Forests and Their Management
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Module - 03
Forest Soils
Lecture – 01
Soil and Soil Profile

[FL]. Today we begin a new module that is Forest Soils.

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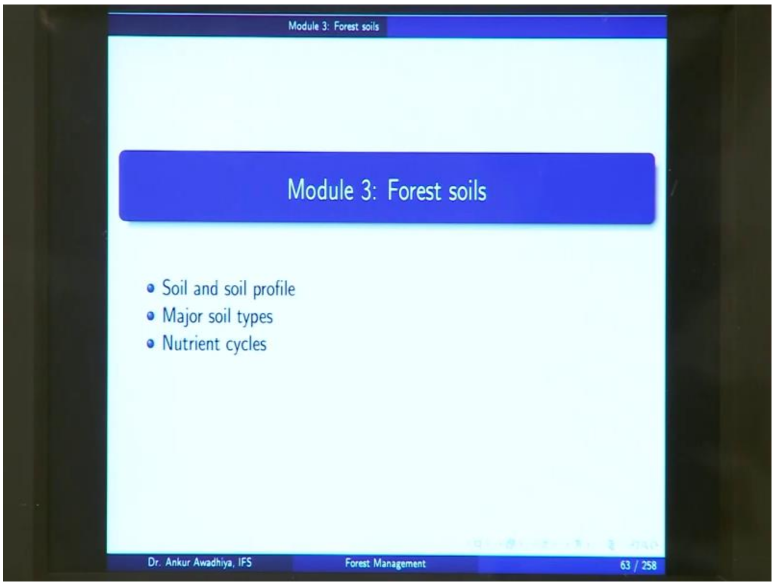

This module will have 3 lectures: soil and soil profile, with major soil types and nutrient cycles. So, we begin with soil and soil profile.

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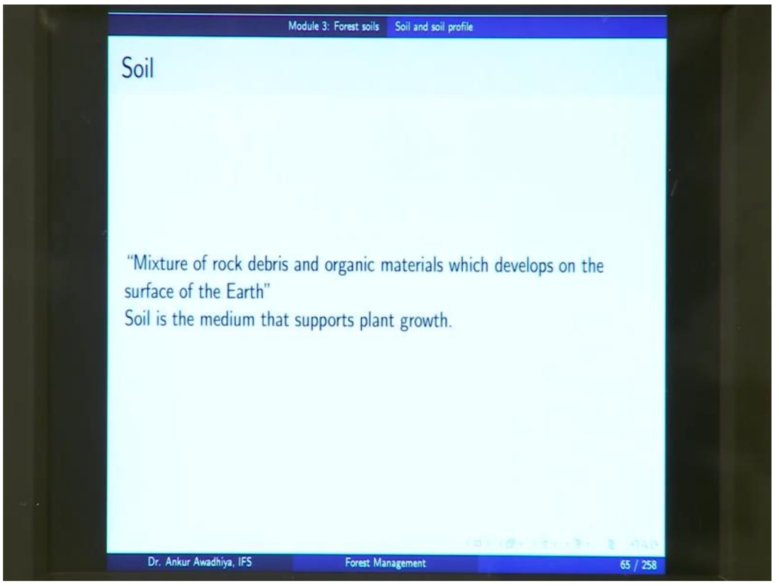

So, what is the soil? A soil is defined as a mixture of rock debris and organic materials, which develops on the surface of the earth. So, soil has two components - rock debris and organic materials along with air and water, and it develops on the surface of the earth and it is the medium that supports plant growth. So, when we talk about silviculture, when we want to raise any particular forest species, we need to ensure that this the soil matches the requirements of the plant species, because soil is the medium that is going to support the plant growth.

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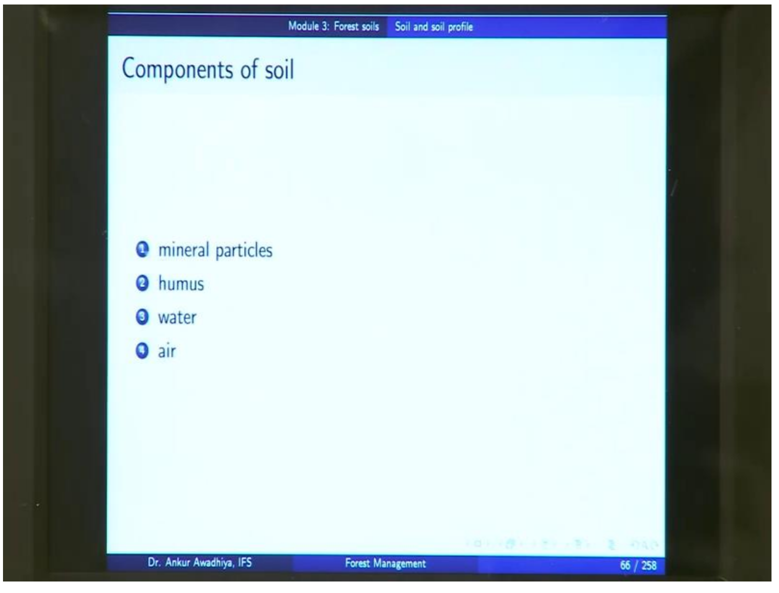

As we saw, there are four components of the soil. There are mineral particles, there is humus or the organic matter, water and air. Now, mineral particles provide a number of nutrients to the plants. So, these mineral particles might be a number of salts, and these salts will provide different - the plants, and humus or the organic matter provides texture to the soil.

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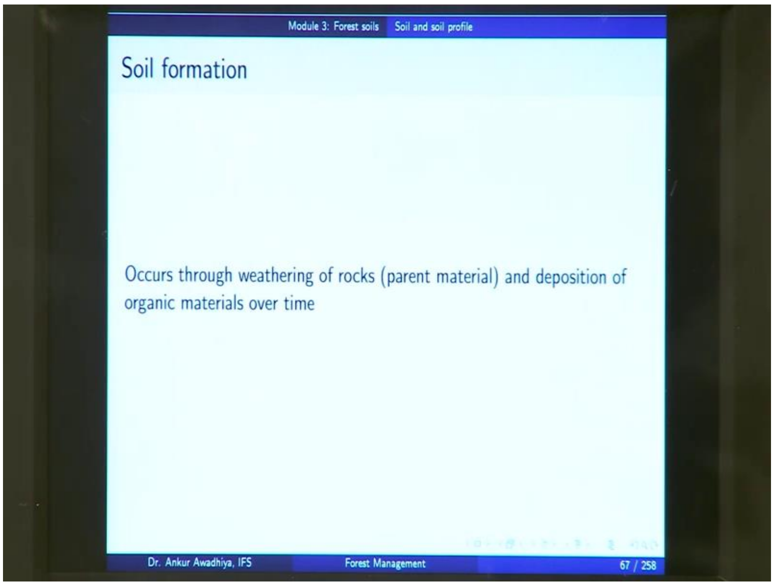

How does soil form? The soil formation occurs through weathering of rocks. So, weathering is the breaking up of rocks, and rocks are also referred to as the parent material. So, soil formation occurs through weathering of rocks and deposition of organic materials over time. So, as we saw that there is - mineral particles; so, the mineral particles come from the weathering of rocks, and the humus comes from the deposition of organic materials, over time.

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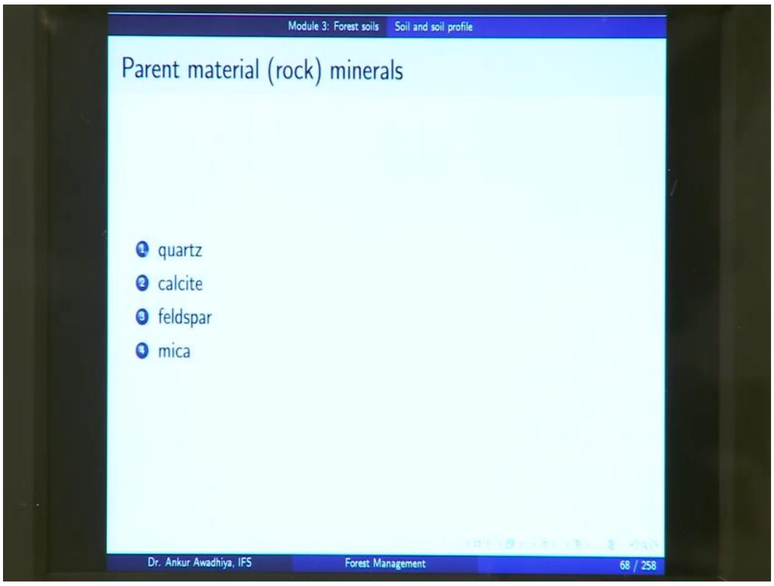

And, when we look at the parent materials or the rock minerals, there are 4 major parent materials or minerals that form the soil - we have quartz, calcite, feldspar and mica.

