Ground Water Hydrology
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Module No # 06
Lecture No # 26
Graphical Representations of Ground Water Quality (Contd.), SURFACE/SUB-SURFACE Investigation of Ground Water: Geological / geophysical exploration; Remote Sensing / electrical resistivity methods

Welcome to this lecture 26 in which we will continue with the previous lecture's unfinished portion.

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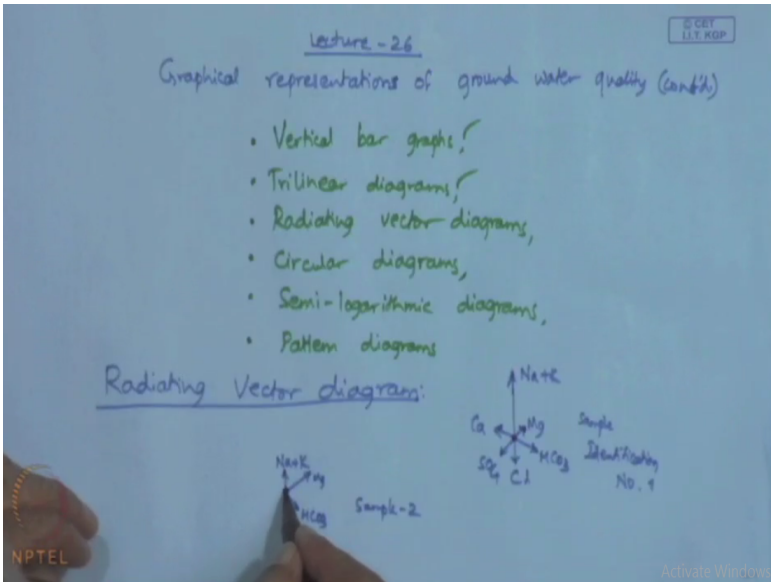

That is Graphical representation of ground water quality continued. And after this I will move on to the new chapter that is on surface and subsurface explorations of ground water. So here I have already discussed that is in the previous lecture the graphical representations are of the type of vertical bar graphs followed by tri-linear diagrams followed by radiating vector diagrams followed by circular diagrams followed by semi-logarithmic diagrams.

And there is one last there is another method of graphical representation that is known as the pattern diagrams. So this in the first two methods I have already discussed in the previous lecture. So we will move on to the third method that is the radiating vector diagram.

In this radiating vector diagram so the concentration the sample identification number is written and in this each of this there are 6 lines which are at 60 degree orientation and the length of each line and of course the order is maintained same. So here always the vertical line represents sodium plus potassium concentration.

The line and of course the length of each of these lines represent is proportional to the concentration the next the 60 degree line represents the magnesium concentration the length of the 60 degree line and from the vertical similarly the length of the 120 degree from the clockwise from the vertical represents the bicarbonate concentration. The length of the 180 degree or vertically downward line represents the chloride concentration.

And the length of the 240 degree line clockwise from the vertically upward line represents the sulphate concentration. And then lastly the length of the 360 degree line clockwise from the vertically upward line or 60 degree from the vertically anticlockwise from the vertically upward line represents the calcium concentration. So here so this is in this the sample identification number and then if there is another sample so this is one.

And then say this is sample two so this case so again the same thing so this could be the same pattern is maintained. And that the 120 degree it is HCo3 and so here so it could be the chloride concentration and it could be so this next line is the sulphate concentration. And then followed by the calcium concentration this is for sample two. So these are the radial vector diagrams so basically an each is the length of this one.

There is lengths represent the concentration in milli equivalent per liter so this is the radiating vector diagram.

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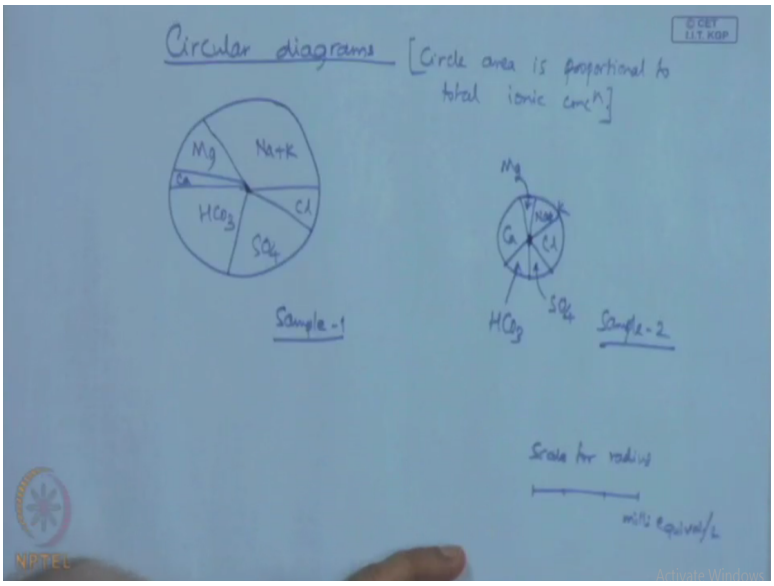

