

CONTRIBUTIONS
TO THE
PLEISTOCENE HISTORY
OF OREGON



BY
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The Department of Geology takes pleasure in presenting in its original form, this paper which amplifies the pioneer work of the esteemed geologist, father of the author, Professor Thomas Condon.

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INTRODUCTION

The Pleistocene history of Oregon presents some very interesting unsolved problems, and it may prove both pleasant and profitable to review the literature on the subject, study the new facts, and draw such conclusions as seem to be justified from the study of both new and old.

The writer wishes to acknowledge the valuable assistance of Prof. E. L. Packard, especially in the preparation of the Pleistocene faunal chart.

THE WILLAMETTE SOUND AND ITS RELATIONSHIP TO THE MARINE TERRACES OF THE COAST

There is an interesting marine chapter to our Pacific Coast Pleistocene which we believe corresponds to a time of depression following the glacial period. The proof of this depression is found in the elevated beaches sometimes two or three hundred feet above the present tides. They extend from Alaska to San Diego, California, and are often found far inland as in many localities along the shores of Puget Sound and in San Francisco Bay. In places, these elevated beaches yield oyster and clam shells, many of them identical in species with those now living on the Coast. With regard to this period of depression, Osborn says :*

Subsidence—Continental depression was the grand feature of post-Glacial times on both the Atlantic and Pacific coasts The subsidence carried both the North Atlantic and the North Pacific shores several hundred feet below their present level.

Professor LeConte also wrote as follows :1-

During this period of depression the ocean flowed in through the Straits of Carquinez between San Francisco Bay and the Sacramento and San Joaquin rivers and covered all the low land in these valleys, making an inland sea 300 miles long by 50 miles wide. During this period of subsidence (Champlain) at the same time the sea entered the Columbia River and spread over the Willamette Valley forming a great sound, and passed up to and possibly beyond the Cascades. Icebergs were a common product of this depression in lakes and inland seas.

Chamberlin and Salisbury state that:

Along the western coast of the United States there are marine deposits reaching inland some distance from the coast. They are known to extend up to altitudes of 200 or 300 feet in California and Oregon, and perhaps even higher. The Pleistocene submergence indicated by the disposition of these beds must have given origin to considerable bays in the lower courses of the Columbia and Willamette valleys. By far the larger part of the marine Quaternary deposits of the coasts of the continent are still beneath the sea.

One of the first studies of this period of depression as it affected the Northwestern Coast was made nearly 50 years ago by Oregon's pioneer geologist, Professor Thomas Condon. His research first took him to Willapa Bay on the coast of Washington, of which he wrote in 1871:

*Osamu, H. P. *The Age of Mammals*, p. 444, 1910.
thisCowns, Jossen, *Principles of Geology*, p. 582, 1909.
:CHAMBERLIN, T. C. and SALISBURY, R. D. *Geology*, Vol. p. 476, 1906.
:CONDOM THOMAS, *The Willamette Sound*, *Overland Monthly*, Vol. 7, pp. 468-78, Nov., 1871 ; also *Oregon Geology*, p. 186, 1910.

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At intervals along this whole shore line one can plainly discern what in the distance appear as landslides, but on nearer approach prove to be portions of the bluff shore undermined by the storm-surf, and in their present form showing fine sections of the strata of which they are composed. On examining these more closely one sees a bank, not of common earth, but disposed in stratified layers of sediment, once evidently continuous over the whole region and of nearly uniform thickness, now worn away above into a rolling surface, yet showing everywhere a fine persistence in the old water-lines that ruled its formation. Buried in this mass of sediment, and occasionally cropping out in exposed sections, are vast beds of sea shells. So completely do these represent the life now around them that when an apparently exceptional form does appear, memory at once recalls having seen it somewhere on the coast. And yet, identical in species as these shells unquestionably are with those now living in the surrounding waters, the two sets of conditions are separated by the whole import of the term "fossil." The waters that buried these fossil shells, and covered them with one hundred or more vertical feet of ocean sediment, were waters that so defined our northern coast as to give it a far different outline from that of its present geography.

