Mineral Resources: Geology, Exploration, Economics and Environment

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Lecture - 54
Mineral Economics (Contd.)

Welcome to today's lecture. So, we will continue our discussion on some of the aspects of Mineral Economics which we started. And we have been discussing about some certain macroeconomic aspects under which we got ourselves introduced to the national mineral policy which is a regulatory tool for the policy of sustainable exploitation of mineral resources in tandem with the national economic policy.

And in linkage with other industrial activities; still mineral industry being given the status of a standalone industry. And we also had a brief look at one such thing that is in an international perspective that is the Law of the Sea for exploitation of the resources of the seabed which by spirit belongs to the mankind, but generally the countries which are having coastline

are the ones which will mostly be getting the benefit of the mineral resources of the seabed; although a very active exploitation of the mineral resources of the seabed is yet to start.

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So, we will just continue our discussion with a little bit of more on this Law of the Sea just to make you aware. India as a country had a very elaborate and ambitious plans of exploitation of resources of the seabed concentrating mostly on the central Indian Ocean basin.

And its efforts for exploitation of an exploration and exploitation of the mineral resources of the seabed goes back to the 70s in the last century and by the time; it was by 1980 - 81 or so, India already had identified or, delineated certain regions in the central Indian ocean basin for exploration and exploitation of the mineral resources. And mostly it was focused on the manganese nodules which we all know are very rich resources for not only just iron and manganese, but for nickel and cobalt.

And so, under the ages of this United nations convention on the Law of the Sea and which came to be effective since 1994 and has been signed they are about 90 countries who have been signatory to such conventions. And there are still some of the issues which are not yet resolved such as the benefit that is to be given to countries which are landlocked.

So, keeping those issues aside, under this Law of the Sea, there is a statutory body a preparatory commission was established. This preparatory commission was to oversee the applications of the countries which are essentially known as the pioneer investor. So, this concept of pioneer investor came into existence. And this preparatory commission is like an international regulatory body which was entrusted with the responsibility of granting license or permission for exploration and exploitation of different parts of the ocean floor or, the sea floor.

So, by that time in the mid 80s there were four countries including India that is France, Japan and erstwhile USSR who were identified as the pioneer investor. And India and there were some clauses laid out and there will be minimum of 150000 square kilometer area which is to be delineated by a pioneer investor and an amount in the order of 1 million US dollar to be paid as a initial fee to this preparatory commission for obtaining the permission.

And in India, already identified in the central Indian Ocean basin two such areas and the condition of this preparatory commission was that the pioneer investor will be allowed to do the exploration and exploitation in half of this area and relinquish the other half for

future use by whatever way it could be decided. So, when it was selection of half of this area. So, there was all initiatives taken in dividing this part in the ocean in the central Indian Ocean basin into several blocks and kind of preliminary estimation of reserves and all were made.

And by 1980 by 1981 even India started to dredge and recover the modules from the seabed in the central Indian ocean basin and there were organization like council of scientific and industrial research were taking up active research on recovery of this metals from this manganese nodules by using various hydro metallurgical processes.

At the same time there were research laboratories were also assigned with the development of the technology for seabed mining. And as of now, it is still in the process and they are still going on and sometimes it is being criticized also that since it is very high expensive affair to do the seabed mining and recovery of the resources of the seabed. Still this has been quite and welcome effort and it has given provided a lot of boost and we all look forward to exploitation of this especially the manganese nodules. And also in addition to that some of the seafloor hydrothermal systems; where, metal sulphide deposits also could be exploited in the near future.

So, that is what the Indian status is? We have been identified as a pioneer investor and ready to exploit the seabed resources. So, with this little bit of idea on this statue or, this r international regulatory body like that is formulated as law of the sea being agreed upon by the different all the all the countries of the world.

But there is an always political factor which is involved in it in proper implementation and which we see even though there are many of the things which are delineated but still we have many such conflicts as we come to know. We will have to see how these things are coming up for when the land based resources will get depleted and how the seabed resources are coming to supplement or to augment the resources.

So, with this we will move on to discuss one of the topics of interest in mineral economics that is the metal price.