So now we will go to the next graphic representation that is the circular diagram so in this basically so these all are the pie charts. And so the area of the circle represents the total this the area of the circle represents the total ionic concentration. And this case says this could be Na sodium + potassium.

And this could be chloride this could be sulphate this could be bicarbonate then this could be calcium this could be magnesium so the circles area is proportional to total ionic concentrations. And the sector in each of the circle represents the fraction of this total ionic concentration occupied by respective ion whether it's a positive ion or negative ion. So this is a sample one and then similarly for sample two.

So if the concentration is less so it is represented by smaller circle and within this could be Na + K and this could be chlorine so this could be sulphate so this could be bicarbonate and this could be calcium and then this could be magnesium. So this is sample two so like this using the circular diagrams which are essentially pie charts. And so here the of course the there is a scale for radius because the area of the circle varies as the radius.

So therefore here there is a scale and then so in milli equivalent per liter. So this a circular diagram next we will go to and of course this is also the circular diagram. So here also so this also taken from the source that is Hem in nineteen seventy.

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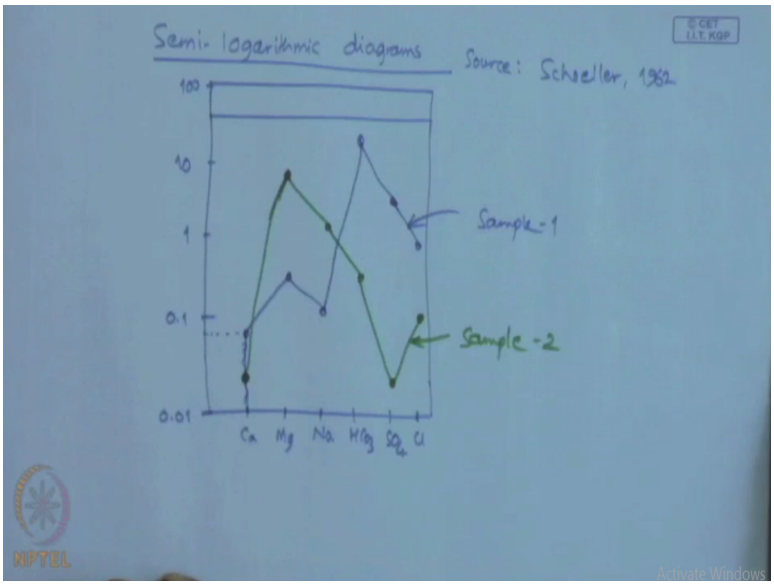

Next we will go to the other graphic representation which is the semi logarithmic diagrams. So in this so this is taken from the source that is Schoeller 1962 and here so essentially so there are lines corresponding to each of the ion like calcium magnesium then sodium then bicarbonate sulphate and then chloride. And here so the line the vertical line represents the concentration in logarithmic axis so this is .1. So this is 1 and then this is 10 and may be here this is 100.

Then this so it could be say for one sample so if this is the ordinate indicates the calcium ion concentration then this ordinate indicates a magnesium ion concentration this ordinate indicates a sodium ion concentration and then this ordinate indicates the Hco3 ion concentration. And this point indicates the sulphate ion concentration then this point indicates the chloride ion concentration and all these are joined so this could be sample one.

And similarly for the another sample so the calcium ion concentration could be this much as indicated in the scale and again so the magnesium ion concentration could be this much the sodium ion concentration could be this much then the bicarbonate ion concentration could be this much sulphate ion concentration could be this much and the chloride ion concentration could be this much. So therefore join each of them by straight line.

So this represents sample two and here so this concentrations so these are in milli equivalent per liter. So this is another method of graphic representation graphical representation of ground water quality and then lastly we will discuss the pattern diagram.

