MINERAL ECONOMICS AND BUSINESS

Prof. Bibhuti Bhusan Mandal

Department of Mining Engineering

IIT Kharagpur

Week 2

Lecture 07: Reserve reporting practices II

Hello everybody, welcome to this class on Mineral Economics and Business, which is hosted on the NPTEL Swayam website. In this class, we will extend the ideas we discussed in the previous class, which was primarily about the reserve reporting system. There will be differences between what we discussed in the last class and in this class. There will be certain features we have added to this new reporting system. Now, the concepts we will cover in this class include a new classification code known as the JORC code.

We will discuss this in detail. By now, we understand that reporting resources and reserves matters greatly in business and in attracting investors. If we do not present reserve or resource estimates properly, it can create significant problems for investors. Due to inadequate information, accountability becomes crucial, which is why this code

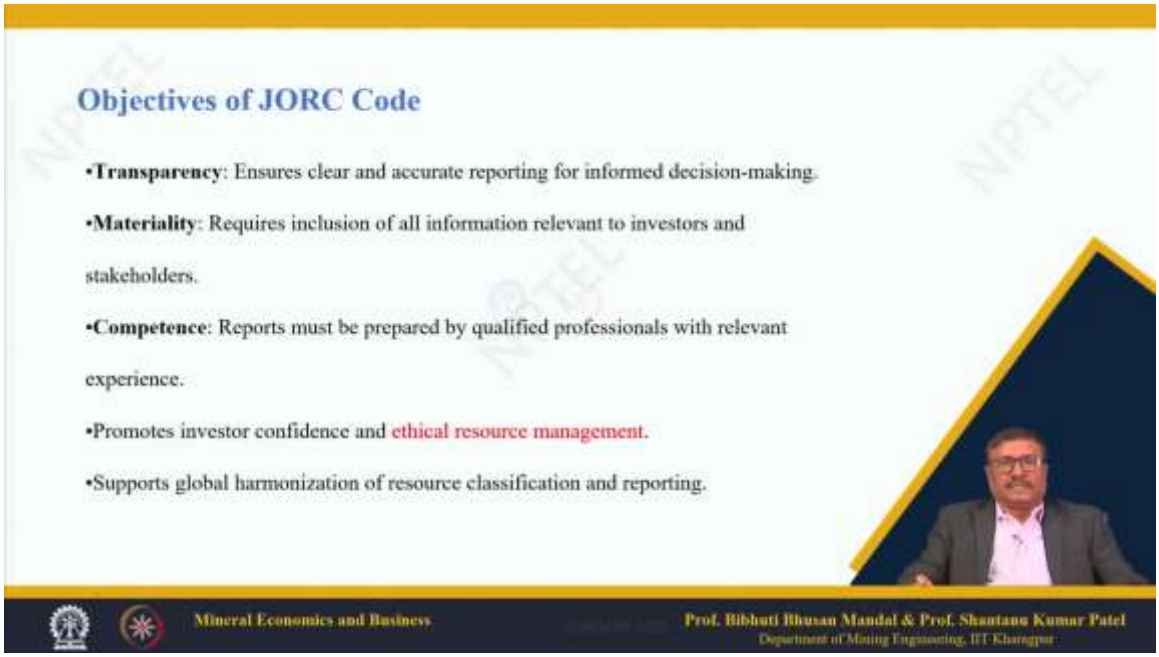
includes the role of competent persons. We will discuss how to classify mineral resources according to the JORC code, ore reserve classification, modifying factors, and the alignment between JORC and CRIRSCO, and how it benefits us.

We will compare UNFC and JORC; we studied UNFC in the last class and are now studying JORC. So, how do they compare, and why do they stand in relation to each other? The reporting guidelines prevent market speculation and safeguard investors and stakeholders. We will also examine a case study on lithium mining in our country. As you can see, JORC, the Joint Ore Reserve Committee,

That code sets minimum standards for reporting exploration results. That means it is something like a guideline where it sets a minimum standard that must be maintained for reporting the exploration results, mineral resources, and ore reserves in Australasia. So, the question is whether we apply these things in our country or not. That depends on the government and also on the company. Many companies I have seen have switched over or rather upgraded to a JORC code in our country. That means they have UNFC at the same time as they have the JORC. So, if you want to have more ideas or better ideas about the classification of the results with more confidence, you can switch over to JORC also in addition to UNFC classifications.

So, this content provides all the information investors need to make a balanced judgment. That means, how much risk is there and how much prospect is there in this business. This

was first established in 1989 by the Joint Ore Reserve Committee of Australia. This provides standards for reporting of exploration reserves, mineral resources, and also the mineral reserves or we call it ore reserves in case of metal mining. This ensures consistency first, then transparency. There is nothing to hide here; it is very clearly understood. And the competence in reporting practices means the persons responsible for this reporting must have the competency to do that. So, the report is prepared properly, and also we can fix the responsibility if there is something wrong with the report.

