Geomorphology
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Lecture - 17
Soil Classification

So friends, welcome to this lecture series of geomorphology and specially the soil classification. So if you remember, we are talking something about the soil formation and its significance on the earth surface. How soils are being used to define the paleoclimatic changes, the tectonism, the paleogeographic changes, it is seen and now we are going to discuss elaborately what is soil classification and why it is useful.

Whenever we talk about these classification, that means we are categorizing something. So categorize means we are making it easy to understand. Similarly, the soil classification is also one process where we categorize the soil into different categories and different categories of soil that define a particular type of geological environment, particular type of climatic conditions, paleogeography that is where the soils were formed.

Similarly, the paleosols, if I understand, these paleosols are those soils which are formed in geological past and later the soil formation process was cut off from this main atmospheric system and they were buried under new sediments. Similarly, the classification of paleosols also indicates what type of geographic condition, what type of climatic change, what type of tectonic scenario, what type of parent material on which they were formed. So today, we will discuss elaborately what is soil classification.

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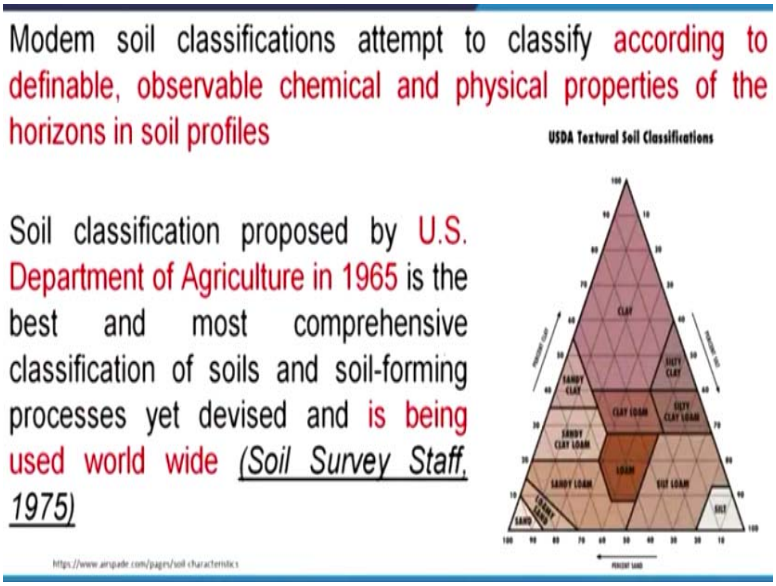

So soil classification is an attempt to classify according to definable observable chemical and physical properties of horizons of soil profiles. So if you remember last class, we are talking something about soil profile and finally we concluded there are five principle profiles and out of which the B horizon of the soil plays a major role in defining the soil classification. So B horizon, it is the horizon, it is the layer of accumulation of elements.

So in B horizon, the soil structures, the peds, they were formed and those B horizons they indicate what type of chemical changes, what type of physical changes, what was the topography, what was the timing and how the ground water movement was there. So all these things, they can be derived from this information of the B horizon. So now, it is a definable and observable chemical, physical properties.

That means, once we classify the soil, we define and observe the physical and chemical properties of the soil. Physical, chemical properties means, its alkalinity, acidity, the degree of soil development and the structure of soils, soil peds, like either it is granular or it is massive or it is prismatic like that. So in these ways, suppose we say it is a prismatic soil. We saw it is chemically or it is an acidic prismatic soil. So what does it mean?

So acidity, acidic means it is an environment. It is saying it is an environment, which is in acidic condition. That means pH less than 7. So that means, there was no circulation of water, no

exchange of chemical elements from this basin or from the region to the other side. So it is an acidic environment and prismatic, that means block type, either it is angular or subangular. It is a different issue, but prismatic ones we say, that means a prism type, block type.

So block type means, it says that means, no sufficient pressure was there, no sufficient overloading was there. That means it is a free space. So that means, it is a horizon, which was exposed to the surface, later on it was not compressed. Similarly, if we say it is a platy. Platy means it is a plate type. It is a compressed type. So that means I want to say by looking a soil ped, by looking its chemical properties, by analyzing its characteristics, we can say what type of physical and chemical environment was prevailing during that time.