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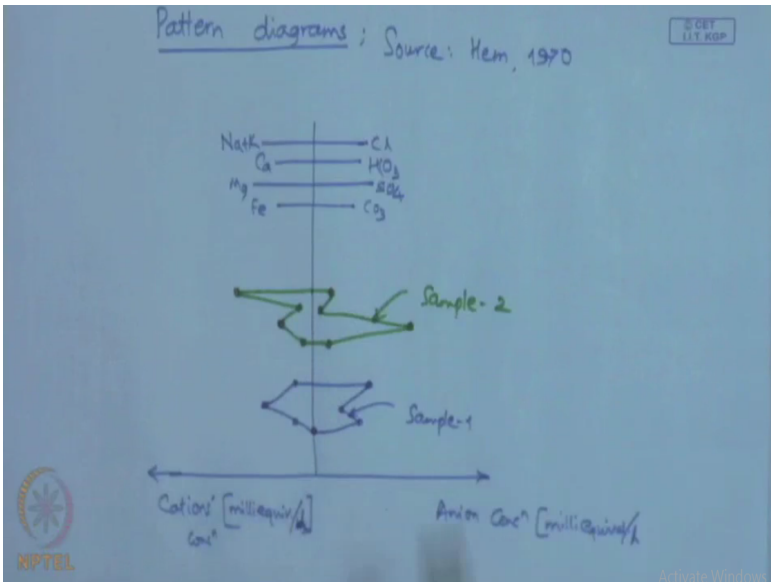

So that is this pattern diagrams again this is taken from the same source that is HEM from 1970. And here so from a vertical line the cations are represented to the left. So this is cations in milli equivalent per liter. Cations concentration and then similarly the anion concentration so that is in milli equivalent per liter and here for each of the sample like so in this so along the top one represents Na + K in the cation side or the left side.

And the along the same line you are in the right side it represents the chloride concentration. Similarly the second line represents the calcium concentration and along the same line it represents the bicarbonate concentration. And then the along the third line it represents the magnesium concentration and along the right side line it represents the sulphate concentration is represented.

And then the bottom was line so it represents the iron concentration and here it could be the carbonate concentration. So basically in this case so there will be there are four cations and then four anions. So in this case say for example a particular sample does not have an iron or as well as carbonate. So in that case both this will be 0 so then if it has a certain magnesium concentration certain sulphate concentration.

Then certain calcium concentration and certain bicarbonate concentration and then lastly it have certain sodium plus potassium concentration and then certain chloride concentration. So in this

case so this represents so this is sample one so basically and this and then similarly suppose you want there is another sample which has say this much of sodium and potassium concentration.

And this much of chloride concentration and this much of calcium concentration and this much of bicarbonate ion concentration and say this much of magnesium concentration and this much of sulphate concentration and may be this much of ion concentration and then this much of carbonate concentration. So in that case simply join each of them so this represents sample two and so on so like this the graphical representation.

So basically indicate through this the lines we indicate they may be 10, 20 and so on so this is a so these are the six different types of graphic representations of ground water quality.

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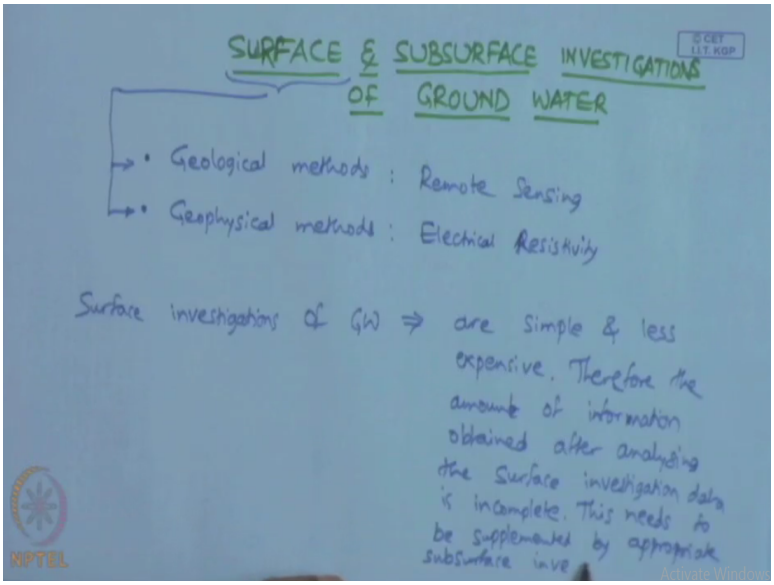

And now we will move on to the new module so that is on surface and subsurface explorations of ground water and explorations or investigations of ground water. So in this lecture we will discuss the geological methods followed by geophysical methods. So in the geological methods let us discuss the remote sensing and in the geophysical method let us discuss this electrical analogy electrical resistivity I am sorry.

