Current Science

Vol. XXV] JANUARY 1956 [No. 1

MINERAL RESOURCES AND THEIR PROBLEMS*

FROM the dawn of human civilisation, man had used mineral products, a few at first and more as time went on. The process was slow in the beginning and even at the dawn of the Industrial Revolution, only a few mineral products were used. But during the present century, mankind has used more metals and minerals than during all its long civilised existence. Modern industry is expanding at an ever-increasing pace, and almost every country is now bent upon industrialisation, and the already industrialised countries are steadily expanding their activities. Unlike the products of the animal and vegetable kingdoms, mineral resources are not renewable seasonally or annually, and only under exceptional conditions can supplies be replenished quickly, like sulphur in areas where volcanoes are active. The only way to replace mineral deposits which have been depleted is to find new ones wherever they might occur.

The relative abundance and distribution of the elements in the earth's crust is well known, but it is not their relative abundance that matters so much as the degree of concentration and the quantity in which they are gathered up by natural processes. Such concentrates are our ore and mineral deposits. Most of the ore deposits are usually derived through the agency of magmatic processes, being associated with igneous rocks and emanations. Both the grade of the ore and tonnage have a definite relation to what we consider a workable deposit. What we call a low grade is dependent on economic considerations of winning the useful mineral first by separating it from the unwanted minerals and waste rock, and then processing or smelting it to concentrate the mineral or metal into a usable form. The average content of uranium in rocks of the crust is of the order of two parts in a million. But it will be a very costly proposition to mine half-a-million tons of rock to process it and recover 1 ton of uranium whose market value at present is roughly Rs. 35,000 to Rs. 40,000. Barely a decade ago, a workable uranium ore had to

* Abstract of the Presidential Address of Dr. M. S. Krishnan, Director, Geological Survey of India, to the 43rd Indian Science Congress, held at Agra, January 1956,

contain not less than 2% of that element. But the demand that has been created after the discovery of atomic energy makes it now worthwhile to mine and process an ore containing only 0·1% uranium.

As is well known, only a few limited areas in the world have been searched intensively for minerals. Such areas are to be found around the North Atlantic, *viz.*, in Western Europe and North America. In other parts of the world, only a few small areas have been examined in detail. The greater part of South America, Africa and Asia remain to be explored with care. In Asia and Africa there are regions which have not yet been mapped geologically. Under the circumstances, it is reasonable to expect that intensive exploration and prospecting would lead to the discovery of a number of mineral deposits of which some at least would be of importance.

In all countries, early in the process of industrialisation only the richest deposits exposed at the surface were worked and utilised locally or exported. Much wastage occurred at this stage. This was soon followed by industrial development marked by the setting up of metallurgical, chemical and engineering works. The national wealth and prosperity of a country increased during this stage. The third stage is a period of depletion of cheap domestic mineral resources and import of raw materials from outside for feeding local industries Thereafter comes the stage of having to depend on foreign ore and other raw materials, leading gradually to the loss of competitive power in foreign markets, due to the necessity for purchase of much of the raw material requirements from outside.

India is just passing through the first stage and entering the second. The further stages could be strengthened by careful husbanding of the resources by the adoption of conservation measures An outstanding example in India, requiring the enforcement of conservation, to which repeated attention has been called, is the misuse of good coking coal for burning in boilers and locomotives for steam raising, for which non-coking coal of a similar grade would do quite well. It is only during the last four or five years that serious steps have been taken to prevent the objectionable use of coking coal.

Conservation has to be effected at all stages of the development of the mineral deposits, in mining, milling and ultimate utilisation. All technological advances in any of these stages automatically bring in improvements which are conducive to conservation. Conservation is also achieved by substituting a more easily available and cheaper material for one which is costly or difficult to get. Substitution is often dictated by necessity, and will be acceptable so long as the easily available substitute is good enough for the purpose for which it is intended. Thus, though it may be worth while using a good grade of mica for all types of electrical insulation, a poorer insulator would serve for some purposes. Mica substitutes are, therefore, coming into use in the countries which have to import this mineral in large quantities.

It is an interesting fact that no mineral has become entirely obsolete and unusable. The pattern of use may change occasionally, but so long as a mineral finds some use, it continues to be employed until it is replaced by something more suitable or is used for some other special purpose. A good example is afforded by monazite for which the black sands of the Travancore coast were originally worked. It was then employed for the requirements of the gas mantle industry. But, after the First World War, the demand for the mineral fell and practically stopped, as gas had largely been replaced by electricity for lighting in Europe. In the meanwhile, ilmenite which is associated with the monazite, found use in the manufacture of a paint pigment—titanium white. This mineral rapidly assumed importance and monazite was nearly forgotten for a while. But during and after the Second World War, monazite has again attained prominence as a possible source of atomic energy because of its content of appreciable amounts of thorium and a little uranium. Ilmenite also continues to be utilised, so that at present there is a good demand for both these minerals.

