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ARTICLE II.

THE GLACIAL EPOCH AND THE NOACHIAN
DELUGE.

BY HERBERT WILLIAM MAGOUN, PH.D.

CAMBRIDGE, MASS.

I.

THE nineteenth century was an era of remarkable progress; but it was also an era of doubt. Developments along many lines contributed to these ends. Near its beginning comparative methods of study were introduced, and scientific research was placed on a solid foundation. Inventions of divers sorts and kinds, all tending to revolutionize established methods of living, appeared one after another in civilized communities; and a spirit of unrest took possession of many people. Questions concerning things supposedly settled began to arise, and among them was that relating to the character and extent of the Biblical flood.

Up to the year 1830, no one, provided he believed in the flood at all, appears to have questioned its universality; and no one who accepted the Bible as the word of God, in any sense, seems to have doubted the authenticity of the account as it stands in Genesis. After the appearance of Lyell's "Principles of Geology," a change began to take place in the attitude of both scholars and laymen toward this particular story, and by degrees it was assumed that the experiences attributed to Noah, though having some sort of a foundation, were in reality much less important than had been supposed, since the Bible account was now regarded as probably nothing more

than an exaggerated description of some local disturbance. This assumption gradually gathered strength, until it came to be generally accepted by "progressive" thinkers.

If any such supposition is true, however, it must be admitted that the narrative displays some remarkable features. Exaggeration, indeed, seems hardly an appropriate term to employ in the premises. It is entirely too mild. To begin with, the ark is represented as landing upon the mountains of Ararat, which are located in Armenia, although Noah is supposed to have done his shipbuilding in the lower Euphrates valley,¹ the belief that he did so being strongly supported by the Babylonian version of the legend. Now, as has already been shown by Dr. Wright, this involves the conclusion that the ark floated up-stream.² Here is a genuine difficulty, but it is only one of several. The Bible story not only involves a journey inland and up-stream but, according to the generally accepted view, it also involves a journey of not far from five hundred miles to the northward and a journey that did not end until the vessel was stranded on the top of Mount Ararat, which is approximately three and a quarter miles above sea-level. This peak is the highest mountain of the region, now rising over

¹ According to Gen. ii. 8-14, a single river (this fact has been ignored) watered the Garden of Eden. It flowed out of Eden (the general region) and was there parted into four heads:—the Pishon (Euphrates), the Gihon (Tigris), the Hiddekel (Dialas, now Diala), and the Euphrates (Arsanias, Murad Su or Eastern Euphrates). The Hiddekel means the Tigris, so that in each instance the name of the smaller river has driven out that of the one to which it was tributary. Minor streams are ignored. Paradise was thus near ancient Babylonla, as has been suggested; but this simple and apparently self-evident solution of the river difficulty seems never to have been thought of. It fits into all the details, makes it clear why the Tigris and Euphrates are mentioned last, and implies that Noah did live somewhere in that region.

² See *Bibliotheca Sacra*, vol. lix. p. 283.

seventeen thousand feet above the sea, and it is practically certain that its altitude has been diminished rather than increased since that day.¹ The account distinctly says that the highest mountains were covered, and it has therefore been assumed erroneously that the ark must have landed on Ararat itself.

If a mere local flood furnished the data, it is not enough to conclude that the account is improbable on its face; for no such catastrophe — one able to meet the requirements of the case — could have taken place by any possibility, unless all ordinary flood conditions were surpassed. Indeed, to produce such a deluge, locally, it would be necessary for the entire region, mountains and all, to be suddenly depressed to a depth of about three miles and a half, and then to be elevated again to its present position. For such a change no adequate cause has appeared, and none is likely to appear. Local floods, moreover, are not wont to carry vessels of the size of a modern Atlantic liner — the Biblical ark was approximately 500 by 80 by 50 feet — five hundred miles inland and then deposit them high and dry on a mountain not far from three miles above the level which they occupied when the flood overtook them.

Why the destructive critics have not seized upon this most extraordinary and most improbable feature of the story — they seem to have accepted Ararat as the place — as a reason for discrediting it altogether, it would be hard to conjecture, were it not for the possibility that they have somehow failed to realize what is involved in the conditions. That they are capable of such an oversight is clearly shown by the brilliant superficiality which has characterized the greater part of their work. Not only is this brilliant superficiality a marked feature of such work among modern critics but it has also been a pecul-

¹ See below, second paper.

ilarity of their predecessors. The fact has not been generally recognized; but it now seems likely that it will be and that too before many years. There are, doubtless, Biblical scholars who will be loth to admit this, but the reality remains and will remain. The truth is that men are seldom originators. They are mostly imitators, with here and there an obstructionist or a doubting Thomas.