Do what does it mean? It means it is indicating the paleoclimatic condition. It is paleodepositional system. It is paleotectonic scenario. All those parameters can be derived from the soil properties itself. So this soil classification, it was proposed by US department of agriculture in 1965 and this is the best classification so far available.

Though there are some classification schemes has been proposed by different countries of the world, but this classification by US agriculture department in 1965, it was worldwide being used comprehensively to classify the soil of different regions. So the soil forming processes yet to be devised and is being used worldwide.

So this US department of soil survey, the classification, it is being used worldwide. Now you see, if we classify the soil structures here or the soil textures here, here percentage of clay, that means this is boundary, this corner it is defining the clay and this is percentage of silt and this is percentage of sand. So based on these 3, sand, silt, clay we define the soil textures. Why not boulders?

Because we know the soil once we see, it is the sufficiently weathered and sufficiently changed its properties. That means, its earlier characteristics, earlier parent rock characteristics has sufficiently been changed. That is why it is called soil. That means the rocks earlier, the parent

rock has been physically weathered, chemically altered, biologically transformed, then the total system is called soil.

So once we say physically altered or physically disintegrated, that means the parent rock has been disintegrated into minute, minute particles. Chemically altered that means it is exchanging the minerals, it is exchanging the ions. Biologically altered that means it is adding the biological material with it. So now, we analyze this total system, it is composed of small, small particles that means starting from sand, then silt, then clay particle.

Apart from that, we have some organic matter. So that is why once we go for soil classification, we must confine ourselves in these three side classes, like sand, silt, and clay and if it is organic matter is there, that will adopt a separate classification taking organic matter as a constituent, but here it is a textural classification we are saying. Textural classification means it is the texture, it is the relationship of one grain to another grain.

So in this case, as we know the soil is composed of fine grain particle, that means starting from sand, silt, and clay. That is why the sand, silt and clay are taken as three end members to classify the soil texture. For example, if you see here, we have clay. We have sand. We have silt, three end members. This part, it is sandy clay. Similarly, silty clay, silt loam, loam, and loamy sand, silt, so these are the terminology we use for texturally classifying the soil.

So that means, suppose we say in soil classification, there is a parameter, what is parent material. So once we say parent material, that means from which the soil has developed that is the R horizon. So if the R horizon or the C horizon we are talking, C horizon is the parent material, it is alluvium and R horizon is the bed rock. So here, the alluvium once we consider, we consider the C horizon, not the R horizon. So here, in C horizon, we will get clay.

Here in C horizon, we will get silt. C horizon, we are getting sand. So if it is mixture of certain percentage, either it is sandy clay loam or it is loam, loam means here clay percentage, sand percentage, and silt percentage, varies from this. So this is called loam. So loam is the parent material or clay is the parent material or sand or silt is the parent material. So from this parent

material, this has been sufficiently weathered, it is agglomerated with this organic matter and forming a soil.

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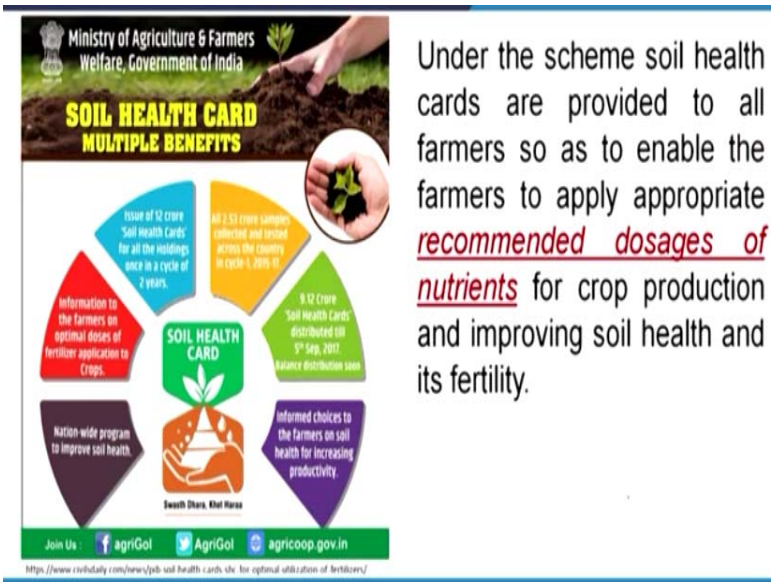

Under this scheme of soil health cards are provided to all farmers, so as to enable the farmers to apply appropriate recommended doses of nutrients for crop production and improving the soil health and fertility. It is very important to understand here. Why we classify the soil? Because until and unless we know and why, which class our soil is. It will be very difficult to recommend what type of crop we are going to grow on it.