The latest prophecy seems to be that atomic energy is going to make coal an unwanted material and that coal mining will be a thing of the past within a decade. But we may well ask whether all the uranium needed for bringing about such a complete revolution in the industrial set-up and power production will be available (as also other materials needed for regulation and control of the nuclear reactions) at a price which will compete seriously with coal. Similar prophecies were made about coal when large developments in the production of petroleum as well as of hydro-electricity took place three or four decades ago. There are as yet no signs of coal becoming unnecessary to mine.

Our present knowledge goes to show that we have only a few surpluses and quite considerable deficiencies in the list of useful mine-

rals needed for industry. There is a sufficiency of surplus in coal, ores of iron, manganese, aluminium, titanium, chromium, magnesium; mica, barytes, kyanite, sillimanite and various types of clays. The chief deficiencies are in copper, lead, zinc, silver, nickel, cobalt, molybdenum, tungsten, tin, antimony and mercury amongst the metals; and sulphur, phosphates, fluorspar, petroleum, potash, graphite, asbestos, amongst the non-metallic minerals. In almost every case our knowledge is confined to surface observations. We do not know enough about what lies below the surface even at shallow depths. There is, consequently, a chance of making good some of the deficiencies by extensive and intensive search in suitable areas.

Only during the last few years has the Geological Survey been strengthened suitably in personnel and equipment to face this task adequately. A Bureau of Mines has been established to look after the work of improving the techniques and standard of mining and enforcing mineral conservation measures. An Oil and Natural Gas Division is being set up to undertake systematic and intensive exploration for petroleum. Within the Geological Survey itself there are specialist wings to study Mineral Deposits, Groundwater and Engineering Geology and to conduct Geophysical Exploration. The co-ordinated efforts of all these will be directed towards the study of all the phases of exploration and development of our resources in minerals, and will contribute steadily to the building up of a strong and prosperous nation.

FIRST CONGRESS ON THEORETICAL AND APPLIED MECHANICS

THE First Congress on Theoretical and Applied Mechanics was held on the 1st and 2nd November 1955, at the Indian Institute of Technology, Kharagpur, under the Presidentship of Dr. K. S. Krishnan, Director, National Physical Laboratory, New Delhi. Of the 147 delegates who registered themselves as members, 101 participated in the deliberations of the Congress. Fifty-two papers were read and were followed by lively discussion. Messages of goodwill were received from a number of distinguished workers all over the world.

Dr. S. R. Sen Gupta, Chairman of the Organizing Committee, stressed the need for both theoretical and experimental approaches to any problem of mechanics and advocated a harmonious blending of the two. This was followed by the Presidential Address on 'The Physics of Heated Filaments is Vacuum'. The theory developed by Dr. Krishnan knits into a single whole the uncorrelated empirical results obtained by various experimenters.

There was a half-hour address by Prof. N. Weiner on 'Some Formulæ in Meteorological Prediction'. He showed how with the help of a lemma formulated by him and Kolmogoroff, formulæ for multiple prediction may be developed making use of phase averages or time averages. Other addresses were by L. E. Payne 'On a Class of Problems in Plane Elasticity' and by V. M. Ghatage on 'Ring Aerofoils and Their Possible Use'. Dr. Payne showed how in the problem of semi-infinite elastic medium or of an infinite strip the use of dual integral equations may be avoided by a suitable decomposition of Airy's stress function. Dr. Ghatage indicated an interesting arrangement of a ring aerofoil and a source which could climb in the vertical direction without any horizontal race on the ground, and could also move backward or forward. Though a practical design of this type had not been worked out, it was quite feasible and deserved thought and consideration. A majority of the papers presented at the Congress dealt with problems on elasticity and plasticity. Among the other topics discussed were fluid mechanics, ballistics, vibrations, thermodynamics, statistics and mathematical physics.

An *ad hoc* meeting was held for the formation of the Indian Society of Theoretical and Applied Mechanics. The following office-bearers were elected: Dr. K. S. Krishnan (*President*), Dr. V. M. Ghatage and Prof. N. R. Sen (*Vice-Presidents*), Prof. B. R. Seth (*Secretary-Treasurer*).

The First Congress on Theoretical and Applied Mechanics has served a useful purpose in bringing together workers in engineering science from all parts of India, and emphasising the need for producing engineer-scientists along with the establishment of colleges for producing working engineers. It may be essential for this purpose to enrol brilliant graduates from Indian Universities with high academic distinctions in basic sciences like applied mathematics, physics, chemistry, geology, geophysics and statistics, and engage them in research work in theoretical and applied mechanics and other basic subjects on which the science of engineering is built up.
