Remote Sensing Essentials
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Lecture – 48
Image Interpretation of Different Geological Landforms, Rock Types and Structures

Hello everyone, and welcome to a new discussion which is on image interpretation of different geological landforms, rock types and structures and in the previous discussion I mentioned that image interpretation is very important and we just saw one example of image interpretation related with groundwater. Though we will have detailed in discussion on how to do the image interpretations for groundwater, stimulations and basically groundwater exploration and groundwater recharge.

Similarly, here we are going to have interpretations about geological landforms, structures, rock types, which are very useful for not only for geologist or scientists but also for civil engineers. So that is why I am keeping and this discussion here the keys which we have just discussed in how to do image interpretation or the keys of image interpretations all those keys will be used here directly.

We may not mention that I am using this key, but all those keys in combination and depending on the major of what kind of data we are having in front of us, accordingly the interpretation will be done.

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If I see an image which is showing part of India and surrounding countries, what we see the Himalaya and how we are saying that this is a Himalayan mountain chain or system is that because we are realizing that it is having association of white patches which might be snow and ice or glaciers, there are some water bodies, which is in part of Tibet there are water bodies in part of south of Himalaya is arts shape and a lot of this is true color image.

So, lot of greenery is also seen in the plain area which is indogangetic plane and so, when we saw this kind of thing, it becomes very easy to interpret. So, the shape color, tone texture association everything is being used here to identify that this is a Himalaya. So, this is how we start doing the real interpretation so, here what, as you can see that Brahmaputra is also there, then Ganges also flowing there, there are mountains, desert areas are also can be seen.

Without any divide is a divide of vegetation and the central India is having undulating terrain, which you can see where is Himalayan terrain is highly regret than the plateau and that is the Tibetan part is also can be seen there are some lakes are they like Mansarovar and others they can be also the those links can also be seen here in this image. So, using all those keys, which we have just learned in previous discussions, are all being used to interpret.

And this particular name is do it is not a single image, it is a mosaic of several image and that to it has been projected on the globe so that we get that not only the height information but how it is

located on the globe that information is also there. So, we are easily able to identify mountains, we are easily identify planes, Valleys, Rivers, Lakes, Desert areas and just mentioned Glaciers also and so on so forth.

So, just one single image whatever the objects which are present here can we identified very easily here and not only the desert which you are seeing in Indian part and also you are seeing in the northern part here also the desert so, you can identify things very easily.

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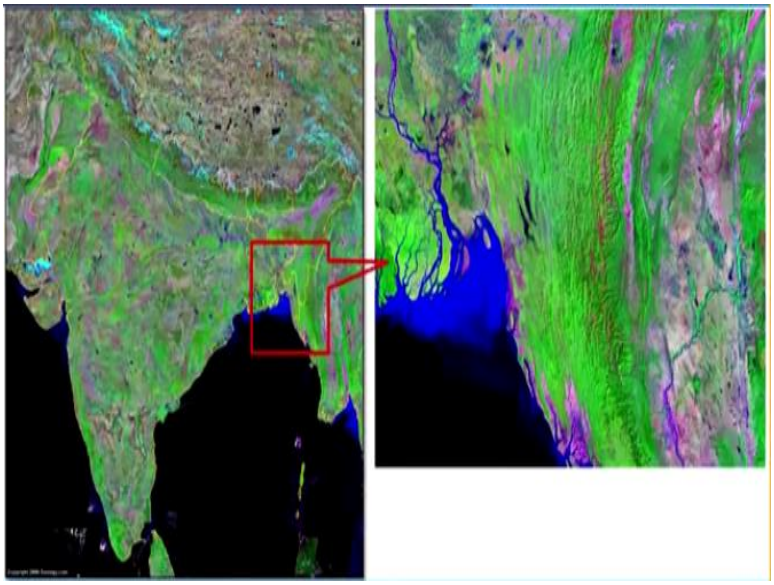

If I go for more finer details now only mainly the India is being shown in this is landsat TM mosaic that is also in true color. So here these glaciated land is being shown in blue color and even you are seeing the sea another parts also generally it is in black color except in the this Sundarban area where you are seeing things are in blue color because of lot of turbidity and that is there so that is bringing not black color in color composites but as a blue color, so blow up on the right side or zoom part of that is also on the right side.

Now we can identify the Delta that is the same Brahmaputra and Ganges are making in the Bay of Bengal so that delta we can identify because we are identifying based on the pattern of the drainage and also the part which we are seeing as having lot of a siltation or turbidity, which is present in the water body initially and also on the right side of the delta we can see several you

know ranges, mountain ranges or geologically we can say these are the folded mountains which we are seeing in the northeast part of the India so, this is how the interpretation can be start.

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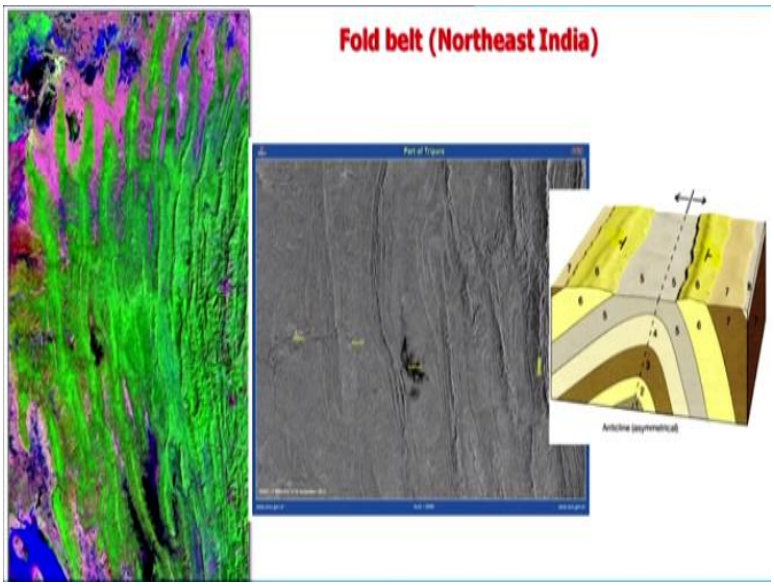

Now, when we see further zoom part of that one then it becomes easier to identify that they say fold belt folded belt area in between 2 you know folds we are sometimes also getting water bodies in it and we are also seeing closers of these folds at different locations in the northern part, when we see the radar image we have already discussed, the radar image this is intensity image or also called power image.