So this is the faulty way of cultivation that still now, we do not have an idea in our country or in global scenario, if I talk, so we do not have an idea how our soil is competent to a particular kind of crops. So that is why we need a classification. So in classification generally, what we say, in modern classifications, we classify the soils in terms of nutrient availability. So in a particular soil developed in a particular environment or particular climatic condition, in a particular parent material, so it will contain a particular type of minerals.

And those minerals may be suitable for a particular type of crop or may not be suitable to different kind of crop. So that is why, once we analyze the soil in terms of chemicals, in terms of chemistry, in terms of mineral content, nutrient content, that means we can categorize, yes this

soil falls in this category and it is suitable for this, this, this, this crops and this soil falls under this category and it is not suitable for this, this crop.

So that is why, soil health, if we do not know that means, without knowing the soil health, if we are going to cultivate, we do not know whether this particular soil will adopt this type of farming or not. Similarly, the soil health it changes from its beginning to now. These changes are of two types, one is the natural changes, one is the artificial changes. For example, suppose in a particular area, a particular crop is being cultivated for hundreds of years.

So that means a particular type of nutrients is being continuously consumed by this crop, so the other residue or residual minerals or the residual elements, they are getting enriched in the soil. So that means, initial soil if you compare, it is consisting of particular type of minerals or elements and now it is different scenario. That means a particular element is totally consumed and this remaining soil is enriched in other type of minerals.

So that means, soil health is being changed. Similarly, in natural process also, this soil health is getting changed, how? Suppose, a particular type of soil, which is very close to a river flood basins or flood plains, so every year, there will be flooding, there will be siltation, there will be sedimentation and there will be water percolation through the soils. So in this way, an element is being added and particular elements are removed.

So that means, once during the formation of a soil for a particular parent material, this element was xyzpqrs, suppose, but nowadays due to continuously flooding minerals constituents are being added to it. Some minerals are being removed from it by percolation by water soluble minerals are going out. So that means, soil health is also getting changed. So that means, soil health is a function of different kind of parameters like some of these parameters they are natural occurring and some of the parameters, they are artificially might thrust upon it.

So that is why knowing the soil parameters, knowing the soil health it is very important to address the present scenario of cultivation of the subcontinent.

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In U.S. soil taxonomy (Soil Survey Staff, 1975) the hierarchy of terms, *in descending order of rank*, is:

Order
Suborder
Great group
Subgroup
Family
Series

Eleven soil orders are defined, based on the presence or degree of development of the various horizons in soil profiles

So US soil taxonomy or soil survey staff 1975, the hierarchy of term in descending order of soil rank is, one is order, suborder, great group, subgroup, family, series. So these are the classification that means like our stratigraphic classification, eon, era, period, like this. Similarly, soil classification the descending order of rank that means first is order, that means is the larger rank. It is a broad order.

Then, again order is subdivided into suborder. Suborder is subdivided into great group, then divided into subgroup, then family, then series. So these are the hierarchy of classification. Eleven soil orders are defined. So once we have 11 soil order, so that means soils the whole world has been classified or has been categorized into 11 orders, 11 broad groups, based on the presence or degree of development of their various horizon of the soil profile.

That is important to know. These 11 orders has been defined based on the presence of degree of development of various horizons in the soil profile. Degree of development, if you remember, we can say the degree of development means how definely, how precisely the soil structures has been developed, the peds has been developed. That means if a soil horizon and whenever we talk about the degree of development of soil, we are talking about the B horizons.

So that means, the B horizons how well it is developed? Whether these peds has been completely developed and peds have been matured or this ped has been compressed, the peds are prismatic

in nature or the clay cutans are there, thick clay cutans are there, thin cutans are there, motels are there, so in these basis, that means the scenario this is the complete package for defining a degree of development.

So based on this degree of development, various soil horizons, the soil profiles or the soils in the world has been classified into 11 orders, that means broad 11 subdivisions. The name of each soil order ends with sol.