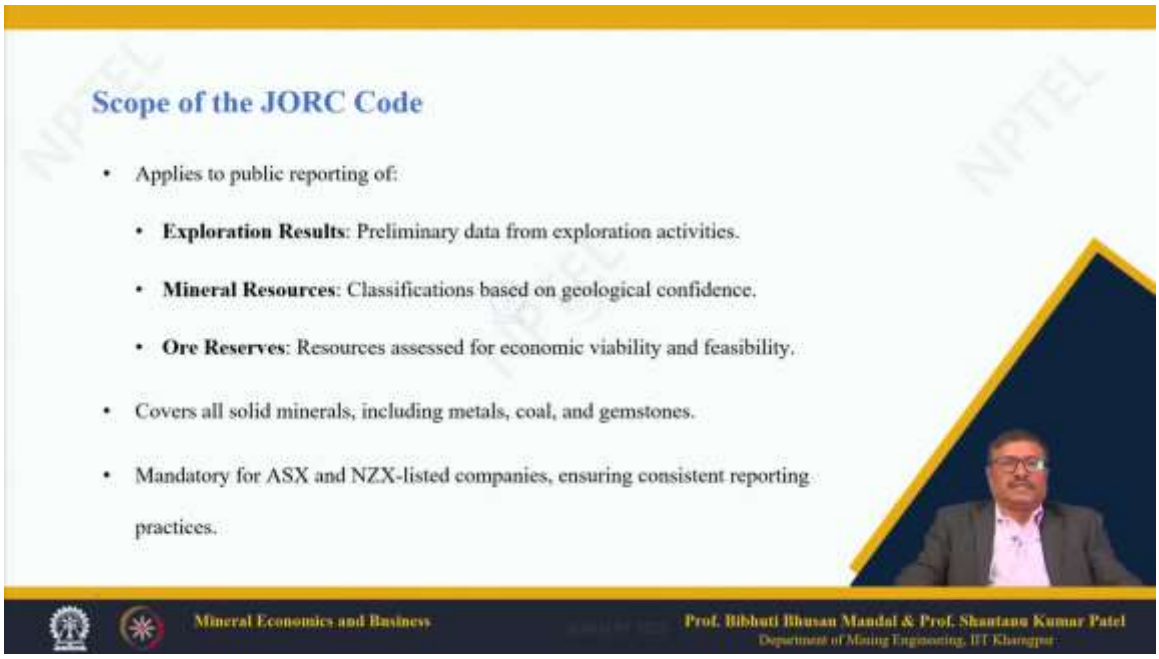


Now, this is mandatory for companies listed in the Australian Securities Exchange and, of course, the New Zealand Stock Exchange. This is mandatory for them, but it is not mandatory for all. But people prefer it because it is more useful, and when it is used in conjunction with or as an addition to UNFC, it gives a much fuller understanding of the prospect of the result. This is also aligned with international reporting frameworks, famous frameworks like the CRIRSCO. What are the objectives of this code? It offers transparency, meaning it ensures clear and accurate reporting for informed decision-making.

Then the materiality, inclusion of all information relevant to investors and stockholders, all all relevant information will be included here, not just a technical information. Competence, the reports must be prepared by qualified professionals with relevant

experience Now then what happens it promotes the investor confidence and of course ethical resource management very very important. I personally think it is a very very important aspect of the job code ethical resource management. That means when you are offering a natural property, a natural resource to the investors or the stakeholders to enjoy the benefits of business and the society, then we must be able to report it properly, so that what are the effects on the feasibility, on the technical feasibility, on the social aspects, environmental aspects, everything.

that is very clearly understood. So, we are introducing the word ethical here because the people who are reporting this must be held responsible for this thing. We should not be engaging ourselves in fraudulent reporting and misleading information and misleading all the stakeholders. This supports global harmonization of resource classification and reporting. So, that means, we have ah if you have a common platform.



So, common platform everywhere then what happens is that we can compare with each other and we are in harmony. So, we can compare a resource in one country with the other with a very clearly understood and accurate reporting for informed decision making. Now, this where do we apply this thing? So, we apply in exploration results, in mineral resources, in ore reserves classification,

And it covers all solid minerals, including metals, coal, and gemstones. So, as I said, it is mandatory in certain countries but non-mandatory in others. What is the role of the

competent persons? So, a qualified professional must have at least 5 years of relevant experience; that is mandatory.

In the resource being reported, that means someone who is in gold mining or copper mining. So, naturally, with 5 years of relevant experience, they should be reporting those kinds of resources. They are not easily interchangeable with others unless they have diverse experience. So, what are the responsibilities attached to it? It ensures accuracy, reliability, and compliance of reports with the job standard.

