Photogeology In Terrain Evaluation (Part – 1)
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Lecture – 03
Fundamental Principles in Remote Sensing

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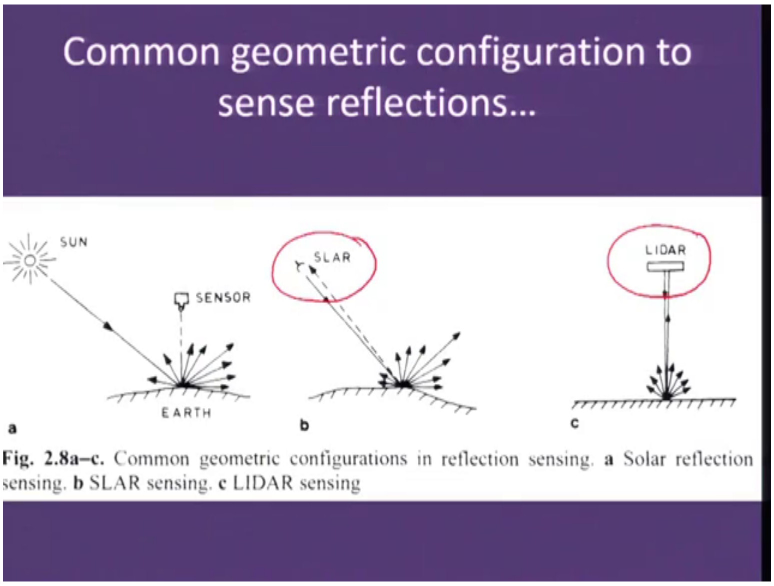

Welcome back. So, in last 2 lectures, we have been discussing about the electromagnetic spectrum and, we also talked about the earth energy balance and budget and mostly, this was been discussed, because this plays an important role and in terms of the data which we are interested in, collecting in form of the reflectance of light.

Now different material will have different reflectance and different effective reflectance curve or, we can say spectral curves, and these are the few sensors which we discussed the last, which are most commonly used SLAR, which is side looking airborne radar and LIDAR is your light detection and ranging. Now, coming to the fundamental principle, it is remote sensing as we have to discussing that, different material will have different spectral curves, because in some of the bends, the material or the object on the earths surface, will not reflect any light, the energy which has been radiated or incident on that object will be absorbed.

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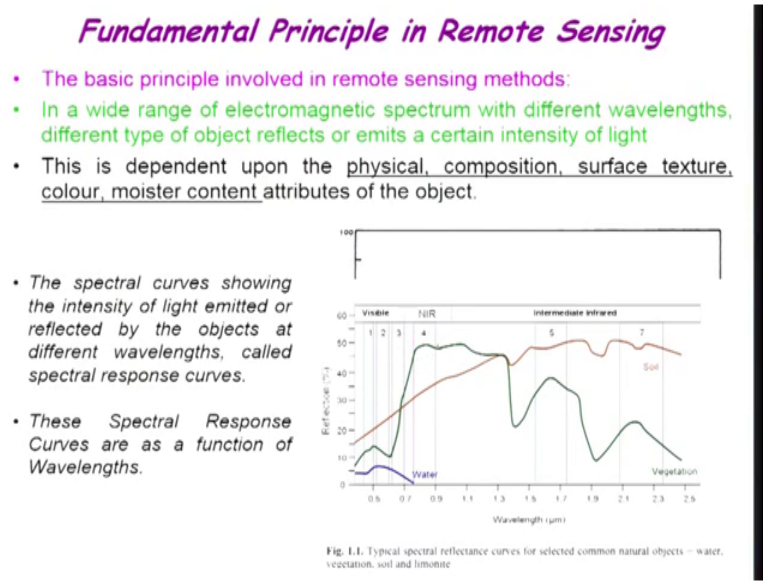

So, the basic principle involved in remote sensing methods is that, in a wide range of electromagnetic spectrum, but different wavelengths. We were talking about, the wavelengths which is covering fluorite from the gamma ray and goes up to the infrared and all that. So, this wide range of electromagnetic spectrum, for different wavelengths, different objects reflects or emits a certain intensity of light. So, part of it will be absorbed and part of it will be reflected and that is dependent on, basically the physical composition, surface texture, color moisture content, etc.

So, for example, if you are looking at the body, on the earths surface, which is containing water, then the reflectance will be very less, most of the light will be absorbed. If you are looking at vegetation, then it will have different spectral, if you are looking at the barren terrain as we were talking in terms of the image from greater enough kutch, we were having different colors and that is dependent on the absorption capability or the, reflecting capability of the object.

So, this is these are the curves which are standard curves, which are available for example, vegetation in different wave bands, you will have different reflectance, which you will be able to pick up and for example, dry soil you will have different curves, for example, for water you will not be able to look at or identify, the water body interest of the wavelengths. So, you will have to look, if you are interested in looking at the water body, you will have to look at within the this spectrum which is more or less in the range of visible light.