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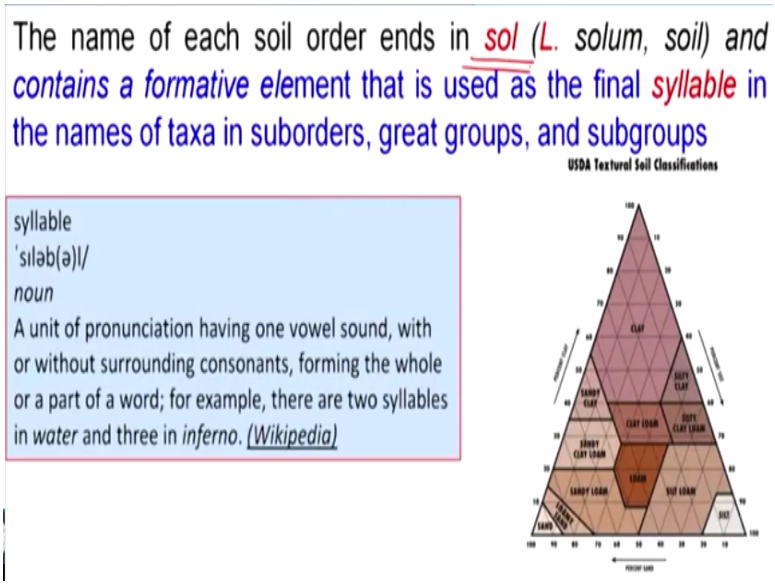

Sol, it is a latin word and it means latin word representing solum and its meaning is soil. So every 11 order, the end is sol, like this suppose for example, it is entisol, vertisol, mollisol, so that means the sol is, that is the name of these orders and the sol is the representation of soil and contents a formative element that is used at final syllable in the name of taxa, suborder, great group, subgroup. So the prefix is something else.

The prefix with soil, sol, it is used to name a soil order. The prefix is the names of taxa, suborder, great groups and subgroup. That means, if we break those prefix, if we analyze the words in the prefix, you will find the soil characteristics that is which environment it was, which type of parent material on which it was formed. So all those things, they are restricted. They are capsulized within the prefix used with the sol.

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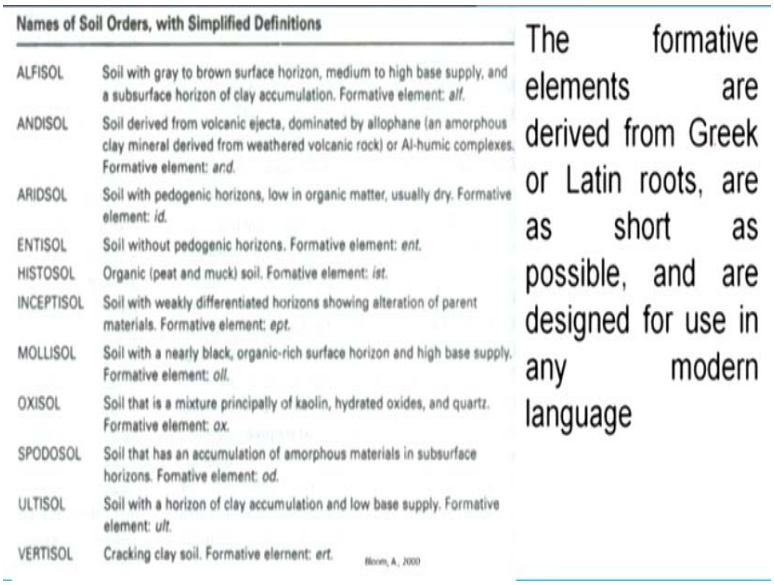

So now here, these 11 orders are listed. One is alfisol, andisol, aridsol, entisol, histosol, like so on. So here if you see, the sol with the sol alfi is associated. The alfi is the prefix. So by analyzing the meaning of alfi, why alfi stands for? We can say what type of environment, what is the colour, and what is this parent material, what type of geochemical condition, in which the soil was formed, so all those information they are comprised together and encapsulated within this term alfi.

For example, here if we analyse the alfisol, we can say soil with grey to brown surface horizons, medium to high base supply and a subsurface horizon of clay accumulatin, formative element is alf. So alfisol, alf sol alfisol. So this alf, al stands for aluminum, f for ferrous content, so all those elements, these information behind the names, it is indicating what type of characteristics of soil is there. What type of environment on which the soil was formed and why this alf, it is standing?