Few individuals can do their own tailoring. Most persons of the male sex, in this part of the world at least, buy their clothes "ready made." Those who are more particular have them made to order. A few, mostly professionals, do their own work and make garments for themselves. This is only what ought to be expected. The peculiarity is that a similar statement holds good of thinking. Few men do any real thinking for themselves. The great mass buy their thoughts from day to day prepared in advance to suit them. Some few are particular and hire their thinking done by certain professionals whom they have come to rely upon for such purposes. It is easier to do this than it would be to think the thing through for themselves. Men who make it their business set the style for our outer garments, and, in a similar way, professional thinkers determine our mental fashions by selling us their wares or else by foisting their productions upon us. We are not over particular, in this latter connection, concerning either the fit or the goods, provided the combination bears the trademark, "Made in Germany."

Now, there is an old formula, which has happily become threadbare, although it was once in common use among philologists. It is this: "Every school-boy knows." Classical scholars have come to recognize such expressions as a "bluff" pure and simple, and a like condition is fast obtaining in another field, where a similar history is being enacted; for the

theologians are passing through a corresponding experience. As to the expression, "the trend of scholarly opinion," it is perhaps enough to say that its users all recognize more or less distinctly that they are treading on shifting sand. But there is another formula and a much more seductive one, namely, "the established results of modern scholarship," of which it may be said that a searching analysis frequently fails to find any such results, and it often reveals a woeful lack of thoroughness in their attempted production. The rank and file cannot be expected to know this, although they undoubtedly do feel it, in a more or less nebulous way; but educated men ought to know it, and they should at least look with care at the opposite side of every question before fully accepting any conclusion that either openly defies or flatly contradicts some long-established belief, especially where such belief arose from supposedly reliable data. The belief may be wrong in minor details, and it often is; but this is likely to be the result of a misunderstanding and therefore merely an incidental outcome of a false interpretation rather than the product of an error in the original documents. It is accordingly fallacious to assail the authenticity of the records and then condemn those who still have confidence in them, as "not up to date" or "behind the times." Retrogression is not progress and never will be; but much of what is now "up to date" is really retrogressive and nothing more. Sooner or later the fact must be faced. Happily, the discredited "conservatives" are fast recovering **their breath and their power of speech**; and it cannot be long before they also will have to be reckoned with.

But — to return to the task in hand — peculiar and apparently unaccountable as this particular detail of the supposed legend seems to be, the very improbability of such a journey is in this instance an evidence of the reliability of the account.

Men are rightly held to be incapable of inventing such a tale unless they embellish it with fantastic and often ridiculous circumstances. And yet no features of that character are to be found in the Bible story. Not only is this true, but the very *crux* of the narrative, the improbable inland journey of half a thousand miles, fits and fits admirably into certain requirements of modern geology. More than a score of difficult geological problems may, in fact can, be solved in a simple and rational manner, provided the Biblical version is a true account of events that actually occurred. Rash as this assertion must appear, it can be justified; and it is the purpose of this series of papers to show in what respect such a statement can be true. A few points need to be noted first, to clear the way for what is to follow.

It is not to be supposed that the voyage inland and upstream is a peculiarity of the Genesis record. On the contrary, it is a common feature of the flood legends of various peoples. The Greek Noah, Deucalion, with his wife Pyrrha, is reported to have been carried away by the engulfing waters and to have landed on Mount Parnassus, or on Mount Othrys in Thessaly. The general direction taken must have been north, and the distance traveled must have been considerable, provided any such journey ever took place. He is said to have constructed the vessel at the warning of his father, Prometheus. According to the *Çatapatha Brâhmana*, the Hindu Noah, Manu, fastened the cable of his vessel to the horn of a great fish, a Jhasa, and was thus towed to safety on the slopes of the Himalayas. Here again the same direction is indicated, and the distance traveled is not small. It must have been sufficient to land him beyond the summit; for it is distinctly said that he passed over the mountains of the north and gradually descended as the waters receded. The Mexican Noah, Tezpi, with his wife Xochiquet-

zatl and their children, landed on Mount Colhuacan. The Babylonian Noah, Xisuthrus, with his family and his most intimate friends, as he is portrayed in the Nineveh flood tablet, was driven by the tempest from Sippara, the City of the Sun, which was situated a short distance north by west from Babylon; and his involuntary voyage was continued for a week, or until he landed on Mount Nizir somewhere in Armenia. His journey is thus made to correspond closely with that of Noah himself; for the mountains of Ararat are in Armenia. According to Berosus, pilgrims went, even in his day, to the Gordyan Mountains in Armenia, in search of wreckage or other remains of the ark to use as amulets against witchcraft.

