warrant their recognition as belonging to a distinct species. This may be known, after the discoverer, as *Diceros whitei*, sp. nov.

Diceros whitei, sp. nov. The humerus of this species differs most remarkably from that of *D. bicornis* in the shape of its distal end. The olecranon fossa is very much narrower than in *D. bicornis*, being 29 mm. in diameter, as compared with 51 mm. for a specimen of the latter. Indeed, the whole bone, although evidently that of a fully adult individual, is smaller and much slighter in proportion to its length, which is 330 mm., from the trochlea to the head of the humerus, while *D. bicornis* measures 358 mm. The tibia, although not differing to the same extent as the humerus, is nevertheless slightly narrower in proportion, and a little shorter. This species is evidently a form of rhinoceros smaller and less heavily built than *D. bicornis*. For this reason it is also distinct from *D. sinus*, and from *D. simplicidens*, Scott,¹ which is likewise larger than *D. bicornis*. I hope shortly to publish figures showing fully the differences between the species.

Equus sp. Several molars probably belonging to a zebra.

Connochates taurinus, Burch. The basal portion of a horn-core.

Strepsiceros strepsiceros, Pall. An imperfect horn-core.

Taurotragus oryx, Pall. Portion of a horn-core.

In addition to the above there are in the Rhodesia Museum a number of bones and teeth of various other antelopes, not identifiable with certainty.

AVES.

An incomplete pelvis of a small bird, an ulna, and several leg-bones.

AMPHIBIA.

The ischial portion of a frog's pelvis; also an astragalus and calcaneum.

VI.—IRON ORE SUPPLIES.

By BENNETT H. BROUGH, Assoc. R.S.M., F.G.S., F.I.C.

OF all the problems with which the practical geologist has to deal, none is of greater importance at the present time than the discovery of fresh sources of iron ore supply. Every inhabitant of the United Kingdom, of the United States, and of Germany requires annually about a quarter of a ton of the iron of which the world last year produced 60,000,000 tons, the result of the smelting of over 120,000,000 tons of ore. Year by year the production and consumption are increasing, and many of the deposits of the richer ores are showing signs of depletion. The question of ascertaining how the demand for the vast supplies of iron ore that will in the future be needed will be met calls, therefore, for very serious consideration, and a few statistical notes may be useful as a contribution to a discussion of the subject.

¹ Third Rep. Natal Geol. Survey, 1907, p. 201. In employing the generic name *Opsiceros* for his species, Scott has overlooked a paper by Thomas in P.Z.S., 1901, p. 158, where it is shown that Gray's name *Diceros* antedates by twenty years *Opsiceros*, Gloger.

During the past half-century the development of the iron industry has been remarkable. In 1854 Mr. J. K. Blackwell showed that the world's production of pig iron did not exceed 6,000,000 tons, of which the United Kingdom produced 50 per cent., France and the United States each 12½ per cent., and Germany 6·6 per cent. In 1905 the world's production had attained the enormous total of 56,000,000 tons, of which the United States produced 42·7 per cent., Germany and Luxemburg 20 per cent., the United Kingdom 17·6 per cent., and France 5·5 per cent.

In Great Britain the principal iron-ore producing districts are Cleveland, in North Yorkshire, which in 1905 yielded 41 per cent. of the total output of the kingdom; Lincolnshire (14·8 per cent.), Northamptonshire (13·9 per cent.), and Leicestershire (4·7 per cent.), together yielding 33·4 per cent. of the total output; Cumberland (8·6 per cent.) and North Lancashire (2·7 per cent.), Staffordshire (6·1 per cent.), and Scotland (5·7 per cent.). The Cleveland iron ore occurs in a 10-foot bed in the Middle Lias, and contains about 30 per cent. of iron. It is worked by underground mining. In Lincolnshire, Northamptonshire, and Leicestershire the brown iron-ore beds form part of the Inferior Oolite, and contain about 33 per cent. of iron, the workings being mostly opencast. In Cumberland and North Lancashire the red hæmatite occurs in irregular masses in Carboniferous Limestone. It contains more than 50 per cent. of iron, and is worked by underground mining. The ironstone in Staffordshire and in Scotland is mostly obtained from mines that also produce coal.

Such, in brief, are the home deposits from which the British supply of 14,590,703 tons of iron ore, valued at £3,482,184, was obtained in 1905. Even that enormous output did not meet the consumption, and 7,344,786 tons were imported. Of that amount 78·5 per cent. was brought from Spain, 5·4 per cent. from Norway, 4·2 per cent. from Greece, 4·0 per cent. from Algeria, 2·6 per cent. from France, 2·6 per cent. from Sweden, 1·5 per cent. from Russia, and smaller quantities from Turkey, Germany, islands in the Pacific, Belgium, Newfoundland, India, Australia, Italy (Elba), Persia, Portugal, and other countries. In fact, the world is being ransacked for fresh iron-ore fields to supply ores for the British blast-furnaces. The port at which most of the ore was delivered was Middlesbrough (1,789,639 tons), then followed Glasgow with 1,042,179 tons, and then Cardiff with 875,462 tons.

While it is probable that the British iron-ore fields will be exhausted in a century or two, the outlook in other countries is similar. This is borne out by data relative to the available iron-ore supplies of the world which have been collected by Torneböhm for the Swedish Parliament, and, although largely conjectural, these figures are of great interest.

