Fluid Inclusion in Minerals: Principles, Methodology, Practice and Application

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Lecture- 10
Fluid Inclusion Petrography

Welcome to today's lecture on Fluid Inclusions in Minerals and this is a concluding part of the second module of the lecture series, in which we plan to get also introduced into the principles of microthermometry and will be discussing which one of the very very important and crucial aspect of fluid inclusion study that is Fluid Inclusion Petrography.

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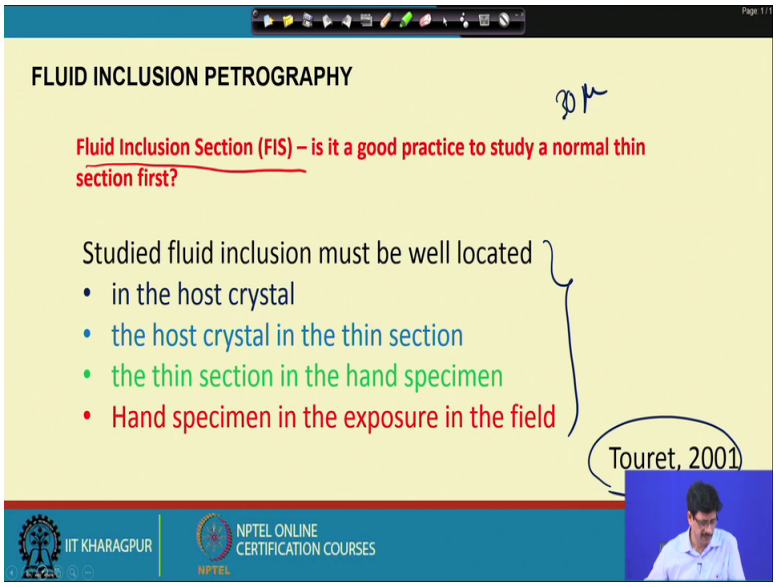

As you will see when they should be more of it as will be going through many of the case studies on various situations like over from ore forming environment metamorphic environment or deformation and so on and so forth.

So, we will be continuously reiterating many of the aspects of many of the situations, in which we will see that the fluid inclusion petrography actually constitutes the backbone of the fluid inclusion study. And to be honest enough it will be difficult to really tell that that whatever could be discussed here, there to be many more things to it and it will possibly cover a whole course to discuss about fluid inclusion petrography. Taking many of the accessible situations, many of the uncertainties, many of the curiosities, questions

that all arise during the study of fluid inclusions. Again we will try to put things in very simple manner.

So, if we talk about fluid inclusion petrography. So, let us say that it is anything like very akin to or similar to what we know as petrography of rock. But before that let us be reminded of the fact that we study fluid inclusions in sections, which we call them the w which are the (Refer Time: 02:12) thin sections we call them as vapors or there can be called as fluid inclusion sections. There are fluid inclusion section means the vapor that we have made about maximum up to 300 micron in thickness and depending on the nature of the sample sometimes we have to make it less thicker or a little thinner than 300 microns depending on the clarity, visibility of the host mineral that we are considering.

In any case a fluid inclusion section is the thing that we begin with, but then sometimes it would be a good practice to also have to study that particular depending on the problem that we are addressing; either as an ore specimen or a rock is always good practice to study a normal thin section and then see whether in normal thin, because normal thin sections of 30 micron in thickness. It is also still possible to observe fluid inclusions in such kind of thin sections, which will give us some guideline that we well which are the kind of samples, which will prepare the fluid inclusion sections can be prepared. So, that you could see some better inclusion there; or better population of inclusions in those in those samples.

So, it possibly would be a good practice, but then if the problem has been defined that we are going to study fluid, then we can also under certain circumstances since for example, we are going and looking at quartz veins of different generations and we sample the quartz grain. And we need to study fluid inclusion quartz grain and it possibly would be a situation where you can directly can prepare fluid (Refer Time: 04:16) section, but in most other cases it would possibly be wise to look at the thin section and be aware about the occurrence of fluid inclusions in those sections.

Now in the beginning if you remember we discussed that, fluid inclusion study actually the beginning is made very much during the time that we are we are doing the field work. We have defined the problem that we are trying to address the issue of original evolution of the fluid any environment.

So, it is one of the experts in fluid inclusions that touret. So, we say that studied fluid inclusion must be well located. So, well located in the host crystal; the host crystal in the thin section; thin section in the hand specimen and hands specimen in exposure. So, this itself tells us the importance of a very well planned field work, and a very well recorded observations in the field because in many situations, we will see different generations of quartz veins occupying in different sets of fractures or any kind of structural with planes or different generations of mineralization mineralizing veins. And then those kind of field those fieldwork have to be really done in the systematic way, keeping in mind that will be studying fluid inclusions in them.

So, this is this is a good idea to begin with when we our study of fluid inclusion petrography.

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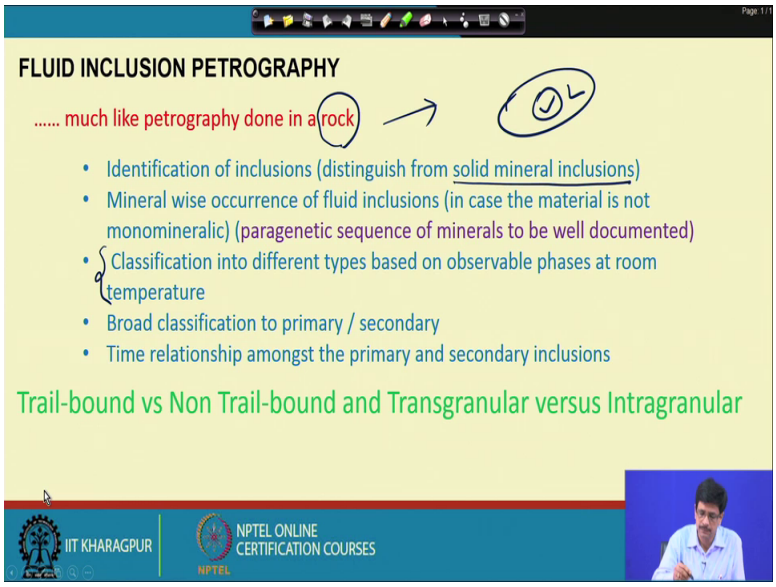

So, it is much like petrography done in a rock. When we do a petrography why I say that much like a petrography done in a rock because in a rock if you make a thin section our first objective is to identify all the minerals.

