Nos. 1 to 3, 3 to 5, &c., represent intervals between successive minimum epochs, and Nos. 2 to 4, 4 to 6, &c., intervals between successive maximum epochs. These are shown graphically in the annexed figure.

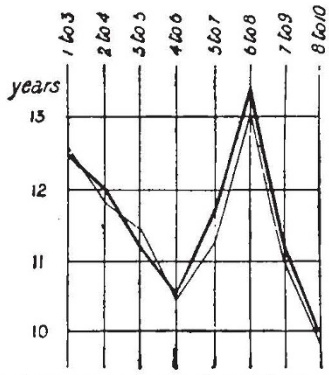

FIG. 2.—Length of sun-spot and magnetic periods compared. The thick line shows the variation in length of successive sun-spot periods, and the thin line that between successive magnetic periods. Odd numbers indicate periods from minimum to minimum, and even numbers periods from maximum to maximum.

Examining further the collected curves, it is seen that the several maximum points have at different epochs very different degrees of intensity. Arranged in order of intensity these are as follows :—

	Order of Epochs.					
Sun-spot curve ..	...	1870	1848	1860	1894	1884
Declination curve	...	1870	1848	1860	1894	1884
Horizontal force curve...		1870	1860	1848	1894	1884

The agreement is complete, excepting that in horizontal force the epochs 1848 and 1860 are transposed, although otherwise falling in with the order of the other curves.

The paper goes on to point out that—considering how the irregularities in the length of the sun-spot and magnetic periods, and also the order of epochs as regards elevation or depression of the maximum points of the curves, so entirely synchronise, and, further, the usually sharp rise from minimum to maximum and the more gradual fall again to minimum, a characteristic of all three curves—"there would appear to be no escape from the conclusion that such close correspondence, both in period and activity, indicates a more or less direct relation between the two phenomena, or otherwise the existence of some common cause producing both." Reference is also made to the question of the supposed lagging of the magnetic epoch, as referred to the sun-spot epoch, which the results presented do not appear much to confirm.

The paper concludes with an inquiry as to how far the practice of including in the Greenwich tabulation of magnetic elements all days (except those of extreme disturbance) may have affected the results presented, for which purpose diurnal ranges were deduced for the years 1889 to 1896 from five selected quiet days in each month —days free from magnetic disturbance—with result that the diurnal ranges so found show the same variation with sun-spots as do the diurnal ranges of the ordinary tabulation. WILLIAM ELLIS.

MONOGRAPHS OF THE UNITED STATES GEOLOGICAL SURVEY.

THE GLACIAL LAKE AGASSIZ.[1]

ONCE upon a time in North America the continental ice-sheet attained an area of about four million square miles, while its maximum thickness, in the central portion, was probably from one to two miles. It extended from the Atlantic to the Pacific, and from the northern United States to the Arctic Sea. During the closing stage of this glaciation there existed an immense lake, whose area is estimated to have been about 110,000 square miles ; a lake which extended 700 miles in length, and attained a width of 250 miles. Its maximum depth was 700 feet above the present level of Lake Winnipeg.

That the idea of the former existence of this great lake is no romance of modern days, no "glacial nightmare," is indicated by the fact that so long ago as 1823 the traces of it were recognised by Keating. Not, however, until 1879 was its present name applied to it in honour of Louis Agassiz.

Placed almost in the centre of North America, and occupying what is now part of the plain of the Red River and Lake Winnipeg, together with the Lake of the Woods and other smaller sheets of water, it lay for the most part in territory now Canadian, but a fifth part occurring within the United States. In the southern region, however, its ancient shore-lines have been more exactly explored. A very large part of its area in Canada, besides a considerable tract within its limits in northern Minnesota, is covered by forest, which makes it impracticable to trace there the beach-ridges and deltas, usually but a few feet high, the low escarpments of erosion, which range from 10 to 30 feet, and the other evidences of this lake, which in the prairie region could far more readily and definitely be followed.

It was evident that the scientific study of this interesting region should not be restricted by national geographical circumstances, and it is pleasing to note that arrangements were made between Director Powell (of the U.S. Geological Survey) and Director Selwyn (of the Canadian Survey), that the work of mapping the shores of Lake Agassiz should be continued by Mr. Upham through the prairie region of south-western Manitoba. Altogether this work comprises the results of field-observations carried on during six years.