In the United States the iron-ore production in 1905 exceeded 42½ million tons, the highest output ever recorded, the ore containing more iron than the ores raised in Germany, in the United Kingdom, and in Spain combined. The bulk of the production was obtained in the Lake Superior region, where the five iron-ore belts or ranges (Marquette, Menominee, Gogebic, Vermilion, and Mesaba), beds of pre-Silurian age, have furnished since the beginning of regular mining

over 300,000,000 tons of iron ore. The average percentage of iron in the ore is 55, the 60 per cent. ores produced ten years ago having been exhausted by wasteful mining methods. The amount of ore still available in the United States is estimated by Torneböhm at 1,100,000,000 tons.

In Germany and Luxemburg two-thirds of the iron ore raised ($23\frac{1}{2}$ million tons in 1905) is derived from the so-called minette beds of Jurassic brown iron ore. The seams yield on an average 36 per cent. of iron and 1.7 per cent. of phosphoric acid. Owing to the high percentage of phosphorus the ore was of little value until 1879, when the basic method of making steel was brought into practical use by Thomas and Gilchrist. The amount of ore still available in Germany is estimated at 2,200,000,000 tons.

In Spain the chief deposits are near Bilbao, the ores, which are of great purity, occurring in beds of Cretaceous age. Up to the present time the Bilbao district has yielded about 115,000,000 tons of ore, and for many years pessimistic estimates have been made of the quantity of ore remaining. Twenty years ago it was thought that by the year 1900 there would be no ore left. Nevertheless, in that year Bilbao exported 5,000,000 tons of ore, and Don Julio de Lazurtegui, the most competent authority, estimated that there were still over 57,000,000 tons left. The richest red hæmatite ores are, it is true, now exhausted, and brown hæmatites and spathic ores have taken their place, with the result that more attention has to be paid to calcination and to the washing of ores to enable them to satisfy market requirements. Torneböhm's estimate of the quantity of ore still available in Spain is 500,000,000 tons.

In Sweden deposits of magnetite of great purity occurring in gneiss supply material for the charcoal blast-furnaces, and ores rich in phosphorus are mined for export at Grängesberg, in Central Sweden, and within the Arctic Circle at Gällivare, Kirunaåkra, and Luossavara, where there are ample supplies to meet the increased demand that is likely to arise. These deposits have been described in great detail by Dr. Stutzer in a paper submitted at the last meeting of the Iron and Steel Institute. The export of iron ore from Sweden in 1905 amounted to $3\frac{1}{2}$ million tons. In Northern Norway important discoveries of similar iron-ore deposits have of late been made. The amount of ore still available in Sweden is estimated at 1,200,000,000 tons.

In France the most important deposits are the beds of Oolitic iron ore in the department of the Meurthe-et-Moselle; and in Russia the greater portion of the iron ore produced is obtained from the Ural region, where, on the western side, the ores are chiefly limonite and spathic ores of a stratified character, and, on the east, masses of magnetite associated with igneous rocks. The amount of ore available in France is estimated at 1,500,000,000 tons and in Russia at the same amount. The available resources of other countries are estimated by Torneböhm at 1,200,000,000 tons. Including 1,000,000,000 tons for Great Britain, he estimates the known available resources of the world at 10,000,000,000 tons.

The outlook for the British industry is not altogether a depressing

one; for, whilst the rich ores of Bilbao and Elba are becoming scarce, there are still vast quantities of ore available in the north of Scandinavia, in the south of Spain, in Algeria, Canada, Cuba, Brazil, Venezuela, Chili, India, China (notably in the Shansi district), Australia, and South Africa. The high cost of carriage is, of course, an important factor; but the great economies which have and will be effected in transport will reduce this item. The future of the home demand is likely to be affected by the development of the basic open-hearth process of steel-making which enables phosphoric ores to be utilised. In the course of time such phosphoric ores will doubtless occupy a very prominent place in the manufacture of high-class steel. The development of magnetic concentration and of the briquetting of pulverulent ores for furnace use will render possible greater utilisation of poorer ores, while the development of the electric furnace will doubtless render it possible to utilise black sands and other titaniferous iron ores which, although met with in abundance, cannot at present be treated profitably in the blast-furnace. There need, therefore, be no immediate anxiety regarding the supply of the more impure iron ores, the application of which cannot fail rapidly to increase.

NOTICES OF MEMOIRS.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE: SEVENTY-SEVENTH ANNUAL GENERAL MEETING HELD AT LEICESTER, AUGUST 1ST, 1907.

I.—ADDRESS TO THE GEOLOGICAL SECTION. By Professor J. W. GREGORY, D.Sc., F.R.S., President of the Section.

(*Concluded from the September Number, p. 418.*)

IV. *Plutonists and Ore-formation.*—Belief in the earth's internal fires was most faithfully held amongst geologists by the Plutonists of the eighteenth century, and repudiated with equal thoroughness by the Neptunists, who refused to concede that volcanic action was due to deep-seated cosmic causes. Thus Jameson in 1807 stoutly maintained that volcanoes were superficial phenomena due to the combustion of beds of coal beneath fusible rocks, such as basalt, and that the explosions were due to the sudden expansion of sea-water into steam by contact with the burning coal. Volcanoes, according to this view, were correctly described as burning mountains, giving forth fire, flame, and smoke. The extreme Neptunist and Plutonist schools have long since been extinct, but the controversy is not quite closed. The battlefield is now practically restricted to economic geology, and the issue is the origin of some important ores.

Ore deposits present so many perplexing features that deep-seated igneous agencies were naturally invoked to explain them, and some of the most thorough-going champions of the igneous origin of ores make claims that remind us of the eighteenth-century Plutonists. The question is to some extent a matter of terms. Many of the ores which Vogt, for example, describes as of igneous origin he attributes,