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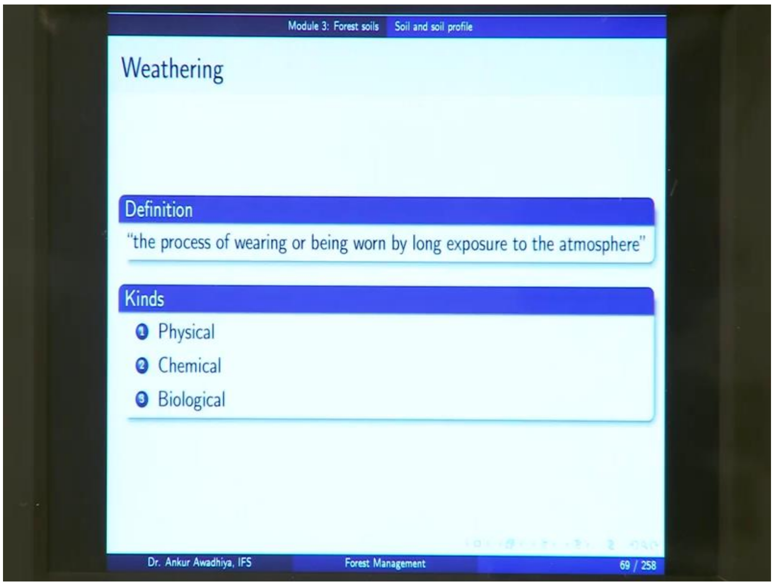

Now, these minerals that are present in the rocks, they come into the soil through the process of weathering, and weathering is defined as the process of wearing or being worn by long exposure to the atmosphere. So, you have a rock that has all these minerals, and when this rock breaks up; when this rock wears up, because of long exposure to the atmosphere, then we have these mineral particles that get released, and come into the soil. There are 3 kinds of weathering - we can have physical weathering, chemical weathering or biological weathering, and we will look at all 3 of these in more detail now.

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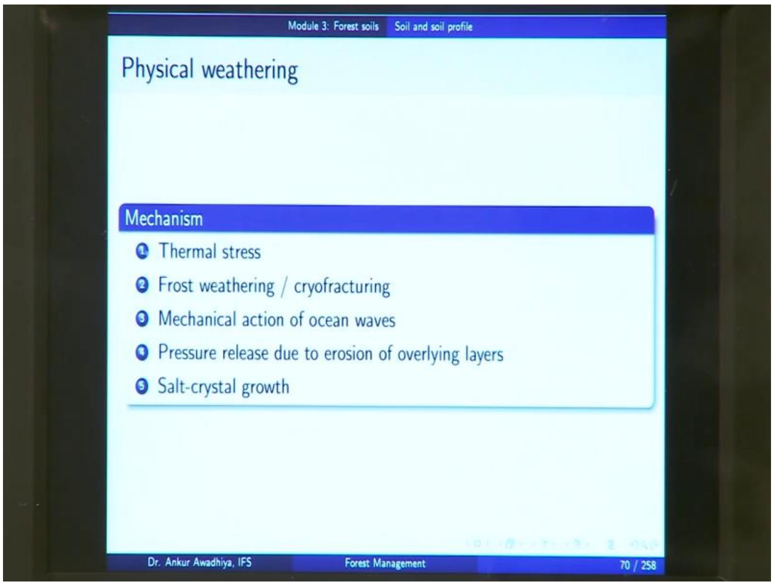

So, physical weathering can occur because of these 5 main mechanisms. We can have thermal stresses, frost weathering or cryofracturing, mechanical action of ocean waves, pressure release due to erosion of overlying layers and salt-crystal growth.

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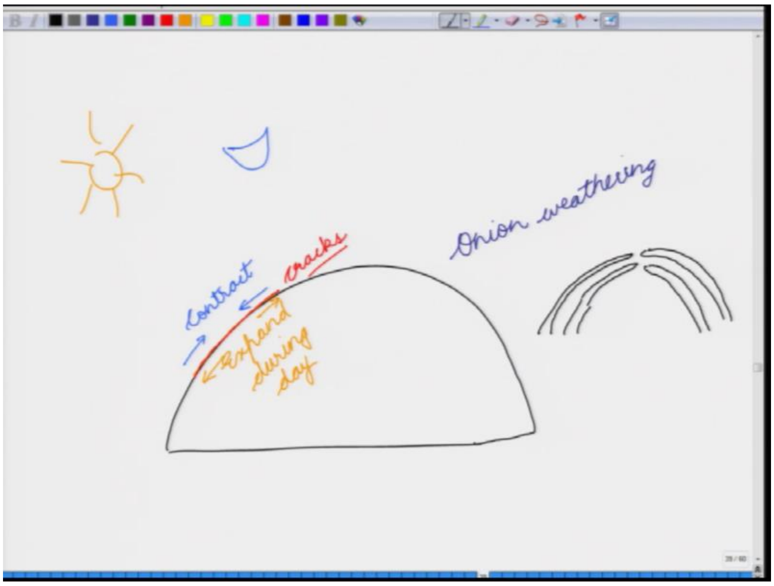

So, how does thermal stress lead to weathering? Suppose, you have this rock, and this rock is now exposed to the sun during the day. So, what happens is because of the heat of the sun, this portion will expand during the day; and at the night time, when you have the moon, this portion will contract. So, we are seeing a regular expansion during the day and contraction during the night. And, this expansion and contraction are occurring because of changes in the temperature, because every day this rock will be heated up during the day, and during the night time this rock will cool down, and when it cools down the surface shinks.

So, when the surface layer when it expands and contracts every day; so, after a while what you will see is that there will be cracks that develop on the surface. And, once you have these cracks because of the regular expansion and contraction, then after a while these cracks might even come out. So, these layers will come out, and this kind this sort of a process is known as 'onion weathering,' because these layers will be coming out layer by layer as you can peel an onion. So, when you look at a rock surface that has gone through this onion weathering, you will see that the surface will look something like this. So, you have this layer that is cracked and is coming out, then somewhere here you will be having some other crack and it will look like layers of onion.

The next kind of weathering is frost weathering or cryofracturing.

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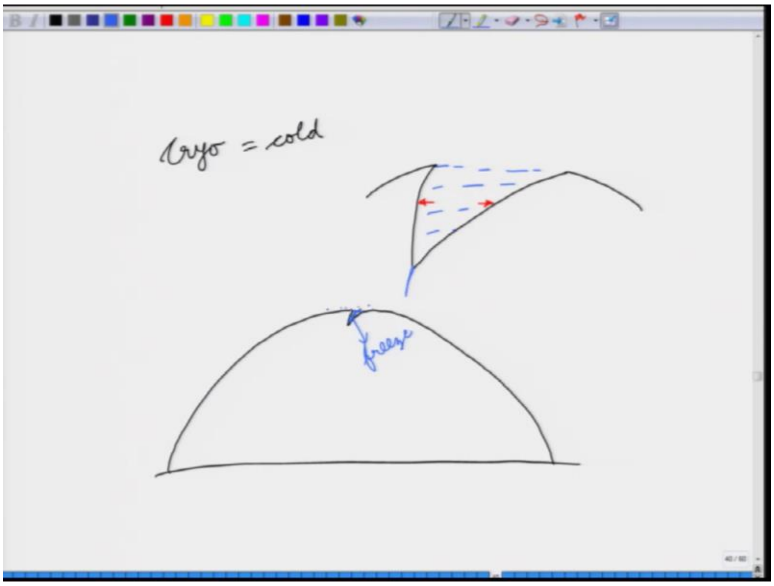

Now, ‘cryo’ is ‘cold’ and ‘fracturing’ is ‘breaking up.’ So, this is a breaking up or weathering of rocks because of cold. So, how does this happen? So, you have a rock, and on the surface there will be some minor cracks that have developed over time, and during the night time, you might have some frost that develops because the surface has cooled. So, you will have some small droplets of water that get inside this small crack. Now, if the temperature goes down, then this water might start to freeze. And, as you know that the density of ice is less than the density of water because of which the ice floats on water.

This happens because when the water is freezing the volume expands. So, for per unit mass the volume increases. Now, when you have ice formation, and the volume is expanding, this ice; so, if we look at this layer. So, we have water here, and when this water is converting into ice, the volume is expanding, and when the volume is expanding this will exert a pressure to the outside, because this ice is undergoing an expansion. So, it is going to push both the sides or all the sides, and when that happens this crack increases further.

And so, because of a regular action of frost, we will be having a fracturing in the rocks which is known as cryofracturing. So, this is (a) another form of physical weathering. Then, you can have mechanical action of ocean waves. So, when you look at an ocean there are waves on the surface, and these waves regularly come to the shore, and they start pushing on the rocks that are there on the shore. So, this mechanical action of the waves bumping against the rocks after a while might lead to some amount of fracturing or weathering. So, this is another form of physical weathering, then you can have pressure release due to erosion of overlying layers.

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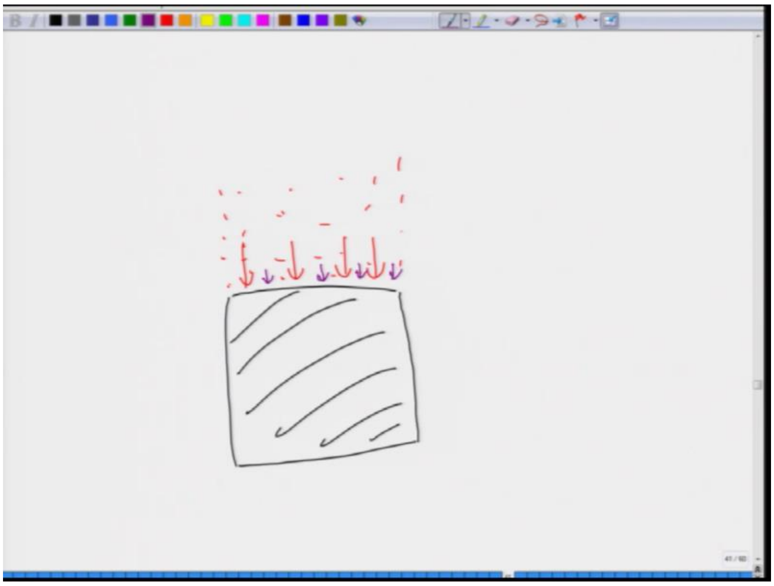

So, what this says is, suppose you have a rock and on top of this rock there is a large portion of soil that was formed earlier. Now, this soil is exerting a huge amount of pressure on this rock. Now, if these overlying layers get eroded so, you are having that this layer is now reduced because of erosion. Now, when that happens the amount of pressure that was - that is being applied to the rocks it reduces. So, earlier you had a rock that was extremely compressed, and now you are having a rock where the compression is less.