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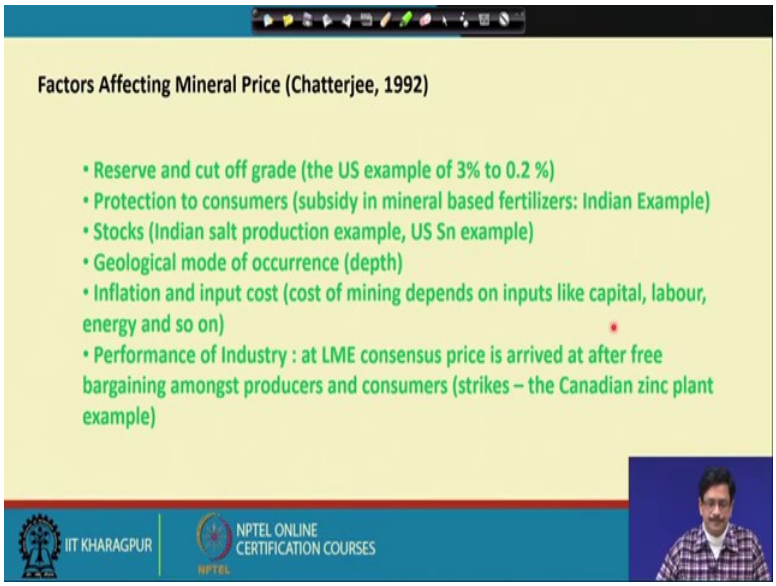

We all know that these metals or, ores which are produced in all the mineral producing countries, some recovery processes are there as different hydro and l pyro-metallurgical processes. The metals are extracted and the metals are marketed in international market.

There is a international hub like called the London Metal Exchange LME; where, producers and consumers do bargain and come to mutually agreeable prices and which are stated as the price of that particular metal that is traded in between different countries in the import export and all. So, there are many factors on which this prices depend. If we look them look at them one by one then it could possibly be the reserve, the total amount the total metal that is available the total mine life for how many years and what is the total revenue that is expected from a particular mineral deposit.

So, reserve and cut off grade is one of the points which decide as to what price the metal should be marketed. For example, in the old day in the earlier time when there was no much of technology for bulk mining that was developed. The cut off grade of a metal like copper was say for example, 3 percent. At the time the copper price definitely must have been higher, but as and when the bulk mining technology improved and like most of the porphyry copper deposits were able to be mined and the cut off grade went down to as low as 0.2 percent and the mining technology improved and the cost of production of the ores in the mines also improved.

So, with that the price definitely started to fall or the price varied. So, it is one of the important points. Sometimes the prices are also decided on the policy of giving protection to consumers like we can give an Indian example where these fertilizers, a price ceiling is fixed because most of these fertilizers are used in agriculture and agriculture is promoted and some amount of subsidization is done.

So, the price could also vary on this issue. There are stocks like sometimes some of the mineral producing country could use a policy of certain called as a stockpiling; that means accumulation of the metals in huge amount. For example, at one point of time United States not being a part of the international team counsel, accumulated a reserve of almost about of the tune of 2 years of world production of tin and was actually controlling.

So, it was not allowing the tin price to go up and with the situation that it could release the tin to the market and some such situations also take place and then Indian salt production examples also could be sited for that. Ideological mode of occurrence is definitely one of the reasons, but which is of non political or non economic issue. If the ore body, the rich part of the ore body is available in near surface and in favorable geological conditions in which the mineral could be mined at a low cost and the cost of the metal also is likely to remain low.

The inflation and input cost that is the cost of mining depends on inputs like the capital labor, energy and so on. As and when the capital cost increases the cost for mining increases and correspondingly the cost of the metal also goes up. The performance of the industry, so like there are certain points of time in which there has been quite a bit of turbulence or the strikes in different industries.

Like the example of the Canadian zinc plant could be given during which there is always an artificial or there is some kind of perturbation to the situation and it also effects the metal prices.

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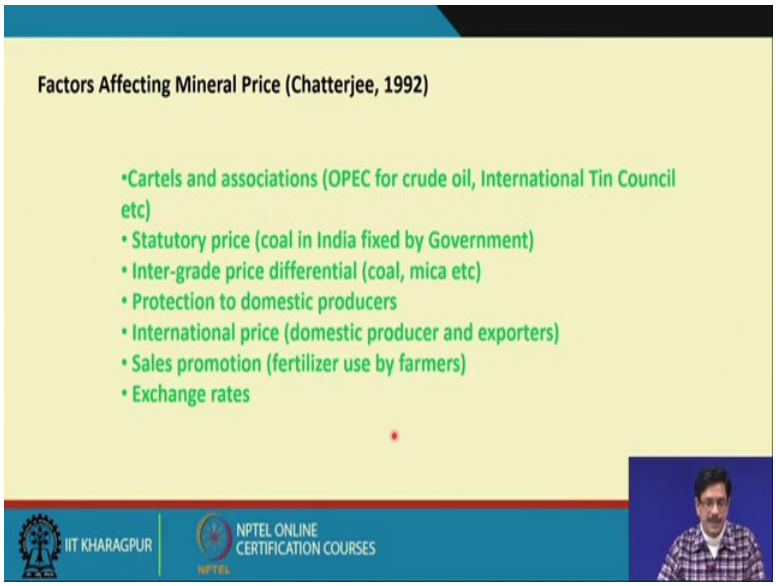