There we can identify these things much more clearly because here the vegetation and other things are not affecting that much and therefore, we can identify it is a part of the proof of Northeast India, we can identify different geological features which are present fold, fold belt, barriers folds are there, their closers are there and of course water bodies the drainage system can also be identified very easily.

So, using such images, we can make interpretations that how they folded part of rocks is appears on the surface, as shown here in this 3D diagram, that they will appear something like this that these dipping on the opposite direction and say anticline fold and also the get feeling about whether it says symmetric anticline or asymmetric anticline. So, interpretations to that level can go and now in this one, we are also visualizing what is beneath these rocks are there?

Beneath these landforms which we are seeing on the satellite images so, we started with the very simple interpretations using those keys which we have discussed in previous lecture and now, we have started interpreting using these images along with of course our geological knowledge and we started interpreting what is beneath the surface in this area and this for individual folds and other things we can identify.

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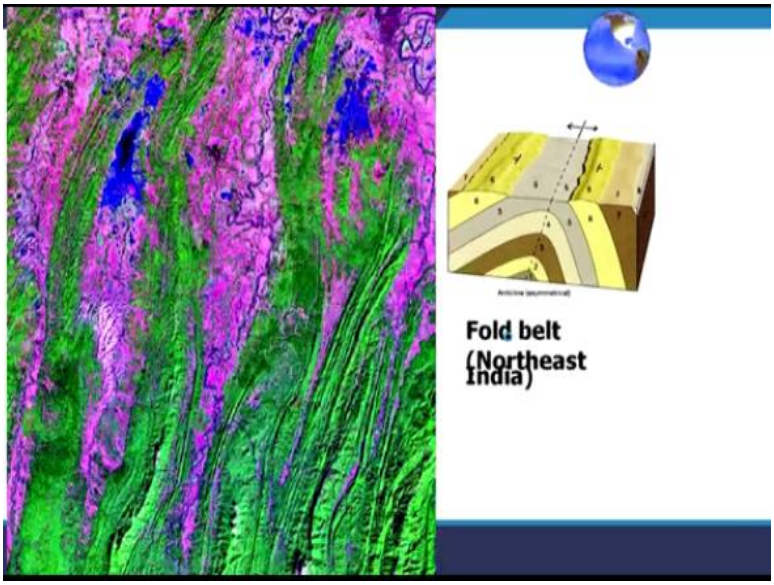

Similarly, here, when we go further, in zoom, zooming part here we can individually see that they are the closers which are seen here, here also the closers are there and fold belt again Northeast India and you know anticlinal asymmetric fold is there.

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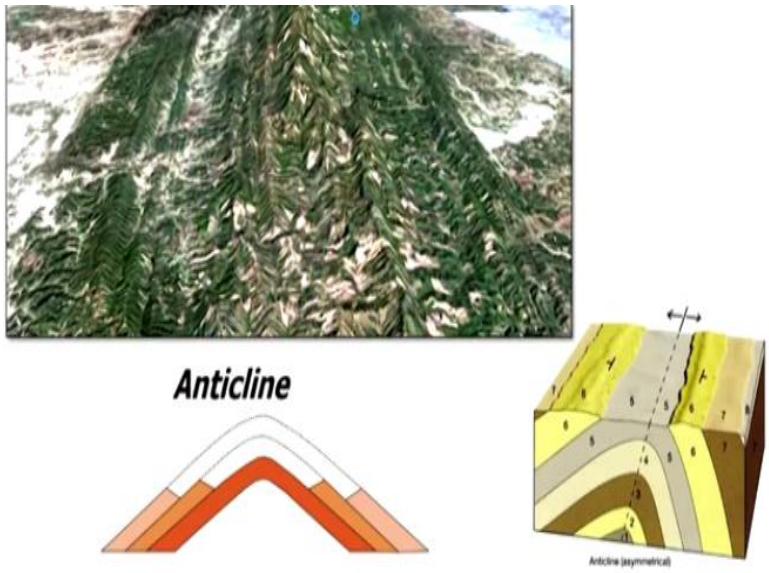

Sometimes you know, what we are seeing only the top part here not the beneath. So, interpreting this part using a 3D perspective view that is possible very easily in Google Earth, then we can make the interpretation that they say anticline only and only that parts of these 2 limbs of that anticline are seen the top part that is the hinge region is has got eroded, we are seeing only these 2 limbs and they are dipping in opposite direction.

And therefore, has to be a fold so, we are getting subsurface information just looking the surface information. Similarly, if I am seeing in the same area because if there is anticline there might be also possibility of getting a syncline visit, just oppose it in that means so here what we are seeing that.

