

evidence in this condition, it is not surprising that the theory, though fully accepted by a few, and hesitatingly by others, has failed so far to be generally adopted.

For the last ten or twelve years I have constantly been on the look-out for a specimen which, while possessing a large median true vomer has also a pair of large distinct paired prevomers. Mr. D. M. S. Watson believes he has discovered in the British Museum a specimen of *Lycosuchus* showing a median vomer between the pterygoids, and certainly a pair of large prevomers in front. Unfortunately, though the specimen is satisfactory enough for those who believe the median vomer to be quite a different element from the reptilian paired "vomers," it is not convincing enough for the doubter.

In two species of the small Upper Permian Theropcephalian genus *Ictidognathus*, I find a peculiarly complicated but single median vomerine bone, but in a third species, closely allied, I find clear evidence that the apparently single bone is composed of the paired prevomers ankylosed. Further, the ankylosed prevomers have exactly similar relations to the palatines and pterygoids that the median bone in *Dicynodon* has, and at first it looked as though the theory had received a severe blow.

Fortunately a specimen of a large species of *Dicynodon* has just been discovered that clears up all the confusion. The median bone, which lies between the posterior pairs in *Dicynodon* is the ankylosed prevomers. Above it, and completely concealed by it, is a large, well-developed, typically mammalian median vomer extending from the basisphenoid behind to the premaxilla in front. Along its upper side the vomer is grooved for the large basal and ethmoidal cartilages. Posteriorly it is closely united to the basisphenoid. The bone completely confirms the view I expressed in 1898 that the mammalian vomer is the reptilian parasphenoid, and quite a different element from the prevomers.

R. BROOM.

American Museum of Natural History,
New York, August 10.

THE TWELFTH INTERNATIONAL GEOLOGICAL CONGRESS.

THE first meeting of the International Geological Congress in Canada, and the third in the western continent, held its session in Toronto from August 7 to August 14, under the presidency of Dr. F. D. Adams, of McGill University. Altogether 1152 members were enrolled, about half of whom attended the meeting; and forty-six countries were represented by their leading geologists. Probably never before had Canada entertained a gathering so distinctively international, and great interest was manifested in the work of the congress, not only in Toronto, but throughout the Dominion. The honorary president of the congress, H.R.H. the Duke of Connaught, who was unable to attend, was represented at the opening session by the Right Hon. Sir Charles Fitzpatrick, Chief Justice of the Supreme Court of Canada, and by him a warm welcome to the Dominion was extended to the visiting delegates in a graceful speech in French, the official language of the congress. Ontario was represented by the Hon. W. H. Hearst, Minister of Mines for that province, Toronto by Alderman Church, and the University of Toronto by President Falconer, to whom the congress was indebted for the use of

several of the university buildings during the meetings.

The chief work delegated to the twelfth congress had been the preparation of a monograph on the coal resources of the world, to serve as a companion work to the iron resources of the world, prepared for the eleventh congress at Stockholm. The general secretary of the congress, Director Brock, of the Canadian Geological Survey, presented the monograph, and summarised its main features. It consists of three quarto volumes, accompanied by a 68-page atlas, and contains reports from sixty-four different countries. The editing has been in the hands of a committee of the Geological Survey of Canada, consisting of Messrs. McInnes, Leach, and Dowling. Mr. Brock contributes the preface, Mr. Dowling an introduction summarising the main reports, while contributions by experts from the various countries of the world form the major part of the work. The total coal resources of the world are estimated at 7,397,533 million tons, of which 4,000,000 million tons are bituminous, 3,000,000 million tons brown coal, and the remainder anthracite. As the world's production in 1910 was 1,145 million tons, the exhaustion of our coal supplies is by no means an immediate problem. Approximate reserves of some of the chief countries are as follows:—Canada, 1,234,269 million tons; United States, 3,214,174 million tons; United Kingdom, 189,535 million tons; France, 17,585 million tons; Germany, 85,551 million tons; Russia, 233,997 million tons. In Switzerland only 4500 tons of coal remain. The preparation of the monograph involved a large amount of special investigation in several of the countries from which reports were submitted; and the three volumes, with the atlas of beautifully executed maps, will serve as a fitting companion volume to the iron resources of the world.

In order to facilitate business, the congress resolved itself into three sections, which met concurrently. Over eighty papers were presented, the majority of which had direct bearing on the topics which had been suggested for the consideration of the congress. On the subject of the differentiation of rock magmas the session was interesting, rather because of the variety of hypotheses than because of any distinct contribution to views already propounded elsewhere. Daly advocated stoping and gravitational movement, Harker fractional crystallisation, Lœwinson-Lessing differentiation in liquid state, Evans immiscible liquid phases, while Bergent emphasised recurrent basic and acid succession in its bearing on the problem. Iddings and Washington pointed out from different points of view the necessity of sufficient analyses within petrographical provinces. Hobbs referred to the relationship between certain petrographical provinces and clay states, and Cross discussed Hawaiian lavas from the point of view of the Atlantic-Pacific classification. Bäckström, in summing up the discussion, advocated the conservative attitude until experimental work was sufficiently advanced to justify broad conclusions.