Over the greater part of the old lacustrine area there is boulder clay from 100 to 300 feet thick. A series of terminal moraines marks the stages of retreat of the ice-sheet. For a while the lake gradually increased in size northwards, finding an outlet to the south in the "glacial" River Warren, whose channel was cut to a depth of 90 feet, and whose course is now occupied by Lakes Traverse and Big Stone and by the Minnesota River. As the ice-front retreated the lake was eventually drained by the natural slope of the land to the north-east, excepting in those areas which now form the lakes of Manitoba.

The steady uplifting of the area of Lake Agassiz, resulting from the unburdening of the land by the recession of the ice-sheet, gave to its beaches a northward ascent, and caused the several shores of its southern part to become double or multiple as they are traced northward.

The author gives a full and particular account of the beaches formed at different stages in the history of the lake, and discusses various earth-movements, some of which were independent of glaciation.

His work is by no means devoid of practical value. A chapter is devoted to artesian and common wells, and to the distribution and origin of certain saline waters ; and another chapter is given to the agricultural and material resources of the area.

THE FLORA OF THE AMBOY CLAYS.[1]

This work, which was very nearly finished in 1890, by the late Dr. Newberry, was placed in the hands of Mr. Hollick in 1892. His task has not been unattended with difficulty, but he has carefully indicated his necessary alterations and additions.

The Amboy Clays take their name from Perth Amboy

[1] By Warren Upham. ("Monographs of the U.S. Geological Survey," vol. xxv. Pp. xxiv + 658 ; 38 maps, and 35 other illustrations.)

[1] By John Strong Newberry. Edited by Arthur Hollick. ("Monographs of the U.S. Geological Survey," vol. xxvi. Pp. x + 137, with 58 plates.)

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and South Amboy in New Jersey, where they form the local base of the Cretaceous group. The clays constitute an important item in the mineral resources of the State. The mollusca found in the Amboy Clays prove them to be of estuarine origin. Compared with European strata it seems probable that they may be regarded as Upper Cretaceous.

156 species of plants are described, and these include 8 ferns, 17 conifers, and 5 cycads, in addition to the many dicotyledonous angiosperms, and a few doubtful forms. No palms are recorded.

GEOLOGY OF THE DENVER BASIN IN COLORADO.[1]

In this work the authors describe an area of about one thousand square miles, in the centre of which stands the city of Denver in Colorado. Topographically the area itself forms a kind of basin, but geologically it has been found that the rocks of the Cretaceous system, which occur over a large part of the country, constitute a well-defined syncline which is named the Denver Basin.

The mountain range on the west comprises a crystalline complex of pre-Cambrian rocks, flanked by highly inclined rocks of the age of the Jura-Trias, and these are succeeded with apparent though deceptive conformity by Cretaceous deposits which assume a fairly horizontal position beneath Denver, and are uptilted slightly on the east so as to form the before-mentioned basin.

It is held that considerable portions of the crystalline nucleus of the Rocky Mountains constituted an archipelago of large islands in the Palæozoic seas. Within the area now described no outcrops of Lower Palæozoic rocks are found, but there is good reason to believe that they underlie the later sediments, and are concealed along the Archæan borders by the overlapping Mesozoic and later deposits.

The movements that took place at various intervals subsequently to the early Palæozoic times are briefly indicated. They are complex, and have variously affected the character and distribution of the strata. The present relations of the Jura-Trias and Cretaceous to the crystalline nucleus are not due to a simple vertical upward movement of that core: the structure has rather been produced by tangential compression, the effect of which was to produce a structure somewhat analogous to a vertical upthrust, but as a result of a horizontally rather than of a vertically acting force.

The strata referred to the Trias consist, curiously enough, of brilliant red conglomerates, sandstones and shales, with thin limestones and gypsums in the upper part. They are known as the Wyoming formation, and are overlaid by a series of freshwater marls—the Morrison formation—grouped as Jurassic. This group is also known as the Atlantosaurus clays, from its abundant reptilian remains.