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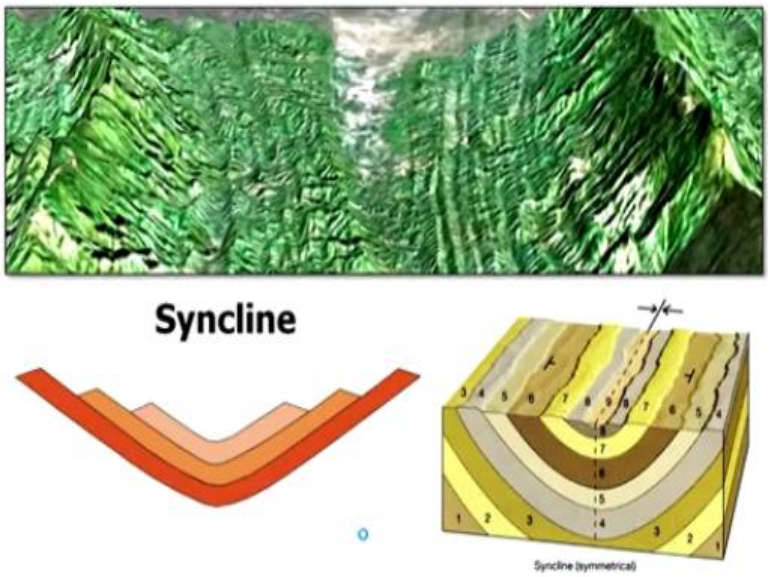

On the top we are being we may not be seeing the core, but when these rocks are or beds are dipping towards each other and we are seeing a kind of depression in between, it becomes easier to identify that this is a syncline in fold that we can see in 3D perspective much easier, even without having if we do not have the 3D perspective is still such interpretations to some extent can be made easily so, that kind of interpretation can be done.

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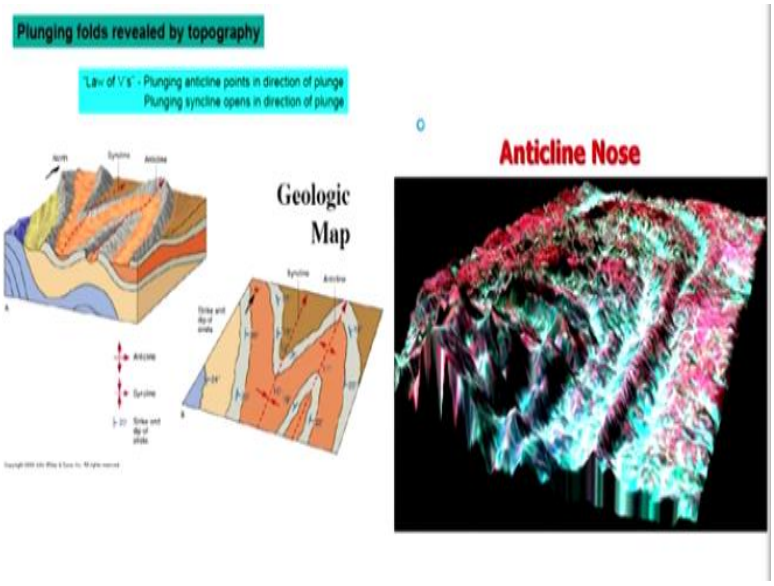

If we find closers as here shown anticline nose is there, then we can see here the many of these slides have been given to me by one of my friends and who is very good on interpretation. So, I am using his slides here and I would like to acknowledge the Jesothidas for this and his

interpretation is skill set through him I have also learned these interpretations especially of this part of the country so, the plunging.

So, we have identified and anticline we have identify syncline and closers now, we are seeing the you know these plunges. So, there that because the closers are there in the images so, these images can also tell us that they are the anticline nose is there that it means the closer of the fold is also very clearly visible so, if I when I see the image I might be seeing something like this. So, when I see the bed pattern on the surface is like this, these closers will have this kind of expression as shown here, so this is how we do interpretations.

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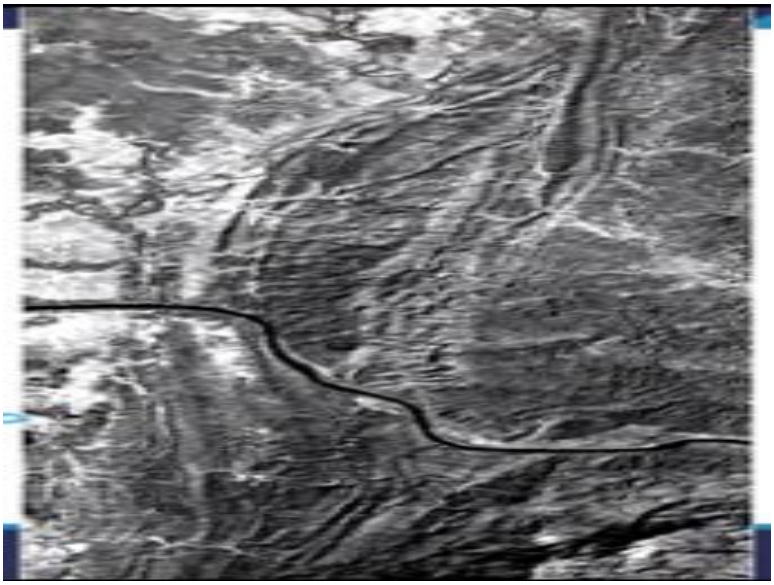

If we look for the same area again radar image, it gives us a much more detailed information about the topography or you know, these landforms and interpretations can be done, we can create a merge product of optical images along with radar images and can do much more better reliable interpretations.

