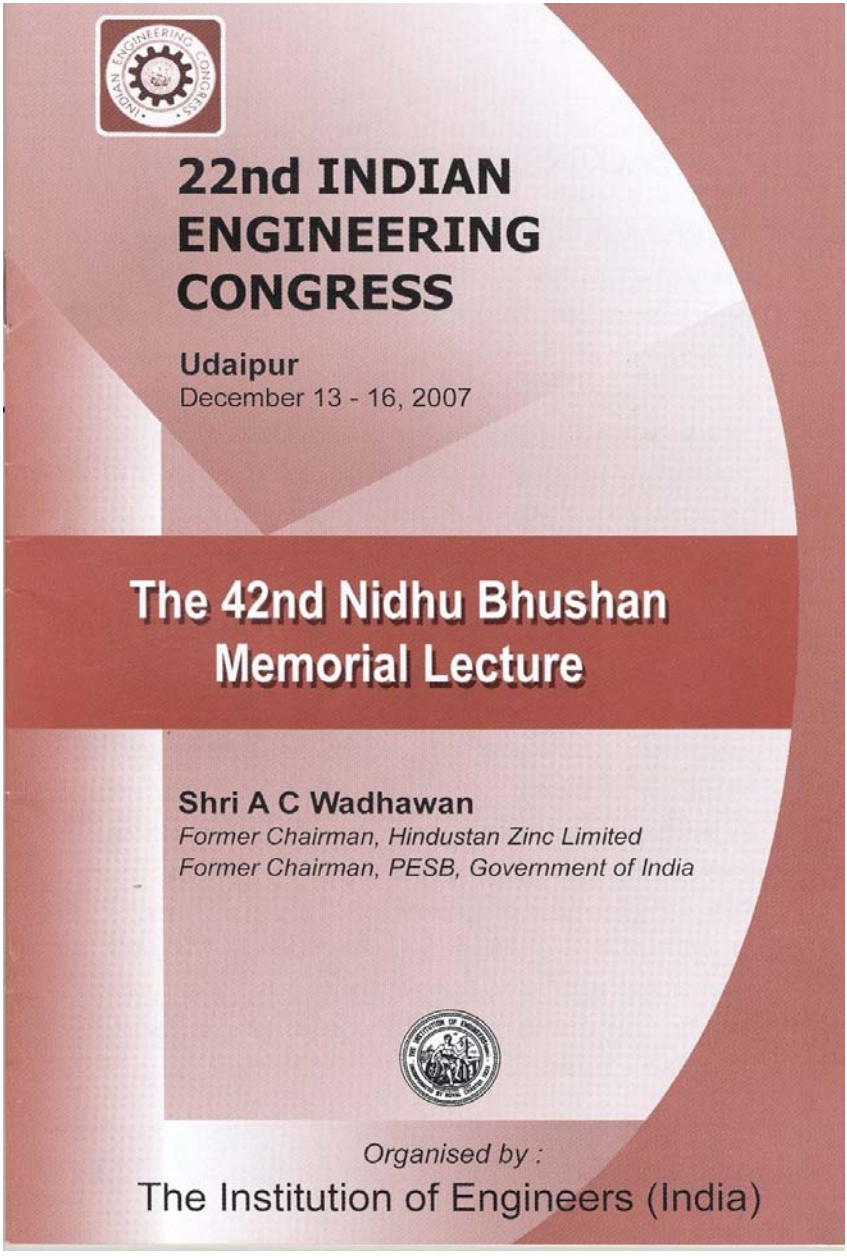

22nd INDIAN ENGINEERING CONGRESS
Udaipur
December 13 - 16, 2007
The 42nd Nidhu Bhushan Memorial Lecture
Shri A C Wadhawan
Former Chairman, Hindustan Zinc Limited
Former Chairman, PESB, Government of India
Organised by :
The Institution of Engineers (India)