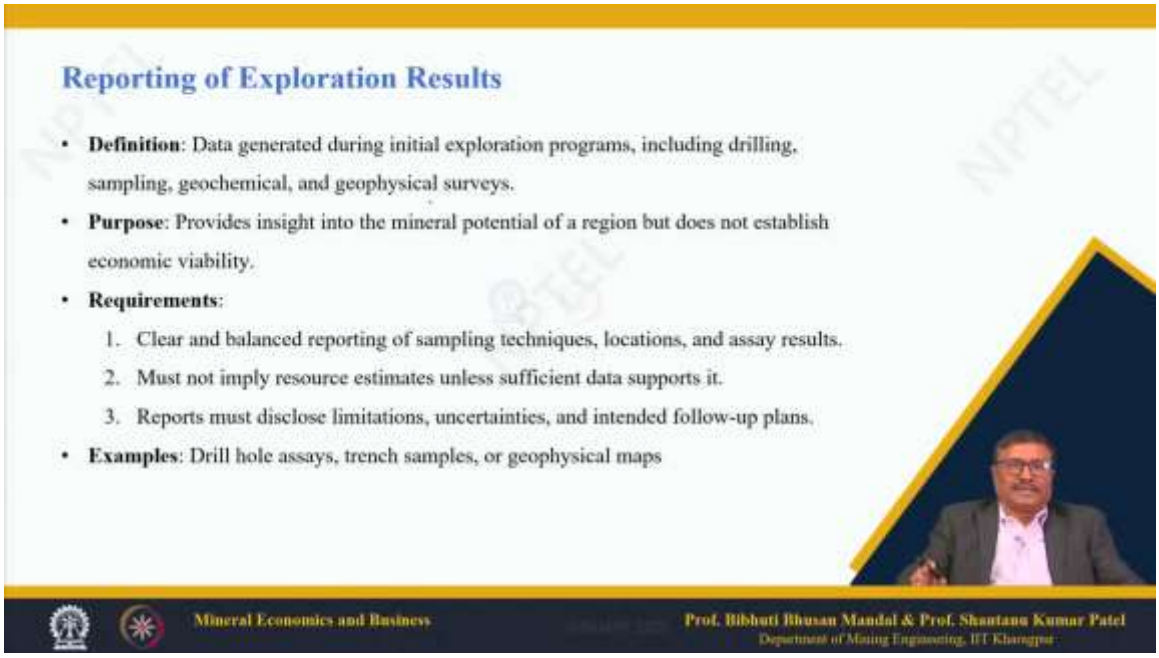
And it also certifies that the data presented in the report is credible and meets industry requirements. That means he is taking responsibility. So, people can believe that someone competent, qualified, and experienced enough is reporting here. So, we can have more confidence in the report and its use for our investment decisions. Professional affiliation: we prefer that they must be a member of a recognized professional organization, for example, the AUSIMM or AIG.

What are the reporting categories? For example, exploration results. So, in exploration results, we have preliminary data such as drilling and sampling outcomes. What we found in the drilling? What was the sampling outcome results?

But it will never imply economic viability without further study. It is only a preliminary data that gives you idea about the resource. And when we try to classify them in terms of mineral resources, then we can term as inferred this is the lowest confidence rather with limited geological data indicated with moderate confidence support some mind planning. So, you will get some idea of the feasibility and measured means high confidence supports detailed design.

when you are you are now switching over to ore reserve then the economical aspect is the most important now. So, the economical aspect here of the mineable portion of the resources is classified as probable that means with moderate confidence in modifying factors and proved means you are having the highest level of confidence in modifying factors. Reporting of exploration results So, here now we are taking one by one. First we will talk about the exploration results.

The data generated during the initial exploration program including drilling, sampling, geochemical analysis, geophysical survey that will be defined as exploration results. What is the purpose? It gives insight into the mineral potential of the region. What is the potential? future you can you can expect some potential but does not establish the economic viability at this stage.



So, also the requirements are clear and balanced reporting of sampling techniques, what techniques you have used here, what are the locations that you have used and what are the assay results that you must be recorded here. This must not imply resource estimates unless sufficient data supports it. And of course, we must report the limitations and uncertainties in accessibility this kind of reporting. And what are the follow up plans that we are planning to give it more completeness and give more information about the resources. Examples drill hole assay, trench samples or geophysical maps.

Now coming to the resource classification, so this is a concentration of material of economic interest within the arts class with reasonable prospects for eventual extraction that means here also we are not talking about the economic viability. We are having some economic interest in this and then we are trying to classify the resources accordingly. Later on when the reports are prepared or rather the further analysis is done, we can switch over to the reserve. In between the exploration and the reserve, we have something called resource. That means we have definite economic interest and we are now classifying in terms of Inferred, Indicated and measured.

