THE MINERAL RESOURCES OF INDIA

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Booklet Number Ten

INTRODUCTION

One of the most striking features of India's economy during the last seven years has been the steady rise in her output of minerals. In 1938 the value of these was Rs.34,21,87,929 or £25,536,412.

The principal of these, coal, iron and petroleum, are true measures of the industrial prosperity of a country, and to these may be added building materials and clays, which include stone, brick, cement, lime, pottery, tiles and road-metal.

Of the other mineral products of which the output figures have reached the million sterling mark in these seven years, manganese ore and mica are largely exported and the gold production is practically restricted to the four mines operating at Kolar in the Mysore State.

Salt is in a position by itself. Its manufacture is a Government concern, and the value of the production, excluding the duty on it, varies between half a million to three-quarters of a million sterling. In addition India imports about half the value of her internal production, chiefly from Aden, Germany and Egypt, to supply the needs of Bengal and the adjoining country.

Spectacular percentage increases have taken place in the outputs of what may be termed the industrial minerals :—ilmenite, monazite, chromite, kyanite, magnesite and other refractories, gypsum, bauxite and graphite, though the individual amounts are not large. These are principally exported.

It may be realised that in the space of this pamphlet it is impossible to give a full account of India's mineral resources. All that can be attempted is to draw attention to those minerals of which considerable increases in production for export are to be expected. Gold, salt and copper have been omitted as they are absorbed in India.

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Building Materials

THE building material for ordinary village uses in the Indian plains is essentially mud or silt, either used by itself or in the form of sun-dried or kiln-fired brick, set in mud mortar. Where stone is available it is used, often set in mud-mortar, or in lime made from *kankar*, the concentrations of carbonate of lime found in the alluvium of the plains, or from the deposits of excellent limestone in which Peninsular India is rich.

Of recent years numerous potteries run on up-to-date lines have arisen all over India, and in these tiles, ordinary bricks and fire-bricks, glazed earthenware pipes and sanitary fittings, telegraph insulators, domestic pottery and ornamental ware of excellent quality are made from ordinary clay, fire-clay and china clay.

Every town has its associated brick-fields and there is a large internal trade in lime, burnt in localities favourably situated with regard to limestone and fuel.

The building-stones of India are justly famed through the magnificent Buddhist and Moslem architecture of Northern India and the ornate temples of the Peninsula.

In Northern India, the great expanse of the Vindhyan system yields unsurpassable sandstones, in colours ranging from cream or buff to rich reddish-brown, from which gigantic blocks, thin slabs, and monoliths used for rafters and telegraph-poles, can be quarried. They are associated with limestones of excellent quality. The older marble of the Raialos is found in white, clouded grey and pink tints, and was used in the Taj Mahal at Agra and the Victoria Memorial in Calcutta, and there are many other varieties of white and coloured marble in Rajputana, one of which was used in the elaborately carved Jain temples of Dilwara.

The temple architecture of Southern India is largely carried out in granite and allied crystalline rocks, and in dolerite or epidiorite of so hard and tough a nature that the intricacy of the carving executed in it is well-nigh incredible.

Both the sandstones and the granites are admirably suited for public works of the strongest nature.

Amongst other well-known building-stones may be mentioned that from Porbandar, largely used in Bombay and Karachi, a soft foraminiferal limestone of sub-recent age, and the Karnul limestone of Shahabad in Hyderabad, which produces excellent flagstones and is also used for cement manufacture.

Slates are quarried near Dharmsala in the Kangra district, Punjab, and at Kund, near Rewari in the Gurgaon district, Punjab, and also near Monghyr in Bihar.

Bauxite

About 200,000 square miles of India are covered by Deccan Trap, basalt which under suitable climatic conditions decomposes to form laterite. Laterite is a mixture of bauxite (aluminium hydroxide) and ferric hydroxide, with some free silica and titania.

When the ferric hydroxide, silica and titania are low enough, the bauxite can be used commercially.

The production of Indian bauxite is chiefly from Katni in the Jubbulpore district, C.P., and Kaira district, Bombay, and for the last two years has been about 15,000 tons. Large deposits are known in Bilaspur and Mandla districts and Sirguja and Jashpur States, C.P., Kolhapur State, Bombay, Ranchi district, Bihar, and Jammu, Kashmir, and there are doubtless others still undiscovered, as bauxite is an ordinary-looking, clay-like rock, and is often covered by a layer of the ferruginous laterite.