So, the spectral curves, which are been shown here, the intensity of the light emitted or reflected by the objects at different wavelengths, which is termed as spectral response curves. So, what we are looking here are the spectral response curves of different material, this spectral response curves are as a function of wavelengths. So, at different wavelengths, you will have different for example, for water you would not be able to, identify because, everything is getting absorbed until this point, and this is the range which, we are having of visible band 0.4 to 0.7 here.

So, if you have to look at the vegetation for example, the green line here, then you will be most prominent observations you can make when you are looking at the bend 4. So, this is like 127 we are having different bends, which are available in multi spectral data if you are having. So, depending on what, information you need you may select the bands and try to extract the information, which is useful for the user.

I am going further this is what I was talking about, that different material will have different for example, the physical composition will be different, surface structure will be different, color and moisture content it depends on that, and that will be responsible in emitting the light.

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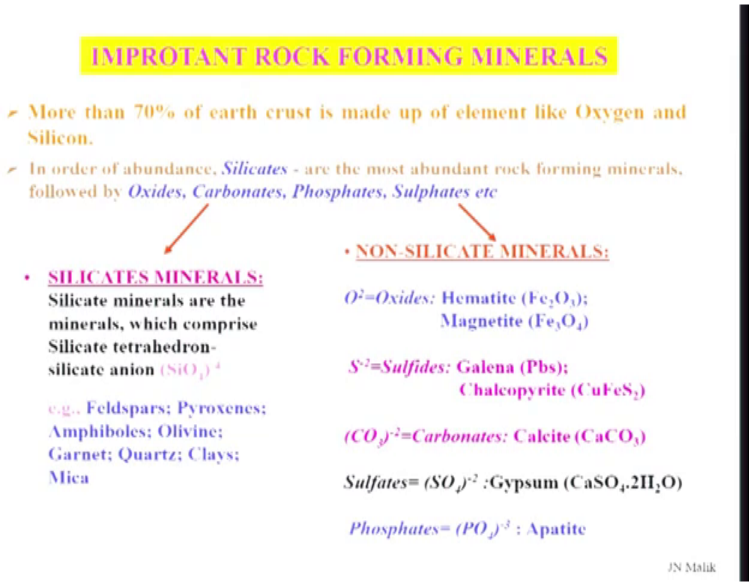

For example, this is very quickly I will just go through, but not part, but it is important that more than 70 percent of earth crust has made up of elements like oxygen and silicon. Now, in order of abundance if you take, silicates are the most abundant rock forming minerals because, we are why we are talking this here because, we are talking about the earths surface and earth surface is comprised of this material, either in the form of rocks or in form of the sediments, or in form of a soil.

So, the most abundant is your silicates, which are the most abundant rock forming minerals, followed by oxides carbonates phosphates and surface and all this minerals will have different spectral curves, because the composition is different, they have different textural characteristics or in terms of, if we talk about the crystal forms or crystal structures. So, depending on that they will have different spectral curves. So, just for an example, we have silicate minerals, you have non-silicate minerals here, which are having different composition.

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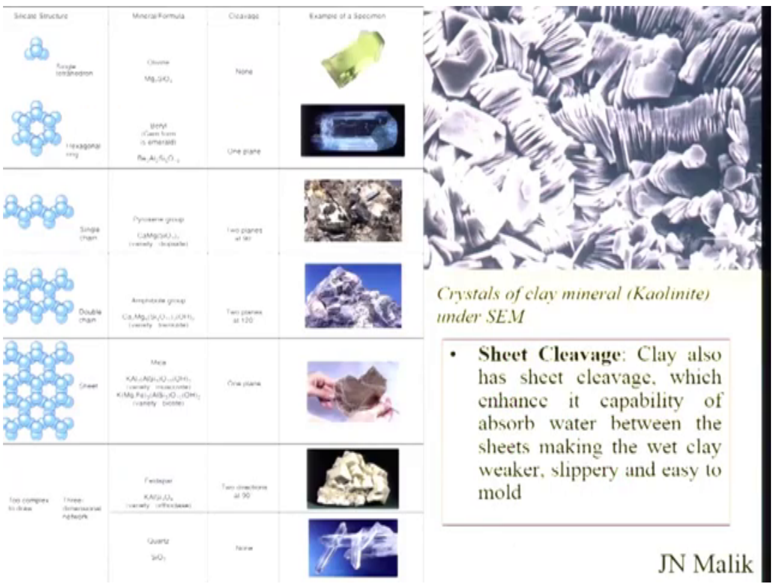

So, if you look at further, this is what you can look at the silicate structures, here you have silicate structures and then, you are having the composition here of different minerals and what are the basic cleavage forms? And all that now for example, here the clay if you incident your light on a clay, then it may appear slightly darker, because it has incapability of absorbing water and in the dry conditions, you may have better reflectance. Then again, it what we talked about that different type of crystal forms, in different minerals and if you aggregate this minerals, then you may have look like you will finally, having rocks.

