suppose, as he suggests, that the earth consists of a shell of rock similar to what we have now at the surface, and of an interior mass which conducts heat much more rapidly than the outer crust.

Now, if this be the case, the effect of the greater interior conductivity will obviously be to keep the joining surface of the shell and nucleus at a higher temperature than the surface at the same depth in Lord Kelvin's imaginary earth. Near the surface of the earth, therefore, the rate at which the temperature increases with the depth would be greater now in Prof. Perry's than in Lord Kelvin's earth. But this rate decreases as the time since consolidation increases. Hence, a given downward rate of increase of temperature (say 1° F. in 50 feet) would be reached much earlier with Lord Kelvin's than with Prof. Perry's conditions. In other words, if Prof. Perry's supposition be correct, and on this point most geologists will probably agree with him, Lord Kelvin's estimate of the age of the earth errs by being far too small.

How much too small cannot be determined, but it is sufficient for geological purposes to know that the upper limit of 400 million years may have to be greatly increased, and that one of the orders to stop payment on the Bank of Time is for the present practically withdrawn.

C. DAVISON.

III.—RECONSTRUCTION OF THE ANTILLEAN CONTINENT. By J. W. SPENCER, Ph.D., F.G.S. Bulletin of the Geological Society of America, vol. vi. pp. 103 to 140, January, 1895. With a plate.

DR. SPENCER was led to undertake this investigation by his study of submerged valleys in higher latitudes, and he found that similar evidence existed in the Antillean region. Recent geological work in Florida and in some of the West Indian islands led him also to visit Cuba and to study its geological structure. One result of this visit has already been published in this MAGAZINE, and now we have another important contribution to West Indian geology.

The first part of the essay is a study of submarine geography: the author points out that the continental shelf of the east coast is continued in the broad plateau on which the Bahama Islands stand, and that outside this upper shelf there is a much lower one, termed the Blake Plateau by Prof. Agassiz, which lies at an average depth of 2700 feet below sea-level; from this there is a steep slope down to 12,000 feet (2000 fathoms).

The outer margin of this lower shelf is indented by embayments from the deep water beyond, and the submarine plateau is trenched by deep and narrow depressions which appear to be submerged valleys¹ formed by river erosion, and these valleys open into the embayments.

¹ Dr. Spencer's application of the term *fjord* to these valleys is not quite in accordance with European usage, for their coastal portions are filled with alluvium and are not open inlets.

Particulars are given of some of the channels which cross the Blake Plateau; some of them are traceable for 200 or 300 miles and reach a depth of 10,000 feet before they are lost in the sub-oceanic embayments. The deep troughs which furrow the Bahama Plateau present the same features, and a study of the United States hydrographic charts of the Gulf of Mexico exhibits a similar state of things—an upper continental shelf to about 600 feet, and then a slope, in some places gradual, in others steep, down to depths of 9000 to 10,000 feet. Both shelf and slopes are traversed by valleys, the floors of which are often several hundred feet below the plateaux on each side, and these valleys seem to be prolongations of those by which the modern continent is drained.

All these features are shown on the map which accompanies the paper, and below the Straits of Florida a broad submerged valley is seen *draining westward* into the Gulf of Mexico, not into the Atlantic. The Sea of Honduras and the Caribbean Sea are basins comparable to the Gulf of Mexico, but the floor of the former seems to have been deformed by late orogenic disturbances which have produced long depressions parallel to the mountain ranges of Cuba and Jamaica.

Dr. Spencer's conclusion from all the evidence is, that after making all allowance for possible foldings the northern side of the Gulf of Mexico has been sunk not less than 8000 feet, and that the south-east part of North America, together with the Greater Antilles, has been depressed for 10,000 or 12,000 feet; that before this depression the two Americas were united along the West Indian ridge, and that the deep basins of the Caribbean, the Honduras Sea, and the Gulf of Mexico were broad plains through which rivers ran *westward* into the Pacific Ocean. He believes that these conditions lasted till a comparatively recent date and that when the barrier of Central America was raised the Antillean basins sank.

He next endeavours to determine the probable dates of elevation and subsidence, a study which of course involves a correlation of the various formations that have been described by different authors in the several islands of the West Indies. This part of the essay is not quite so satisfactory, partly because too little is yet known of the geology of the West Indies, and partly because Dr. Spencer's own observations in Cuba are not yet published, so that we are here presented with some of his conclusions without all the data on which they are founded. His reading of Antillean history is as follows:—

In Eocene times there were islands round which shallow-water deposits were formed, but no continental connection. The Miocene period was one of deep subsidence, and deposits, largely of deep-water origin, were accumulated to a thickness in some places of more than 2000 feet, the Pacific and Atlantic being broadly united. During Pliocene times came a great upheaval, and the sea floor was raised to elevations of from 8,000 to 12,000 feet above the present sea-level. The Antillean region was united to both Americas, and the drainage was westward into the Pacific.

"In Cuba, Jamaica, and San Domingo, resting upon the upturned edges and denuded surfaces of Miocene and earlier formations, there is a deposit of soft earthy white or creamy limestone, made out of the mechanical residue of older limestones, with some small masses of corals and shells. All the observed species in Cuba are the same as the living ones. To this formation the writer has given the name of the Matanzas series. Owing to the modern facies of the organic remains Salterain has included it in the post-Pliocene, but states that it may be Pliocene." Dr. Spencer correlates this with certain deposits in Florida, Yucatan, and elsewhere, and infers a great subsidence and drowning of the Pliocene land at this time.

But the present position of the Matanzas limestone and the deep valleys which have been cut through it indicate a subsequent upheaval of the whole region equal to that of the Pliocene elevation. This was a second continental period, but it seems as if the Atlas of the Antilles soon became tired of holding up the land at such a height, and so let it down again for a time in the later Pleistocene to receive another set of marine deposits (Zapata and Columbian). Finally there were other movements of less extent, by which the present arrangement of sea and land has been produced. With respect to the formation of the Central American barrier, Dr. Spencer thinks that it was accomplished entirely within Pleistocene time. Islands doubtless existed there from early Tertiary times, but the deformation which converted them into a ridge and the Antillean Seas into basins did not *begin* till late Pliocene time, and the Pacific waters were not finally shut out till the very latest, or post-Zapata, upheaval of the land.

Dr. Spencer has evidently thrown all his well-known energy and acumen into this investigation, and may be congratulated on the work he has accomplished in connection with it. Many of his conclusions are doubtless based on substantial evidence and ascertained facts, but the wonderful series of earth-movements which he postulates depends on correct correlation of deposits in different parts of the area, and in this matter there is at present room for difference of opinion. Future researches may possibly necessitate some modifications in the later part of his history, and he will have to prove that the latest deformation did not include a north and south upheaval of the Windward Ridge as well as a warping up of Central America, for this seems to me very possible. However this may turn out it would not materially affect the broader generalizations now made, as to the former continental extension, and as to the late date of the Central American barrier.

Dr. Spencer is fully sensible of the startling nature of his conclusions, but so far as the magnitude of the vertical movements are concerned they will not astonish anyone who has accepted the results of recent work in Barbados.

A. J. JUKES-BROWNE.