So, whenever we do a normal petrography, petrography of a rock the first thing that we do is that we identify all the minerals that represent in a rock; and then the next job at hand is to understand the time relationship between the different minerals and this the if the this exercise at hand is exactly that we must be in a position to identify the inclusions in the minerals. When there is when a beginner starts to study fluid inclusions, it

sometimes becomes difficult for him or her to even distinguish a fluid inclusion from a mineral inclusion and this is a very very basic part of it that a fluid inclusion and a mineral inclusion must be distinguished.

So, mineral inclusion in any case when we go to a look at it have magnification, see the interference colors with an (Refer Time: 07:14) and it generally will be more distinct in that stage. Whereas, a fluid inclusion as I as we discussed, it is it will be distinctly different or it will be optically very distinct within the host mineral, and also its typical whenever the present in the typical biphase like a liquid plus vapor.

A mineral will never occur in that kind of a form, and for a 2 liquid plus vapor. So, only the scenario in which a mineral inclusion and fluid inclusion could possibly be confused only in the case of the monophase inclusion, which is a little bit of a if not rare, but infrequent.

So, the inclusion subtype identified. So, the inclusion some of the inclusion which with by this time we have seen photographs of so many inclusions, we see that there can be variable identified. A liquid vapor biphase inclusion could very well identify or if there is a solid crystalline with inclusion cavity can be identified, and even though it is not likely to display exactly the optical characteristics by in a (Refer Time: 08:36) nickel because of the very small quantity that is there or the transparency in the inclusion host, but still its sometimes it is possible.

And then so, when we are studying a fluid inclusion section, by the time will finish the studying the fluid inclusion section it is expected that we should have identified the all the types of inclusion that is occurring in that particular sample particular wafer and then the mineral wise occurrence of fluid inclusions means if where not studying a material, which is monomineralic like it quartz vein sometimes we study fluid inclusion say metamorphic rock consisting of the many of the metamorphic minerals like (Refer Time: 09:18) clan piracy or sometimes even cordierite or other scapolite or some other mineral in which we can see fluid inclusions. There it is very essential that we make a one to one correspondence between the inclusions and their host.

If the if its polymineralic aggregate, then the paragenetic sequence of the minerals have to be well documented; whether it is a suppose for example, live we are studying an ore specimen in which there is quartz there is calcite there is (Refer Time: 09:39) in all these

3 minerals host from fluid inclusions, and their paragenetic sequence should be very well established; so, that the fluid inclusion characteristic can be correlated and can be compared to see what exactly is the path of evolution of the fluid. So, the classification it different types based on observable phases at room temperature, and the broad classification to primary and secondary.

Now, here the situation which needs to be closely looked into is the classification into different types. Generally what happens that, there is a practice that its inevitable is invariably true that if we look at the host minerals from wide diversity of geological situations, it would be hardly original rare to the to see only one type; that means, for example, only liquid plus vapor biphase inclusion are only a your carbonic inclusion, it will always the rather rule other than exception that a host mineral will have a varied types of inclusion.

Send it is essential to come before we conclude the petrography, fluid inclusion petrography that you classify them into different types; like type 1, type 2, type 3 and type 4 based on what their phase room temperature phases simply as an composition is. In this context it should be it would be important so, for example, we are seeing aqueous biphase inclusions say for example, we were seeing aqueous biphase inclusions.

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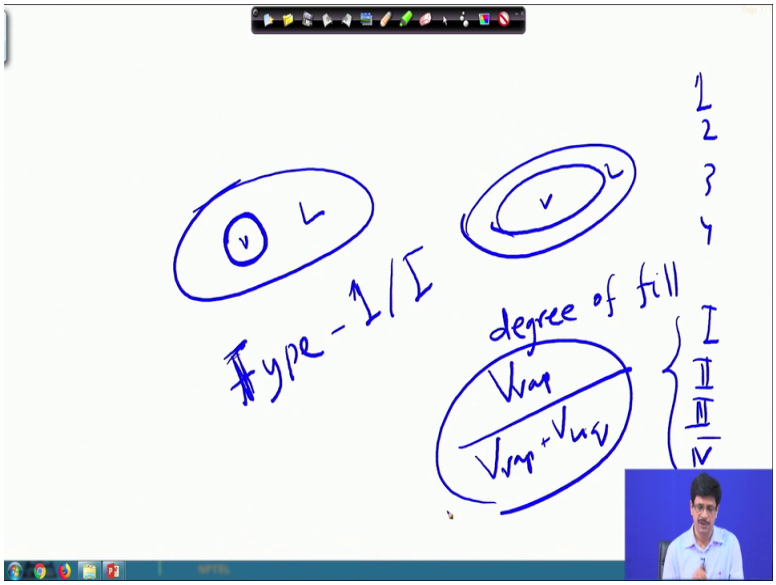

I will suppose this is one inclusion and here there is another inclusion, where these 2 inclusions are visibly different proportion of liquid and vapor.

Previously are many of the workers even preferred to measure because we know that there is a big uncertainty they are, we do not see the third dimension. So, that is the reason why we cannot immediately jump into the conclusion as to what could be the so, and this inclusions generally the situation is described with a with a parameter which is called the degree of fill; which is essentially the volume of the vapor divided by the total volume of the inclusion or I would say the volume of vapor plus volume of liquid. Since we have already seen inclusions of the very wide diversity in their shapes and sizes in at least shape, and what would be visibly be seeing as variable this degree of fill or the vapor by vapor plus liquid ratio.

