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- Mine in India to Make in India -

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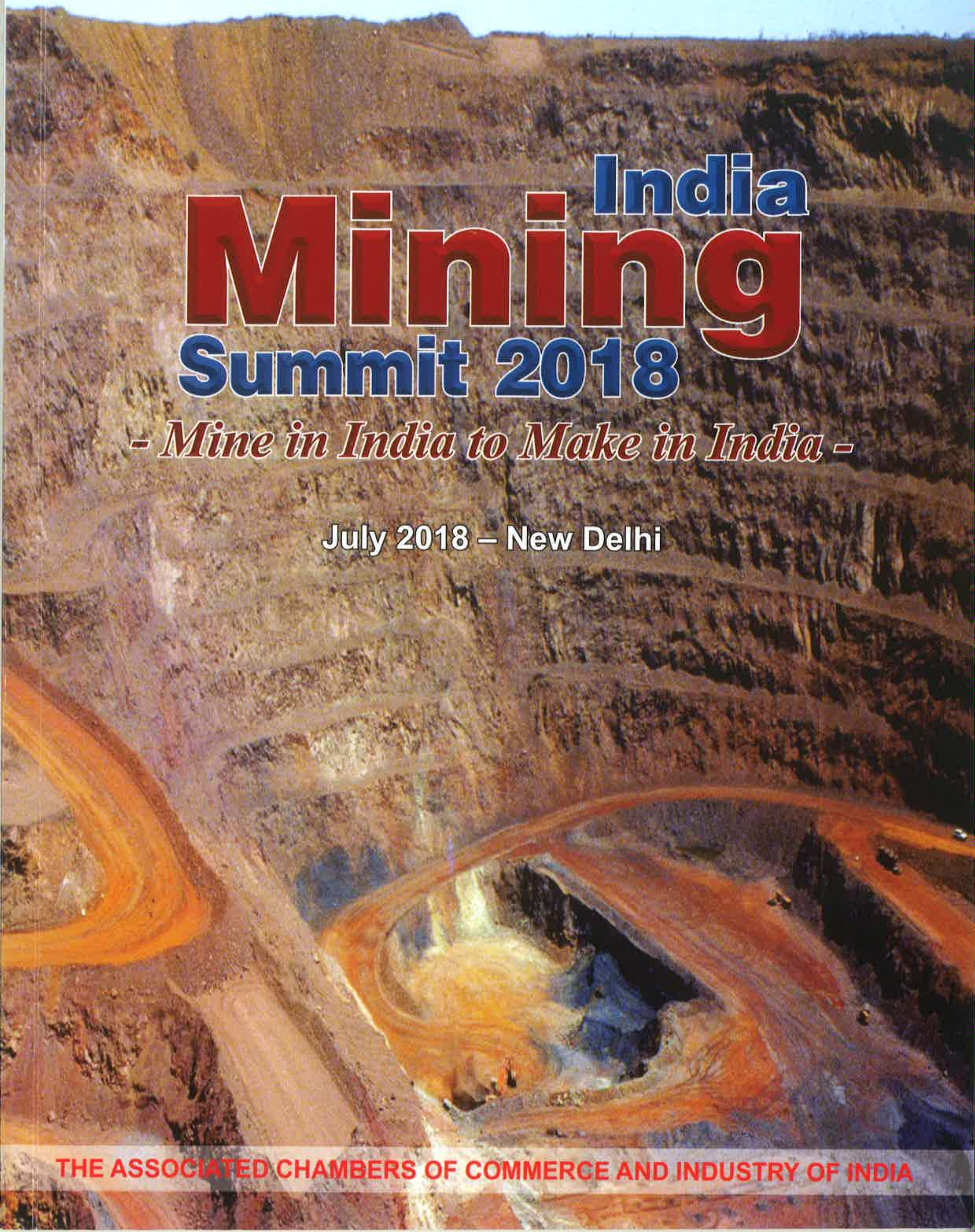

