RAW MATERIAL SECURITY
ROLE OF STATE

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FOREWORD

Mineral resources security is an issue of significance both at strategic as well as economic level. One of the key objectives of the 12th Plan for the mining sector, which is strategically very important for the country, is the raw material security for all its user industries. Securing access to sustainable supply of minerals is increasingly becoming an important factor for strategic planning. These concerns underline the need to develop a policy framework that leads to more exploration, exploitation of our natural resources and making them available to the manufacturing or other industries where these minerals are required as raw materials.

2. The long term geological availability of raw materials in future is not such a big concern; of greater relevance are the changes in the geopolitical – economic framework that impact the supply and demand of raw materials and also the high level of concentration of minerals in a few countries.

3. FIMI has gone deep into this subject and has prepared a comprehensive Report on various aspects of raw materials' security for the country. The Report gives an account of FIMI's perception and mineral-wise analysis, exploration strategy and policy initiatives to be adopted to secure raw materials both for mid-term and long-term for the country. The Report was submitted to the Prime Minister, Minister for Mines, Steel and Labour and Employment as well as Minister for Coal and Power as well as other concerned Ministers on 3 June, 2014. We hope the Report will generate healthy discussion and help in finding out ways and means to provide the country the security that it seeks for raw materials for its industry, defence and other areas.

New Delhi
03-06-2014

(R.K. SHARMA)
SECRETARY GENERAL

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RAW MATERIAL SECURITY – ROLE OF STATE

IMPORTANCE OF MINING IN INDIA'S ECONOMY

Next to agriculture, mining is the most important economic activity in the life of a nation. Apart from generating economic activity in areas where the minerals occur, mining also provides employment in the remote and tribal areas. Mining thus provides backward and forward linkages in the economy more than any other sector in making available raw materials for a vast spectrum of products. Fortunately India known to be a repository of a wide variety of mineral resources.

2. Unfortunately, the contribution of mining in the total GDP of the country hovers around 2% whereas considering the immense mineral wealth, it should have been much greater. What is more disturbing it that the growth of mining in the last three years has been negative : it was (-) 2.00% in 2011-12, (-) 2.4% in 2012-13 and (-) 4.5% in April-May, 2013-14.

3. It therefore hardly needs any emphasis that mining alone can redress the problem of regional imbalances by fostering accelerated investment and growth in employment in mineral – rich States which are still reeling under poverty and unemployment. It is also strategically important to accelerate mining activity as the geographical situation of many of the mineral-rich states impose constraints for growth of agriculture and manufacturing sector. Thrust on mining is also a sure recipe for containing naxalite and maoist activities that are now spread across 200 districts in the country.

CONCERN FOR RAW MATERIAL SECURITY

4. In the present-day economic scenario world over, it is essential that the Government should strive to secure raw material availability to domestic industry at reasonable prices to maintain competitive edge over its competitors, Government has therefore to play an active role in securing supply chain from domestic and foreign sources for domestic industry.

5. Raw material security is also very necessary to take care of the rapidly changing economic scenario in South-East Asia as well as in the world. Global population growth — together with upward trends in urbanization and industrialization has led to strong demand for commodities from the mining and metals industries. What impact it has now or will have in future and how we cope with such an emerging situation will have its repercussions on India's raw material security. It will also have its impact on India's economic, political and social milieu.

6. The concern for raw material security emanates primarily because of hostile geo-political situation as is existing now and may evolve in future on our northern and north western or eastern frontiers as well as in littoral states / countries around India. How will India's raw material requirements be ensured in case hostilities break out, surrounded as we are from all sides by hostile and non-cooperative nations? Unless these compulsions are taken care of fully, the survival of our nation will itself be in jeopardy.

7. Concern for raw material security is further compounded by the lack of seriousness or the willingness of Central and State governments to promote exploration of natural resources and their optimum exploitation for the benefit of the nation. The lackadaisical manner with which the resource-rich States deal with mineral concession applications from entrepreneurs makes one believe that

they are not interested in the development of mineral resources for the economic benefit of local people or the nation*. It has to be remembered that minerals can be explored and exploited where they occur and since they occur in remote and tribal areas, they have the largest spread in terms of providing employment and bring about socio-economic revolution in these areas.

NEED FOR SECURITY

8. Mineral resources security is an issue of significance both at strategic as well as economic level. One of the key objectives of the 12th Plan for the mining sector, which is strategically very important for the country, is the raw material security for all its user industries. Securing access to sustainable supply of minerals is increasingly becoming an important factor for strategic planning. These concerns underline the need to develop a policy framework that leads to more exploration, exploitation of our natural resources and making them available to the manufacturing or other industries where these minerals are required as raw materials.

9. The long term geological availability of raw materials in future is not such a big concern; of greater relevance are the changes in the geopolitical – economic framework that impact the supply and demand of raw materials and also the high level of concentration of minerals in a few countries. For most commodities, the primary reserves are not located in the same places that generate most of the demand. Many developing economies are pursuing industrial development strategies by means of trade, taxation and investment instruments aimed at reserving their resource base for their exclusive use.

** As per data collected by Ministry of Mines, there are : (as on 05-05-2014) 643 concession applications pending for grant of RP with various states, 19891 for PL and 42861 ML and (as on 05-05-2014) 265 LOIs and 2515 renewal applications including of captive mines pending with the various state governments.*

GEOLOGICAL SETTINGS AND NATIONAL MINERAL POLICY 2008

10. Geologically, India has more or less the same prospectivity as other resource-rich countries such as South Africa, Australia, Canada, Brazil, Chle, etc. Why is it that India continues to be under-explored and under-exploited? Is it the lack of policy initiative or apathy of State and/or Central governments? And if there is already a policy at the Central level, is it the will or desire of Central and/or State governments not to implement this policy at ground level? Or the policy itself is flawed?

11. Following acceptance of the recommendations of High Powered Committee (popularly known as Hoda Committee) set up by Planning Commission under the Chairmanship of Mr. Anwarul Hoda, the National Mineral Policy (NMP) for non-fuel and non-coal minerals was revised in March, 2008. Apart from emphasizing that *"India is a federal structure with a single economic space"* (para 2.6), NMP 2008 has the following important enunciations that are desirable for inviting FDI and alongwith it the state-of-the-art technologies, not available in India:

> *"In order to make the regulatory environment conducive to private investment the procedures for grant of mineral concessions of all types, such as Reconnaissance Permits, Prospecting Licenses and Mining Leases, shall be transparent and seamless and security of tenure shall be guaranteed to the concessionaires. The first-in-time principle in the case of sole applicants and the selection criteria in the case of multiple applicants will be appropriately elaborated. Prospecting and mining shall be recognized as independent activities with transferability of concessions playing a key role in mineral sector development. (para 3.3)"*
>
> *"……In mining activities, there shall be arm's length distance between State agencies (Public Sector Undertakings) that mine and those that regulate. There shall be transparency and fair play in the reservation of*

ore bodies to State agencies on such areas where private players are not holding or have not applied for exploration or mining, unless security considerations or specific public interests are involved. (para 4.1)"

"……the private sector would in future be the main source of investment in reconnaissance and exploration and government agencies will expend public funds primarily in areas where private sector investments are not forthcoming despite the desirability of programmes due to reasons such as high uncertainties.(para 5.2)"

12. How then, despite such lofty enunciations in NMP 2008, hardly any FDI has percolated in this country? In fact, the initial euphoria is gradually giving way to nonchalance in so far as foreign companies are concerned. Many of them, who had opened their offices in India, have wound them up. The delays taking place in State governments and the introduction of Mines and Minerals (Development and Regulation) Bill, 2011 in Parliament which provided for high fiscal levies, provision for auction and other stipulations were negative factors for the multi-national and other exploration companies to have second thought on investment in Indian mining sector. Such regulatory uncertainties and delays in clearance of licences are forcing the foreign investors to withdraw from the country.

13. The experience of some of the foreign and Indian companies as reported to FIMI, who went for reconnaissance / exploration, had not been pleasant:

–	Govt. of Rajasthan :	Rejected 10 PL and one ML applications for **gold** of Metal Mining India Pvt. Ltd. (MMI) after expiry of their RPs/PLs in 2008. Reserved the areas in favour of RSMML (a State PSU) in 2010.

		:	Reserved the area for RSMML for **potash** for which PL was applied by two Indian companies who had technology tie-up with foreign companies. Potash is a rare mineral, entirely imported requiring solution mining deep below the earth surface, involving an initial investment of about US$ 2 billion. Rajasthan has also reserved manganese ore and rock phosphate for RSMML.
–	Tamilnadu	:	No RP / PL for **nickel** to Premier Nickel Mines Ltd. as area was reserved for exploration through MoU between TAMIN (a State PSU) and GSI.
–	Karnataka	:	Rejected four PL applications for **gold** by Deccan Exploration (P) Ltd. and Geomysore Services (India) Pvt. Ltd. after expiry of their RPs in favour of Hutti Gold Mines Ltd. (a State PSU). RP applied by HZL for gold in 1999 and approved by Government of India in 2010 is yet to be executed by Government of Karnataka.
–	Chhattisgarh	:	While issuing a LOI for **copper** in favour of Mira Exploration Pvt. Ltd. stated that Govt. can not assure ML in case of adverse decision of the Committee. Chhattisgarh has a policy of reservation of bauxite leases in favour of CSMDC who then contract these to private parties.

–	Gujarat	:	Reserved entire **bauxite** and **limestone** areas in favour of GMDC (a State PSU).
–	Jharkhand	:	GSI getting priority over prior applications for exploration by private entrepreneurs.
–	Orissa	:	Reserving all areas for iron, manganese, chromite and bauxite for Orissa Mining Corporation despite their working only in few areas given to them and that too in joint venture with private partners.

14. The policy of various State governments to reserve mineral areas for their units which are among the critical raw materials as far as India is concerned is highly skewed and counterproductive. These public sector units have neither the financial wherewithal nor technical and managerial capabilities to explore and exploit them. Had it been so, they would have explored and developed these resources. Importing these minerals is causing a huge drain on the foreign exchange revenues. Reservation of the areas for public sector has neither benefited the country nor would it be in its long-term interest. Resources available in the country have to be explored by latest technologies, if necessary, by attracting foreign investment and exploited to its advantage.

15. The case studies conducted by International Council on Mining & Metals (ICMM) and the consultancy firm Oxford Policy Management (OPM) and World Economic Forum (WEF) gave valuable insights into the macro-economic contribution of mining. The emerging evidence indicates that mining FDI combined with foreign exchange earnings can increasingly create positive development efforts, such as contribution to job creation and poverty alleviation.

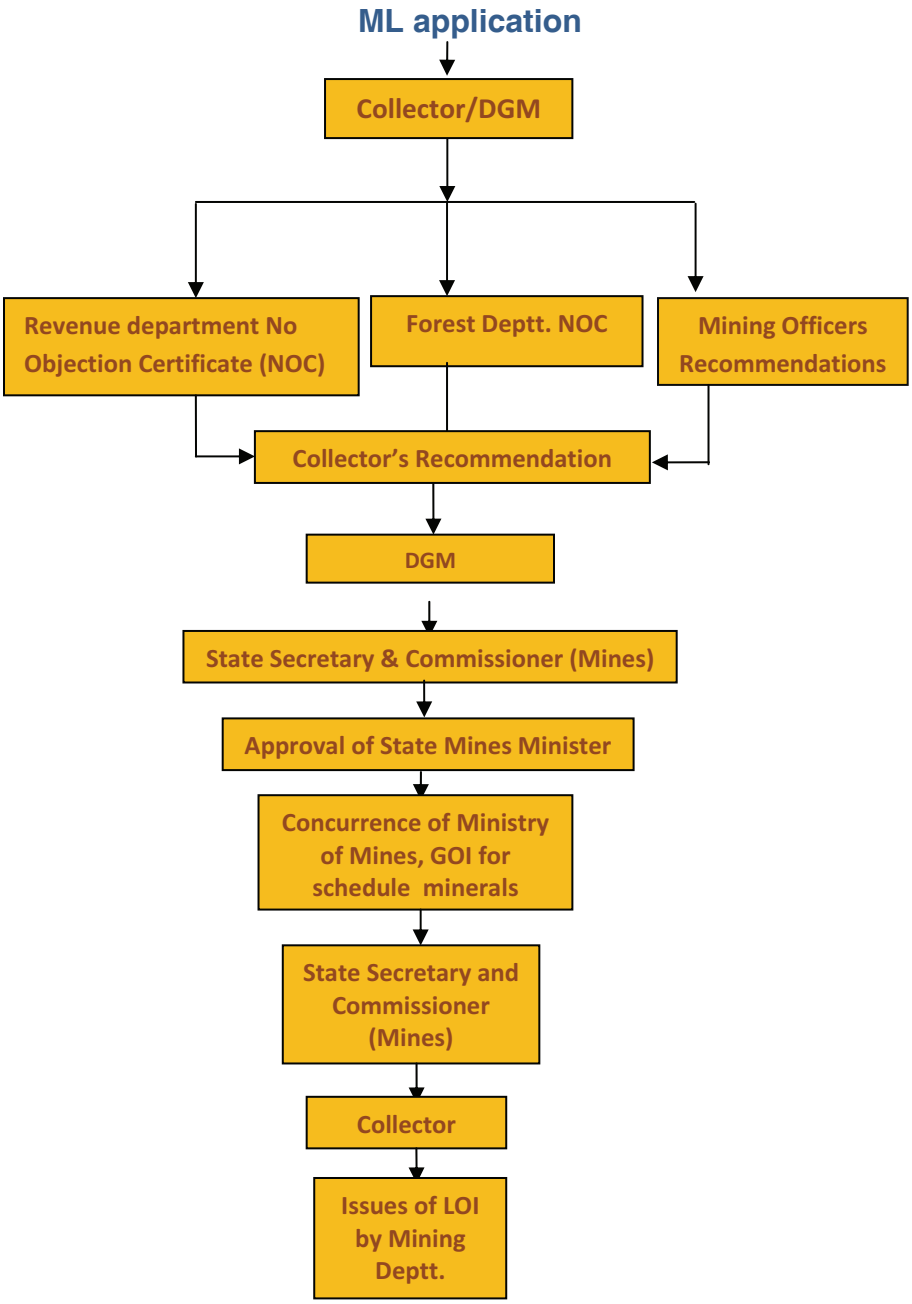
16. The World Bank, in its 2013 report on "Ease of Doing Business" has placed India in 132nd position out of 185 economies, while Fraser's 2012 – 13

survey of mining companies has put India at 81st out of 96 in a comprehensive assessment of the attractiveness of mining policies in a jurisdiction. These reports comprehensively bring out the policy and regulatory environment so inimical to doing business in India, particularly in mining sector. These reports therefore provide direction and potential for improvement in the mining sector by the Government to consider and implement.

MINERAL REGIME IN ACTION: DELAYS AND FRUSTRATIONS

(A) MMDR Act, 1957

17. Although MMDR Act does not provide detailed procedure for grant of mineral concessions (it only provides that an entrepreneur has to apply to the respective State government), various State governments have delineated different procedures. The following chart brings out broadly the procedure being followed for the grant of mining lease:

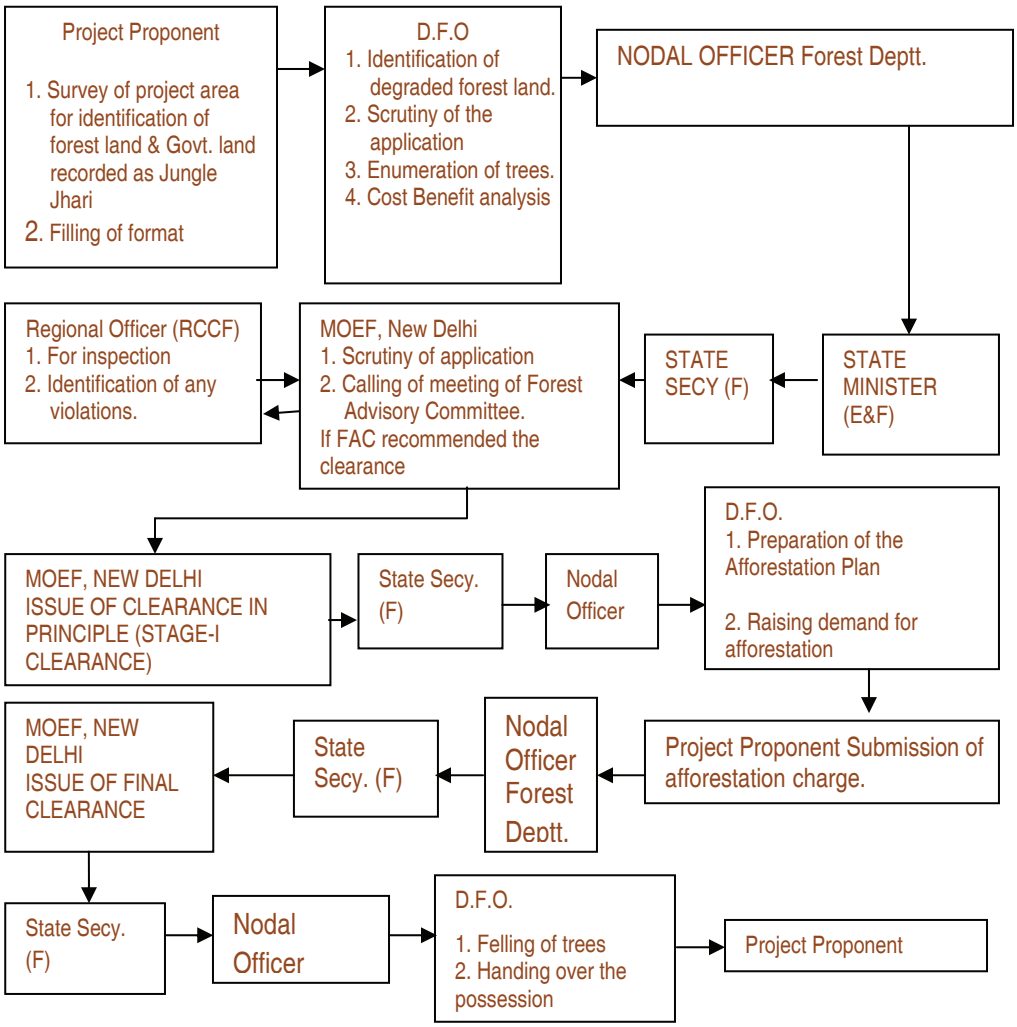


After the grant of letter of intent (LOI) from the State government, a lessee has to prepare plan (MP) for approval by Indian Bureau of Mines (IBM) / State government before the execution of the lease deed. This is no where done in any resource-rich country anywhere in the world.

(B) FOREST (CONSERVATION) ACT, 1980

18. For exploring and mining on forest land, prior permission of Central government is required under Forest (Conservation) Act (FCA), 1980. Rule 6 of the Forest (Conservation) Rules, 2003 prescribes the procedure for submission of proposal for seeking prior approval of the Central Government under Section 2 of FCA 1980. While guidelines issued under F(C) Act have exempted drilling of boreholes in forest areas (4" dia) upto a limit of 20 nos. in 10 sq km for exploration purpose, this is grossly inadequate for prospecting under prospecting licenses for all practical purposes. As a result prospecting in forest areas has come to a standstill since procedures for forest clearances for prospecting are the same as for mining, and take years to obtain. Compensatory afforestation (CA) and payment of net present value (NPV) of forest land are the most important conditions stipulated by the Central Government while approving proposals for de-reservation and diversion of forest land for non-forest purposes. The proposal is cleared in two stages: in first stage, the proposal is agreed to in principle whereas in the second stage, the final approval is granted. The following chart brings out the process through which the proposal for diversion of forest land for mining and exploration has to pass.

Procedure for Processing of Application for Mining in Forest Land



The Schedule Tribes and other Traditional forest Dwellers (Recognition of forest Rights) Act, 2006 – Forest Clearance under F(C) Act 1980 is nowadays granted only after a certificate that all forest rights have been settled, and consents from all *gram sabhas* obtained.

(C) ENVIRONMENT (PROTECTION) ACT, 1986

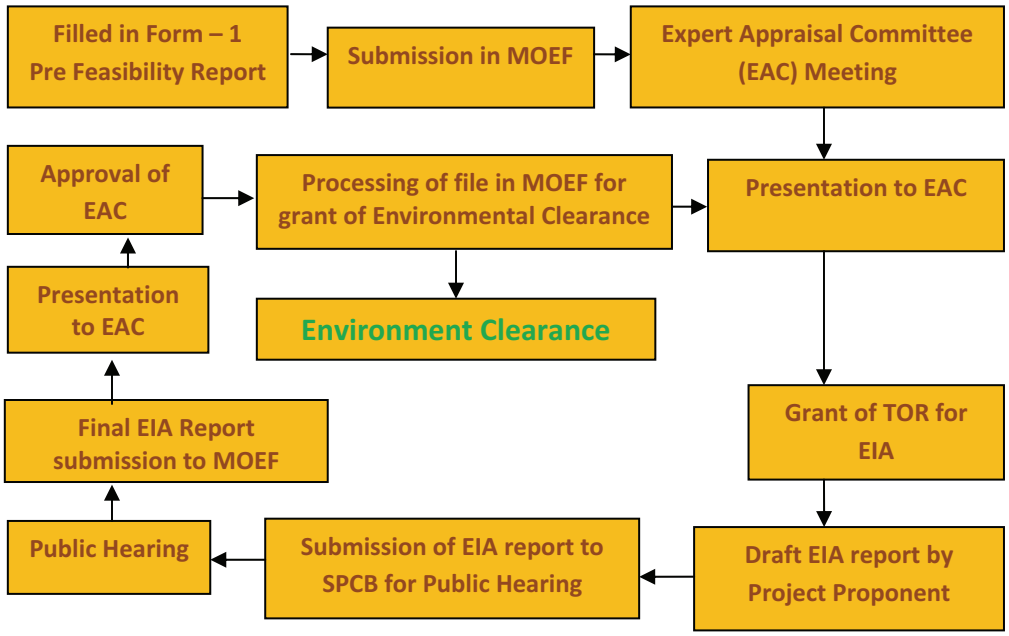
19. Environment (Protection) Act (EPA) 1986 and the rules framed thereunder provide for prior permission from the Ministry of Environment and Forests. The following table brings out clearly the mining projects requiring environmental clearance, although prospecting operations have been exempted:-

Project or Activity		Category with threshold limit		Conditions if any
		A	B	
1		Mining, extraction of natural resources and power generation (for a specified production capacity)		
(1)	(2)	(3)	(4)	(5)
1(a)	[(i) Mining of minerals (ii) Slurry pipelines (coal lignite and other ores) passing through national parks/ sanctuaries/ coral reefs, ecologically sensitive areas.][16]	[≥ 50 ha. of mining lease area in respect of non-coal mine lease > 150 ha of mining lease area in respect of coal mine lease. Asbestos mining irrespective of mining area All projects.][16]	[[<50 ha of mining lease area in respect of minor minerals mine lease; and] <50 ha ≥5 ha .of mining lease area in respect of non-coal mine lease. ≤150 ha ≥5 ha .of mining lease area in respect of coal mine lease.]	[General condition shall apply [except for project or activity of less than 5 ha of mining lease area for minor minerals: Provided that the above exception shall not apply for project or activity if the sum total of the mining lease area of the said project or activity and that of existing operating mines and mining projects which were accorded environment clearance and are located within 500 metres from the periphery of such project or activity equals or exceeds 5 ha] Note: (i)Prior environmental clearance is required at the stage of renewal of

Project or Activity		Category with threshold limit		Conditions if any
		A	B	
1		Mining, extraction of natural resources and power generation (for a specified production capacity)		
(1)	(2)	(3)	(4)	(5)
				mine lease for which an application shall be made up to two years prior to the date due for renewal. Further, a period of two years with effect from the 4th April, 2011 is provided for obtaining environmental clearance for all those mine leases, which were operating as on the 4th April, 2011 with requisite valid environmental clearance and which have fallen due for renewal on or after the 4th November, 2011.] ["Provided that no fresh EC shall be required for a mining project or activity at the time of renewal of mining lease, which has already obtained an EC, under this Notification".] [(ii) Mineral prospecting is exempted.]