In some of these bluff exposures their past record is read in masses of buried forest trees; trunk, leaves and seed so buried in clay and so well preserved that the spruce cone, fragile at all times, is scarcely discernible from one of last year's fruitage drifting in the neighboring waters. From these vegetable remains, as from those of the shell-fish, the same truths are taught; for the trees are the same kind as those growing on the bluffs one hundred feet above them, while the waters that covered them there with one hundred feet of sediment have passed away

The lowest marine remains of these bluffs plainly prove when they lived, the waters around them were at, or near, their present level. They were species that love shoal water, and they are "in place" where found. The oyster is very abundant among them The common cockle—another lover of shoal water—is also abundant among these remains, and like the oyster, lies fossil where it lived, the opposite valves often occupying the very positions, relatively, that they held while living. So, too, with *Mactra* or *Solon* or *Venus*—all are evidently in their native beds where they lived and died

Another truth plainly taught in these stratified bluffs is: The waters here became afterward much higher, or speaking more exactly, the land became much lower. There must have been a change of more than one hundred feet, for a stratified sediment of one hundred feet in thickness as now seen in some of these bluffs—that for instance near the North River—would require more than that depth of water to place it there, and this sediment is so fine in material as to warrant the conviction that it once existed evenly distributed over the whole region, bay and all. The upper layers, too, have in them the finest materials and the fewest fossils; both facts indicating increasing depth of water as the upper beds were deposited

That every inlet on our northern coast has its group of facts of like import, there can be no doubt. Our line of thought needs only those that mark its extension to the Columbia River, and there the lessons gleaned from the bluffs of Shoal-Water Bay reappear in all their clearness. A fine instance of this is seen in a bluff on the old Whealdon farm, just inside the cape. Several others may be seen along the streams that fall into Young's Bay, on the south shore of the river, and just back of Astoria.

Professor Condon finally decided that a tentative "measuring rod" of 200 feet would be a safe theory of the elevation of waters over the present mouth of the Columbia and with 200 feet as a guide, he searched the Columbia Valley clear through the Cascade Gorge before he found the evidence of high water he was looking for, and then, near the mouth of the Deschutes, his facts forced him to the

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conclusion that his 200 feet should have been 350 feet, for here *" buried in the stratified sands, clays and gravels that mark the wash of those streams into and along that old lake beach, are found the tusks, teeth and bones of the land animals of that period, marking at once the height at which these waters stood and the life record of the times."

It is unfortunate that this pioneer classic was not first published in a scientific journal instead of in a popular magazine,t but when 25 years later, Dr. Diller, of the United State Geological Survey, first began his work in western Oregon, he waived all technicalities of publication and generously gave credit for work accomplished at Willapa Bay, in the Columbia and Willamette Valleys, at Yaquina Bay, and elsewhere. Diller writes in 1896

The data for the accurate determination of the depth of water in the Willamette Valley have not yet been fully made out, but the evidence already known to Professor Condon indicates that the water extended as far south as Spencer's Butte, three miles from Eugene. Judging from the height of the terraces on the Columbia near the mouth of the Deschutes he estimated the depth of the water over the place where the city of Portland now stands to have been 325 feet. This may well be, and yet when we study the deposits of which the hills about Portland are composed a much greater depth of water is indicated.

Diller then refers to the fine argillaceous sediment on top of Portland Heights as being "in places distinctly stratified and was evidently laid down under water," and then adds, "if this material was deposited in the Willamette Sound of Condon as appears to be the case, the depth of water at Portland must have been not less than 600 feet."