BACKGROUND OF THE LECTURER

This lecture was instituted in 1966 by the illustrious metallurgist philosopher Late Prof Guru Prasad Chatterjee in memory of his father Late Shri Nidhu Bhushan Chatterjee. In Nidhu Bhushan, we find a man, who without being an engineer in the conventional sense, had the urge to serve the mankind through his knowledge of science coupled with great inspiration derived from his knowledge of Meta-physics. Although Late Shri Nidhu Bhushan got admission to the Bengal Engineering College, Sibpur (West Bengal), now known as Bengal Engineering and Science University, through a stiff competitive examination, he could not then complete his studies on pecuniary ground. He wanted to be an engineer, since he believed that one with love for scientific studies should alone become an engineer, who has better opportunities to prepare himself for a better service to his fellow beings and the society. With a strong determination, Late Shri Nidhu Bhushan, a science graduate, could raise himself to the position of an Inspecting Accountant in the Finance Division ofthe Central Public Works Department (CPWD). He continued to serve the society, never caring for name or fame. Late Shri Nidhu
Bhushan was a firm believer in the fact that only fundamental discipline in life can help man to set around from within to face life with no fear or frustration.

EMPOWERING INDIAN MINERALS AND METALS INDUSTRY - WAY FORWARD

Shri A C Wadhawan
Former Chairman, Hindustan Zinc Limited
Former Chairman, PESB, Government of India

TRIBUTES TO NIDHU BHUSHAN

It is an honour and privilege to be. invited to deliver the 42nd Nidhu Bhushan Memorial Lecture. Although. Nidhu Bhushan was not an engineer in the conventional sense, he had the determination to serve humanity through his knowledge of science. He further inspired us to work with commitment to serve the society without being bothered about name or fame. He was a firm believer in self-discipline, which he rightly thought was the path lo success. He was a sinning example for all of us to emulate.

I never had the good fortune to meet Nidhu Bhushan. I, however had the opportunity to meet Prof G D Chatterjee, many times. He was like his father, a very dedicated person to serve his profession. As well as, humanity. One always admired his ideals.

For the memorial lecture. I have chosen to speak oil **'Empowering Indian Minerals and Metals Industry - Way Forward'**

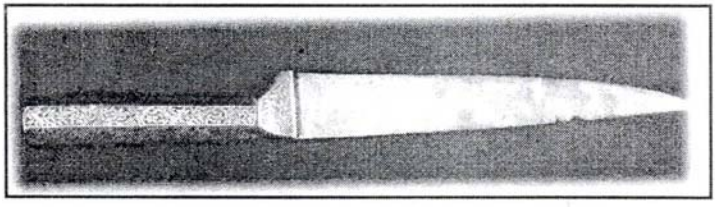
INTRODUCTION

It is well known that India had a rich heritage in minerals and metals.

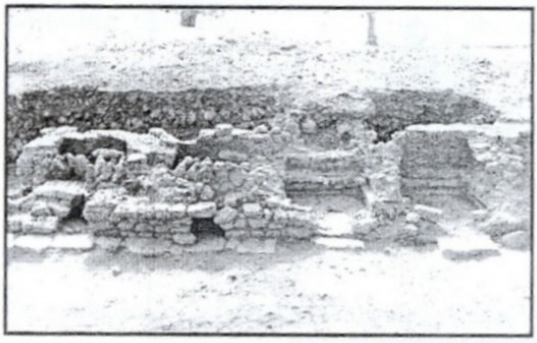
Kautilya classic 'Arlliashastra' put it very aptly as early as in the fourth century B C:

'Mines and minerals are the source of treasury
From the treasury comes power to the state'

Thus, the economic wealth of the state is largely influenced by its richness in minerals and metals. It may be of immense interest to the people of Rajasthan to know that mining and metallurgical industry existed in ancient times. Archaeo-metallurgical investigations revealed that mining and smelting of zinc in India, centering Rajasthan is the earliest dated in the world - perhaps as far as back as pre-Harappan period. It is also on record that zinc was manufactured several centuries ago at Zawar by using ancient distillation furnaces. These furnaces carried out sophisticated pyrometallurgical operations, a precursor to the high temperature operations of today. The distillation furnaces found at Zawar are divided into two parts : a lower condensing chamber, separated by a perforated plate from the upper main furnace chamber. The retorts rest on the perforated plate which consists of a regular pattern of large holes to accommodate the condenser necks and small holes for the passage of air into _.the furnace and for ash to drop through. The area in. the front of the furnace, is paved with large bricks. In the upper main furnace chamber filled retorts rested on the perforated plate with the condenser necks protruding down into the cooler chamber below. The retorts were filled insitu, with charcoal over and around them. The charcoal was also serving as reducing agent. The condensed zinc dropped into the zinc collecting vessels placed beneath. After considerable research work by British Museum, University of Baroda and Hindustan Zinc Limited, they