20. The following table brings out the procedure for grant of environmental clearance:

Grant of Environment Clearance by MOEF



(D) LAND ACQUISITION

Land Acquisition / Land owner's consent

21. Rule 22(3)(h) of Mineral concession Rules 1960 requires the applicant to obtain surface rights over the area applied or to obtain the consent of the owner for starting mining operations, after execution of lease deed but before entry into the said area. "The Right to Fair Compensation and Transparency in Land Acquisition, Resettlement and Rehabilitation Act 2013", comes into effect from 1st January, 2014, and is applicable for land acquisition by the appropriate government for its own use including for PSUs and for public purposes. The provisions relating to resettlement and rehabilitation also apply in case of purchasing land through private negotiations for an area equal to or more than the limit prescribed by the concerned State government. In such cases, land use change shall be permitted only if the R&R is complied with in full. The following chart delineates the process one has to go through to acquire land as per provisions of this Act :

Process Flow for Land Acquisition under new Act

Receipt of Proposal by State Govt.		
Consultation with Panchayat/Munc.	Legitimacy of Public Purpose Examined	
SIA by State Govt. within 6 months of its commencement.	Public Hearing	Consent of 80% Affected sought (Procedures to be completed within 6 months of SIA notification)
SIA and SIMP made available to Panchayat, published in affected area, Govt. offices, uploaded in Govt website.	Social Impact Management Plan	
SIA Examined by Expert Group and recommendations <2 mths	Collector submits report on Alternative sites	
Decision of Government communicated to Panchayat, Gram sabha, website, District offices		
Preliminary Notification (PN) to Acq. Within 12 months from the date of appraisal of SIA Report or else such report will be deemed to have lapsed		
Administrator (R&R) conducts survey and census of affected families		
Draft Decl. & R&R Scheme published, wide publicity, discussed in Gram Sabha		
Public Hearing		
Administrator R&R submits scheme to Collector report on claims/objections at Public hearing.		
Collector submits draft scheme to Commissioner R&R for approval		
Commissioner R&R will make available approved R&R scheme to Panchayat, Distr. Offices and in website. Requiring Body deposits acquiring amount		
State Government (Collector) **Declaration within 12 months from the date of publication of PN**		
After making such Declaration the Government may acquire land as per the Act		

.....Process Flow for Land Acquisition

The Collector shall cause the lands to be marked out and measured and a plan to be prepared
The Collector shall publish the public notice on his website that the Government intends to take possession of the land.
The Collector shall make an award within **12 months** from date of publication of Declaration under section 20.
The Collector shall take possession of land after ensuring full payment of compensation and R&R entitlements within payment of 3 months of compensation and **6 months of R&R from the date of the award.**

22. Any entrepreneur who wants to invest in Indian mineral sector will simply be aghast if he sees these charts which depict the levels / processes through which one has to pass through and the time which the whole process will take

before he gets mineral concession and to start mining. The labyrinthine maze of procedures mixed with movement of files with an `infinite slowness of a glacial' at each level will shy away any investor, domestic or foreign, unless serious steps are taken to look seriously into whole gamut of rules and regulations.

23. This emphasizes the need for integration and simplification of laws procedures and reduction of delays involved therein. For example, `public hearing' at the time of Land Acquisition Act should be sufficient for purposes of environment clearance and no separate `public hearing' should be necessary again. This, while reducing time taken for clearances, will actually make the environmental and social impact assessment more robust. Although forestry is a separate subject which can be handled by specialized agency like Director General Forests, as far as environment is concerned, it forms a part of mining plan to be approved by Indian Bureau of Mines (IBM). The EIA / EMP and environment appraisal process can very easily be integrated with the process of `mine plan' approval by integrating Environment Appraisal Committee (Mining) of Ministry of Environment and Forests with IBM.

24. Before granting the lease, the Government of India should ensure that an entrepreneur is not required to go for clearance under Forest (Conservation) Act, 1980 by making forest land available for mining subject to such conditions as payment of compensatory afforestation charges and net present value (NPV) of the forest land. Even in the case of clearance under Forest (Conservation) Act 1980, no clearance should be required at the time of renewal as the area has been already diverted for mining and all the formalities completed and the charges for compensatory afforestation and net present value already paid at the time of fresh grant.

EXPLORATION ONLY WAY TO UNLOCK MINERAL POTENTIAL

25. There is an urgent need to explore minerals / metals which are necessary for country's economic and political security. Indian mineral regime can be divided in three distinct categories:

i. 95% of the bulk minerals like limestone, bauxite and almost 20% iron ore are captive to industries for which these are raw materials. The balance quantity is extracted by a large number of concessionaires spread all over the country.

ii. In other cases, the ownership of mineral concessions is mostly with individuals, partnership firms or private limited and some public limited companies, both private and Government.

iii. The minerals/metals with which India is vitally concerned now and will be in future such as gold, lead/zinc, copper, nickel, PGMs, diamond, REEs are not yet fully developed or their potential not realized because of:

- Lack of state-of-the-art exploration technologies
- High risk and size of the capital required not available in India so far
- Most of the deposits so far are thus chance discoveries

This category of minerals / metals will require latest and state-of-the-art technology for exploration as well as exploitation, which requires huge investment.

26. There is a shortage of mineral commodities like apatite – rock phosphate, manganese ore, copper ore and coal (coking and non-coking). In addition, there is going to be a new demand for rare earth elements and energy critical metals like tellurium, selenium, germanium, gallium, vanadium, lithium, niobium, rhenium and tantalum which find application in high tech futuristic and cutting edge technologies. These metals are characterized by high density, high melting point, high conductivity and high thermal conductance. These unique properties make them indispensable for a variety of emerging and critical technology applications relevant to India's energy security. These metals though used in very small quantities but when multiplied by large volumes of ultimate products,

become strategically important. These are the minerals for whose exploration, least attention seems to have been given. GSI has no doubt done regional exploration but to exploit a deposit and to analyse its economic viability, one has to go for detailed exploration and analysis of the ore body to choose appropriate technology.

27. The total mineral potential area in India covers 5.75 lakh sq. kms. of which only 75,000 sq. kms. area has been explored in detail so far but not at depth. India has high resources of iron ore, limestone, bauxite and coal, mica, barites, chromite, kaolin and manganese for which it finds a place amongst the top ten countries globally. The minerals/metals with which India is vitally concerned now and will be in future such as gold, copper, nickel, PGMs, diamond, etc. have not yet been fully explored and developed or their potential realized.

28. Despite the huge resources, there has been abysmally low exploration activity and minimal private sector participation particularly in exploration of strategic and deep seated mineral deposits requiring state-of-the-art technologies and risk capital. Because of lack of exploration, the incremental growth in mineral commodities in the country has been negligible. The business of mineral exploration and mining are dictated by the fluctuating market prices of mineral commodities and ever changing costs of input services and innovations in technology.

29. Mineral exploration is a highly competitive and specialized job done by exploration companies, a large number of what are popularly known as *junior exploration companies*. Their exploration expertise in most cases is linked to a particular mineral or group of minerals. For exploration job, they bank on venture capital or hedge funds. No mineral-rich country that has developed its mining industry has done so on the basis of government exploration in the last more than 30 years. The government in these countries create favourable

conditions and provide necessary data to the private sector to explore. Mineral rich countries such as US, Canada, Australia, Brazil, South Africa, Chile, Mexico etc. do not want 'to spend' tax payers' money on the risky venture like exploration.* These countries therefore encourage the private companies to undertake detailed exploration by providing various incentives and security of tenure besides priority in grant of concessions as well as freedom to sell / transfer the concessions.

30. An idea of the exploration expenditure incurred by various companies world-wide in the last five years can be had from the following table :

Year	Companies involved	Amount spent (US$ billion)	%age increase / decrease over last year
2009	1846	7.32	(-) 42.0
2010	2089	10.68	45.90
2011	2400	17.25	61.52
2012	3500	20.53	19.00
2013	3500	14.43	(-) 29.70

Source: Metals Economic Group, Canada

31. The exploration expenditure is dependent on the market conditions for a mineral / metal and swing in favour one, whose demand and price is more attractive, than the one whose demand and consequently price is comparatively less attractive. This will be clear from the following table :

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* *The exploration work is extremely risky : if during aerial survey, 1000 anomalies are observed, it may be that only 100 anomalies are worth ground prospecting and it may again be that only one out of these 100 turns out to be worth economic exploitation. The Governments do not therefore prefer to spend the tax payers' money on exploration because it does not want the tax payers' money to be invested in risky and hazardous ventures like exploration.*

(US$ billion)

Commodity	2006	2007	2008	2009	2010
Gold	3.21 (45%)	4.10 (41%)	4.914 (39%)	3.51 (48%)	5.45 (51%)
Base Metals (copper, lead/zinc, nickel)	2.28 (32%)	3.60 (36%)	5.04 (40%)	2.64 (36%)	3.52 (33%)
Diamond	0.86 (12%)	1.00 (10%)	1.008 (8%)	0.36 (5%)	0.32 (3%)
PGM (platinum group of metals)	0.21 (3%)	0.30 (3%)	0.378 (3%)	0.15 (2%)	0.21 (2%)
Other Minerals	0.57 (8%)	1.00 (10%)	1.26 (10%)	0.66 (9%)	1.18 (11%)
Total	**7.13 (100%)**	**9.99 (100%)**	**12.6 (100%)**	**7.32 (100%)**	**10.68 (100%)**

Source: Metals Economic Group, Canada

32. In the strategy paper prepared by McKinsey for the Ministry of Mines for "Unlocking the Potential of Indian Minerals Sector" (Nov. 2011), it is stated that the Indian mining sector has the potential to:

- Add US$ 210 billion to US$ 250 billion (Rs. 945 thousand crore to 1,125 thousand crore) to GDP by 2025, a growth of 10 to 12 per cent per annum. This includes US$ 60 billion to US$ 80 billion (Rs. 270 thousand crore to 360 thousand crore) direct and US$ 150 billion to US$ 170 billion (Rs. 675 thousand crore to 765 thousand crore) indirect contribution.

- Create 2 million to 2.5 million direct jobs by 2025, and an additional 11 million to 13 million jobs through indirect employment opportunities created in other sectors, thereby contributing 3 per cent to total employment.

- Contribute US$ 55 billion to US$ 70 billion (Rs. 275 thousand crore to 315 thousand crore) of revenue to the Central and State governments through corporate taxes, royalty and export duty collections by 2025 – around 50 per cent of the current combined fiscal deficit of the Central and the State governments.

33. In the next five years huge investments are needed on mineral exploration / prospecting to realize the potential of the Indian mineral sector. Despite opening up of the mineral sector for 100% FDI since February, 2000, there is

virtually no inflow of investment, domestic and foreign, in exploration, mining and metallurgical sector, and the incremental growth in mineral commodities in the country has been negligible. The opportunity loss to India in commodities like iron ore, diamond, gold, coal and bauxite compared to Australia as a consequence of less exploration is given at **Annexure-I**. If we are unable to discover these strategic minerals, either due to lack of exploration activity or any of these minerals is simply not available in the country, efforts will have to be made to have linkages with the friendly countries which have them either by way of trade agreements or acquiring assets.

THRUST AREAS

34. These can be divided into four broad categories in the Indian context:

(i) Bulk Minerals : Coal – coking as well as non-coking coal, iron ore, limestone and bauxite

(ii) Scarce / rare minerals which are available in small quantities and are limited to some countries. There is going to be a new demand for rare earth elements and energy critical metals like tellurium, selenium, germanium, gallium, vanadium, lithium, niobium, rhenium and tantalum which find application in high tech futuristic and cutting edge technologies. These metals are characterized by high density, high melting point, high conductivity and high thermal conductance. These unique properties make them indispensable for a variety of emerging and critical technology applications relevant to India's energy security. These metals though used in very small quantities but when multiplied by large volumes of ultimate products, become strategically important.

(iii) Strategic minerals can include nickel, phosphatic minerals (apatite/rock phosphate), potash, lithium and uranium etc.

(iv) High value minerals / metals like gold, nickel, copper, PGM as well as diamonds, most of which India only imports. These have not yet been explored, leave aside properly or

fully. A large number of deposits discovered so far are chance discoveries rather than concerted or detailed exploration. To realise their potential, state-of-the-art exploration technologies together with heavy dose of investment with attendant high risk would be required which is not available with public sector. In many of these minerals, detailed exploration is required to convert inferred resources into reserves for exploitation.

35. While dealing with bulk minerals, only important minerals like coal, iron, limestone and bauxite have been taken into consideration for the reason that there is enough production capacity to take care of requirements but full benefit is not being availed of due to the domestic environment / NGOs lobby and policy issues which are hampering supply chain and the country has to import them in substantial quantity. As regards iron ore, its availability, both in terms of resources and production, has never been in doubt and India has already produced iron ore much in excess of domestic requirements and also to meet export demand, basically from China. Thanks to steel lobby, Government of India imposed export duty @ 30% from December, 2011 and Railways hiked export freight 3.6 times the domestic freight. The exports became inviable and the country lost export opportunity, resulting in closure of mines and large scale unemployment. The main reason of restricting exports appear to be to deliver cheaper iron ore to steel companies which has encouraged them to continue with obsolete technologies and avoid adoption of latest technologies. Further, the domestic consumer did not get any benefit because of cheap raw material supply and continued to pay more than the international price of steel.

CRITICALITY OF RESOURCE

36. The criticality of their requirements can be appropriately gauged from their availability within the country as well as their existence in other countries and how their absence in the nation will affect its economic, strategic and long-term interests. A raw material is labeled `critical' / `strategic' when the risk of supply

shortage affects the programmes of futuristic high tech applications especially in clean technologies, defense, etc. and their impacts on economy are higher compared to most other raw materials. The strategic/critical minerals will vary from industry to industry and nation to nation. The critical elements for military hardware and defense system are gallium, lithium, niobium, the rare earth elements, rhenium and tantalum.

37. In Indian context, the strategic minerals are rare earth elements (REE), energy critical elements (ECE) — tellurium, selenium, germanium, cadmium, gallium and vanadium and lithium, which are essential for futuristic high tech application, especially in clean technologies. No reliable data on indigenous production of these elements is available. There is shortage of mineral commodities like apatite-rock phosphate, coal (coking and non-coking), copper, lead-zinc and nickel etc.

38. While detailed write-up on each of the minerals dealt with in this section is at **Annexure-II**, the narration hereunder is only to emphasize their criticality in the Indian context.

39. **(i) Bulk Minerals**

(a) Coal (coking and non-coking): Despite having the world's 5th largest coal reserves, coal imports have been growing at a fast rate. Coal production in 2012-13 was around 558 million tonnes against a projected demand of 773 million tonnes. The XIIth plan Working Group on coal and lignite has assessed a coal demand at 980.50 million tonnes by the terminal year 2016-17. The indigenous coal supply projections for the same year are 715 million tonnes. To meet the shortfall, adequate measures need to be taken to boost indigenous production. During 2012-13, India imported about 137 million tonnes of thermal coal and around 20 million tonnes of coking coal. The question arises when India has to import from private sector mines from abroad, why this country deprives the domestic private sector to play its role within the country?

(b) Iron ore : India has large resources of iron ore, estimated by Indian Bureau of Mines (IBM) at 28.53 billion tonnes as on 1.4.2010. Its production has been more than domestic demand. There is no doubt that India will be able to meet the iron ore demand of 206.2 million tonnes estimated at the end of terminal year (2016-17) of 12th Five Year Plan. However, the nature of domestic iron ore demand is heavily tilted towards consumption of lumps, making fines (which ultimately constitute more than 70% of production) surplus. Unless fines are exported, domestic production will be affected and India will have to import lumps / pellets as has happened in 2012-13 when imports were of the order of 3.05 million tonnes. India should therefore promote fines-based steel making technologies and have an open mind to export surplus fines till domestic industry is able to fully utilise them.

(c) Limestone : Limestone deposits of all categories and grades are placed at 184,925 million tonnes as on 1.4.2010. At present production is more than the demand. There is no likelihood of any shortages in the foreseeable future. However, since the resources are mostly fall in forest and CRZ, the life of residual limestone resources has been placed at 52 years (at 12% annual growth) by Working Group of the Planning Commission for 12th Five Year Plan. The country has therefore to find ways and means and technology to mine limestone from these areas without any or least damage to environment and regeneration of forest after mining to provide long-term raw material security to cement industry.

(d) Bauxite : Indian resources of bauxite are placed at 3480 million tonnes as on 1.4.2010 by Indian Bureau of Mines. Major resources are concentrated in the East Coast in Odisha and Andhra Pradesh. Production of bauxite is more than its demand. The Working Group of the Planning Commission for 12th Five Year Plan has concluded that the country has abundant bauxite resources of metallurgical grade and would be sufficient for its long-term requirements. However, here also, since most of the resources are on the East Coast, where NGOs have full play (as happened recently in the case of Niyamgiri), the country has been put in a serious situation. The bauxite deposits in the East Coast spread across Odisha and Andhra Pradesh occur on hill tops as a cap of 40-45 metres where there is no or hardly any forest cover ; forest growth is below this cap. It can easily be mined and transported through closed conveyor belts without any damage to environment and ecology of the area. India has the technology to do this but NGOs, under influence of foreign multinationals, are provoking tribals and villagers against the exploitation of bauxite deposits. These multinationals are afraid that once these deposits are available

to domestic aluminium industry, India will be one of the cheap producers of alumina / aluminium in the world.

40. **(ii) Scarce / Rare Minerals**

(a) **Cobalt :** Cobalt is a metal used in numerous diverse commercial, industrial and military applications, many of which are considered strategic and critical. On a global basis, the leading use of cobalt is in rechargeable battery electrodes. Superalloys, which are used to make parts for gas turbine engines, are another major use for cobalt. Cobalt is also used as catalysts for the petroleum and chemical industries; cemented carbides and diamond tools; corrosion- and wear-resistant alloys; dying agents for inks, paints, and varnishes; ground coats for porcelain enamels; high speed steels; magnetic recording media; magnets; and rubber adhesion for steel belted radial tyres.

India does not have any primary cobalt resource and the entire requirements are met through imports.

(b) **Sulphur :** Though its major derivative, sulfuric acid, sulfur ranks as one of the most important elements used in industrial raw materials and is of prime importance to every sector of the worlds' fertilizer and manufacturing industries. Sulfuric acid production is the major end use for sulphur, and consumption of sulfuric acid has been regarded as one of the best indexes of a nation's industrial development.

(c) **Tin :** Tin is one of the earliest metals known and used mainly in bronze implements. It is a scarce element having an incidence of about 2 ppm in the earth crust. Its unique combination of properties like non-toxic nature, high malleability, chemical inertness and ease with which it can form an amalgam and alloy with other metals, has given it a special status among non-ferrous metals. Tin, as a metal, is the most preferred and environment friendly packing material.

The country has minor production of tin ore (around 60,000 tonnes concentrates per year) and almost entire requirement / demand of tin and its alloys are met through imports only.

(d) **Tungsten :** Tungsten is a whitish gray metal with many unique properties and a wide variety of commercial, industrial and military applications. The leading use is as tungsten carbide in cemented carbides, which are wear-resistant materials used by the construction, metal working, mining and oil and gas drilling industries. Also used for lamp filaments and as Heavy Alloy Penetrator (HAP) in defense missiles.

Tungsten is not produced from primary sources in the country and the entire demand is met through imports. Keeping in view the criticality of requirement of tungsten for various defence applications, there is a need to become self reliant. Locating new deposits and its techno economic feasibility may require three to five years. It is imperative to reassess tailing dumps of Hutti Gold Mines for production of scheelite concentrate and other primary occurrences in the changed scenario.

(e) **Molybdenum :** Molybdenum is a refractory metallic element used principally as an alloying agent in cast iron, steel and supper–alloys to enhance hardenability, strength, toughness and wear-and corrosion-resistance.

In India, the molybdenum is associated generally with copper ore. The by-product concentrates of molybdenumare produced intermittently from uranium ore of Jaduguda mine of M/s. Uranium Corpn. of India Ltd. (UCIL) in Jharkhand. The internal demand for molybdenum and its products is met mostly through imports.

(f) **Vanadium :** Vanadium is a scarce element. It occurs in association with titaniferous magnetite and recovered as a by-product during iron and steel manufacturing. Vanadium's primary use is as a hardening agent in steel, in which it is critical for imparting toughness and wear resistance.