So, there will be some amount of expansion and that can also lead to weathering. So, this is another form of physical weathering. Also, you can have salt crystal growth.

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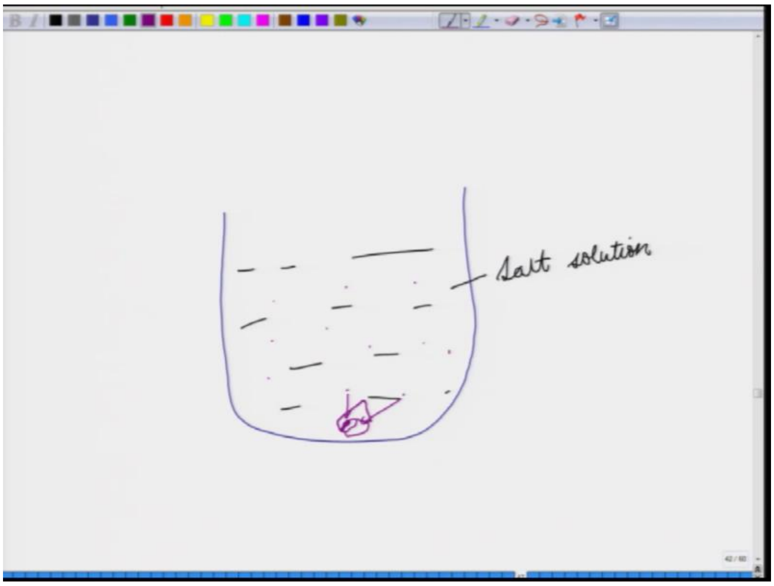

Now, if you take a beaker and put in a salt solution, you will see that and if the solution is sufficiently concentrated, after a while you will you might see some small particles of salt that have precipitated out. And, the salt particles that are there in this solution with time will get into this is small crystal that has found, and the size of the crystal will grow with time. Now, when that happens again, you are seeing something that is expanding in size.

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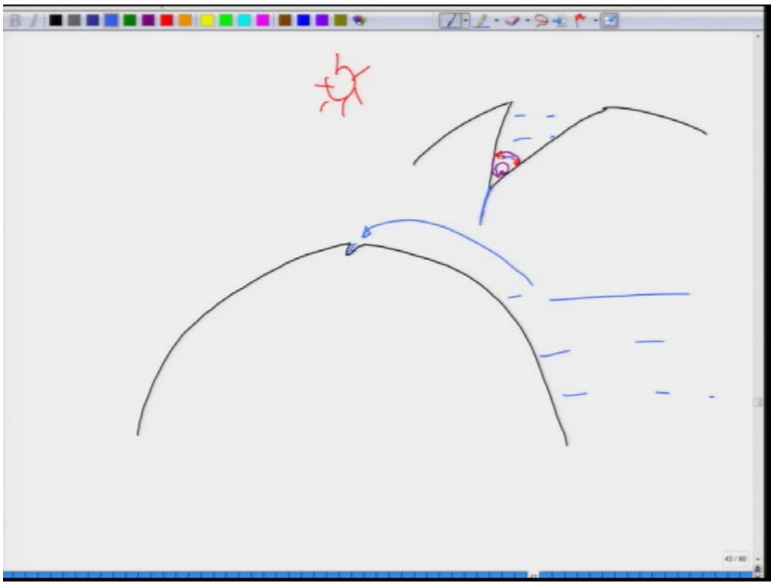

Now, consider a rock that is near the seashore, and there is a small crack here and it is right next to the sea. Now, when there is a wave, there might be some amount of sea water that gets inside this crack. Now, this sea water, when it is exposed to the sun the water will evaporate, but the salt will remain inside this crack. So, with time the concentration of salt in this small crack goes on increasing.

And, when this concentration goes on increasing, we will start seeing small crystals and with the growth of these crystals, there will be again a pressure that is exerted. So, we have this crack, this crack has seawater, and the seawater resulted in the formation of a small crystal. Now, this is crystal grows with time, and after a while it will start exerting a force on all the sides. So, again you have a crystal that is growing, it is exerting the force on the sides, and that will lead to the growth of this crack further. So, this fracturing will increase, and after a while this rock will be crumbled apart.

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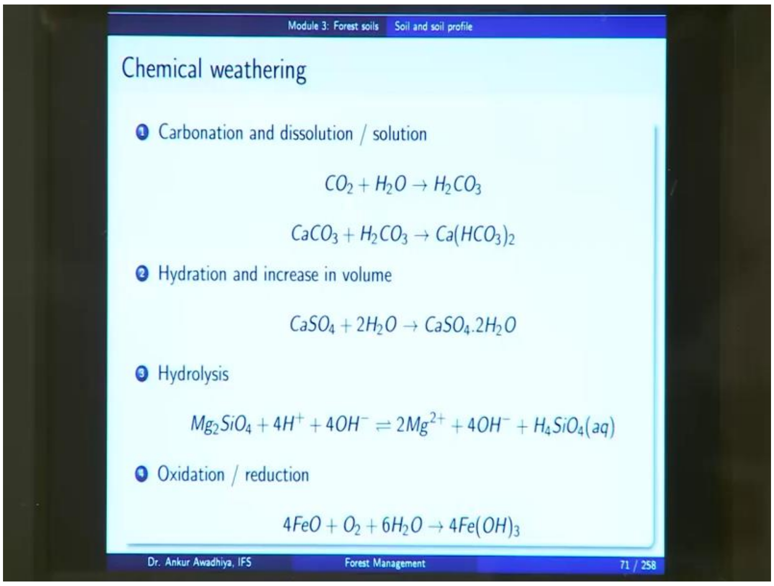

Next, let us have a look at chemical weathering. So, chemical weathering can be through carbonation and dissolution or solution. Now, what is carbonation? Carbonation is the addition of carbon dioxide.

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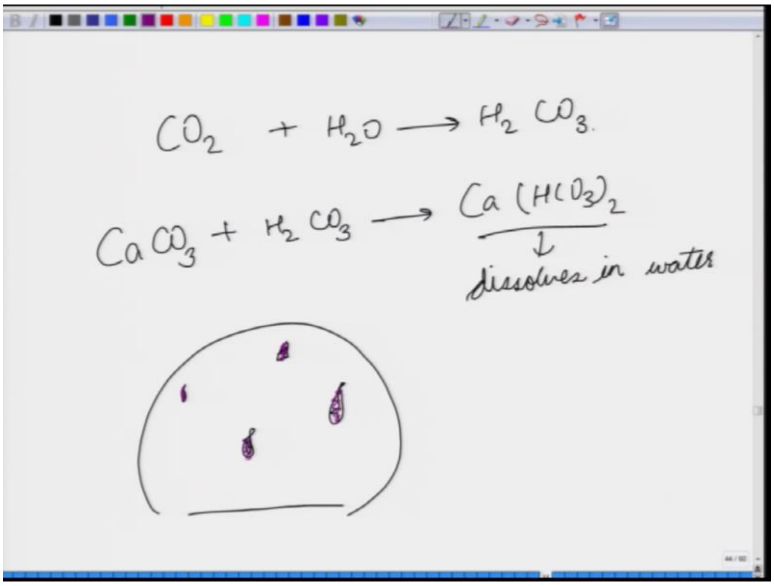

So, we have carbon dioxide in the air, when it mixes with water, we get carbonic acid H_2CO_3. And, if we look at a number of rocks, they have calcium carbonate and this calcium carbonate, when it reacts with the carbonic acid this will form calcium bicarbonate, and this calcium bicarbonate dissolves in water. So, what we are seeing here is that you had a rock, and in this rock, you had calcium carbonate at different positions. Now, when it reacts with carbonic acid, these potions are dissolved and so now, you have some cracks that have developed on the surface.

And, these cracks might then be exposed to the other forms of physical or chemical weathering. So, you are seeing that the mineral calcium carbonate that was there in the rocks is now dissolved, and it is leached out and so, there is weathering that is occurring because of the chemical reactions. And so, this is a chemical weathering. Another example is hydration and increase in volume. So, here we have calcium sulfate, when you add water to it, it forms gypsum. Now, the which is calcium sulfate dihydrate.

Now, when you have a formation of gypsum because of the action of water, again this in the volume of gypsum is greater than the volume of anhydrite that was used to form the gypsum. So, again we are seeing that there is an increase in volume, and an increase in volume might result in formation of new cracks, or expansion of the existing cracks. Then, you can have hydrolysis. So, you have magnesium silicate, which is which when reacts with water it forms all the different ions.

So, you have magnesium ions, you have the hydroxyl ion, and you have this H4SiO4 the acid which again dissolves. So, you have this magnesium silicate that was there in a solid form but through the action of water it is getting dissolved and so, the rock is breaking up. Then, you can even have redox reactions - oxidation or reduction. So, for instance, iron oxide and with oxygen in water, it forms the iron hydroxide, and here again there is a change in the volume.