So this firstly this and of course all this they belong to the surface investigations of ground water. And after completing this surface investigation of ground water so we will move on to the subsurface investigations of ground water. And here one thing you should realize the surface

investigations of ground water so they are simple and less expensive. Therefore the amount of information obtained after analyzing the surface investigation data is incomplete. So this needs to be supplemented by appropriate subsurface investigations.

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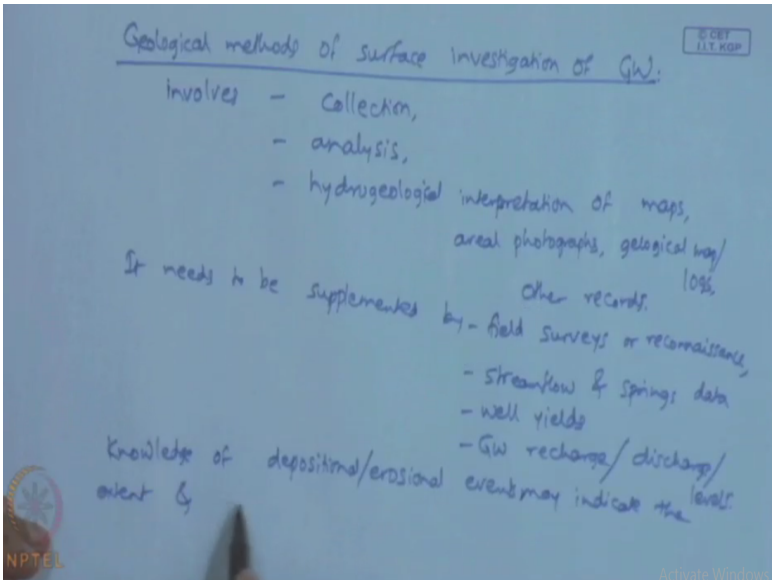

so now let us move over to the geological methods of surface investigation of ground water. And here so basically so it involves collection that is data collection analysis and hydro geological interpretation of maps coma aerial photographs geologic maps geological maps or logs coma other records.

And here so this must be supplemented by it needs to be supplemented by field surveys or reconnaissance or reconnaissance coma stream flow and spring springs data well yields ground water recharge or discharge or levels. So only when it is supplemented so it will give some here the knowledge of deposition erosion events may indicate extend and regularity of aquifers or water bearing formations.

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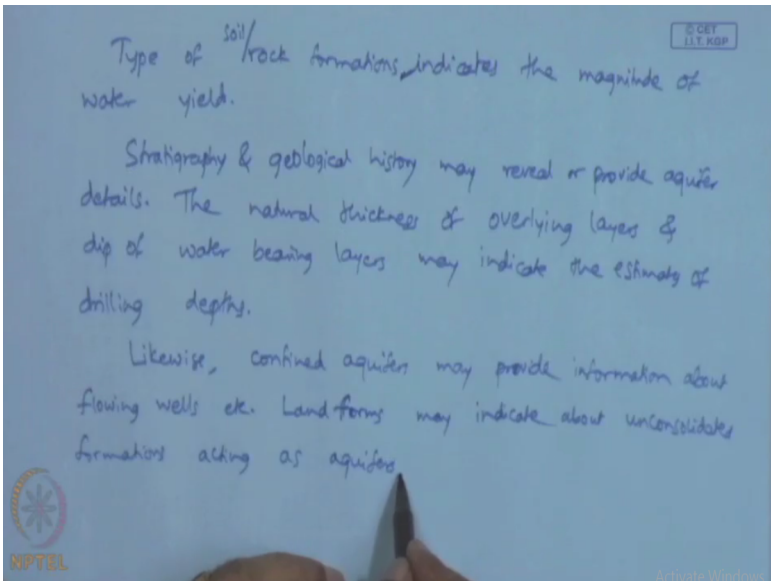

Also the type of rocks type of rock formations indicates so here this is not only rocks the soil or rock formation indicates the magnitude of water yield. This stratigraphy and geological history may reveal or say provide aquifer details. The natural thickness of over lying layers and dip of water bearing layers may indicate the estimated estimates of drilling depths.