These and other incidents of the Bible account are preserved in various forms. The Peruvian Noah is made to travel many hundreds of miles to a country he knows not of. Wind, water-spout, and rain assail the Babylonian ark. But it was only for six days and nights: on the seventh day the rain is reported to have ceased. Xisuthrus sends out a dove, a swallow, and a raven, while the Mexican Tezpi sends forth a vulture and a humming-bird. A coin, or medal, said to have been struck at Apamea in Phrygia, near the end of the second century A.D., bears on its face the likeness of a floating ark, which contains a man and a woman, the ark being inscribed with the word NOE in Greek letters, while above it a bird carrying a branch is represented as flying toward them. These things are interesting; but there are others of much greater importance. According to Genesis vii. 11, "the same day were all the fountains of the great deep broken up"; and other accounts contain similar statements. The Babylonian says that waters belched forth from caverns and overwhelmed the earth; but, as Ovid tells the story,¹ Neptune helped Jupiter to produce the flood

¹ Met. i. 274 ff.

and, striking the earth with his trident, made it shake and laid open the sources of its waters. Rivers then burst forth and rushed over the plains, until all became a shoreless ocean. In the dissertation "On the Syrian Goddess" attributed to Lucian (sect. 12), what is said to be an Aramæan tradition relates how vast masses of water suddenly burst forth from the earth with a great rain. Rivers overflowed their banks and the sea passed all bounds, until everything was covered with water. The account then goes on (sect. 13) to tell of a huge chasm which swallowed up the flood. A Druid legend holds that the waters of a lake, *Llyn Llion*, burst forth and covered the face of the whole earth. Preceding this catastrophe, it teaches that a pestilential wind arose, and this was followed by a tempest of fire which split the earth asunder to the great deep and allowed *Llyn Llion* to burst its bounds. "The waves of the sea lifted themselves on high round the borders of Britain." The rain also came down in torrents. The "Patriarch" and a "select company" escaped in a vessel which had a strong door; but another Celtic legend maintains that only Dwyvach and Dwyan escaped and that too in an open boat.

A new feature is here introduced into the account; namely, an earthquake of stupendous proportions. But the Chinese story duplicates it in the book called "Li-Ki," according to which "the pillars of heaven were broken," the earth shook to its foundations, the sun and stars changed their motions, the earth fell to pieces, and the waters within it burst forth with violence until they overflowed. Even in Greenland a similar legend has been found; for the natives teach that "the earth was once tilted over," and that all men who did not become fire spirits were drowned, as a result, save one. To substantiate the story, they report that various remains of fishes have been found far inland and that the bones of whales have been

discovered on high mountains. They seem to believe that these facts prove the legend to be true. Many more details might be given; but it is hardly necessary for the purpose in hand, and this side of the question has already been ably treated by Mr. William Restelle.¹

It may be fair to ask where all these notions came from. Are they merely variations of a single original, and, if so, what mean their divergences? Are they nothing but the wild dreams of excited or disordered imaginations? Were the whale skeletons placed upon the mountains by the natives themselves, and, if not, are they without significance? Or did the Greenlanders invent the story? Would they be likely to do so, or can it be corroborated by any similar facts? Apparently it can. Oyster shells and the shields of crabs are reported on good authority to be found in the sands of East Tartary, far from the sea-coast; and the Mongols are said to assert that the whole region was flooded at one time and that from time immemorial it has been told how in remote antiquity a deluge covered the district and left land in its place when it finally retired. Is this pure fiction, or without bearing on the case? Where so much smoke is there must be some fire. What is it?

The problems concerning bones and shells are properly geological ones, and they may therefore be grouped with the others already referred to, which are more or less familiar but need to be briefly enumerated at this point. Where did the loess originate? It is scattered far and wide and is found in some places to the depth of hundreds of feet. Is it volcanic mud? And does this solution, if it is a correct one, fully explain how such a peculiar loam came to be distributed over Belgium and Germany, England and France, China and Russia, Canada and the United States, to say nothing of the South-

¹ See *Bibliotheca Sacra*, vol. lxiv. pp. 148 ff.

ern Hemisphere? It strongly resembles a certain glacial product. Is this a mere accident? It found its way to the top of the islands of Guernsey and Jersey, although they are many feet above sea-level and it is difficult to see how they could have obtained such a coating identical in character, as it is, with that found on the mainland. How did it do so? And then, too, there is the rubble drift, which is another characteristic of these islands. Where did this come from? Its sharp and broken pebbles, evidently from local sources, indicate some sudden and violent disturbance like that produced by rushing water; but no regular action of such a sort can have been possible, since the pebbles themselves are not water-worn or otherwise abraded, and they rest at a point some distance above the level of the sea. And how about the raised beaches and dunes of blown sand which underlie them? How did it happen that these were not disturbed to any great extent?¹

Next come the peculiar deposits known as Breccia. These are composed of fragments from adjacent rocks and are intermingled with broken bones. It is a strange combination and it fills to the brim many remarkable fissures in the hills and limestone cliffs of Southern Europe. What made these fissures and their unusual deposits? The bones are those of carnivora and herbivora mixed together in endless confusion; but there is not a particle of evidence that any of the living animals were ever the prey of the others. At Santenay in Central France, two such clefts have been found, and fissures of a like character exist on the rock of Gibraltar. Near Palermo, in Sicily, similar deposits have been discovered, which contained a vast quantity of dismembered Hippopotamus skeletons strangely commingled with occasional bones of the ox, the deer, and the elephant. How was it done? In the limestone regions of

¹ See *Bibliotheca Sacra*, vol. lli. pp. 724 ff.