These cartels and associations, one of the example is which we generally come to know in our day to day life is the OPEC the Organization of the Petroleum Exporting Countries; who actually regulate the price of oil and also put a restriction on what should be the annual rate of production of the of crude. So, that the price is maintained at a little higher level.

So that the oil producing countries get the benefit of it and the international team council is one of the examples. And it definitely remains as a fact that in spite of the presence of such kind of the cartels, sometimes there is more imposing geopolitical issue which sometime overrides such kind of cartels and control the prices.

There are sometimes a country can decide to fix a statutory price for example, coal in India fixed by the government and it is regulated by the government for different purposes and the price is not allowed to rise or fall from a certain value. Then the inter-grade price differential, sometimes there are prices of the same coal, but could be different for different rates and also in case of mica. For example, the mica is a good example; mica the highest price will be for the very well formed mica books. And gradually the price falls with quality and sometimes with the impurity present and since they can be used by different types of industries.

And so, in this case even sometimes even a particular mineral resource which has got two different types of occurrences inter deposit variation also could be a factor in which

the price could be different, but if it is being regulated by a single body the price could also possibly be made up in that way. International price there is a domestic producer and exporters that is a controlling factor.

The sales promotion, for example, government decides to production for the larger scale production of fertilizer which will be used by farmers for agriculture. And in that case also the price will be regulated and the exchange rates that are the inflation and all these issues come into consideration for example, you all know that the value of rupee keeps on fluctuating with respect to dollar and that also will definitely have an impact on price of any commodity including the mineral commodities.

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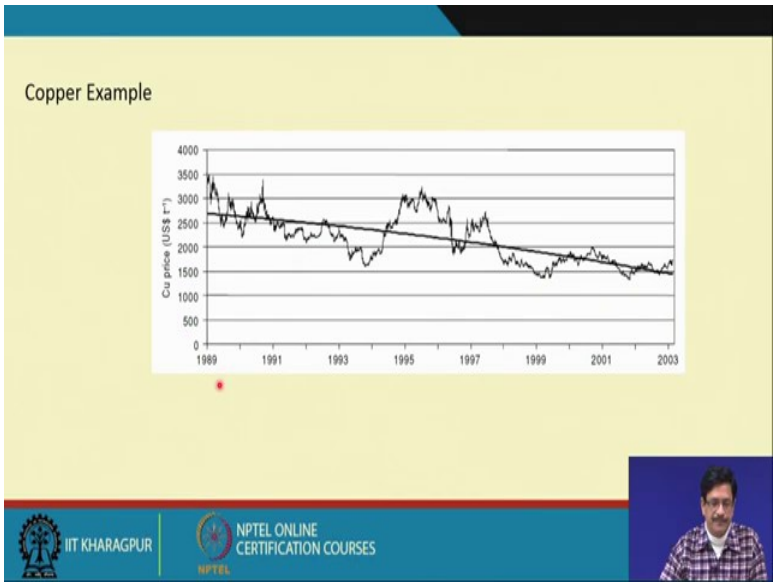

It is just an example; as one of the exercise that is taken up in mineral economics to study such kind of behavior over a considerable period of time and the longer the period the better it is.

And as we also discussed before that mineral economics it involves quite rigorous, extensive amount of research and analysis on the production consumption and price data of the past to understand the cycle, to understand the behavior or the way in which price varies. This is an example of a variation of a price of metal copper for a period from starting from 1989 to 2003 about 14, 15 years time.

We could see that this price does not remain constant it is expected and there are several periods in which the price is high and there are drops and peaks. So, these provide ample scopes for econometric time series analysis and to establish the trend which for example, we can see a trend of a decreasing trend from 1989 to 2003.

And sometimes the forecasts can only be done based on the number of years past years of data that we have and will have its uncertainty, but still many of the economic policies etcetera are made on the basis of what is the forecast that is made by looking at the behavior of the price of the metal.