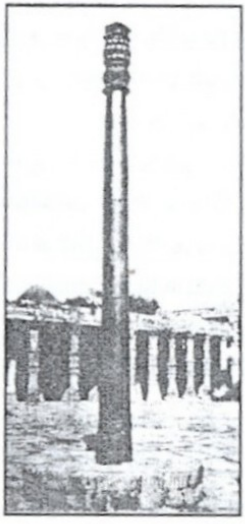


A dagger found in Ooty, Tamil Nadu

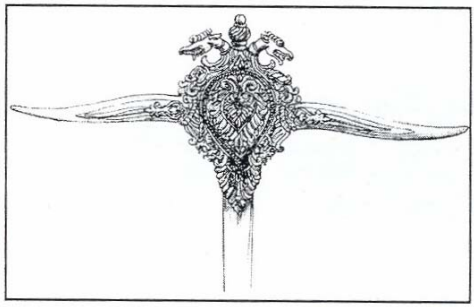


Front view of distillation furnaces

A pair of retorts



Iron Pillar at Delhi



Sword from Thanjavur Armoury

documented the technology and process and this spot has been declared as a metallurgical heritage site by the American Society of Metals.

The rustless wonder' Iron Pillar' at Delhi is another standing monument to a glorious Indian tradition in the field of metallurgy. It is amazing how a metallic object weighing nearly 7t could be fabricated over fifteen centuries ago. It is said that the pillar was made by hammer forging and welding ball of pasty iron in many steps. This structure is the earliest and the largest surviving iron forging in the world, recorded as a marvel that has defied the laws of corrosion, even after so many centuries.

India also led the world in developing an impressive tradition of making in South India a high grade steel known as 'wootz'. Wootz steel became synonymous with the Damascus steel since it was used to make the well \mown Damascus swords. The term 'wootz' was coined when European travellers from the seventeenth century onwards came across the making of steel by crucible processes in Southern India. 'Wootz' is derived from the Kannada word 'ukku' which means steel.

With such a glorious past, India was truly a world leader in the processing of minerals, metals and their products. Somehow, due to a variety of reasons, our pre-eminence in this specialized area

gradually declined and following the Industrial Revolution, several other countries soon overtook us and kept their pace of growth and domination for several years.

POST INDEPENDENCE INDIA

When India became free, there were two steel plants, namely, Tata Iron & Steel Company, Jamshedpur and Indian Iron & Steel Company Limited, Burnpur. In the 1950s, three 1 Mt steel plants were set up at Bhilai, Rourkela and Durgapur. Hindustan Aluminium Company came up around the same time and in the 1960s and 1970s units like Hindustan Zinc Limited and Hindustan Copper Limited were also set up for production of zinc, lead, copper etc. All these units were catering to the limited demand within the country.

In India the consumption of steel and non-ferrous metals had a stunted growth initially due to the restrictive policies like import restriction, quota regime, price and distribution controls etc. In this era, our focus in the emerging growth process was naturally power, irrigation, agriculture etc, and this continued up to the 1990s. More or less there was a limited activity with marginal growths in the area of metals and the year 1991

saw a major path-breaking initiative in India, namely, the introduction of macro-economic reforms and the ultimate journey towards a 'free market economy'. As a result, during the last decade or so, Indian metallurgical industry has tried to capitalize on the many benefits of the

liberalization, privatisation and globalisation processes. Today, once again India has become the fifth largest producer of steel in the world, aspiring to become the second largest producer in a decade or so. Currently, India ranks fourth in the production of coal and lignite, sixth in bauxite, manganese and zinc and tenth in aluminium.

Following the economic reforms as well as the massive investments and thrust on infrastructural growth, building and construction, exports etc, there is a quantum jump in demand for steel as well as non-ferrous metals. Over 100 companies are waiting to sign MoUs, mining leases etc, in the states of Orissa, Jharkhand and Chattisgarh for setting up steel plants. An investment of Rs 5 lakh crores is envisaged, which is over six times the total money ploughed into the sector since independence. This would create a steel production capacity of over 240 Mt, nearly five times of what the country has now. The Indian non-ferrous metals players too are expanding their production capacities and aspiring to come within the 'top ten producers' in the world.