It is not wise to classify this suppose these are the inclusions which are occurring, and suppose we follow a hierarchy, it is always a good practice because in any particular host that we are studying the fluid inclusion, when we see say n number of types of inclusions 4 type 4 type five types or six types. All of them could it is not possible that all will be occurring in equal population, there will be definitely difference in some particular type would be more dominant or occurring in greater population then others. So, it to be easier to name then the first time which is the most dominant type could always go as a type 1. Let us say for example, we see that in a host mineral there are aqueous biphase inclusions in this L plus v you can identify them the aqueous biphase inclusions.

So, you could there possibly the dominant type. So, we say that they are the type 1, either we could put think we could put as a roman one or numerical one like the type 1 or type 1 sometimes they putting a type 1 2 3 4 or you can even say type 1 2 3 4 many a times it is observed that this is more used by fluid inclusion workers. So, suppose that this becomes a this is our type 1 inclusion is liquid plus vapor biphase inclusion, it would not be good practice to further classify them into type 1 a or one b by saying that we are visibly saying one vapor to be smaller and the other vapor to be larger. Because as we will see later this particular ratio which is your vapor by vapor plus liquid ratio is very well calculable, once we do the micro thermometric experiments.

And one the another important point also to remember is that, by making a lot of further subclasses classification only complicates the picture and at the end of it we are going to represent the fluid inclusion data with respect to their inclusion different inclusion types and their max thermometric behavior. Having said that there are situations in which some

very exotic type or some very special type of inclusions may be occurring, they may possibly be documented and can be assigned a type.

So, the classification into different types based on their observable phases at room temperature is a practice which is followed and the broad.

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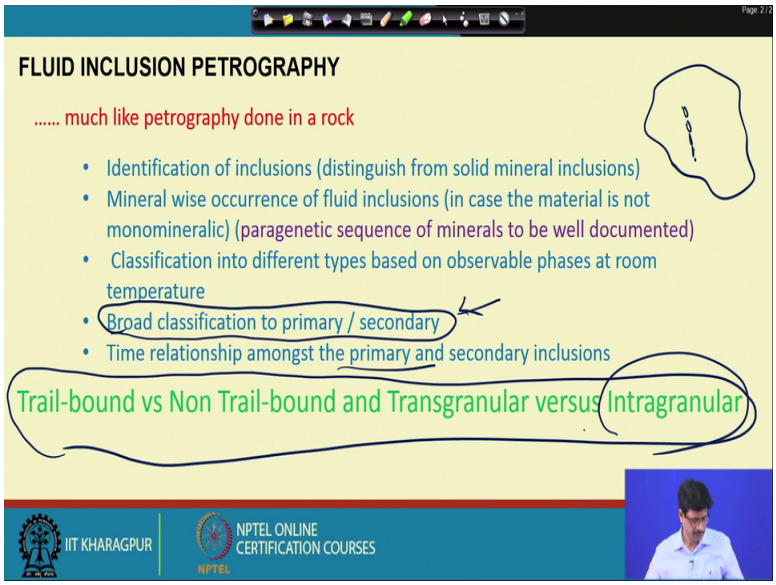

So, now they measure or the most important aspect of fluid inclusion study with generally is formed with lot of un uncertainty or lots of question mark sometimes is put, that the broad classification into primary and secondary. And when we know that primary inclusions are the ones which supposed to be the ones which are entrapment during and entrapped during the primary growth of the host mineral and the secondary inclusions are the ones which are trapped anytime after words in response to fluid activity in a week a plains in fracture planes, which generally result in the ceiling of the crack and then their present is trail bound inclusions.

And one thing also to be kept in mind these processes also do not also sometimes happen at very greater pressure temperature conditions, and we can see that there a there a phenomena which is which is not just very surficial and so, this broad classification to primary secondary is the one of the challenging jobs in fluid inclusion petrography. Now what boils down to the fact then we see them then we can only possibly.

So, the time relation amongst the primary and secondary even it might so happened that, we may see primary inclusion, but they may be of different generations. In same quartz there may be the quartz could have grown in different stages and there are primary inclusions. See if you are defining the primary inclusions to be the once which occur in a random 3 dimensional network without being aligned on any trail or any hill crack and then what actually sometimes becomes the practical thing when somebody is doing a fluid inclusion petrography, then to look for or to describe the inclusions whether they are trail bound or non trail bound. And if they are trail bound whether they are present in transgranular hill cracks or intragranular hill cracks.

As we know that the ones which are present in something like if this happens to be the grain of quartz, and there is there is a there are inclusions which are just trapped in this kind of a trail, and this trail is not transgressing into this adjacent grain is terminating within the grain itself. And we have labeled them a designated them with a term call pseudo secondary. So, essentially pseudo secondary means primary is they look like secondary inclusion, but there not secondary inclusion so. The fact remains that during the petrography, we can only describe them and when there is whether they are trail bound or non trail bound.

If they are trail bound then if the trails are transgressing through many grains in their host mineral, it is almost the entire section entire 5 years that we study, we could still trace the hill crack.

So, it is always; so, these are the way that we can go on describing, but it is a fact that each. So, fluid inclusion petrography is the backbone of the fluid inclusion study, before we go for fluid inclusion micro thermometry. It is expected that the fluid inclusion petrography should have been done very meticulously.

But the fact remains that many a times, even some of the inclusions which could have been wrongly identified which happens in mostly the cases of aqueous carbonic inclusion where an aqueous carbonic inclusion by virtue of its irregular geometry, may be wrongly classified as a aqueous biphase. But only when we take them to the heating freezing stage and do the and lower the temperature, then sometime we find that well what was essentially.

So, those kind of corrections of course, has to be made, and they do not hamper the work of the do not affect the work in many in any serious way because finally, when the rater been presented they are being presented as belonging to that particular class.

So, we will see what exactly a fluid inclusion section is, but the fact remains that all our description will be based on this kind of parameters.