Vanadium sludge is separated as by–products during the production of alumina by hydrating through Bayer process having a very low content of vanadium. The demand for ferro-vanadium has to be met by imports.

(g) **Rare earth elements and energy critical metals :** Monazite is an important source of REE in India but is found along with radioactive elements, thorium and uranium. The heavier rare earths are not present in sufficient concentration in monazite. Further, indigenous resources for energy critical elements (ECEs) like lithium, tellurium, selenium and indium are also scarce. While brine is a source for lithium, gallium, tellurium and indium are available as byproducts in the extraction of base metals such as aluminum, copper and zinc. These are however not extracted because of their minuscule presence and lack of economic viability.

(h) **Gallium :** Gallium is a strategic metal used in opto-electronic and defence applications. It expands by 3.1% when it solidifies. There is no primary source of gallium in the country.

In India, it is extracted as a by-product from the Bayer-liquor during the processing of bauxite to alumina. Though laboratory and pilot scale studies for extraction of gallium have been carried out, no gallium is produced by NALCO. However, Hindalco is having a capacity for gallium recovery at 55 kg. per year at its Renukoot plant.

(i) **Indium** : is essentially obtained as a by-product during zinc refining. Hindustan Zinc Limited (HZL) is yet to make efforts to recover this metal.

(j) Both **Selenium and Tellurium** are byproducts of the electrolytic refining and smelting of copper. Selenium is currently produced only in small quantities in India.

41.**(iii)** **Strategic Minerals**

(a) **Nickel :** Nickel, when added in small quantity to iron, increases its properties manifold and makes the product hard and stainless. When it is used in plating, it makes the surface tarnish-resistant and provides polished appearance. Nickel is not produced from primary sources in the country and the requirement / demand is met through imports. However, it is being recovered as nickel sulphate as byproducts obtained from copper refining. Keeping in view the strategic nature and increasing demand of nickel and the fact that 40% of world production comes from lateritic sources, it is high time that a view is taken on the process options available for exploring the indigenous lateritic nickel reserves available in the form of chromite over-burden in Sukhinda valley (Odisha) by adopting suitable extraction technologies.

(b) **Phosphatic Minerals (Apatite/Rock phosphate) :** The reserves of chemical and fertilizer grade of apatite and phosphate in India are very limited. The resources of apatite as on 1.4.2010 are 2.1 million tonnes and that of rock phosphate only 34.8 million tonnes. The country has no alternative except to depend upon their imports for domestic requirements.

(c) **Potash :** Potash is an essential nutrient for protein synthesis and it aids plants to use water more efficiently. The country does not have any primary potash resources. Marine evaporate deposits and surface and subsurface potash rich brines are principal source of potash. The entire requirement of potassic fertilizer for direct application as well as for production of complex fertilizer are met through imports.

(d) **Lithium** : is the major battery material that is sought after for several applications. Demand for lithium may grow to a sizeable quantity in the near future. Lithium is usually extracted from brine by an evaporation

process, but it may be worthwhile to look for **spodumene** and other hard rock deposits that would contain Li.

(e) **Uranium :** In order to meet the increasing demand of power in the country, the contribution of nuclear power will need to go up substantially. In this context, Department of Atomic Energy (DAE) has set up a goal to generate 20,000 MWe of nuclear power by the year 2020 from the present production of 3900 MWe, which is about five times. To achieve a quantum jump, the availability of adequate uranium, which is already in short supply, has to be ensured. The technology denial regime, which prevents imports of uranium, underscores the imperative need for augmenting the availability of uranium indigenously to meet the fuel requirement for nuclear power. There is a critical need for augmentation of uranium supply from indigenous sources by adopting strongly focussed exploration strategy for discovery of uranium deposits.

42. **(iv) High Value Minerals/ Diamonds / PGM**

There is urgent need to explore minerals/metals in which this country is deficient e.g. gold, copper, nickel, platinum group of minerals as well as diamond for which we depend entirely on imports. In the other minerals/metals such as lead/zinc etc. although we may be self-sufficient now but, looking to our growing requirements, will have to import in future. These are the minerals for whose exploration, least attention seems to have been given. GSI no doubt has done regional exploration but to exploit a deposit and to analyse its economic viability, one has to go for detailed exploration and analysis of the ore to choose appropriate technology.

ROLE OF PRIVATE SECTOR – MINING LAW REFORMS

43. As mentioned earlier, world-over, it is private sector or junior exploration companies, specialized in exploration techniques for a mineral / metal or a group thereof, undertake exploration work. They draw upon capital, venture capital or hedge funds to finance their activities. The governments of the resource-rich countries do not also want the tax-payers' money to be spent on such risky activities. Their job is limited to making conditions congenial for these exploration companies so that they are encouraged to undertake these activities.

Some of the conditions that facilitate investment, including FDI in mining, are as under :

(i) **(a) Principle of first-cum-first served (FCFS)** : In any resource-rich country, the principle of first-come-first-served (FCFS) is cardinal to generate investors' confidence. MMDR Act, 1957 has the provision of `preference' which has not been enough to attract an investor in exploration and resource development in India.

(b) State Governments are not granting even RPs. Also, even after grant of RPs, significant time (8 – 12 months) is lost in getting aerial survey permissions from different government agencies. Simplification of such procedures and approvals is crucial to facilitate faster exploration.

(ii) **Seamless transition from exploration / prospecting to mineral concession** : MMDR Act, 1957 does provide, though not in very categorical or clear terms, for seamless transition from exploration / prospecting to mineral concessions. However, in many cases, this process has been violated and the lessee has been deprived PL/ML after completion of RP.

(iii) **Security of tenure** : MMDR Act, 1957 has provision for security of tenure to the mining lessees.

(iv) **Easy transferability / sale** : Easy transferability is one of the most important principles to attract an investor to invest in exploration so essential before mining. Prospecting and mining being separate branches of the mining / resource industry, a prospector and/or a miner should have the freedom to sale/transfer licence or a mining lease to any prospective buyer at a mutually agreed price. There is no doubt a provision for transfer in MMDR Act, 1957 but it is conditional and requires prior approval of Central / State government.

(v) **Fiscal regime** : Fiscal regime in a country which will give an entrepreneur adequate return vis-à-vis other industries / countries is of prime importance for an entrepreneur to invest. This is all the more necessary in mining because the industry suffers from frequent bouts of cyclical fluctuations in the market and the risk involved in exploration and mine development is enormous and time consuming. Consequently, the mineral resource exploration and development has remained confined to a few select countries.

In India, exploration and/or mine development has remained confined to some surfacial bulk minerals like iron ore, limestone, bauxite, etc. or some chance discoveries or ancient workings of some base and precious metals.

44. The mining industry in India is the highest taxed industry in the world. With current royalty and tax rates, the effective tax rate for mining sector in India is 52% compared to 45% in Indonesia and 40% in Australia. In Australia, with coming into power of new government following last election, the Mineral Resource Rent Tax (MRRT) and carbon tax have been withdrawn.

45. Although the contribution of public sector in the national economy is enormous but looking to the long time-frame it has operated, its performance has been sub-optimal. It has led to high cost economy and a culture of scarcity in any field it has entered. It has cultivated a delivery system which has resulted in its bureaucratizing and corruption. What is more surprising it has become self-serving and will not permit its dilution and entry of private sector.

46. Barring a few Central public sector units and a sprinkling of State units, these units mostly take recourse to contract mining through private contractors or by entering into joint venture with private parties. The public sector has not developed any significant new technology and its finance not properly utilized. The result is that the country's resources have remained untapped. It is strange that while India continues to import coal (coking and non-coking), gold, diamonds, nickel, copper, etc. from private sector mines operating abroad, putting a heavy financial burden on country's resources, but the government will not allow private sector to operate in India. Such an attitude has led to stoppage of development of mineral resources for the benefit of the country and made it dependent on imports, which is not in the long term interest of the country.

47. Time has come when there has to be a relook at the whole economic policies, particularly for developing country's mineral resources, to make country

secure for raw materials availability for its manufacturing industry as well as for its vital defence requirements. In view of its dynamism and technological capabilities, private sector should be allowed to play its part. As an International best practice, government survey organizations should carry out fundamental geological, geophysical and geochemical surveys throughout the country to create a database. Providing geological and geophysical data over prospective areas will facilitate investment by private exploration companies as is in vogue in countries like Australia, which do not risk the tax payers' money in exploration.

48. India should therefore facilitate private FDI since they have the state-of-the-art technologies and high investment required therein. A large amount of FDI and domestic capital – in fact it is being invested abroad – is waiting to be pumped into the country but we have negative verve running all-around to thwart growth. We have to change it and make it positive by taking corrective measures.

DERESERVATION OF MINERAL BEARING AREAS FOR PRIVATE SECTOR EXPLORATION AND MINING

49. Since the adoption of Industrial Policy Resolution 1956, large number of mineral bearing areas were reserved for public sector from time to time. Provisions were made in MMDR Act in Sections 4(3), 17(2), 17(4), 17A(1A) and 17A(2) which give special powers to Central and State governments to undertake reconnaissance, prospecting or mining in certain areas after reserving them exclusively for public sector. These public sector units neither have the technologies nor financial capability. Consequently, these areas could neither be explored nor worked and the country was deprived of the benefits of its own mineral resources.

50. Hoda Committee went into all aspects of reservation and observed as under :

> *"These provisions run counter to the spirit of level playing field, which is essential if private investment, especially FDI, is to be attracted to the mining sector. Given the fact that expenditure on exploration in India is a small fraction of world expenditure there is need for not only increasing public spending in exploration but also attracting private investment, including FDI, into exploration and mining. It was pointed out to the Committee that the reservation powers have been and are being used by the states to stall private sector initiative and it was argued that there should be a level playing field between the public and private sectors and that the government should adopt an arm's-length approach.*
>
> *(para 1.74)"*

51. The Hoda Committee thereafter made the following recommendations :

> *"(i) The emphasis on both public and private sector investment in exploration, especially regional exploration or reconnaissance, needs to continue. However, looking at the need for private investment in these activities it is necessary that PSUs of the Central and state governments be treated at par with private sector companies in the grant of mineral concessions. The reservation provisions for PSUs for exploration and mining should be modified so as to limit the scope of such reservations to specified purposes such as to meet the requirement of SMEs for raw material. Besides, promotional work at public expense need not be undertaken if the private sector is willing to spend and invest on the same work.*
>
> *(ii) Where detailed exploration/prospecting is undertaken by state or Central organisations like GSI, MECL, or state- level Directorates as promotional work (i.e. at public expense) and mining based on such prospecting is to be undertaken by a third party, then such areas/blocks should be farmed out for mining on a tender/auction basis. This would not only ensure that transparency is maintained, but also the revenue generated from such auctions would help augment the resources of the states. This would also help small miners (SME sector) who do not have sufficient resources to take up prospecting singly by themselves but can do so collectively or even outsource the work. (para 1.76)"*

PRIVATISATION OF PUBLIC SECTOR UNITS

52. Indian public sector suffers from lot of inherent weaknesses because of which it has not been able to deliver, barring a few exceptions. Apart from huge unproductive high cost surplus labour inducted in most cases out of political considerations, it has, over the course of time, become unaccountable. There is constant interference from parent Ministry / Department. Decisions are not taken in time and are excruciatingly slow, leading to cost over-runs, making the projects in most cases unviable. Unproductive assets keep on mounting, causing avoidable losses to the units. Over and above this, the ministerial and political interference in their day-to-day working, as brought out by ex-coal Secretary in his book *`Crusader or Conspirator?'* put a damper on the initiative and drive of the management of these units. This affects efficiency and morale of the people who want to work for the benefit of the unit. In many public sector, particularly those in States, there is virtual paralysis. Tax-payers, whose money has been invested, do not get any return.

53. To avoid risk or responsibility, officers resort to tenders for various works. Sometimes due to lack of capable staff particularly in State units, these units enter into joint venture with private companies or appoint private contractors. This leads to political interference and corruption. The result is that these public sector units, who are sitting on huge mineral resources, have not been able to exploit resources for nation's economic benefits.

54. Even if latest technologies are imported at high costs, they are not integrated into the system with the results, these units continue to depend on foreign suppliers for upgradation. Many times improvements are attempted and perfected, these are nor patented with the result, the initial technology provider takes the credit and gets it patented under its own brand name.

55. Under economic pressure, country attempted liberalisation of the economy in 1991. Subsequently some public sector units were privatized when NDA came to power. The process was stopped when UPA came to power in 2004. Consequently the country continued to suffer from under–performance. Public-sector units, such as Coal India Limited, Hindustan Copper Limited, NALCO and almost all state units have not been able to deliver and the country continues to import vital raw materials from foreign private sector mines. Now since NDA is back in power with absolute majority, time has come for the new Government to revert to its original economic policy and privatise these and other public sector mining / metal companies. If Indian private sector and/or FDI is given the space, not only will the country be able to explore un-explored resources in remote and tribal areas, where these minerals occur, but the nation and the people living in these areas will benefit economically and socially and we would be able to face unforeseen future eventualities. The development of domestic mineral resources will expand economic base and generate more employment and revenues to the Central and State governments.

56. Some of the Central and State units which are monolith and huge will have to be bifurcated into economic size. Coal India Limited and SAIL which are huge but are unable to deliver should be bifurcated into viable economic units and then privatised. The public sector units sitting on huge resources but are unable to deliver have to be privatised. State governments have to be persuaded to fall in line. The privatization should be done on “Strategic Sale” basis, where the majority shareholding along with management control passes into the hands of the acquiring private entity who can then bring in quicker decision making, risk capital and implementation capabilities to turn around these companies and realize the potential of India’s crucial mineral resources.

DRASTIC POLICY CHANGES REQUIRED

57. International tensions and India's geopolitical situation will continue to be a cause of concern. It will therefore be necessary for India to

- invest in science and technology to explore, extract, recycle and substitute metals and minerals; and
- institute sound raw materials policy.

The experience of the working of MMDR Act, 1957 has brought out the weakness in its implementation particularly with regard to the attitude and response of State governments to various directions / advice / guidelines of the Central government. Of late, industry's experience with various State governments, barring a few, is that they are impervious to the development of resource industry despite its widest spread in far-flung and interior areas. In fact, Indians find it easy to get concessions in foreign countries rather than in India, putting the country in a serious situation in times of emergency.

58. **Auction by competitive bidding not a sound policy** : Unless the Central government takes corrective measures, country's raw materials security will be in jeopardy. Recent controversy on allocation of coal blocks and supposed loss to the exchequer has dampened any interests which a foreign entrepreneur might have had in investing in Indian resource sector. The recent amendment (Section 11A) in Mines and Minerals (Development and Regulation) Act, 1957 introduced in February 2012 provides for the grant of reconnaissance permit, prospecting license or mining lease for coal or lignite through auction by competitive bidding and will be limited to a company engaged in

(i) production of iron and steel;
(ii) generation of power;
(iii) washing of coal obtained from a mine; or
(iv) such other end-use as Central government may, by notification in the official gazette, specify.

59. The competitive bidding, however, will not be applicable to an area containing coal or lignite —

(a) where such area is considered for allocation to a government company or corporation for mining or such other specified end use;

(b) where such area is considered for allocation to a company or corporation that that has been awarded a power project on the basis of competitive bids for tariff (including Ultra Mega Power Projects).

60. One auctions a commodity when one is sure what one is auctioning and the bidder should know what he is being offered in terms of quantity and quality of the product. Since exploration is highly capital intensive it is not possible to explore the entire deposit initially at one go as it would render any industry based on the mineral uneconomic / unviable. How can one auction or anybody bid for reconnaissance or prospecting over an area when no one knows what it contains? Same is the case for mining lease since nobody knows what coal/lignite deposit under auction is worth in terms of quantity and quality.

61. This point can be explained by way of example of Goa where at the time of its liberation in 1961, Geological Survey of India estimated iron ore resources at 325 million tonnes and felt these would last 20 years. However, since 1961 till now, Goa has exported more than 1000 million tonnes since liberation and even now Indian Bureau of Mines has established Goan resources at 927 million tonnes as on 1.4.2010. Similarly despite having mined 997 million tonnes between 01.04.2005 and 31.03.2010, resources of haematite iron ore in India increased by 3277 million tonnes at 17882 million tonnes as against 14630 million tonnes as on 1.4.2005.

62. Similarly, in the case of coal, the resources of coal as on 31.12.2001 were estimated at 220,983 million tonnes. After having mined 2250.71 million tonnes between 2002-2007, the resources increased to 1,208,572 million tonnes or more than five times as on 01.01.2007. During 2008-2013, India mined 3112.088 million tonnes of coal, but its resources further increased to 1,389,914 million tonnes as on 1.4.2012.

63. This, in other words mean, that as one mines, there is more and more exploration activity which leads in most cases discovery of more resources. The resource availability is thus a dynamic concept and one can not estimate at a given time the exact quantity of a mineral deposit. If one can not estimate exact quantity and its quality, auction becomes a farce and questionable.

64. The whole concept is therefore fraught with serious consequences. For argument sake, if somebody bids for any deposit based on certain assumptions and if the reserves / resources work out near the estimation, the bidder will be comfortable. But if these falls below the estimation, he will be in a serious economic problem because his industry based on certain assumptions have now gone awry. However, if the resources / reserves come out more than the estimates, the government will lose.

65. Further, suppose even if one participates in an auction and he is successful, he has to get environment clearance under Environment (Protection) Act and if the area is under forest, forest clearance under Forest (Conservation) Act. Both these clearances are an arduous task and even if one is not given, the whole amount spent on auction goes waste. As we are aware, mining in most of the allotted coal blocks could not start because of the delay or non-availability of any or both these clearances. Auction route is not pursed in any resource-rich country and they follow time-tested principle of first-cum-first-served (FCFS).

66. No mineral resource rich country in the world takes recourse to auction of its natural resources for various reasons :

- a company would like to recover the cost as fast as it can
- selective mining leaving low grade minerals in the ground
- no serious exploration
- huge wastage of resources
- will increase the cost of final product making it uncompetitive vis-à-vis imports
- may result in cartelisation and monopolistic practices

67. The Hon'ble Supreme Court in its judgement delivered on 27th September, 2012 on a special Presidential Reference No. 1 of 2012 has this to observe on auction :

> *"These drawbacks include cartelisation, "winners curse" (the phenomenon by which a bidder bids a higher, unrealistic and unexecutable price just to suppress the competition; or where a bidder, in case of multiple auctions, bids for all the resources and end up winning licenses for exploitation of more resources than he can pragmatically execute), etc."*

68. In the scenario in which India is today, no FDI is possible in mineral resource sector. Unless the attitude of Central and State governments changes to attract private capital, which also brings with it technology, there is no likelihood of resource development. Overdependence on public sector will render mineral resources remaining untapped, causing serious situation at a time when there is need to fall back upon them.

69. **Adoption of FCFS principle** : To overcome the serious fault-lines that have crept in allocation of mineral resources, it is better that we fall back on time-tested principle adopted by all resource-rich countries, popularly called first-cum-first-served (FCFS), for grant of mineral concessions. Strict enforcement of FCFS principle eliminates discretion and favouritism and satisfies all stakeholders. Adoption of FCFS principle with the provisions of seamless

transition from exploration to mineral concession and easy transferability / sale as well as security of tenure will transform the mineral sector in the country. It will result to intensive exploration activities and exploitation of resources, leading to employment generation and socio-economic benefits in remote and tribal areas. Development of mineral resources will also stand in good stead when there is an emergency.

70. **Centre to grant mineral concession for Schedule I minerals**: The experience of the entrepreneurs, both domestic and foreign, has been that despite stipulations in law, State governments are averse to take decisions on mineral concession applications. Some of the applications are pending even for grant of RPs for 5-10 years. Despite directions from Central government from time to time, States continue to defy Centre. The result is that the investment (including Indian) which should come to India, gets diverted to other countries where conditions are more congenial. The investment money with the exploration / mining companies is scarce whereas the opportunities available are many. It has therefore to be grabbed at the earliest opportunity.

71. "Regulation of mines and mineral development" appears in both Union List (entry 54) as well as State List (Entry 23) of the Constitution of India. The MMDR Act 1957 lays down the laws for regulation and development of mines and minerals while recognizing the States' ownership of land and minerals. Section 2 of the Act avers: – it is hereby declared that it is expedient in the public interest that the Union should take under its control the regulation of mines and the development of minerals to the extent hereinafter provided. Thus, the prospecting licences (PL) and mining leases (ML) for minerals listed in First Schedule of MMDR Act are to be granted by State Government only after obtaining prior approval of the Central Government. Further, in respect of Part A (Coal and Lignite) and Part B (Atomic Minerals), the PLs and MLs are granted by the State governments based on decisions taken by the Central Government.

72. Internationally, the resources rich countries have the provisions and regulatory regime where powers for grant of mineral concessions are fully delegated to the concerned States. In ideal conditions, a similar structure would be desirable in India also, since the States are owners of land as well as minerals. However, the experience of last many years with most of the States is that the States either do not take any decisions or take decisions which are not in the best interests of mineral development or national economic development. In such a scenario, it will be desirable to amend the Act to provide for grant of all mineral concessions in respect of all minerals listed in First Schedule (including Part C) by the Central Government.

PROPRIETARY RIGHT OF THE STATE ON MINERALS?

73. In its epoch-making judgement delivered on 8th July, 2013, the Supreme Court in *Threesiamma Jacob & Others vs. Department of Mines & Geology & Ors. (Kerala)*, has observed that

> *"there is nothing in the law which declares that all mineral wealth sub-soil rights vest in the State; on the other hand, the ownership of sub-soil / mineral wealth should normally follow the ownership of the land, unless the owner of the land, is deprived of the same by some valid process."*

74. Although the judgement is limited to Threesiamma Jacob & Others since in the last penultimate sentence, the Supreme Court has observed: *"we hold that the appellants are the proprietors of the minerals obtaining in their lands"*, there is enough ground to ponder whether the States have sub-soil rights on mineral wealth, a presumption on which the States are considered to own sub-soil mineral resources?