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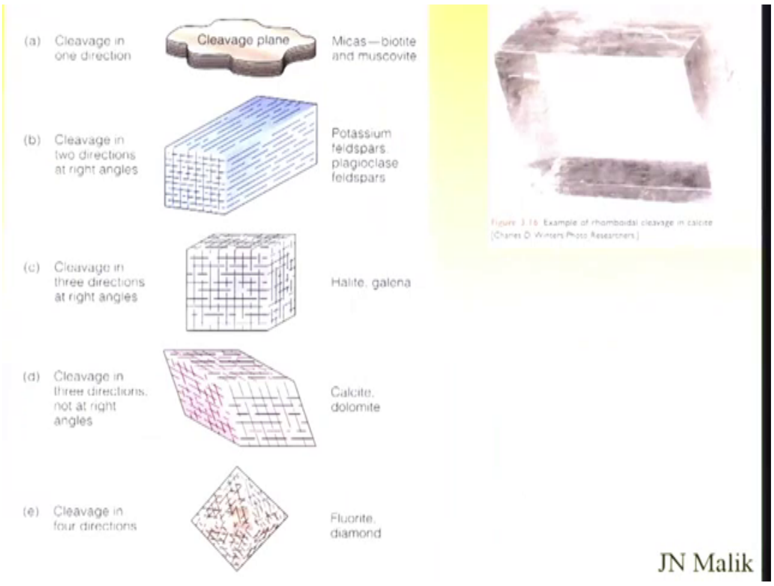

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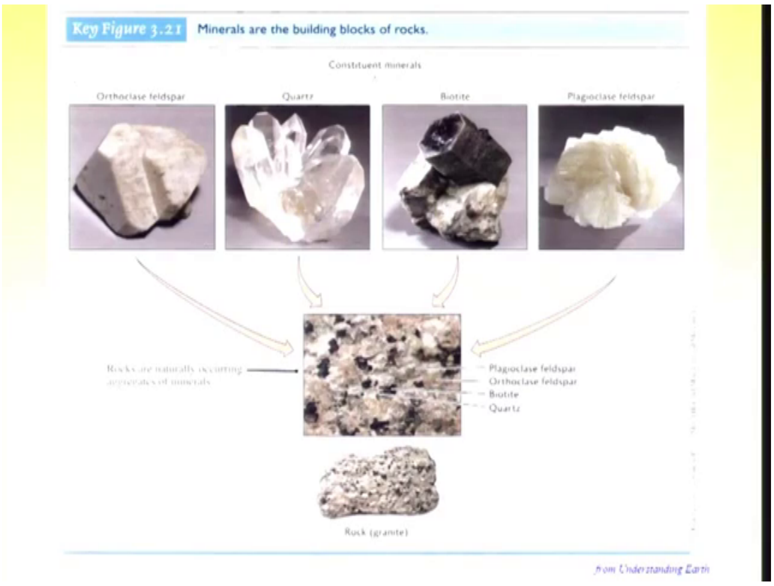

So, rocks are comprised of different minerals. So, for example, if you take granite then, you have the major constituents of the granitesare, feldspar, quartz biotite and plagioclase feldspar, now all this 3 or the 4 minerals which you will mostly come across in the granite, are having different crystal forms and of course, the composition is also different.

So, all this will reflect different amount of light. So, for example, quartz we will have good reflectance, because of it is color and all that, and other minerals like biotite, I will appear darker. So, spectral features of mineralogical constitutions, if you look at, then we have it depends again on, what we have discussed upon the composition crystal form, internal atomic structures.

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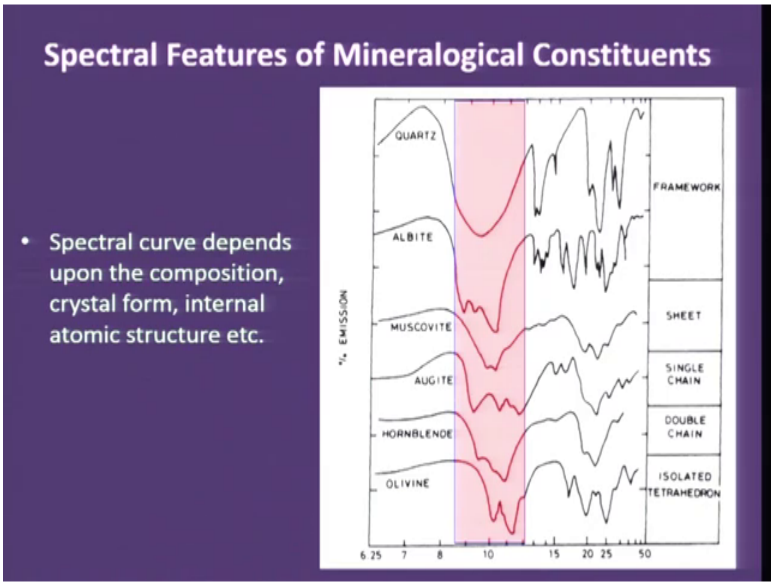