Southern England, such fissures abound, and the bones are those of the ox, horse, deer, wolf, hyena, tiger, hare, water-rat, weasel, boar, etc. But that is not all; for Malta exhibits deposits of the same general character, and they are also abundant in certain other islands which lie along the Croatian coast near the northern end of the Adriatic Sea. How are they to be explained? Similar conditions exist at other points on the Adriatic and indeed all about the Mediterranean, and it is also said that many parts of Southern Europe and especially the railway cuts in Swabia have revealed extensive remains of the mammoth, which could never have been so well preserved unless the animals were suddenly buried in large numbers. How was it done? ¹

Vast areas of Northern and Central Europe are covered by beds of gravel, sand, and clay; and they have the same characteristics as similar beds which are known to have originated from the action of water. They contain stones and even boulders, occasional human remains and implements, and, in some instances, great quantities of broken and disjointed skeletons identical in character and in lack of coördination with those of the neighboring breccia. How were these beds produced? And why are they filled with such a conglomeration of bones? Did the latter bury themselves? Human implements and, here and there, human remains are found in the loess; but there is no evidence of design in their location. What does that mean? Boulders likewise occur in the loess. How did they get there? Bones there are in the rubble drift, but no remains of marine animals. What does this signify? Piles of clean and unbroken shells of different kinds and different habitat are said to be found in countless numbers, in a heterogeneous mass, at

¹ See *Bibliotheca Sacra*, vols. III, pp. 729 ff.; II, pp. 699 ff.; LXIV, pp. 537 ff.; and *Urquhart's New Biblical Guide*, vol. I, pp. 361 ff.

Uddevalla in Sweden, on the Skagerak; and they are reported to show every appearance of having been deposited by some sudden inundation, since life in such a position was an impossibility. Is their appearance deceptive? And, if it is, what was the true cause of such a curious phenomenon? The other deposits already mentioned are repeatedly found far above the level of the ocean, — in some instances their elevation is fully twenty-five hundred feet, — and they extend over vast regions in an unbroken expanse. How is this to be accounted for?

In some places, near high hills, bird remains, along with those of animals, have been discovered, while in others, in Siberia, mammoths with their buried and frozen bodies all pointing in the same general northerly direction, as if they had been overwhelmed and engulfed in the midst of a fearful headlong flight to higher ground, have been unearthed. What do such things seem to imply? And how did it happen, in those same regions, that rocks, twigs, and the leaves of trees were covered with deposits of sand, loam, and magnetic sand, which, to the depth of even one hundred feet, show distinct evidences of having been deposited at one and the selfsame time? Great masses of gravel are spread over a large part of Northern Africa, and a similar condition prevails in Patagonia. What can be postulated of their origin? And what is their meaning?

Now, the animal remains that are found in these many deposits, including the breccia, although they differ in different countries, are always of the same species and genera, and they all belong to the same geologic age. They are to be classed in every instance as Palæolithic, and they disappeared at the end of that period. Huge and powerful and numerous beyond computation, they nevertheless suddenly ceased to be. They seem to have been thoroughly and completely destroyed. How was it done? The same peculiar condition is found to

exist in Europe, in Northern Asia, and in North and South America. Climatic changes did not do it, nor yet did man; for he disappeared in like manner. No remains of Palæolithic men are found with those of the Neolithic race, and, what is more, a great gap separates these two forms of human life from one another. What caused that gap? There must have been a reason for it. Had Noah's flood anything to do with it?

That the phenomena already mentioned point clearly to some frightful catastrophe, which involved the action of a single great deluge or of different local floods extending over districts of a greater or less extent, has long been held; and to this opinion weight has been given by such men as Cuvier, Buckland, Hugh Miller, Sedgwick, Dana, Murchison, J. W. Dawson, Howorth, Erman, Geikie, the Duke of Argyll, Claypole, Prestwich, and Sir Henry De la Beche. Were these men mistaken? A sudden submergence will seemingly account for practically all of the results. Is it an impossibility? The facts appear to support it and to be final, as Rev. D. G. Whitley has clearly shown.¹

But there are yet other riddles involved. How, for instance, did arctic seals find their way to Lake Baikal and to the Caspian Sea? They are there, and their characteristics have not been materially altered since they took up their abode in such unexpected quarters. Though land-locked and living in water that is fresh or comparatively fresh, they still persist in maintaining their ancient traits even in the Caspian. How is this to be explained? And why has the Caspian only about a third as much salt in solution as the ocean? The Aral Sea is even more remarkable; for it is still sufficiently fresh for animals to drink. Lake Baikal has an outlet; but the other two bodies of water are land-locked. Why are they not more salt?