THE ASSOCIATED CHAMBERS OF COMMERCE AND INDUSTRY OF INDIA

We Need to Mine in India to Make in India

*By **S. Vijay Kumar,** Distinguished Fellow, The Energy and Resources Institute (TERI)*
(former Secretary Mines, Govt. of India)

Introduction and context

Minerals are a valuable natural resource and vital raw material for infrastructure, capital goods and basic industries. The history of human civilization is a record of how mankind has progressively acquired knowledge to use materials, particularly metals, to meet his security, food and shelter needs, make war and transform his surroundings for his comfort. Nations and societies that have been able to understand this have prospered; societies and nations those that did not, foundered. Today there is no alternative to ensuring that the extraction and management of minerals is well integrated into the overall strategy of the country's economic development. The exploitation of minerals has to be guided by long-term national goals and perspectives based on national security and sustainable human development.

Fortunately, India is blessed with ample resources of a number of minerals and has the geological environment for many others .After independence, national planning ensured that the major metals and minerals needed for growth of manufacturing and industry and infrastructure could be produced domestically. This included steel, aluminium, cement, copper etc. As the country develops and industry grows, assured availability and proximity of mineral resources will continue to play an important role in giving a competitive edge to Indian industry. The multiplier effect of minerals processed into metals on downstream industrialisation is a phenomenon that cannot be over emphasised. As rightly mentioned in the National Manufacturing Plan 2011, availability of high quality raw material and production inputs is essential for ensuring sustained growth of the manufacturing sector. Significant impetus is required towards developing production capacities in the sectors of Steel, Aluminium, Cement, Fertilizers etc.

Changes in the world economic order, the emergence of post-industrial societies, and the rapid growth of countries such as India and China based on or in response to new and emerging technologies , and global challenges such as climate change mitigation and adaptation has many implications for materials and energy demand and use patterns. While India may be able to meet its needs of the "classical" metals and minerals like steel and cement and aluminum because fortuitously the resources are relatively easy to locate and extract , we should not get lulled into thinking that the same is true for the new set of metals and minerals that we need (the "new-age" metals: including the so-called

Technology Metals (TM)[1] and Energy Critical Elements or Metals[2] (ECE/ECM)); or worse that because the quantities of some of the so-called "minor metals" (e.g holmium, ytterbium, and lutetium) among the new-age metals are deceptively small, that they can always be easily managed through imports or other means. Inadequacies in the mining sector to understand and meet these challenges can not only become a critical bottleneck in meeting the demand-supply gap, but expose the country to being content with a technologically subservient status.

"Make in India" as a strategy not only encompasses traditional manufacturing but also new-age technologies , processes and applications which need to be adopted to ensure that domestic industry is able to produce the latest range of goods and services in a globally competitive market. Global competitiveness and a supporting industrial base needs a steady supply of raw materials and must also anticipate future demand. As India transitions from a lower-middle income economy to an upper-middle income economy, it will need to keep in mind the imperatives of the emerging global order which will be premised on sustainable development, efficient resource use, lower carbon footprint and a greener economy. A "business as usual" approach cannot address the emerging challenges.

The 21st century challenges of "Make in India" and other national goals:

The sectors identified by the Government for "Make in India" include:

- Automobiles and Aviation,
- Biotechnology , Chemicals and Pharma,
- Construction, Ports and shipping, railways, roads and highways
- Defence manufacturing and Space,
- Electrical machinery, electronic systems,
- Food processing,
- Information Technology
- Mining, Oil and Gas
- Thermal power and Renewable energy
- Textiles and garments

In addition India, as part of its climate change mitigation commitments has already undertaken to reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level, and achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030. This will imply:

- Introducing new, more efficient and cleaner technologies in thermal power generation.