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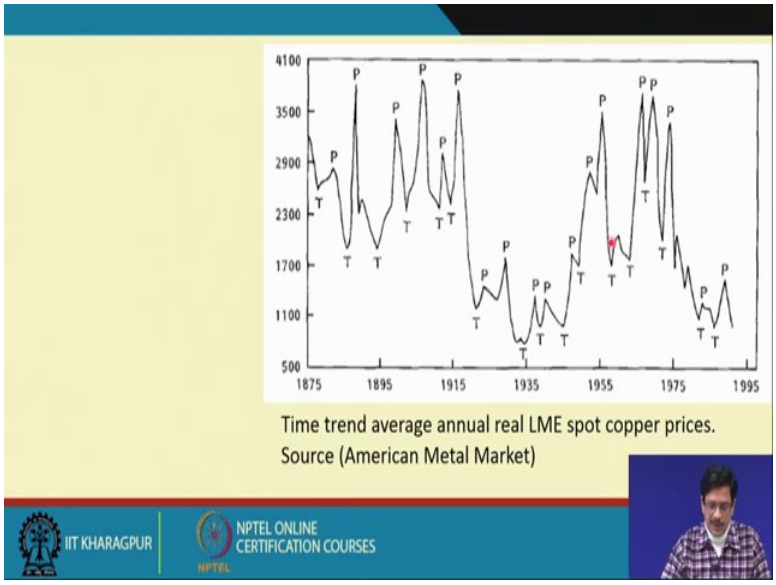

And if we look at this diagram which gives a period which is 1875 to 1995 almost around 120 years; here also we could see that there are peaks and drops which is very usual for the variation. So, people have proposed cyclicality; that means, the variation of the metals prices obeys like kind of a cyclic behavior with rise and fall in the price which is demarcated by this peak and drop.

And it is also being correlated with the normal business cycle. So, business cycles always also go in the form like with peaks and drops. So, the mineral prices also follow the similar kind of trend. So, the econometric time analysis tries to find out the trend and the seasonality; that means, in the previous diagram. In this kind of a diagram if we take a smaller period from say 1895 to 1915; we will see several, about at least 2 or 3 and within this 120 years time we could see a number of peaks and drops.

So, depending on the time span we can describe them as having some seasonality and can analyze that seasonality and which will be useful for a prediction and. So, there is something like in context of price, also the terminologies which are used as they called as the elasticity in the price.

This elasticity could be because of demand or supply. So, as and when there is an increase in the demand of the particular metal, the price increases when there is a fall in the demand the price decreases. And also in the context of price, metal price also is said to be volatile and there is some kind of a the past memory is not kept, but it is more important to see the cyclicality and the elasticity in the metal prices.

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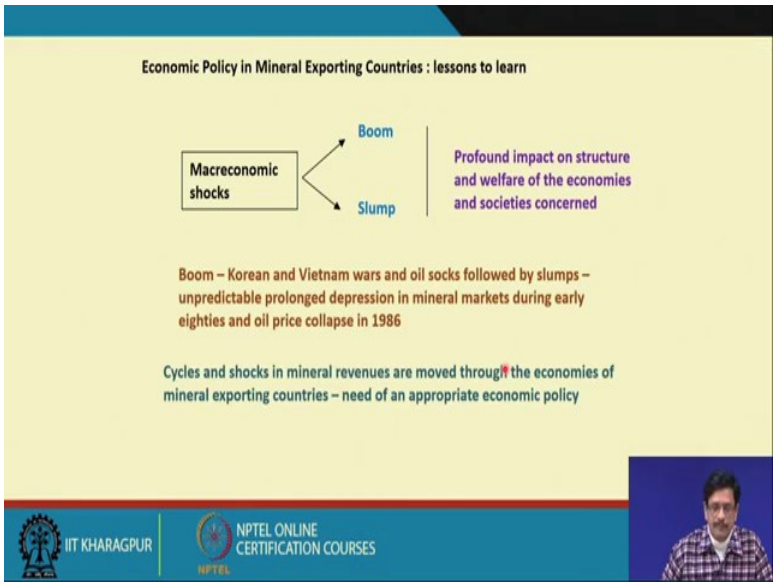

So, from this we can possibly just look at that whenever a we are considering the macroeconomics of mineral resources. And in macro economy we generally have shocks; the shocks either could be a Boom or a Slump. So, boom in means positively, there is a very sudden hike in the price of a particular commodity; say particular metal and that will make the producer have increased revenue.

