original observations in the crude form the Office can do the rest. I can assure them that I have never known the staff of the Office to be at a standstill for lack of ideas to carry out, and from the freedom of this chair I will be bold enough to say that there are worse services to meteorology than helping to carry out the ideas of the Meteorological Office.

The Fellow as a Centre of Local Influence.

And outside the immediate sphere of the society there is much that is necessary to create an atmosphere favourable for the development of the science. We want people to know that meteorology is not exclusively forecasting. No doubt the view into the unknown future is, as Prof. Schuster said in his address to the British Association in 1915, the lure of scientific research, but the long way that has to be travelled in order to make sure of it rewards us with many side-views of common human interest. The discovery of the separation of the atmosphere into troposphere and stratosphere surely belongs to the great achievements of the human intellect, and the meteorological exploration of the globe is worth reciting. So I picture to myself a meteorologist, even in a part of the kingdom or the Empire so remote that he cannot share the privileges of our monthly meetings, who would be a centre of knowledge of the weather without aspiring to a reputation for foretelling the fortunes of his neighbour's hay or anticipating the prospects of a smooth passage.

RECENT IRON-ORE DEVELOPMENTS IN THE UNITED KINGDOM.[1]

WHILST the basis of the prosperity of a country is admittedly agriculture, its industrial growth is founded on mineral resources, and its participation in the world's markets is chiefly dependent on the extent to which these raw materials can be applied to home manufactures.

It is true that the first historical reference to this country mentions the export of tin from Cornwall, and that Great Britain's production and export of copper in the early part of the nineteenth century were the largest in the world; but for its modern industrial pre-eminence it is indebted to its coal and ironstone.

The cheap manufacture of iron and steel in this country has in the past been greatly aided by the providential dispensation that the ironstone was so closely associated in Nature with the fuel required to smelt it that the factor of transportation was practically eliminated

But the gradual exhaustion of the richer blackbands and clay-ironstones of the Carboniferous formation, and the introduction of the acid Bessemer process of steel manufacture, which requires a pure ore free from phosphorus and sulphur, made it necessary to find other sources of iron-ore supply. For many years the United Kingdom has been dependent for 30 per cent. of the iron-ore used in its blast furnaces on foreign countries. Foreign ore plays even a bigger *rôle* than at first sight appears, since it contains 50 per cent. of iron as against an average of 30 per cent. for home ores. The importation of hæmatite, rich in iron and low in phosphorus, from Spain and the Mediterranean has built up the big iron industries that are engaged in the manufacture of steel by the acid process in South Wales, on the North-West Coast, on the North-East Coast, and in Scotland, where the ports of Cardiff, Port Talbot, Whitehaven, Barrow, Middlesbrough, Newcastle, and the Clyde, situated in close proximity to an ample supply of labour, enable foreign ore and native coal to be easily assembled and cheaply handled.

But it was found to have its drawbacks when the war broke out; and the scarcity of ship-tonnage, which resulted from the activity of the enemy submarines, raised the cost of imported ore from about 20*s*. (at which best Bilbao ore ruled in British ports in 1914) to an actual price of more than 6*l*. per ton, although (under the cloak of Government subsidies) it figured at a lower level. At one period of the war the supply from these sources threatened to be cut off altogether.

To meet this situation an increased development of the Jurassic ironstones of this country was decided on. These ironstones, although abundant and cheaply worked, are what the ironmasters term "lean"—that is to say, they are low in iron, averaging only 28 per cent. of that metal. Moreover, they have a high phosphorus- and sulphur-content, and for the most part are rather siliceous.

The increased production of the domestic phosphoric ores brought about by the war raised many difficult problems. In the first place, it necessitated a different metallurgical treatment. This involved the substitution of basic-lined steel furnaces for those of the acid type, with consequent increased supplies of suitable refractory materials. It also involved large additional supplies of fuel for smelting, and of limestone for fluxing the ore in the blast-furnaces.

Especial difficulties arose with regard to magnesite and magnesite bricks. Prior to the outbreak of the war the magnesite-brick industry was almost wholly in the hands of the Austrians. Possessing in their own country extensive deposits of magnesite peculiarly suited for brick-making, they devoted both skill and money to the perfecting of their products, with the result that before the war they commanded practically the entire custom of the steel trade of this country. To make up for the loss of the Austrian material, arrangements were made by the Ministry of Munitions for the manufacture in this country of magnesite bricks, and the raw material was obtained from Eubœa, in Greece, and from Salem, in Madras.