To the Willamette Valley portion of these waters Professor Condon gave the name Willamette Sound because of its striking resemblance to the sound on the north that penetrates far into the state of Washington. Puget Sound has a grand entrance through the Straits of Juan de Fuca, while the entrance to the Willamette Sound was over eighty miles in length, from five to twenty miles in width and deep enough to satisfy the needs of our greatest battle-ships. The Willamette Sound, like its northern neighbor, stretched away southward for over a hundred miles with many long arms winding among its foothills.§ They both had their high wooded islands, their grand mountain ranges covered by forests and crowned by lofty snow peaks, for Puget Sound has its Rainier, its Baker, and its Olympics; the Willamette Sound had its Adams, its

• CONDON, THOMAS, *Oregon Geology*, p. 142, 1910.
† CONDON, THOMAS, *The Overland Monthly*, Vol. '7, pp. 488-478, 1871.
‡ DILLER, J. S., *17 An. Rept. pt. 1. p. 485, 1888. A Geological Reconnaissance of Northwestern Oregon. U. S. Geol. Surv.*
§ CONDON, THOMAS, *Oregon Geology*, Chap. 11.

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Hood, St. Helens, Jefferson, and Three Sisters. There were indeed many points of likeness, but there was one great difference*—the Willamette Sound had its Columbia, the Puget Sound had no such river. The ocean waters that push through the Straits of Juan de Fuca into the interior of Washington meet with but little resistance. The ocean that tried to overrun the interior of Oregon met at the very gateway the powerful current of a great and swiftly flowing river. The Columbia, like the greater Amazon, boldly faces the ocean tides and the current of the Amazon is said to remain fresh fifty miles out at sea. This relation of the Columbia's current to the inland waters seems quite important because of its bearing on the question whether the Willamette Sound was *a* body of fresh or salt water. The discoverer and author of its name said distinctly in 1905 that no remains of salt water life had been found in the deposits of the Willamette Sound and he undoubtedly realized that the name was not quite accurate *as a* technical definition of its apparently fresh water condition, for it was the likeness of its physical features to those of its northern neighbor rather than the chemical constituents of its waters that suggested the name. In estimating the powerful seaward current of the Columbia River during the late Pleistocene it is well to consider a greater river than the Columbia of our times, for (speaking geologically) just before the Willamette Sound epoch, the mountains of our Pacific states had been rejuvenated by upheaval and *by* the outpouring of volcanic lavas, so that their slopes had become much steeper and the mountain streams that fed the rivers were swifter in their descent. Large mountain glaciers were melting and the upper Columbia River was probably both larger and swifter than it is today. Under such conditions it seems very doubtful if the waters of the Willamette Sound were sufficiently salt to support marine life. But if elevated beaches are found in San Francisco Bay *as* far inland as San Pablo Bay at the straits opening into the San Joaquin and Sacramento valleys, and if they are also found along the inland shores of Puget Sound at Restoration Point and Alki Point near Seattle, how could the open mouth of the Columbia Valley lying between the two escape its share of flood?

There is also another important collection of facts that strengthens the evidence for the Willamette Sound, namely the erratic boulders that are found scattered from one end of the Willamette

³10Conics.ox, ELLEN, *A Study of Oregon Pleistocene*, Univ. of Ore., *Bull. N. ser.*, Vol. 8, 1906.

⁴Alitioin IL Tertiary and Quaternary Pectens of Calif., U. S. Geol. Surv. Prof. Paper 7. D. 82, 1W.

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Valley to the other. Speaking of the mountains west of Portland, in 1883, Professor Condon says :*

If we examine the layer underlying this surface one, that of the boulder clay, we shall find a like stretch of history to mark its preparation for its place. The drift of the glacier that brought its heavy boulder masses to their present place, the history of the occasional piece of granite that seems so far out of place among porphyries and basalts as to suggest an iceberg journey from some northern shore—all these fragments of story unavoidably come into our conception of the creation of the boulder drift that constitutes the second layer of our Portland Mountain.

Diller writes in 1896:1

At various places along the western side of the Willamette Valley, between Forest Grove and Corvallis, a number of boulders of granite and schist were observed under conditions that strongly suggest transportation by ice, probably in the form of icebergs, floating upon the Willamette Sound.

The first one was noted upon the hill slope at an elevation of 120 feet above the sea. The boulder is of biotite granite and is about ²¹ feet in diameter. Chloritic boulders were seen near Amity, at an elevation of 190 feet.