Likewise confined aquifers may provide information about flowing of artificial wells etc. Landforms may indicate about unconsolidated formations acting as aquifers land. That is I am sorry sand dunes glacier outwashes etc so basically in this geological methods so we will try to get the as much data from the aerial photographs as well as from the the ground details and now let us go to so this remote sensing.

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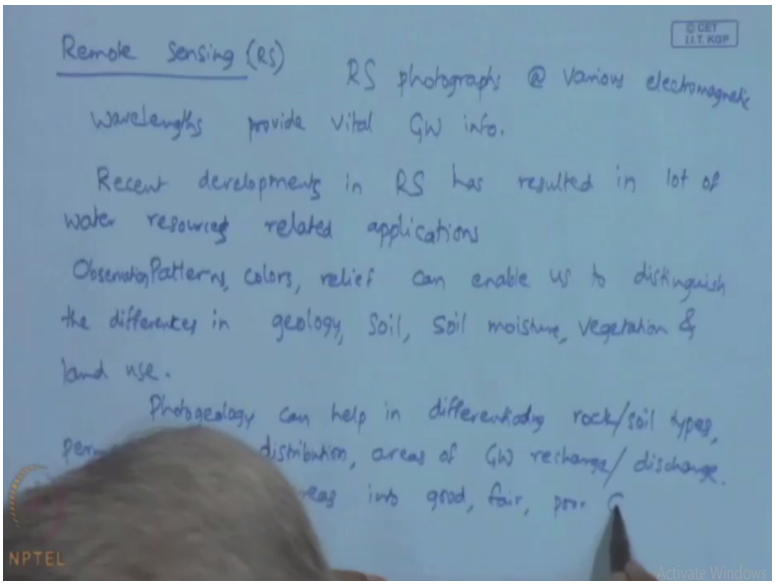

So this remote sensing photographs which is generally abbreviated as RS so RS photographs at various electromagnetic wavelengths provide vital ground water information. So this RS has developed very fast in the recent years recent developments in RS in remote sensing has resulted in lot of water resources related applications.

And here so the observation patterns colors relief can enable us to distinguish the different the differences in geology soil moisture vegetation and land use. So this photo geology can help in differentiating rock or soil type's permeability areal distribution areas of ground water recharge or discharge. Maps can classify areas into maps which can classify areas into say good fair or say poor ground water yield can be prepared.

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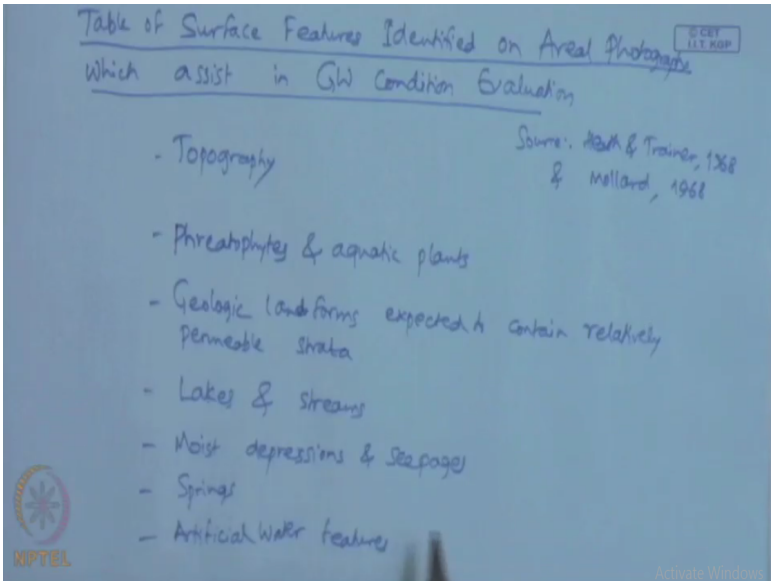

Now let us list the tabular so the surface features so this is the table of surface features identified on aerial photographs which assist in ground water condition evaluation and this is taken from sources Heath and trainer 1982 and Mollard 1982. So here firstly there will be details of topography and there will be details of phreatophytes basically they are the plants at the surface of ground that is on the ground surface or say even water surface and aquatic plants.

So this is the second data and thirdly there is geologic land forms expected to contain relatively permeable data. Then it is followed by we can also identify this lakes and streams so lakes means they could be natural or they could be reservoirs constructed out of dams or so there could be moist depressions and sea pages there could be springs and lastly they could be artificial water features like wells developed springs reservoirs canals etc. So all this can be identified in this table of surface features.