Also during the last few years, India has also gone beyond its shores on a buying spree, looking for opportunities for global takeovers, acquisitions and mergers. While Mittal Steel took over a major steel producer Arcelor

in Europe, Tata Steel acquired an Anglo Dutch enterprise Corns in one of the largest buyout operations (US $ 12 billion). Similarly, Hindalco effected synergy in their operations by taking over Novelis in North America (US $ 6 billion). Hinda1co and Vedanta have also acquired copper mines in Australia, Zambia and a gold mine in Armenia. In other words, India has come full circle now and bounced back as a major global force to be reckoned with, in the area of minerals and metals. The question now is 'How do we sustain the growth momentum?' The answer lies in how successfully we exploit our inherent natural resources, guided by the long term national goals and perspectives.

MINERALS, OUR CORE STRENGTH

Minerals are finite, non-renewable, valuable natural resources. They constitute a vital raw material to the basic industries and

are a major source for development. Management of mineral resources, therefore, has to be closely integrated with the overall strategy of development. It is very essential to achieve the best use of available resources through scientific methods of mining, beneficiation and their economic utilization.

India possesses 1.85 million krn2 of area, potential for mineral wealth and have a flourishing mining industry, producing 84 minerals out of which 4 are fuel minerals, 11 metallic, 49 non-metallic and 20 minor minerals.

India's bauxite reserves are estimated at 2 926 Mt, accounting for 7% of the world's reserves with a life index of 211 years. Similarly, India's recoverable reserves of iron ore are put at 13 460 Mt with a life index of 131 years. Therefore, a tremendous scope exists for augmenting the resource position by further exploration of known deposits and discoveries of new deposits, adopting state-of-the-art technology and modern methods like aerial reconnaissance or geophysical surveys.

MINING OBJECTIVES

The country's accelerated growth rate warrant a rapid development of the mining sector, on which most of the basic industries in the manufacturing sector depend. With increasing competition on account of globalization and the level of technology employed, initiatives for growth in the mining sector had assumed critical significance.

Though it had been the endeavour of the Government of India to encourage greater investment in exploration and mining, there is a need for focused and sustained efforts to increase the investment, both foreign and Indian. A conducive working environment is also called for by removing the bottlenecks which hinder the productivity and efficiency of this sector. This requires

changes in the National Mineral Policy to enable attune the present requirement of the world economy.

Broadly our National Mineral Policy (NMP) addresses the key issues:

- exploration for identification of mineral wealth on land and in offshore areas,
- development of mineral resources, taking into account the national and strategic considerations keeping in view the present needs and future requirements
- promotion of necessary linkages for smooth and uninterrupted development of the mineral industry,
- encouraging research and development in minerals,
- establishment of appropriate educational as well as training facilities for human resource development,
- minimizing the' adverse" effects of mineral development on the forests, environment and ecology through adequate protective measures and
- finally to ensure mining operations with due regard to safety and health of all concerned.

PUBLIC ISSUES AND CONCERNS

Thus, the overall objectives of the National Mineral Policy are laudable and well conceived. What remains now is the successful translation of those noble objectives through scientific implementation and investor friendly policies and guidelines. Obviously, these need the goodwill and support of all the stakeholders including the public at large, Of late, it is increasingly observed that whenever any new industrial or mining or construction activity commences, there are wide spread concerns. While it is difficult to go into their individual merits and demerits, it becomes very obvious that there was no initial effort by the entrepreneurs in creating a prior awareness among the people who legitimately feel that they have not beep

compensated adequately and/or that their very livelihoods are being endangered or threatened. It is here that the government, legislators, media, NGOs etc, have a greater social responsibility in creating the right awareness and assurance among the 'public that any new investments in mining, industrial projects etc, are in act going to generate multiple spin-off benefits and privileges to the very same community, enhancing their standards of living

GDP AND MINING GROWTH

The economic growth of a country is truly reflected by its Gross Domestic Product (GDP). During the last few years, India's impressive GDP growth has been the subject of intense discussion in many world for a and our country is rightly called the emerging power house/superpower of the Twenty-first century.

The Indian economy has registered a significant growth of 9.2% in 200607 as against 8.4% in 2005-06. Mining and quarrying sector as a whole had registered a growth of 4.5% in 2006-07 as compared to 3.6% growth in 2005-06.