¹ See *Bibliotheca Sacra*, vol. lxliv. pp. 519 ff.

Other such seas are decided saline. What has made the difference?

At Kief, on the Dnieper, Professor Armachevsky found human implements and burnt stones, together with bones of extinct animals, at a distance of fifty-three feet beneath the undisturbed loess. How came they there? A glacial deposit was beneath them. What is the significance of that fact? Similar discoveries have been made elsewhere. What do they mean? The Chinese have a tradition that the vast tract now known as Gobi, which simply means the "Desert," was once an immense expanse of water called Han-Hai; and the tradition has every appearance of tallying with the facts. Lob-Nor, in Chinese Turkestan, which is hardly more than a marsh at the present time, is a relic of that inland sea. What does the former existence of such a body of water signify? That these facts are all to be connected with those already given, Dr. Wright has made evident, and he has done so convincingly.¹

But the end is not yet. The channel of the Hudson River is said to extend out into the ocean for approximately a hundred miles beyond Sandy Hook and to occupy a sort of cañon averaging a thousand feet in depth. Other rivers, such as the Delaware and the St. Lawrence, show similar depressions beyond their mouths, and like conditions obtain on the Pacific coast of North America and on the Atlantic coast of Europe. What is the lesson which they teach? Has it any connection with the fact that borings for oil in various parts of the United States have brought to light eroded channels in the rocks, where now a mass of glacial *débris* fills the entire cutting? And if these old channels were thus filled up during some former age, why did such a basin as that occupied by Lake Baikal fail to suffer the same peculiar fate? In a

¹ See *Bibliotheca Sacra*, vol. 11x. pp. 707 ff.

northern latitude characterized by intense cold, Lake Baikal has a lofty mountain environment and but a single outlet. Might it not be expected that its bed would show some traces of a similar glacial deposit? And yet this lake does not appear to have been perceptibly affected. It still has an average depth of half a mile, and it is nearly a mile in depth where the silt from the inflowing waters should be the deepest. How did it chance to escape? And why has the enormous mass of sediment that is known to be constantly emptying into its basin made no more of an impression than it has? The Dead Sea, in like manner, is receiving from day to day all the mud that the Jordan brings down from the regions above it; yet its depth has been but little affected. The results produced by sedimentation are conspicuous enough elsewhere, as in the deltas of the Nile and the Mississippi; but they can hardly be detected here. Why not? Between this sea and Lake Baikal there lies a region that was once well watered, although it is now sufficiently barren. Traces of ancient lakes are to be found in many places, and most of the locations contain salt beds at their bottom. The country is one vast basin with no outlet to the sea and no connection with it. Where did these lakes come from, and where did they obtain their salt? These questions are all pertinent to the general problem.¹

There remains a group of phenomena which form a class by themselves. On Kelley's Island, in Lake Erie, grooves have been found in the rocks, which resemble nothing so much as the work of some giant moulding plane. In divers other places similar grooves are known to exist, although they are not so remarkable as these; and, in many instances, scratches too rough or too insignificant to be classed as grooves have been discovered on the surface of the ledges which underlie the soil.

¹ See *Bibliotheca Sacra*, vol. lix. pp. 537 ff.

What caused these markings? In some places, large masses of till, or unstratified boulder clay, now lie above great quantities of stratified stones; and boulders are occasionally found in the clay. What does this mean? Boulders occur at a distance of even eight hundred miles from their place of origin, as is made evident by their composition; and some of them are located at an elevation as great as three thousand feet above their former resting places. They are often of huge size. How did they get there? And what of the Drumlins, or hills of till? Lenticular in shape, they form a conspicuous part of the landscape and often add to its beauty. Such are common about Boston. What formed them? And what formed the Kames, or hills of sand and gravel that resemble a rolling prairie? Something must have done it. Finally, what of the Moraines? These strange accumulations of rocks, intermingled in vast quantities and in a curiously irregular manner with earthy *débris*, have been traced across the United States from Northern Pennsylvania to Southern Illinois and thence to the northwest into Canada. In the western mountains they trend to the south again; but they are all confined to a limited area and show a certain regularity of location in the two or more nearly parallel lines formed by them. Nothing else like them is found in the neighborhood. In Europe a similar line runs from the southern limits of Great Britain eastward through Germany and Russia, then northeastward and ultimately northwestward through Eastern Russia to the sea. Drumlins and kames are also met with. In the plateaus of Asia similar conditions are known to exist. How are these facts to be interpreted?