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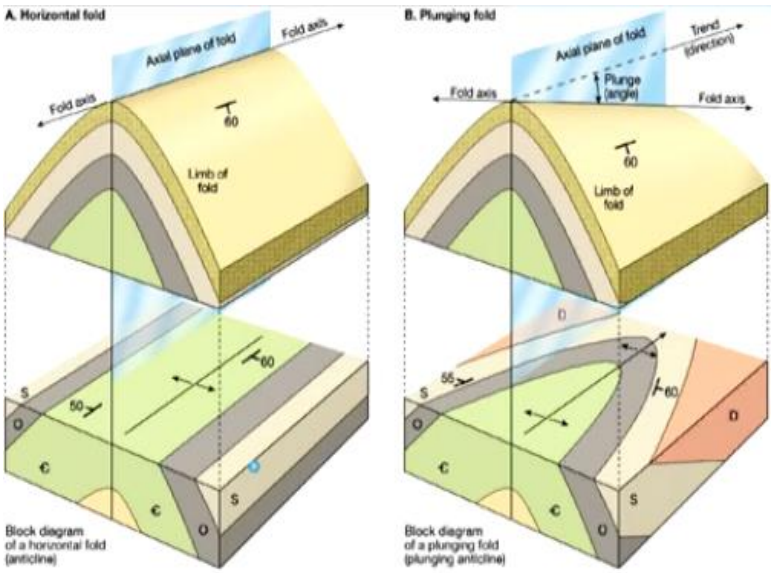

So we can do interpretations about anticline, syncline we can do the interpretations about plunging folds through identifying closers.

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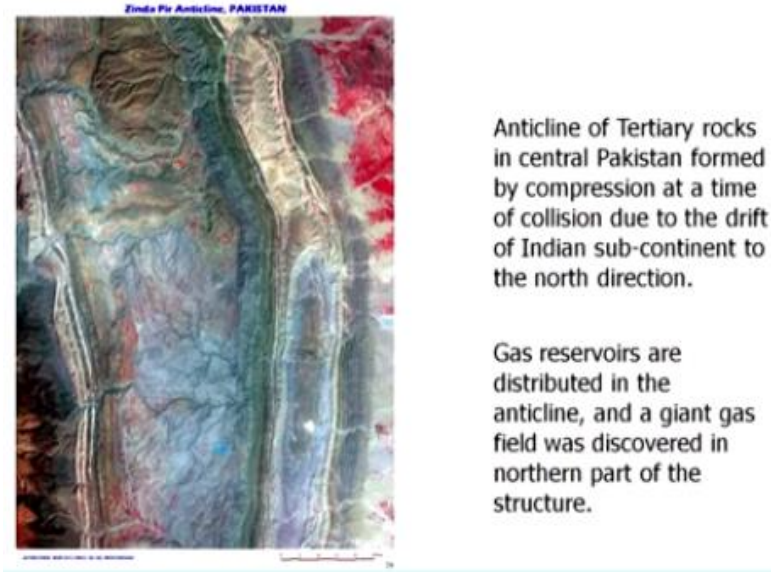

And many such interpretations can be done, now, let us take another example of an area where vegetation is not a problem and still we get and very good interpretation about images this is the zinda anticline in located in Pakistan and we see very clearly there is a these folds are visible here very clearly these folds can be seen in the central Pakistan which is formed because of compression of collision due to the drift of Indian subcontinent to the north direction.

And those anticlines have created now importance of these anticlines because they are the Gas reservoirs and that is why interpretations of such images and understanding such as structures are very important.

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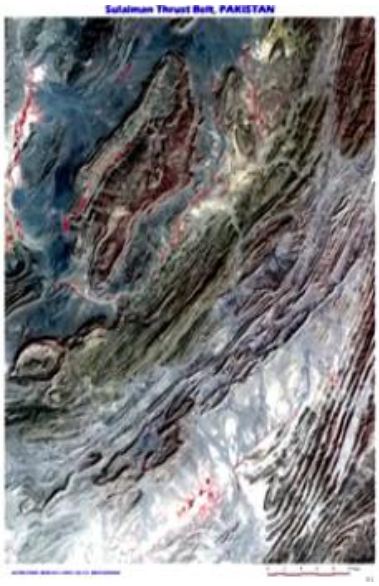

Fold system and Thrust belt in Central Pakistan.

One of the major natural gas production areas in Pakistan.

Similarly, we are also seeing in the Sulaiman thrust belt again and lot of landforms features fold thrust falls all those can be seen very easily because these areas are having minimum vegetation and when the sky is clear images are taken, then interpretations of such a areas and becomes very, very easy. This area is one of the major and natural gas production areas in Pakistan so, though on surface we are not seeing any evidences of these gas or while desert.

Of course these textures tell that there are possibilities. So, based on that, further explosions are required and that has been done these closers again you are seeing the folded belt and other things on there.

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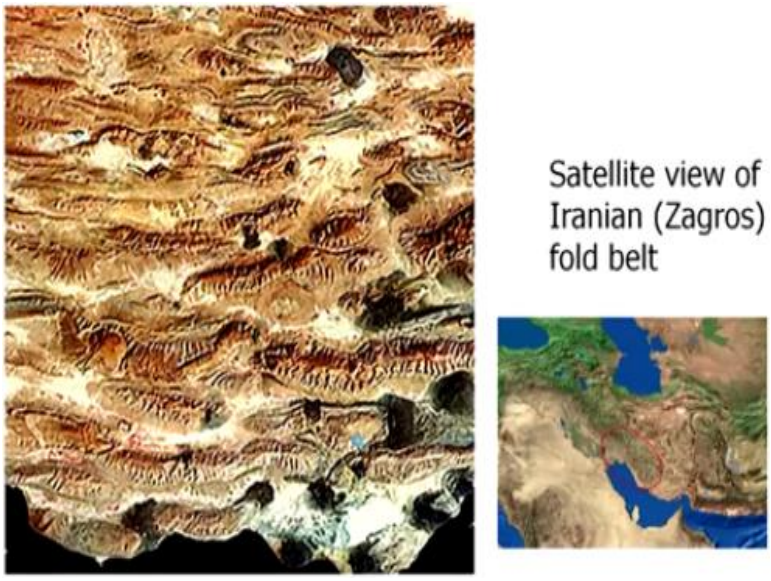

This is another very famous satellite image from Zagros mountain of Iran that is a fold belt located here in this you know southwest or south of Iran. There you can see that these folds are there, their closers are there, very clearly and again is also having very less vegetation. So, it becomes much easier to make interpretations.