Why it is there and what type of geochemical environment, which was responsible for accumulation of aluminium for accumulation of iron in the soil horizon that can be unraveled by looking the soil name. So here, the formative elements are derived from Greek or Latin roots, are as short as possible and are designed for use in any modern language. So here the alf is the formative element, here and is the formative element, here ent is the formative element.

So those formative elements, they are of Greek origin or Latin origin. So these are the short form of a particular terminology and those short forms, they are encapsulated, they are capsulating some information by elaborating it, we can get what type of parent material is responsible, what type of climate was responsible, what type base exchange reaction was responsible, so what type of environment was responsible for formation of the soil.

So if you analyze all those names, it is ending with sol. Sol stands for soil and those formative elements, which are used as prefix, this part, which are used as prefix, those indicate what type of environment, what type of chemical composition, what type of tectonic scenario, what type base exchange reaction, what type of parent materials, under which or from which the soil was formed.

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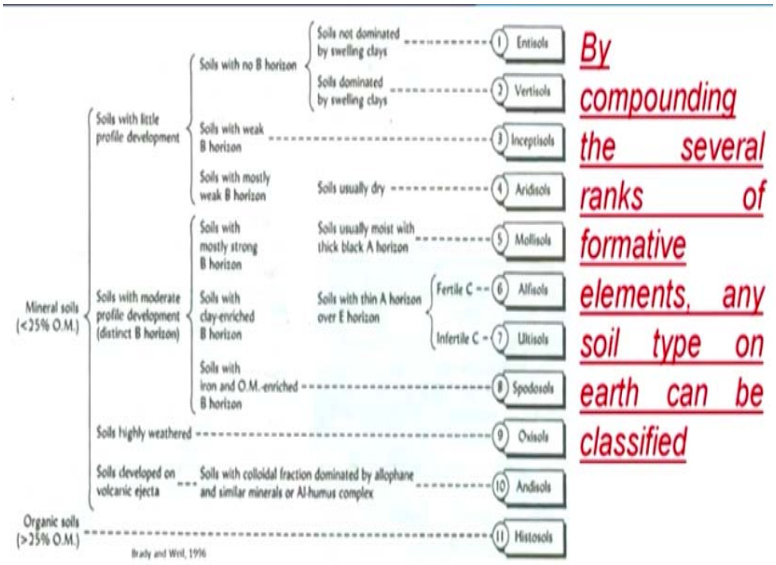

So now, by compounding the several ranks of formative elements, any soil type on earth can be classified. For example, if you see here, entisol, here soils not dominated by swelling clays. Again, it is soils with no B horizon. So ent, recent, it stands for recent, recent, this ent, it is for recent. So if we remember your last class, when we were talking something about the time or the chronostratigraphy of soil, we are talking something that with time, the thickness of the soil horizon increases, if other parameters remain constant.

So in recent soil, which are very recent, that means there has been no B horizon, because B horizon formation takes time. It is from illuviation of material and accumulation and it is the reaction from the surrounding material, binding of the surrounding material, by which the B horizon will be formed. So formation of B horizon will take some geological time and recent soil, which is sediments deposited very recently, is hardly the B horizon is developed there.

So that is why recent soil, soils with no B horizon and soil not dominated by swelling clays. Why? Once B horizon is not developed that means, these sediments or the rock has not gone sufficiently weathered. It is the soil deposited or formed on the alluvium. So to weather to that degree of minerals, to form the swelling clays, it also takes time. So that is why recent soil or entisol, it is neither the B horizon is developed nor they contains swelling clays.

Why because swelling clay formation, it also takes some geological time from weathering of silicate minerals. So that is why if we analyze the entisol, that means we are saying enti, recent, so recent soil or entisol, it does not contain B horizon and does not contain this swelling clays in the soil body. Here vertisol soils dominated by swelling clays. Soil dominated by swelling clays, swelling clays means again the clays is formed from the weathering of the silicate minerals.

That means it is taking time, okay, so that is vertisol. Here soil with little profile development. This side soil with moderate profile development. Soil with highly weathered and soil with volcanic ejecta. So now if you see here, compare these two, soil with little B horizon development, that means the degree of development is less. Here with moderate B horizon development, that means soil which is developed relatively more as compared to the upper part.