To furnish the required dolomite and limestone, new quarries were opened up in this country.

With regard to labour a fresh supply had to be found, not only to work the new quarries of ironstone, limestone, dolomite, etc., but also to build the railways required to open them up, to erect extensions to existing plant, to man the new works, to reline furnaces, etc., and this in face of the incessant and urgent calls of the Army to fill the gaps in the fighting line.

Considerable use was made of prisoner labour. The difficulty with prisoners was to induce them to work. On account of the Army regulations, work could be compelled neither by force nor by a reduction of rations The difficulty was overcome by the introduction of piece-rates, but only to a limited extent, as there was no outlet for surplus earnings in the canteens, food supplies having been cut down on account of the general food shortage. On the average, the efficiency of prisoner labour was about 50 per cent. of that of British labour.

The shortage of quarrymen led to active steps being taken in responsible quarters to supplement and to increase the efficiency of the manual labour at the quarries by the provision of mechanical appliances for stripping, breaking, and loading the ironstone.

In these open workings the output per man employed varies with the thickness of the ironstone-bed, the amount of cover to be removed, the use made of mechanical appliances, and the condition of the weather. The weather materially affects the output, especially where hand-labour is concerned. From

[1] Abstract of a lecture delivered at the Royal School of Mines on May 27 by Dr. F. H. Hatch.

returns made to the Ministry of Munitions in December, 1917, it appears that the average output in the Midlands per man employed was 5 tons per shift, and that it ranged from 3·8 tons where hand-labour was alone employed to more than 15 tons where mechanical excavators were in use under favourable conditions. The actual saving of manual labour which resulted from the installation of mechanical plant in the ironstone quarries during the war is estimated to have been equivalent to more than 3000 men.

The Jurassic ironstones have a wide distribution both in this country and on the Continent. In 1913 Germany mined in Lorraine and Luxemburg 28,000,000 tons of minette ores of Jurassic age out of a total production of 36,000,000 tons of iron-ore, while she imported in addition 3,800,000 tons of the same ore from Briey. Without the Lorraine iron-ore basin, which she stole from France in 1871, Germany would have been unable to go to war, and she took care to secure the remaining portion of the field (*i.e.* the Longwy and Briey basins) soon after the commencement of hostilities. One of the best guarantees for future peace is the provision in the Peace Treaty that no portion of this iron-ore field remains in German hands.

In England the Jurassic formation stretches as a broad band from the coast of Yorkshire to that of Dorset. The ironstones occur on four different horizons, as shown in the following table, which also gives the proportion in which they were worked (in relation to the total production of the United Kingdom) in 1917, and their average iron-content.

Table showing Relative Production and Iron-content of the Jurassic Ironstones.

Ironstone	Ratio to total production. Per cent.	Average iron content (as mined). Per cent.
Inferior Oolite (Northamptonshire and Rutland) ...	21	32
Middle Lias (Cleveland) ...	32	28
Middle Lias (South Lincolnshire, Leicestershire, and Oxfordshire)	9	25
Middle Lias (Raasay) ...	0·5	23
Lower Lias (North Lincolnshire)	18	23
	80·5	27·6

The Jurassic ironstones accounted in 1917 for more than 80 per cent. of the total output of iron-ore in the United Kingdom, the remaining 20 per cent. being made up of hæmatite mined in Cumberland and Lancashire (10½ per cent.), blackband and clay-ironstone mined in the English and Scottish coalfields (8 per cent.), and sundry ores mined in Wales, Forest of Dean, Devonshire, Weardale, and Ireland (1½ per cent.).

The Jurassic ironstones, although poor in iron, are valuable because of their considerable thickness and widespread occurrence at only a slight depth below the surface. With the exception of the Cleveland district of Yorkshire, where the ironstone is now mined underground, the workings are almost everywhere at the surface, the ironstone being quarried after stripping off an overburden of soil, sand, or clay, as the case may be. Since the angle of the dip is usually small—or, in other words, the beds are practically horizontal—considerable areas can be worked before the overburden becomes too great for removal at a reasonable cost. As much as 60 ft. of soft material (sand or clay) can be removed, and, under favourable conditions, probably 100 ft. will be removed.