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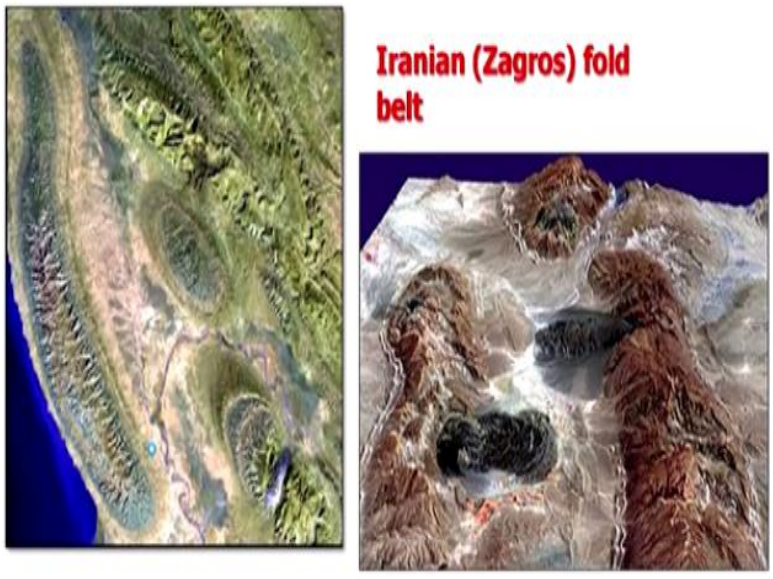

Again from the same Zagros Mountain fold belt, having some other high resolution satellite images, these fold belts and dunes and other structures can be identified very easily from these images. While doing these interpretations of course we are using I am repeating again we are using these keys here.

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And this is a rigid structure of Mauritania see the circular structure huge eye of the earth in the Sahara desert and this is a dune structure and that has been formed by the intrusive rocks which have come from an interior of earth and they have created such a structure. So these because of the, you know the pattern and association and of course colors and another thing we can identify.

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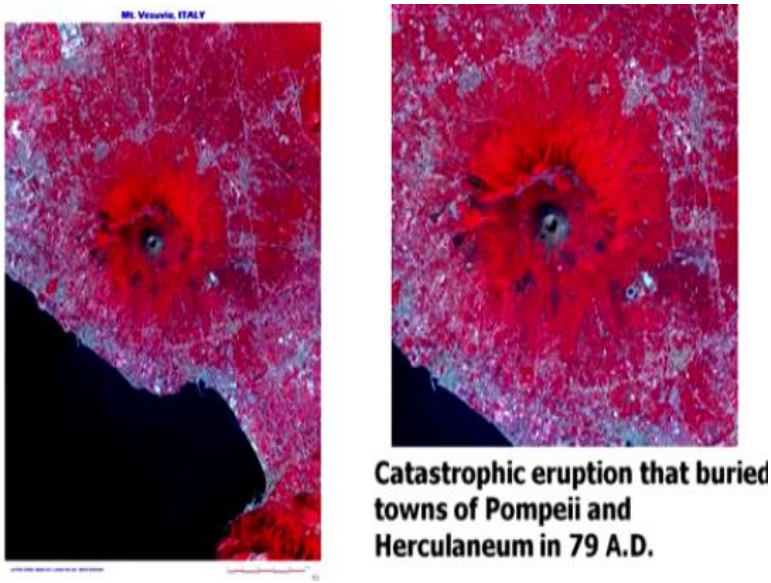

And that it is a dune structure in, if we see a volcano, this is how it should be and the zoom part we can see the volcanic neck and that eruption has occurred this is folds color composite and but it occurred you know way back in 79 A.D and it has brought a lot of fertile you know rock so soil developed good soil and therefore, you are seeing in false color composite and good growth of vegetation or forest along this but it still we can identify, that is a volcano they are.

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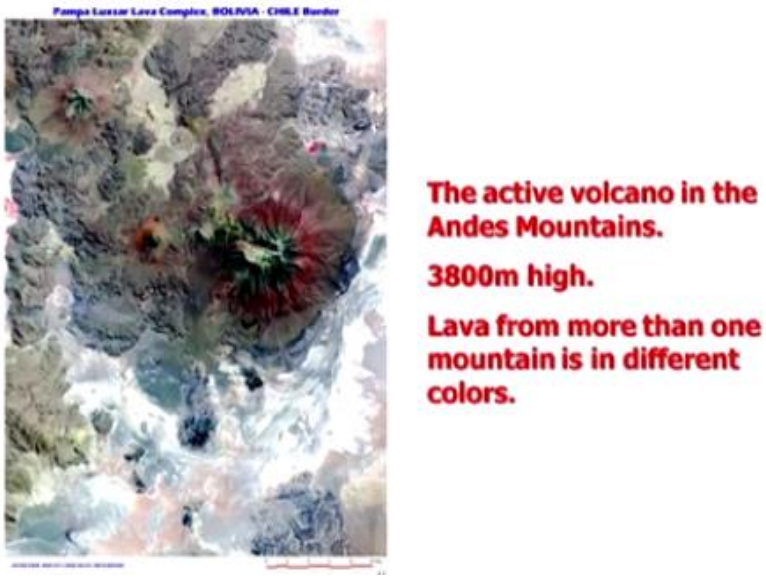

And they are similarly, if we see active volcano, then this is what we will be seeing different and not yet growth of vegetation but different Lava flows can be identified, and volcanic neck and other things can be identified very easily, this is from the Bolivia Chile border area.