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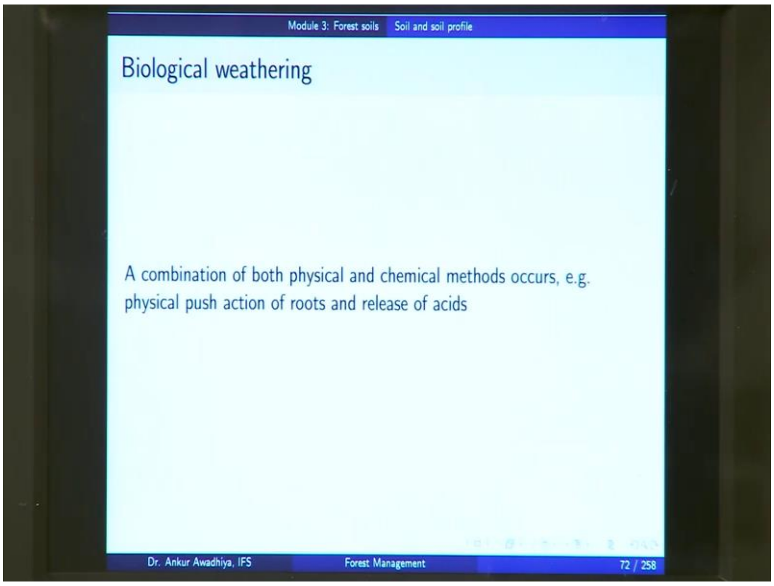

Another form of weathering is biological weathering, which is a combination of both physical and chemical methods.

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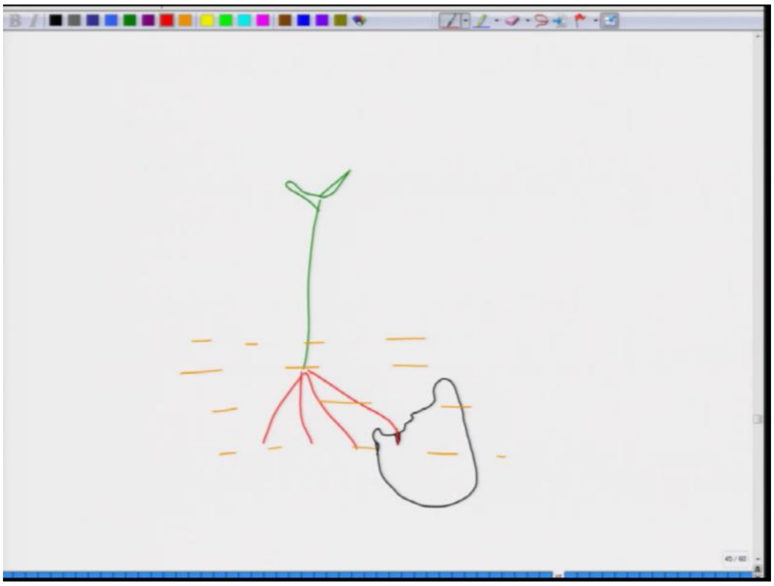

So, for instance, if you look at plants so, if you look at a plant, the plant will be having roots and then if there is a rock; so, this is the soil layer, and if there is a rock and there is a crack in this rock. So, this root can get inside and the growth of the root of the root will again start to exert a pressure on this rock. So, that will be some amount of physical weathering. At the same time, when this plant dies or this root portion when it dies, then this portion that was inside the rock, it is now degraded, because of the action of microorganisms and it might even leach out some organic acids. So, when there is an action of acids, you will also be seeing some amount of chemical weathering that is occurring on this rock. So, biological weathering typically involves both physical as well as chemical weathering.

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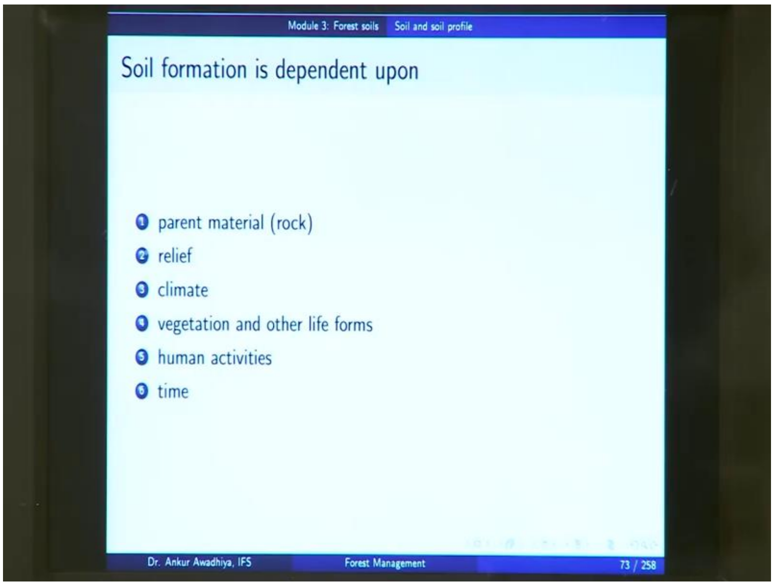

Now with all these forms of weathering, we can say that soil formation is dependent upon a number of factors. So, it depends on the parent material or the rock. Now, as we saw that in the case of physical as well as chemical weathering, when you are exerting a pressure on the rock, if the rock succumbs to the pressure then weathering will be easier. Whereas, if the rock is extremely rigid, then the weathering will be difficult. So, the amount of weathering or the action of the weathering agents is also dependent on the kind of rock that you have.

If it is a soft rock, then it will weather easily. If it is a hard rock, then weathering will be more difficult. Similarly, in the case of chemical weathering, we saw that there are certain minerals that are very susceptible to weathering; such as calcium carbonate. Now, if you have a rock that has sufficient amounts of calcium carbonate, then the action of carbonation will be much greater than in a rock that is that does not have calcium carbonate in it.

So, the amount of chemical weathering because of carbonation will depend on the amount of calcium carbonate that you have in this rock. Similarly, for the other chemical reactions as well, it depends on what minerals are there in the rock. So, the amount of weathering depends a lot on the parent material or the rock from which the materials for the formation of soil are going to be derived.

It also depends on the relief. So, why does it depend on the relief?

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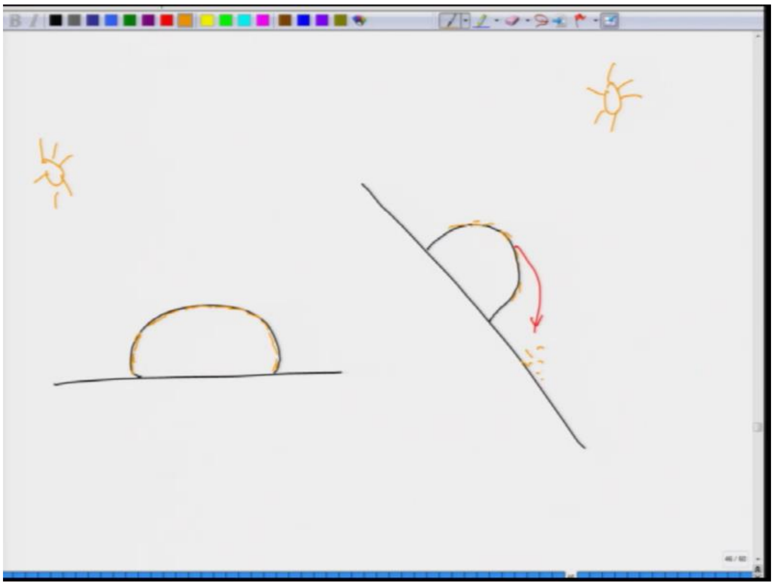

So, if you have a rock that is there on a plain surface, then the amount of weathering will be much less than a rock that is lying on a slope. Why? Because, let us consider the effect of physical weathering because of changes in temperature. So, when you have the sun, in the case of this rock on a plain surface, we are seeing that there is; there are cracks or layers that develop on the surface because of repeated expansion and contraction. But then once you have these layers, the underlying rock is protected from the extreme action of heat and cold by the upper layers.

Whereas, if we look at a rock that is there on a sloppy surface; so, when you have these cracks that are formed then after a while because of the graph - because of gravity these flakes will come down, they will accumulate somewhere here. And so, the rock surface will again be exposed to the action of heat and cold. So, the relief determines to quite a lot extent the rate of the weathering. Then we have climate. So, if there is a rock that is being exposed to extreme heat and cold then the amount of weathering will be much greater than a rock that is in an area that has a more equitable climate.

So, climate determines the rate of soil formation. Then, you have vegetation and other life forms, because the biological weathering depends on vegetation and other life forms. So, if you have vegetation and other life forms, biological weathering will lead to a quicker formation of soil as compared to an area that is devoid of vegetation and other life forms.

Also, at the same time, we saw that soil is comprised of mineral particles, humus, air, and water. So, when we say that we are seeing the soil formation, they should also be humus in it, and this humus will only come from vegetation and other life forms. Then you have action of human activities.