It is believed that Indian bauxite is at present largely used as a filtering material in petroleum refineries, and for the manufacture of alum. Its utilisation for the preparation of aluminium, refractories and abrasives is now being undertaken.

Cement

The manufacture of cement started in India on a large scale in 1914, and since then the progress of the industry has been rapid. At present there are about 20 companies in operation, with a capacity of well over a million tons annually.

In most cases the limestone used belongs to the Vindhyans and can be so selected as to contain a considerable amount of the clay constituent required, the remainder, if any, being made up from shales associated with the limestone, or from local surface

silts. The small amount of gypsum necessary, 2 to 3 per cent., comes from Khewra in the Punjab, or from Jodhpur State.

Indian cement is made in several grades and is of such high quality that it has almost ousted imported cement. With the abundance of bauxite in India, there is likely to be an increasing production of aluminous rapid-hardening cement. India's great reserves of magnesite will also be invaluable in the manufacture of special cements.

Chromite

Chromite is mined in India at Hindubagh and Khanozai in Baluchistan, in the Shimoga, Hassan and Mysore districts of Mysore and west of Chaibasa, Singhbhum district, Bihar, and is known in several other localities.

The average production for the last three years (1936-37-38) has been 52,000 tons.

Most of the chromite is exported, but from the remainder chromite bricks of high quality are made for the steel industry.

Coal

The coalfields of India are of two ages, Lower Gondwana (Permian) and Tertiary, which supply 98 and 2 per cent. of the output respectively.

Coalmining is India's most important mineral industry employing about 200,000 persons for an output of 28,342,906 tons in 1938, with an estimated value of Rs.10,64,23,835 or £7,942,077. India comes ninth on the list of the world's coal-producing countries, with 2 per cent. of the total.

The railways are the principal customers, taking about one-third of the output, followed by the iron and steel industry, which takes two and a half million tons annually, from which a recovery of about 71 per cent. of hard coke is obtained. The remainder is distributed among factories, power-stations and smaller industrial concerns and the shipping industry. The domestic consumption of India has been estimated at about two million tons annually, which is negligible for a population of 330 million, but efforts are being made to popularise soft coke as a domestic fuel.

The last three years have seen a considerable increase in exports to foreign countries, chiefly Burma, Ceylon and the Far East, the figure for 1938 being 1,343,033 tons.

A Coal Grading Board, under Government, arranges for the classification and certification of the coal exported, so that buyers overseas may rely on the quality supplies. The following are the grades fixed by the Board:—

Low Volatile Coals.	High Volatile Coals.
Selected Grade:—Up to 13 per cent. ash and over 7,000 calories or 12,600 B.T.Us.	Up to 11 per cent. ash ; over 6,800 calories or 12,240 B.T.Us. and under 6 per cent. moisture.
Grade No. 1—Up to 15 per cent. ash and over 6,500 calories or 11,700 B.T.Us.	Up to 13 per cent. ash ; over 6,300 calories or 11,340 B.T.Us. and under 9 per cent. moisture.
Grade No. 2—Up to 18 per cent. ash and over 6,000 calories or 10,800 B.T.Us.	Up to 16 per cent. ash; over 6,000 calories or 10,800 B.T.Us. and under 10 per cent. moisture.

Grade No. 3—All coals inferior to the above.

Dr. C. S. Fox has estimated the total amount of coal in the Lower Gondwana Coalfields of India to be 60,000 million tons, of which 20,000 million tons may be considered workable, *i.e.*, it is in seams over four feet in thickness, averages 20 per cent. ash, (does not exceed 25 per cent. on a mixture-free basis) and lies within 1,000 feet of the surface.

Reserves of good quality coal, in seams of more than four feet in thickness, an ash content of 16 per cent. on a moisture-free basis, and lying within 2,000 feet of the surface are now 4,850 million tons. Of this about 1,400 million tons are coking coal.

Coal was discovered in the Raniganj field, about 130 miles from Calcutta, in 1774, but mining did not really start until 1814. From that date until the railway reached Raniganj in 1855, coal was boated to Calcutta on the Damoder river. By the beginning of this century other fields, especially Jharia, had been opened out by railway connections and expansion of output was uninterrupted until 1919, with an all-India output of 22,628,039 tons in that year. In the following year it dropped to 18 million tons in round figures and since then it has fluctuated between 20 million tons and 24 million tons, but a distinct improvement set in in 1937 (25 million tons) and 1938 (28·3 million tons).