The mineral and mining industry including fuel minerals contribute around 2.8% to the GDP of the Nation. Though India has good resources of iron ore, bauxite, copper, gold, chromite etc, without fuel minerals, the contribution is around 0.8% only.

EXPLORATION

Mineral deposits with their high tonnage and grade are capable of maximizing economies of scale and thus have great influence on market factors due to their potential ability to deliver bulk production at low cost ~nd high returns throughout the metal price cycle. Even with low probability of discovery, such resources are great motivators In exploration planning.

The known resources are capable of sustaining current levels of production for the next few decades, with depleting resources being constantly replaced through new discoveries. The progressive discoveries will demand a higher level of exploration technology because near surface, areas of reasonable accessibility and promising mineral potential have already been, or will shortly be well explored. Future exploration investments will have to be made in inaccessible, but prospective terrains, or in those countries which have not witnessed inflow of exploration and development funds It is generally observed that many discoveries immediately follow the introduction of either new methods of exploration or improved technology, primarily because each new technique temporarily reduces the cost of exploration with an increased probability of success.

To meet the rising demand and to counter continuous depletion of known resources, dedicated efforts are required to discover new economic resources, for which ample opportunities exist, given the highly prospective geology and mineral potential of the country.

The whole objective of exploration is to find an economic deposit in the shortest possible time, and at the lowest possible cost. This is, however, not an easy task. The risk of failure is great and cost is high. Experience in

western countries has shown that a find generally requires around 15 years or more with substantial financial inputs. Unlike in the past, it will take highly professional teams using all the state-of-the-art exploration tools available to stand a chance of an economic success, as new ore deposits are expected to be discovered (buried beneath the surface).

The three most important ingredients of a successful exploration campaign are, selection of the right geological terrain, optimum level of funding and efforts, and keeping abreast with new technology.

SCIENCE AND TECHNOLOGY
Advanced Techniques

Mineral processing is an essential step in metal extraction process for sectors, such as, ferrous and non-ferrous metallurgy. Continuous endeavours towards fundamental process improvement and explosion of technological advancements has driven mineral processing plants to look for high level of efficiency and consistency in output quality. With the improvements driven by the fundamental research in mineral processing, improved understanding, advanced instrumentation, process modelling, simulation techniques, on-line optimization and control methods, the entire process of mineral processing has now become more predictable and controllable. There are also challenges, such as, handling of uncertainty in ore quality, lack or insufficiency of advanced instrumentation, process changes, adaptation required due to changing process and market conditions, and the business challenge of striking an optimal balance of plant sophistication and cost.

Although Advanced Process Control (APC) and optimization is certainly an effective vehicle to drive successfully towards meeting these challenges, it needs to be supported by methods and techniques to facilitate continuous learning, adaptation and intelligent decision making. Methods to overcome lack or absence of sophisticated instrumentation can be countered by use of a thoughtful mix of soft computing techniques, statistical methods and data mining.

Bioleaching

With the rapid depletion of high grade ores and concerns about environmental degradation, the necessity for utilising lean grade mineral resources has become an the more urgent. With the

advent of bioleaching since the early 1960's, possibilities of metal extraction in an environment-friendly manner have emerged. As of now three metals, namely, copper, uranium and gold are commercially produced around the world.

Bioleaching of base metal concentrates, such as, those containing copper, zinc and nickel has also been proved to be commercially viable during this-decade. Bioreactor technology using bacteria holds the key for the successful and efficient bioleaching of chalcopyrite, sphalerite etc.

Microorganisms find use in environmental control and mineral beneficiation as well. Microbially-induced mineral floatation and flocculation have been proved to very cost-effective and environment friendly.

There has been some effort in development of relevant technologies for recovery of copper, zinc, gold etc in India, during the last two decades or so. However, there has been no viable plant on a commercial scale so far. With abundant lean ores available, it is essential to pay more attention to further develop this technology in association with foreign consultants, if required. This is the technology of the future and we should not lag behind in this field.

Recycling of E-waste

At present India has become an IT power, with massive induction of computers in all walks of our life. These are imported in large numbers and much more is indigeneously assembled too. These electronic gadgets including TV s, cellphones etc, contain some heavy metals and when they are eventually scrapped, they become a source of potential recyclables, generally called e-waste. Here again, we should identify modem and cost effective technologies for recycling them and recovering the valuable metal content in these waste products.