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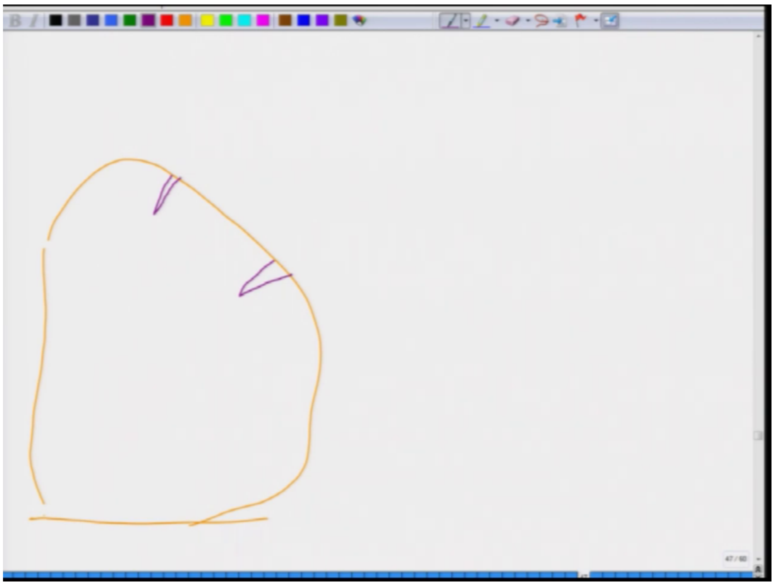

So, for instance, if you have an area with a large sized rock, and if there is no human activity, then perhaps this rock will take a huge amount of time to be weathered. Whereas, if you have human beings and they are mining the this rock for different minerals, then probably they will be using say, some explosives to fragment this rock. And, when you are using explosive to fragment a rock, then this smaller piece will be weathered at a much faster rate.

So, if we see mining in any area, the amount of weathering is bound to increase. Then, it also depends on time because all of because the action of all of these agents takes time. So, if you have more time, you will have more formation of soil.

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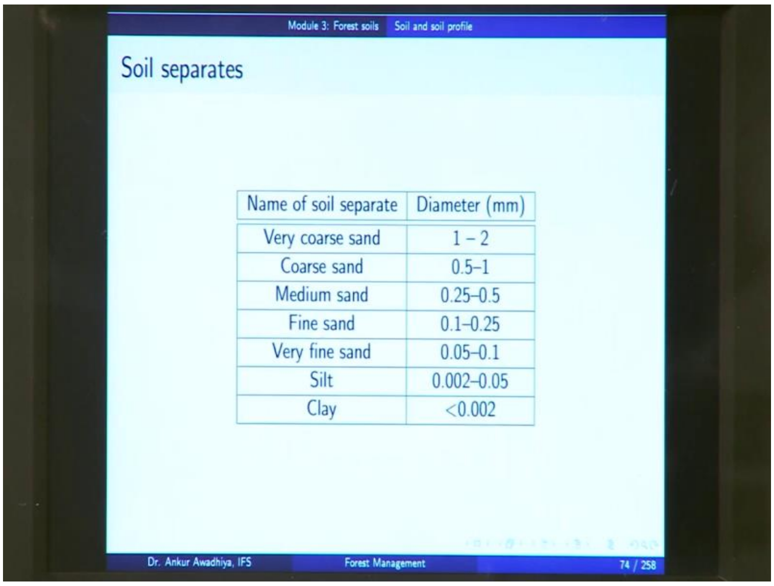

Name of soil separate	Diameter (mm)
Very coarse sand	1 – 2
Coarse sand	0.5–1
Medium sand	0.25–0.5
Fine sand	0.1–0.25
Very fine sand	0.05–0.1
Silt	0.002–0.05
Clay	<0.002

Now, if we look at a sample of soil and if we put it through several scenes to separate the particles of soil according to their size, we will see these different soil separates. So, we defined 'clay' as those particles that are less than 2 microns in size. Then, we have silt which is 0.002 millimetres to 0.05 millimetres.

Very fine sand - 0.05 millimetre to 0.1 millimetre.
Fine sand - 0.1 millimetre to 0.25 millimetre.
Medium sand - 0.25 millimetre to 0.5 millimetres.
Coarse sand 0.5 to 1 millimetre.
And, very coarse sand which is 1 to 2 millimetres.

So depending on size, we have these different soil separates; from clay which is the very fine particles to very coarse sand, which comprises of very coarse particles.

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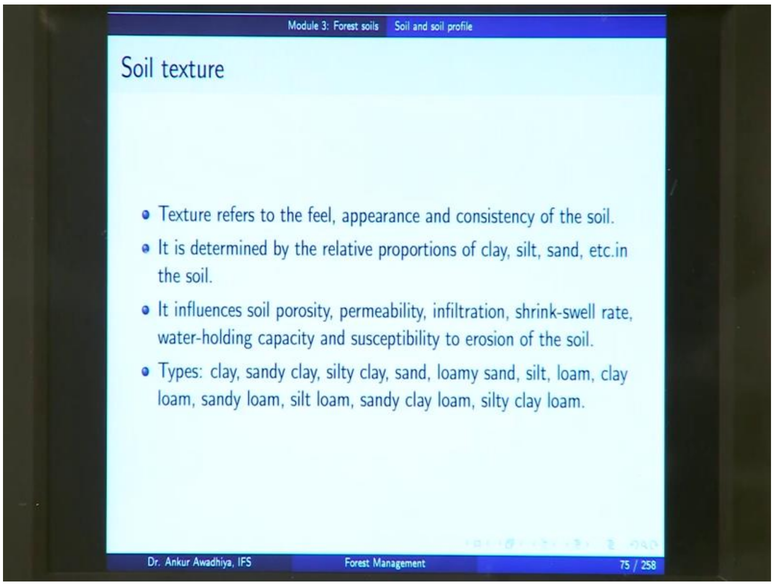

Now, when property of soil that is of interest in forestry is soil texture. Now, texture refers to the feel, appearance and consistency of the soil. So, if you look at any area where you are developing a forest, and if you look at the soil there and by your look if you can see that this soil is comprised of very fine particles, then probably this is a clay soil. On the other hand, if you see that you have very coarse particles, then probably this is a sandy soil. So, texture refers to the appearance of the soil; the feel of the soil.

So, if you take a sample of the soil in your hands, and you try to break it apart into its smaller fragments. So, you can feel whether it is comprised of very fine particles, in which case the particles will look like or feel like talcum powder, or it is comprised of coarser particles where it will feel like sand. So, the texture refers to the appearance, the feel and the consistency of the soil. So, when you take the slump of soil, when you are trying to break it apart, if it is comprised of very fine particles then probably it will be very much aggregated.

So, the consistency will be of a harder material as compared to sand, in which case you can just drop all the particles and they will flow very easily. So, texture is the feel, appearance and consistency of the soil, and it is determined by the relative proportions of clay, silt, sand, etcetera, in the soil. So, why is texture important? It is important because by looking at the texture you can make an inference about the kind of soil separates that will dominate in this soil.

So, if you have a take a soil that has a sandy texture, then you can very well make an inference that it is having coarse particles. And, if it has coarse particles its properties will be very different from a soil that will be having fine particles. So, texture can give you a very quick estimate of the properties of the soil, and we look at properties in a short while. Now, soil texture influences soil porosity; so, porosity is the amount of pores that you have in this soil.

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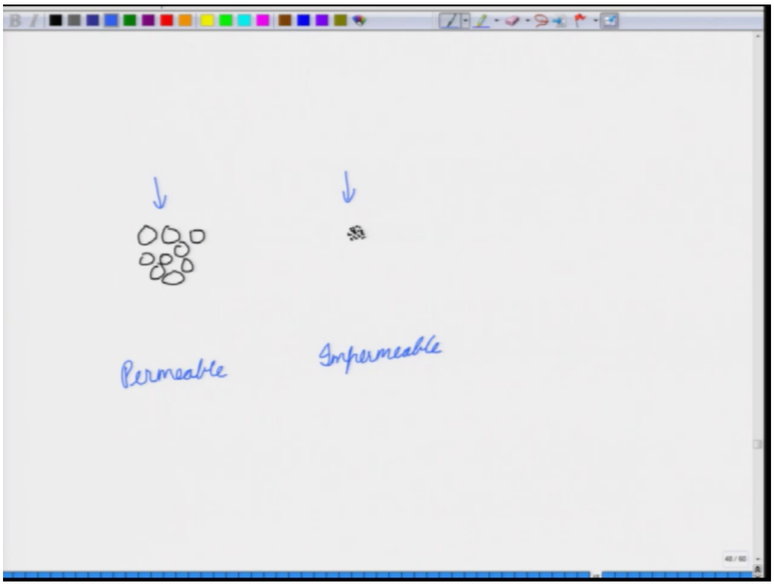

So, if you have a soil that is made of coarser particles; so, suppose you consider a soil that is made up of coarser particles. And, consider another soil that is made up of finer particles. So now, if you look at this soil, the amount of pores are much greater than the amount of pores that are there in this soil. So, texture influences the soil porosity. At the same time, it also influences the permeability of the soil. So, permeability is if you add water to this soil, will it pass through? So, this soil which is made up of coarser particles is more permeable, and this soil is more impermeable.

So, if you have a soil that is comprised of a lot of clay particles, then probably it will be so impermeable that you will find out that water is sitting on the surface of the soil. Whereas, in the case of a sandy soil, if you add water, the water will go through in no time. Next, it influences the infiltration rate; so, infiltration is the speed at which the water enters into a soil.

So, the speed in the case of a permeable soil that is made up of sand particles is much greater than the rate of infiltration in a fine textured soil, such as clay soil. It also influences the shrink swell rate. So, shrink swell rate is something where we have a piece; where we have a sample of soil. And, when you add water to it; so, suppose your soil has a lot of clay particles, and when you add water to it, then this soil swells.