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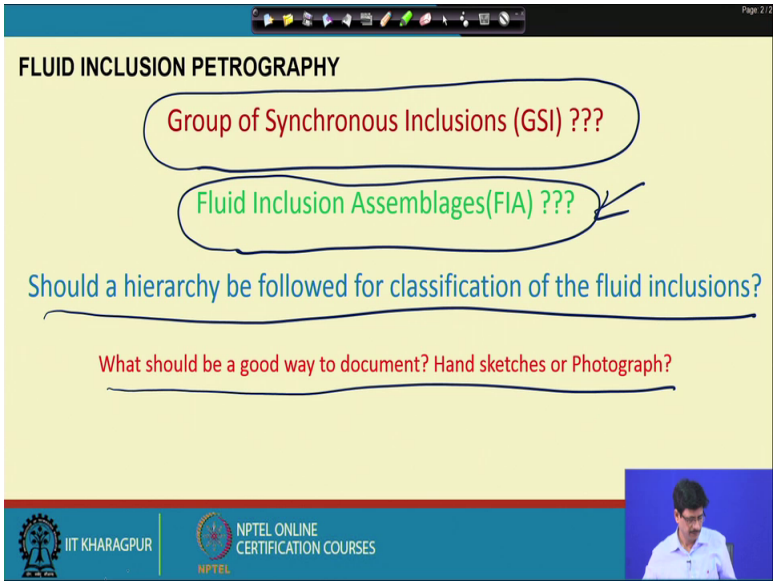

So, as far as the fluid inclusion petrography is concern, there has been many ideas that have been proposed by many different workers experts or who have the proponents or pioneer workers in the field. There was a concept which was given by jacks turret as a group of synchronous inclusions means is. If you are as we as we all know that inclusions which will be which were seen in a 300 micron thick of fluid inclusion section, and will be getting focused at different depths in terms of tens of microns when we lower or raise the microscope stage.

So, different planes get focused contumely fluid inclusions, and there was a possibility which has raise that any of these group of inclusion which are actually being observed as on occurring on the same plane and not following any of the trails could possibly be trapped at the same time and synchronous to each other and it could be possibly mapped.

On a if you if we think that we are taking a taking this kind of a section fluid inclusion section, and we can always put the positions of such kind of individual inclusions and

label them as per the micro thermometric response. Now, but we know that experiences told that it is not always possible; even if there are two inclusion which have occurring the same vein of the host mineral, not being trail bound that may not also be trapped at the same time.

So, that is why we will go into the details of discussion in when we keep pick up the respective individual case studies. Rather the concept of fluid inclusion assembly is a little bit more practicable and is a more realistic way of doing a fluid inclusion petrography in describing the inclusions means. In the same field of view when I am not seeing the inclusion all of the same type for example, I have seen inclusions in my samples where there are aqueous biphase inclusions, where there are aqueous polyphase inclusions.

Not considering the very special type of polyphase inclusion, which are the where the dotted crystal is a is a accidently trapped crystal rather than actually precipitating from the fluid. This also we will elaborate it later for the time being, that is thing that in a particular field of view or in a particular host mineral when we are changing the field of view, we see many different types of inclusions.

And they may be occurring on the same plane. So, it is always better to describe them in terms of fluid inclusion assemblies that what are the fluid inclusion types that I am seeing in my sample. Hierarchy that I am talking about the following it classification of fluid inclusion says in terms of actually population the most populous type should be given the first typing in my section.

If it happens to be the aqueous carbonic type to be the most dominant types so, it will it be I will put them is a type 1 as aqueous carbonic and aqueous biphase may be occurring a less number and so on. And also one of the another point during the fluid inclusion petrography which should also remember, say aqueous biphase inclusions they are occurring both has primary; that means, occurring as part of the random freedom assailant that work and also occurring as trail bound. It may not be a very good practice to say that well type 1 is primary and type 2 is secondary it should be avoided because type 1 inclusions which are when depending on depending on the nature of the problem.

Suppose I am only interested in sampling the primary fluid, and I am using the primary fluid inclusion aqueous biphase inclusion, but there are secondary hill cracks in which

the single aqueous biphase inclusions are there. It is possibly good to describe that these inclusion occur as both primary and secondary, and then depending on the my plan of my fluid inclusion micro thermometry, I can do thermometry on both of both this primary in the secondary type and can present them in different ways just to distinguish them whether the fluid that I am sampling is same or different.

Well. So, these are some of the very general preliminary ideas of such a very vast and pretty complicated topic, which is fluid inclusion petrography. Sometimes it was suggested that to a documentary fluid inclusion petrography in well did well may well done hand sketches written when sketch of the fluid inclusion the way they are occurring. But to my belief at the present time with the very good quality high resolution camera and the m s compilation and (Refer Time: 25:12) kind of software that we have. It is absolutely easy to even represent a whole thin fluid inclusion section in terms of the occurrence of the different inclusions in different parts of it, and can have a full idea.

Because it actually will be more it will be reliable it will be anyone can see it and believe it, rather than actually going on doing it on the hand sketch hand sketches possibly it is not that its it to be discouraged, but a more practical way of doing it is captured the images high resolution images, where the image inclusion are identifiable and can be each of the frames could be joined into mosaics or could be (Refer Time: 25:57) them and can give us a very good idea about the occurrence on the fluid inclusions in the samples in fluid inclusion section.

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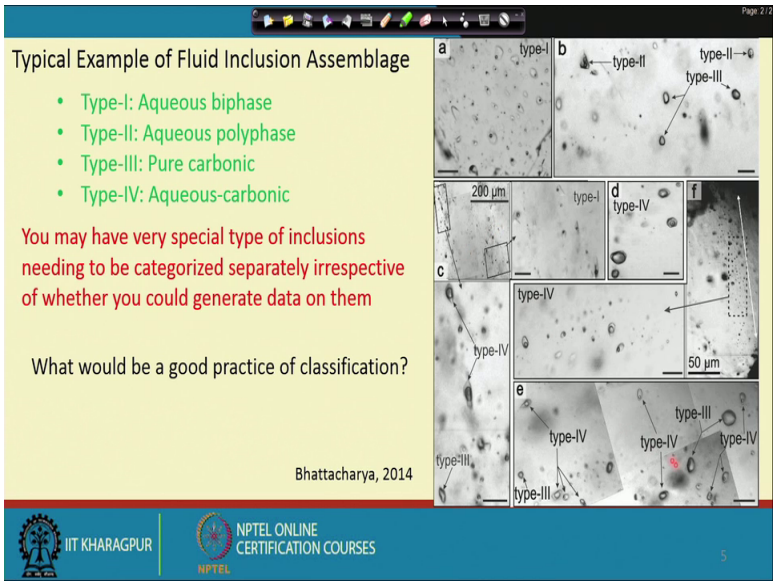

So I will just very quickly browse through what I have said. So, here you could see that what you understand by fluid inclusion assemble the typical example of fluid inclusion assembly which is which I have taken from the work that is done in all are lamp. So, for example, in this situation in a why I am seeing only aqueous biphase inclusion only the type 1 whereas, in the just figure which is beside that type 2 and type 3 inclusions are all occurring side by side together.