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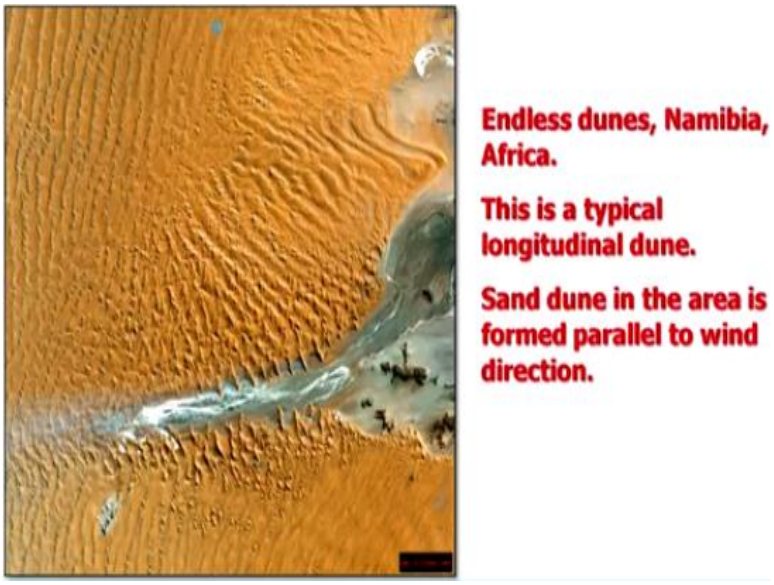

So, all these kind of objects if we see an image of a desert then dunes and what kind of dune this can be identified, you have this image belongs to the Namibia of Africa and what we are seeing there are different types of dunes are there in desert condition. So this dunes which we are seeing are the longitudinal dunes which you can also identify running for kilometers together long and

dunes running and we can also identify the, you know, prevalent wind direction that might be like this so, using these information,

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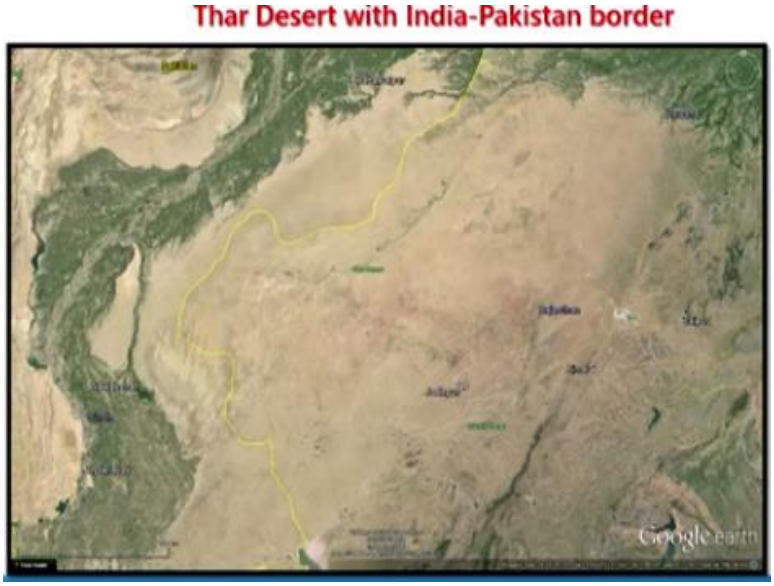

We can also have a lot of information if we go for our own Thar desert and though we do not have that resolution image, but it is still these dunes longitudinal dunes can be identified on the image between border of India and Pakistan. Because generally desert areas are very flat, only dunes are creating undulations, divided of completely almost completely divided of vegetation this though you say Google earth image it is in true color.

But nonetheless you do not identify and you do not have water bodies either and hardly you would see denied system or anything. So it becomes much easier to using these keys to identify whether it is a desert area or not and wherever you are having a water body and like here, in part of Pakistan, you are seeing a lot of growth of vegetation agriculture practices going on and that is what you see here. In other parts of India, of course, the vegetation growth is there the each pattern and that you also see.

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Dune say, on the ground, they look like this So, there are undulations, but when these undulations are have only few meters, so, in the images you may not get that kind of effect of shadow nonetheless if it is a high resolution satellite images or desert you will see shadows as well and then you can identify different types of dunes and based on their location and shape one can identify prevalent wind direction as well now, I am also having one more image is the Great Dyke, you know, very world famous Dyke,