As usual, Inferred has limited geological data. low confidence, indicated as moderate confidence, sufficient for mine planning, you can go for planning. Measured means it supports detailed economic and technical studies and we have high confidence in this

database. The reasonable prospects are defined by technical, economic and environmental assumptions. What are the assumptions that you have taken?

And it excludes material without realistic extraction potential. That means, technically not feasible resources are excluded. So, that now we can switch over to reserve for economic benefit. So, how do we classify the Ore reserve now? The definition of ore reserves are economically mineable portions of measured and or indicated mineral resources.

And the categories are two, probable reserve and proved reserve. So, the probable reserves are derived from indicated resources with moderate confidence in modifying factors. And the proved reserves are derived from measured resources with high confidence in modifying factors. So, the key considerations are in modifying factors such as mining, processing and legal factors, they determine the reserve viability. So, the prospect of mining whether it is technically feasible or not that is most important.

So, it is not only that geotechnical aspects are suitable for you. But the method that you are adopting is going to give us safety and economy—safety and business both—and that must include the whole thing since it is not always that we will be selling ore. We will be

processing, and then we may partner with some companies, possibly installing smelters. So, as a whole, the totality—in totality—how viable is it? Then, legal factors are there.

In any country, the legal factors, rules, and regulations are very important in establishing any business. So, whether that is suitable for establishing a mining business in that country or not. So, that will give us the total reserve viability. And ore reserves must be supported by pre-feasibility and feasibility studies. That means when you declare that this is an ore reserve—mineable and technically viable, economically viable—then it must be supported by at least two stages, like the pre-feasibility study and feasibility study reports.

So, the reserves are basically ultimately reported as estimates because you have not mined them; when you mine them, you will know. So, these estimates are based on realistic assumptions, and they will definitely have certain uncertainties that will be recorded in the report—that will be very much recorded in the report. Now, we have been talking several times about modifying factors—modifying factors. What are the modifying factors? That means the factors influential in the making of the report.

If there is a change in that, in that case, the viability of the report will be affected. So, the modifying factors are essential considerations used to convert the resources into results.

What are the key factors? Number 1 is the technical part, which includes the mining method, geotechnical stability, and grade control. These are based on certain technical investigations and the information that we received from drilling and other modeling data.

Now, the economic part includes commodity prices. If the prices fluctuate, naturally your whole economic model will change. Maybe you will have more benefits than expected, and if there are operating costs, the labor cost changes. Or the prices of other commodities or materials that you use for mining—if that changes. The financial analysis style—the way you analyze it through a particular type of model. So, if you change that, it can definitely affect the economic attractiveness of the resource. Now, the legal and regulatory regimes can change. Usually, it is positive unless there is something very wrong. Otherwise, nowadays, especially in India, at least the approval process is being streamlined. It has been made easier than ever before. Royalties—how much you have to pay—are very much streamlined, and compliance with government standards is well-organized.

So, if the legal and regulatory things do not change in your favor, then it is a different matter. Otherwise, it is expected that in our country, the whole thing—like the approvals, royalties, and compliance with government standards—is becoming easier day by day. Environmental and social impact assessments, waste management, and community agreements—these are all social responsibilities. This particular matter—if the government becomes more stringent on waste management. And then you have to think about recycling or even dumping waste materials—how to do that.

So, how much money you are investing there whether it is going to adversely affect the environment or the social environment that that is very important. So, this part also comes into play when there is a change in the in the in the rules and regulations. So, in that case there will be could be minor changes in the model that we are proposing. And then the importance is that it ensures that the reserves are technically feasible number one, economically viable and environmentally sustainable. That means it has got all the qualities that we should think, we can think of when you are doing mining business with a mineral resource converting into mineral reserve or ore reserve.

This is a graphical presentation of what we have we are talking about you can see that ah on the x axis you have the increasing level of geological knowledge and confidence and if you are having then then then you are you are transforming things from the mineral

resources to over reserves as the as the confidence increases from indicated to probable or say measured to ultimately proved. That means as you are having more knowledge and more confidence and then when you are considering the mining, processing, metallurgical, infrastructure requirement, economic viability aspects, the marketing prospects, legal rules and regulations, environmental aspects, social and government factors. So, these are the modifying factors that will transform successfully if you have full knowledge of these things and if you do all these things in due