Pit's mouth values, which had kept between Rs.2-8 and Rs.3-8 a ton from the beginning of the century to the middle of the Great

Digboi Oilfield.

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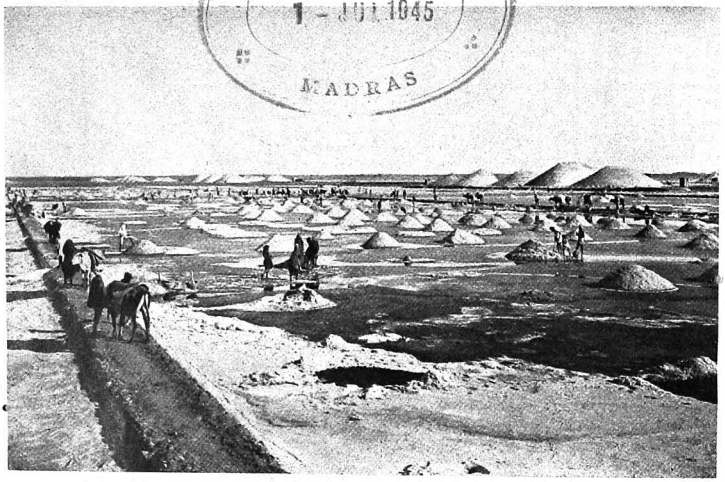
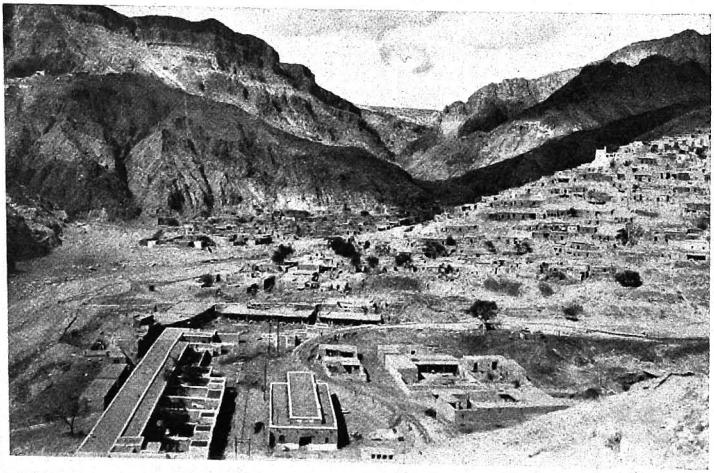


SALT : General view from Nawa end, Sambhar Salt Lake, Rajputana.



Khewra Salt Mine.

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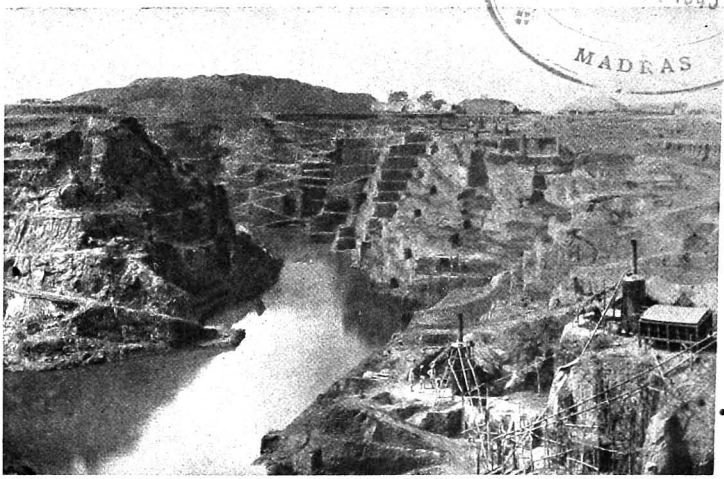
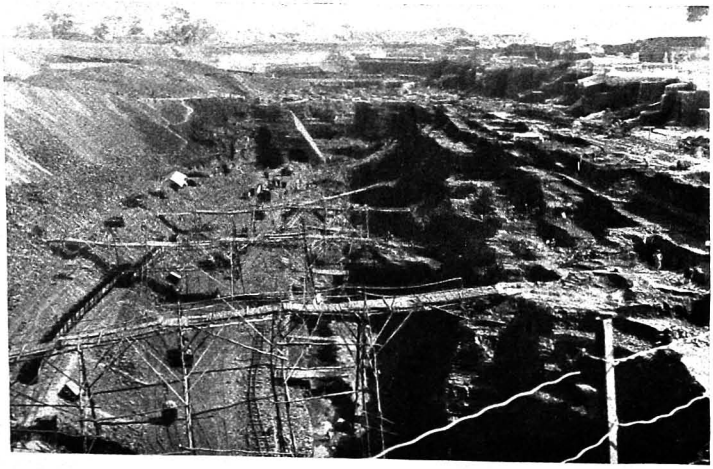


MANGANESE : Quasey Kodur, Vizagapatam Dist., Madras.