And even in case of the photograph over here type 3 type 4 and type 2 were all together here, and this image that I am showing here it also gives me gives us a good idea say for example, if you look at this see and there are 2 places where the part have been blown up and the inclusion occurrence have been shown.

So, what is actually and that is the same case where you could see inclusion f where. So, if always a good practice to start looking at the fluid inclusion sections at first the lower magnification. To look at the where the grains are together it say decrystallizer aggregate, whether it is a grain with pretty much interlocked and an add well kind of grains interlocking and the distribution of inclusions in the grains whether the inclusion population is more in the chore or in the rim and even some of the cases even the zones are also there sometimes also the zonal arrangement of the fluid inclusion also come out pretty clear, as the picture that I showed in the very first introductory part of this lecture series.

=So, it is always good practice to start with low magnification may do a good prepare a good map of the section, and then describe the inclusion and it is also easy to see the transgranular or cracks hill cracks the transecting through the adjacent grains and not only just one even all the sets of such inclusion.

So, in this context I have intentionally not mentioned about another way of this describing this inclusion, which is essentially the concept of a fluid inclusion plane which we will discuss when we discuss the application of fluid inclusion to deformation. So, the fluid inclusion with the samples when they collected with the oriented section from the field; It is also possible to classify the inclusions into occurring in different planes and the concept of fluid inclusion plane is also become quite popular.

So, the classification accordingly done and say for example, I have here I have only given the case of some of the very regular type inclusions like a type 1 could be aqueous biphase arrived told, that the hierarchy could be different depending on the inclusion population. Type 1 aqueous biphase type 2 is a aqueous like the one which has been shown here.

Type 2 aqueous polyphase or type 3 is pure carbonic type 4 is aqueous carbonic, but it may so happen the sometimes you make at a very special type of fluid inclusion photograph I will show and they need to be categorized. Irrespective of the fact whether there micro thermometry data is being used non or not, but there they do are represent some special circumstances. Say for example, inclusions containing graphite which are be showing later.

So, they good practice for the classification is that that the it should be simple, because it has it is to be correlated with the micro thermometry data, but at the same time the information should be very properly represented the fluid inclusion sections just is an example.

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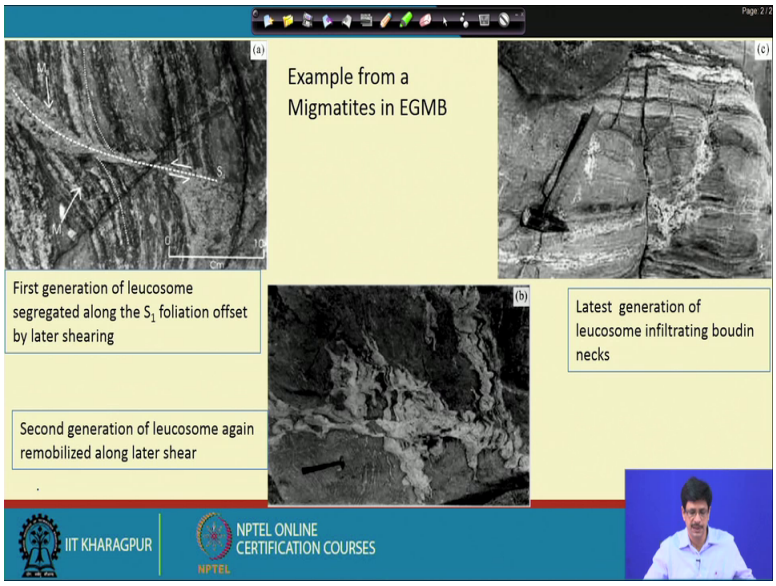

This is taken from and just to show that how the fluid inclusion work actually begins from we field. So, this is one taken from the eastern ghats mobile belt migamatites eastern ghats mobile belt nice basement and there are different generations of melts, that were generated in the present is form of leucosome.

So, proper field study will definitely be able to delineate for example, here they nice is have their leucocritic bands and the later on there have been offset by the shear. So, this kind of field features are to be if your if your addressing a problem of evolution of the of the mobile belt in terms of the basement and the later on phases or deformation and the generation of the different types of migmatites, then it is very essential that we make a very good observation in the field, correlate them at the observable structural as this for example, these particular nice clay has been offset by let us shearing, and that temporal specter has to be identified. And suppose these of the first generation of the melts; these are the second generations of melt which can be identified petrography of course. And there are suppose there are 3 different generations of generation melt and we see them is leucosome sometimes are confirming to the massy clearing, sometimes to the shear planes, sometime getting into the boudin necks of the existing rocks.