With a single exception, this concludes the list. It is a formidable array of scientific enigmas, roughly outlined with little or no regard for minute details. They are certainly puzzling; and yet it is not impossible to find a satisfactory solution for

every question that has been mentioned. Data from existing conditions furnish the key to a large part of the problems, and it is not too much to say that the scientific imagination can be trusted to postulate the rest, provided there is a strict adherence to known facts and nothing is assumed that runs counter to the laws of nature or to human experience as far as it goes. To begin with, the phenomena attending modern accumulations of ice show conclusively that the peculiar conditions dealt with in the last paragraph are precisely like the ordinary products of glaciation at the present time, although they are of such a character that they must have been the outcome of glaciation on a gigantic scale. In size and extent they differ from the results observed in connection with modern glaciers but not otherwise. These last riddles may accordingly be regarded as having been successfully solved. They have been carefully dealt with by Dr. Wright in his "Man and the Glacial Period," and in a still more masterly fashion in his "Ice Age in North America." With regard to these, then, there need be no further concern. The phenomena involved are due to ice or to its melting, but to ice in enormous masses and of vast extent.

At this point a new difficulty arises concerning the origin of such immense accumulations of ice. The cause is not certainly known, and conjecture must be resorted to, as it has to be in all matters not capable of a mathematical demonstration or of positive proof. Conjecture holds an important place even in the most sedate of sciences, as is attested by the Nebular Hypothesis. It is the very foundation of Evolution, some of whose teachings seem destined to survive while others slowly perish. Recent tests, made with the blood, appear to prove not only that all men are but variations of a single species, but also that no Anthropoid ape could possibly have been the ancestor of man, a conclusion already reached on other grounds by various

investigators. The wave theory of light required the postulation of ether, a substance which no one has yet been able to isolate, and a return to the corpuscular theory now seems imminent. A working hypothesis is usually all that can be expected in such cases because of a lack of sufficient data. Such an hypothesis will be offered in the next instalment. It will seek to account for the ice accumulations and to show, in a general way, whither the diverse and widely scattered threads of this whole great problem appear to lead. In the present section, it only remains to refer to the exception noted above, which has to do with certain conditions found in the ocean bed or floor. No one seems to have thought of connecting them in any way with the phenomena already mentioned, and it accordingly appears desirable to treat this particular phase of the subject by itself. Exploration has now made the conformation of the ocean bed, in its main features at least, a matter of practical certainty, and the peculiarities of its topography are such that they seem to bear directly on the subject in hand. It is too early to say just how much importance may be attached to the points at issue; but they appear to be connected in a vital way with the ultimate effects of glaciation. How this can be true may not be altogether clear at the start; but in the following paper it will become more and more evident as the argument progresses. What, then, are these seemingly remote elements in the problem?

As is well known, the ocean floor is quite irregular. Much of this irregularity is doubtless due to the effects of shrinkage; but certain considerations lead to the conclusion that there was something more than shrinkage involved in the conditions found to exist in various places. A great plateau or ridge, varying in shape and dimensions, is encountered in almost every part of the mid-Atlantic. On either side an extensive

depression appears, showing a depth of from sixteen to twenty thousand feet, with an occasional basin two or three thousand feet deeper yet. Above the plateau the depth averages twelve or thirteen thousand feet; but there are places only six thousand five hundred feet in depth. Shrinkage was doubtless the original cause of this peculiar arrangement; but the plateau shows evidence of a later modification due to other forces. What caused that modification?

With the exception of the Bermudas, the Atlantic is practically free from coral islands. These number about three hundred in all, and they occupy a shoal or platform approximately twenty-three by thirteen miles in extent. Outside their immediate neighborhood, the water reaches a depth of about fifteen thousand feet. To account for the facts, it has been supposed that coral started to grow on the top of a submarine mountain, which then settled gradually until a great depth was reached. Subsequent changes turned the coral into limestone; but that was not all. Coral does not grow above tide water; and yet these islands reach a maximum elevation of one hundred and eighty feet. How did they obtain it? Admittedly, by an elevation probably connected with a much larger elevation of a comparatively recent date. This will now be considered.

The Madeiras, Canaries, Cape Verde Islands, and St. Helena, lie in the East Atlantic. The Greater and Less Antilles are in the West Atlantic. In the Central Atlantic are the Azores, Ascension Island, and Tristan da Cunha, a group of three small islands, one of which is more than a mile in height. They are volcanic in origin, as are all the others named; and it does not appear that any of the islands in the list antedated, in their present formation, the later Tertiary or Upper Miocene period. Since that time, however, as shown by their fossil de-

posits, many of them have suffered an elevation, said to amount, in some instances, to fifteen hundred or even two thousand feet. What caused it?