Coal seams in Kirea State.

MICA : Making mine entrance safe, Jorasimar, Kodarma, Bihar and Orissa.



Damagaria quarry, view looking eastward from dyke bridge.

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War, stood above Rs.7 during 1922-24 and then commenced a slump to between Rs.2-14 and Rs.2-12 in 1934-36, from which they are only now recovering.

The coalfields of Bihar and Bengal account for about nine-tenths of India's output;—Jharia, Raniganj, Bokaro, Giridih and Karanpura being the principal ones in order of output.

The Jharia field is the main source of coking coal of metallurgical quality. It contains 18 workable seams of a total thickness of 200 feet.

In the Raniganj field the coals of the lower measures (Barakar) are low volatile, high fixed carbon, the better of which form hard coke ; those of the upper measures (Raniganj) are mostly high volatile coals, and are non-coking with the exception of two seams. In the upper measures there are six seams aggregating 50 feet of coal, two of them 18 feet thick, and in the lower measures 12 workable seams, with not less than four feet of coal in each. All the Raniganj coals are good steam-raisers.

The Bokaro field is remarkable for the great thickness of its seams, up to a maximum of 126 feet of solid coal, which enables them to be won in vast open quarries. Two of the seams are of good coking quality.

The Giridih field, though small, produces the best metallurgical coke in India, made from the slack, while the lump coal is burnt in locomotives by the State Railways.

The large Karanpura field has recently been opened out. It also has remarkably thick seams up to a maximum of 90 feet, and some of its coal yields coke, if mixed with certain Jharia coals.

Outside Bihar and Orissa there are important coalfields in the Pench Valley of the Central Provinces, in the Korea and Talchir States of the Eastern States Agency and at Singareni and Tandur in Hyderabad State.

The remaining coalfields have each outputs of less than 300,000 tons annually.

Gypsum

Gypsum is the bedded variety of the mineral which in its crystalline form is known as selenite and when massive as alabaster. When calcined it is the well known ' plaster of Paris.'

It is a mineral characteristic of arid conditions, deposited in lagoons and salt lakes, and in India is widely developed in immense

quantities, in the Cretaceous beds of Trichinopoly district, Madras, the Eocene of Baluchistan, Punjab, and the North-West Frontier Province, and associated with the Salt Marl in the Salt Range ; sub-recent deposits are those of Nagaur in Jodhpur and Jamsar in Bikaner.

The production of India has reached 70,000 tons, chiefly from Jhelum district, Punjab, Bikaner and Jodhpur States, and Trichinopoly district, Madras.

Gypsum is extensively used in cements and plasters, as paints and fillers, and as a ' top-dressing ' in agriculture.

Ilmenite, Monazite and Zircon

It is convenient to treat of these three minerals together, as they are all found (with rutile, garnet, &c.) concentrated by wave action, in the beach sands of Travancore for about a hundred miles along the coast on each side of Cape Comorin, in the extreme south of India. They are recovered by washing and magnetic separation.

The industry started in 1911, on monazite alone, which was then used as a source of thoria for gas mantles, and in 1918 the output reached 2,118 tons. It then practically died out, to one hundredweight in 1925, presumably owing to the supplanting of incandescent gas lighting by electricity, but in 1922 the recovery of ilmenite and zircon had commenced and increased so remarkably that in 1938 the output of ilmenite attained 252,220 tons and of zircon 1,450 tons.

Ilmenite is the source of titania, a valuable white paint and used in certain alloys ; zircon yields zirconia, a high-grade refractory, and also an alloy material.

Concurrently the output of monazite recovered, rising to 5,221 tons in 1938. This is no doubt partly due to cheaper costs, as monazite is now a by-product in the much larger scale production of ilmenite, but also to the discovery of uses for the Cerium in monazite, in such compounds as the spark-producing elements in pocket lighters, the tips of tracer bullets, and in searchlights and ultra-violet lamps.

India is now the world's main source of these minerals.