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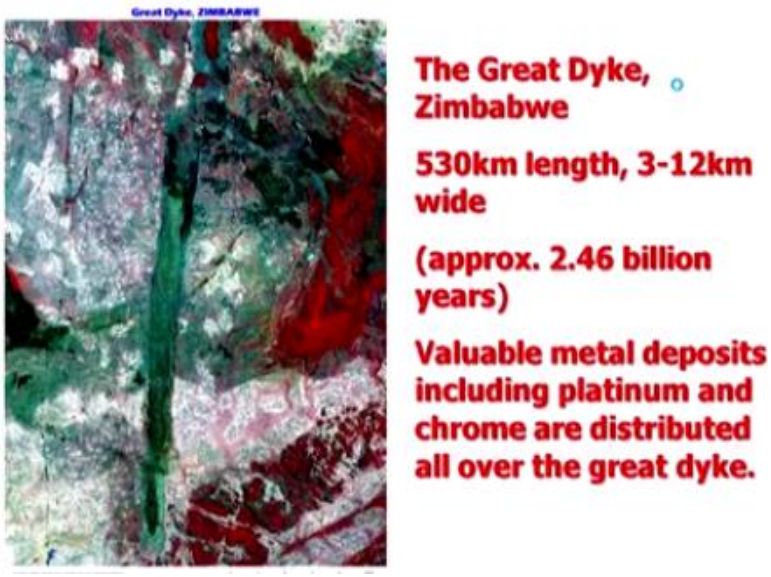

A geological feature of Zimbabwe where it is running of 530 kilometer long and 3 to 12 kilometer wide this dyke which you are seeing in the center of this image and, of course age and other things cannot be determined on the images but this information is coming from elsewhere

that it is 2.46 billion years old but the important point here if we can identify such dykes or very old dykes.

There are chances of getting mineral deposits and valuable mineral deposits have been identified have been searched in this part of the world, in the Zimbabwe. So, these structures are important we have seen folds anticlinal folds and other things, where oil and natural gas is being used or exploited. Similarly, we are seeing a dyke, through image interpretations of course, we are seeing, but, these are these can be valuable and metal deposits or old deposit areas which one can use. So depending on where it is located, what is the association and what is the color and other things we can identify.

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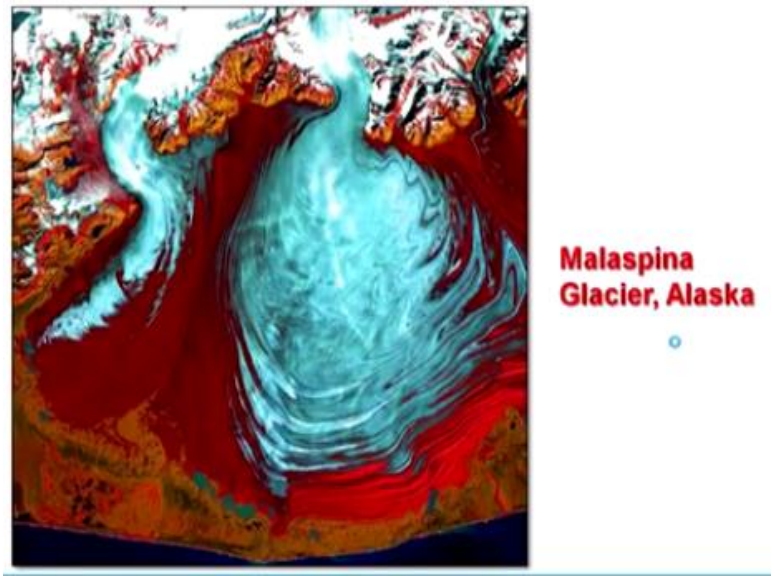

This is a Glacier very famous Glaciers, Malaspina Glacier of Alaska and see the glacier you can identify you can also identify the different marines which are along the glacier some other glaciers is fin shaped glaciers, but there are other glaciers are also there. So, you can buy while doing image interpretations and having knowledge of glaciated terrain lot of things can be extracted from the image.

So, as a also mentioned earlier that a picture tells 1000 words and whereas, a satellite image can tell 10,000 words only it requires a good scale of image interpretation.

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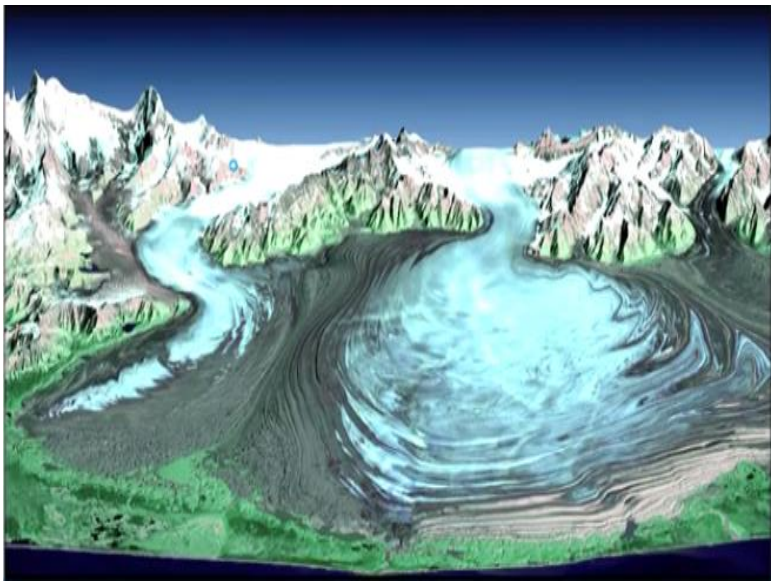

Then lot of things can be extracted from the image this is the 3D perspective view of the Malaspina Alaska glacier which we have seen.