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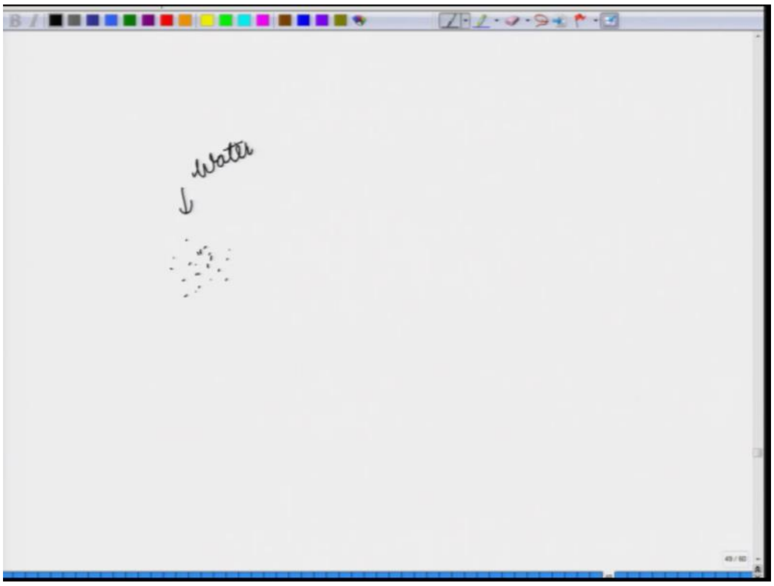

Whereas, when you, when the water is removed from the soil, it shrinks. So, this is a property that we see in clay soils. And, we will look at it in more detail in the next lecture. Then, it also influences the water holding capacity of the soil. So, water holding capacity is how much amount of water can be retained in this soil. If you have a sandy soil you add water, the water passes through. So, it does not retain much amount of water. Whereas, if you look at a clay soil, then the water will be retained inside the pores of the soil.

So, texture also influences the water holding capacity of the soil. It also influences the susceptibility to erosion of the soil. So, erosion is the process in which the soil is moved from one area to another area through the action of predominantly wind or water. Now, if you have a soil that is made up of very fine particles, then it is easier for wind or water to remove these particles, because of the physical action.

Whereas, if you have a soil that is made up of much coarser materials; so, each particle is having so much of weight that wind or water are not able to remove this material. And so, the texture or the amount of fine and coarse particles in the soil also influences the susceptibility of the soil to erosion.

Now, based on texture, we have these following types of soil. We can have clay soil, sandy clay, silty clay, sand, loamy sand, silt, loam – now, loam soil that has roughly equal proportions of clay, silt and sand. And, this is considered to be silt loam, sandy clay loam and silty clay loam. Now, you do not have to remember all of these, but you just need to know that we can that based on texture we have and - a different classification of soils.

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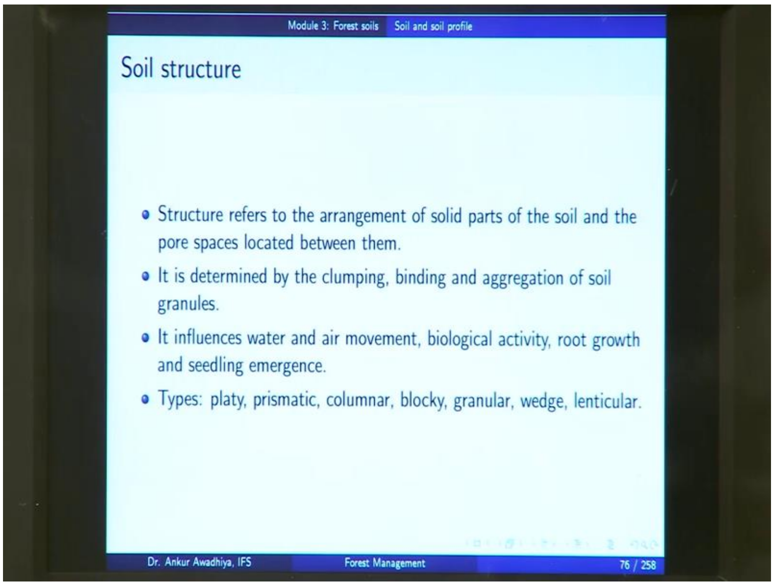

Next, we have a look at the soil structure. Now, there is soil texture and there is soil structure. So, when we talking about texture, we were talking about the proportion of fine and coarse particles in the soil. When we talk about structure, we are talking about the arrangement of these particles; the arrangement of these solid parts in the soil, and the pore spaces that are between them.

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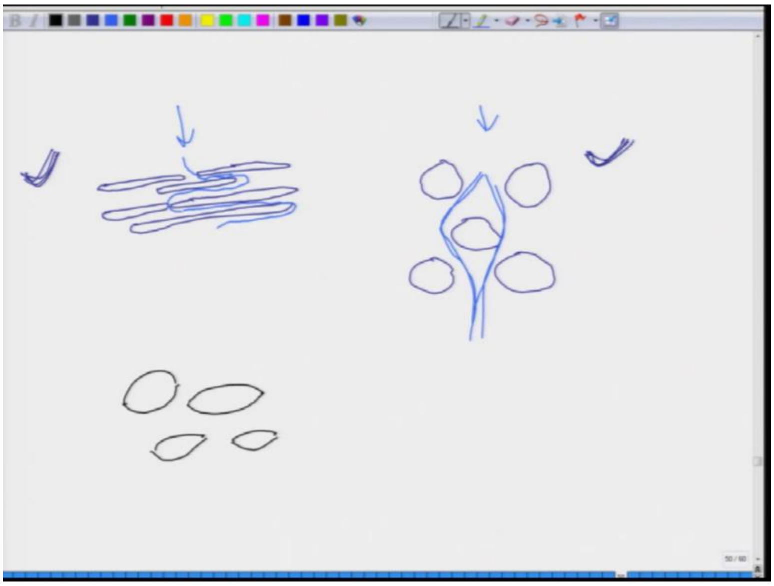

So, to understand structure, let us look at two different structures. So, you can have a soil that has a platy structure. So, you have these plates, or you can have a soil that has a granular structure. Now, let us consider that both of these soils have the same texture. So, let us say that both of these soils are comprised of silt particles; predominantly comprised of slit particles, these are silty soils. But, one soil has a structure that looks like this and the other soil has a structure that looks like this.

So, even though you have silt particles in both these soils, but because these particles are clumped together in the form of granules in one structure, and they form layers of sheets and another structure, the properties of both of these soils will be very different. So, for instance if you add water to these soils, then a soil with a granular structure will let water pass through it very easily. Whereas, in the case of these sheet-like structures, the water will have very much difficulty to traverse this structure.

So, this is a soil structure; the arrangement of the solid parts and the pore spaces that are located between them. It is determined by the clumping, binding and aggregation of soil granules. So, we have the granules - how do they clump together? how do they bind together? how do they aggregate together? - is something that tells you how the soil structure will be. It influences air and water movement, biological activity, root growth and seedling emergence.

And, the soil based on soil structure, we can have platy soils, prismatic soils in which your granules have a prism like structure. You can have columnar soils, in which they form columns. They can form blocks. They can form granules. They can even be wedge shaped or they can be lenticular, lenticular is lens shaped. So, you can have a soil in which the particles form the shape. So, this is a lenticular structure. Now, let us have a look at some soil properties.

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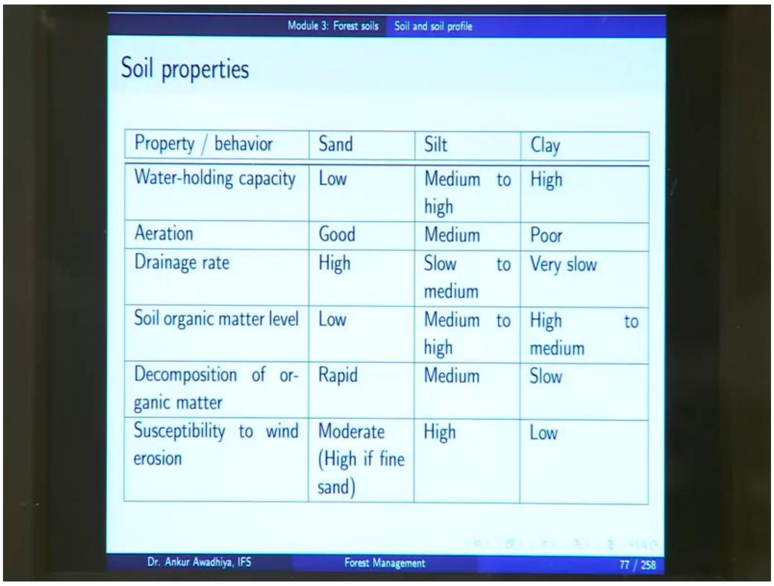

Property / behavior	Sand	Silt	Clay
Water-holding capacity	Low	Medium to high	High
Aeration	Good	Medium	Poor
Drainage rate	High	Slow to medium	Very slow
Soil organic matter level	Low	Medium to high	High to medium
Decomposition of organic matter	Rapid	Medium	Slow
Susceptibility to wind erosion	Moderate (High if fine sand)	High	Low

And, we will look at three different textures, and for the case of the other textures, you can make inferences. Now, if you look at water holding capacity, how much water is retained by the soil? The sand has a very low water holding capacity, because if you put any water to this soil, the water will just flow through. Clay has a very high-water holding capacity, because it is able to retain this water inside the pore spaces, and silt has a medium to high water holding capacity. It lies in between.