MONITORING MECHANISM TO BE PUT IN PLACE

75. There are no doubt enough provisions in MMDR Act, 1957 and rules framed thereunder namely Mineral Concession Rules (MCR), 1960 and more particularly Mining Conservation and Development Rules (MCDR), 1988 to monitor the mining sector. While MCR, 1960 deal with process of grant and renewal of mineral concessions, MCDR, 1988 delineate monitoring of operations right from reconnaissance to prospecting and mining operations, including scientific mining and protection of environment. The MCDR 1988 also provide for penalties and issue of directives.

76. However, the provisions in MCDR, 1988 confine basically to systematic working and maintaining environmental standards. There is no monitoring in any State about the number of applications received, processed and disposed of. Nor any responsibility is fixed on anybody in case these are not disposed of within the time frame prescribed in MCR, 1960. Similar is the situation with regard to applications referred to Central government for prior approval. A Regulator or a Monitoring Body is therefore required to monitor the processing and disposal of applications for mineral concessions. This is necessary as it is felt that State governments are impervious to the necessity for development of mineral resources which can bring about not only economic benefits to the people where these mines will operate but will come in good stead whenever there is national emergency.

77. Looking to the recent clamour about illegal mining in various parts of the country by lessees in collaboration with or patronage of authorities / politicians; it is necessary that an institution is created to monitor and oversee the mining operations in terms of systematic working as well as within the four walls of various sanctions under MMDR Act, 1957, Forest

(Conservation) Act, 1980 and Environment (Protection) Act, 1986 and various rules framed thereunder. Such an institution should be established both at Central level for Schedule I minerals and at State level for other minerals.

RESOURCE DEVELOPMENT A DESIDERATUM

78. There is a misconception that mining destroys forests (since most of our minerals are found in them) and environment. Further local population does not benefit from resource development as minerals once extracted are dispatched outside, either within the country or abroad, for manufacturing industries. Moreover, mining companies bring technical people from outside and employ locals only for unskilled and semi-skilled jobs. This perception is generally true if we see our past records: except few enlightened companies like TATAs, most of mining companies, even public sector, did not adequately look after local people to the extent they should have.

79. However, if we look at the mining policy as it worked at ground level by the State governments, the policies of almost all State Governments were to give preference to public sector or captive mines, dividing a deposit into small leases on political considerations and, in the case of minor minerals, auction of deposits and lease it out for a few years. These policies have played havoc with resource development of this country and creating doubts and distrust among local communities against mining industry. This feeling in local communities in genuine but we have to seek ways and means to overcome it.

80. This will require complete overhaul of the dispensation at Central and State levels. The Ministries at the Centre and Departments at the State level are manned and headed by people who have little idea and hardly any long term horizon about the trickle-down benefits of the development of the resource industry. This applies even to the technical and scientific people who work in

these departments. The establishment at the Centre and State level have to be manned by people who know the significance of resource sector in terms of economic development, socio-economic benefits, infrastructure development, skill development of local people and its benefits in terms of environment and forest issues. These officers will have to ensure that the local community gets due benefits in terms of skill development, employment which will lead to socio-economic development on a sustainable basis. After grant, there should be stiff monitoring by a competent and honest Regulator.

81. Adverting to the apprehension about damage to forest and environment, it is no doubt true that mining initially affects forest and environment as any disturbance on ground does affect both these vital ingredients of human and animal life. But let us also see how non-exploration of mineral resources for the country's benefit will affect these two vital ingredients of human life :

— About 60% of India's GDP is contributed by service sector. Services sector, no doubt vital for economic growth, looks after/covers only elite class which forms only a tiny section of Indian society. On the other hand, manufacturing sector contributes only 16% of India's GDP (as against 38% in China). It is only manufacturing sector which provides jobs to all sections of society — unskilled, skilled, technical, scientists, researchers, professionals etc. — on a regular / sustained basis and brings prosperity permanently. Development of mineral resources will feed manufacturing sector on a sustainable basis.

— Unless there is wide spectrum of growth engulfing all sections of society, which manufacturing can provide, people who are left aside like tribals and the people in remote areas, there will be dissatisfaction and animosity against the mining industry.

— It has been world-wide experience that the growth of population is basically in countries which do not provide enough opportunities to keep people engaged in some constructive work.

— If development of raw materials and manufacturing sectors does not take place because of misplaced notions, the growth in population will damage forestry and environment which can not be contained easily.

82. The development of mineral resource will benefit the country in various ways :

— development of mineral resources for the benefit of the country, leading to more manufacturing and industrialization of the country;

— lead to more economic development and provide employment in remote and tribal areas, thereby bring about socio-economic change;

— protect environment from burgeoning population since people will be busy / engaged in productive work. In the absence of any productive avocation, people resort to activities which are many times not in consonance with law and order ; and

— on an average, Indians consume 2 cubic meters of wood each year whereas people residing in forest areas consume 200 cubic meters per year (since these people do not have any access to fuel like gas / kerosene in remote areas). There will be no doubt impacts on forest at initial stage of mining but mining can be done in such a way that there is least destruction. This can be done if the area under mining is larger enough so that the area brought under mining in a particular year can be afforested before new area is opened up. It has already been experienced in some cases in India and abroad where rehabilitation of forest, consisting of trees of local varieties, is better and more dense that it was when the mining lease was granted. This will ultimately help in regeneration of forests.

NEED FOR ONE OVER-ARCHING MINISTRY

83. It has been observed over the course of time that to get a mining lease, an entrepreneur has to struggle 5-6 years if the area is not in forest and upto 10 years in case the area is in forest. Most of the times applications for mineral concessions keep pending with State governments for years together. Like Central government, State governments have multiple departments to deal with specific aspect.

84. Lack of coordination between various departments and ministries such as Mining, Coal, Steel, Environment and Forests has severely impeded planned and coordinated growth of mining in India. Compulsions of coalition government to

accommodate more members of Parliament have led to the bifurcation and creation of Ministries like Coal, Steel and Mines. Many a time these Ministries have developed different interests. The best example is that of the Ministries of Mines and Steel having adopted adversarial postures in regard to the export of iron, manganese and chromite ore not required in the country.

85. Countries like Australia, Canada, South Africa and even China have an umbrella Ministry called Ministry of Resources (or Land Resources). India can adopt similar model where an omnibus Ministry of Resources can be thought of having one Cabinet Minister and all the departments like coal, steel, mining, power, environment and forests can be its part and headed by Ministers of State. This will ensure much closer relationship leading to ease of investments and clearances as well as access to raw materials for manufacturing industries. This will reduce delays drastically and go a long way in development of mineral resources as well as industries based thereon.

ROLE OF NON-GOVERNMENT OFFICIALS (NGOs)

86. There is of late-spurt in the activities of NGOs particularly in mineral-rich states. Many of these NGOs get grants from international agencies and various funds (such as Rockfeller Family Fund) with the active or passive connivance of their governments. Since countries like India who are having natural resources will be able to produce metals at a much competitive prices compared to what these developed countries manufacture, the developed countries like US and Western Europe put all sorts of impediments through local NGOs and provoke people against these mineral-based industries in developing countries. They ensure that the industries and the natural resources of countries like India are not developed which may pose direct challenge to their own existing industries.

87. The vested interests in US and Western Europe thus provoke local NGOs through financial contribution to file public interest litigation (PIL), organize local protest, contact opposition legislators so that the fate of the project become uncertain leading to financial unviability of the mineral-based industries as well as mineral resources. This is particularly witnessed in mineral-rich states like Odisha, Jharkhand, Karnataka, Goa, Chhattisgarh, etc. where PILs are filed leading to judicial adverse pronouncements which has resulted in slowing down investments in these states.

88. The acknowledgement of what has been stated above came from none other than ex-Prime Minister, Dr. Manmohan Singh who openly exposed certain vested interests in US for creating a problem in Kudankulam Atomic Power Project. Once the public statement was made, everything came out in the open : NGOs were booked and the whole movement fizzled out and the plant was operationised. The fate of POSCO steel plant, Niyamgiri Bauxite Mining Project and many such projects is hanging in balance because of these NGOs.

CONCLUSION

89. The recent imposition of restrictions on export of rare earths by China has created a scare in the developed countries to look for alternatives. Along with rare earth elements (REEs), these countries have also focused their attention on other energy critical elements (ECEs), particularly in the context of clean energy technologies. To be self-reliant on REEs and ECEs, which is a must to minimize green house gas emissions – we must adopt novel routes that emphasise not only on economic viability but also self-reliance.

90. **Stockpiling Strategy** – Till the time of domestic exploration and production of rare earth elements (REEs) and energy critical elements (ECEs) is accelerated to achieve self – sufficiency, a strategy is required to be adopted to address supply chain disruptions and ways to build a national stockpile for these

strategically critical input materials. The XII Plan report had also recommended this and identified NFTDC (Non Ferrous Materials Technology Development Centre) to work as a coordinating agency on behalf of Ministry of Mines and also to focus on process R&D for rare earth elements (REEs) and energy critical elements (ECEs). It was also recommended to create a national body comprising of Ministries of Commerce, Industries Defence, FIMI and other industry bodies and C-TEMPO under the aegis of Ministry of Mines (which has since been wound up), with a corpus fund of Rs. 500 crores, responsible for national sourcing of REEs and ECEs. These recommendations need to be implemented expeditiously.

91. Similarly, China has recently put restrictions on the supply of tungsten. To avoid similar situation for other mineral commodities, there is an urgent need to locate indigenous resources and incentivize their domestic exploration by speedy grant of licenses. It is also important to encourage applied / process R&D within the country. We have to emulate the business models in advanced countries like Canada and Australia which are able to deliver because scientific regulations ensure that R&D happens.

92. Since post-2008, a pattern is emerging globally. There is more state intervention in the flow of goods and money. There is more regionalization of trade and countries are gravitating towards like–minded neighbours, fondly dubbed by *The Economist* of London as "*gated globalization*." However, in the case of India, our neighbours are either hostile or not favourably disposed of. The Government of India has therefore to take lead and reposition itself as a facilitator in directly dealing with minerals listed in Schedule I of MMDR Act, 1957 since these minerals are vital for the security of the country. The Ministries / Departments, namely, Coal, Mines and Atomic Energy which deal with these minerals should rehash their policies and allow private sector to play more leading role to develop the resources, right from exploration to mine

development, which India imports from private sector companies abroad. Instead of benefitting foreign private sector companies, it makes more sense to assign these private companies more important role, through FDI or otherwise, to expand the base of Indian resource sector. This will generate more employment in remote areas where minerals are generally found and will give more revenues to Indian and State governments.

93. Nani Palkivala once observed : *"we are not poor by nature but poor by policy"*. For too long, this country has suffered from policy-deficit. Now since the new Government has taken over, it is expected by everybody that firm and expeditious policy decisions will be taken up in the national interest. In peroration, FIMI would seek Government of India's policy initiatives with regard to:-

- need for one umbrella Ministry for resources
- integration and simplification of procedures to curtail delays to the minimum in grant of exploration and mining concessions, and environment and forest clearances
- promotion of transparency
- regulatory regime
- recalibration of exploration
- examination of the feasibility of contract mining in Indian context
- promotion of risk capital markets
- privatisation of public sector
- mining taxation reforms
- create conditions for private investment – domestic and foreign
- no forest clearance at the time of renewal of mining lease
- stockpiling of REEs and ECEs
- need for checking the role of NGOs

94. If we are unable to discover these strategic minerals, either due to lake of exploration activity or any of these minerals is simply not available in the country,

efforts will have to be made to have linkages with the friendly countries which have them either by way of trade agreements or acquiring assets.

95. Once policy decisions on above areas are clear and sincerely implemented, this country can transform itself in one decade as a hub of mining activity providing employment in tribal and remote areas and bringing about socio-economic transformation.

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ANNEXURES

Annexure-I

Incremental growth in some mineral commodities in India vis.a.vis Australia

The table below depicts the growth of mineral commodities (exploration) in India vis.a.vis Australia during 1980 to 2010.

RESERVES	INDIA		AUSTRALIA	
	1980	2010	1980	2005
Iron Ore (hematite) (million tonnes)	11470	17882	15000	40000
Diamond (million carat)	0	2.6	0	230
Gold (metric tonnes)	56.1	326.7	400	6000
Coal (billion tonnes)	111 (inferred)	276 (inferred)	29 (Proved)	42 (Proved)
Bauxite (million tonnes)	2489	2636	3000	8700

Opportunity Loss to India

With the exception of coal, no other commodity has seen significant mineral exploration in India. The opportunity cost lost as a consequence is significant. As an example, had India between 1980 and 2010, followed a proportional growth path as Australia, then in value terms, the tangible opportunity lost works out to:

- For iron ore : approximate 20 billion tonnes equating to about US$ one trillion (at mine gate price of US$ 50)

- For gold : 500 tonnes equating to about US$ 25 billion (at a price of US$ 1400/ounce)

- For bauxite : 4 billion tonnes equating to about US$ 80 billion (at a mine gate price of US$ 20)

Annexure-II

MINERAL-WISE ANALYSIS

(i) BULK MINERALS

(a) COAL

Reserves : World proved coal reserves, both anthracite and bituminous coal and sub-bituminous coal and lignite, have been estimated at 860.938 billion tonnes at the end of 2012. Indian resources of coal as on 1.4.2012 are estimated at 293.5 billion tonnes to a depth of 1200 metres and those of lignite at 41.96 billion tonnes. Out of this, proven coal reserves are 118.15 billion tonnes and that of lignite 6.186 billion tonnes. According to German Federal Institute for Geosciences and Natural Resources (BGR), there are 1038 billion tonnes of coal reserves left equivalent to 132 years of global output in 2012. Coal reserves reported by BP are much lower — 861 billion tonnes equivalent to 109 years of coal output.

2. **Production and consumption**: As per World Coal Association, the world production of coal was 7830 million tonnes in 2012 as against 7678 million tonnes in 2011. An idea of top 10 coal producers in 2011 and 2012 can be had from the following table :

Table-I

Total — Coal production (in million tonnes)

Countries	2011	2012	Countries	2011	2012
China	3471	3549	Russia	334	359
USA	1004	935	South Africa	253	259
India	585	595	Germany	189	197
Australia	414	443	Poland	139	144
Indonesia	376	421	Kazakhstan	117	126

Steam Coal

Countries	2011	2012	Countries	2011	2012
China	2831	3039	Australia	199	200
USA	849	782	Russia	178	201
India	509	504	Kazakhstan	98	108
Indonesia	373	440	Colombia	80	85
South Africa	250	258	Poland	65	68

Coking Coal

Countries	2011	2012	Countries	2011	2012
China	504	510	Canada	29	31
Australia	146	147	Mongolia	20	21
USA	82	81	Ukraine	20	18
Russia	78	75	Kazakhstan	13	13
India	35	47	Poland	11	12

Brown coal / lignite

Countries	2011	2012	Countries	2011	2012
Germany	176	185	Australia	69	73
China	136	-	Poland	63	64
Russia	78	78	Greece	59	62
Turkey	74	66	Czech Republic	43	43
USA	74	72	India	41	43
			Serbia	-	38

Source : World Coal Association London

3. Coal provides 29.9% of global primary energy needs and generates 41% of the world's electricity. Approximately 13% (over one billion tonnes) of total coal production is currently used by the steel industry and around 70% of total global steel production is dependent on coal.

4. An idea of domestic demand, production, despatch / supply and gap during the last five years can be had from the following table :

Table-II

(in million tonnes)

Year	Demand	Production*	Despatch*	Gap
2008-09	550.00	492.757	489.172	60.828
2009-10	604.33	532.042	513.792	90.538
2010-11	656.31	532.694	523.465	132.845
2011-12	696.03	539.950	535.299	160.731
2012-13 (P)	772.84	557.707	569.767	203.073

P-Provisional * Includes production/dispatch for captive coal blocks to Private companies

Source: Parliament Question (Rajya Sabha) No. 1088 answered on 1 6.12.2013

5. Any shortfall in domestic supply was met from imports which is building year after year.

6. **Imports and Exports :** During the last three years, world coal trade was as under :

Table-III

(in million tonnes)

Year	Steam	Coking	Lignite
2010	789	282	5
2011	857	283	4
2012	963	290	3

Source: World Coal Association, London

7. Following are the top coal exporters in 2012 :

Table-IV

(in million tonnes)

Country	Total of which	Steam	Coking
Indonesia	383	380	3
Australia	301	159	142
Russia	134	116	18
USA	114	51	63
Colombia	82	82	-
South Africa	74	74	-
Canada	35	4	31

Source: World Coal Association, London

8. India figures third among top coal importers in the world in 2012.

Table-V

(in million tonnes)

Country	Total of which	Steam	Coking
China	289	218	71
Japan	184	132	52
India	160	123	37
South Korea	125	94	31
Chinese Taipei	64	56	8
Germany	45	36	9
UK	45	40	5

Source : World Coal Association, London

9. 12th Five Year Plan has projected the following demand for coal for various sectors :

Table-VI

(in million tonnes)

Sector	2016-17
1. Steel and coke oven	67.20
2. Power (utility)	682.08
3. Power (captive)	56.36
4. Cement	47.31
5. Sponge iron	50.33
6. Others	77.22
Total	**980.50**

10. As against the above demand projection, supply is likely to be as under :

Table-VII

(in million tonnes)

Source	2016-17
CIL	556.40
SCCL	57.00
Others	101.60
Total domestic supply	**715.00**
Imports	
Coking	35.50
Non-coking	230.00
	265.50

Source : Report of the Working Group for Coal and Lignite for XII Plan

11. **Way forward** : Despite the nationalization of coal mines since 1973, the country has not been able to provide enough coal to met the demand. Coal mines were nationalized because the private sector mines were not paying proper wages to workers and mines were working unscientifically. While today, workers are being paid enough wages but the delivery in terms of production to meet country's demand is just not there; nor is it likely to be there in times to come.

12. Government of India takes various steps from time to time to overcome the shortage. CAG passes adverse comments and the matters come to Supreme Court to conduct CBI enquiry, putting the Government in a flux. Country continues to import coal in increasing quantity year after year. It is strange that despite huge coal reserves in the country, we are not able to exploit it to meet the domestic demand.

13. Coal mines were started in India in the first half of 19th Century. India has enough technical capability to increase production. What then is holding production particularly when there is demand. The answer is the nature of the public sector units which are controlling production. These units suffer from all the pitfalls from which Indian public sector suffers.

14. Despite all-round acknowledgement that these public sector units, particularly Coal India Limited (CIL) , will not rise to the occasion because of its very nature, politicians of all hues do not want to take on trade unions who control CIL. Country continues to import and will continue to import coal from abroad. It is surprising that whereas India imports coal from

private mines from abroad but will not allow the Indian private sector to play its part. Involvement of private sector, domestic or foreign, will

- bring scarce capital with latest technology
- develop new areas providing employment to a large number of people in remote areas
- change socio economic milieu of these areas where these mines will open up
- bring additional revenue to both - Central and State governments and increase country's GDP

For this purpose, it will therefore be necessary that not only private sector is involved in new areas which should be thrown open but the CIL and its subsidiaries are privatised over the course of time gradually in a way that there is least disruption. For this purpose, it will be necessary to enlist the cooperation of trade unions and its workers. Further, privatization should be done with proper check and balances in such a way that a large section of people get its benefit. Privatisation in favour of a person or group will invite criticism from people and the stake holders. Most Important will be the establishment of an impartial Regulator to look after post-privatisation scenario so that there is a smooth transition as well as working of mines.

(b) IRON ORE

Reserves : World resources of iron ore have been estimated by US Geological Survey at more than 800 billion tonnes with more than 230 billion tonnes of iron content at the end of 2013. Indian reserves have been estimated by Indian Bureau of Mines at 28.53 billion tonnes as on 1 April 2010, out of which 17.88 billion tonnes are haematite and 10.63 billion tonnes magnetite. Most of magnetite deposits are in Karnataka on Western ghats, most of which have been declared as eco-sensitive. However, if the Government of India permits, these can be exploited with latest technologies with least damage to environment.

2. **Production and consumption** : The world production of iron ore during last three years can be seen from the following table :

Table-I
World production of iron ore

(million tonnes)

Countries	2010	2011	2012
Brazil	372	397	367
India	212	170	155
China*	343	322	280
Australia	433	477	520
Rest of world	506	532	541
Total	**1866**	**1898**	**1863**
***China** :	1065	1149	1309

Note: Actual production of iron ore in China was converted that its iron content is about equal to that on average in the rest of the world

Source: UNCTAD: The Iron Ore Market 2012-2014

3. An idea of production, domestic demand, exports, imports and the surplus still available, can be seen from the table :

Table-II

(Qty: million tonnes)

Year	Production	Domestic Demand	Exports	Imports	Mine-head stock	Surplus
2008-09	212.96	85.33	105.86	0.69	74.6	87.66
2009-10	218.55	97.74	117.37	0.89	90.2	93.64
2010-11	207.157	103.25	97.66	1.87	112	124.09
2011-12	168.582	97.39	61.74	0.98	123.8	132.95
2012-13	136.02	100.5	18.37	3.05	120.2	137.34

Source : IBM, MMTC and Ministry of Commerce

4. The 12th Five Year Plan has estimated the requirements of iron ore based on projected steel production as under :

Table-III
Estimation of Demand for Iron Ore during 12th Five Year Plan Period

(Qty. : million tonnes)

	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Crude Steel Production	73.7	85.9	94.5	104.0	114.5	125.9
Pig iron Production	6.1	6.9	7.7	8.5	9.4	10.0
Total Iron Ore Requirement	115.0	135.7	149.4	166.7	185.2	206.2

Note: The estimates are based on the technology mix in steel production, standard input-output norms and transit and handling losses of raw materials in the process.

Source: Estimated on the basis of projections of crude steel and pig iron production during 12th Plan.

5. The requirement will increase from 115 million tonnes in 2011-12 to 206.2 million tonnes in 2016-17. The note under the above table extracted from 12th Five Year Plan document emphasizes that "the estimates are based on the assumed technology mix in steel production, standard input-output norms and transit and handling losses of raw materials in the process". 30-32% of the crude steel production is contributed by induction furnace (IF) units which do not require iron ore. Similarly, the requirements of sponge iron units, which basically use lumps, have not been separately indicated.