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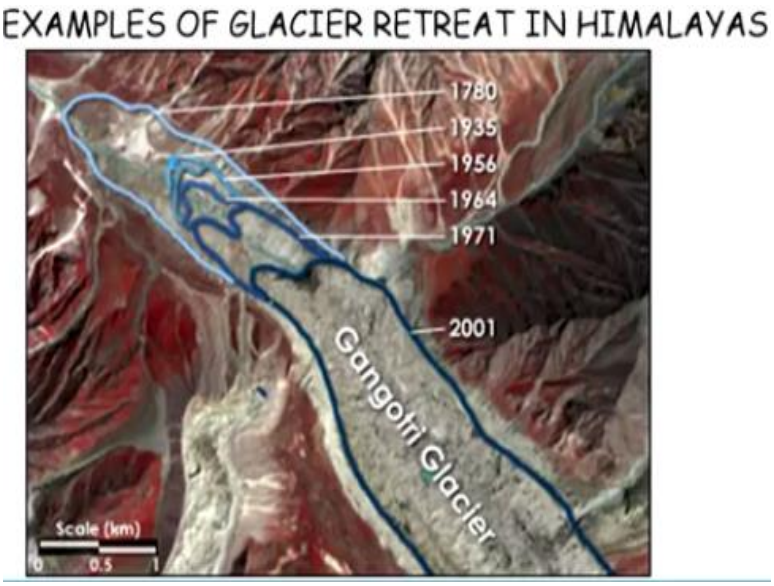

Sometimes, we use the successive data or data from other sources. We can put on the same image or on the boundary and we can identify how things have changed that is basically the change detection yesterday. So in 1780s, of course, we did not have our satellite images, only these started coming after 1972. But, these were based on 2 proceeds or a field surveys and other things so, people have identified that there is a glacier was here.

And now it has retreated and now you are seeing the snout of that place here so, the images can also help. So, if we can have images, this is 1964 this information is also coming from aerial photograph and all these things can be put together and the chain detection is studies and can be found how things have changed what is the rate and other thing, so otherwise it is simple image of a glaciated part of Himalaya.

But if we start using the these images along with some other datasets, as I also mentioned related with groundwater, then lot of interpretations can be done that this and this is what exactly is done in the GIS also.

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Landsat image of Betsiboka River, north-central Madagascar.

Now, there is also another image another very good example of this image that you are having an image of Betsiboka River in north-central Madagascar and as you can see that beautiful land form is being formed and finally, this river meets the sea also. So, different colors are telling the turbidity or a concentration of particles, size, maybe the size of particles, the growth of vegetation, the pattern and everything is so clearly visible in these images.

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This is again part of India and these are our Indian River, Ganges and, and this is Ganges and what we are seeing the meanders oxbow lakes so, they are all associated with the images we, with the river system which is flowing in a almost flatter in like indo gangetic plane. So, these when river is having then these structures will be they paleo channels oxbow and these meanders can be seen very clearly in the images.

These are the very good if somebody is interpreting these images then these are the paleo channels or these oxbow lakes are very good source of water. So, one can identify where easily where these structures are there like here I am seeing no water body but still the form landform is being is visible, and therefore, it becomes easier to identify or guess that groundwater availability is going to be very high in such areas.

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Similarly, this is braided channel of Brahmaputra what you are seeing here, you can guess about the erosional conditions in upstream area which is supplying use sediment into the Brahmaputra of the river and that is why these things. So, sometimes in the images what you see that is important, but how it is being formed, what is the what is happening at the source of this where from the water is coming in the river can also be estimated or guessed or an interpreted that probably such things are happening that is why I am seeing this thing, this is world famous alluvial fan which we are seeing

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This is a Google earth image and this say, and this river, the Kosi river which starts from Nepal, and then which enters in the Northern Bihar and then ultimately meets a Ganges and what you

seeing a fin shaped land form which is called alluvial fan. Earlier this river used to flow like this and in about 150 years it has migrated slowly towards the east and they every year this river is also bringing floods in the plains of Bihar and we can see the paleo channels.

We can see other landforms associated with fluvial systems and we can also see that which are the inundated areas in this area which are and they are often Northern Bihar. So, a lot of interpretations can be done and should be done. Whatever is being seen in the images should be understood and whatever is not being seen. But maybe the source of that change in landforms or creation of that landform should be, for example, if I start interpreting, then why they say I have to have some background knowledge.

Then only that kind of interpretation can come, but let me just very briefly because the use sediment supply is coming from in this Kosi river from Nepal might be due to a lot of human activities, load of constructions of roads or buildings and other things and deforestation. And when torrential rain is there that brings lot that creates a lot of erosion in the part of Himalaya or the Kosi basin.

That brings a lot of sediments in the river and as soon as the sediment enters in the plain area, the river loses the energy and it start depositing those sediments in this plain area and therefore and such structure or such landforms of such a magnitude of a huge scale article. This is word biggest alluvial fan, which can be easily identified in satellite images and it is because of a lot of sediment supplies.

So, tomorrow if by some means by some measures, if sediments supply reduce significantly, probably you might not be seeing such a devastating behavior of this river every year during monsoon season. So, what my point was here that what you see in the images is fine, you can identify, but one should go beyond that, what you are not what you are seeing one should of go what you are not see and try to interpret that that is only possible if you are having knowledge of that area and for what you are going to make interpretations accordingly.

If I look for this is a same image for civil engineer point of view, then if a bridge has to be constructed here. The site has to be located across this, then one need to find out where the migration of this river is minimum and channel is narrow. So, the same image can be interpreted by a civil engineer for different purpose and the same image, same data set can be interpreted by a geologist or our scientists completely differently and the same image can be interpreted by agriculture scientists completely differently.

A soil scientist differently, a forester a you know, those who are interested for forest or green management, they can look that or interpret this image differently. So, this is what and that is why we can get 10,000 words from an image because it is a generic data and the same image can be applied or used by various people for various purposes, and this is what we do in satellite data image interpretation, so this brings to end of this discussion. Thank you very much.