future in ameliorating the lot and uplifting the coloured people, socially and morally.

Although no one is more fully aware than Sir Harry Johnston of the failings and moral weaknesses of the negro, he takes a very hopeful view—which many persons with a less intimate knowledge of the black man may think unreasonably sanguine—of his future, and especially of the hybrid's prospects, in the New World, provided only that he follows the example and teaching of his great and wise leader, Dr. Booker Washington, who "wants the negro to become the most industrious race in the United States" (p. 407), because only work will exhaust his energies and keep him out of mischief.

The book starts with a statement of Sir Harry Johnston's views on the negro's place in nature, which for the most part are well known to readers of his other books.

It is unfortunate, however, that on the very slender basis of the evidence afforded by the skeletons in the Grimaldi caves (see p. 26) he extends the habitat of

FIG. 2.—Type of Modern Negro; an electrical engineer trained at Tuskegee. From "The Negro in the New World."

the negro over half the continent of Europe and the whole of the British Isles!

It is not as a work of science, however, that this work, with its introductory *vulgarisation* of anthropology, is to be judged, but as a book of exceptional interest, and as the reasoned judgment of a man of wide experience on one of the most difficult sociological problems of the present time.

G. ELLIOT SMITH.

GEOLOGICAL CHRONOLOGY.[1]

THE vexed question of the age of the earth has passed through several distinct phases. Lyell and his contemporaries, accustomed to dwell on the extreme slowness of geological processes, considered themselves free to make unlimited "drafts on the bank of time"; but, since 1862, this position has been seriously challenged from the physical side. The chief argument brought against it was that, granting the globe to have cooled from a molten state, it would attain its assumed present thermal condition in a few scores of millions of years, only a fraction of which time would be available for the stratigraphical record. If the general body of geologists, influenced by the high authority of Lord Kelvin, have tried to adapt themselves to this narrow limitation, it has not been without reluctance, and some sturdy dissentients have refused any such coercion. To these, during the last few years, welcome support has come from unexpected quarters. The nebular hypothesis of the earth's origin, upon which the estimates of Kelvin and King were tacitly based, has been shaken by Moulton's calculations and other arguments put forward by Chamberlin. Moreover, the remarkable discoveries in the domain of radio-activity have compelled a reconsideration of the thermal state of the globe. Estimates of the earth's age deduced from its supposed rate of cooling clearly become futile if we have no good reason for believing that the earth is a cooling body. On the other hand, from the radio-active properties of various minerals Strutt has deduced geological ages liberal enough for the most extreme uniformitarian.

The debate concerning the age of the earth is thus no longer an issue between geologists and physicists, since the newer school of physics has declared on the side of the ampler chronology. Meanwhile, there has arisen within the body of geologists a formidable minority who contend, on geological grounds, for an estimate of geological time no more elastic than that imposed by the old argument from refrigeration. The discussion has followed two distinct lines, starting on one hand from the rate of accumulation of sediments, and on the other from the rate at which sodium is carried down by rivers into the sea. The interesting memoirs by Mr. Clarke and Dr. Becker, recently published by the Smithsonian Institution, deal mainly with the second mode of approaching the problem, but Becker offers also a revised estimate of the earth's age as calculated from the rate of cooling.

In 1899 Prof. Joly made estimates, first, of the total amount of sodium contained in the ocean, and, secondly, of the amount annually carried down by rivers, and, dividing the one by the other, obtained the quotient 97,600,000 years as the age of the ocean, supposed to be initially of fresh water. If the sea contained some salt from the beginning, this figure must be reduced accordingly. The choice of sodium is dictated by the consideration that this constituent is less removed from sea-water than any other. A relatively small correction is made for salt carried inland by the wind, and it is assumed that there is no other process of importance by which sodium is being continually removed from the oceanic waters. We may note in passing that certain observed facts, such as the evident chemical action of sea-water upon potash-granites, throw some doubt upon this assumption.

The data at Joly's command were very defective, and the main object of Clarke's memoir is to revise the calculation in the light of more recent information. In particular he has drawn upon the large mass of observations relative to the discharge, drainage-areas, and salinity of American rivers contained in the Water-Supply Papers of the United States Geological Survey. He has brought together the available information on the same points for other parts of the world, and indicated where additional observations are especially desirable. The "denudation factor," *i.e.* the number of metric tons annually removed in solution from each square mile of a drainage-basin, varies from 105 for the St. Lawrence to 16 for the Nile, and the

[1] "A Preliminary Study of Chemical Denudation." By F. W. Clarke. Pp. 19. Smithsonian Miscellaneous Collections, vol. lvi., No. 5. (Washington, 1910.)
"The Age of the Earth." By G. F. Becker. Pp. 28. *Ibid.*, vol. lvi., No. 6. (Washington, 1910.)

relative amounts of the different dissolved salts also vary widely, these variations being related to climatic and lithological differences. Clarke computes the amount of sodium annually carried down by rivers to be 175,040,000 metric tons, and the total amount of sodium in the sea $14,130 \times 10^{12}$ tons, which gives as a quotient 80,726,000 years. He apparently considers possible corrections to be unimportant, or to balance one another, for he believes this crude quotient to be "as probable as any other value that might be chosen." As representing the age of the ocean, he considers this figure, for reasons set forth in Becker's memoir, to be "certainly a maximum."