6. As against the above projections, the production of iron ore over last five years has been as under :

Table-IV
Production of Iron Ore

(Qty. : million tonnes)

A-Mine head Production			Year	B-Final Product		
Lumps	Fines including concentrates	Total		Lumps	Fines	Total
88.31 (47)	99.39 (53)	187.70 (100)	2006-07	56.31 (30)	131.39 (70)	187.70 (100)
97.85 (45)	115.40 (55)	213.25 (100)	2007-08	63.98 (30)	149.27 (70)	213.25 (100)
92.40 (44)	120.56 (56)	212.96 (100)	2008-09	63.89 (30)	149.07 (70)	212.96 (100)
90.26 (41)	128.29 (59)	218.55 (100)	2009-10	65.56 (30)	152.90 (70)	218.55 (100)
82.16 (39)	125.84 (61)	208 (100)	2010-11	82.40 (30)	145.60 (70)	208.00 (100)
62.79 (39)	105.78 (61)	168.58 (100)	2011-12	50.57 (30)	118 (70)	168.57 (100)
53.89 (40)	82.13 (60)	136.02 (100)	2012-13	41.10 (30)	94.92 (70)	136.02 (100)

Note: Figures in parenthesis show percentage to total

Source: Indian Bureau of Mines, Nagpur

7. The above table brings out clearly the phenomenon occurring world-wide that as we go deep down for mining, the generation of fines is more. In India also, the production of lumps is gradually going down and that of fines going up. Big boulders and lumps are further crushed in the size of 6-18 mm for sponge iron plants and 10-40 mm for steel plants. On an all-India basis, roughly 70-72% becomes fines and the rest 28-30% as lumps. For convenience sake, we have assumed the same proportion of lumps and fines (30:70) for all the seven years as will be seen in Section B of the Table-IV, although the proportion of fines might be more.

8. This therefore emphasizes the need to encourage technologies that predominantly or wholly use fines, either as pellets or sinter feed. Since pelletisation involves sizeable cost in the form of capital, energy and water (the last two being scarce), it would be more appropriate to use sinter-based blast furnaces for further steel making. Further, while pelletisation improves metallization marginally (just around 1-2%), sintering on the other hand can significantly enhance the Fe content by about 5-8%. Except US, globally pellets are not used extensively :

	USA	EU	Japan	South Korea	China
Sinter %	10	62	74	75	70
Pellet %	82	25	6	10	12

9. Fines-based technologies for steel will enable us to utilise fines produced in the country from the existing mines and minimize the necessity to export fines. Unless steps are taken right now in this direction, exports will have to continue to supply lumps to the domestic industry, basically sponge iron plants. Any attempt to reduce or stop export of fines will directly affect the production of iron ore and make availability of lumps difficult and costly.

10. Indian iron ore contains high alumina which requires more energy in blast furnace. The steel industry therefore consumes high Fe content to compensate for extra energy cost. The mechanical beneficiation is a costly proposition though TATAs are reported to have attempted it successfully. Would it therefore be not more prudent to import low alumina iron ore to blend with high alumina Indian iron ore?

11. The above discussion leads us to the following conclusions :

- there would be no shortage of iron ore during the 12th Five Year Plan period. In fact the country already produces more iron ore than estimated the last year of 12th Plan.
- there should be no allocation of captive mines so that the surplus capacity in the existing mines are fully utilized.

- till the surplus production from the existing mines is fully utilized, there should be no curtailment / ban on the export of iron ore.

- import low alumina iron ore to physically blend with high alumina Indian ore.

12. The concept of granting captive mines to steel or aluminium plants is a typically Indian phenomenon. This has deprived the country of world-class standalone resource mining companies which could have led to sustainable development of iron ore resources with attendant benefits such as development of infrastructure and socio-economic growth in areas where these could have developed. This has created distortion. While the companies which have captive mines have either become inefficient leading to almost stagnant steel production or have generated exorbitant profits leading to the purchase of sick steel companies abroad to provide jobs and investment in those countries. The steel companies who do not have captive mines clamour for shortage of iron ore (where there is none) and high prices. The whole policy of grant of captive leases therefore requires a re-look.

13. **Way forward**: Iron is the earliest metal to catch the human imagination; Iron age followed just after Stone age. Since iron ore is one of the most wide-spread mineral (other being alumina) constituting 5% (alumina 8%) of the earth crust upto a continental depth of 75 kms, human civilization has not so far faced any scarcity of the ore / metal; nor is it expected that it ever will.

14. However, the level of exploration and subsequent mining depend on the demand for iron and steel. The inventory of iron ore that we have today is directly linked to the level of exploration which depend on the level of mining activities which again depends on market (outlet) and the forecast of resources at a particular point of time will never be accurate. The following table will illustrate this :

Table-V
Indian Iron Ore Resources and Production between 1980-2010

(Qty: Million Tonnes)

	Resources as on 01-04-1980	Production between 1980-1990	Resources as on 01-04-1990	Production between 1990-2000	Resources as on 01-04-2000	Production between 2000-2005	Resources as on 01-04-2005	Production between 2005-2010	Resources as on 01-04-2010
Haematite	11469		12197 (+728)		11426 (-771)		14630 (+3204)		17882 (+3252)
Magnetite	6095		10590 (+4495)		10682 (+92)		10619 (-63)		10644 (+25)
Total	17564	465	22787 (+5223)	656	22108 (-679)	532	25249 (+3141)	997	28526 (+3277)

Notes: **(i)** Figures in parenthesis indicate decrease (-)/increase (+) in resources over previous Figures
(ii) The resources are with a cut-off grade of +55% Fe and roughly estimated upto 50 metre depth with sparse and far-between drilling. Cut-off is now 45% Fe while iron ore in many cases occurs much deeper.
(iii) These resources do not include around 1000 million tonnes of hematite iron ore recently discovered by DMG, Chhattisgarh in Kabirdham district.

Source: Indian Bureau of Mines (IBM), Nagpur

15. The situation is not different if we analyse world situation about iron ore resources. More demand leads to more production, leading to more intensive exploration through modern state-of-the-art technology, application of better and scientific mining technologies, leading to the discovery of more resources of iron ore. This will be evident from the following table:

Table-VI
World Iron Ore Resources and Production between 2000-2010

(in Million Tonnes)

Resources as on 1.1.2000	Production from 2000-2004	Resources as on 1.1.2005	Production from 2005-2009	Resources as on 1.1.2010
140,000	5700	160,000	7560	180,000

Source: U.S. Geological Survey

Further, technology leads to utilisation of low grade iron ore resources, better agglomeration and beneficiation techniques and lower to zero wastage.

16. A recent study by Metal Bulletin Research has estimated that some 40 countries jointly account for more than 95% of the generation and consumption of four key sources of iron units in steel industry : iron ore, pig iron, DRI/HBI and scrap. All these 40 core steelmaking nations are expected to use more scrap in steelmaking by 2020 than they do now; some will actually use less iron ore by

then than they do now. Once the economy is on path of maturity, there is a tendency of life cycle and recycling playing an important role in its economic growth. It is also quite possible that China could become significant net exporter of steel scrap by 2020 depending on the changes in Chinese tax code.

17. The motivation for setting up of domestic steel / aluminium industry is due to strong domestic demand for these metals and not the raw materials availability. Not many countries in the world have developed its steel / aluminium industry based on the availability of domestic raw materials i.e. Japan and South Korea. They invariably import them. However, it is evident that there will no shortage of iron ore to meet the projected domestic demand and future capacity expansion of the steel industry. If efforts are made to stall development of raw material industry, neither steel / aluminum industry will come up nor could our resources develop and they would remain unutilized.

(c) LIMESTONE

Reserves : The total resources of limestone of all categories and grades as on 1.4.2010 are estimated at 184,925 million tonnes, of which 14,926 million tonnes (8%) are reserves category and 170,009 million tonnes (92%) are under remaining resources category. Karnataka is the leading state having 28% of the total resources followed by Andhra Pradesh (20%), Rajasthan (12%), Gujarat (11%), Meghalaya (9%) and Chhattisgarh (5%). Gradewise, cement grade has leading share of about 69%, followed by SMS and BG grades (12%) and chemical grade (3%). Remaining 16% are others, not known and unclassified grades.

2. **Production and consumption** : The production and consumption of limestone in India during the last three years are as under :

Table-I

(in thousand tonnes)

	2008-09	2009-10	2010-11
Production	221573	232950	237774
Consumption	160733	191960	140650

Source : Indian Bureau of Mines, Nagpur

It will be observed that the production of limestone in the country is much more than the requirements.

3. Report of Sub-Group-II of the Working Group on Mineral Exploration and Development (Other than Coal & Lignite) for the 12th Five Year Plan has projected the following requirements of limestone with the growth scenarios of cement @10%, 11% and 12% for the respective GDP growth of 8%, 9% and 10% and balance life of reserves is as under :

Table-II

2012-17	Scenario-I (10%) GDP 8%	Scenario-II (11%) GDP 9%	Scenario-III (12%) GDP 10%
Limestone Requirement during 12th Plan projected for various growth Scenarios (Mn.t)	3162.96	3252.73	3344.87
Life of the residual limestone reserves excluding the reserves falling under forest & CRZ beyond terminal year of XII Plan years)	54	53	52

Although the limestone resources have been estimated around 185 billion tonnes but they are falling under forest and CRZ, the residual life of the limestone reserves has been estimated for 52 years (at 12% annual growth)

4. **Imports and Exports** : The following table brings out the imports and exports of limestone from the country :

Table-III

(in million tonnes)

	2009-10	2010-11
Imports	3.90	5.04
Exports	2.35	1.04

Source : Indian Bureau of Mines, Nagpur

5. **Way forward** : In order to ensure the availability of cement grade limestone for projected cement production beyond 12th Five Year Plan, Working Group had recommended various steps, some of which are as under:

i. Presently the average assessment depth for limestone reserves by private/government exploration agencies is merely 30 – 70m which should be increased.

ii. Geologically limestone is deposited in major geological basin, and clustering of cement plants is developed accordingly. Initially small sizes of the leases were granted to these plants. Due to the restriction for lateral expansion of mine mineral would be blocked after certain depth keeping provisions of statutory pit slopes, 7.5 m safety zone near boundary etc. Deeper mines could be developed if two or more small quarries are allowed to merge or well planned mining cooperatives are formed for winning blocked reserves from depth as well as from common boundary zone or safety zones.

iii. At present periodic assessment of the captive limestone mines is negligible. The directives issued time to time for carrying out statutory exploration/ reassessment as per UNFC norms required to be monitored and reviewed to assess the future availability of limestone reserves.

iv. Strengthening of exploration capabilities of state DMG for exploration of concealed deposit (Geophysical, deep drilling etc.), inaccessible areas (airborne mineral survey, remote sensing, etc.) etc., keeping in view the transfer of power to award the mining lease being decentralized.

v. Incentives on utilization of mineral beneficiation techniques with better recovery from low grade limestone and mine rejects may be thought of by

reduction in limestone royalty charges which could be either based on weighted ore recovery percentage or grade upgradation basis.

vi. Concept of Special Mineral Economic Zones for limestone can be thought of where the mineral wealth of the area can be shared. The plants should be located conveniently away in non-mineralized belt. The plants, colonization, inhabitation already in place in the limestone belt cannot be removed now.

vii. The availability of potential limestone deposits of hill states and north-eastern states is restricted due to Forest Conservation Act. Efforts have to be made to release the deposits for exploitation on selective basis.

viii. The exploitation of offshore/onshore deposits has been restricted by declaring coastal stretches as Coastal Regulation Zone (CRZ). Review of the provisions of the CRZ is essential to enable eco-friendly use of enormous reserves of cement grade limestone blocked along Gujarat coast and to save operating plants from gradual demise.

ix. In order to ensure rational utilization of reserves of various grades available in the mining lease area and to assess the shortfall, if any, for expansion of existing cement plants, periodic re-assessment of captive limestone reserves has to be made mandatory.

x. The Royalty rates of limestone need to be rationalized following one standard norm with respect to quality.

xi. Development of rail-road, infrastructural and communication network may be taken up on priority to utilize the available resources especially in hilly and inaccessible areas.

(d) BAUXITE

Reserves : World bauxite resources have been estimated by US Geological Survey at the end of 2013 between 55 to 75 billion tonnes : in Africa (32%), Oceania (23%), South-America and the Caribbean (21%), Asia (18%) and elsewhere (6%). Indian resources of bauxite as on 1.4.2010 are placed at 3,480 million tonnes. These resources include 593 million tonnes reserves and 2887 million tonnes as remaining resources. About 84% of the resources are metallurgical grade whereas refractory and chemical grades are around 4%. State of Odisha accounts for 52% of the resources, followed by Andhra Pradesh (18%), Gujarat (7%), Chhatisgarh and Maharashtra (5% each) and Madhya Pradesh and Jharkhand (4% each). Major bauxite resources are concentrated in the East Coast in Odisha and Andhra Pradesh.

2. **Production and consumption** : The world production of bauxite during the last two years can be seen from the following table :

Table-I

World production of bauxite

(in million tonnes)

Country	2012	2013*
Australia	7603	77
Brazil	34	34.2
China	47	47
Guinea	17.8	17
India	19	19
Indonesia	29	30
Jamaica	9.34	9.5
Rest of world	25.56	25.3
	258	259

* Estimated

Source : U.S. Geological Survey

3. As per latest data available, the production and consumption of bauxite in India in the three years are as under :

Table-II

(in million tonnes)

	2008-09	2009-10	2010-11
Production	15.46	14.12	12.64
Consumption	12.35	12.23	11.77

Source : Indian Bureau of Mines

It will be observed that the production of bauxite is more than its demand.

4. **Imports and Exports** : The following table brings out imports and exports of bauxite from the country :

Table-III

(in tonnes)

	2009-10	2010-11
Imports	54345	63584
Exports	475692	119154

Source : Indian Bureau of Mines

5. **Way forward** : Report of Sub-Group-II of the Working Group on Mineral Exploration and Development (Other than Coal & Lignite) for the 12th Five Year Plan has gone deep into the bauxite resources of the country and has come to the conclusion that the country has abundant resources of bauxite of metallurgical grade. Development of bauxite mining in future would depend upon growth of aluminium sector i.e. the capacity of alumina refining. With the brown field expansions already planned by the existing industries, the refining capacity at the end of 12th Plan would be 10.40 million tonnes. This should increase bauxite production to around 31 million tonnes by 2017. During the subsequent five years, with addition of two million tonnes alumina plant for export, the bauxite mining capacity may reach to 45 million tonnes. The resources of the country are adequate to sustain the future requirements.

(ii) SCARE / RARE MINERALS

(a) COBALT

Reserves : Identified world cobalt resources have been estimated by the US Geological Survey at about 15 million tonnes metal content. The vast majority of these resources are in nickel-bearing laterite deposits, with most of the rest occurring in nickel-copper sulfide deposits hosted in mafic and ultramafic rocks in Australia, Canada and Russia, and in the sedimentary copper deposits of Congo (Kinshasa) and Zambia. In addition, as much as 1 billion tonnes of hypothetical and speculative cobalt resources may exist in manganese nodules and crusts on the ocean floor.

2. Indian resources of cobalt ores as on 1.4.2010 have been estimated by IBM at 44.91 million tonnes : 9 million tonnes in Jharkhand, 5 million tonnes in Nagaland and 30.91 million tonnes in Odisha.

3. **Production and Consumption** : The total world refining capacity for cobalt (metal content) is estimated at 118,000 tonnes of metal content. As against this, cobalt production (metal content) in 2012 is estimated at 110,000 tonnes as against 109,000 tonnes in 2011. Congo (Kinshasa) is the largest producer with 60,000 tonnes in 2011 and 2012 respectively followed by China with 7000 tonnes, Canada 6700 tonnes, Russia 6200 tonnes, Australia 4500 tonnes, Brazil 3700 tonnes and so on.

4. There is no domestic production of cobalt from indigenous ores. The refineries produce cobalt from heterogeneite type cobalt ores imported from Congo (Kinshasa). Refinery capacity is estimated by IBM at 2560 tonnes per year. In 2010, Indian production is estimated at 1187 tonnes and 1300 tonnes in 2011, mainly contributed by Nicomet Industries Ltd. and Rubamin Ltd.

5. **Imports and Exports** : There is no import duty on cobalt ores and concentrates. However, import of cobalt waste and scrap are restricted. In 2010-11, India imported 5041 tonnes cobalt ores and concentrates as against 9590 tonnes in 2009-10 and exported 51 tonnes to China and one tonne to Netherlands.

6. **Way forward** : India does not have any primary cobalt resources. Five possible secondary sources are nickel-bearing laterite deposits in Odisha and declining copper slag produced by HCL (Hindustan Copper Limited), which have been under R&D studies for commercial applications over the years. Recovery in small quantities of cobalt from wastes like cutting-tool scrap and beta-naphtha cake from zinc industry was carried out in the late 1980s. . The cobalt refineries in India are working with imported ores from Congo and have catered to the market for chemical applications and cobalt oxide for cutting tools applications. However, the supplies from Congo present a high risk due to political instability and are subject to supply interruptions. It is necessary that R&D studies are intensified with proper support from the Government of India

(b) SULPHUR

Resources: World resources of elemental sulphur in evaporite and volcanic deposits and sulphur associated with natural gas, petroleum tar sand and metal sulfides amount to about 5 billion tonnes of sulphur. The sulphur in gypsum and anhydrite is almost limitless. It is estimated that about 600 billion tonnes of sulphur is contained in coal, oil shale and shale rich in organic matter. However, low-cost or economical methods have not yet been developed to recover sulphur from these sources. One-fifth of the world's total resources are estimated to be in US.

2. In India, there are no mineable elemental sulphur reserves. The resources of sulphur (pyrites) are estimated in inferred category at 1674 million tonnes as on 1.4.2010. Major resources are located in Bihar and Rajasthan.

3. **Production** : The total world production of sulphur in all forms was 70 million tonnes in 2012 compared to 70.50 million tonnes in 2011. In 2011 and 2012, world output of sulphur matched its demand but in 2013, there is likely to be a shortage which is likely to continue till 2014. However, it is expected that with increased production from oil sand in Canada, natural gas in the Middle East, expanded oil and gas operations in Kazakhstan and heavy oil processors in Venezuela, its production is likely to increase to match world demand. Additional production is also expected to come from increased sulphur recovery from natural gas in Russia and improved sulphur recovery at oil refineries and new development of more gas deposits in Asia.

4. The domestic production of elemental sulphur is limited to by-product recoveries from petroleum refineries and fuel oil used as feedstock for manufacturing fertilizer. In addition, sulphur is recovered from sulphide ores, sulphur is recovered in the form of by-product sulphuric acid. The following table will bring out the Indian production of by-product sulphur and by-product sulphuric acid.

Table-I

Production of by-product sulphur and by-product sulphuic acid

(in tonnes)

	2009-10	2010-11	2011-12
By-product sulphuric acid			
(a) From domestic ores	1045522	1199730	1313539
(b) From imported ores	2130015	2112774	2166889
Total	**3175537**	**3312504**	**3480428**
By-product sulphur	**263124**	**236998**	**381146**

Source: Indian Bureau of Mines, Nagpur

5. The total reported consumption of elemental sulphur in 2011-12 was reported to be about 1.69 million tonnes as against 1.67 million tonnes in 2010-11. Fertilizer industry consumed about 72.5% followed by chemical industry 15.9% and the rest by others.

6. **Imports and Exports** : An idea of the imports and exports trade of sulphur can be had from the following table :

Table-II
Imports and Exports of Sulphur

(in tonnes)

	Import			Export		
	2009-10	2010-11	2011-12	2009-10	2010-11	2011-12
(i) Excluding sublimed, precipitated and colloidal	1533628	1356774	2037635	124884	167009	163372
(ii) Sublimed, precipitated and colloidal	2369	5468	2981	5608	22332	42673

Source : Indian Bureau of Mines, Nagpur

7. The Working Group on Mineral Exploration and Development (other than coal and lignite) for 12th Five Year Plan (2012-2017) has recommended for fiscal intervention to encourage recovery of sulphur going as gaseous emissions in the refinery and petrochemical industries.

8. **Way forward** : Sulphur and sulphuric acid will continue to be important in agriculture and industrial applications for a long time to come. Phosphate fertilizer, where sulphuric acid is consumed, is expected to be in dominant usage for agricultural produce in India. Other usage for sulphur and sulphuric acid will be in ore leaching, copper and nickel being the main consumers. As demand for nuclear power increases in India, uranium leaching will be another area for its usage.

9. India will continue to be dependent on outside countries for its requirements of sulphur in view of its usage in fertilizer. Increase oil exploration and recovery during expected increased production of non-ferrous metals from sulphide ores may fill in some gap. However, India will still face some shortfall in times to come. US Geological Survey is of the view that "in the near term, potential deficits of elemental sulfur are projected as a result of lower global production and a strong demand. However, this is expected to reach near-balance conditions and long-term, marginal surplus worldwide in the near future. Sulfur trade is expected to show a strong increase, which would be driven by increased import demand in the fertilizer and ore leaching sectors." India will have therefore to work from now onwards for likely new sources of supply, in addition to the supplies from the traditional countries from where we are importing at present.

(c) TIN

Reserves : The world reserves of Tin has been estimated by USGS at 4.9 million tonnes of metal content. The maximum reserves are reported to be in China at 1.5 million tonnes of tin content, followed by Indonesia 0.8 million tonnes and Brazil 0.71 million tonnes.

2. In India tin occurs in primary as well as secondary (alluvial or placer) forms. The total resources of tin ore in the country as on 1.4.2010 are placed at 83.73 million tonnes containing about 102,275 tonnes metal. About 7131 tonnes ore containing 1132 tonnes metal are placed under reserved category and are in Chhattisgarh. However, bulk of the resources i.e. about 83.72 million tonnes containing 101,142 tonnes metal are placed under `remaining resources' category. 64% of total ore resources are located in Haryana, 36% in Chhattisgarh and balance in Odisha.