The theme "The Influence of Depth on the

Character of Metalliferous Deposits" was of special interest to economic geologists and mining engineers. Kemp dealt generally with primary and secondary precipitation; Krusch with colloidal precipitation of primary and secondary ores; Emmons with experimental evidence bearing on the precipitation of gold, silver, and copper, and the effect of the primary ores; Fermor with the action of oxygen and carbonic acid at considerable depths; Fanning with ore occurrences in the Philippines. In the general discussion, in which Lindgren, Winchell, Lawson, Kitson, and others took part, the question of the formation of veins consequent on mineral crystallisation, and that of secondary gold deposition from placers, were taken up.

What were perhaps the most interesting discussions to the majority of the members of the congress were those on the sedimentation and the correlation of the Precambrian. The excursions provided to the vast Precambrian areas of Canada had attracted to the congress authorities from the Precambrian fields in all other countries; and the discussions were illuminating in that they focussed the experience of work in many fields on the intricate problems presented. The succession in Finland was given by Sederholm, who also illustrated by slides some clear instances of granitisation on a regional scale. Cole explained the intrusive relationships in north-west Ireland. The difficulties encountered by Scottish geologists in correlating the Precambrian of the Highlands were explained by Horne. An outline of the Precambrian of the British Isles was given by Strahan. Holland pointed out the broad similarities between the series in India and in North America. Coleman and Collins dealt more particularly with the area east of Lake Superior. A rather keen discussion took place when the classification submitted by Lawson as based on work in the Rainy Lake area was questioned by Leith and Lane. Altogether the session was illuminative of the difficulties in the way of any attempt to correlate the Precambrian in widely separated areas.¹

Other topics considered can only be mentioned in brief. On the physical and faunal characteristics of Palæozoic seas papers were presented by Chamberlin, Schuchert, Ulrich, Frech, and Høltedahl. To the topic of interglacial periods Lamplugh, Coleman, Upham, Alden, Tyrrell, Wolff, and Holst contributed; while at a special session on tectonics papers were given by Paulcke, Dahlblom, Mess, and Smith, McDonald, Howe and Hovey. Numerous miscellaneous papers were also submitted dealing with subjects of geological and mineralogical interest.

During the session of the congress two popular lectures were delivered, to which the Toronto public were invited. The first was by M. Emmanuel de Margerie on the geological map of the world. The lecturer gave some very practical

suggestions to the committee in charge of the preparation of the map. He advocated the continental as opposed to the world map, and the discrimination by colour between marine and lacustrine sediments, and between folded and unfolded areas. The continental areas were discussed seriatim, with practical hints as to map-construction. Of more interest to the general public was a lecture by Dr. W. F. Hume on desert phenomena in Egypt. The lecture, which was illustrated by slides, presented a clear picture of the geological conditions, and in particular of the effects of sand erosion on the exposed rocks. Much could be inferred from the slides as to the actual conditions under which work is carried on in desert countries.

Notwithstanding the interest evinced in papers and discussions, the value of the twelfth congress to the visiting delegates lay mainly in the excursions which they were enabled to undertake to many points of geological and mining interest throughout the Dominion. Elaborate preparations had been made by the Geological Survey of Canada to ensure the success of this feature of the meeting, and the total length of line covered by the guide books considerably exceeded 20,000 miles. From July 13 to September 23 excursions practically without a break were arranged for—frequently three, or even more, concurrently. The maritime provinces were visited, before the session, under the guidance of Dr. G. A. Young; Sudbury, Cobalt, and Porcupine before and after the session, the excursions being led by Dr. W. G. Miller; while two transcontinental excursions, the first of more particular interest to petrologists and stratigraphers, the second to economic geologists and mining engineers, had as leaders Dr. Adams and Mr. Brock respectively. An excursion of particular interest, of which many would have gladly availed themselves had time permitted, was that to the Yukon and Alaska boundary, led by Mr. McConnell. Besides these longer excursions numerous field-trips were made, both before and during the session in Toronto. To the localities in the vicinity of Toronto Dr. Coleman and Dr. Parks acted as guides.

For the excursions a series of guide-books was prepared by the Geological Survey of Canada, which contained besides the reading matter numerous coloured maps, topographical maps, and photographs. Apart from the immediate value to the members of the congress, the guide-books represent an important contribution to Canadian geology. They summarise a large amount of investigation accessible only in the reports of the survey, and contribute as well a considerable proportion of new material. They cover the main routes of travel, and will prove valuable books of reference, not only to geologists and engineers, but also to any travellers who may be interested in the resources and rock formations of the country. The interest which the excursions had aroused in Canadian geology was shown by the eagerness with which the literature supplied by the Geological Survey and mines branches was sought after. From this point of view the con-

¹ The discussion had at least one permanent result. A resolution proposed by Dr. Sederholm was passed by the Congress to the effect that geological surveys of countries which have contiguous areas of Precambrian rocks form international committees to include representatives of the geological surveys of all the countries concerned, for the purpose of correlating the Precambrian formations in the different countries.

gress has served as an excellent distributing agency for the literature on the geology and mineral resources of the Dominion.