The fundamental weakness of all such calculations, whether based on sedimentation or on solvent erosion, lies in the assumption that the present annual rate represents with sufficient approximation the mean rate throughout geological time. To the present writer this consideration deprives the conclusions of even a remote relevance to the actual problem. We know, for instance, that, even during the accumulation of a single formation at a given spot, the rate of deposition may vary widely, and in a shallow-water formation may be at one time positive and at another negative. To accept the thickness of a formation as a measure of its time of accumulation, with whatever qualifications and allowances, must inevitably lead to error, and probably to a greatly exaggerated estimate of the rate of sedimentation. Like reasoning applies to all processes of chemical as well as mechanical erosion and deposition, which are necessarily controlled by varying conditions. Even if we could eliminate the effects of relatively rapid and local variations, we have still to consider probable secular changes and others of a broadly periodic kind.

A partial recognition of this side of the problem has led Dr. Becker to discard Joly's assumption of a constant rate of increment of sodium in the sea, and to adopt instead a secular change of rate. He lays stress on the fact that at present the felspathic rocks are, over great areas, covered with a blanket of rotten rock in place, which contains only a negligible amount of sodium; and he pictures a distant future, when all massive rocks may be decayed down to sea-level, and addition of sodium to the ocean will practically cease. He thus reaches the remarkable conclusion that the rate of increment of sodium in the sea is progressively *declining*, and he accordingly represents it by a descending exponential expression. The age of the ocean is calculated, according to different hypotheses, as from 74·4 millions of years. The argument is not one which is likely to convince geologists. A decayed crust covering large continental areas must certainly have existed at many past epochs, and, indeed, the present time seems to be peculiarly favoured, in that extensive tracts have been recently scoured by ice. Further, stratified deposits yield more sodium, per square mile, than crystalline rocks, and, throughout geological time as a whole, the sediments have certainly made an increasing proportion of the whole land-surface. Most geologists believe, moreover, that the total area of land-surface has, on the whole, been growing. It would be possible, therefore, to make out a strong case for a secular *acceleration* of the rate of addition of sodium to the sea. There is another consideration of even more weight. The larger vicissitudes of the earth's history indicate a certain rough periodicity, and there is good reason to believe that we are living in a time of geological activity above the average. The author himself remarks that the continents stand at present above their average level, which, of course, greatly promotes erosion; and he also recognises that the recently glaciated regions of the globe are contributing soduim to the ocean at a rate which must raise the average. Unfortunately, he is content to leave these important considerations without discussion, assuming that they are sufficiently offset by an increased marine erosion.

The second part of Dr. Becker's paper, in which he revises Kelvin's refrigeration argument, we must pass over very briefly. It is ingenious in treatment, but involves too many precarious hypotheses to carry much weight. The special feature is that no assumption is made relative to the present superficial temperature-gradient. This is eliminated by making use of Hayford's "level of isostatic compensation," which is computed to lie at a depth (71 miles) beyond any disturbance from radio-activity. Of several special cases considered, the author prefers one which gives sixty million years since the *consistentior status*, and leads to a present temperature-gradient of 1° F. in 77 feet. We may take this latter value as a crux of the whole argument. Dr. Becker remarks that it is low as compared with observation, but he fails to see that, for the gradient *due to refrigeration*, it must certainly be far too high. Here at least radio-activity cannot be left out of consideration, and, indeed, Strutt has maintained that the observed gradient can be wholly accounted for by heat generated in the outer crust of the earth. If we allow some fraction of the annual loss of heat to represent secular cooling, it still appears that the age of the earth must be enormously greater than any estimate included in Becker's suppositious cases.

A. H.

PROF. ANGELO MOSSO.

THE School of Physiology in Leipzig was the Mecca that attracted young men from all quarters of the globe to study physiology under that great master, teacher, and experimenter, Carl Ludwig. A steady stream of young, ardent, able, and talented students crossed the Alps from Italy to prosecute research and acquire a knowledge of the methods in use in the Leipzig School. Amongst the earliest of these Transalpine scholars was L. Luciani—happily still amongst us—and a little later came Angelo Mosso, one of the most illustrious of Italian physiologists, whose death at the age of sixty-four the whole physiological world to-day deplores. He was born on May 31, 1846, in Turin. After studying at his native university—with no advantages of wealth, fortune, or high social position—he, by the exercise of his own high intellectual and brilliant gifts, soon became distinguished amongst his compeers, and he was selected by Moleschott to be his assistant in the university. He also acted as assistant to Prof. M. Schiff in Florence.

Before coming to study under Ludwig in the early 'seventies of last century, Mosso had already published his well-known researches on the movements of the Œsophagus, and determined in the dog the weight that could be lifted in the process of swallowing an olive-shaped ball (1872). In fact, the study of movements of all kinds always proved to him a fascinating and fertile subject of study. At an early period of his career he made observations on the movements of the Iris, and he attributed part of the change in size of the pupil to the filling of the blood-vessels of the membrane itself. Ludwig set him the problem to study the peculiarities of the movements of the vascular wall as they can be inferred from the results of the perfusion of blood through an excised organ, such as the kidney, a method which already had yielded such brilliant results in other organs. His results were published in 1874.