3. **Production and consumption** : China is the largest producer of (undifferentiated) Tin at 156,000 tonnes, followed by Indonesia 43000 tonnes (primary) and Malaysia 40267 tonnes (primary) :

Table-I
World smelter production

(in tonnes)

	2009	2010	2011
Ground Total :	**335000**	**337000**	**339000**
primary	178000	170000	166000
secondary	17200	17200	17200
undifferentiated	140000	150000	156000

Source : U.S. Geological Survey

Table-II
World mine production

(in tonnes)

	2011	2012	Reserves
World Total	**244000**	**230000**	**4900000**
China	120000	100000	1500000
Indonesia	42000	41000	800000
Malaysia	28900	29000	250000
Brazil	11000	11500	710000
Bolivia	20300	20000	400000

Source : U.S. Geological Survey

Table-III

4. As against this, Indian production was :

(in kg.)

	2008-09	2009-10	2010-11	2011-12 (P)
Tin concentrate	59778	59016	61355	48971
Tin metal	26568	27129	24013	23451

Source : Indian Bureau of Mines, Nagpur

5. The main consumers in India are the tin plate and solder industry, the latter being the biggest single end-use. No precise idea of domestic consumption is available except that Rourkela consumed 20 tonnes of tin and the Tin Plate Company also consumed tin.

6. **Exports-Imports** : An idea of exports and imports of tin can be had from the following table :

Table-IV

Exports-Imports of tin and alloys, including scrap

(in tonnes)

	2009-10	2010-11	2011-12
Exports	2315	1900	1673
Imports	7672	7494	8060

Source : Indian Bureau of Mines, Nagpur

7. **Way forward :** The demand of tin plate for packaging industry is likely to grow at a moderate level of 5% per annum. Likely ban on the use of lead, lead-free solder, tin will be required for soldering of electronic and electrical devices in the future. The increase in demand of tin in the world was led by China and a global boom in consumer electronics and a rapid transition to the use of lead-free solders. US Geological Survey is of the opinion that during the next decade, technological changes are likely to affect tin consumption in its main applications of electronics, solder and tin plate could reduce its consumption. It is felt that there is no likelihood of any scarcity of tin in the foreseeable future. However, seeing the current trend of China restricting supply of rare earths and tungsten, India has to increase its domestic production to reduce dependence on imports.

(d) TUNGSTEN

Reserves : World reserves for tungsten have been estimated by US Geological Survey at 3.2 million tonnes of tungsten content, China is the largest depository with 1.9 million tonnes of tungsten content. Indian resources of tungsten ore as on 1.4.2010 have been estimated at 87.4 million tonnes containing 142,094 tonnes WO_3 content.

2. **Production and consumption** : World production of tungsten in 2012 is estimated to be 73,000 tonnes as against 73,100 tonnes in 2011. China was the largest producer of tungsten with an output of 62,000 tonnes in 2012 as against 61,800 tonnes in 2011.

3. India does not produce tungsten, although some production was reported from Degana (Rajasthan) and Chendapathar (West Bengal) in the past. The entire domestic requirements of tungsten ore / concentrates are met by imports. Annual consumption of tungsten ore / concentrates and ferro-tungsten during 2008-09 and 2010-11 is estimated at 530 tonnes and 18 tonnes respectively.

4. **Imports and exports** : Following are the imports and exports of tungsten :

Table

	2009-10		2010-11		2011-12	
	Imports	Exports	Imports	Exports	Imports	Exports
Tungsten ores and concentrates (in tonnes)	87	—	27	32	327	321
Tungsten and alloys including scrap (U) (in kgs.)	356156	79513	404654	430970	637994	638430

Source: Indian Bureau of Mines, Nagpur

5. **Way forward** : World tungsten supply will continue to be dominated by Chinese production and exports. The Chinese tungsten concentrate production quota for 2012 was increased by 2% to 89,000 tonnes (65% WO_3). The export quota for 2012 was reduced to 15,400 tonnes of all tungsten products which is likely to be reduced further. Tungsten use is strongly influenced by general economic conditions and also influenced by Government spending for defense applications.. Future consumption of tungsten will depend on the performance of the industries such as : automotive and aircraft production; construction; electronics manufacturing, where cemented carbide microdrills are used in circuit

boards; general manufacturing; large equipment manufacturing; mining; and oil and gas drilling. In the next few years, tungsten mine production outside of China is expected to increase.

6. Recently China has imposed restrictions on the export of pure tungsten powder affecting the defense projects in India. Locating new deposits and its techno-economic viability requires a long gestation period. It will be worthwhile to reassess the known occurrences of tungsten and the scheelite occurring associated with the tailing dumps of Hutti Gold Mines Limited.

(e) MOLYBDENUM

Reserves : World resources of molybdenum have been estimated by the US Geological Survey to be about 19.4 million tonnes of metal content. Molybdenum occurs as the principal metal sulfide in large low-grade porphyry molybdenum deposits and as an associated metal sulfide in low-grade porphyry copper deposits. Resources of molybdenum are considered adequate to supply world needs for the foreseeable future.

2. In India, molybdenum is associated generally with copper ores. The resources of molybdenum ore as on 1.4.2010 are estimated at about 19.29 million tonnes containing about 12,640 tonnes of MoS_2. The resources are located in Tamilnadu (9.97 million tonnes), Madhya Pradesh (8 million tonnes) and Karnataka (1.32 million tonnes).

3. **Production and consumption** : The world production of molybdenum was 250,000 tonnes in 2012 as against 264,000 tonnes in 2011. China is the largest producer of molybdenum and produced 105,000 tonnes in 2012, followed by US with 57,000 tonnes and Chile with 35,300 tonnes.

4. In India, molybdenum concentrates are produced intermittently incidental to uranium mining at Jaduguda mine of Uranium Corporation of India Limited (UCIL). Usually, molybdenum is used in the form of roasted concentrates, oxide or ferro-molybdenum in defence industries. In India, molybdenum is used chiefly in the form of ferro-molybdenum.

5. Non-ferrous Technology Development Centre at the Defence Metallurgical Research Laboratory, Hyderabad has a pilot plant for producing molybdenum powder. Institute of Minerals and Materials Technology (formerly RRL), Bhubaneswar is carrying out basic research on recovery of molybdenum from spent catalysts.

Table-I

Production and consumption of ferro-molybdenum

(in tonnes)

	2008-09	2009-10	2010-11	2011-12
Production	2112	2822	3050	4362
Consumption (Total) :	971	855	929	671
Alloy Steel+Electrode	693	574	596	458
Foundry	63	57	50	50
Iron & Steel	215	224	283	161

Source: Indian Bureau of Mines, Nagpur

6. **Imports and Exports** : The internal demand for molybdenum and its products are met mostly through imports. Following table will bring out imports and exports of molybdenum :

Table-II

Imports and exports of molybdenum

(in tonnes)

	2009-10	2010-11	2011-12
Imports			
Ore and concentrate	3751	4382	5223
Scrap	297	412	826
Exports			
Ore and concentrate	9056	938	4477
Scrap	7	15	27

Source : Indian Bureau of Mines, Nagpur

7. **Way forward** : During the past decade, molybdenum consumption has shown a strong annual average growth rate, primarily fueled by rapid increases in China's industrial growth. Molybdenum demand continues to be driven largely by the steel sector. As emerging economies, such as China and India, continue on the path to industrialization, they are expected to need increasing amounts of molybdenum, and this trend is expected to contribute to the growth of its global demand in the coming years.

8. Molybdenum plays a vital role in the energy industry, and it may become an increasingly essential factor in green technology, where it is used in high-strength steels for automobiles to reduce weight and improve fuel economy and safety. Molybdenum may play a critical role in reducing sulphur in liquid fuels by acting as a cracking agent. Its consumption may more than double in the oil refineries in the future. Analysts expected global demand for these types of catalysts to increase by more than 5% annually until 2013. The need for companies to reduce carbon dioxide emissions from coal-fired power stations will require plants to run at higher temperatures, resulting in greater demand for higher grade molybdenum-bearing steels. Since India meets most of its demand through imports, process R&D for recovery of molybdenum from primary sources of Tamilnadu needs to be incentivized.

(f) VANADIUM

Reserves : World resources of vanadium are estimated by the US Geological Survey to exceed 63 million tonnes metal content. Vanadium occurs in deposits of phosphate rock, titaniferous magnetite, and uraniferous sandstone and siltstone in which it constitutes less than 2% of the host rock. Significant amounts are also present in bauxite and carboniferous materials, such as coal, crude oil, oil shale and tar sands. Because vanadium is usually recovered as a byproduct or co-product, demonstrated world resources of the element are not fully indicative of available supplies.

2. In India, vanadium is associated with titaniferous magnetite which contains 0.8 to 3% V_2O_5. It also occurs in significant amounts in association with chromite, laterite, bauxite and ferro-magnesium-rich rocks, such as pyroxenite, anorthosite and gabbro. The total estimated resources of vanadium ore as on 1.4.2010 are placed at 24.72 million tonnes with an estimated V_2O_5 content of 64,887 tonnes. Out of the total resources, the reserves are 0.41 million tonnes having 1603 tonnes of vanadium, while the remaining resources are 24.31 million tonnes having 63,284 tonnes of V_2O_5 content.

3. **Production and Consumption** : The world mine production of vanadium was 63,000 tonnes metal content in 2012 as against 62,400 tonnes in 2011. China was the largest producer with 23,000 tonnes in 2011 and in 2012 respectively. China is followed by South Africa (22,000 tonnes) and Russia (16,000 tonnes) in 2012. In India, vanadium sludge is separated as a by-product during the Bayer process for production of alumina hydrate at Balco's Korba plant and Hindalco's Renukoot plant. Nalco is not producing vanadium sludge commercially. However, it could be extracted successfully in lab-scale studies.

4. Ferro-vanadium producing units in India consume either imported vanadium concentrates or indigenous vanadium sludge. The domestic availability of vanadium sludge from aluminium industry is limited for ferro-vanadium production and the gap is met by imports.

Table-I

Production and consumption of ferro-vanadium

(in tonnes)

	2008-09	2009-10	2010-11	2011-12
Production	1501	1389	1521	2459
Consumption (all industries)	480	569	960	1171
Foundry	6	6	4	4
Alloy steel	62	78	52	26
Iron & steel	412	485	886	1141

Source : Indian Bureau of Mines, Nagpur

5. **Imports and Exports** : Following table brings out imports-exports of vanadium in last two years :

Table-II

Imports and Exports of ores & concentrates

(in tonnes)

	2009-10	2010-11	2011-12
Imports	60	4	109
Exports	124	-	1250

Source : Indian Bureau of Mines, Nagpur

6. **Way forward** : Vanadium consumption is heavily influenced by steel production, especially high-strength steel grades which is being increasingly used in construction, energy and transportation industries. Aerospace applications are also rapidly expanding with the introduction of next generation of commercial aircraft. Vanadium is becoming more widely used in green technology applications, especially in battery technology.

7. The precise rate of growth in world consumption of vanadium will depend on a number of factors, particularly new regulations for Chinese high-strength construction steel which has the potential to significantly increase vanadium demand. Fluctuation in the supply and demand balance has resulted in significant volatility in vanadium prices during the past few years.

8. As far as India is concerned, since future alumina plants will depend on east coast bauxite which has low vanadium content, it will be difficult to generate adequate quantity of vanadium sludge to meet increasing domestic demand. It is therefore necessary to initiate steps to utilise huge vanadium-bearing titaniferous ores available in Karnataka, Maharashtra and Odisha through R&D efforts to meet the domestic demand for vanadium pentoxide and ferro-vanadium.

(g) RARE EARTH-ELEMENTS AND ENERGY CRITICAL METALS

Reserves : Rare Earths are relatively abundant in the Earths' crust, but discovered mineable concentrations are less common than for most other ores. US and world resources are contained primarily in bastnasite and monazite. Bastnasite deposits in China and the United States constitute the largest percentage of the world's rare-earth economic resources, while monazite deposits constitute the second largest segment. Apatite, cheralite, eudialyte, loparite, phosphorites, rare-earth-bearing (ion absorption) clays, secondary monazite, spent uranium solutions and xenotime make up most of the remaining resources. Undiscovered resources are thought to be very large relative to expected demand. In terms of rare-earth oxide (REO) content, USGS has estimated world reserves at 110 million tonnes with China at 55 million tonnes, followed by US at 13 million tonnes, India 3.1 million tonnes and Australia at 1.6 million tonnes.

2. In India, monazite is the principal source of rare earths and thorium. Department of Atomic Energy has estimated monazite resources at 10.70 million tonnes, which include indicated, inferred and speculative categories. Monazite is a prescribed substance under Atomic Energy Act, 1962. It occurs in association with heavy minerals such as ilmenite, rutile, zircon, etc. in beach and inland placer deposits of the country.

3. **Production and consumption** : The world production of rare earths in terms of REO is estimated to be 110,000 tonnes in 2012 as against 111,000 tonnes in 2011. In 2012, China was the largest producer with 9,5000 tonnes REO, followed by USA 7,000 tonnes, Australia 4,000 tonnes, India 2,800 tonnes.

4. As far as India is concerned, the following table brings out production and consumption figures of rare earths:

Table-I

(in tonnes)

	2008-09	2009-10	2010-11	2011-12
Production	22	16	NIL	NIL
Consumption*:	158	118	128	75
Paint Driers / pigments	85	92	76	-
Cinema arc carbon	66	25	46	-
TV colour picture tube	-	1	-	-
Glass / optical polishing	2	-	1	2
Glassware decolouring	-	++	1	28
R&D and others	5	-	4	45

*Consumption relates to sales figures of Indian Rare Earths Ltd.
Source: Department of Atomic Energy, Mumbai
Figures of 2011-12 : Indian Bureau of Mines, Nagpur

5. **Imports and Exports and future outlook :** Indian Rare Earths Limited (IREL) : IREL operated its monazite processing plant in Kerala till 2004 when it suspended operations due to availability of rare earth metals at very competitive prices from China. IREL is now in the process of setting up a Monazite Processing Plant (MoPP) at its OSCOM unit in Odisha, with a capacity to process 10,000 tpa of monazite and produce 11,000 tpa of RE chlorides equivalent to ~ 5000 tpa of REO (~ 3-4%) of world demand). Currently, about 500 tpa is being imported for domestic consumption, 90% of which is Cerium oxide. As domestic market for RE compounds is limited at present. IREL shall predominantly export its RE production.

(ii) ENERGY CRITICAL ELEMENTS

6. Many of the ECEs are by-products of the production of base metals. The supply of these is critically dependent on the production of base metals.

Table-II

Important Energy Critical Elements and their applications

Element	Production	Applications
Gallium	Al, Zn processing	solar cells, LEDs, mobile communications, ICs
Germanium	Zn, Cu, Pb refining	substrate in Ga-As solar cells, fiber optics, defence
Selenium	Cu refining	solar cells, glass industry, alloys
Indium	Zn, Cu, Tin refining	LED, Solar cells, Battery
Tellurium	Cu refining	solar panels

7. **Lithium** : Lithium is essentially used in batteries that are required for several uses such as electric vehicles, energy storage during intermittent generation from renewable energy sources etc. In India there has been no significant activity for lithium production.

Demand for REE and ECE

8. India has ambitious plans for generating solar power of 30,000 MW and wind energy of 50,000 MW by 2030. The demand of REE and ECE is therefore likely to increase in future. With respect to the wind energy, the critical component is the high strength RE permanent magnets. For production of 1MW wind energy, 600 kg Magnet with 25-30% Nd i.e. 150-186 kg of Nd is used.

9. If the magnets required for generating at least half of wind energy is to be met with indigenous supply of REEs, it would require about 7500 tonnes of Nd. Electric vehicles also require permanent magnets. A Toyota Prius requires a magnet in which Nd content is about 1Kg. Neodymium requirement for 4 wheelers alone would be of the order of 1500 tonnes.

10. The requirement of triband phosphor (made of Tb, Eu and Y) for lighting industry in India may go up from 180 tonnes to over 1000 tonnes by 2020.

11. **Way forward** : Rare earths are not rare in the sense of their abundance, have earned this descriptive because they are rarely concentrated enough for an easy recovery from their ores. Rare-earth use in catalysts, magnets, phosphors, and rechargeable batteries is expected to continue to increase to keep up with future global demand for automobiles, consumer electronics, energy efficient lighting, and alternative energy sources. Demand for cerium and lanthanum for use in automotive catalytic converters and catalysts for petroleum refining is expected to follow refinery and automotive production.

12. Rare-earth content of world reserves is greater than cumulative world consumption expected into the 21st century; however, recent shortages of rare earths for alloys, magnets, and phosphors have compelled companies to explore and develop rare-earth deposits throughout the world. Although the industry had shifted away from using naturally occurring radioactive rare-earth ores, several new projects are based on monazite ores. Long-term demand for monazite is expected to increase because of the mineral's abundant supply and low-cost by product recovery. Thorium's use as a nuclear material is a possible substitute for uranium in the future. If consumption of thorium increases, monazite could resume its role as a major source of rare earths.

13. To ensure their long term availability, primary occurrence of rare earth minerals within carbonatite, synites, albitites and pegmatites need to be explored for establishing their economic viability. Encourage cooperative research in exploration, extraction and process technology as a long term measure. For the short term, tie-up with countries like Afghanistan, Mozambique and Ukraine which hold potential for rare earth minerals.

(h) GALLIUM

Reserves : Gallium occurs in very small concentrations in ores of other metals. Most gallium is produced as a byproduct of treating bauxite, and the remainder is produced from zinc-processing residues. Only part of the gallium present in bauxite and zinc ores is recoverable, and the factors controlling the recovery are proprietary. Therefore, an estimate of current reserves comparable to the definition of reserves of other minerals cannot be made. However, resources of gallium in bauxite have been estimated by the US Geological Survey to extend one billion kilograms gallium content and a considerable quantity could be present in world zinc reserves. However, only a small percentage of this metal in bauxite and zinc is economically recoverable.

2. India does not have any primary source of gallium. However, it can be recovered from the Bayers solution during processing of bauxite.

3. **Production and consumption** : The estimated world annual gallium production capacity in 2012 is placed at 474 tonnes. In 2012, world primary gallium production is estimated to be 273 tonnes, 7% less than the 2011 world primary production of 292 tonnes. China is the largest producer followed by Germany, Kazakhstan, etc. Refined gallium production is estimated at about 354 tonnes in 2012. This figure includes primary gallium production and some possible scrap refining. China, Japan, UK and US were the principal producers of refined gallium.

4. Renukoot plant of Hindalco is reported to have a capacity for gallium recovery at 55 kg. per year. However, actual production is nil due to low gallium content in Indian bauxites.

5. Similarly, no data of gallium consumption is available.

6. **Imports and exports** : No data of imports and exports of gallium is available.

7. **Way forward** : With increased use of smartphones and power device market, the demand for gallium is likely to increase significantly in times to come. However, due to paucity of data, it is not possible to estimate Indian demand.

(i) INDIUM

Reserves : As per US Geological Survey, indium's abundance in the continental crust is estimated to be approximately 0.05 part per million. However, quantitative estimates of reserves are not available. Indium is most commonly recovered from zinc-sulfide ore mineral sphalerite. Although the geochemical properties of indium are such that it occurs with other base metals — copper, lead and tin — and to a lesser extent with bismuth, cadmium, and silver, most deposits of these metals are sub-economic for indium.

2. **Production and consumption** : World production of indium is estimated to be 670 tonnes in 2012 as against 662 tonnes in 2011. China is the leading producer with 390 tonnes, followed by Japan, Canada and Republic of Korea with 70 tonnes each and Belgium with 30 tonnes.

3. No data of Indian production and consumption of indium is available. Hindustan Zinc Limited (HZL) is yet to make efforts to recover this metal.

4. **Imports and Exports** : No data on imports and exports is available.

5. **Way forward** : Demand for indium is expected to continue to follow demand for indium tin oxide (ITO) for LCD production. The market share of LCD television is increasing, while that of plasma-display panels and cathode-ray-tube television is decreasing.

6. On the supply side, China is expected to continue to be the main global supplier of primary indium. Moreover Japan and Republic of Korea have increased their recycling capabilities. Brazil and France are likely to add additional primary production capacity.

(j) SELENIUM AND TELLURIUM

Reserves : US Geological Survey has estimated world reserves of selenium at 98,000 selenium content and of tellurium at 24,000 tonnes of tellurium content based on identified copper deposits. But the metals are recovered as by-products during copper, lead-zinc, gold and platinum ore processing.

2. As far as India is concerned, no figures about availability of selenium and tellurium resources are available.

3. **Production and consumption :** In 2011, world production of selenium was 1980 tonnes of selenium content which increased marginally to 2000 tonnes in 2012. Germany and Japan are the largest producers with 650 tonnes each in 2012, followed by Belgium with 200 tonnes and Russia with 145 tonnes. As far as tellurium is concerned, there are no definite figures available except that Japan and Peru produced 35 tonnes of tellurium content each in 2012 followed by Canada with 10 tonnes.

4. In India, selenium and tellurium metals were being recovered as allied products of Ghatsila Copper Smelter of HCL (Hindustan Copper Limited) in Jharkhand where there is an annual installed capacity of 14600 kg. However, in recent years there has not been any production of selenium and tellurium by HCL. Hindalco is reported to have produced 38,810 kg, 41,274 kg and 73, 870 kg of selenium from imported concentrates at its Dahej Smelter in Gujarat during 2008-09, 2009-10 and 2010-11 respectively. There is no information of installed capacity of selenium recovery plant of Sterlite.

5. No figures for consumption of selenium and tellurium in India are available.

6. **Imports and Exports :** Following are imports and exports of selenium and tellurium from India :

Table

(in tonnes)

	2009-10	2010-11	2011-12
Selenium			
Imports	190	209	194
Exports	400	182	184
Tellurium			
Imports	9	3	1
Exports	44	58	13

Source : Indian Bureau of Mines, Nagpur

7. **Way forward :** The supply of selenium and tellurium is directly affected by the production of the principal product from which it is derived — copper — and to a lesser extent, by the production of gold, lead, nickel, or zinc produced from sulfide ores. Increased recovery rates at copper refineries could increase selenium and tellurium supply, and longer term investments in gold-telluride deposits and other sources of tellurium, such as the tellurium mines in China, could boost the global growth rate for tellurium production above the growth in copper concentrate production. Although increased environmental regulation and prices have encouraged the recycling of electronic scrap, recovery of selenium and tellurium has been declining during the past several years owing to the reduction in available scrap selenium- and tellurium-based copier drums. However, many high-grade tellurium producers and users were recovering much of the manufacturing scrap from the production of consumable goods. Further, solar-cell recycling plants have been built in the United States and around the world which would capture selenium and tellurium from copper indium gallium diselenide (CIGS) and amorphous silicon and thin-silicon, cadmium telluride (CdTe).

