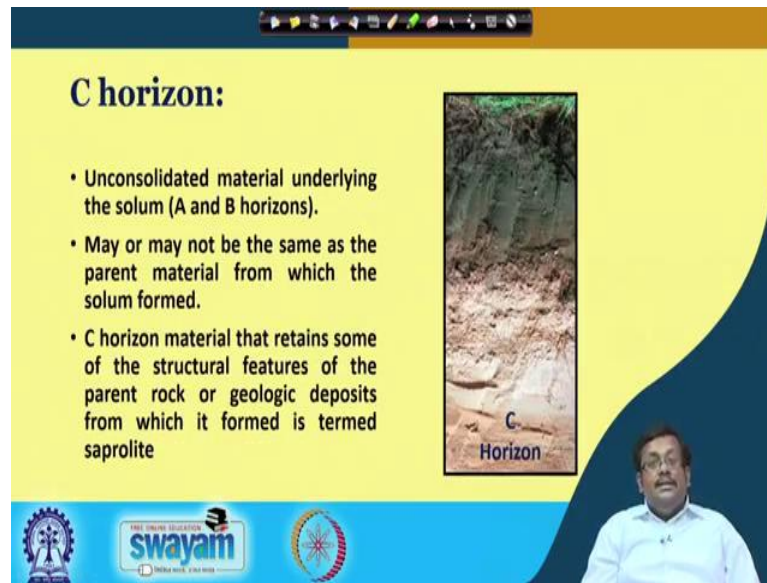


The slide features a yellow background with a blue header and footer. The footer contains logos for the Central Board of Secondary Education (CBSE), the Swayam portal, and the Ministry of Education. A small inset image shows a soil profile with a shovel, illustrating the A and B horizons.

So, the next important master horizon is B horizon and B horizon form below an O, A or E horizons. So, materials have been accumulated in the B horizons materials have been accumulated typically by washing in the form of horizons above a process termed as a illuviation.

Now, you all know about eluviations. Eluviation is movement of clay iron and aluminum from upper horizon to the lower horizon. So, when the eluviated materials deposited at the lower horizon or in the B horizon these process is called illuviation. So, remember that the B horizon occurs mainly due to the process of illuviation. So, in the B horizon you will see maximum accumulation of materials such as iron aluminum oxides and silicate clays and as a result of illuviation of silicate clays there will be a sub horizon. Specific sub horizon we call it Bt horizon, you will find it in the humid region. And, remember that calcium carbonate or calcium sulphate may accumulate in the B horizon giving rise to Bk and By horizon respectively in arid and semi arid region these are again this Bk and By are again subhorizons.

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**C horizon:**

- Unconsolidated material underlying the solum (A and B horizons).
- May or may not be the same as the parent material from which the solum formed.
- C horizon material that retains some of the structural features of the parent rock or geologic deposits from which it formed is termed saprolite

C Horizon

swamyam

C horizon: C horizon is basically the unconsolidated material underlying the solum. Now, what is solum? We generally consider A horizon plus B horizon combinedly as solum or in other words solum is the basically combination of A horizon and B horizon. So, C horizon is unconsolidated material which generally occurs at the bottom of the solum and this C horizon may or may not be same as the parent material from which they the solum formed. And finally, C horizon material that retains some of the structural features of the parent rocks or geologic deposits from which it forms is termed as saprolite.

So, as you can see in the picture there is a clear demarcation of C horizon which is basically the unconsolidated parent materials.

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**R horizon:**

- Consolidated rock.
- Little evidence of weathering

The slide shows a photograph of a soil profile with a black arrow pointing to the R horizon. The slide also features logos for IIT Bombay and Swamyam.

So, we have covered both O, A, E, B and C horizon. And let us see the final one that is R horizon which is basically the consolidated rock from which the soil forms. And you will see very little evidence of weathering in this unconsolidated rock and generally we termed this horizon at R horizon as you can see in this picture.

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**Subdivisions Within Master Horizons**

- Often distinctive layers exist *within* a given master horizon.
- These are indicated by a numeral *following* the letter designation.
- Three different combinations of structure and colors can be seen in the B horizon, then the profile may include a sequence such as B1-B2-B3

The slide shows a photograph of a soil profile with sub-horizons labeled A, B1, B2, BC, and C. The slide also features logos for IIT Bombay and Swamyam.

So, what is the sub division within the master horizons? Obviously, the often distinctive layers exists within a given master horizons and these are indicated by a numeric no numeral following by the letter designation. For example, we know three different



combination of structure and color can be seen in the B horizon then the profile may include a sequence of B 1, B 2 and B 3. So, you are seeing we are including numerical digits just after the letter designation of the master horizon to show this sub division or sub no or sub horizons.

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**Transition Horizons:**

- Transitional layers between the master horizons (O, A, E, B, and C) may be dominated by properties of one horizon but also have characteristics of another.
- Written as AE, EB, BE.
- E/B when distinct parts of the horizon have properties of E while other parts have properties of B.

Handwritten diagrams: A circle with 'A' and 'E' inside, an arrow pointing from 'A' to 'E', and another circle with 'B' and 'E' inside, an arrow pointing from 'B' to 'E'.