The different beds of ironstone vary considerably in thickness. The thickest is the Frodingham bed in North Lincolnshire. This ironstone is 25 ft. to 30 ft. in thickness, and consequently can be worked very cheaply by mechanical excavation. Before the war the cost of the stone in wagons at the quarries (exclusive of royalty) was not more than 1*s.* per ton. Probably it is double that now.

As compared with 1916 figures, the production of the Jurassic ironstones as a whole was increased by 45,000 tons per week, equivalent to 2⅓ million tons per annum. The increase reached this maximum in the first half of the year 1918. But it was not possible to maintain production at that figure on account of the calls of the Army on labour. The increase was made mainly in Northamptonshire, Rutlandshire, and Leicestershire, the quarries in these counties accounting for 59 per cent. of the total increase; but Cleveland accounted for 26 per cent. and Oxfordshire for 9 per cent.

With regard to the non-Jurassic iron-ores of this country, the most important are the hæmatite deposits of Cumberland and Lancashire. These ores are remarkable for their richness in iron and their freedom from both phosphorus and sulphur, and therefore furnish a pig-iron very suitable for the acid Bessemer process, and yield an exceptionally pure steel. They are, consequently, in great demand, and this demand was emphasised during the war by the difficulty at one time experienced in securing sufficient supplies of hæmatite ore from Spain. Every effort was therefore made to push production to the utmost, and many abandoned mines were reopened in order to extract the pillars.

The deposits occur in masses of irregular shape in the Carboniferous Limestone, a formation which in this district rests unconformably on the old Skiddaw Slates, and is itself concealed in places by overlying Coal Measures and Red Sandstones or by Boulder Clay. The existing mines are situated between Lamplugh, in Cumberland, and Ulverston, in Lancashire, a distance from north to south of thirty-five miles.

No doubt, besides the known deposits, many undiscovered ore-bodies exist in the Carboniferous Limestone that can be found only by systematic prospecting by boring. Already before the war borings through the Red Sandstones had disclosed, south of Egremont, some of the largest ore-bodies that have been found in either county, with the possible exception of that worked by the Hodbarrow mine. The Beckermet, Ullcoats, and Ullbank Companies are now engaged in developing and working these deposits.

Since the Carboniferous Limestone is of widespread occurrence in the United Kingdom, it might have been expected that valuable hæmatite deposits would have been discovered in other parts of the country. With the exception, however, of deposits of limited extent in South Wales and in the Forest of Dean, this has not proved to be the case.

In the industrial recuperation of this country, now that the war is over, the working of the low-grade Jurassic deposits, which it is fortunate in possessing, is destined to play a great part. This has been rendered possible by the great extensions to iron and steel works that have been initiated with Government assistance during the war. These works have been planned on the most modern lines, and possess on the same site by-product coke-ovens, blast-furnaces, steelworks, and rolling mills. They are designed for the basic process of steel-making, and will be fed with home ores. In choosing the sites for these works regard has been paid to the situation of the raw materials—ore, fuel, and flux—required to supply them. On the completion of these extensions there

should be no necessity for this country to import a single ton of foreign steel. Before the war something like 2,500,000 tons of steel, in the form of slabs, blooms, and billets, were imported into this country annually, mainly from Germany.

But for success in this great undertaking cheap ore and fuel are essential, and these can be obtained, in face of the greatly augmented cost of labour and material, which is a legacy of the war, only by an all-round increase in efficiency, embracing capital, engineering, and labour—capital by the installation of up-to-date equipment, engineering by improved mining methods, and labour by an increased output per man per shift.

These are the pressing problems of the immediate future.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—The following appointments have been made:—At King's College: Mr. J. E. Barnard, lecturer in microscopy; Major J. Quinton, lecturer in mathematics; and Dr. W. Wilson, as whole-time senior lecturer in the department of physics. At Bedford College for Women: Mrs. Orson Wood, demonstrator in the department of physics; Miss Woodman, part-time demonstrator in the department of physiology. The chemical department of the college has been divided into the two departments of (*a*) organic chemistry and (*b*) inorganic and physical chemistry. The following appointments have been made to the staff of the new departments:—Mr. Crompton, head of the department of organic chemistry and director of the laboratories; Dr. Spencer, head of the department of inorganic and physical chemistry; Miss Vanderstichele and Miss Triffitt, demonstrators in the department of organic chemistry; Miss Crewdson, demonstrator in the department of inorganic and physical chemistry. At Goldsmiths' College: Mr. G. T. White, head of the engineering and building department.