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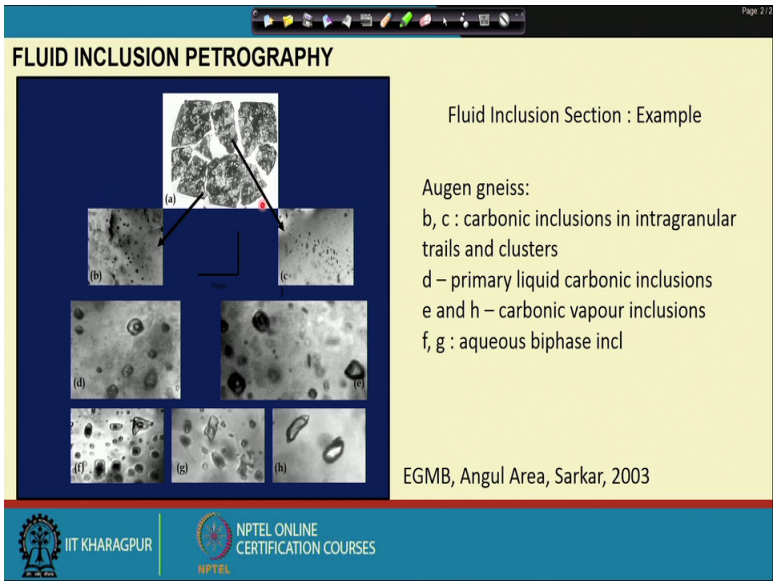

So, each has to be properly sampled and then I will just give you an example, but I understand by a fluid inclusion section. So, as you see here as I discussed before that, we generally make a fluid inclusion section which would be at least about 3 sending 2 2 2 2 to the power 5 centimeter square section, but the fluid inclusion stage the one the photograph which I showed will not be able to accommodate the entire section. It is also not advisable to put the entire section into it, because it will difficult to do that. So, now, this particular fluid inclusion section has been divided into different fragments, for the ease of.

So, the not only just for ease of doing a micro thermometric analysis, but also in terms of occurrence of fluid inclusions in different parts; which could very well be labeled this part has this type for example, the aero shows here the show the occurrence of the pure carbonic inclusions in forms of cluster as well as trail bound and some other quad there are pure carbonic inclusion occurring is part of the 3 dimensional network.

There are vapor carbonic inclusions and so, this entire fluid inclusion section once it is fragmented can also be reassembled, and label as part 1 2 3 4 whatever is convenient and then the fluid inclusion occurrences could also be indicated as to which are so, these are the chips that will a break out of the fluid inclusion section. And for that there could be accommodated in the stage is not only that one of the very practical aspect of fluid inclusion study which will be just discussing.

So, this is one example of fluid inclusion section and the way that fluid inclusion petrography has to be conducted just be carried out.

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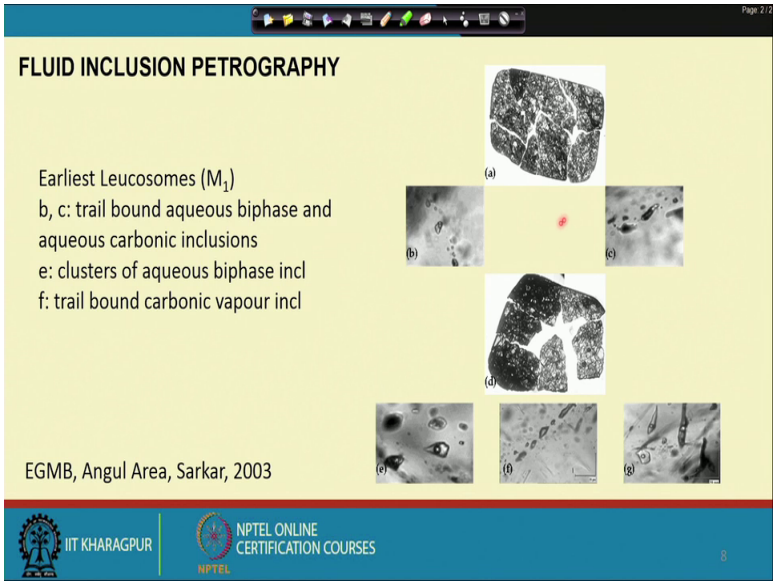

This is also another one supposed with see the different types of as we discussed there are 3 generations of melts. So, if we say that well the latest generation of melt is characterized by some type of very specific type of fluid inclusions, then it is quite obvious to expect that this particular type to be occurring as trail bound or secondary inclusions in the in the immediate earlier phase of the leucosome syntheses are same.

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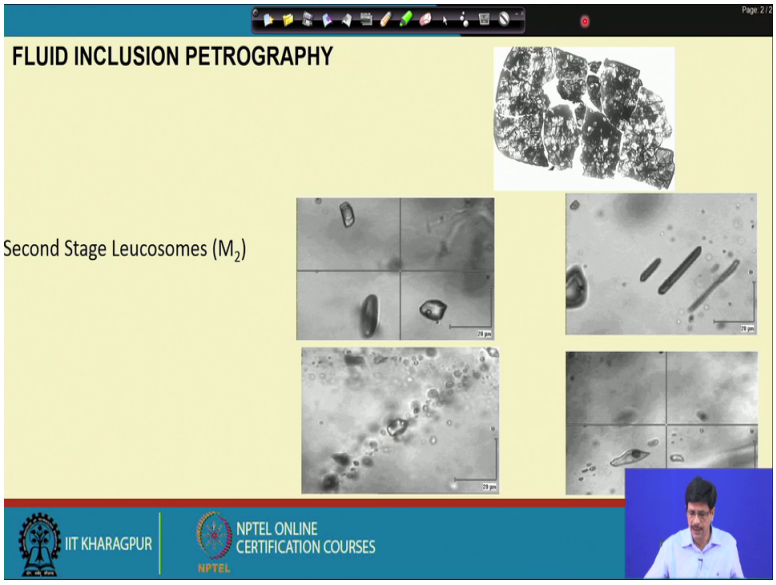

And as I was discussing are there are situations in which we could be saying some very special type of occurrence of fluid inclusions like here.