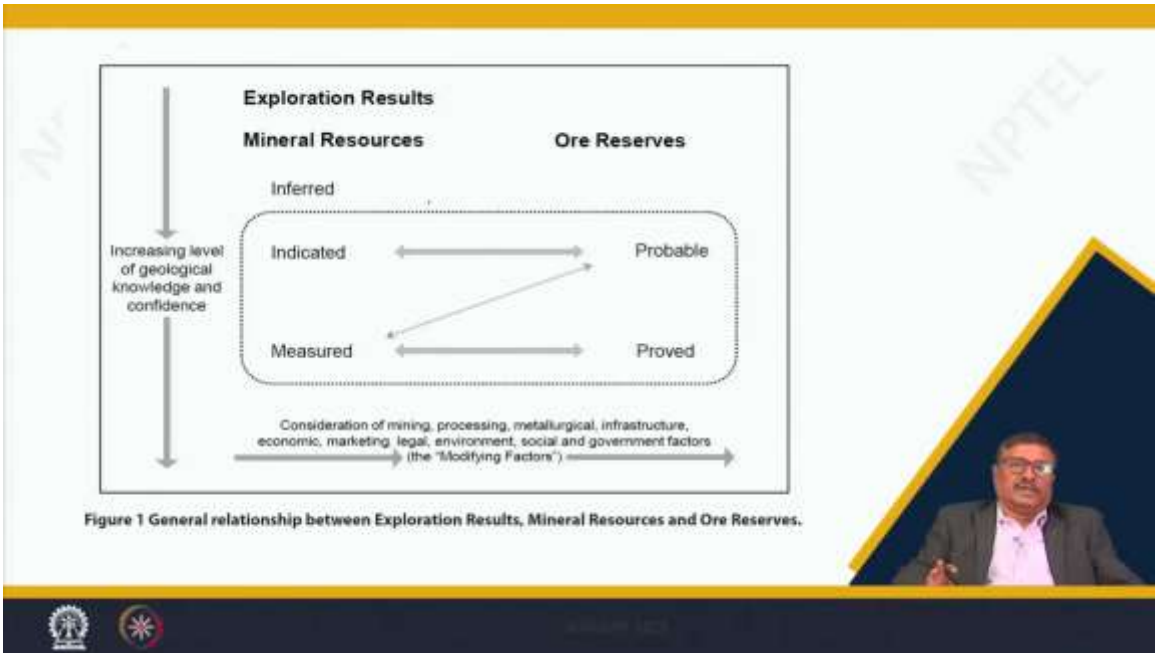
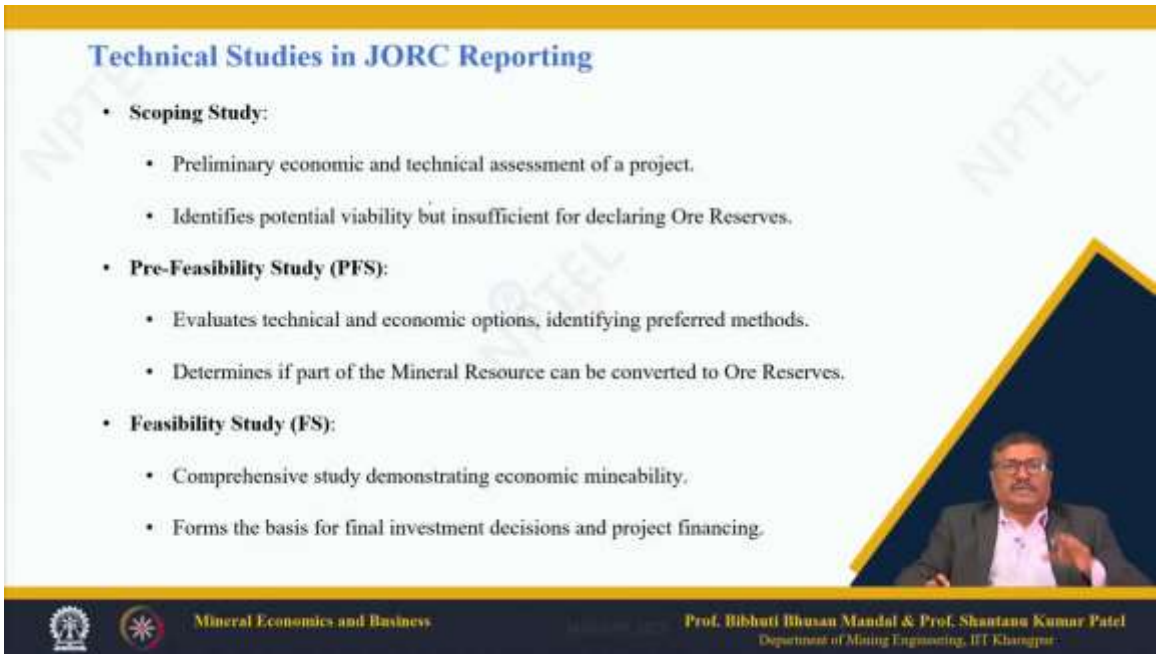


Figure 1 General relationship between Exploration Results, Mineral Resources and Ore Reserves.

due diligence, in that case you can successfully transform the resources into a viable ore reserve and then attract investment without any doubt. So what are the technical studies support that support the job reporting? Number 1 you should have a scoping study, the preliminary economic and technical assessment of any project. It identifies potential viability but insufficient for declaring the over reserve in the beginning that is the scope. Now it would be supported by a pre-feasibility that gives you an indication that it because it evaluates the technical and the economic options and it identifies preferred methods.