The title of assistant professor of physiology has been conferred upon Dr. O. Rosenheim, of King's College.

OXFORD.—Mr. Julian S. Huxley, a scholar of Balliol from 1905 to 1909, and from 1913 to 1916 associate professor of biology in the Rice Institute, Houston, Texas, and Mr. Henry Clay, scholar of University College from 1902 to 1906, and author of "Economics for the General Reader," have been elected fellows of New College.

DR. A. W. STEWART, of the University of Glasgow, has been appointed to succeed the late Prof. E. A. Letts in the chair of chemistry in the Queen's University of Belfast.

THE late Sir Archibald D. Dawnay bequeathed for scholarships 5000 *l.* shares in the firm of Archibald Dawnay and Sons, Ltd., to the Royal Institute of British Architects, 5000 to the London County Council, 1000 to the South Wales Institute of Engineering, Cardiff, and 1000 to the Battersea Grammar School. The bequests will become operative after the death of Lady Dawnay.

APPLICATIONS for the William Julius Mickle fellowship, which is of the value of at least 200*l.*, must be made to the academic registrar of the University of London before October 1 next. The fellowship is open to both men and women, and will be awarded to a graduate of the University, resident in London, who has done most to advance medical art or science during the past five years.

APPLICATIONS are invited by the Joint Studentship Committee of the Empire Cotton-growing Committee of the Board of Trade and the British Cotton Industry Research Association for studentships from graduates desirous of continuing their studies on the living plant. The studentships are of the yearly value of about 150*l.*, and applications must reach the secretary of the British Cotton Industry Research Association, 108 Deansgate, Manchester, on or before August 27.

THE prospectus of university courses in the Municipal College of Technology, Manchester, for the session 1919–20 has now been published. The college offers systematic training in the principles of mechanical, electrical, municipal, and sanitary engineering; of architecture and the building trades; of the chemical industries and the textile industries; and of photography and the printing crafts. It possesses extensive laboratories and workshops equipped with full-sized modern machinery, tools, and apparatus, including not only machines of the types now in general use, but also machines especially constructed for demonstration, experiment, and original research. There is a generous provision of both entrance and post-graduate scholarships. Courses of post-graduate and specialised study and research are offered for a fourth year to students who have successfully completed the three years' course for a degree in the Faculty of Technology in the Victoria University of Manchester conducted in the college, or are otherwise deemed competent to enter upon them.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 21.—M. Léon Guignard in the chair.—J. **Boussinesq**: The existence of an approximate relation, pointed out by M. Carvallo for quartz, between the two rotatory and dispersive powers of bodies.—A. **Gautier** and P. **Clausmann**: The action of fluorides upon vegetation. Field culture experiments. The fluorine in these experiments was added in the form of amorphous calcium fluoride; it was found to be favourable to the growth of wheat, oats, carrot, broad bean, cabbage, pea, poppy, potato, and hemp. No effect was observed with barley, rye, bean, buckwheat, and mustard, whilst beetroot, turnip, and onion were prejudicially affected by fluorides.—P. **Sabatier** and A. **Mailhe**: The catalytic formation of alkyl chlorides, starting with the primary alcohols. A mixture of hydrochloric acid and alcohol vapour, passed over alumina heated to 370° to 450° C., gives the alkyl chloride mixed with the ethylenic hydrocarbon produced by the dehydration of the alcohol. Primary, secondary, and tertiary chlorides may be formed in this reaction.—V. **Grignard** and G. **Rivat**: The addition compounds of halogen acids to diphenylarsenic acid. The addition products $[(C_6H_5)_2.AsO.OH]_2HCl$ and $(C_6H_5)_2.AsO.OH.HCl$ and two corresponding compounds with HBr were isolated and analysed.—G. **Giraud**: The classification of substitutions of certain automorph groups of n variables, and the algebraic relations which exist between any $(n+1)$ functions corresponding with certain of these groups.—M. de **Broglie**: The X-ray spectra of the elements. Measurements of the K spectrum of rhodium and L absorption spectrum of radium.—J. **Hebert-Stevens** and A. **Larigaldie**: Radiotelegraphy by infra-red radiation. The light from an arc projector is filtered through a screen which absorbs all the visible rays but allows a portion of the infra-red rays to pass. The receiver is a parabolic mirror with a sensitive thermo-couple placed at its focus, and the latter actuates a relay. Messages have been sent