So, if you look at the amount of emission of, in terms of the percentage and if you look at on the y axis, you have the wavelengths. So, at different wavelengths, you will have different reflectance. So, the quartz, albeit, muscovite, augite, hornblende, olivine will have very good reflectance or emission of light between this range is between around 6.5 maybe you can go up to 10.

So, you are moving into the, then your infrared and all that, but further you will have a complete absorption. So, it will not yield anything. So, if you are choosing any bend from the multispectral data and if you are looking at and this region, then you may not be able to identify any minerals. So, you need to be careful, which bend you are interested in. So, this is the area of absorption, you will not be able to see much.

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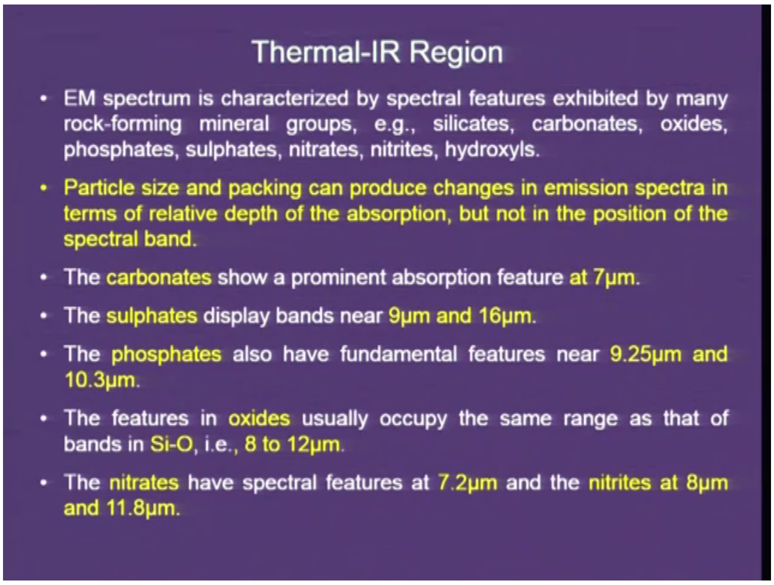

Further, in terms of the thermal infrared region, if you take the electromagnetic spectrum is characterized by spectral features, exhibited by many rock forming minerals groups, for example, silicate, carbonates, oxides, phosphates, sulpahtes, nitrates and so on. So, particle size and packing, can produce changes in emission spectra, in terms of relative depth of absorption, but not in the position of the spectral band.

For example, the carbonates shows a prominent absorption feature at 7 micrometer, sulphates displays bends near 9 and 16. Phosphates also have fundamental feature near 9.25 to 10.3, and features in oxides usually occupy the same range as that of silica, SiO 2 or so, on 8 to 12 and the nitrates have spectral features, these are the prominent spectral features, which we are talking about at 7.2 and nitrates at 8 and 11.8. So, this minerals are having very typical spectral features, which are exhibited at different wavelengths.

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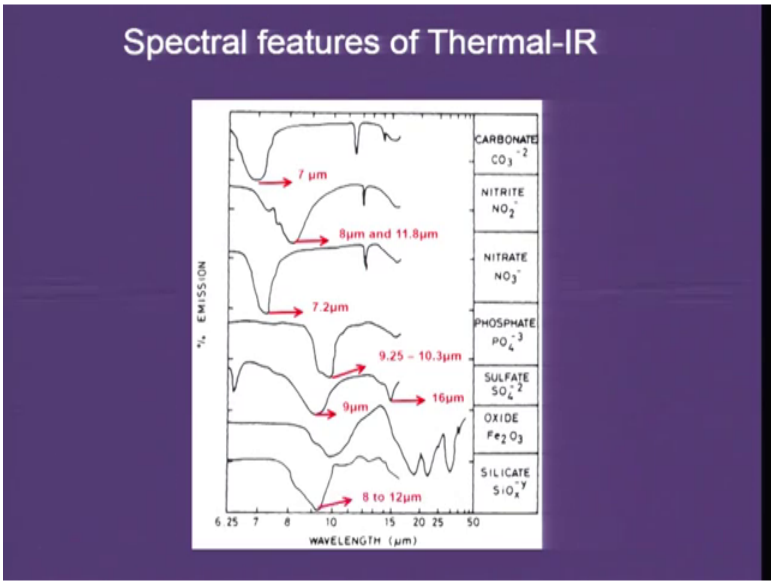

Now, for example, spectral features of some of this minerals, if you look at that what we have been discussing that, you will have and around 7 that is carbonates 8 to 11.8, that what we discussed in the previous slide, when you have nitrates and you are having. So, this is the absorption, which you will come across.