So the degree of development as it increases, the soil properties changes, the mineralogy changes, the exchange reaction changes, the development of peds changes. So that is why, some changes also occur within that mineralogy, within the soil horizon, the thickness changes, the colour changes, the mineralogy changes, is not it? So now soils with weak B horizon, that is inceptisol. Soil with mostly weak B horizon, it is soil usually dry aridsol.

Aridsol, it stands from arid region. Arid region, if you go there, so that region is dominant by physical weathering. Arid region is mostly dominated by physical weathering. So physical weathering it is responsible for breaking down of minerals from larger to smaller particles, but for development of B horizon, only breaking down of mineral is not sufficient, the chemical breakdown is important because clay minerals has to be developed.

In that case, that is why soil with usually dry region in arid region, that is called arid soil. Soils with mostly strong B horizon. Soils usually moist and thick block A horizon that is mollisol. Soils with mostly strong B horizon. Strong B horizons means more chemical reactions, more chemically breakdown of rocks. So that is why, usually moist, which moist because if you remember last class, when we were talking something about the water, the role of moisture in soil horizons.

Then we find the warm humid environment is more responsible for breaking down of minerals for chemical weathering and more chemical weathering, that means more thick the soil horizon is. So that is why, if you analyze here, soils with mostly strong B horizon, that means here soil usually moist, generally moist means it is promoting chemical reactions, chemical breaking down of mineral, development of clay.

That is why, it will develop a thick B horizon as compared to other part. Soils with clay enriched B horizon, soils with thin A horizon over E horizon and that is alfisol and ultisol. It is fertile C, infertile C, that is it is ultisol and it is alfisol. Soils with clay enriched B horizon, that means more accumulation, more accumulation means more leaching, more accumulation in B horizon that means more leaching in A and E horizon.

So that is why here usually thin A horizon over E horizon, that means totally leached soil. That means the A horizon and E horizon has been leached down. So that is why, here that will be thin. Then soils with iron and OM enriched B horizon, organic matter enriched B horizon, that is called spodosol. Here iron will be enriched, then organic matter will be enriched. So that is called spodosol. Soils highly weathered that is oxisol. This means oxygenated, oxidized.

It is highly weathered. Soil developed on volcanic ejecta, like volcanic ash the tephras. Soils with colloidal fraction dominated by allophanes and similar minerals Al humus complex, that is called andisol. Similarly, organic soil greater than 25% organic matter, that is called histosol. So these are the 11 orders of the soil. That is the broad classification based on those properties. Based on these properties, these are the 11 soil orders that has been worldwide the soils has been classified.

Now we will go to suborders, then great groups, then subgroups, then family like this.

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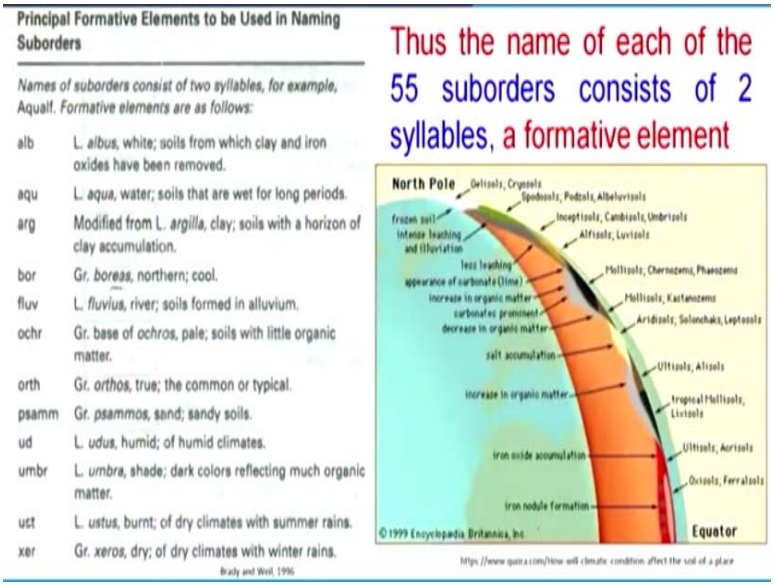

So after orders, the next low hierarchy it is the suborder. So if you see the suborders, it is alb, aqu, arg, bor, fluv, orch, so these are the formative elements for the suborders. For example, alb is a Latin. It stands for albus, that means white. So soils formed with clay and iron oxides have been removed. So now, if we remove the clays, we will remove the iron oxide, we remove the iron stains, so it will be totally light colour, light colour soil.