The slide features a yellow background with a blue wave-like shape on the right side. At the bottom, there is a blue banner with the 'swayam' logo and a small video inset of a man in a white shirt.

And, there is another important horizon we call transition horizons. So, transition horizons or transition layers occurs between the master horizons and may be dominated by properties of one horizon, but also have characteristics of another. As we write I mean you know we generally denote them as AE, EB and BE and so on so forth. So, E slash B when distinct parts of the horizons have properties of E while other parts have properties of B.


Now, when we call AE horizon for example, that basically denotes that this soil or these horizon has characteristics mostly similar to A horizon and some properties are similar to E horizon. Similarly, while we are talking about BE horizons; that means, this horizon are this horizon is having is showing the properties mostly of B horizon and some properties from E horizon. So, this is the physical interpretation of these transition horizons.



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## Subhorizon Distinctions:

- Since the capital letter designates the nature of a master horizon in only a very general way, specific horizon characteristics may be indicated by a lowercase letter following the master horizon designation.
- E.g., Oi – O horizon with slightly decomposed organic matter.



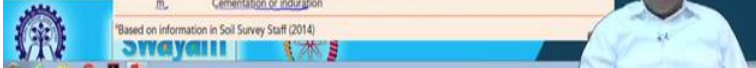
So, since the capital letter designates the nature of master horizons in only a very general way specific horizon characteristics may be indicated by a lower case letter following the master horizon designation. For example, Oi that is O horizon with slightly decomposed organic matter, we have already seen this.

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### SOME COMMON SUBHORIZON DISTINCTIONS WITHIN MASTER HORIZONS\*

Lower Case Symbol	Distinction	Lower Case Symbol	Distinction
a	Highly decomposed organic matter	n	Accumulation of sodium
b	Buried soil horizon	o	Accumulation of iron and aluminum oxides
c	Concretions or nodules	p	Plowing or other disturbance
co	Coprogenous earth	q	Accumulation of silica
d	Dense unconsolidated materials	r	Weathered or soft bedrock
di	Diatomaceous earth	s	Illuvial organic matter and iron, aluminum oxides
e	Intermediately decomposed organic matter	se	Presence of sulfides
f	Frozen soil	ss	Slickensides (shiny clay wedges)
ff	Dry permafrost	t	Accumulation of silicate clays
g	Strong gleying (mottling)	u	Human-manufactured artifacts
h	Illuvial accumulation of organic matter	v	Plinthite (high iron, red material)
i	Slightly decomposed organic matter	w	Distinctive color or structure without clay accumulation
j	Jarosite (yellow sulfate mineral)	x	Fragipan (high bulk density, brittle)
ii	Cryoturbation (frost churning)	y	Accumulation of gypsum
k	Accumulation of carbonates	yy	Gypsum >50% of soil by mass
kk	Engulfment of carbonates, >50% of soil by mass	z	Accumulation of soluble salts
m	Cementation or induration		

\*Based on information in Soil Survey Staff (2014)



So, in this slide or in this table you will see some common sub horizon distinction within the master horizons. For example, if you use lower case symbol a sorry, if we use lower case symbol a that will you know that will denote highly decomposed organic matter. If

we use lower case symbol b that will denote buried soil horizons, if we use c that will see that will denote concretion of nodules, if you use e; that means, intermediately decomposed organic matter, if you use f that will show frozen soil, if you use i that is slightly decomposed organic matter. If you use j that is showing basically jarosite or yellow sulfate mineral present into the soil, if we use k that will see that will denote the accumulation of the carbonates. If you will use m that will indicate the cementation or induration inside the soil, z basically denotes the accumulation of soluble salts, y denotes accumulation of gypsum, x denotes fragipan which is the layer with high bulk density and brittleness, v shows plinthite which is high iron red color material.

So, as you can see also n shows accumulation of sodium, o denotes accumulation of iron aluminum oxide, p denotes plowing or other disturbances. Similarly q denotes accumulation of silica, r denotes weather weathered or soft bed rock, s shows illuvial organic matter and iron aluminum oxide and sc shows presence of sulfides.

So, as you can see all these symbols when you use along with the along with the letter symbol of master horizon they show different or I mean specific soil property. And, for describing any soil a soil scientist or a scientist has you know need to have one needs to have complete understanding of all these important process which are responsible for soil formation. And by visually seeing any soil profile you can understand; what are the important soil processes which occurred for the formation of that particular soil.

Remember one thing that all soil will not show the similar sequence of soil horizons, one soil will show some horizons and another soil will show another set of horizons, some horizons may not be present in all the soils specifically E horizon which is only present in specific soils. And, most of the time these horizons differentiation are done in the field by the experienced soil scientists by using some qualitative diagnostic features, their color, their structure, their texture as well as some small visual characteristics and in other words every soil profile gives basically the snapshot of the processes through which that particular soil forms.

By this we have concluded the soil forming factors as well as soil profile. If you have any question regarding or any if you need any clarification feel free to email, and I will be more than happy to answer your queries. And, from the next lecture will be starting a new topic. And I hope that you have learned something new in these lectures.

Thank you very much.