If you look at aeration, then because sand has coarser particles larger sized pores and so, the aeration is much better as compared to a clay soil, and silt lies in between. Now, if we have a look at the roots of the plants, they also require air for their survival. And, in the case of a soil that is predominantly a very clay soil, the roots might find it difficult to get air. Now, drainage rate is high in sandy soil, the water just passes through. It is very slow in the case of clay soils, because it is highly impermeable. And, in the case of silty soils, the drainage rate is slow to medium.

If you look at the decomposition of organic matter, then the decomposition of organic matter is rapid in the case of sandy soils. Because if you add any organic matter, then this matter is very quickly exposed to the action of air, water and the organisms; because the each of these are able to move very quickly. And, even when you have any decomposition of the organic matter, this the fragments or the detritus that form will be very easily removed, when there is water that is moving through the sand.

And so, the decomposition of organic matter is very rapid in the case of sandy soils, it is slow in the case of clay soils, and it is medium in the case of silty soils. Now, because the organic matter decomposes very fast so, the amount of organic matter that you will find in sandy soil will be very low. Because, any organic matter that was there is decomposed very quickly and it gets removed. Whereas, in the case of a clay soil, because the decomposition is very slow; so, you will find a high to medium amount of organic matter in the soil.

In the case of silty soil, you have a medium level of organic matter, or in certain cases, you may have a higher level of organic of soil organic matter in a silty soil. Now, if you look at susceptibility to wind erosion, if we look at sandy soils, they have a moderate level of susceptibility to wind erosion. Because, when we look at sand, we you can have a fine sand particles, medium sand particles or coarse sand particles. Now, if you have coarse sand particles, then it is difficult for wind to move these sand particles. Whereas, if you have fine sand particles, then your susceptibility to wind erosion will be higher.

In the case of clay soils, this typically have low susceptibility to wind erosion. Now, why is that so? Even though they have very fine particles of soil, but still, because they are able to retain water; because they are able to have a large amount of humus inside them; so, these small particles are not exposed, and typically they are clumped together, and because of which the susceptibility to wind erosion for clay is low. And, it is high in the case of silty particles, because they have a smaller particle size, and at the same time, they do not have much amount of binding due to water or organic material.

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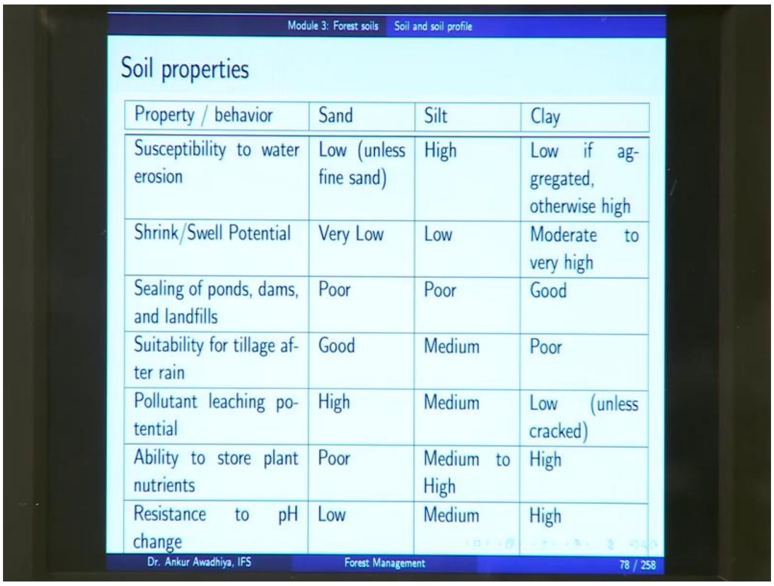

Now, if we look at the susceptibility to water erosion, here we have - low in the case of sand, high in the case of silt and low again in the case of clay, if it is aggregated otherwise high amount of susceptibility to water erosion. Because, as we saw before, clay retains water and so susceptibility to water erosion is higher. Except, when these clay particles are aggregated together in which case because of their structure they will form larger granules.

Now, shrink and swell potential is moderate to very high in the case of clay, in most cases, we find that clay soils show huge cracks in the case of summer season, because they shrink during the summers, when the water is less. And, when with the first rains they swell and these cracks get filled up. So, these are moderate to very high shrink and swell potential for clay soils, and it is low for silt, very low for sand.

We do not find much shrink or swell potential in the case of sand. Now, if we want to use these soils for sealing of ponds, dams and landfills then clay is a very good soil for sealing the bottom layers of a pond. Now, why is that so?

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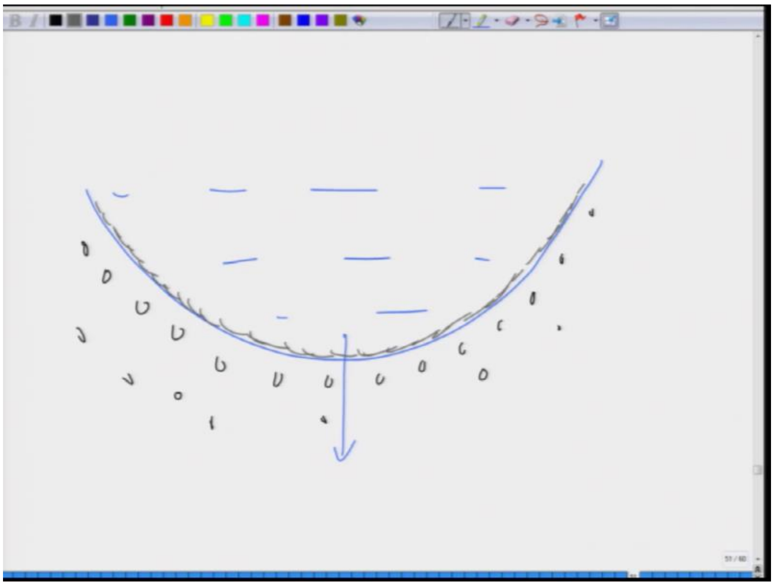

Suppose, you have this pond and this pond is in an area with sand - predominant soil. Now, in that case any water that comes into this pond will just pass through. But if you add a layer of clay to the bottom, then this clay will form an impermeable layer and the water will be retained in the pond. So, the ceiling for the ceiling of ponds, dams and landfills, clay is a very good soil, and sand and silt hardly have any utility for the sealing purpose. Now, if we look at suitability for tillage after rain, sand is very good or very much suitable for tillage after rain. Silt has a medium level of suitability, and clay has a poor suitability.

Because, right after rain the clay soils will swell, they will expand, they will swell and they will become a very sticky aggregate, because of which it will be difficult to till this soil. Now, if we look at a pollutant leaching potential, then because leaching is high in sand; so, pollutant leaching will be high. It is medium in silt, and low in clay soils, unless they are cracked because of the shrink soil potential. Now, ability to store the plant nutrients is high in the case of clay soils, and poor in the case of sandy soils with silt coming as medium to high. Why?

Because, in the case of plant nutrients, if we talk about mineral salts, if there is any water that flows through the sand, then it will take out all the nutrients along with it. So, because sandy soils have a poor retention of water, they have a good drainage. So, water will remove all the minerals; all the nutrients from the sandy soil very easily. Now, if you look at resistance to pH change, then because the clay soils have a huge amount of organic materials; so, they are able to resist changes in the pH levels. Whereas, the sandy soils which have hardly any organic materials, they have a very low resistance to pH change. Now, this is because a number of organic materials are very good buffers, and they help the soil to resist the pH changes. And, silt comes as a medium resistance to changes in pH or the acidity levels.

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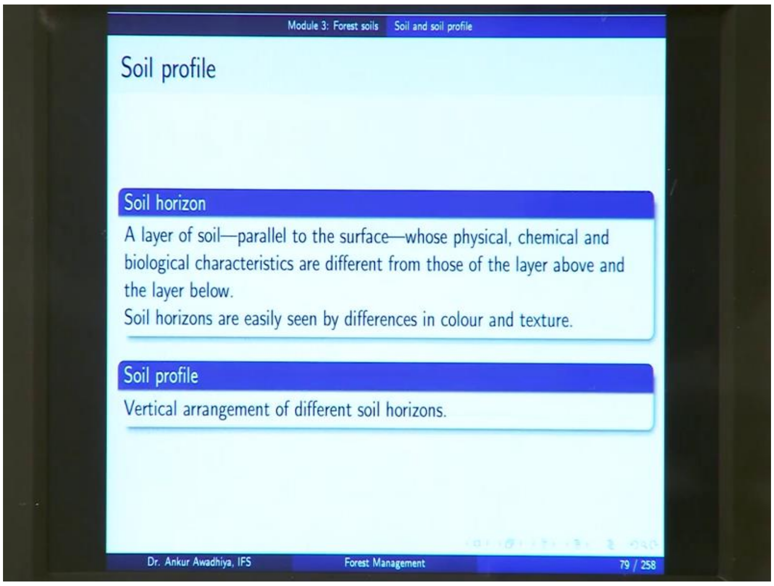

Now, if we have if you go to any area and if you dig a hole, then you will find that these soils have different layers and these layers are arranged one on top of the other, and they make a soil profile. So, we differ and we can define soil horizon as, "a layer of soil that is parallel to the surface whose physical, chemical and biological characteristics are different from those of the layer above and the layer below."