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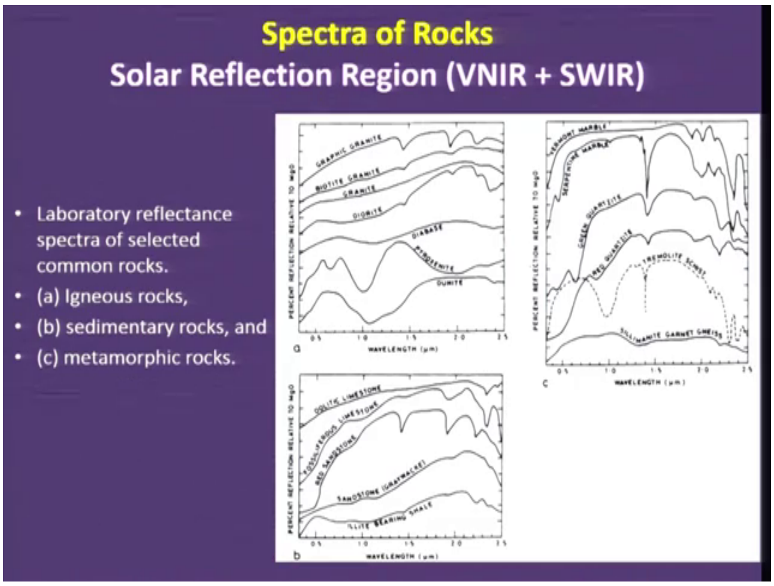

So, spectra of rocks, if you look at then different rock types, which you should refer at that, we have 3 different type of rocks, that is igneous sedimentary and metamorphic you will have typical spectra. Now, major reasons of electromagnetic spectrum, if you look at. So, for us, the visible light, this region will be extremely important that is from 0.4 to 0.7 micrometer.

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Major regions of the electromagnetic spectrum

Region Name	Wavelength	Comments
Gamma Ray	< 0.03 nanometers	Entirely absorbed by the Earth's atmosphere and not available for remote sensing.
X-ray	0.03 to 30 nanometers	Entirely absorbed by the Earth's atmosphere and not available for remote sensing.
Ultraviolet	0.03 to 0.4 micrometers	Wavelengths from 0.03 to 0.3 micrometers absorbed by **ozone** in the Earth's atmosphere.
Photographic Ultraviolet	0.3 to 0.4 micrometers	Available for remote sensing the Earth. Can be imaged with photographic film.
Visible	0.4 to 0.7 micrometers	Available for remote sensing the Earth. Can be imaged with photographic film.
Infrared	0.7 to 100 micrometers	Available for remote sensing the Earth. Can be imaged with photographic film.
Reflected Infrared	0.7 to 3.0 micrometers	Available for remote sensing the Earth. Near Infrared 0.7 to 0.9 micrometers. Can be imaged with photographic film.
Thermal Infrared	3.0 to 14 micrometers	Available for remote sensing the Earth. This wavelength cannot be captured with photographic film. Instead, mechanical sensors are used to image this wavelength band.
Microwave or Radar	0.1 to 100 centimeters	Longer wavelengths of this band can pass through clouds, fog, and rain. Images using this band can be made with sensors that **actively** emit microwaves.
Radio	> 100 centimeters	Not normally used for remote sensing the Earth.

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Fundamental Principle in Remote Sensing

- A set of multispectral images in green, red and near-infrared bands of the same area, indicating that various features may appear differently in different spectral bands.
- Therefore, using information from one or more wavelength ranges, it may be possible to differentiate between different types of objects, e.g., dry soil, wet soil, vegetation, etc.), and map their distribution on the ground.

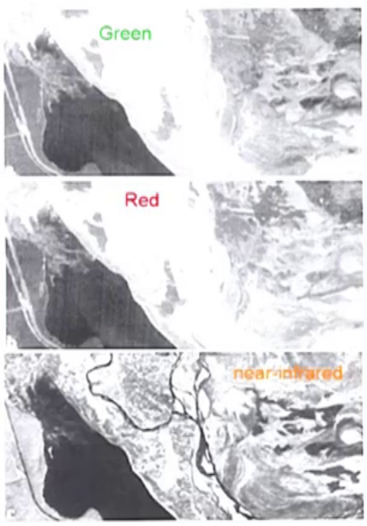

Fig. 1.2a–c. Multispectral images in a green, b red and c near-infrared bands of the same area. Note differences in spectral characters of various objects in the three spectral bands. (IRS-LISS-III sensor images of a part of the Gangetic plains)

So, the fundamental principle in remote sensing further, if you look at this image, which has been shown 3 images. So, these are all like multispectral images. So, you have a green, red and near infrared bands, of the same area. So, this is from the, gangetic plains into gangetic plains, now all 3 are not giving the similar information, though they are been taken from the same area or the images are of the same area, but they are not giving the same information.