It determines if part of the mineral resource can be converted. Maybe the whole thing is not a result; some part may be very poor in grade, or there may be technical disturbances so significant that it would not be technically viable to mine, meaning it is technically not feasible. So, we can at least declare and identify that area where this part of the resource

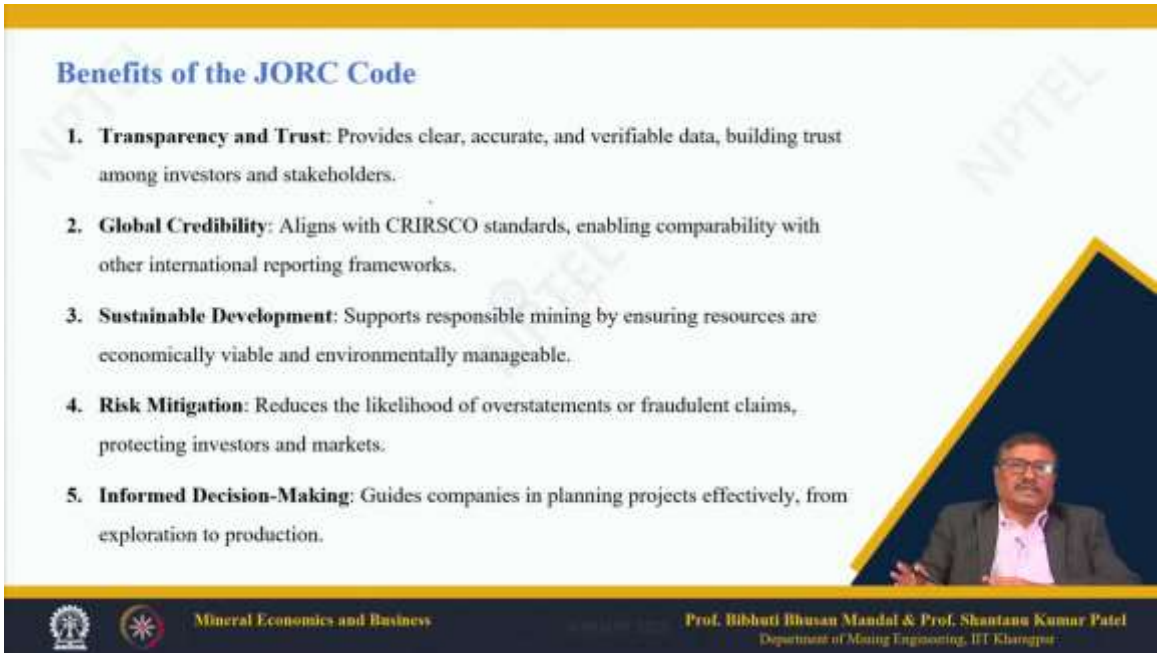
can be termed as ore. And then, it is supported by the final feasibility study. This is a comprehensive study demonstrating the economic mineability, and it forms the basis for final investment decisions and project financing. This feasibility study will provide the maximum information and confidence regarding our final investment decisions.



Now, in the beginning, I mentioned that alignment with international bodies like JORC is part of the Committee for Mineral Reserves and International Reporting Standards. So, CRIRSCO creates globally consistent definitions for resource reporting. Anyone attending the course can search for CRIRSCO's definitions for resource reporting. The whole document is available and provides broad guidelines for preparing codes like JORC, detailing what kind of definitions to use. It outlines the methods to follow in resource reporting so that there is global harmonization in reporting methods. There are member reporting standards, such as Canada's NI 43-101, South Africa's SAMREC, or Europe's PERC.

What are the benefits of this alignment? It facilitates international comparison of resource data, as I said, between two regions in one country, between two countries, or compiling data to compare which part of the world is suitable for investment in a particular mineral. It ensures consistency across jurisdictions, promoting global investor confidence—something I repeatedly emphasize in this class. What are the benefits of using the JORC code? So, let us summarize. The first one is transparency and trust—it provides clear, accurate, and verifiable data.

So, that builds trust in the investors and the stakeholders. So, what is the global credibility? Because we align with CRIRSCO standards, enabling comparability with any other international reporting framework. Then we have sustainable development because we are supporting responsible mining by ensuring resources are economically viable,



environmentally manageable, and sustainable. Risk mitigation reduces the likelihood of overstatements or fraudulent claims. Protecting investors and markets, as we have seen in our previous class about the example of the Poseidon Nickel or Bre-X scandals.