While the delegates were in Ottawa occasion was taken to do honour to the memory of the first director of the Geological Survey of Canada. Affixed to a block of Laurentian rock, in which formation Sir William Logan did pioneer work, a tablet has been placed in the Victoria Memorial Museum. The tablet, which was unveiled in the presence of the visiting delegates, bears the following inscription:—"William Logan, K.T., LL.D., F.R.S., 1798-1875, the Father of Canadian Geology, Founder and First Director Geological Survey of Canada, 1842-1869. Erected by the International Geological Congress (Canada), 1913." Two of the Canadian universities took advantage of the opportunity afforded them to honour some of the visiting members of the congress. On August 1, McGill University conferred the degree of LL.D. on J. F. Kemp, U.S.A.; H. Bäckström, Sweden; A. Lacroix, France; A. Bergent, Germany; and A. Harker, England. On August 14, the last day of the congress, the University of Toronto paid a similar honour to P. M. Termier, France; T. C. Chamberlin, U.S.A.; R. Beck, Germany; J. J. Sederholm, Finland; T. Tschermyshev, Russia; A. Strahan, England; and W. G. Miller, Canada. A ceremony very different in character—though no less dignified—was performed when the delegates visited Montreal. At the old Indian reservation of Caughnawga the visitors were treated to a short exhibition of the Indian national game, to an Indian play depicting the courtship of former times, and finally four of the party were selected to become chiefs of the tribe. They were:—I. P. Tolmatchew, Russia; W. Paulcke, Germany; H. M. Cadell, Scotland; and F. D. Adams, Canada. After going through the dance of adoption they were given Indian names, and were received as full members of the tribe.

No account of the twelfth congress would be complete without reference to the kindnesses showered on the delegates during their visit to Toronto. The local committee and ladies' committee, aided by the executive committee of the congress, had made very extensive and thorough arrangements, and the people of Toronto responded in a most whole-hearted manner. Receptions, banquets, garden-parties, and afternoon teas were prominent features in the proceedings; automobiles were at the disposal of the members; and several of the clubs in town were thrown open while the congress was in session. If one may judge from the appreciative remarks to be heard on every side, the visiting delegates carried away with them very pleasant memories of Toronto and its people.

On the invitation of M. A. Renier, who represented the Government of Belgium, it was decided to hold the thirteenth congress in Belgium four years hence. The subject on which a special monograph shall be issued by the executive committee of the congress of 1917 was left to the discretion of the new committee.

R. C. W.

NO. 2288, VOL. 92]

THE OIL-FIELDS OF BURMA.¹

THE appearance of this memoir will be welcomed equally by those who are engaged in the study of petroleum from a purely scientific point of view, and by those who are merely concerned with its profitable exploitation in Burma and other parts of the Indian Empire; not only because the author possesses a special knowledge of the subject in both aspects, but also because he has brought together, and arranged in a concise and readable manner, a mass of information that has hitherto been scattered through the pages of a voluminous literature, not always readily accessible.

For close upon a century after Michael Symes and Hiram Cox, in the course of their journeys up the "Erai-Wuddey" to the court of Ava, had visited the earth-oil wells of "Yanangheoum," the great oil-belt of Burma remained almost unexplored by Europeans. The virtues of "Rangoon oil" as a lubricant, especially for small arms, became well known; and following on Dr. Christison's discovery, in 1836, that it contained a large proportion of solid paraffin, considerable quantities of the crude oil were imported into this country for the manufacture of candles. But no further developments took place until, within a year of the annexation of Upper Burma, in 1886, exploitation on modern lines began to supersede the antiquated methods of the Burmese, and a systematic investigation of the conditions under which the oil occurred was taken in hand.

As a result of these investigations, carried on not only by officers of the Geological Survey, but also by geologists employed by the several oil companies, it has become apparent that the petroleum is practically confined to certain horizons—whether one or more has not yet been definitely ascertained—in the upper portion of the enormous accumulation of clays and incoherent sandstones known as the Pegu system, corresponding fairly closely with the Miocene of Europe. These beds, according to Mr. Pascoe, were deposited in a great gulf some 400 miles in length, occupying the greater portion of the present Irrawaddy valley. Orogenic folding, proceeding, in part, simultaneously with the deposition of the beds, has thrown them into a series of elongated domes, beneath which the oil has accumulated. The second and third parts of the memoir are devoted to a discussion of the structure of each of the anticlines so far examined, and of its capabilities as a producer of oil.

The most productive of these anticlines as yet discovered is that of Yenangyaung, where Dr. Oldham first recognised, in 1855, the connection between anticlinal structure and the accumulation of petroleum. Here the oil is confined within an area of less than one-and-a-half square miles, and yet, since the year 1888, this little field has produced more than a thousand million gallons. Nothing like this has been discovered elsewhere in

¹ "The Oil-fields of Burma." By E. H. Pascoe. Pp. xxxix+269+54 plates. Memoirs of the Geological Survey of India. (Calcutta: Geological Survey; London: Kegan Paul, Trench, Trübner and Co., Ltd., 1912.) Price 6s. 8d.