Because they reflected I will, vary from band to band. So, for example, the green, if you look at. So, this is a set of multispectral image, in green red near infrared bands, of the same area indicating that, various features may appear differently and different spectral bands. So, in different spectral bands you will have different features, which are enhanced or they are subjective, because they will not be able to give the good reflectance.

So, therefore, using information from one or more wavelengths, it may be possible to differentiate between different type of objects, for example, dry soil, wet soil, vegetation and map their distribution on the ground. So, in the last one here, you can see that the channels, are coming out very prominently, where is here you are not able to pick up this.

But in few locations, you are able to pick up clean near infrared, they are able to pick up the more detailed area here whereas, here you are not able to pick up. So, you may use in combination of this bands, when you are doing or using the multispectral images, then you can enhance, the features which you require or interested in and then accordingly, you can extract the information.

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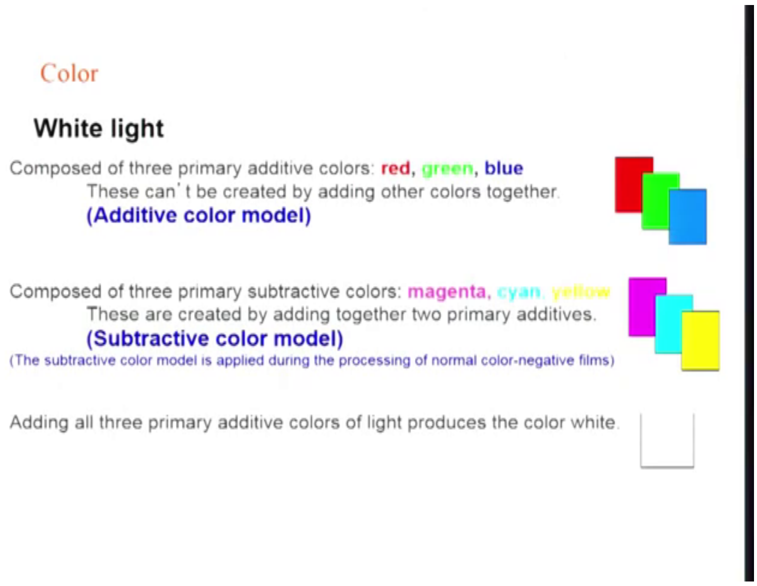

So, if you look at that what we would be talking of that, we have like if you take the 7 colors here. So, if you keep on adding, those images either in the red band or the green band or the violet band or the blue band, then you will be able to enhance the different features, which are in which you are interested in actually.

Now, again as we will talking about, the reflectance and the absorption of the light the photographic films versus the visible radiation, if you take. So, photographic film is sensitive, to visible radiation and also to the radiation of longer as well as shorter wavelengths.

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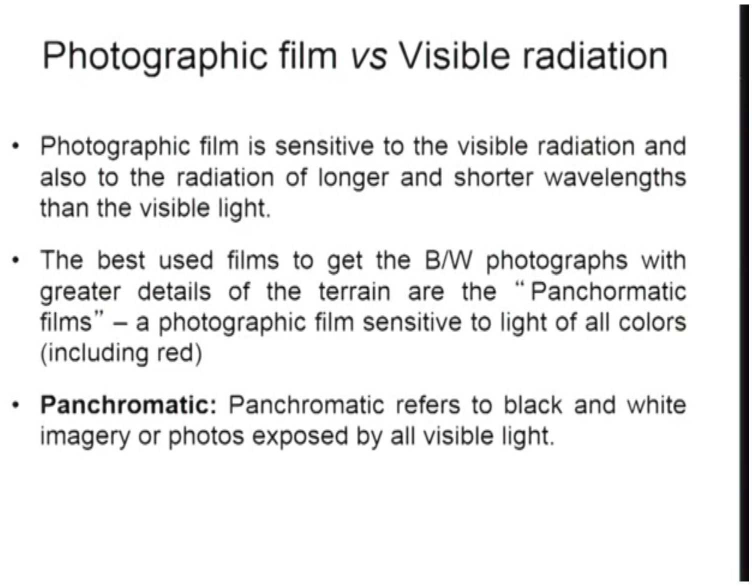

So, we have starting from gamma, we are having shorter wavelengths and we are moving towards further, towards the visible light within longer wavelengths. So, this films are sensitive to visible radiation, that is from 0.4 to 0.7 and also to the radiation of longer and shorter wavelengths and the visible light. So, on the either side they will be sensitive, if you take the electromagnetic spectrum.