MINING MULTIPRONGED STRATEGIES

In order that we are successful in our mining operations, a multipronged strategy needs to be adopted.

Mineral Conservation

The best use of available mineral resources can be ensured by adopting, during mining operation, effective measures for conservation and beneficiation, recovery of associated minerals and later by efficient processing of minerals. Mine development and mineral conservation should be on a sound scientific basis, with the regulatory agencies closely interacting with R&D organisations, scientific and professional bodies.

As an important conservation measure, recycling of metallic scrap like steel, copper, aluminium, zinc, lead etc should be encouraged and facilitated by fixing appropriate standards for classification and grading of scrap and adoption of fiscal measures Information about technological changes leading to substitution of the mineral or the products made out of such a mineral shall be compiled and disseminated from time to time to enable the mineral industry to adapt itself.

New Mining Methods

Attempts should be made for augmentation of resource base through improvement in mining methods, beneficiation techniques and utilisation of low grade ores and rejects, recovery of associated minerals, reduction in the requirements of minerals per unit of material output.

Indigenous industry for manufacture of mining equipment and machinery should be strengthened. Wherever necessary, imports of machinery and equipment should be permitted to improve the efficiency,

productivity and economics of mining operations and safety and health of persons in the mines and the surrounding areas. In order

to improve the competitive edge of the national mining industry, emphasis should be laid on mechanisation, computerisation and automation of the existing and new mining units.

The mineral processing unit should not only get an assured supply of the mineral raw material but should also have close links with the production and marketing agencies of the mineral based end products.

Productivity Improvements

Studies for fixing productivity norms and goals need to be taken up to protect productivity of men and machines as well as to improve the consumption norms of fuels and materials.

Human Resource Development

HRD plays a very vital role in the mining sector. At present there is a limited awareness of the huge career/ job opportunities available in view of the massive investments in the mining and metals sectors. Opportunities for education and training are limited now and should therefore be expanded. Existing facilities for basic and specialized training should be constantly reviewed and upgraded from time to time to ensure that adequately trained and skilled manpower at all levels is available for the development of mines and mineral based industries.

Research and Development

R&D in the mineral sector has to cover the entire gamut of activities from geological survey, exploration, mining, beneficiation, extraction of minerals to development of materials. R&D should be oriented not only to ensure maximum economic recovery of the prime minerals, but also optimal recovery of the associated minerals and valuable metals. Research organisations should be strengthened for developing processes for beneficiation

and mineral as well as elemental analysis of ores and ore dressing products.

Efforts should be directed to the development of new technologies for conversion of existing mineral resources into viable economic resources. Appropriate technologies should be developed to enable indigenous industries to utilise the mineral resources with which the country is abundantly endowed and as substitutes for minerals whose reserves are poor. Efforts should be directed to find new and alternative uses for minerals whose traditional demand is on the wane.

Indigenous technology has to be upgraded through research and appropriate absorption and adoption of technological innovations even from overseas. R&D efforts should be made to improve efficiency in process, operations and also the recovery of main and by-products and reduction in specific consumption norms. Efforts also need to be directed to evolve low capital and energy saving processing Systems.

Mining methods determine the safety, economy, speed and the percentage of extraction of the ore reserves from a mine. R&D thrust should be directed specially in the areas of rock mechanics, ground control, mine design engineering, equipment deployment and maintenance, energy conservation, environmental protection, safety of operations and human engineering.

Attention must be given to beneficiation and agglomeration techniques to bring lower grades and finer size material into use.

Foreign Investments

Huge capital investments are required for mining and mining-related activities. While India has been investing adequate funds and it is growing in this sector, more FDI inflow should be encouraged. For 100% FDI projects, there is an arrangement for

automatic approval of these projects by the Government of India. However, so far, not many projects in India have come with 100% FDI. Perhaps, if the policies at the Central and State levels are made more investor-friendly, including effective implementation of the Single Window Clearance concept, then there is a ray of hope to promote such investment in the Country.

Infrastructural Facilities

A major thrust needs to be given for development of infrastructural facilities in and near mineral bearing areas following an integrated approach for mineral development, regional development and also social and economic up liftment of the local population, including tribal population.