Iron

In ancient times the people of India seem to have acquired a fame for metallurgical skill, and the reputation of the famous

wootz steel, which was certainly made in India long before the Christian era and exported to the Mediterranean lands to be worked into the 'Damascus' blades, has probably contributed to the general impression that the country is rich in iron-ore of a high class. Its qualities, however, were not derived from any special virtues in the ore, but from the fuel, charcoal, and from the painstaking treatment of the iron, after the reduction of the ore, by repeated hammerings, reheatings and carburisation in charcoal, anticipating the cementation process for crucible steel.

One of the finest examples of their craftsmanship is the pillar at the Kutb Minar, south of Delhi; this is made of skilfully forged wrought iron, 23 feet 8 inches in length, over a foot in diameter, and weighing six tons. It is believed to date from about 415 A.D.

It is true that throughout the Peninsula, which is so largely occupied by ancient crystalline rocks, quartz-haematite and quartz-magnetite schists are very common, but most of these occurrences consist of quartz and iron-ore so closely interbanded that only a highly siliceous ore of low grade (up to 40 per cent. iron) can be obtained, and magnetic concentration has not been successful, owing to the intimate intermixture of the quartz, magnetite and haematite.

For a number of years, however, haematite ore-bodies of great size and richness have been recognised in a belt running through the Singhbhum district of Bihar, the Eastern States, and Orissa, and constituting what is one of the most important groups of iron-ore deposits of the world.

It has been calculated that there are 3,600,000,000 tons of this high-class haematite available, forming the upper portions of great ridges, rising 1,500 ft. or more above the plain, along which for many miles the ore can be cheaply quarried in benches, by gangs of unskilled labour, and loaded straight into trucks, little or no selection being necessary.

At, for instance, Tata's Naomundi Mine, the average day's run of ore is 62 per cent. iron, and they can arrange consignments to the works of anything up to 69 per cent. iron, the latter containing only 1 per cent. of impurities, theoretically pure haematite containing 70 per cent. of iron and 30 per cent. of oxygen. Ore containing less than 60 per cent. iron is not used by the two large producing companies; the Mysore Iron and Steel Works use 55 per cent. to 64 per cent. ore.

Between 1830 and 1875 many attempts were made to produce iron on a commercial scale, using charcoal as a fuel, but all were failures, in spite of the genius of J. M. Heath, who first used manganese in the production of steel.

In 1875 trials were made of Indian coke at Kulti, on the Raniganj coalfield, at a plant which afterwards became that of the Bengal Iron Co. Ltd., and first succeeded in smelting iron on modern lines.

The first furnaces of the Tata Iron and Steel Co. Ltd., were blown in in 1911-12, followed ten years later by the Indian Iron and Steel Co. Ltd., and the charcoal-iron furnace of the Mysore Iron and Steel Works.

Since the beginning of the present century the annual production of iron-ore in India has risen from 65,000 tons to 2,743,675 tons in 1938, representing 1,539,889 tons of iron smelted.

India is now the second largest producer of iron and steel in the Empire, excelled only by the United Kingdom.

Her reserves of ore are about three-quarters of those of the United States and are of better quality, than the bulk of the American deposits.

The ores are believed to have been originally banded haematite quartzites, the quartz of which has been leached and replaced to some extent by haematite.

Typically they run about 64 per cent. of iron, sulphur is usually below 0·03 per cent., and phosphorus varies from 0·03 to 0·08 per cent. Titanium is low.

As these reserves are much larger than the available amount of coal suitable for making metallurgical coke, it would seem that India can, sooner or later, spare great quantities of ore for export.

In 1938, 264,151 tons of ore were exported to Japan. In that year, the total exports of pig-iron from India were 525,254 tons, of which 323,046 went to Japan, and 129,824 to the United Kingdom.

Kyanite and Sillimanite

Kyanite and sillimanite (and andalusite) are sillicates of alumina, all of which, when heated sufficiently highly, change to 'mullite.'

Mullite is a valuable refractory material for the construction of furnaces, especially for glass manufacture and in electrical work.

Nearly all the Indian kyanite at present on the market is quarried at Lapsa Buru, Kharsawan State, Bihar, and the average production for the last three years (1936-37-38) has been approximately 27,000 tons.

Sillimanite-corundum deposits are known in Nongstoin State in Assam, and at Pipra in Rewa, but transport difficulties have been against production ; there has also been a small output of sillimanite from Travancore.