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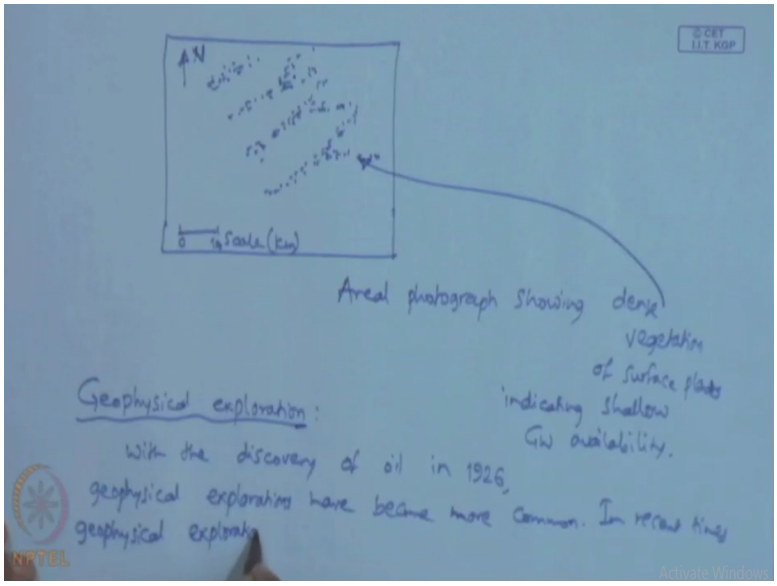

And say for example if there is an aerial photograph which shows the dense vegetation like this so then it is an indication of the availability of so this aerial photograph showing dense vegetation of surface plants. So indicating shallow ground water availability and here so this could be the scale and say may be kilometers. And this could be the north direction so by identifying this.

So this dense vegetation of surface plants or phreatophytes so we can conclude that there is shallow ground water availability in that area so next we will go to the geophysical exploration so in the geophysical exploration so this scientific measurements are carried out to obtain hydro geological properties regarding the mineral deposits as well as geological structure. And so with the so discovery of oil in say 1926.

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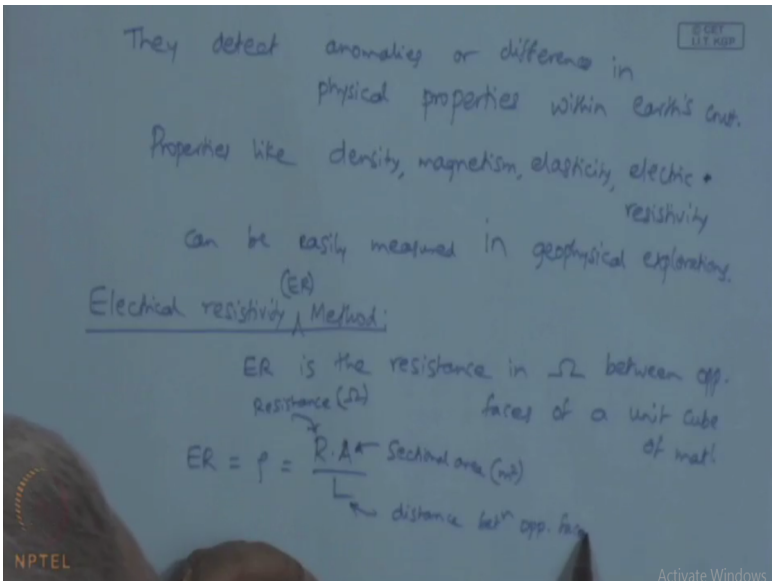

So this geophysical explorations have become more common in recent times. Geophysical explorations have being widely used for ground water investigations. So this geophysical explorations they detect anomalies or differences in physical properties within earth's crust. So here some of the properties like density magnetism elasticity electric resistivity electric resistivity can be easily measured in geophysical explorations.

And so this electric resistivity electrical resistivity method so is a very important geophysical method under the for ground water exploration. So this electrical resistivity which is abbreviated as ER so this ER is the resistance in ohms between opposite faces of a unit cube of material. So this ER the electrical resistivity which is also denoted as rho so this is = R into A / L, where this R is the resistance.

So this is in ohms and A is the sectional area meter square and L is the distance between opposite faces so that is in meters. So this electrical resistivity so it will be in terms of ohm meters. It has units of ohm meters and this one the electrical resistivity so we will discuss about the electrical resistivity in the next lecture thank you.