

Mineral Economics and Its Concept

THE USE of minerals has been instrumental in raising the standard of living of mankind. The names of minerals and their products have been used to christen various eras of civilisation, such as the Stone Age, the Bronze Age, the Iron Age and the Nuclear Age. The sophisticated world of today is largely the result of the enlarged use of minerals, whether it be as fertiliser for food; coal, petroleum, natural gas and atomic energy as sources of power; or countless other necessities of life, like automobiles, aeroplanes, ships, modern communications and a host of chemicals which are derived from the use of minerals. All engineering and structural material, machinery, plants, equipments and anything from pins to planes are manufactured from metals and their innumerable alloys. The properties to withstand extreme temperature, pressure and corrosive actions possessed by refractory minerals like chromite, magnesite, fireclay, quartzite, dolomite and several alumino-silicate minerals which are required for lining the furnaces and smelting tanks, have made it possible to smelt and treat minerals and ores for obtaining metals, alloys and chemicals. Iron and steel and their special alloys are the most common metals which largely enter into the fabrication industry. Other metals which are required most commonly are aluminium, copper, lead, zinc and tin. Alloying metals like manganese, silicon, tungsten, chromium, cobalt, nickel, vanadium, etc., find wide applications in the manufacture of engineering goods, plants, equipments and other components. Chemical industry depends largely on the use of sulphur. There is not a single industry which can do without minerals or their products. Minerals thus form a part and parcel of

our daily life. Since the beginning of this century the use of minerals has been greatly diversified and expanded. Their consumption has shown an unprecedented increase, year after year. It has been estimated that the quantity of minerals consumed in the last 50 years even exceeds the aggregate quantity consumed in previous human history. The sharp rise in consumption has accelerated attempts in continuous search for locating new deposits and even deeper probe into the womb of the earth and the ocean beds.

Minerals do not occur where we want them to be nor deposits become assets unless explored and developed. Experience shows that no country possesses adequate resources of all minerals. Several countries are practically devoid of mineral wealth, many have inadequate resources, some possess resources of important minerals adequate for their own needs only, and few have enormous reserves of certain minerals by virtue of which they hold monopoly in the supply to the world market.

Even advanced countries like the U.S.A., the U.S.S.R., the U.K., West Germany and many others lack in several minerals. The entire economy of Japan is based on imported ores. Because of the uneven distribution of minerals bestowed by nature, the international trade in this commodity is unavoidable. At the same time it has led to several regional groupings, monopolistic tendencies, cartels and imposition of preferential tariffs and other taxes and even causes of conflicts. The formation of European Common Market, European Free Trade Association, European Coal and Steel Community, Latin America Free Trade Association, Inter-Governmental Council of Exporting Copper Countries, International Tin Council, Organisation of Petroleum Exporting Countries, etc., is the result of such inter-regional groupings. Wars increase the consumption of minerals. Fear of interruption in supplies of strategic minerals compels some countries like U.S.A. to maintain stockpiles. Even in normal times, most industrialised countries invest in exploration and mining in other countries to ensure regular supplies of minerals for their industries.

Concept

The concept of mineral economics has emerged from these economic problems rooted in the peculiar character of mineral deposits; the basic fact being their localisation and exhaustibility. The pressing needs of augmenting mineral production, the intricacies of

assuring future supplies, economic evaluation of the deposits, the economics of location of plants in relation to domestic and imported mineral raw material are the subject matters of a special study. These form a broad spectrum of mineral economics under the geological science requiring in-depth study of the world-wide distribution of mineral resources, reserves, utilisation, ore dressing practices, research, planning and development of mineral based industries, trade in minerals, the part played by minerals in economic productivity, their influence on economics and politics—both national and international—and such other related matters. Mineral economics can, thus, be defined as the synthesis of such theories and practices of geological science, mineral engineering, political science, law and economics that are involved in or attracted to the planned development and management of the country's mineral resources.