Magnesite

Magnesite production commenced in India in 1902, from the " Chalk hills " in the Salem district, Madras, where the quantity of the mineral is practically inexhaustible ; it occurs in a network of veins over an area of 4½ square miles, standing up to a height of 140 feet in hillocks, from which it is quarried.

It is calcined to form either ' caustic ' magnesia at a temperature of about 800° C. or ' dead burnt ' at about 1,700° C. Caustic magnesia is the principal ingredient of ' Sorel ' or ' oxy-chloride ' cements and dead-burnt magnesia is a refractory used to line the furnaces in the basic steel process, for which the bricks made in India are stated to be superior to the Australian bricks which they have supplanted.

The Indian production is about 26,000 tons annually, of which roughly 2,500 tons is from Mysore and the remainder from Salem.

Manganese-Ore

Deposits of manganese-ore are widely distributed in the ancient rocks of Peninsular India, and since the beginning of the century India has shared the position of the world's chief producer with Russia, sometimes one leading, sometimes the other.

As the demand for manganese is governed by its uses in the manufacture of steel, it is subject to great vicissitudes as the heavy industries rise and fall with the calls from trade and the manufacture of munitions.

This was particularly the case during the world trade slump in the years 1930-3, when India's production dropped to a little over a fifth of that of five years previous, with a value of less than one-nineteenth.

Recently, however, there has been a recovery, with the result that the production of India, for the first time in the history of the industry, exceeded one million tons in 1937.

The United Kingdom, Japan, the United States and France, have been the principal customers.

The principal areas in which manganese-ore is mined are the Balaghat, Nagpur and Bhandara districts in the Central Provinces, Sandur State and Vizagapatam in Madras, the Panch Mahals district in Bombay, Singhbhum district in Bihar and the adjoining States of Keonjhar and Bonai.

The ores are mixtures of psilomelane, braunite, and pyrolusite, and tend to form hills, so that quarrying is easily and cheaply carried out by gangs of unskilled labour. Many of the ore-bodies are of great size. The main disability under which the industry labours is the distance of the larger deposits from the nearest sea-ports.

Mica

India is the world's leading producer of sheet mica, which is mined mainly in Hazaribagh and Gaya districts in Bihar and Nellore in Madras, and to a minor extent in other districts in Madras and in Tonk State and Ajmer-Merwara in Rajputana, about 80 per cent. coming from Bihar and most of the remainder from Nellore. This pre-eminence in the world's markets is due largely to the excellent quality of the so-called " Bengal ruby " mica of Bihar, but also to the great manual dexterity and cheapness of the aboriginals, mainly women and children, who trim and split the mica with crude soft-iron sickles (or shears in Nellore). So much is this the case that there is an appreciable import of block mica into India, to be re-exported in the form of splittings. Mica has been used in India for centuries for decorative and medicinal purposes.

The mica occurs as " books," giant crystals which have been found, exceptionally, as large as 10 feet in diameter, in great veins of pegmatite traversing mica schiests. The mica, which is muscovite, occurs with felspar and quartz, and other minerals such as beryl, which from Ajmer is exported as an ore of beryllium.

The export of mica from India amounted to 297,343 cwts. in 1937, most of it going to the United Kingdom and the United States.

Petroleum

Petroleum has been successfully exploited in the Tertiary rocks at the extreme ends of the great plain of Indo-Gangetic alluvium,

at Digboi in Assam and in the Attock district, Punjab, south-west of Rawalpindi at both of which places there are refineries.

The Digboi oil is particularly rich in wax. South of Digboi, in the Surma Valley of Cachar, are two other fields, Badarpur, which has proved disappointing, and Masipur, from which output has not yet been obtained.

In Attock petroleum is being produced from two fields, Khaur and Dhulian, 8 miles apart, the latter having recently been most successful, after great perseverance in the face of difficulties at Khaur.

In 1938 the production of Digboi was 66 million gallons and of Attock 21·1 million gallons in round figures.

Steatite

This mineral, also known as soapstone, potstone, talc and agalmatolite, and in its powdered form as " French chalk " is one of the most variously used industrial minerals, in multitudinous minor ways, from idols and slate-pencils to switchboards and chemical tanks, and, powdered, from anti-adhesives, polishers and fillers to face-powders.

The annual production of India is reported as about 18,500 tons in 1938, the chief sources being Jaipur State, Guntur district in Madras, and Jubbulpore district in the Central Provinces, but there are numerous other minor deposits and probably a good deal of it does not come into the statistics.

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