The best used film, to get the black and white photographs, with greater details of the terrain are the panchromatic films, these are the photograph photographic film sensitive to light, of all colors. So, this is very important. So, panchromatic data or panchromatic film is been used, to have the complete spectrum in terms of because, they are sensitive to light of all colors including red. So, panchromatic refers to black and white images or photos exposed by all visible light.

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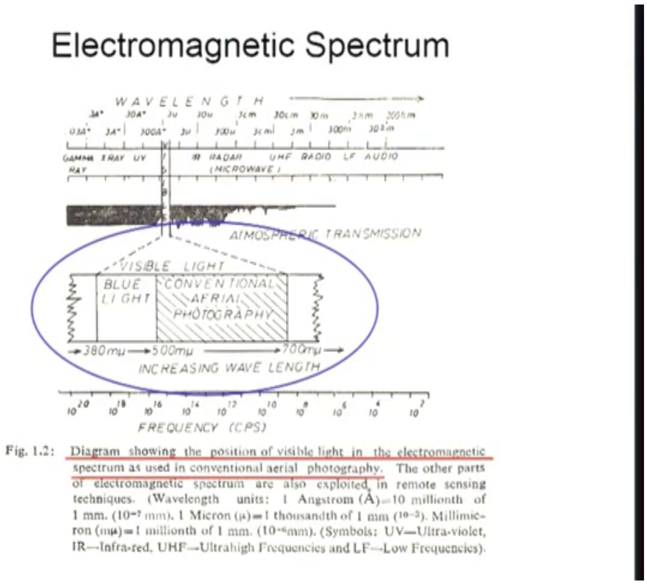

So, this we have been talking about, we have talked about in detail, about the electromagnetic spectrum. So, for us this area is extremely important, which is been used for the conventional aerial photography.

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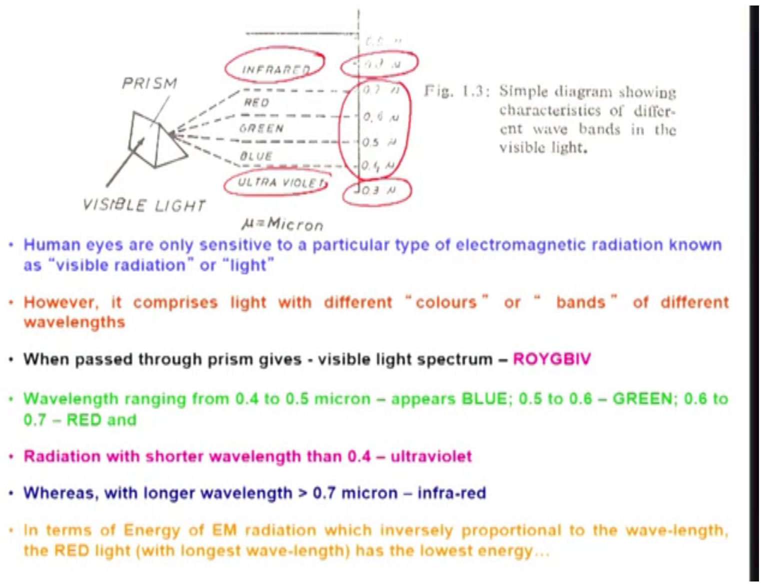

So, this is an again simple diagram, which explains about the spectral. So, if you take why this is very much important again, as human eyes are only sensitive to a particular type of electromagnetic radiation, which we call visible radiation; however, it comprises light, with different colors or bands of different wavelength. So, it is having point 0.4 to

0.7. So, we are having this is the range, which we are talking about this is. So, human eyes are sensitive to a particular type of electromagnet, that is a visible radiation

So, when this is passed through a prism, then you will have the light spectrum, which is red orange yellow green blue indigo and violet. So, wavelength ranging from 0.4 to 0.5, microns appears blue, 0.5 to 0.6 green, 0.6 to 0.7 red. So, this is the range which you will see, mostly in the visible light spectrum. So, radiation with shorter wavelengths than 0.4 I terms it is ultraviolet, then greater than 0.7 microns are infrared.

So, you are having this less than, this is ultraviolet and greater than 0.7 is your infrared. So, in terms of energy of electromagnetic radiation, which is inversely proportional to the wavelength, the red light with longest wavelength has least energy. So, this is another important point, which you can remember. Now, looking at with the understanding that the about thepanchromatic data and all, that let us look at, what is the main difference between the normal film and the panchromatic film.