Certain details may not be amiss. Ascension Island is a solitary peak on a submarine ridge between the North and South Atlantic basins. It is covered with the usual products of volcanic action and abounds in the steep and rugged ravines which are wont to be left by such disturbances. On the north, the Azores rise from the great mid-Atlantic plateau, which seems to extend continuously from that point northward to the latitude of Newfoundland and southwestward to the latitude of Florida. They contain many hot springs and boiling fountains. Sulphur deposits surround the latter, and vapors issue from many crevices. Extinct volcanoes, deep ravines, earthquakes, subterranean eruptions, and "Muddy Crater," with its boiling caldron, all testify to the volcanic origin of the group. On the south, Tristan da Cunha rises from a low submarine elevation, which runs down the Central South Atlantic. These islands are also plainly volcanic, the largest being a great cone or crater flanked by precipitous cliffs. One of them shows evidence of a later elevation. The Madeiras, off the coast of Morocco, are the summits of lofty mountain peaks, whose original rocks were covered by the ejectamenta of volcanoes during the Miocene or later periods. There is abundant evidence of a later upheaval in mass; for marine shells of the Miocene period are found in different places at least twelve hundred feet above the sea. Leaf beds occur beneath twelve hundred feet of lava, and some of the leaves have been identified as those of living species. The ancient stones beneath the volcanic deposits show great alterations and dislocations. Craters are rare, and no signs of life appear in them, although lava once flowed and solidified about conical hills which are

plainly of a late formation. On some of these hills cinders and slag, seemingly of only yesterday, are found. Deep ravines, as well as the great confusion now existing in the stratified rocks, testify to the violence of former earthquakes, and the inference is clear that a great cataclasm overtook the group at no very remote date.

Near by are the Canaries, which are likewise mountain summits of a similar character. Within one hundred and twenty years lava streams have issued from the mountain sides, and red bands of laterite between some of the deposits of lava indicate long periods between eruptions. Certain shells in raised beaches give evidence of upheavals during the Pleistocene period, which includes the Glacial Epoch. Further down the African coast are the Cape Verde Islands, also plainly volcanic. Marine shells imbedded in tufa bear witness to an upheaval of some recent date. Still further south is St. Helena with its huge and broken crater. It contains other evidences of volcanic action.

The Antilles are left. They rise from a more or less distinct plateau lying between North and South America. Fossil remains of South American animals which perished with Palæolithic man, found in the islands and on the adjacent northern coast, show that they once formed a connecting link between the two continents. Pleistocene times are given as the date of this condition of things. Hayti shows special evidences of metamorphic changes; but many of the other islands are also plainly volcanic, at least in part. Coral reefs along the shores, limestone below the two-hundred-and-thirty-foot level, and the coral-formed Bahamas just to the north, all point, however, to a period which may have antedated volcanic action. It should be added that calcareous sand is found in the Cape Verde Islands, while limestone appears in the Madciras, St.

Helena, and Jamaica, in the latter instance overlying igneous rocks.

The above facts plainly imply that coral growths in the Atlantic were, in some instances, overwhelmed by volcanic agencies. They also go to show that at some time during the Upper Miocene period great pressure in the earth's interior began to produce volcanic disturbances in the Atlantic region, and that these continued, apparently with increasing violence, well into the Pleistocene period. They seem to indicate that the ultimate outcome was a great uplift, of which evidences still remain, and that this uplift affected extensive portions of the mid-Atlantic plateau. What caused it? It seems to tally with the close of the Glacial Epoch so far as its date is concerned. What is the meaning of the coincidence? Is there any possible connection between the two?

Of the Pacific less is known; but enough is established to be significant in the premises. A stretch of shallow water in the Central Pacific shows a submarine plateau trending northwesterly and southeasterly on the eastern end of which the Sandwich Islands are located. They are volcanic; but they show signs of other earlier formations, coral and lava being found interstratified, and they contain indubitable evidence of a great elevation during some former age, since there are old coral reefs a hundred feet above the water, beds of coral limestone four hundred feet above the sea, and coral sands four thousand feet above sea-level. The entire area occupied by the islands is involved. A similar plateau supports the Ladrones and the Carolines, which also show both coral and volcanic elements. To the eastward two plateaus support the Marshall and Gilbert Islands, which are largely atolls. Many other oceanic islands, most of which occupy similar plateaus, are found in the South Pacific. A few are mountain peaks.