1 *TMs generally include Cobalt(Co), Uranium (U), Thorium(Th), Lithium(Li), Cadmium(Cd), Bismuth(Bi), Selenium(Se), Rare Earths (RE),Platinum Group of Elements (PGE), Zirconium(Zr), Gallium(Ga), Germanium(Ge), Rhodium (Rh),Tantalum(Ta) etc.*

2 *ECEs/ECMs generally include Rare Earths(RE), Platinum Group Elements (PGEs) ,Gallium (Ga), Germanium (Ge), Selenium (Se), Indium (In), and Tellurium (Te), ;Cobalt (Co), Helium (He), Lithium (Li), Rhenium (Re) and Silver (Ag). Many elements have technology as well as energy applications and are in both lists.*

- Promoting renewable energy generation and increasing the share of alternative fuels in the overall fuel mix.
- Reducing emissions from the transportation sector.
- Promoting energy efficiency in the economy, notably in industry, transportation, buildings and appliances.

And not least, India is committed to the 2030 Agenda for Sustainable Development adopted by the United Nations in 2015, which comprises 17 Goals including:

- **Goal 7:** Ensure access to affordable, reliable, sustainable and modern energy for all
- **Goal 8:** Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- **Goal 9:** Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
- **Goal 11:** Make cities and human settlements inclusive, safe, resilient and sustainable ; and
- **Goal 12:** Ensure sustainable consumption and production patterns

A Study by the Centre for Energy , Environment and Water (CEEW) titled "Critical Non-Fuel Mineral Resources for India's Manufacturing Sector A Vision for 2030" analyses the criticality of the new-age metals in the near future. The main aim is to assess the implications of critical minerals on the manufacturing sector directly arising from supply constraints (and recycling potential and substitutability). The study provides evidence-based analysis for policy makers to consider as they take steps to ensure a sustainable supply of minerals to meet the increasing consumption needs of the economy. Though not a definitive approach, it also identifies interventions at other levels: trade, recycling or finding technical substitutes. The study also highlights minerals with low or no reserves in India, and the ones which are available only as an associated, or by-product from other mineral processing. Some of the critical minerals/metals identified in the base year (2011) are:

- **Rare earths (light):** Major use of light rare earth elements as an alloying material to impart pyrophoricity property to steel. Modern day applications in electronics manufacturing is yet to begin in India
- **Strontium:** used in manufacturing of aluminium alloys.
- **Vanadium:** Chiefly used in manufacturing of ferro- alloys. Although the share of specialised steel production in very low in India, overall value addition from the sector is substantial.
- **Lithium:** Major use in India is in manufacturing of chemical compounds (high value add sector) whereas globally its major application area is in manufacturing of Li-ion batteries. Some amount of total consumption goes towards refineries and secondary fuel manufacturing
- **Boron:** used in manufacturing of a wide range of chemicals

- **Barium:** Almost 75% of total usage is in the chemical sector. Also used as a drilling fluid in Oil & Gas wells
- **Molybdenum:** Major consumption is in the metals sector to produce alloys
- **Silicon:** Wide usage across metals (40%), electronics (38%) and transport equipment (17%)
- **Chromium:** Used extensively within the metals sector (80%). Mostly in the production of stainless steel.
- **Cobalt:** Major uses of cobalt are in chemicals (paints and dyes) and in corrosion resistant alloys
- **Niobium:** Major use is as an alloying agent in steel industry

Based on projected GDP growth rates, and concomitant pattern of industrial development and manufacturing, the study also identifies metals likely to be critical in the near future (i.e 2030) including:

- **Rhenium:** Super-alloys in aerospace and machinery use rhenium as a principal alloying element India is currently 100% import dependent, with no declared resource/reserve so far, as it is mainly obtained as a by-product of copper/molybdenite ores.
- **Beryllium:** Current use is exclusively in the paper sector; potential use in a diversified group of sectors. Complete import dependency with 99% of global supplies controlled by US and China. For most of the applications, substitutes are difficult to find.
- **Rare earths (Heavy):** All the major green technologies (i.e reduced emissions and lower carbon footprint) depend on heavy rare earths imparting the special properties to them. Extensive applications are within the defense industry. India is 100% import dependent, with 94% of global supplies controlled by China. India's current known resources are mainly deposits for lighter rare-earth elements (in the form of monazite).
- **Germanium:** Decline in its consumption in manufacturing likely, while gaining demand from high value sectors (electronics and metals).India is likely to continue with 100% import dependency. It is a secondary mineral, recovered mainly as a by-product of Zinc refining (also from silver, lead and copper). Recyclability is low and alternative substitutes are a difficult to find.
- **Graphite:** Diversification of its use from electronics into other value-add sectors likely to take place. Majority of the resources of graphite are unexplored and those identified are of poor grade. Only 5% of declared resources have been translated into viable reserves. India can seek to reduce future risk by carrying out exploration.
- **Tantalum:** Decline in its consumption from current uses and increased demand from high value sectors (electronics and metals) is likely. No declared resource available in India, while 95% of global supplies are controlled by a single country Brazil. Substitutes are difficult to find, and recycling potential is also low.
- **Zirconium:** Rising demand from the high value chemical manufacturing and electronics sector. 75% of domestic resource is already identified as a viable reserve. Few substitutes and difficulty in recycling makes it susceptible to high risk.