Scope of Study

The purpose of giving special treatment to the subject is to stimulate study in providing proper background of mineral administration and to prepare students for holding key posts in industry and government departments responsible for mineral development. The subject provides an intimate knowledge of the country's mineral wealth in relation to its industrial applicability. A mere knowledge of mineral occurrences will not be of much help to the students of mineral economics. Rather an intelligent study of various deposits in relation to their economic evaluation is required to be made. In mineral industry usually a number of minerals go to form a single product. The economics of selecting the site for a particular industry in proximity to mines and certain deposits, besides other considerations, require a great deal of scrutiny. It is first to be decided whether it is essentially a power based or raw material based industry. Power based industries like aluminium, ferromanganese, electrolytic copper and zinc and several others need not necessarily be anchored near the deposits but near the source of cheap electricity because of the high consumption of electricity required. The following data will indicate power requirements in the main plants in principal electro-metallurgical and electro-chemical industries.

In the case of power based industries a careful study of the cost analysis of power consumption in relation to overall cost involved in transportation of raw material to the proposed site is required to be made. Cost analysis can be worked out in a manner given on

<i>Industry</i>	<i>Unit of power consumption per tonne</i>
<i>Metals & Alloys</i>	
Aluminium	18 500 kwh
Electrolytic cobalt	6,000 "
Electrolytic zinc	4,500 "
Ferro-manganese	3,400 "
Electrolytic copper	2,500 "
<i>Chemicals</i>	
Caustic soda	4,000 kwh
Calcium carbide	4,000 "
Phosphoric acid	3,900 "
Calcium ammonium nitrate	3,200 "
<i>Element</i>	
Elemental phosphorus	18,000 kwh

page 5. To give an example aluminium industry has been chosen. It is clear from the cost data that power consumption alone accounts for about 41 % in the reduction plant (potroom), the largest single item in relation to other raw material.

The total cost of metal production in most of the cases works out to be about three times the cost of raw material required.

On the other hand primarily raw material based industries like iron and steel and cement are necessarily to be located near the deposits because in such industries the bulk cost involved is in the transport of raw material. In a steel plant, for every tonne of steel production nearly five tonnes of raw material in terms of iron ore, coking coal, limestone, dolomite, manganese ore, and several other fluxing and refractory material are required to be mined, hauled and put into the furnace, besides ferro-manganese. Raw material requirements per tonne of steel production are approximately 1.7 tonnes of iron ore of 60% Fe, nearly same quantity of coking coal, 0.5 tonnes and 0.25 tonnes of flux grade limestone and dolomite respectively, 40 kg of manganese ore, 10 kg of ferro-manganese and 65 kg of refractories of which 40 kg, 20 kg and 5 kg are of fireclay, basic and silica bricks respectively. The cement industry requires for every tonne of cement nearly 1.3 tonnes of limestone, 400 to 500 kg

<i>Raw Material</i>	<i>Qty. required per tonne of ingot produc- tion</i>	<i>Average per tonne price at the factory site</i>	<i>Total cost of raw material</i>
Bauxite (Average 50% Al_2O_3)	5.5 tonnes	Rs. 65	Rs. 358
Caustic soda	200 kg	Rs. 1700	Rs. 240
Cryolite	33.5 kg	Rs. 7500	Rs. 251
Aluminium fluoride	33 kg	Rs. 9400	Rs. 310
Fluorspar	3.5 kg	Rs. 2250	Rs. 8
Petroleum coke	445 kg	Rs. 2100	Rs. 934
Fuel oil	320 kg	Rs. 851	Rs. 43
Anthracite and coke	25 kg	Rs. 3900	Rs. 97
Electricity (for reduction plant only)	18,500 kwh	Rs. 0.12	Rs. 2220
			Total: Rs. 4461

of clay, a small quantity of laterite, bauxite or silica to balance the alumina and silica proportion and 40 to 50 kg of gypsum of 75 to 80% purity. Obviously for these reasons the raw material based industries are generally located in proximity to the source of principal mineral deposits.