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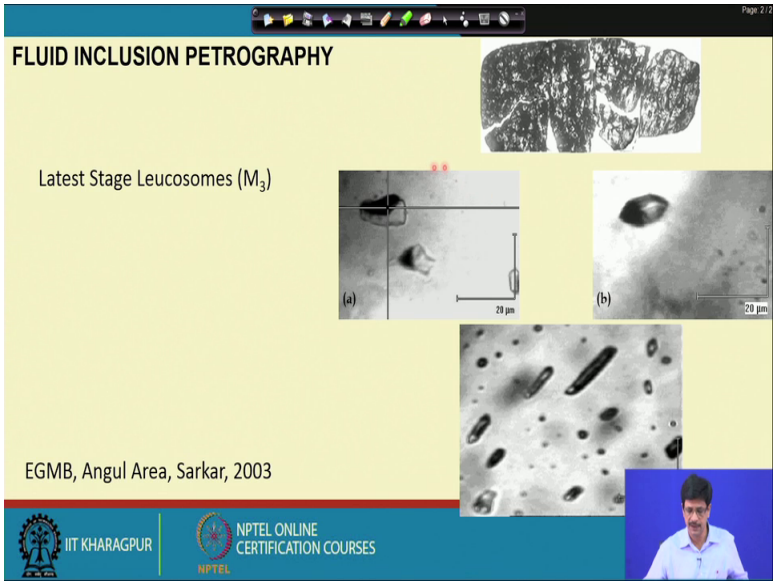

We could see that this particular inclusion content graphite which is confirm from a little type of study; so, this content graphite.

So, this definitely has to be documented that they may not be not more or occurring in very high population, like the one which is here is a. So, if this occurs in the latest phase of the leucosome that in the Eastern Ghats mobile belt migatities and the content and this particular latest stage of fluid is very much characterize by this. So, we will again come back to this case study when we discuss applications of fluid inclusion results to study metamorphism, and such kind of complex will be formed and metamorphic starin. So, this for the (Refer Time: 35:10) of time and just skipping this know for the time being, and the last.

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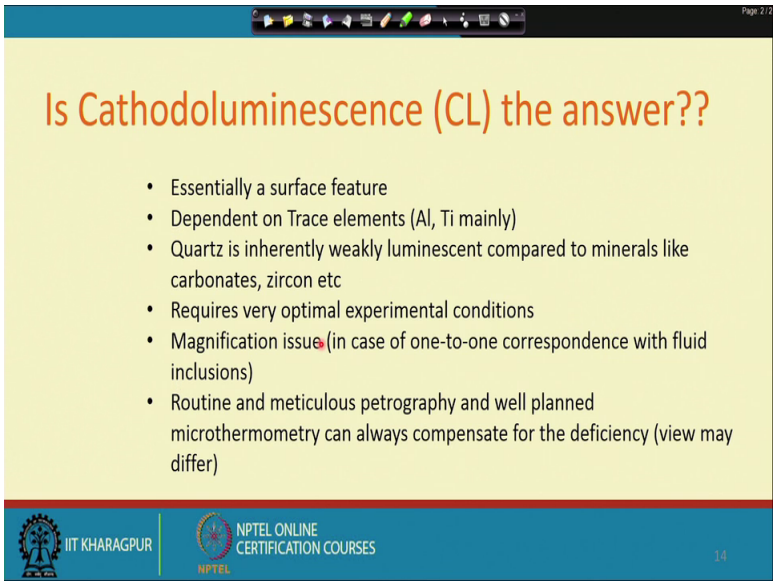

So, of this fluid inclusion petrography in many of the places now forever the facilities available is being correlated with the therm with a cathodoluminescence study of the sample, and this cathodoluminescence study is only being done on quartz and the quartz shows a variable dominations based on the trace element content like aluminum and titanium and it can be a, but since there is essential is a surface feature, and a dependent on the aluminum and titanium content, and quartz is inherently weekly luminescent are mineral compared to the carbonate and other minerals zircon. Very I mean such kinds of studies are not that vary widely successful, because it also depends on a very optimal combination of the experimental parameters to get good cathpdoluminescence images.

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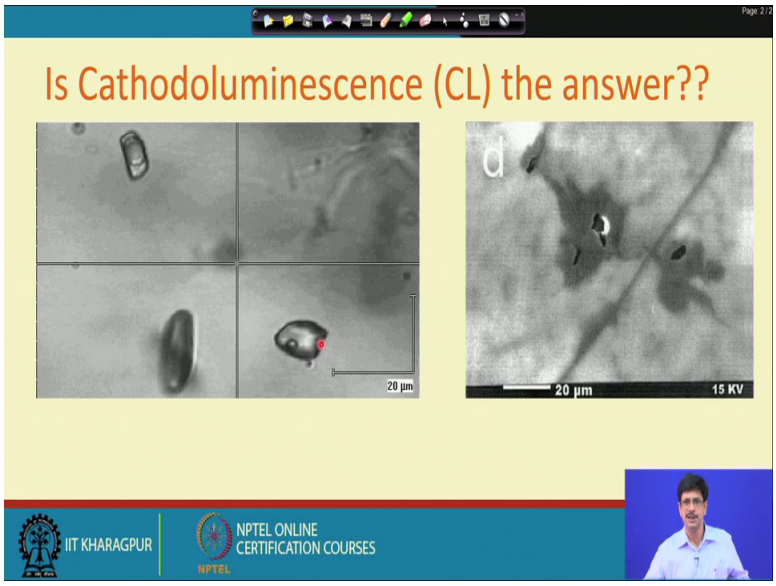

So, there supposed to reveal the different go zones in a quartz grain or different domains, I will just finish this discussion with a very character very specific a say for example; this inclusion is a network is a vapor carbonic inclusion, in a which homogeneous into vapor, this inclusion is an aqueous sorry is a carbonic liquid inclusion.

If you look at the phase diagram of carbon dioxide, existence coexistence of liquid carbon dioxide and vapor carbon dioxide corresponds to very very low temperature situation in which neither any temper any primary growth nor any crystal crystalline is expected. So, one would suspect that possibly this liquid carbonic inclusions where trapped early and later on this vapor carbonic inclusions where trap because of some recrystallization of the host mineral.

And this diagram which has been taken from the literature from Kerkhof Van Dan Kerkhof and Hein, a very clearly shows this is a host mineral of quartz and there is inclusion over here and this is a recrystallized domain of the inclusion which is presence.