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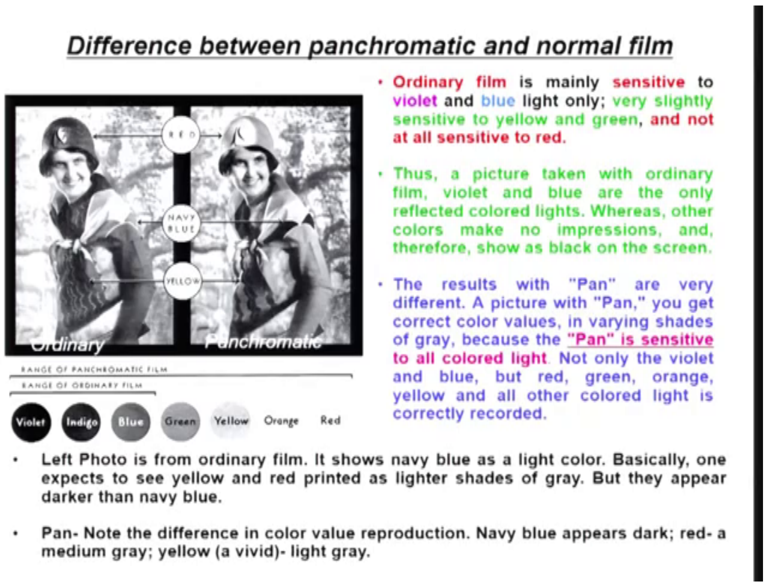

So, here to your left and to your right, what we are having. So, left is your ordinary picture taken by ordinary film, normal film and then another one is your panchromatic film. So now, a days mostly we use panchromatic film, actually now, if you look at the difference you will be able to make out that, the panchromatic photo or the photo which was been taken, by panchromatic film has greater details as compared to the ordinary film.

Because they are the ordinary film will not be sensitive to all, colors of visible spectrum. So, it will appear dark or some of the colors. So, ordinary film is mainly sensitive to violet and blue, very sensitive to yellow and green, and not at all sensitive to red. So, any material or an object or a body, is with red color on the earth surface will appear dark, in that film when it has been through the data is collected.

Thus, a picture taken with ordinary film, violet and blue are the only reflected color lights whereas, other colors make no impression and therefore, show black on the screen. So, if you are having for example, but it says that violet and blue are the only reflected colors. So, if you are having the violet, they are reflected no problem, but red appears dark here on the screen.

The result with the pan, are very different a picture with panchromatic film, you can get a correct color values, in varying shades from gray. Because the pan images or the pan photographs, are sensitive to all colored light. So, not only the violet and blue, but red green orange yellow and all other color light in, is correctly reflected. So, if you look at this is what is the spectrum, which has been given.

So, the ordinary films are only sensitive to violet indigo and blue whereas, this has a complete range. So, left photo is from your ordinary film, it shows navy blue as light color basically one expects to see yellow and red printed as light shade of grey, but this appears darker than the negative whereas, pan note the difference in color values reproduction navy blue appears dark, red medium gray and yellow light gray, again this is which has been seen yellow over here, which is light green whereas, here it appears dark green.

And here also, the red is an lighter shade of gray, but here we are having the red is completely dark, hence with this understanding the it was been I have been dismally understood that the panchromatic images, or the photographs taken are much better, because it gives and wide range of shades, which we require to identify different features or objects on your surface.

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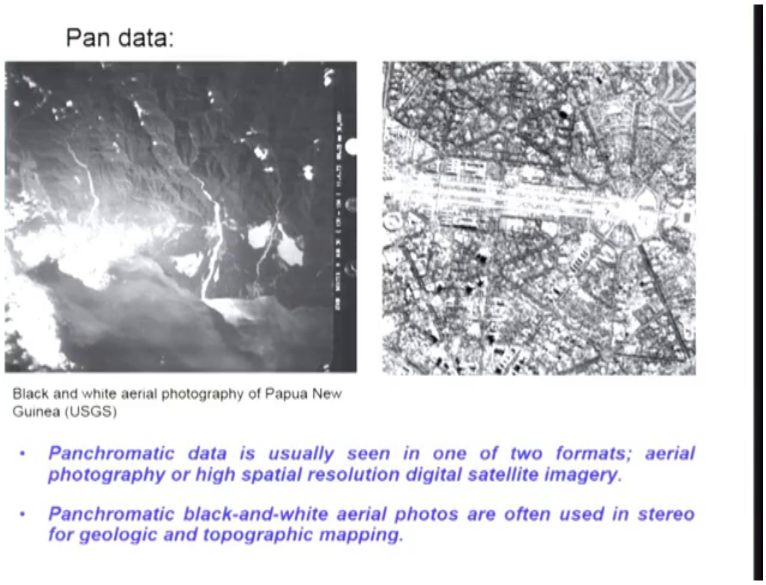

So, this is an example of the pan data, which has been taken from the aerial platform and this one is another one is from, the high resolution immediately. So, one is aerial photograph, otherwise the high-resolution satellite imagery. So, in of course, we will be using both, will be having a look on the aerial photographs, not only panchromatic of course, the panchromatic is also we can get color. So, we will use both the pan data, as well as the high-resolution satellite images also. So, I will stop here and we will continue in the next lecture.