(iii) STRATEGIC MINERALS

(a) NICKEL

Reserves : Identified land-based resources averaging 1% nickel or greater contain at least 130 million tonnes of nickel content. About 60% is in laterites and 40% is in sulphide deposits. US Geological Survey has estimated reserves at 75 million of nickel content. Extensive resources of nickel are also found in manganese crusts and nodules covering large areas of ocean floor. The long-term decline in discovery of new sulfide deposits in traditional mining districts has forced exploration teams to shift to more challenging locations like east-central Africa and the sub-Arctic. Development of awaruite deposits in Canada may help alleviate projected shortage of nickel concentrate. Awaruite, a natural iron-nickel alloy, is easier to concentrate than pentlandite.

2. In India, important occurrence is nickeliferous limonite in the overburden of chromite in Sukinda Valley (Odisha) where it occurs as oxide. A suitable process is under process for development for its utilisaton. Nickel also occurs in sulphide form along with copper mineralization in East Singhbhum district (Jharkhand). As per IBM, the total resources of nickel as on 1.4.2010 are placed at 189 million tonnes, about 92% of which (i.e. 175 million tonnes) are in Odisha. The remaining 8% resources are distributed in Jharkhand (9 million tonnes) and Nagaland (5 million tonnes). Nominal resources are reported in Karnataka (0.23 million tonnes).

3. **Production and consumption :** The world mine production of nickel in 2012 was 2.1 million tonnes of metal content (all products) as against 1.94 million tonnes in 2011. Philippines is the largest producer with 330,000 tonnes of metal in 2012 as against 270,000 tonnes in 2011. Indonesia produced 320,000 tonnes in 2012 as against 290,000 tonnes in 2011. Russia is the next largest producer with 270,000 tonnes of nickel content in 2012, as against 267,000 tonnes in 2011. Australia follows Russia with 230,000 tonnes of metal production in 2012 as against 215,000 tonnes in 2011. Canada followed Australia with 220,000 tonnes in 2011 and 2012 respectively. Indian production of nickel (metal content) was a bare 90 tonnes in 2010 and 2011.

4. The world over stainless steel is the major end-user of nickel consuming 66% of its total output. Other users are non-ferrous alloys (12%), electroplating (11%), other steel alloys, including casting (10%) and balance 6% is used in chemical applications like nickel-cadmium battery. Domestic consumption of ferro-nickel during following years was :

2008-09	—	2120 tonnes
2009-10	—	2124 tonnes
2010-11	—	2133 tonnes

5. **Imports and Exports** : Following are the imports and exports of nickel.

Table

(in tonnes)

	2009-10	2010-11	2011-12
Imports of nickel and alloys including scrap:	23909	33306	34787
nickel ores and concentrates	91	219	41729
nickel and alloys	22922	32264	33658
nickel waste and scrap	987	1042	1129
Exports of nickel and alloys including scrap:	1524	1429	5340
nickel and alloys	1375	1260`	5218
nickel waste and scrap	149	169	122
Exports Nickel ores and conc.	-	-	450

Source : Indian Bureau of Mines, Nagpur

6. **Way forward**: About 60-70% of world nickel demand is for the production of stainless steel. Nickel accounts for 10 to 20% input cost in stainless steel production depending on the nickel content. The future outlook for nickel depends mainly on the production of stainless steel which is one of the main drivers for nickel production. The production of stainless steel is estimated to be 5 million tonnes by 2016-17 by the end of 12th Five Year Plan.

7. At present, India is wholly dependent on the import of nickel. It is therefore necessary that the technology to recover nickel from the overburden of chromite ore in Sukinda valley in Odisha is established on a commercial scale. Process Research Ortech, Canada has developed a flow sheet for recovery of nickel, cobalt and iron from chromite overburden of Sukinda valley which holds promise. This needs to be firmed up on pilot scale in India.

8. Some substitutes for nickel are being developed. These will take sometime to perfect. For example, low-nickel, duplex or ultrahigh-chromium stainless steels are being substituted for austenitic grades in construction. Nickel-free specialty steels are sometimes used in place of stainless steel in the power-generating and petro-chemical industries. Titanium alloys can substitute for nickel metal or nickel-based alloys in corrosive chemical environments. Lithium-ion batteries instead of nickel-metal hydride may be used in certain applications.

(b) PHOSPHATIC MINERAL (APATITE / ROCK PHOSPHATE)

Reserves : World resources of phosphate rock are estimated to be more than 300 billion tonnes. World reserves have been estimated at 67 billion tonnes in 2013 by US Geological Survey. Phosphate-rock resources occur principally as sedimentary marine phosphorites. The largest sedimentary deposits are found in northern Africa, China, the Middle East and the US. Significant igneous occurrences are found in Brazil, Canada, Finland, Russia and South Africa. Large phosphate resources have been identified on the continental shelves and on seamounts in the Atlantic ocean and the Pacific ocean .

2. In India, total apatite resources as on 1.4.2010 are placed at 24.23 million tonnes. The reserves are estimated at 2.09 million tonnes and balance 22.14 are resources. Out of this bulk (57%) are in West Bengal, followed by Jharkhand (30%) and Meghalaya (5%). The resources of rock phosphate as on 1.4.2010 are placed at 296.3 million tonnes. Reserves are placed at 34.8 million tonnes and balance 261.5 million tonnes are resources. Of the total resources, 36% are in Jharkhand, 30% in Rajasthan, 17% in Madhya Pradesh, 9% in UP and 8% in Uttarakhand.

3. **Production and consumption** : The world mine production of phosphate rock is estimated to be 198 million tonnes in 2011 which increased to 210 million tonnes in 2012. China is the largest producer with a production of 81 million tonnes in 2011 which increased to 89 million tonnes in 2012. This was followed by US with a production of 28.10 million tonnes in 2011 which increased to 29.20 million tonnes in 2012. Morocco was next with a production of 28.00 million tonnes in 2011 as well as in 2012.

4. The following table brings out the production of apatite and rock phosphate in India :

Table-I

(in tonnes)

	2008-09	2009-10	2010-11	2011-12
Apatite	6415	5992	3845	3053
Andhra Pradesh	3902	3882	2585	2917
West Bengal	2513	2110	1260	136
Phosphate/ rock phosphate	1803954	1605489	2097490	2326876
Madhya Pradesh	250556	212168	133358	243960
Rajasthan	1553398	1393321	1964112	2082916

Source: Indian Bureau of Mines, Nagpur

Rock phosphate production is predominantly limited to public sector state-owned companies.

5. The following table brings out the consumption of apatite and rock phosphate in 2008-09, 2009-10 and 2010-11 :

Table-II

(in tonnes)

	2008-09	2009-10	2010-11	2011-12
All Industries	3351500	3145600	3675800	3955100
Chemical	847900	818100	830100	787500
Fertilizer	2503200	2327100	2845300	3167200
Other (glass, sugar, iron and Steel)	400	400	400	400

Source: Indian Bureau of Mines, Nagpur

6. **Imports and Exports :** Since domestic production is not sufficient to meet demand, India has to import rock phosphate. The following table brings out imports and exports of rock phosphate and its various products :

Table-III

(in tonnes)

	2009-10	2010-11	2011-12
Imports			
Rock phosphate	5683654	5194203	9729592
Phosphorus (elemental)	15911	19949	22630
Phosphoric acid	2692899	2008376	2324532
Phosphatic fertilizers	72805	85282	110644
Exports			
Rock phosphate	924	711	248
Phosphorus (elemental)	407	337	429
Phosphoric acid	143195	6508	18674
Phosphatic fertilizers	1458	1205	827

Source: Indian Bureau of Mines, Nagpur

7. **Way forward** : There is no substitute for phosphorus in agriculture. Only about 20% of requirements are met from domestic sources. The remaining requirement is met through import in the form of rock phosphate, phosphoric acid and direct fertilizers. The reserves of chemical and fertilizers grades apatite and rock phosphate in India are very limited. The resources have therefore to be converted into reserves through intensive exploration in States where the resources are known to exist. There is a great need for enlisting private sector in exploration and subsequently for mining in order to reduce India's dependence on imports.

8. As per the Report of the Working Group for 12th Plan period (2012-17), the apparent demand of apatite and rock phosphate was 7.23 million tonnes in 2009-10. The apparent consumption of apatite and rock phosphate is estimated at 8.59 million tonnes in 2011-12 which is expected to increase to 13.22 million tonnes by 2016-17 at 9% growth rate. Demand of phosphatic fertilizer will continue to rise due to growth in population and corresponding increase in food requirements.

9. The Working Group for 12th Plan period has recommended that : (i) mining of rock phosphate may be opened for private sector; (ii) cluster mining may be resorted to reduce the mining loss and degradation of environment to the extent possible; (iii) environmental issues may be sorted out amicably to start mining operations in Aravali areas; (iv) technology for extraction of low grade ores may be adopted; and (v) further exploration is needed in various parts of the country. Government of India as well as the State governments have to take urgent action on these recommendations.

(c) POTASH

Reserves : Estimated world resources of potash are placed at about 250 billion tonnes. US Geological Survey has estimated in 2013 reserves at 9.5 billion tonnes. Canada has largest reserves at 4.4 billion tonnes, followed by Russia at 3.3 billion tonnes.

2. Indian resources of potash are estimated at 21.82 billion tonnes as on 1.4.2010, 94% of which are in Rajasthan followed by Madhya Pradesh 5% and remaining one percent in U.P. No estimation of reserves has been made due to lack of exploration in depth and high cost involved therein. Presently there is no production of potash in the country.

3. **Production and Consumption** : According to USGS, world mine production of potash was 34 million tonnes of K_2O in 2012 as against 36.40 millions of K_2O in 2011. Canada, which is the largest producer of potash, produced 9 million tonnes of K_2O in 2012 as against 11 million tonnes in 2011. Russia is the next largest producer at 6.5 million tonnes of K_2O in 2011 and 2012 respectively followed by Belarus which produced 5.65 million tonnes in 2012 as against 5.5 million tonnes of K_2O in 2011.

4. According to International Fertilizer Industry Association, world potash consumption for all uses is projected to increase at the rate of 3% per year to 36.6 million tonnes K_2O in 2016 from 32 million tonnes K_2O in 2012. Potash production capacity is projected to increase by 33% to 61.4 million tonnes in 2016 from 46.2 million tonnes in 2012.

5. Indian consumption of potash has been estimated at 1.42 million tonnes, decreasing from 1.88 million tonnes in 2010-11 in fertilizer industry. Apparent consumption of potash fertilizer was 5.2 million tonnes in 2009-10 and 4.6 million tonnes in 2010-11 based on export-import data.

6. There is no commercial exploitation and the entire requirements of potassic fertilizers for direct application as well as for production of complex fertilizers are met through imports.

7. **Imports and exports** : Following table brings out imports and exports of potash in last two years :

(in tonnes)

	2009-10	2010-11	2011-12
Imports			
Potash fertilizers	5188833	4617512	2842342
Potassium nitrate	530	466	219
Exports			
Potash fertilizers	29606	29512	32497
Potassium nitrate	2543	1597	1320

Source: Indian Bureau of Mines, Nagpur

8. **Way forward** : Potash is an essential fertilizer nutrient that cannot be substituted. More than 90% of world consumption is in fertilizer products. Growth in population and consequently need for more food production will require that India explores its potash deposits. Since potash exploration and mining involve state-of-the-art technology and heavy investment, it is of utmost importance that private sector is involved to ensure the regular supplies of the critical mineral.

(d) LITHIUM

Reserves : US Geological Survey has estimated world resources of lithium at about 39.5 million tonnes of lithium content, out of which 5.5 million tonnes are in US. The reserves are estimated at 13 million tonnes of lithium content. The largest reserves are in Chile at 7.5 million tonnes, followed by China at 3.5 million tonnes and 1 million tonnes in Australia. Global production of lithium was 37,000 tonnes in 2012, with Chile and Australia (13,000 tonnes each), and China 6,000 tonnes) being the leading producers.

2. No commercially workable lithium resources have been so far identified in India.

3. **Production and consumption** : No data about production and consumption of lithium in India is available.

4. **Imports and exports** : No data about imports and exports of lithium is available.

5. **Way forward**: Lithium supply security has become a top priority for Asian technology companies. These companies have been encouraging strategic and joint ventures with lithium exploration companies world wide to ensure a reliable, diversified supply of lithium for Asia's battery suppliers and vehicle manufacturers.

6. World lithium consumption forecasts for 2015 and 2020 were projected by numerous lithium producers and many leading lithium market analysts. On average, their conclusions indicated that world lithium consumption is likely to increase to approximately 190,000 tonne/per year of LCE (lithium carbonate equivalent) by 2015 and to 280,000 tonne/per year of LCE by 2020. From 2012 to 2017, average annual growth in world lithium consumption was expected to be approximately 11%. New lithium producers were expected to supply approximately 25% of the lithium required by 2020.

7. Annual growth in lithium consumed globally for batteries averaged 21% per year between 2000 and 2012. Demand for rechargeable lithium-ion batteries continues to have the greatest potential for growth. The lithium-iron battery market was expected to increase by 200% by 2017, the equivalent of an additional 90,000 tonnes of LCE. The global market for lithium-ion batteries is forecast to reach $9 billion by 2015, with potential to exceed $50 billion by 2020. Other lithium end uses were projected to increase also, but at lower rates than batteries.

8. A new technology, the lithium-air battery, may be capable of substantially increasing the energy density of lithium batteries, effectively rivaling the energy density of petroleum. Although development of lithium-air battery technology is still in its infancy, a coalition of U.S. national laboratories and commercial partners led by International Business Machines Corp. anticipated having a laboratory prototype battery ready by 2013, a scaled-up prototype capable of powering a car ready by 2015, and commercial batteries in production within a decade.

(e) URANIUM

Reserves : According to World Nuclear Association (WNA), London, known recoverable uranium resources in various countries in 2011 are as under :

Table-I

Known recoverable resources of Uranium 2011

Country	tonnes U	% of world
Australia	1661000	31%
Kazakhstan	629000	12%
Russia	487200	9%
Canada	468700	9%
Niger	421000	8%
South Africa	279100	5%
Brazil	276700	5%
Namibia	261000	5%
USA	207400	4%
China	166100	3%
Ukraine	119600	2%
Uzbekistan	96200	2%
Mongolia	55700	1%
Jordon	33800	1%
Other	164000	3%
World total	**5326500**	**100%**

Source: World Nuclear Association, UK

2. It will be observed that Indian resources are not reflected in the above figures although India is mining uranium. The figures about resources or production are not disclosed as this mineral is covered under prescribed substance under Indian Atomic Energy Act.

3. **Production :** About 64% of world production of uranium is from mines in Kazakhstan, Canada and Australia. At present 45% of uranium is produced by *in situ* leaching. After a decade of falling mine production to 1993, output of uranium has generally risen since then and now meets 85% of demand for nuclear power generation.

4. As will be seen from the following table, Kazakhstan produces the largest share of uranium from mines (36.5% of world supply from mines in 2012), followed by Canada (15%) and Australia (12%).

Table-II

Production from mines (tonnes U)

Country	2010	2011	2012
Kazakhstan	17803	19451	21317
Canada	9783	9145	8999
Australia	5900	5983	6991
Niger (est)	4198	4351	4667
Namibia	4496	3258	4495
Russia	3562	2993	2872
Uzbekistan	2400	2500	2400
USA	1660	1537	1596
China (est)	827	885	1500
Malawi	670	846	1101
Ukraine (est)	850	890	960
South Africa	583	582	465
India (est)	**400**	**400**	**385**
Brazil	148	265	231
Czech Republic	254	229	228
Romania (est)	77	77	90
Germany	8	51	50
Pakistan (est)	45	45	45
France	7	6	3
total world	**53671**	**53493**	**58394**
tonnes U_3O_8	**63295**	**63084**	**68864**
percentage of world demand*	**78%**	**85%**	**86%**

* WNA Market Report data

Source: World Nuclear Association, UK

5. As per estimates made by WNA, India produced 385 tonnes of uranium in 2012. According to WNA, mining methods have been changing. In 1990, 55% of world production came from underground mines, but this shrunk dramatically to 33% by 1999. From 2000, new Canadian mines increased production.

6. **India vis-à-vis world uranium requirements** : As of April 2012, there were 435 operable nuclear reactors world-wide, out of which 21 were operating in India. The strong demand for uranium as an energy resources is expected to grow with the global expansion of nuclear power. Many countries are adopting the use of nuclear power for the following reasons :

— the relative cost competitiveness of nuclear power versus the alternatives;

- security of supply and independence from fossil fuel energy imports;
- diversity of domestic electricity production and reduction in volatility arising from input fossil fuel costs; and
- reduction in greenhouse gases and subsequent effects on global climate.

7. WNA has projected new nuclear capacity in world between 2013-17 as under :

Table-III
Projected new nuclear capacity worldwide 2013-17

Country	New reactors	New capacity (GWe)
Argentina	1	690
Brazil	1	1340
Bulgaria	2	2100
Canada	3	2160
China	44	48000
Chinese Taipei	2	2600
Finland	1	1600
France	2	3500
India	10	8400
Japan	1	1400
Pakistan	2	680
Romania	2	1440
Republic of Korea	6	7400
Russian Federation	16	16400
Slovakia	2	880
Ukraine	2	2000
US	4	8000
Total	**101**	**108590**

Source: World Nuclear Association, UK

8. In India, 10 reactors (2840 MW) are fuelled with indigenous uranium. 9 reactors (1840 MW) are fuelled with imported uranium (imported from Russia, France, Kazakhstan). Recently, significant uranium resources have been found by AMD which are under active development by UCIL / AMD for production. India's uranium resources are 1,86,653 tonnes of U_3O_8 (in Tamilnadu, Andhra Pradesh, Karnataka and Meghalaya).

9. If India has to achieve the above level of nuclear capacity, it is imperative to further intensify exploration and extraction of uranium for which private sector involvement will be necessary to get state-of-the-art technology as well as heavy investment requirements. This will bridge the supply gap and secure India at critical times.

(iv) HIGH VALUE MINERALS / DIAMONDS / PGM

The minerals/metals with which India is vitally concerned now and will be in future such as gold, lead/zinc, copper, nickel PGMs, diamond have not yet been fully developed or their potential realized because of lack of state-of-the-art exploration technologies, high risk and size of the capital required not available in India so far. A large number of the deposits discovered so far are chance discoveries.

2. There is therefore urgent need to explore minerals/metals in which this country is deficient e.g. gold, copper, platinum group of minerals as well as diamond for which India depends on imports. In the other minerals/metals such as lead/zinc etc. although we may be self-sufficient now but, looking to our growing requirements, will have to import in future. These are the minerals for whose exploration, least attention seems to have been given. GSI has no doubt done regional exploration but to exploit a deposit and to analyse its economic viability, one has to go for detailed exploration and analysis of the ore to choose appropriate technology. These minerals are being dealt with in brief hereunder :

(a) GOLD

3. **Reserves :** USGS has estimated gold reserves at 52000 tonnes gold content world-wide. Australia, South Africa, Russia, Chile, US, Brazil, China are most prominent countries who are known to have significant gold deposits.

4. In India, total resources of gold (primary), in terms of metal, stood at 659.84 tonnes as on 1.4.2010. Out of these, 110.54 tonnes were placed under reserves category and balance 549.30 tonnes under resource category.

5. **Production and Consumption :** World mine production of gold was 2,700 tonnes in 2012 as against 2,660 tonnes in 2011, China, which 15 years back used to produce around 3 tonnes was the largest producer at 370 tonnes in 2012 as against 362 tonnes in 2011. After China, Australia was the largest producer with 250 tonnes in 2012, followed by US at 230 tonnes, Russia at 205 tonnes, South Africa at 170 tonnes and Peru at 165 tonnes.

6. India produced 2,438 kgs. of primary gold in 2008-09, 2,084 kgs. in 2009-10 and 2,399 kgs. in 2010-11 and 2,192 kgs. in 2011-12. The total gold bullion production during 2011-12 was 11,284 kgs. which also included gold recovered as by-product from imported copper concentrates by Hindalco. Its consumption is far higher which is met through imports. While major part is consumed within the country, some part of it is exported in the form of gold jewelry.

7. **Imports and exports** : Following table brings out imports and exports of gold in last two years :

Table-I

(in kgs.)

	2009-10	2010-11	2011-12
Imports of Gold			
- Non-monetary and monetary	851023	969738	1078354
- Non-monetary : other semi manufactured forms	4760	51961	49905
- Non-monetary : other unwrought forms	846231	917775	1028449
- Non-monetary : powder	32	2	-
- Gold-clad metals / base metals	-	-	-
Exports of Gold			
- Ores and concentrates	7568	-	82031
- Non-monetary and monetary	22990	34595	169126
- Non-monetary : other semi-manufactured forms	297	87	28
- Non-monetary powder	25	16	-
- Monetary	1	-	6
- Clad metals / base metals, NES	1	1	-

Source: Indian Bureau of Mines, Nagpur

8. **Way forward** : The 12th Plan document has projected a production level of 44 tonnes of gold by the terminal year of 12th Plan and 100 tonnes per year in next 15 to 20 years with following recommendations :

i. Accelerating grant of exploration and mining concessions for gold to attract private investments and contemporary technologies

ii. Establish a “Precious Metals Authority” to facilitate and accelerate such approvals and investments

iii. HGML/BGML have potential to increase production to 10 tonnes.

iv. Tax regime to be amended to incentivize by-product gold production from copper concentrates indigenously

(b) COPPER

Reserves : US Geological Survey has assessed global land-based resources of copper at more than 3 billion tonnes. Deep-sea nodules and sub-marine massive sulphides are unconventional copper resources. However, copper reserves are placed at 680 million tonnes.

2. Indian resources of copper as on 1.4.2010 are placed by IBM at 1.56 billion tonnes (equivalent to 12.28 million tonnes of contained copper) but the reserves under proved and probable categories are 394.37 million tonnes (4.76 million tonnes of contained copper). Largest resources are in Rajasthan (49.86%), followed by MP (29.2%) and Jharkhand (18.49%).