So, those fraudulent activities will be minimized, and there will be no overstatement because we provide clear, accurate, and verifiable data through the JORC code. Informed decision-making guides companies in planning projects effectively, from exploration to final production. You can see the comparison here, which we have been discussing. Say we have the purpose: the JORC code focuses on public reporting of exploration reserves, mineral resources, and reserves, while the UNFC is a broader classification system for all resource types, including renewable energy, with an emphasis on policy and sustainable resource management. In classification, we have inferred, indicated, and measured, and in the case of reserves, we have probable and proved. Here, the UNFC's major strength is the three-axis system, which we studied in the previous class. Now, in scope, it is applicable to solid minerals, particularly in Australia, but the UNFC's global applicability extends to diverse resource types, such as petroleum, geothermal energy, and more.

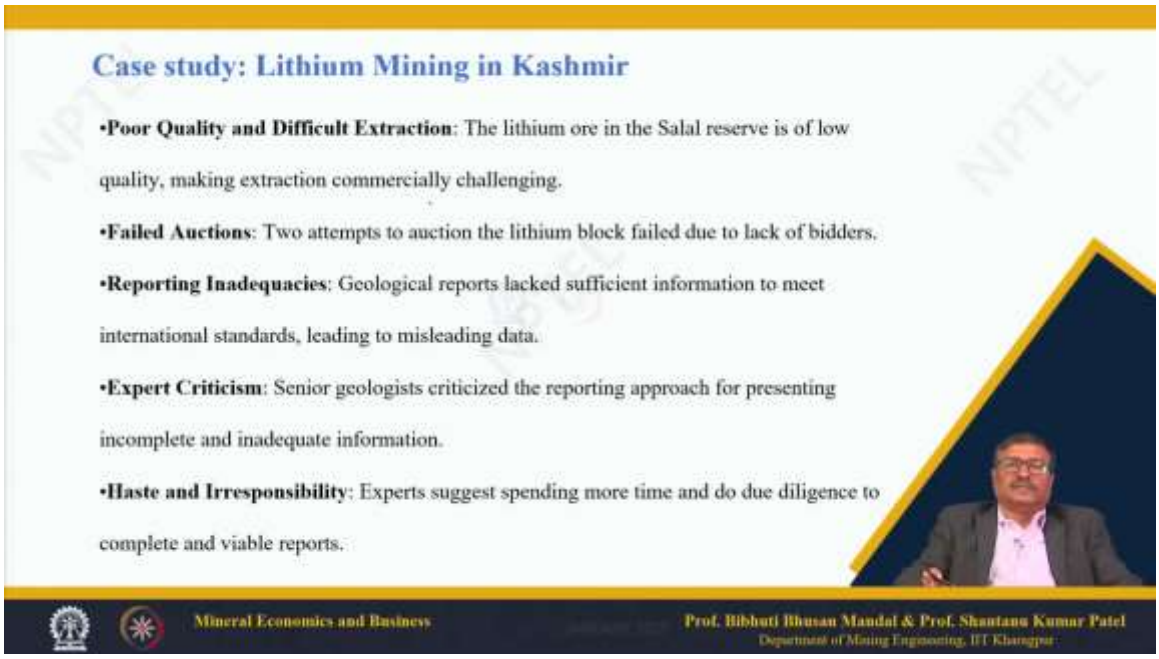
Of course, you can adopt the JORC. So, to become truly internationally acceptable anywhere and everywhere. So, global alignment: both align with CRIRSCO standards, but the UNFC integrates broader sustainability and ESG, like environmental, social, and

governance considerations. Adoption in Australia and New Zealand stock exchanges requires the JORC; for others, it is voluntary adoption, often used by governments for resource policy. So, market speculations, as I said, are reduced due to transparency, as all data presented is clear and verifiable.

The accountability is set since we have fixed the responsibilities the competent persons who are reporting the data. Global standards we are allying with the frameworks such as JORC and UNFC. So what is happening it is enhancing the consistency and reliability in reporting. and investors are having their safeguard because they are having now more data and the competent people are preparing it with the fixed responsibility. So, we can evaluate the resource potential much more effectively than before.

So we will take a very simple case in lithium mining prospect in Kashmir in our country which has recently our government is also trying because the lithium as is considered as the white gold. So, we have a report ah actually it was first identified when geologists were ah exploring bauxite for the production of aluminium, but lithium was there. Now, since due to the energy ah storage ah ah modules like in batteries it is being extensively used. So, we have a relook on the lithium mining prospect in ah ah Kashmir. Now the when it was first reported the report was not good enough and later on we saw that it is of low quality and the extraction is commercially challenging.