The most crucial study required is about the investment which baffles planners. It is rather difficult to say off hand the likely investment or amount required to be spent in prospecting, mining and milling and related metallurgical plant, as these depend on numerous variant factors. In each case a detailed study is required. However, a simple formula works well with good proximation in estimating likely investment. In case of producing mine an investment at the rate of 5% of the total value (selling price at the mines head) of mineral produced can safely be earmarked each year for prospecting and improving further reserves. If a mine has rated capacity to produce say, 100,000 tonnes of chromite, the total sale proceeds in a year will come to Rs. 10,000,000 calculated on the selling price of Rs. 100 per tonne. The 5% of this sale proceeds Rs. 500,000 i.e. at the rate of Rs. 5 per tonne can be invested each year for prospecting. For the same capacity of iron ore mine fetching price Rs. 20 per tonne at the pit's head an investment of Re. 1 per tonne can be made on prospecting. No ready-made criterion can be evolved for

initial prospecting especially of hidden deposits. Total investment in mining can be safely made up to one and half times the value of one year's production at targetted capacity. This ratio is workable provided the reserves available are sufficient to last for 20 years. In exceptional cases, the investment in mining may be increased not exceeding twice the value. In case of metallurgical plants the total investments twice the ex-plant value of the envisaged annual installed productions of the metal is found reasonable. The norm of investment indicated above also takes into account the expenditure to be incurred on townships. Based on these norms investment per tonne on setting up alumina aluminium, steel, electrolytic copper and cement plants work out to be Rs. 3350; Rs. 25,000, Rs. 4000; Rs. 7000 and Rs. 800 respectively. It should be carefully realised that the norm of investment is closely linked with the optimum level of production planned and to be maintained below which capacity it may not be economically viable. For example, in the present day economy installation of a new unit of an integrated aluminium smelter having less than one lakh capacity a year and that of iron and steel plant less than 2.5 million tonnes capacity a year is considered not economical. Similarly, in the case of a new cement plant and asbestos-cement plant a minimum of 6 lakh tonnes and 36,000 tonnes respectively annual capacity is suggested.

Related studies arise in acquiring a thorough knowledge of the laws governing mines and minerals, the method and procedure of obtaining mining rights, mineral taxation and royalties, tariff and other taxes, mining finance, grading and marketing. These among many others, like production and the study of consumption patterns of minerals in different industries, projecting future requirements, stock-piling and procurement programmes, methods and prospects of utilising low-grade minerals and ores, conservation, substitution, trade in minerals and formulation of mineral policy, are the special features of mineral economics.

The subject matter of mineral economics is so varied and complex, and at the same time so fascinating that one has to make an exploratory trip through the entire range of the mineral industry. In fact, mineral economics is mineral intelligence. The study should impart to students, the idea of becoming a 'spying agent' for the search, mobilisation and utilisation of minerals. A mineral economist has necessarily to acquire this professional acumen. He must maintain an inventory of world mineral resources, the sources from

which other countries are obtaining their supplies and keep a vigil on any development in this respect; and depending upon his own country's deficiency or inadequacy he should frame policy and advise his government appropriately in such matters. His responsibility does not cease here. He must study and work out plans to ensure the inflow and maintenance of regular supplies both during peace and war. He has to study and work out such strategy. A mineral economist can easily predict a war, and also from which quarters it is emanating. The outbreak of the Second World War was predicted by the American mineral economists about seven years before it actually took place. It was possible to predict by making an intelligent probe into the stock-piling programme which the Germans had then undertaken. On the same analogy he can prevent a war by studying the procurement programme of mineral raw material of hostile countries and getting their supplies cut by diplomatic means or even by force.

A mineral economist is regarded as a custodian of mineral wealth of his country and the repository of mineral information. He is required to be concerned with the management, conservation and development of nature's non-renewable mineral resource. Realising the basic importance of minerals, many countries have well organised mineral economics departments to foster the development of mineral resources.