So the alb stands for Latin word albus that means white, so this white colour, in a soil white colour soil will be formed. That means iron will be removed, clay will be removed, then the remaining mineral will be rich in white colour, minerals are there. Similarly, aqu stands for aqu that means water. Soils that are wet for long period, so moist soil. Moist soil means chemically reactive soils, thicker chemical horizon, thicker B horizon will be there.

Arg for argillite, argillite means clay. Soils with a horizon of clay accumulation that is called arg. Similarly, bor, boreas, northern that is cool, that is a Greek word, boreas means cool, so those soil was developed in cold environment. This formative element is used for that. Fluv, fluvis, river, soil forming alluvium. So soil which is formed in alluvium this formative element, it is this fluv is used. Similarly, these are the formative elements.

They indicate different type of environment, different type of chemical constituents of this soils. Thus, the name of each of these 55 suborders consist of 2 syllables a formative element and if you see here, from north pole to equator we are moving, these type of formative elements, order, suborder are the name of these soil profiles has been name of the soils has been classified like here. For example, here is aridsol.

Aridsol, if you remember few minutes back we were talking, it is indicating arid region. So arid region now you see here. Arid region means salt accumulation. So here soil they consist of salt accumulation within that soil profile, like this calcrete development. Calcrete development, it is indicator of arid region, indicator of arid climate. Similarly, we have salt accumulation here that name aridsol, okay. Similarly, here organic matter, mollisol, means it is an organic rich soil.

If you see here, increasing of organic matter, because here chemical weathering is more, here rainfall is more, so that is why we are getting mollisols here, organic matter enriched.

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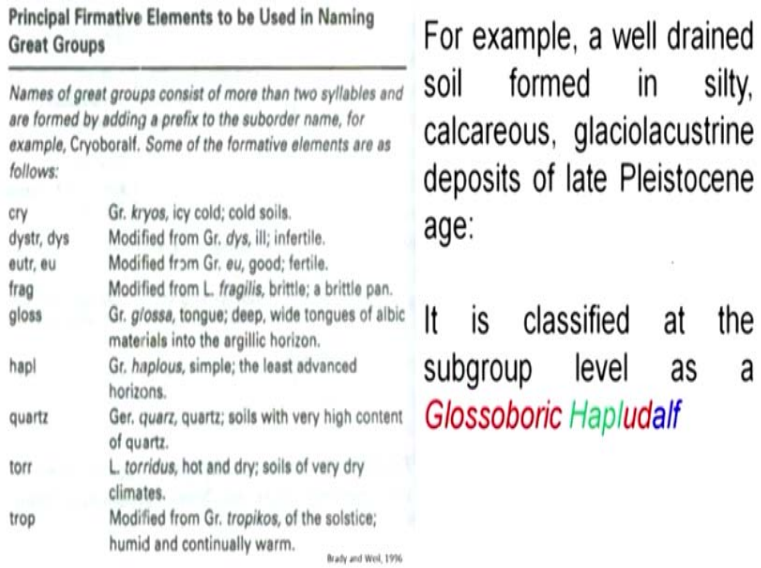

Now principle formative elements to be used naming great groups. Next lower hierarchy is the great group. Here cry, it is Greek word cryos that is ice. This is cold soil, cold environment. This formative element is cry. Dystr, dys that indicates infertile. Similarly, these are the formative elements they are indicator of great group. For example, if a well drained soil formed in silty, calcareous, glaciolacustrine deposits of late Pleistocene age, imagine.

A well drained soil formed in silty calcareous, glaciolacustrine deposite of late Pleistocene age. So that can be named or classified at the subgroup level as Glossoboric Hapludalf. So if we unravel this, if you expand these names alf, it is the order alfisol, ud it is again suborder ud, suborder if you see here ud, that means it is humid climate. Then hapl, hapl means here hapl, that means simply at least advanced horizon, the least advanced horizon.

So that means, I want to say if we analyze this part of the soil that means it will indicate what type of chemical constituents is there, what type of environment it was formed, and what is its degree of development, what is its organic content, what is the colour of the soil, all those things can be unraveled by looking this part of the soil. So now this term comes glossoboric.