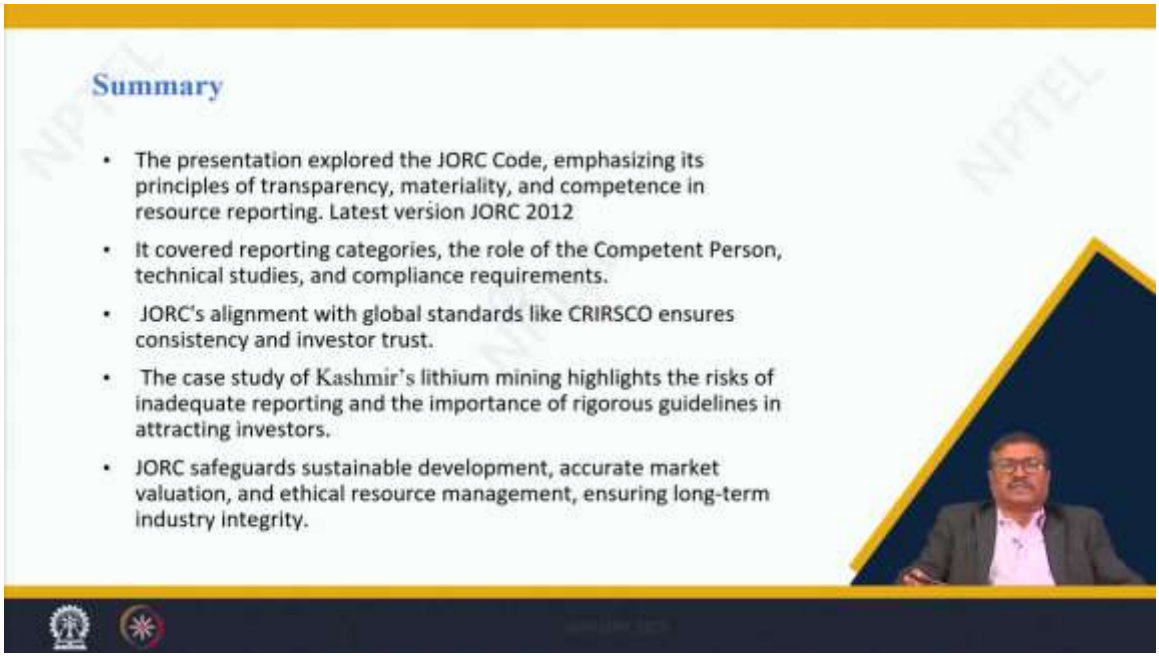
So, there have been two attempts to auction this lithium block which there is no bidder recently also we had auction of this mineral, but there are no takers so far as on date. Why ? We think that the geological reports lacked sufficient information to meet international standard leading to misleading data. That means the people who are getting into it they are trying to invest because lithium is very very important very very important. So, the data was not sufficient for them to invest when they closely looked at it they they found it that not yet attractive. So the expert criticised that the senior geologist involved in this the reporting approach for the presenting is incomplete and inadequate information.



So what we do that we suggest that we spend more time and do the due diligence to complete and make the reports viable. If we can do that then what we will do? will be projecting the right information about our lithium result and then people will be easily in understanding whether to go for this or if you want to have some modification in the method of mining or maybe some kind of your mechanization is required to make it faster mining or easily extracted to make it more economically attractive that those decisions can be taken based on the report, based on the detailed report that can be presented in near future. So, what we studied today, we explored the JORC code

And we emphasize these principles of transparency, materiality and the competency in resource reporting. And the latest version as I I must say you that the 2012 version is the

latest version. So, it covered reporting categories, the role of the competent person, the technical studies and the compliance requirements. JORC's alignment with global standards like the CRIRSCO ensures consistency and investor trust and as I said when you want to compare between two regions, two jurisdictions, two countries and then between continents. it it has to be aligned with the with some international reporting standard, you can easily compare.



So, the case study of Kashmir's lithium mining also that highlights the risk of inadequate reporting, we expect that more information will be available and we will have more rigorous guidelines in attracting investors. the importance of rigorous guidelines. That means when you make the guidelines more rigorous and we make people responsible who have made this report, then it becomes thorough, detailed and complete in nature. So, the investors will be easily understanding what they are reading, what information they are getting. JORC will safeguard sustainable development.

Accurate market valuation, ethical resource management—which I have emphasized in one of the slides here—and ensuring long-term industry integrity will create credibility and trust in the business, right from the reporting to the mining procedure. If you want to

read more 2012 versions, you can read these connections I have already mentioned in my slide. If you just click there, you will definitely see the entire document, and you can go through it to understand the basic requirements, the purpose of these things, and the lithium case study—of course, it is easily available. So, you can compare the JORC and UNFC and see what the differences are. And also, study how JORC has helped in creating a trustworthy database, which can easily and more clearly inform the investors.

So that investment decisions are quick and easy for all the stakeholders. Thank you very much.