3. **Production and consumption :** The global mine production of copper during 2012 was estimated at 17 million tonnes as against 16.1 million tonnes in 2011. Chile is the largest producer at 5.37 million tonnes in 2012, followed by China with 1.5 million tonnes, Peru with 1.24 million tonnes and US with 1.15 million tonnes. World consumption of copper – 2010 : 19.356 million tonnes; 9China 7.4 million tonnes)

4. Production of copper in India in the last three years is as under :

Table-II

(in tonnes)

	2008-09	2009-10	2010-11	2011-12
Copper blister	29472	17864	14245	19473
Copper cathodes	513690	532865	512124	504677
Copper electrolytic wire bars	-	-	-	-
Continuous cast wire rods	314425	312447	300416	287550

Source: Indian Bureau of Mines, Nagpur

Table-III

(in tonnes)

	2009-10	2010-11	2011-12 (P)
Cu Ore	-	3601984	3478189
Cu Concentrates	124577	136856	130458

Source: Indian Bureau of Mines, Nagpur

5. Copper consumption figures in India are shown in Table-IV and imports and exports of copper in Table-V:

Table-IV

Copper consumption in India

(in tonnes)

Year	Qty.
2009	610,000
2010	635,000

Source : 12th Five Year Plan Report

Table-V

Imports and Exports

(in tonnes)

	2009-10	2010-11	2011-12
Imports			
Copper ores and concentrates	-	1902026	2124501
Copper and alloys	110169	140163	172084
Copper scrap	24214	39651	57866
Copper and alloys (scrap)	27	-	06
Brass and Bronze	14626	16714	16271
Brass and Bronze (scrap)	56555	63580	104063
Cement copper precipitated	2177	147	30
Copper and alloys (excluding brass and bronze and scrap)	110169	140163	172084
Refined copper	-	8055	18524
Cu & alloys (incl. brass & bronze)	-	260108	350290
Exports			
Copper ores and concentrates	40422	19701	20
Refined copper	199842	422388	238138
Copper and alloys (including brass and bronze)	303749	564164	334913
Copper-scrap	2250	2709	7531
Copper and alloys	274690	529962	287488
Brass and Bronze	26565	31266	39216
Brass and Bronze (scrap)	225	208	625
Cement copper precipitated	-	02	1

Source : Indian Bureau of Mines, Nagpur

6. As will be seen that mine production is much less than smelter production resulting in import dependence to the extent of 90% for India's smelter production. Copper demand in India is projected to reach 1.3 million tonnes by

2015-16, while the production of refined copper will lag behind significantly since the expansion plans of Sterlite Copper smelter have been shelved.

7. Over a course of time, in a number of applications, copper has many substitutes such as

- aluminium substitutes for copper in power cables, electrical equipments, automobile radiators and cooling and refrigeration tubes;
- titanium and sled are used in heat exchangers ;
- optical fibre substitutes for copper in telecommunications applications; and
- plastics substitute for copper in water pipe, drain pipe, and plumbing fixtures.

8. However, high growth in copper demand is likely to be from sectors like electrical, transport (auto and railways), air conditioners and refrigerator manufacturers and consumer durable sectors. Further new potential user sectors are emerging such as gas supply, plumbing tube, solar water heater and desalination.

9. It has been estimated that India's refined copper consumption has increased at 10% per year over the last four years. The demand for copper by 2015-16 is estimated at 1.227 million tonnes at 8% GDP growth against a projected production of 1.347 million tonnes of refined copper during the same period. India has enough resources of copper. However, the public sector unit — Hindustan Copper Limited sitting on huge resources has not risen to the occasion with the result, country has to import a large volume of copper in various forms. If private sector is encouraged in exploration and mining, country's dependence on imports will be substantially reduced, we may become self-sufficient.

10. **Way forward** :

i. Intensive exploration for copper to be taken up either by existing producers or by inviting junior exploration companies
ii. Acquisition of copper mining properties abroad
iii. Developing the available indigenous resources for quick exploitation
iv. Encourage recycling of scrap

(c) LEAD AND ZINC

Reserves : US Geological Survey has identified world lead resources at more than 2 billion tonnes. Reserves are at present estimated at 89 million tonnes of lead content. Highest reserves are in Australia at 36 million tonnes, followed by China at 14 million tonnes, Russia at 9.2 million tonnes, Peru at 7.9 million tonnes, Mexico at 5.6 million tonnes, US at 5 million tonnes and so on.

2. Zinc resources in the world have been identified at 1.9 billion tonnes. Reserves are placed at 250 million tonnes zinc content. Largest identified reserves are in Australia at 70 million tonnes, followed by China at 43 million tonnes, Peru at 18 million tonnes, Mexico at 16 million tonnes and India at 12 million tonnes.

3. In India, the reserves of lead and zinc as on 1.4.2010 are 11.55 million tonnes of lead content and 36.66 million tonnes of zinc content. Besides, 0.118 million tonnes lead+zinc metal resources are available. Rajasthan has 88.61% resources followed by Andhra Pradesh 3.31%, Madhya Pradesh 2.16%, Bihar 1.67% and Maharashtra 1.35%.

4. **Production and consumption** : World mine production of lead was 5.2 million tonnes lead content in 2012 as against 4.7 million tonnes in 2011. China produced 2.6 million tonnes, followed by Australia at 0.63 million tonnes, US 0.345 million tonnes, Mexico 0.245 million tonnes, Peru 0.235 million tonnes and so on.

5. Zinc mine production in the world was 13 million tonnes zinc content as against 12.8 million tonnes in 2011. China led the world at 4.6 million tonnes followed by Australia at 1.49 million tonnes, Peru 1.27 million tonnes, US 0.748 million tonnes and so on.

6. Indian production of lead and Zinc (primary) are as under :

Table-VI

(in tonnes)

	2008-09	2009-10	2010-11	2011-12
Lead				
Concentrate	133768	133921	147625	161157
Metal	60323	64319	57294	92100
Zinc				
Concentrate	1224077	1279880	1427231	1412291
Metal	579091	613964	740402	783647

Source : Indian Bureau of Mines, Nagpur

7. USGS has estimated global consumption of refined lead in 2012 at 10.8 million tonnes and that of zinc 13.4 million tonnes. Consumption of lead and zinc may be seen from the following tables. It is understood that lead and zinc are consumed in the country in the form of metals as well as compounds and oxides. Battery industry consumes 74% of lead followed by pigments and compounds 9%, rolled and extruded products 8%, alloys 3%, cable sheathing 2% and the balance 4% is consumed by other industries. The galvanizing industry consumes about 57% of zinc, followed by coating 16%, die-casting alloys 14%, oxides and chemicals 7% and extruded products 6%.

Table-VII

(in tonnes)

	2010-11	2011-12
Apparent consumption of lead (primary)	114217	125606

Source : Indian Bureau of Mines, Nagpur

(in tonnes)

	2010-11	2011-12
Zinc	542591	558879

Source: DGCIS, Kolkata

(Thousand tonnes)

	2006	2007	2008	2009	2010	2016-17 (e)
Lead	275	285	290	297	312	568

(Thousand tonnes)

	2007-08	2008-09	2009-10	2011-12 (e)	2012-13 (e)	2013-14 (e)	2016-17 (e)
Zinc	415	420	525	550	600	660	880

e= estimated

Source: 12th Five Year Plan

8. **Imports and exports :** Following are the imports and exports of lead and zinc:

Table-VIII

(in tonnes)

	2010-11	2011-12
Lead (Imports)		
Lead ores & conc.	9722	30282
Lead and alloys including scrap	285662	240698
Lead & alloys	227387	174045
Lead (scrap)	58275	66653
Lead (pig lead)	3136	6000
Lead unrefined NES	24260	17431
Refined lead unwrought	92372	76789
Lead (by items)	285662	240698
Lead (Exports)		
Lead ores & conc.	39195	10226
Lead and alloys Including scrap	48646	69629
Lead & alloys	48536	69628
Lead & waste scrap	110	01
Refined lead, unwrought	35449	43283
Lead & alloys unwrought, NES	4850	13906
Lead unrefined, NES	21	-
Lead & alloys: worked (bars, rods, plates etc)	801	981

Source : Indian Bureau of Mines, Nagpur

(in tonnes)

	2010-11	2011-12
Zinc (Imports)		
Zinc ores & conc.	88171	63194
Zinc and alloys inc. scrap	112228	131432
Zinc & alloys: worked (bars, rods, plates, etc.)	12944	10764
Zinc & alloys	82411	82852
Zinc & alloys, NES	3613	6294
Zinc or Spelter	61164	61425
Zinc (scrap)	29817	48580
Zinc (by items)	112228	131432
Zinc (Exports)		
Zinc ores & concentrates	67501	5591
Zinc & alloys inc. scrap	264251	295071
Zinc & alloys	264219	295033
Zinc & alloys: worked (bars, rods, plates etc)	2387	4463
Zinc (scrap)	32	38

Source : Indian Bureau of Mines, Nagpur

9. Sub-Group II on Metals and Minerals for XII Five Year Plan has estimated the demand for zinc at 600,000 tonnes in 2012-13 which was expected to increase to 880,000 tonnes in 2016-17. Lead demand in 2012-13 was expected to be 433,000 tonnes which is expected to increase to 560,000 tonnes by 2016-17. Two companies are operating in India; Hindustan Zinc Limited and Binani Zinc Limited. Binani Zinc Limited produces zinc metal from imported concentrates.

(d) DIAMOND

Reserves :. World reserves of industrial grade diamonds are estimated by USGS at 600 million carats with Congo (Kinshasa), Botswana, Australia, South Africa and Russia being the main host countries for diamonds occurrences. Indian Bureau of Mines has estimated that as on 1.4.2010, diamond resources are 31.92 million carats, out of which only 1.04 million carats are reserves. Further, only 2.37% of the resources are of gem variety, and 90% of the resources occur in Madhya Pradesh.

2. **Production and consumption :** World production of gem diamonds in 2012 was 71 million carats as against 69.90 carats in 2011. Botswana was the largest producer with 24 million carats, followed by Russia with 18.50 million carats, Canada with 10.50 carats, Angola with 7.2 carats, Congo (Kinshasa) with 3.9 million carats, South Africa with 2.8 million carats and Namibia with 1.4 million carats. World production of natural industrial grade diamond was estimated at 78 million carats in 2012 as against 77 million carats in 2011. Botswana was the largest producer (24 million carats), followed by Congo (Kinshasa – 16 million carats), and Russia (15 million carats).

3. India produced 18,489 carats of diamonds in 2011-12 as against 11,222 carats in 2010-11. Only 8% of the production was of gem variety, remaining being off-colour and dark brown varieties of industrial grade.

4. **Imports and Exports :** Following are the figures of imports and exports of diamonds :

Table-IX

(in carats)

	2009-10	2010-11	2011-12
Imports			
Diamonds (industrial)	2216	104159	18681
(mostly uncut)	130101282	182227342	152810849
(Powder) (000 carats)	107077	136271	204315
Exports			
Diamonds (industrial)	770352	734036	251923
(mostly uncut)	66090838	78951465	62654023
(Powder) (000 carats)	16961	28544	22334

Source : Indian Bureau of Mines, Nagpur

5. Diamond industry employs around one million artisans who are experts in cutting and polishing small diamonds and are in a position to process full range of sizes and qualities of gemstones using latest technology. The cutting and polishing industry in India is facing growing competition from China. Further diamond producing African countries are demanding a greater share of processing of rough diamonds within their respective countries. KPMG has estimated that by 2015, India's share in value terms will come down to 49.3% of the world diamond roughs from the present 65%. In the same period, China's

share is expected to grow to 21.3%, Russia to 7.1%, South Africa to 5.5%, Israel to 4.7% and the US to 1.4%.

6. Till 250 years back, India was the sole supplier of diamonds to the world till it was found in South Africa and other countries. All the well-known diamonds in the world were found in India. Recent discovery of diamond deposit in Bunder in Madhya Pradesh by Rio Tinto is an indication of more diamond deposits in India. At present De Beers and Rio Tinto are actively engaged in exploration of diamonds.

7. The Working Group on minerals for 12th Five Year Plan made the following recommendations for diamonds :

i. Investor-friendly policies to offset high expenditure and high risk in exploration to attract junior and other players to locate diamondiferous kimberlites and lamproites

ii. Simplification of procedures for approvals for Airborne Surveys

iii. Incentives to attract venture capital, speedy approvals and assured transition from RP to ML

iv. GSI to conduct regional surveys and technology upgradation for diamonds, viz, regional airborne geophysical surveys, magneto-telluric survey, litho probe project, and seismic tomography, etc.

(e) PLATINUM-GROUP METALS

Reserves : USGS has estimated world resources of PGMs in mineral concentrations that can be mined economically to total more than 100 million kilograms while reserves are estimated as 66 million kgs. The largest reserves are in Bushveld complex in South Africa with 63 million kgs.

2. Indian resources of PGMs as on 1.4.2010 have been put at 15.7 tonnes of metal content, out of which 14.2 tonnes are in Nilgiri, Boula-Nuasahi and Sukinda areas in Odisha and the balance 1.5 tonnes in Hanumalpura area in Shimoga schist belt of Karnataka.

3. **Production** : An idea of world production can be had from the following table :

Table-X

(in kilograms)

	2010	2011	2012
World Total	467000	487000	451000
Major Producers :			
Canada			
Palladium	6200	14300	12200
Platinum	3500	8000	7000
Other platinum group metals	400	800	700
Russia			
Palladium	84700	84300	82000
Platinum	25000	25900	24600
Other platinum group metals	12000	12500	12000
South Africa			
Palladium	82222	82731	74000
Platinum	147790	148008	133000
Other platinum group metals	57292	58111	53000
Zimbabwe			
Palladium	7000	8241	9000
Platinum	8800	10826	11000
Other platinum group metals	1820	1820	2200
USA			
Palladium	11600	12400	12300
Platinum	3450	3700	3670
Other platinum group metals	-	-	-

Source : US Geological Survey

4. India is not a PGE producing country and is meeting is demand entirely by imports.

5. **Imports and exports** : Following table brings out imports and exports of platinum-group metals :

Table-XI

(in kilograms)

	2009-10	2010-11	2011-12
Imports			
— Platinum alloys and related metals	6215	5072	6129
— Platinum (powder, unwrought & others)	4210	2275	3219
— Other metals of platinum group	1192	2220	2078
— Platinum (others)	814	577	832
— Platinum-clad-base/precious metal	22	5	07
— Platinum unwrought	3938	1157	1567
— Platinum powder	272	1118	1652
Exports			
— Platinum alloys and related metals	10587	3367	382
— Platinum-unwrought	10216	187	110
— Platinum (others)	80	3176	222
— Platinum powder	290	04	20
— Other metals of platinum group	1	-	30
— Platinum-clad-base/precious metal	-	640	01

Source : Indian Bureau of Mines, Nagpur

6. As per Sub-Group for 12th Fiver Year Plan period, the demand for PGMs is expected to reach 80 tonnes by 2017 and may touch 120 tonnes by 2025.

7. About 40% of the world supply of platinum is consumed by the jewellery sector. Palladium, rhodium, iridium and ruthenium are used in electronic and electro-chemical industries, while osmium finds applications in the medical field, such as in chemotherapy and pace-makers (alloy of Pt and Os). These metals are poised to play a vital role in fuel cell technology once the economic viability of fuel cell is established, for which sustained efforts are being made around the world. As the supply of all PGMs together is less than 600 tonnes with about 500 tonnes coming from mine production, the boom in the demand for platinum jewellery and also as an investment can be expected.

8. Platinum production from South Africa was expected to decrease owing to work stoppages and to increased mining costs including electricity and labour. Supply from Zimbabwe was expected to increase from new mining projects, but was subject to political uncertainty. Palladium supply was expected to decrease in Russia owing to a decline in average palladium ore grade. Recycling of platinum and palladium is expected to increase, particularly in the automotive catalyst recycling sector.

9. Exploration carried out by Geological Survey of India and other agencies has resulted in identification of 4 major properties in Odisa, Karnataka and Tamilnadu. In addition, several other occurrences of PGE have been reported in Maharashtra, UP, MP, Manipur, etc. Following recommendations were made by Working Group on 12th Plan for tapping the vast potential of PGEs in India :

i. Boula Nausahi Ultramafic Complex (BNUC), Odisha with potential of 15 tonnes of PGEs should be evaluated through detailed feasibility studies and pilot plant. Simultaneously, feasibility studies on Sittampundi and Hanumalpura deposits should also be initiated along with detailed exploration to upgrade the resources.

ii. GSI needs to generate database incorporating and carry out low-altitude heliborne survey for quick appraisal of larger terrain.

iii. Creating a Centre of Excellence for characterization and beneficiation testwork.

iv. Recovery of PGEs to be focused by technology transfers.

v. Involve private sector junior companies to bring the necessary investments and technologies.

10. Detailed exploration is a specialized job done by exploration companies, popularly known as *junior exploration companies*. Their exploration expertise is in most cases linked to a particular mineral or group of minerals. For exploration job, they bank on venture capital or hedge funds. Mineral rich countries such as US, Canada, Australia, Brazil, South Africa, Chile, Mexico etc. do not want `to spend' tax payers money on the risky venture like exploration.* These countries therefore encourage these private companies to undertake detailed exploration job by providing various incentives and security of tenure besides priority in grant of concessions as well as freedom to sell.

11. An idea of the exploration expenditure incurred by various companies world-wide in the last three years can be had from the following table :

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* The exploration work is extremely risky : if during aerial survey, 1000 anomalies are observed, it may be that only 100 anomalies are worth ground prospecting and it may again be that only one out of these 100 turns out to be worth economic exploitation. The Governments do not therefore prefer to spend the tax payers' money on exploration because it does not want the tax payers' money to be invested in risky and hazardous ventures like exploration.

Table-XII

Year	Companies involved	Amount spent (US$ billion)	%age increase / decrease over last year
2006	1624	7.1	45.5
2007	1821	9.9	40.0
2008	1912	12.6	26.0
2009	1846	7.32	(-) 42.0
2010	2089	10.68	45.45
2011	2400	10.68	61.52
2012	3500	21.50	19.00

Source: Metals Economic Group, Canada

12. Where this money was spent and on which mineral/metal can be observed from following :

Table-XIII

(US$ billion)

Commodity	2006	2007	2008	2009	2010
Gold	3.21 (45%)	4.10 (41%)	4.914 (39%)	3.51 (48%)	5.45 (51%)
Base Metals (copper, lead/zinc, nickel)	2.28 (32%)	3.60 (36%)	5.04 (40%)	2.64 (36%)	3.52 (33%)
Diamond	0.86 (12%)	1.00 (10%)	1.008 (8%)	0.36 (5%)	0.32 (3%)
PGM (platinum group of metals)	0.21 (3%)	0.30 (3%)	0.378 (3%)	0.15 (2%)	0.21 (2%)
Other Minerals	0.57 (8%)	1.00 (10%)	1.26 (10%)	0.66 (9%)	1.18 (11%)
Total	**7.13 (100%)**	**9.99 (100%)**	**12.6 (100%)**	**7.32 (100%)**	**10.68 (100%)**

Source: Metals Economic Group, Canada

13. The amount spent on exploration of each mineral/metal depends on the demand and price movement of that particular mineral/metal. However, the trend over the past decade indicates that gold attracts maximum exploration expenditure, followed by base metals and diamonds.

14. And, finally, which country has spent how much on exploration in last two years :

Table-XIV

(US$ billion)

Country	2008		2009		2010		2011		2012	
	Amount	% age	Amount	% age	Amount	% age	Amount	% age	Amount	% Age
Canada	2.394	19	1.17	16	2.02	18	3.11	18	3.29	16
Australia	1.764	14	0.95	13	1.25	11	2.24	13	2.46	12
US	0.882	7	0.44	6	0.79	8	1.38	8	1.64	8
Russia	0.630	5	0.36	5	0.41	4	0.52	3	0.62	3
Mexico	0.756	6	0.36	5	0.63	6	1.04	6	1.23	6
Peru	0.630	5	0.51	7s	0.79	7	0.69	4	1.03	5
Chile	0.504	4	0.36	5	0.50	5	0.85	5	1.03	5
South Africa	0.378	3	0.23	3	0.00	-	0.00	-	0.00	-
China	0.378	3	0.29	4	0.41	4	0.69	4	0.81	4
Brazil	0.378	3	0.23	3	0.30	3	0.52	3	0.62	3
Argentina	-	-	-	-	0.30	3	0.34	2	0.62	3
Other countries	3.906	31	2.42	33	0.30	31	5.87	34	7.18	35
Total	**12.6**	**100**	**7.32**	**100**	**10.68**	**100**	**17.25**	**100**	**20.53**	**100**

Source: Metals Economic Group, Canada

15 The table indicates that India, despite being clubbed among mineral-rich countries, hardly spends anything on exploration. The amount mostly commonly mentioned is around US$ 5 million annually. This makes India as one of the least explored countries in the world. Since exploration was not encouraged, there was hardly any investment in the mining sector despite the fact that since February 2000, the mining sector was opened up for 100% foreign direct investment. This therefore emphasizes the need to find out ways and means to attract private investment in exploration because government agencies have not been able to find resources which could prove economically viable for investment.

BENEFITS

16. There will be enormous benefits if exploration is opened up for private junior exploration companies. The areas where exploitation of mineral resources is taking place (e.g. iron ore, bauxite, limestone, dolomite, manganese ore, chrome ore, etc.) are widely known and have already been developed over the course of time. These mineral-bearing areas are already reaping the fruits of economic growth. The minerals/metals being talked about are high value, scarce and deficient. There are the minerals/metals where junior exploration companies are interested. These are in areas which have not been adequately

explored and are in the interior. There will be a number of benefits if private investment is encouraged:

- remote/tribal areas will be opened up, creating opportunities for large scale employment.
- dormant resources will be exploited for nation's benefit.
- since the metal content in the ores is low (low tenor ores), value addition will be near the mines (one can not transport vast material excavated from the mines).
- dependence on imports will be reduced and if sufficient quantity and quality is found, imports may dry up.
- new state-of-the-art technology will be imported and applied.
- there will be large inflow of capital (FDI).
- there will be revenue generation for State and Central governments.
- it will stand in good stead at this critical time of any crisis, domestic or foreign.