So, this kind of situation is very possible. So, cathodoluminescence does not always result in very practically useful result, but sometimes are sometimes they can also indicate very useful situation like this, where we can say that cathodoluminescence can come to a big in a big way it can help establishing the time relationship between fluid inclusions, which is a part of the fluid inclusion petrography.

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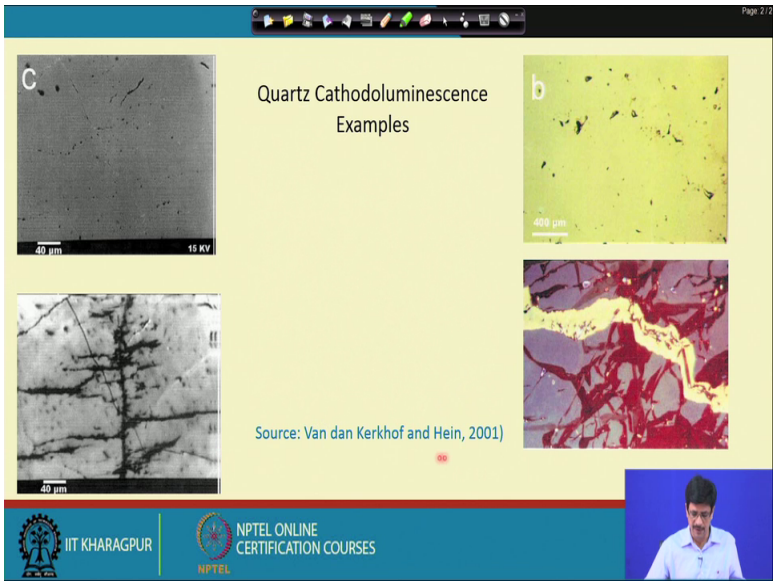

So, here this all these pictures are also taken from Van Dan Kerkhof and Hein and you see this is a normal optical image where up of the whole squares where inclusions are occurring in such kind of a trail. And a cathodoliminescence is very nicely revealing the recrystallized if the part of the quartz, which has a different luminescence; then the surrounding, which clearly indicates the different generations.

But then the question is that when we take it to a microscope a microscope stage on a hot micro thermometric stage where we see them, only in the magnifier higher magnification where such kind of cathodoliminescence, some cases kind of zones are the special the dimension sometime should be much different and the actual thing can be lost that which exactly which inclusion where corresponding to which zone. In summary proof the cathodoliminescence is definitely can be taken help of wherever the facilities available, but a fluid inclusion petrography if very meticulously done and also microthermometry to be followed, it can always compensate for the deficiency because of non availability of cathodoliminescence study.

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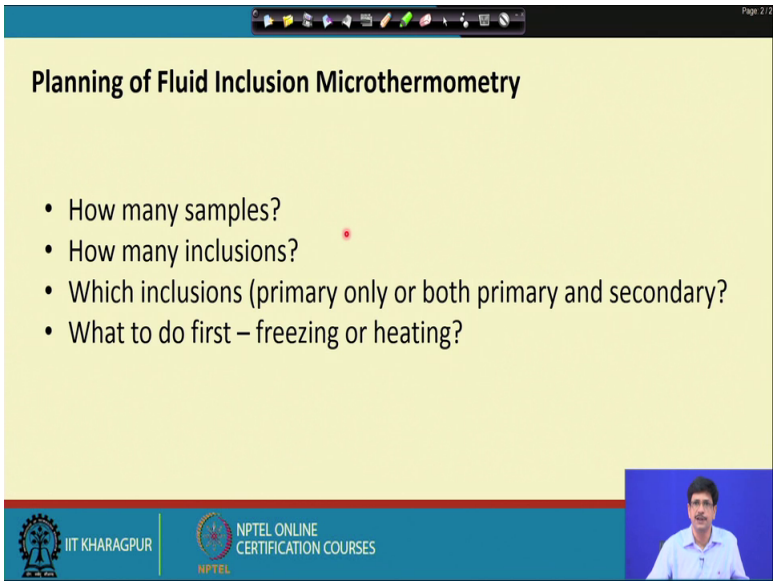

So, coming to the concluding part of it, that the fluid into the micro thermometry has to be well planned so; that means, the questions that are generally coming to a beginners mind is how many samples to study, how many inclusions to study, which inclusions to study primary or only both primary and secondary of what to do first freezing or heating? We will definitely be using this.

So, there is no straight cut answers for that, it may sometimes be that if there is a good fluid inclusion section at least 30 40 inclusions where per fluid inclusion section should be sufficient, it must it must represent all the types that have been observed in that particular affairs, and then when such kind of samples are taken in good number from an exposure depending on the nature of the problem because if I have suppose for example, an over deposit an over body which is measuring in terms of 100 submitters for at least a kilometer. So, I would expect there at least 30 40 samples and which is being studied and at least some 30 40 in inclusions per samples; so which will make a number to take care of the statistics.

Sometimes to talk about the as you will be seeing them in later classes the fluid inclusion data interpretation is also very much dependent on the number of inclusion studied, and this is one methodology where the actual quantity of data is also very important and the will coming to the answer to the last question.

So, which inclusion so, primary only or both primary and secondary is absolutely dependent on the problem being addressed, what exactly is the objective that is defined; whether to trace out the fluid activity in all the different stages of the in the in the particular geological environment or sometimes if the work is if the objective is towards understanding the different stages of deformation, then it is certainly the different fluid inclusion planes containing different types of inclusion have to be studied so, in that case they could be secondary inclusions.

So now, the answering to the question as to what to do first; It is always the advisable to go for freezing of the inclusion first because of the fact that sometimes because of heating or overheating, the inclusions characteristics are changed or inclusions are destroyed, this point will also be elaborately discussed in later for classes when we will be taking of the case studies.

So, we this kind of background information on the fluid inclusion characteristics, the principles of micro thermometry and a little bit of fluid inclusion petrography we would move over to the subsequent lectures in the series, which will be talking about the heating freezing behavior of different types of inclusions and what kind of information can be retrieved from them, and what kind of conclusions could be arrived as far as address in the broader geological problem. So, thank you very much will continue in the next week.

Thank you.