And there are slumps. So, this slumps and boom they have profound impact in the structure and welfare of the economies and societies concerned. We have several such examples in the past during the Korean and Vietnam wars there was boom in the oil prices there, the oil shock of the of the 1980s and also the unpredictable prolonged

depression in the mineral markets during the early 80s when the oil price collapse in 1986 these are all examples of such kind of shocks.

So, the cycles and shocks in mineral revenues are moved through the economies of mineral exporting countries. So, that is why there is always a need for an appropriate economic policy for exploitation of these mineral resources.

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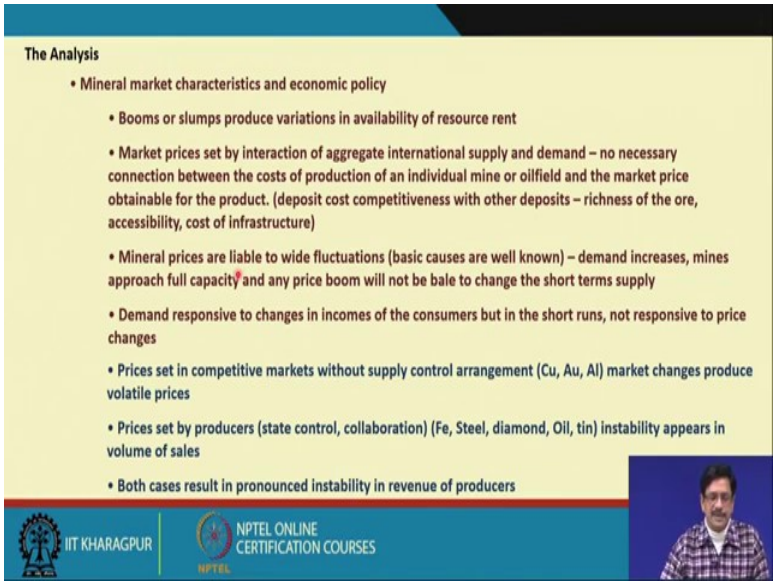

So, the mineral market characteristics and economic policy, booms or slumps produce variations in availability of resource rent.

The market prices set by interaction of aggregate international supply and demand; no necessary connection between the costs of production of an individual mine or oil field and the market price obtainable for the product. Deposit cost competitiveness with other deposits, richness of the ore, accessibility, cost infrastructure which we have discussed in brief.

So, that does not to be any necessary connection between the cost of production of an individual mine or the ore field which we just discussed because there could be inter deposit variation of the cost of production of a particular ore, particular metal. The mineral policies are liable to wide fluctuations basic causes are well known that is a part of the business cycle. Demand increases, mines approach full capacity and any price boom will not be able to change the short term supply.

For example, now even when there is a particular mineral deposit whose exploitation starts with a particular growth plan, the rate of production in terms of the amount of metal per year. And even if there is a sudden rise in demand or a fall in demand, the supply cannot be changed immediately within response to such kind of fluctuations.

So, demand responsive to changes in incomes of the consumers, but in the short runs not responsive to price changes. Prices set in competitive markets without supply control arrangements say example of copper, gold and aluminum market changes produce volatile prices. Prices set by producers; state control or collaboration such as the cartels that we are talking about iron, steel, diamond, oil and tin. Instability appears in volumes of sales, both cases result in pronounced instability in revenue producers.

So, these are the some of the situations which always have to be kept in mind while formulating the economic policy about the possible fluctuations in the market in the international scenario.

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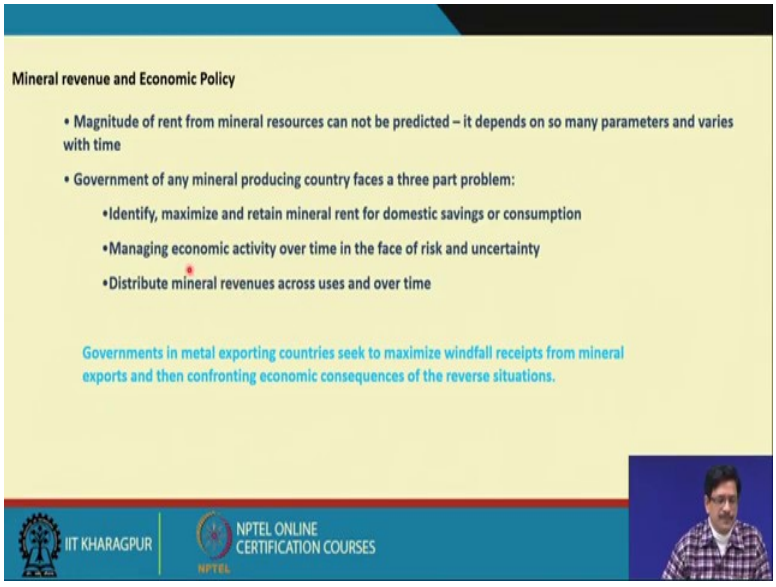

So, in the mineral revenue in context of economic policy; the magnitude of the rent from mineral resources cannot be predicted it depends on so, many parameters and varies with time. Governments of any mineral producing country faces three part problem identify maximize and retain mineral rent for domestic savings or consumption.