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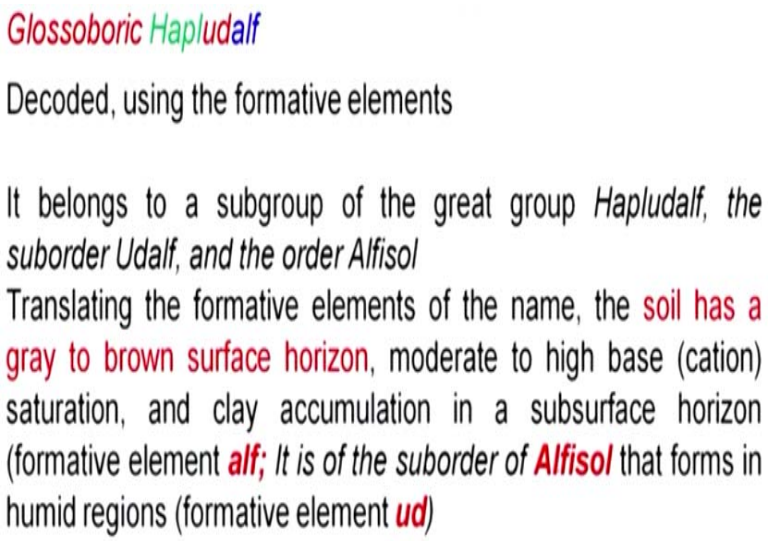

That means decoding this, it is given here. Decoded using the formative elements. It belongs to a subgroup or great group of hapludalf, the suborder udalf, the order alfisol, here alfisol, udalf, hapludalf. Translating the formative elements of the name, the soil has a grey to brown surface horizon, because we have to go for the meaning of this formative elements and the meanings from the Latin or Greek words.

If we analyze those, so this is a soil grey to brown soil horizon, moderate to high base cations saturation and clay accumulation in a subsurface horizon, formative element is alf. It is the suborder of alfisol. This alf stands for this alf, that forms in a humid region. Formative element is ud. So these type of information can be unraveled, can be decoded by this name this soil.

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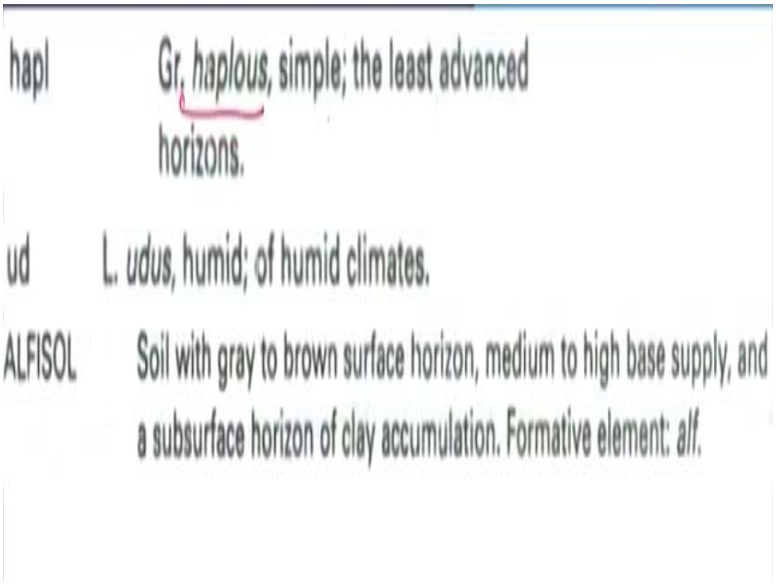

Hapludalf, simple, the least advanced horizon, ud again ud is humid climate, then alfisol soil with grey colour, surface horizon medium to high base supply and subsurface horizon, accumulation, formative element is alf. So that means I want to say, if we decode this second part, that means we can say different information, we can unravel different information regarding the soil development process, the environment, the parent material, degree of leaching, all those things.

So this is all about the soil classification. So by classifying a soil, we categorize it in a particular category, particular class, and we know which class is suitable for which type of crops and which soil is indicating the past geochemical environment, past tectonic scenario, past environment condition, etc. So that means soil classification is an important parameter to define the past climatic condition and geological condition.

So that is for today. I think it is the soil classification over. Thank you very much. We will meet in the next class. Thank you.