The geology of these and of the succeeding Cretaceous, Tertiary and Pleistocene formations, is exhaustively treated, and there is a full account of the igneous rocks. In the chapter on Economic Geology, coal, fire-clays and other clays, building stones, and artesian wells are dealt with. The coal occurs in the Laramie formation of the Cretaceous. A final chapter is devoted to Palæontology, including some account of the Cretaceous plants, by F. H. Knowlton; and of the Jurassic, Cretaceous, and Tertiary vertebrates, by Prof. O. C. Marsh.

The work is well illustrated with maps, sections and pictorial plates. The "spherical sundering in basalt" is well shown in Plate xiv. Among other plates we have restorations of the Jurassic *Brontosaurus*, *Stegosaurus*, *Camptosaurus*, *Laosaurus*, and *Ceratosaurus*; of Cretaceous Birds and Dinosaurs; of the Tertiary Mammals, *Brontops* and *Entelodon*; and of the Quaternary *Mastodon*.

[1] By S. F. Emmons, Whitman Cross, and G. H. Eldridge. ("Monographs of the U.S. Geological Survey," vol. xxvii. Pp. xvii + 556.)

THE MARQUETTE IRON-BEARING DISTRICT OF MICHIGAN.[1]

The Marquette district occupies an area extending from Marquette on Lake Superior westwards to Michigamme, a distance of rather less than forty miles, and with a breadth of from one to over six miles. From the western part of the main area two arms project for several miles, one known as the Republic trough and one as the Western trough. The district is the oldest important iron-producing area of the Lake Superior region.

The rocks comprise three series, separated by unconformities. These are the Basement Complex or Archæan, the Lower Marquette, and the Upper Marquette; the two latter constituting the Algonkian of the district, and perhaps equivalent to Huronian. The Marquette series is mainly sedimentary, although among the strata are included large masses of igneous rocks. The succession of the series is somewhat obscured by irregularities of deposition, and by inter-Marquette erosion. After the Upper Marquette series was deposited the district was folded, faulted and fractured in a complex fashion, with resultant profound metamorphism.

The greater iron-ore deposits occur in the Negaunee formation, which is from 1000 to 1500 feet thick, and occurs in the Lower Marquette series. Petrographically the formation comprises sideritic slate, ferruginous slate, ferruginous chert, jaspilite, and iron-ore. The ferruginous chert and jaspilite are frequently brecciated. The iron-ores resulted from the concentration of the iron-oxides through the agency of downward percolating waters. These concentration-bodies usually occur upon impervious basements in pitching troughs.

The various features connected with this iron-producing region are all worked out in great detail, and the memoir is beautifully illustrated with coloured plates of banded and brecciated rocks, and various pictorial views and sections. H. B. W.

[1] By C. R. Van Hise and W. S. Bayley, including a chapter on the Republic Trough, by H. Lloyd Smith. ("Monographs of the U.S. Geological Survey," vol. xxviii. Pp. xxvii + 608; 35 plates, and 27 other illustrations, together with large folio atlas of maps.)

ANTHROPOLOGY IN MADRAS.

WHEN recently on furlough in England, I was greatly interested in hunting up the facilities for the study of anthropology in London, and in the scheme for the establishment of a bureau of ethnology for the British Empire. And it has been suggested to me that it may interest those concerned in the development of anthropological research to know what is being done, in a mild way, in a remote possession of the Empire, the Madras Presidency, viz. the southern portion of the Indian peninsula. I add this geographical explanation, inasmuch as a friendly critic, in a recent review of my work, got hopelessly mixed between Madras and Bengal, reminding me of the story of the Viceroy-elect, who was overheard murmuring to himself, "Bombay in the west, Calcutta in the east, Madras in the south." Wide as is the area, and numerous as are the tribes, castes, and races included within my limited beat of 150,000 square miles, I have set myself the task, which must perforce occupy many years, of carrying out a detailed anthropological survey. This survey was, with the approval of the Madras Government, inaugurated in 1894. In that year, equipped with a set of anthropometric instruments obtained on loan from the Asiatic Society of Bengal, I commenced an investigation of the hill-tribes of the Nilgiris, the Todas, Kotas, and Badagas, bringing down on myself the unofficial criticism that "anthropological research at high altitudes is eminently indicated when the thermometer registers 100° in Madras." From this modest beginning have resulted: (1) investigation of the

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