Managing economic activity over time in the face of risk and uncertainty; distribute mineral revenues across uses and overtime. So, these are the three important points which actually lie at the backbone of the economic growth from mineral resources because it is a no denying to the fact that; there are economic benefits and definitely mineral resources contribute to the economic growth of any mineral rich country.

But the situation is that the mineral resources when they are getting exploited or any amount of revenue that is earned by the mineral resources have to be very judiciously allocated including for further exploration or allocation to some other form of wealth which we will be discussing in the next point of discussion when we come to certain case studies. So, any government with mineral producing country has to keep these things very much in mind while formulating the economic policies. So, managing the economic activity over time in the face of risk and uncertainty which we just discussed before; there are so many shocks that can happen in a in a in a mineral market.

So, the governments in metal exporting countries seek to maximize, windfall the shifts from mineral exports and then confronting economic consequences of the reverse situations. For example, it is not that very difficult to understand that if a particular country is producing a mineral commodity or a metal which is on great demand in international market.

So, it keeps on getting the benefit out of it in terms of we say what we call is windfall receipts. And then the reverse also can occur, but then the policy would be such that the economy has to be made sustainable by a proper policy which will take into consideration these situations.

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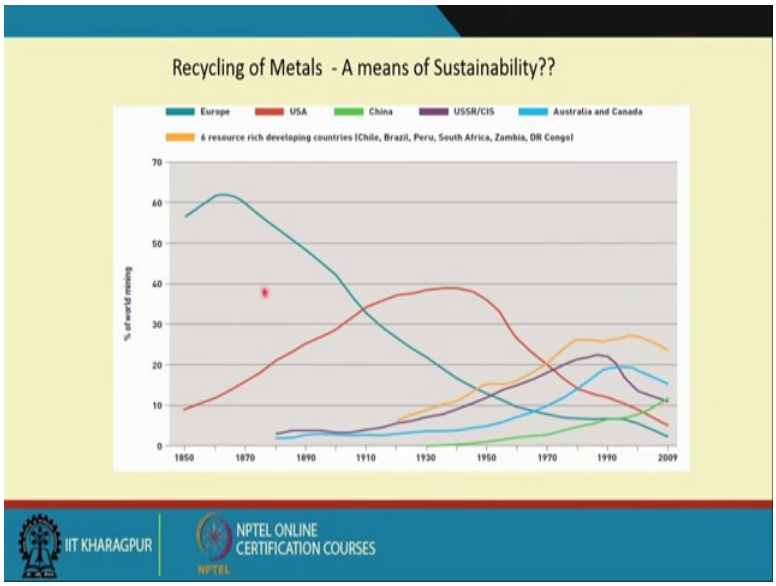

So, now let us look into one of the very interesting aspects of mineral economics when we talk of sustainability. Sustainability is a major concern in the global context and in case of mineral resources we always ask the question to ourselves how long our resources are going to last and we all know that they are going to get exhausted at some point of time. So, before we go to the recycling of metals whether it could be a mean of sustainability; this diagram would be interesting to look at.

If we see the percentage of world mining then we can see that almost all Europe, the United States of America just other than the example of China where the percentage of world mining is still have been increasing till 2009; most other developed part of the world the mining activity has slowed down or the percentage of world mining has almost from Europe starting from almost is greater than 60 percent to now reaching to almost a value of 0.

So, it does look like that these of course, would have some different interpretations in the sense that some of the countries which are already developed countries; they possibly have switched over from resource based economy to service based economy and they are no longer dependent on the natural resources for the growth of the economy.

Whereas, in countries like developing world like India and China we still depend on the mineral resources to contribute to our economic growth. And in cases of the developed countries it is there is one concept that has come to as a intensity of use, where we see

that the contribution coming from the mineral sector to the gross domestic product GDP is taking a reverse direction that indicates that it is switched over from a resource base to a service based economy.

