minimum value of 3 pairs, though too much reliance must not be placed on this figure. It is, however, known that the air radioactivity in this place is only slightly greater than over the ocean. Any residual ionisation which has not been accounted for is therefore minute in amount. The final results of Prof. Millikan's observations may settle this point, but the very slightest trace of radioactive impurity in or on the walls of the vessel would cause an ionisation sufficient easily to account for any difference. Measurements in a metal chamber under varying high pressures is one investigation which would probably give useful information on the residual effect, if made in a submerged submarine in order to exclude the cosmic rays.

Though the ionisation currents dealt with in work on penetrating radiation are small—of the order 10^{-14} to 10^{-15} ampere—the measurements can be made with considerable accuracy, so that there is no possibility for doubt as to the reality of the existence of the cosmic rays. It is, however, a matter for regret that laboratory experiments on the properties of these rays cannot be carried out effectively in Great Britain, since it is only at great altitudes that the cosmic rays contribute more than a fraction of the total ionisation. The possibility of the discovery of a laboratory source of these rays must be regarded as remote, though it is unwise to be dogmatic even on this point.

Mineral Production in India.[1]

AMONG the many useful services rendered by the Geological Survey of India must be reckoned the issue of a Quinquennial Review of the Mineral Production, initiated during the directorship of Sir Thomas Holland. The first of these reviews appeared in 1905 (*Rec. Geol. Surv. India*, Vol. 32, Part I.), and covered the period 1898–1903. Since then, four others have been published, the latest, covering the period 1919–23, being a voluminous and interesting account of the progress during the period, contributed by the director (E. H. Pascoe) and the senior officers of the Survey, including L. L. Fermor, J. Coggin Brown, H. C. Jones, C. S. Fox, and W. A. K. Christie.

The average annual value of the output in India of minerals for which trustworthy returns of production are available, during the five years 1919–23 inclusive, was as follows:

	l.
Coal	9,252,649
Petroleum	7,036,298
Gold	2,094,323
Manganese ore	1,995,341
Salt	948,245
Lead and lead ore	881,710
Silver	642,450
Mica	633,331
Saltpetre	355,118
Tin and tin ore	214,500
Tungsten ore	135,845
Iron ore	114,956
Jadestone	114,329
Ruby, sapphire and spinel	60,660
Chromite	53,764
Monazite	29,294
Copper ore	29,053
Magnesite	16,334
Diamonds	7,262
Graphite	265
Total value	24,615,727

Of the countries in the British Empire, India stands second as regards coal output, being well ahead of the Union of South Africa, Canada, and Australia, although the output of rather more than twenty-one million tons in 1924 amounted to less than 8 per cent. of the output of Great Britain. Of the Indian output, more than 98 per cent. was from Gondwana coalfields, including 52 per cent. from the Jharia field and 28 from the Raniganj. The Bokaro field, with 4·7 per cent. of the output, is now ahead of the output of the Giridih and Singareni fields. It is expected that the Bokaro will before many years prove to be one of the great coalfields of India. Coal exports during the period ranged from a maximum of $1\frac{1}{4}$ million tons in 1920 to a minimum of 77,000 tons in 1922. In its coal export trade to ports in the Indian Ocean, India has to compete with Japan and South Africa, both of which countries are regarded as formidable rivals in this trade. The employment of by-product ovens in coke-making has of late been considerably extended, as also has the employment of electrical energy in mines for pumping, etc.

The large increase in annual value of the petroleum output from an average of 1,073,604*l.* during the period 1914–18, to an average of 7,036,298*l.* for the period under review, does not indicate a corresponding increase in the actual output, which averaged 282,594,121 gallons annually during the former period as compared with 299,453,675 during the latter period. The large increase in value referred to is attributed chiefly to the fact that the value of petroleum during the former period was much under-estimated, and partly to the high exchange value of the Indian currency in 1919 and 1920, during which years there was an increased output. The director of the Geological Survey thinks the chances are that the next five years will show a smaller increase of output than was shown by the last five years, and possibly even a decrease. India still contributes only a very small part of the world's supply of petroleum, the output for 1923 being only 0·83 per cent. of the world's marketed production.

The period was one of substantial progress for the iron and steel industry in India, which was in a declining condition at the outset of the quinquennium. In spite of this progress, however, a Tariff Board was appointed recently to inquire into the question of protection for the steel-making industry. As a result of its inquiry the Tariff Board concluded that, without some form of protection, the Indian steel industry would certainly not develop for many years, and might even cease to exist. Following the Board's recommendations, the Legislative Assembly quite recently (September 1925) agreed to a grant of a maximum of

[1] *Records of the Geological Survey of India.* Vol. 57: Quinquennial Review of the Mineral Production of India for the Years 1919 to 1923. By the Director and Senior Officers of the Geological Survey of India. Pp. viii+398+lxxi+5 plates. (Calcutta: Government of India Central Publication Branch, 1925.) 5.10 rupees; 9*s.* 3*d.*

60 lakhs of rupees to the steel industry up to March 1927, after which date, when the Protection Act expires, the question will be reconsidered.