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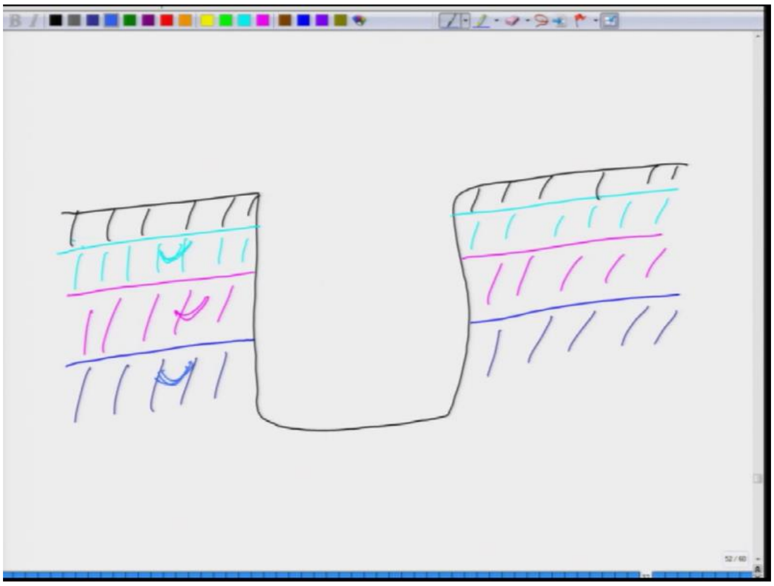

So, what we are saying here is that, you go to an area and you dig a hole in the soil and what you see here is that these soils will be found in layers. So, what you will see is that we have these soil particles that are arranged in different layers, and each of these layers has a different colour; it has different properties. So, the properties of this layer are very different from the properties of the layer above and the properties of the layer below. So, these layers are known as "soil horizons."

So, each of these layers - layer of soil that is parallel to the surface, and whose physical chemical and biological characteristics are different from those of the layer above and the layer below are known as soil horizons.

Now, soil horizons are easily seen by differences in colour and texture. So, typically you will find that the horizon that is near to the surface will be having a very different colour and texture, as compared to the layer that is below, which will be having a very different colour and texture to the layer that is even below. So, they are easily seen by differences in colour and texture. Now, the vertical arrangement of these soil horizons is known as the 'soil profile.'

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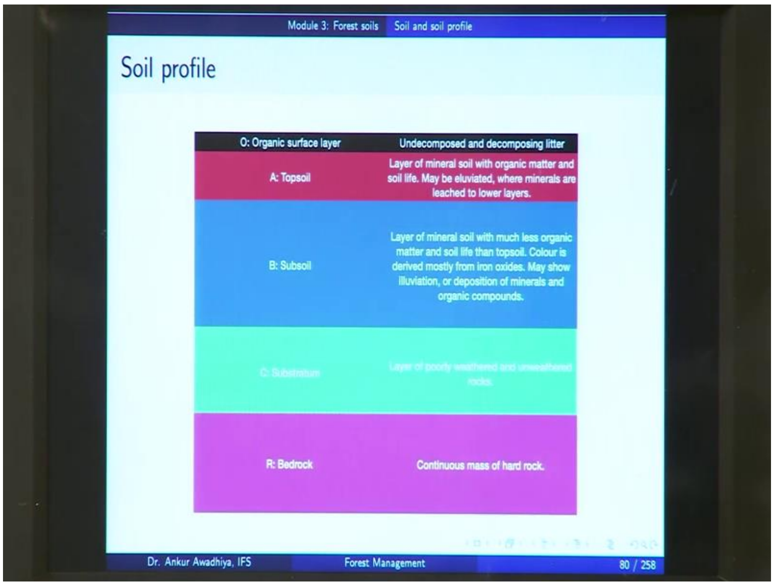

So, a typical soil profile will look like this. So, if you look at the surface layer, you will have the 'O horizon' which refers to the organic surface layer. Now, this organic surface there, because if you see any trees, the dead leaves, the litter, the dead twigs, they all fall down and they reach to the surface. And, on the surface they get degraded because of the action of water and microbes and different organisms, and because of that they will form the humus. So, typically you will find that this 'O horizon' or 'the organic horizon' is very much rich in organic materials.

It comprised of undecomposed and decomposing litter - both undecomposed litter which is your dead leaves, and the decomposing litter which is partly decomposed. Now, the layer below the 'O layer' is called as the 'A layer' or 'the topsoil.' And, this is a layer of mineral soil with organic matter and soil life. And, this layer may be eluviated, where the minerals are leased to the lower layers. So, the topsoil is the most important horizon of the soil. It comprises of mineral soil together with the organic matter, because you are having mineral soils and you are also getting organic matter that is coming from the 'O layer.'

Now, both of these, because they are together, this support a very good amount of soil life and this layer may be eluviated. Now, in the case of eluviation, when you are having rains; so, the rains are taking away minerals from this layer to a lower layer. So, this is known as eluviation. Now, the layer below the topsoil is known as the subsoil. Now, typically your topsoil will be having finer particles as compared to the subsoil. Now, subsoil is a layer of mineral soil with much less organic matter and soil life than the topsoil, because all the most of the organic matter in a soil life are within the topsoil. And, this layer has much less amount of organic matter. Colour is derived mostly from the iron oxides. And, this may show eluviation or deposition of minerals and organic compounds. So, what we are saying is that when there is rain then this rain is taking away minerals from the topsoil and depositing it in the subsoil. So, this deposition is known as eluviation.

Now, below the 'B horizon' we have the 'C horizon' or 'the substratum,' and this is the layer of partly weathered and unweathered rocks. So, in the case of the substratum, you will be having partly weathered rocks and some unweathered rock fragments. But, again this layer is comprising of the of the weathered and unweathered rocks. So, you will be finding a number of boulders in this layer. And then, you have 'R or the bedrock layer,' which is a continuous mass of hard rock.

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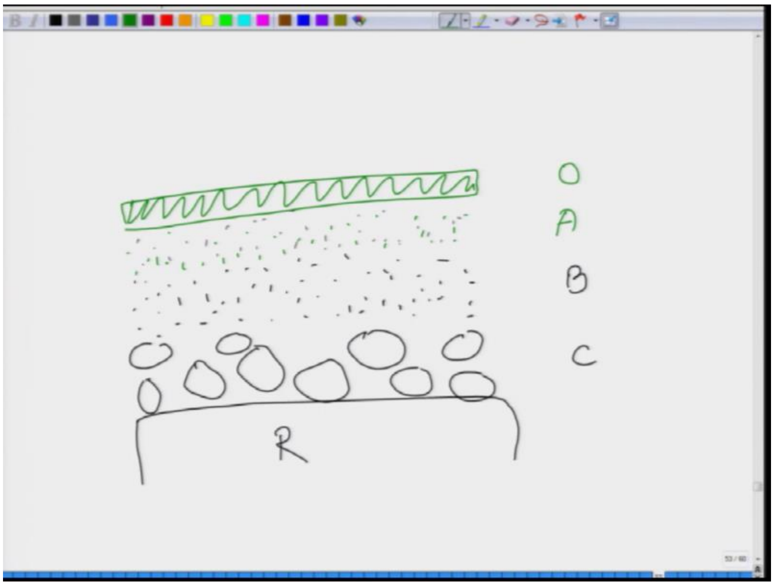

So, typically if you want to represent these layers you will have the R layer, which is comprised of a continuous mass of hard rock above which you will be having some partly decomposed or partly weathered rocks, which form 'the substratum or the C horizon.' Above which, you will be having a layer of broken rock particles and mineral soil, which will be your ‘B horizon or the subsoil.’ Above which you will be having the topsoil, which is having these mineral particles together with the organic material.

So, this will form your ‘A layer or the topsoil,’ and above the A layer you will be having the organic layer, which is predominantly comprised of dead and decaying matter which is the ‘O layer.’ So, you have the sequence O – A – B – C. So, in this lecture we had a look at what a soil is? why is a soil important? how is the soil formed? So, we saw that it is formed because of weathering and deposition of organic materials. Weathering can be physical weathering or chemical weathering. We looked at different forms of physical and chemical weathering, in detail.

Now, soil formation is dependent on a number of factors. It is dependent on the parent material or the R layer that we saw later on, the bedrock when it gets weathered then it forms the soil. So, what is the kind of the bedrock? What is the kind of rock through which the soil is derived that determines to quite an extent how much time it will take for the soil to form? It also depends on the amount of organic activity in the soil. It also depends on the slope at which this rock is kept or the relief of the area.

It also depends on the climate. If you have more amount of rainfall, if you have more amount of sunshine, then probably you will be having a faster weathering. It depends on time. It depends on specific factors like whether your rocks are situated next to a sea coast or not, then we looked at different soil separates. So, we looked at separates like clay, we looked at silt, we looked at fine sand, coarse sand, medium sand and so on. Now, the proportion of these separates in a soil will determine the texture of the soil, which is the feel or appearance of the soil, and based on the texture we have sandy soils, loamy soils, clay soils and so on.

Now, how these particles aggregate together will determine the structure of the soil - whether it is a granular soil, whether it is a platy soil, whether it is a prismatic soil, and so on. So, that is the structure, now texture and structure both govern a number of soil properties. So, we looked at different soil properties, and then we looked at the horizons of soil, and how these horizons are arranged to make the soil profile. Now, with an understanding of the soils of an area, we can very easily make a judgement about what plants to grow in an area.

So, if you have a plant that requires a very good highly drained soil, it does not it does not love water locked soils, then probably you would want to raise it in an area that has more amount of sand. On the other hand, if you have - if you want to raise a plant that requires water logging, then it will be suitable in earthly location. So with this understanding, we can make a judgment about what kinds of soils to be do we require for different plants, and whether we need to be any modifications to the soil to raise a species of interest. So, that is all for today.

Thank you for your attention. [FL].