But the question remains that after all, the per capita consumption of metals or the demand of metals or materials have down never been on a decreasing or declining trend.

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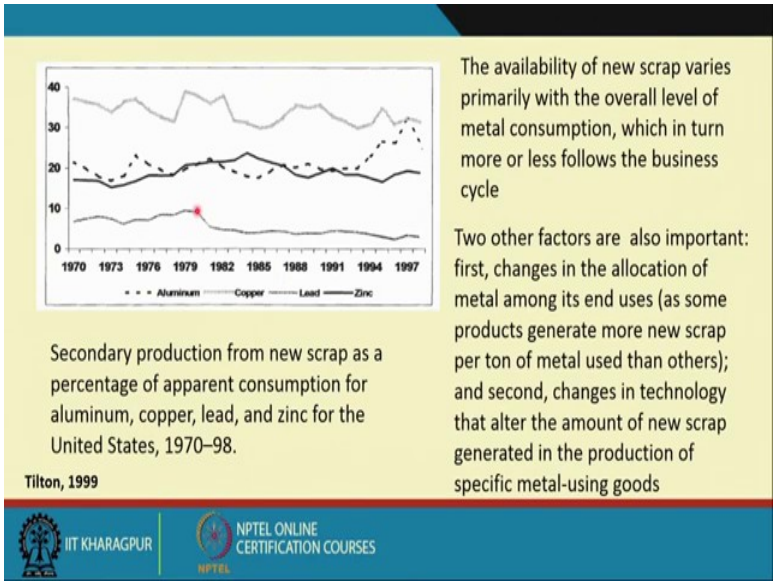

So, let us look at one interesting things that whether we could have recycling of the metals. Because with several centuries, record of exploitation of metals and the minerals we have developed the industry, technology, develop different products at the; we using them for a good amount of time and have been discarding them in terms of scraps.

And so, whether we could use those scraps and to have metals recovered from these scraps and can supplement or can augment to meet the increasing demand of metals or not. So, the scraps are essentially we can think of in two different types that the new scrap and the old scrap. New scrap is not difficult to understand whenever there is any kind of fabrication that is taking place from metals. Take any example like building a car or making a nut or a bolt.

So, there are metals which are coming out as waste which can be called as new scrap. So, the availability of new scrap varies primarily with the overall level of metal consumption which in turn more or less follows the business cycle. More is the consumption of metal

more will be the scrap that will be produced. There are two other factors which are also important, the changes in the allocation of metal amongst its end users; some products generate more new scrap per ton of metal used.

Others, for example, it also depends on the technology of fabrication and second is the change in technology that alter the amount of new scrap generated in the production of scientific metal using goods. This graph shows that copper is the metal which is the most contributing the maximum percentage of the new scrap and the bottom one is for leg and this is zinc and this is aluminum.

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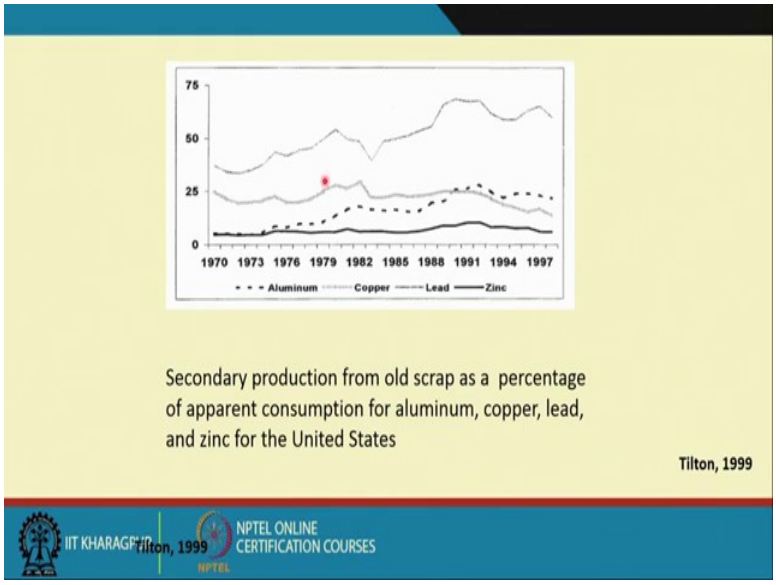

So, the other type of scrap is the old scrap; that means, that is recovered from all the metallic materials or the goods that had discarded. And this is the picture for the old scrap uses where aluminum and zinc are the lowest and we find that lead is higher.

Because its recovery from many of the metal materials containing lead.