- **Chromium:** Identified critical in the reference year (2011) as well. Major application is in manufacturing of stainless steel for which no comparable substitutes are available.
- **Niobium:** Identified critical in the reference year (2011) as well. 100% import dependency; No reserve/resource
- **Rare earths (light):** India is 100% import dependent; its reserves are associated with coastal beach sands of India.
- **Silicon:** Processing of specific silicon-grade sand into Silicon is highly energy intensive. Much of the silicon grade resource is yet to get translated into reserve category.
- **Strontium:** Identified critical in the reference year (2011) as well .India has not declared any resource for Strontium and is 100% import dependent. 90% of global supplies are controlled by China and Spain.

To ensure "Make in India" becomes a reality, it is imperative to grow the mining sector using the latest technologies to be able to extract the minerals that we need now and in the foreseeable future. Many of thé new-age metals are difficult to locate and extract and usually occur in low concentrations or deep underground. The R& D costs of developing processes for extraction and purification of these metals can be enormous and fraught with uncertainty with regard to technical and economic feasibility. The country's R&D infrastructure needs to orient itself to these new challenges, and public policies to facilitate investments in research and in the human resource to enable research are a key issue. In particular the R&D for co-production of by-product metals from major metal ores has to go hand in hand with R&D for recovery and recycling of metal stocks already above ground.

In a study on the new-age metals, the Ministry of Mines in its 2012 publication "Rare Earths and Energy Critical Elements: A Road map and Strategy for India", itself states:

- There is a need for pursuing exploration efforts with modern concepts and tools including remote sensing and computerization capabilities to produce more detailed and accurate data and information of unexplored areas both by GSI and the Atomic Minerals Directorate (AMD).
- Energy Critical Elements (ECEs) have not been a primary target of domestic mineral exploration so far and hence, there is limited knowledge of what geological characteristics to indicate their deposits. A detailed study needs to be conducted on this subject.
- Lithium deserves special attention in view of its application in energy storage devices. It is usually extracted from brine. It also occurs in spodumene associated with granites and pegmatite in crystalline terrains. The evaporite sequence of Tso-kar Ladakh (J&K) needs to be reassessed.
- It is necessary to look for Bastnasite as a source of Rare Earths (RE), so that radioactive contamination does not come into the picture, as it does in the case of Monazite. This would enable the entry of private entrepreneurs in RE technology.
- Extraction of Energy Critical Elements (ECEs) such as Germanium, Gallium, Indium, Selenium, Tellurium etc. are not found in concentrations high enough to warrant extraction as a primary

product. Most of these metals are produced as by-products during the production process and smelting of base metals like lead, zinc, copper, aluminium, and tin. They exist in very low percentages in ore deposits where they occur. Their production is R&D and technology intensive.

- There is an urgent need for a thrust for cooperative research in geological modeling of the mineral deposits, ore forming systems, basic geochemistry and development of indigenous extraction and processing technologies of these elements. The option of collaborating with foreign laboratories should also be kept open. The academic community in India must be energized to work actively in these areas.