India assumed leadership in the production of manganese ore so early as 1907, and, after a relapse in the years 1912–15, regained it during the War period, in spite of much competition from Brazil. The report states, however, that discoveries of new and valuable deposits of manganese ore seem to have ceased, and that the period under review has been marked by stability in this section of the mining industry, accompanied by gradual development of some deposits and exhaustion of others. The average annual output of manganese ore for the period was 624,635 tons, compared with 577,457 tons in 1914–18, and 712,797 tons in 1909–13.

The output of chromite (chromium ore), which had increased substantially during the War period, continued to increase during the period under review, the average annual output being 35,000 tons as compared with an average of 23,000 tons for the previous quinquennium. The increase was due chiefly to greater activity in the chrome mines of Baluchistan.

The output of tungsten ore in Burma, which had increased greatly during the War period, having reached 4542 tons in 1917, dwindled during the period under review to an output of 872 tons in 1923. The tin output, on the contrary, showed an increase to an average annual of 138 tons (metal) compared with an average of 116 tons for the preceding quinquennium.

The gold-mining industry of India suffered during the War period, during which the average production was a little less than 587,000 ounces annually. The decline in output has continued steadily through the period under review, during which the average was 459,875 ounces.

Further marked progress is reported in the output of the lead-silver-zinc mines at Bawdwin and Namtu in Burma. The output of lead extracted from the ore at these mines rose steadily from 19,000 tons in 1919 to 46,000 in 1923, while that of silver increased from more than two million ounces in 1919 to about five million ounces in 1923.

India is the leading producer of mica of good quality. We learn, moreover, from this report that the art of producing fine splittings of mica by hand is practised more efficiently in India than in other countries, so much so that during recent years India has imported mica for conversion into fine splittings for export. India also holds a monopoly in shellac production, which gives her power to control the production of micanite if necessary.

The average annual output of magnesite, chiefly from the deposits at Salem in Madras, increased by 77 per cent. in the period under review.

There was no progress in the jadeite industry during the period dealt with. The average annual exports amounted to 4628 cwt. as compared with 4651 cwt. during the previous quinquennium, but the value was much higher.

The output of monazite declined substantially during the period 1919–23, having fallen from 2000 tons in 1919 to only 125 tons in 1922.

The output of bauxite during the period continued low, averaging 5220 tons annually. The returns for 1924, however, show an increase to 23,228 tons of bauxite, from 6547 tons in 1923. By far the larger part of the 1924 production was from the Kaira district, in the Bombay Presidency.

Among new and interesting features in the mineral production of India, mention may be made of ilmenite, zircon, sillimanite, and kyanite. Ilmenite and zircon occur with monazite in the beach sands of Travancore, and are obtained as by-products in the magnetic concentration of the monazite. The outputs of ilmenite for 1922, 1923, and 1924 were 400, 700, and 641 tons respectively, while those of zircon were 160, 145, and 365 tons respectively.

Sillimanite has in recent years come into prominence as a refractory, and much interest has been taken in the deposit of the Khasi Hills, Assam, which was formerly thought to be one of corundum. Four outcrops of sillimanite have been found, but the extent of the deposit is not known. The quantity of boulders, etc., at the surface is stated to amount to about 3000 tons. No sillimanite appears in the production statistics of 1923 and 1924.

A discovery of kyanite was made in the Lopso Hill area, Kharsawan State, Singhbhum, in 1921. Analyses show the rock to consist of practically pure aluminium silicate, and experiments show that it is suitable for use as a refractory. Several hundred tons have been sent to England, and it is thought that a demand for it as a refractory may arise. An output of 224 tons of kyanite is reported in the production statistics of the Geological Survey for 1924. T. C.

Obituary.

MR. J. H. MAIDEN, I.S.O., F.R.S.

ON November 16, at his residence, Turramurra, Sydney, the death occurred of Joseph Henry Maiden, who in 1924 retired from the position of Director of the Sydney Botanic Gardens and Officer-in-Charge of the Centennial Park. Mr. Maiden was born at St. John's Wood, London, on April 25, 1859, and received his early education at the City of London Middle Class School. He soon showed a taste for science, and for some time was assistant to the late Prof. F. Barff. He came to Australia in 1880, for health reasons, having provided himself with a return ticket, but the climate proved so beneficial that he decided to remain, and became associated with the formation of the Technological Museum, Sydney, of which he was Curator from 1881 until 1896, and he soon began to study the native plants. Some of his early botanical lessons were learnt from the late Rev. Dr. William Woolls, of whom he always retained the most affectionate memories. He was also a colleague in botanical work of the late Baron von Mueller in his latter days, another of the great pioneers of Australian botany. Mr. Maiden was Superintendent of Technical Education from 1894 until 1896; Consulting Botanist to the Departments of Agriculture and Forests from 1890; Director of the Botanic Gardens, Sydney; and Government Botanist from 1896 until his retirement in 1924.