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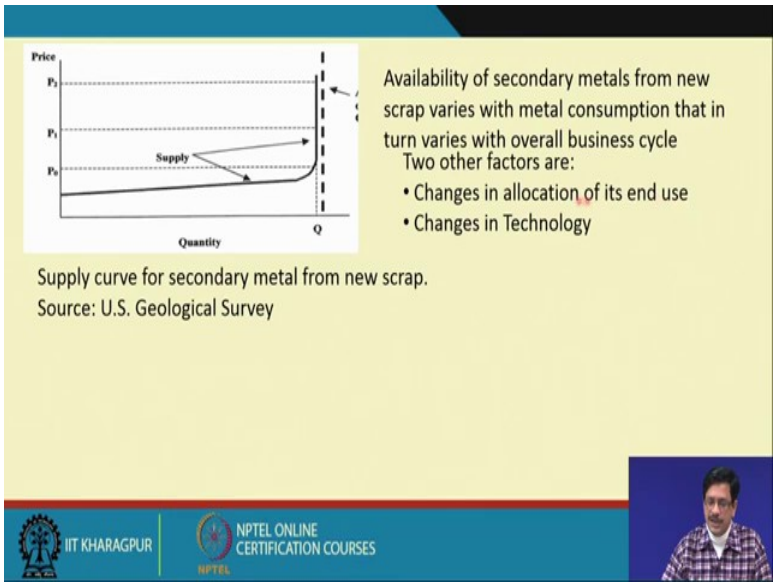

So, here this gives us an idea as to what is the possibility. The new scrap, the availability of secondary metals from new scrap will always have a limit in its supply of quantity; even if it is available or affordable at a price starting at 0. Even if the metal price goes up even up to P 1 or even more than that, the quantity of the metals that will be available from the processing of the new scrap will be limited.

And so, here we see that the availability of secondary metals from new scrap varies with metal consumption that in turn varies with overall business cycle. So, two other factors change in the allocation of its end use and the change in technology which we just discussed.

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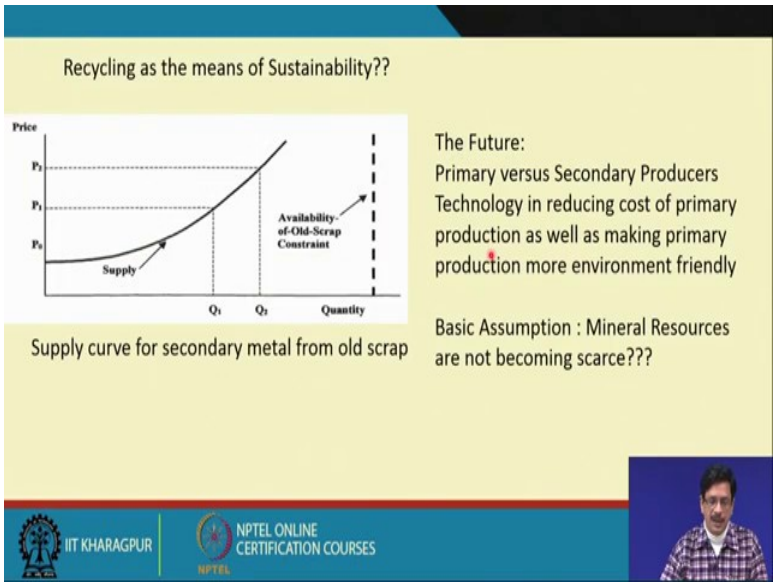

And the picture with the old scrap is a little different because old scrap are difficult to obtain and they also to recover the metal. So, it always depends on what is the maximum price it could be affordable. And we see that the quantity of the metal which will be made available from the old scrap will always have an increasing trend and can be substantial; its quantity can go to very high values and with the increase in the metal price.

So, this the basic difference between the old scrap and the new scrap and the future is that the primary versus secondary producers technology in reducing cost of primary production as well as making primary production more friendly. So, the question remains that whether the mineral resources I mean whether we will be increasingly depending on scraps of these secondary production from old or the new scraps for to meet the demand of a metal or not.

Many of the schools of thought believe that actually the resources the way we fear that the resources are getting depleted or exhausted; it may not be that very true and may be that the recycling will have very negligible or not so, significant effect on the sustainability, but looking at such kind of picture it looks that the recycling is going to be one of the major sources for the sustainable exploitation of the of the metal resources of the world. So, that is all about these some of the macroeconomic aspects.

So, thank you. We will continue our discussion in the next class.