Environment Protection

Extraction and development of minerals are closely interlinked with other natural resources like land, water, air and forest. The areas in which minerals occur often have other resources as well, requiring strategic approach for utilisation of the mineral resources. Some such areas are ecologically fragile and some are biologically rich. The needs of development as well as needs of protecting the forests, environment and ecology have to be properly coordinated to facilitate and ensure sustainable development of mineral resources in harmony with the environment.

Conclusion

'Metals Security' is of strategic importance to India undoubtedly. The growth of our economy is largely dependent on the development of the mining and metals sectors and this calls for a balanced, scientific and integrated approach. India is now at a very critical transitibn point and can emerge as a major force

provided we are successful in implementing and achieving the key objectives enshrined in the National Mineral Policy.

As mentioned earlier, there was a time, centuries ago, when India was a leader in mining and metallurgy of minerals and metals. For a long time, knowledge of extraction of abundant minerals went into oblivion. Since, the spurt in economic growth and, therefore, increase in demand, the activities connected with exploration and extraction have increased significantly and it is only a question of time when India will once again become a world power in the production and usage of metals.

The state of Rajasthan is the right place to echo this important message loud and clear.

Shri A C Wadhawan

Shri Wadhawan was born on January 27, 1938 at New Delhi. He completed B Sc from Delhi University in 1957 and B Tech (Hons) in Metallurgical Engineering from the Indian Institute of Technology. Kharagpur in 1962. He also obtained a Diploma from Association Pour L Organisation des stages en France (ASTEF). 'Steel Making and Processing of Alloy Steels'. Ministry of External Affairs and Finance. Government of France.

After a short stint with the Burn and Company Limited (Martin Burn Group), he joined Heavy Engineering Corporation Limited. Ranchi and served there for a period of about two years. Subsequently. he joined Mahindra Ugine Steel Company Limited after his stint in France and continued there till 1973 before joining Hindustan Zinc Limited (HZL).

Shri Wadhawan joined Hindustan Zinc Limited (HZL) as a Deputy General Manager (Smelter) in December 1973. In May 1977. he became the Director (Smelting Operations) and eventually he took over as the Chairman and Managing Director of HZL in November 1985, a position in which he continued until his retirement on January 31 , 1996.

The most notable amongst many of the awards are Bralco Gold Medal by 11M for his significant contribution to the development of Non-ferrous Metal Industries in 1988. Silver Award by the Institute of Marketing in 1992. Rajiv Gandhi Excellence Award for his contribution to Public Sector (1992) and distinction earned by Shri Wadhawan. Honorary Membership conferred by 11M in 1993. Tata Gold Medal for his contribution to Metallurgical Industries (1994). IIT-Kharagpur awarded 'Distinguished Alumnus 2005' award to him in August 2005.

He was also associated with various national and international professional bodies in various capacity. He was also on the Boards of Public Sector Enterprises like BHEL. Hindustan Copper Limited. Indian Rare Earths Limited. MECON, Rajasthan State Mines and Minerals Limited. He was the Chairman of the apex body. SCOPE during 1995-1996. He was a member of the Research Councils of National Metallurgical Laboratory. Jamshedpur. Regional Research Laboratory. Bhopal as well as Bhubaneshwar, CECRI and all CSIR laboratories for many years.

Shri Wadhawan was the President of Indian Institute of Metals. the professional body of Metallurgists in the country in 1992. He has also been elected as a Fellow of the Indian National Academy for Engineering and a Member of the International Association for Energy Economics. USA.

At present, he is the Chairman of Research Advisory Council of Jawaharlal Nehru

Alumini1!m Research Development and Design Centre, Ministry of Mines. Government of India. He is also on the Governing Councils of NFTDC and JNARDDC. which are under Ministry of Defence and Ministry of Mines, respectively. He is associated with other bodies like Tata Research Design and Development Centre. Recruitment and Assessment Board -CSIR etc as either Chairman. President or Member.

Shri Wadhawan is the Chairman of Transweigh (India) Limited and on the Boards of Tata Metaliks, Hindustan Zinc Limited. Rajasthan Mines and Minerals Limited etc. He has been on the Guest Faculty of top management schools like, Indian Institute of Management. Lucknow, Management Development Institute. Gurgaon, etc.

Shri Wadhawan is the Member of International Association for Energy Economics, USA and a Fellow of Indian National Academy of Engineering.