Ensuring Minerals security

Existing policies and actions recognise India's dependence on the outside world for a sustained supply of oil and natural gas and metallurgical coal , and there is a much better understanding of the country's long-term demands, and as a result efforts have been made to diversify the supply basket, acquire assets overseas and incentivise domestic exploration. However, the same level of understanding is yet to develop for metals and related products; even in the case of aluminium and steel , current policies do not facilitate production and supply of these most basic of metals in the most efficient and economic manner . The notion of 'strategic minerals' or 'critical minerals' is relatively new to policy makers in India as compared to other major economies of the world with whom we aspire to compete . There is no doubt that we need to pay much more attention to efficiently using the metals and minerals that we have. As brought out in the TERI publication "Critical non-fuel minerals security: Why India urgently needs to have a policy in place "(2010), attention should be paid to more reliable estimation of consumption of critical minerals by India; international trade and pricing; understanding the stocks and flows of secondary material available for recycling; in-use stocks; material flows; and other related information. Needless to say, as recommended by the Working Group for the Minerals Sector in 2011, strategies to address supply chain disruptions and ways to build a national stockpile for strategically critical input materials also needs to be developed.

We must also unlock the hidden mineral wealth the country undoubtedly possesses given its geological makeup. Failure to do so may result in our depending on supply chains vulnerable to risks of disruption for a variety of reasons including geopolitical factors with implications for national security. To "Mine in India" we must first "Explore in India". India is far behind global trends in expenditure on mineral exploration. It accounts for only 0.3% of the annual global exploration budget compared with over 19% by Canada, 12% by Australia, 7% by United States, and 4.5% by China. Exploration in India is mostly limited to a depth of 50-100 metre as compared to 300 metres in countries such as Australia. The Geological Survey of India (GSI) has a wealth of expertise and survey data, particularly geological and geophysical data on a regional scale (1: 50,000); however , it has to also acquire and constantly update data on a globally comparable basis , and this includes acquisition of geochemical and aero-geophysical data as well as integration of geoscientific data from other sources. It also needs to be understood that 'geoscientific surveys" and "mineral exploration" are related but distinct activities; while the former is often performed by public agencies expending public funds to create pre-competitive data, the latter activity is, in global best practice, a private enterprise with a commercial end-purpose. Exploration: unremitting, continuous exploration with better and better technologies to locate deeper deposits of minerals is the one strategy for which there is no alternative.

Aligning the exploration framework for 'Mine in India to Make in India"

Clearly, exploration to find potential areas for mining of minerals necessary for the country's needs, particularly the new-age metals, is a high priority. Exploration however is a risky and time consuming business, more so for the kind of minerals that India will need in the future, since they generally occur in small concentrations and are often in deeper locations not easy to find or exploit. The availability of basic geoscientific data in the form of geological, geophysical, and geochemical spatial data is an important factor in increasing exploration success. In India, the GSI has completed geological mapping but geophysical mapping is only partly complete and is being supplemented by aero-geophysical surveys; geochemical mapping of less than 20% of the landmass has been done.

While the GSI deployed its resources for survey and mapping, since 1999, the private sector has been participating in exploration activities through the grant of Reconnaissance Permits with the right to a prospecting licence and mining lease in case of a mineral find. However the lack of basic geoscientific data and inadequate appreciation of the risks and difficulties in exploration resulted in slow rates of investments and few successes.

The Mines and Minerals (Development and Regulation) Act 1957 (MMDR Act) was amended in 2015 with the intention of removing discretion and introducing more transparency in the allocation process. Henceforth mineral concessions will be granted only on the basis of bidding, for the prospecting stage or mining stage as the case may be .The earlier process of granting Reconnaissance Permits on a first-come-first-served basis has been replaced with a system of Non-Exclusive Reconnaissance Permits (NERP) but the NERP holder shall have no right to claim for a prospecting licence or a mining lease on the basis of his reconnaissance. The intention is that the data discovered in an NERP will be used to conduct further exploration by the government agencies so as to auction a mineral find. The NERP holder can submit his data and ask the government to auction the find.