Most of the Pacific is from twelve to eighteen thousand feet in depth. The eastern half is especially uniform and free from islands; but the western is quite the contrary. Just east of Japan and the Kuriles depths greater than twenty-seven thousand six hundred feet are reached, and a basin averaging twenty-four thousand feet stretches eastward in the "Tuscarora Deep." Northwest of the Carolines is a similar though small depression, while shallow seas faced by submarine plateaus line the coast. These plateaus are studded with islands, whose plant and animal life furnishes evidence that Asia once included Japan, Formosa, the Philippines, New Guinea, Australia, and probably New Zealand. The oceanic plateaus seem to indicate an area of elevation which continued this great continental shelf southeastward, while stretching out to meet it is another, on the western coast of Patagonia, which is variously represented. Some make it cover more than 40° of longitude, while others hold that it is a part of the great general elevation containing the ocean archipelagoes.¹

According to Darwin, atolls result from subsidence. The "Challenger" expedition, however, apparently disproved this theory. No evidence of a general subsidence could be found, although evidence of a greater or less upheaval was abundant. Submarine volcanic peaks were discovered, on which deep-sea organisms producing lime and silica were common. This fact needs to be remembered in connection with the Bermudas mentioned above, since it discredits the theory of subsidence there as well as in the Pacific, where submerged limestone is not always to be attributed to the coral polyp. The truth seems to be that deep-sea organisms build on volcanic peaks, until the range of the coral polyp is reached. He then begins his work,

¹ See *Enc. Brit.* (Ninth Ed.), vol. xviii. p. 115, Plate III., and *Cent. Dict.* vol. x. Map No. 2.

flourishing seaward but dying toward the center for lack of proper food. The lagoons of the atolls result, because seawater disintegrates dead coral. The absence of the older sedimentary rocks from all these oceanic islands is significant. They are of a late formation.

A fringe of volcanoes, running northward from Cape Horn to Alaska and southward from the Aleutian Islands through Japan to New Zealand, accounts, in part, for the volcanic mud and sand found near the shores of the Pacific; but it does not account for the vast deposits of clay on the ocean floor. "Everything seems to show that the formation of the clay is due to the decomposition of fragmentary volcanic products, whose presence can be detected over the whole floor of the ocean." These are supposed to come from floating pumice, volcanic ashes, etc., from the lands near by; but "it is also known that beds of lava and of tufa are laid down upon the bottom of the sea," and that these decompose in sea water.¹ Pumice is found everywhere, and its presence on the ocean floor is admittedly remarkable. What do these things mean?

The borders of the Pacific constitute an earthquake belt; Japan testifies to the violence of former disturbances; Java and Sumatra contain active volcanoes, although those of Borneo are extinct; Formosa is partly volcanic, but has, like all the other continental islands, a geological connection with the mainland; Australia contains evidences of a vast fissure in the earth, where the sedimentary rocks have been broken through and contorted by the igneous overflow of basalt and trap, a condition which may explain the presence of igneous rocks beneath the limestone in Jamaica; late volcanic rocks abound in New Zealand; with regard to the Philippines, "it seems certain . . . that much of the archipelago has been heaved from

¹ See *Enc. Brit.*, *l. c.*, p. 125.

below the sea-level within comparatively recent times," while "volcanic forces . . . have had a great share in shaping the archipelago";¹ the Galapagos Islands, west of Ecuador, are volcanic; and the west coast of Patagonia appears to have been shattered by some fearful volcanic uplift, seemingly post-Tertiary, which raised the shingle-covered eastern plains to their present level and left behind it, on the west, more than a thousand islands, as well as the great submarine plateau already mentioned. Conditions in the Pacific, then, seem not only to conform to but also to verify the conclusions reached concerning geological disturbances in the Atlantic; and it may not be without significance that the more important elevated oceanic areas of the Southern Hemisphere are approximately antipodal to what were the northern ice fields during the Glacial Epoch.

Of the Arctic floor little is known; but the ocean itself appears to be comparatively shallow. The Indian Ocean seems to average not far from fifteen thousand feet in depth; but it shows extensive elevated areas over approximately two-thirds of its bed. They follow the coasts of Asia and Africa; for the deepest portions of the ocean are, for the most part, just west of Australia. Ceylon shows unmistakable signs of successive elevations; Madagascar gives evidence of widespread and powerful subterranean action, and it appears to have suffered an extensive late elevation, seemingly post-Tertiary; the Comoro Islands near its northern extremity are volcanic; the Maldives are coral islands on submarine table mountains, probably volcanic in origin; the Laccadives appear to be similar; and the Seychelles are granitic, indicating a probable upheaval from below. The Indian Ocean therefore tallies with the others. It diminishes to less than ten thousand feet in depth as it merges

¹ See *Enc. Brit.*, l. c., pp. 748 f.

into the Antarctic, which shows a still greater elevated area, approximately antipodal to British America. Volcanic islands are known to exist within the Antarctic circle, and the conclusion seems inevitable that vast portions of the ocean floor have been elevated since the beginning of the Quaternary Age and subsequent to the creation of man. Such disturbances do not occur without a cause, and it is legitimate to search for it. An attempt to find a propelling force which would be adequate for the production of these gigantic ocean disturbances will be made in the next instalment; and in the same connection attention will be called, incidentally, to the fact that such a propelling force may possibly account for certain other disturbances, which are known to have taken place in comparatively recent times on the continent of Asia.