

defined with the red sandstone immediately back of Fort Douglas, and also in Provo and Spanish Fork canyons.

At the end of the Jurassic there was still another upheaval or growth of the great plateau above the ocean, but it was a very limited extent in the Territory which rose above the ocean. Then came the Tertiary age, or the third, as its name implies, of the ages since the close of the Carboniferous, all the ages up to the Carboniferous being called the Palæozoic, and the ages after the Carboniferous and including the Tertiary being known as the Mesozoic, while the other ages up to the present are known as the Cenozoic.

The plateau of which we have been speaking still existed during the earlier portion of the Tertiary, but somewhere near the close of the Miocene or the beginning of the Pliocene portions of the Tertiary age, the greater portion of the plateau broke away from its eastern and western edges and fell to an elevation only a little above the surface of the ocean. It is possible that this falling of the plateau was very gradual, and yet, from a geological standpoint, very rapid. At the same time that the plateau fell it is almost certain that its edges rose and so the actual fall of the plateau was only half as large as would seem from a measurement running from the level of the plateau to the tops of the mountains which were then its edges. The line of fracture between the edges of the plateau and what is known as the Wasatch mountains would necessarily be a line of great disturbance, and we would expect to find volcanoes along it, and other evidences of the like. This we find to be the case. In southern Utah we find volcanoes, and all along the line northwest, even into Idaho, we find hot springs and warm springs bubbling out in many places. Our own Hot Springs and Warm Springs are on this line of faulting, as well as those of Ogden.

It doubtless has been noticed by every one that the western edge of the Wasatch mountains is almost precipitous, and the same is true of the eastern edge of the Sierra Nevada; while the eastern slope of the Wasatch and the western slope of the Sierras are very gradual, and now we understand the cause. When the plateau fell, either immediately or some time following, it became filled with water which was apparently a fresh water lake extending all the way from near the Sierras to the Wasatch and was apparently one unbroken lake so far as any great areas of land were concerned, although it is certain that the present mountain chains which occupied the great basin then extended through this lake as islands. We know this to be the fact from the deposits of clays and sands which are found throughout the great basin region, and are known by their fossils to be of the Pliocene Tertiary age.

Somewhere about the close of the Pliocene Tertiary there was again an upheaval within the great basin, and the bed of the lake was tilted so that the highest point was in the center in a line running north and south at a point somewhere now along the line of the East Humboldt mountains, Nevada. The lake was then separated into two portions; an eastern one lying next to the Wasatch mountains and a western one lying next to the Sierra Nevada.

This western lake has been given the name of Lahontan, and so far as we know never had an outlet. The eastern lake is the one about which we are speaking, called Lake Bonneville, and apparently was either drained entirely of its contents by some unknown outlet, or dried up entirely before its history as we now know it began, for it is certain that the present beds of the lake are underlain by material which could not have been deposited in a lake of such extent as the old Lake Bonneville.

It is quite possible that for long, long years the region occupied by the lake was either entirely dry or filled by salt and alkaline lakes which deposited thin layers of clays and then dried up and were covered by layers of sand and other debris alternating one above the other for hundreds or thousands of feet. At last there came a time when, either through an increased amount of moisture in the air or through an increase of cold, the water which fell in the basin of the lake gradually increased till the lake rose to a height of nearly twelve hundred feet above the surface of the earth forming the lowest portion of its bed, and at length reached a point where it had an outlet through what is known as Red Rock Gap, which is located on the Utah and Northern branch of the Union Pacific railroad some distance above Logan, Utah, and beginning some three miles above Swan Lake, Idaho. This most interesting river which has neither beginning nor end as a river, is some thirty miles long and is nearly level, its highest point being at Red Rock Gap and its lowest point being at its union with Port Neuf river. It has every evidence of being an old river bed, and its upper surface is exactly on a level with the highest beaches which were formed by the old lake, and its lowest level or bed is exactly on a level with the great benches known as the Provo bench, the Fort Douglas bench, the Ogden bench and the other greatest benches of the lake.

The water from the lake continued to flow out from this river for a long period of time until it wore away its outlet to the depth of nearly four hundred feet, reaching the present base of the old river. At that time through climatic changes there was not sufficient moisture falling in the basin to equal the evaporation from its surface and therefore the water ceased to flow out from the old lake and it gradually began to dry up. This drying up was not uniform, but was governed entirely by the supply of the moisture in the air, and, as it is a well known fact that periods of dry years and wet years follow each other with more or less regularity, the lake oscillated back and forth between the extreme limits represented by these changes of moisture and therefore would form beaches at its various elevations where it remained the longest, and these beaches would depend for their size upon the length of the time that the lake remained substantially at the same level, and upon the exposure of the shores to the action of the waves and currents. As the lake fell these beaches would be formed in succession one below the other, the lower abutting against the base of the other, and this we found to be the case in all the principal beaches that are known within the area of the old lake.

It is argued by Mr. Gilbert that the

lake rose to its outlet and dried up twice, and its rising is based largely on the discovery of the remains of an ancient beach underlying the present beach, and the fact of the difference in the sediments of the lake, the lower ones being yellow and the upper ones white or light colored, and to the finding of what he supposed to be an illustration of beaches laid one above the other, which could have been formed in no other way than when the lake was rising. To my mind, however, his reasons are erroneous. The change in the sediments of the lake could be due and even are on his own basis argued as due to the saltness of the lake as it dried up, which would change the sediments from yellow to white, and which, upon his own reasoning, would make four sets of beds with yellow clay composing the fourth and the second, and white clay or marl the third and the first. We do not, however, find any such state of affairs. It is perfectly evident that a lake which is falling as Lake Bonneville is known to have fallen, would of necessity have risen in the same way, and when it was rising it would form beaches which were deposited one above the other and then when it fell it would partially obliterate those beaches and build others upon them in succession. This, therefore, will explain all the facts of the history of the lake with one rise and fall far better than the forced assumption of two such periods. These old beaches it would require too much time to enter into a discussion of their history or of the proofs which go to show that they are beaches. It is sufficient, however, to say that they are substantially water levels for a distance of twenty-five hundred miles around the circumference of the old lake and that they show every phase of beaches which are now being formed, not only in Great Salt Lake, but in all other lakes with which we are acquainted.

That the time when the lake had its outlet and was a fresh water lake was a period of cold rather than of increased moisture is proved reasonably well by the fact that at that time a glacier occupied the whole of Little Cottonwood canyon and flowed down into the lake and deposited its sediments there, and its icebergs undoubtedly floated out upon the lake making it a most picturesque and interesting body of water. That the lake was also a fresh water lake is shown by the fact that the life in all the rivers and streams which flow into Great Salt Lake today is identical. The same fishes are to be found in all the streams, and it is unreasonable to suppose that being isolated for a period represented by an almost infinite length of time, that they would not have shown differences, while if they had been isolated only but a few thousand years represented only by the drying up of the lake, their uniformity in character and life would be better understood.

Coming to the present history of the lake, it goes back, so far as my records are concerned, to 1843, the time when Colonel Fremont first saw the lake. The time is not sufficient to explain all the methods by which my diagrams of the oscillations have been made, but it is sufficient to say that the observations of Fremont, the old bar running between Stansbury Island and the main lands and the one running from Antelope Island to the main land, the diaries and memories