The amendments made to the MMDR Act also provide for the creation of the National Mineral Exploration Trust (NMET) funded by a small cess. A National Mineral Exploration Policy (NMEP) has been brought out by the government in 2016 to give further momentum to exploration efforts. The Policy purports to permit the engagement of private agencies to carry out exploration work in identified blocks/areas with the right to a certain share in the revenue (by way of a certain percentage of royalty/premium) accruing to State Government throughout the lease period, with transferable rights. The intention of the Policy is that the preliminary work will be done by public agencies (and their private nominees) so that the data gathered can be used to auction any mineral occurrences, and thus maximize revenues.

Ensuring that mineral occurrences are explored to levels that permit successful auction require substantial ground-level work and financial commitments, with the attendant risk of infructuous expenditure in case the find is not really exploitable for technical or commercial reasons. Currently, the capacity of these public agencies is severely limited in terms of geoscientific and technical resources. Substantial investments (including financial equity in the case of PSUs and budget support in other cases) will have to be made to build up capacity to conduct detailed exploration and efficiently use modern technology to locate deep-seated and concealed mineral deposits. Mineral exploration for concealed or deep-seated minerals also requires substantial multidisciplinary expertise that can only be built up over time.

The annual accrual into the National Mineral Exploration Trust is of the order of Rs 600 crore ($100 million); a significant proportion will be reserved for bringing mineral prospects to auction standards. The amount available to fund private exploration from the Trust funds for exploration under the NMEP is, therefore, likely to be limited. Thus, though paragraph 11.2 of the National Mineral Exploration Policy advocates the development of a mechanism by the Indian Bureau of Mines (IBM) to periodically fix national priorities for exploration, it is difficult to see a major expansion in exploration for deep-seated and concealed mineral deposits or for identified strategic or other minerals identified on the basis of a prioritization process. . It would appear that the Trust can cover only some of the huge expenditure that is entailed exploration, and cannot be of value in stepping up the pace of exploration to locate the kind of minerals that may be needed in the near future as India grows at an average 8-10% per annum and transitions from a lower-middle income economy to an upper-middle income economy.

The way forward

Auctioning of mineral resources not only increases input costs to industry, it increases the risk of mining as a venture, since many metal prices are prone to volatility and fluctuation and cyclicity. It increases supply risk of new-age metals produced at significant costs as byproducts (such as Gallium, Vanadium, Tellurium, Germanium, Indium, Selenium etc). When mines are auctioned for captive purposes, barriers to resource use efficiency are increased since it makes it difficult for new metal-based industries to enter the market with new technologies. It also reduces the scope and incentive for innovation in process R&D to extract by-product metals which occur along with the auctioned major minerals.

The policy of auction of mines in India has discouraged private investments into exploration, since the incentive for private investment in exploration (i.e the mining rights) is no longer there. Exploration with all its uncertainties is too high-risk an activity for Government to deploy public funds on a large scale. This is particularly true of the new-age metals: Technology Metals, Energy Critical Metals and Rare Earths whose exploitation may not only require exploration at deeper depths of the earth's surface, but also substantial R&D in devising extraction processes.

It must be understood that globally it is the "exploration" horse that pulls the 'mining" cart and not the other way around. Auction of mines as a process is not conducive to incentivizing exploration, and hence to pulling the engine of growth of the economy. As the Supreme Court presciently observed in the Presidential Reference Case in 2012 :(Opinion dated September 27, 2012 on a Reference by the President of India: Special Reference No.1 of 2012 under Article 143(1) of the Constitution of India),:

"Therefore, in conclusion, the submission that the mandate of Article 14 is that any disposal of a natural resource for commercial use must be for revenue maximization, and thus by auction, is based neither on law nor on logic.... besides legal logic, mandatory auction may be contrary to economic logic as well. Different resources may require different treatment. Very often, exploration and exploitation contracts are bundled together due to the requirement of heavy capital in the discovery of natural resources. A concern would risk undertaking such exploration and incur heavy costs only if it was assured utilization of the resource discovered; a prudent business venture, would not like to incur the high costs involved in exploration activities and then compete for that resource in an open auction."

Exploration for minerals needs to be aligned with global best practices. India has been called an "unopened jewel box of minerals". It is exploration that holds the key to that box.

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