About twelve miles southwest of Corvallis, boulders of granite and of glaucophane schist were observed by the roadside 250 feet above sea level. That they are erratics carried there from the mountains is evident, for no such rocks are known in the places where they occur. Dr. J. L. Wortman found a large erratic boulder near McMinnville, weighing twenty-five or thirty tons, which he thought must have been carried into the Willamette Valley from as far north as British Columbia, as he knew of no nearer source of such rock material. Dr. W. D. Smith, of the University of Oregon, recently found a specimen of quartzite near Holmes Gap in Yamhill County, which was clearly striated by glacial action. J. B. Winstanley reports erratics near the city of Salem. These erratics are not confined to any part of the valley. One large boulder of biotite granite weighing several tons was found near Harrisburg, Linn County. They are scattered broadcast over the Long Tom and Coyote valleys a few miles northwest of Eugene, and a boulder of granite weighing several hundred pounds is resting at the south end of the valley three miles west of Eugene.

Another twenty-five years have passed and but little has been written about the Pleistocene of Oregon since Diller's reconnaissance in 1896, and some of the younger generation of geologists are becoming skeptical about the Willamette Valley ever having been covered by a great body of Pleistocene waters. It is therefore with interest that we study two publications by Dr. Bretz, of the Univer-

*Condon, THOMAS, *The Development Theory: The Portland Oregonian*, 1871; See *Oregon Geology*, p. 176.
Druza, J. S., *op. cit.* p. 486.

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Sity of Chicago. His original problem *was* not the same as either of his predecessors of fifty or twenty-five years ago, for he was studying the age of the Cascade Mountains ; but he started from the coast of Washington and followed the Columbia and Willamette valleys inland, just as they did, and the evidence he gathers for his problems both enriches and complicates the situation. Bretz calls the Pleistocene formation in the Willamette Valley the Satsop from a river in Western Washington where he found what he believes to be the same formation well developed. Referring to the Satsop formation, Bretz writes :*

Only the lower twenty-five miles of the Willamette Valley of Oregon have been examined in the study of the Satsop formation. Most of this portion is covered by the Satsop. Numerous hills of basalt rise through and several hundred feet above the surface of the Satsop fill. The formation is at least 600 feet thick along the Sandy River, with the base below the river level The Satsop formation of the lower Willamette Valley is maturely dissected, the dissection adjusted to a base level 200 feet or more above present flood plains. This level is recorded in the major valleys by a prominent terrace development mostly in the Satsop formation but in places east in the underlying basalt. This is the Cowlitz Terrace already described. The surface of the Satsop formation in the 'Willamette Valley lies at about 500 feet A. T. in mid-valley and rises eastward toward the Cascade range to 1200 to 1500 feet, at these altitudes passing under the more recent lava flows of this range The broadened portion of the Columbia Valley between the Cowlitz and the Willamette is really a continuation of the Willamette Valley northward into Washington. The surface of the Satsop formation constitutes at least 200 square miles of the flat floor of this part of the valley. It is disposed in two levels, approximately 300 and 500 A. T., the lower of which is the Cowlitz Terrace and the upper probably the original surface of the formation. This filling is very similar in all features noted in the preceding description to that in the 'Willamette Valley The shore line of Willapa Bay, south of Grays Harbor, is largely cliffed, and all of the cliffs are cut in the Satsop formation. Clay and sand predominate. One stratum of highly fossiliferous clay is traceable for several miles along the bluffs. Most of the shells in it are of oysters, many of the valves yet attached in pairs.

He then says:

J. S. Diller has described Quaternary sediments along the Oregon coast which belong clearly to the same formation as those along the coast of Washington Exposures of Satsop formation examined by Diller are as follows: Ilwaco, Tillamook Bay, Yaquina Bay, Nye Beach, etc.

Our subject has thus been enriched by corroborative evidence which Bretz gives of the extent of the Willamette Valley fill during a period of submergence. It has also been enlarged by the long list of erratic boulders he reports in the eastern extension of this submerged area which T. W. Symonds named Lake Lewis in 1882. Bretz finds in Lake Lewis the same or even a larger body of water than was postulated by Professor Condon in 1871. Professor Condon, however, based his Willamette Sound on evidence of submerged

*BRETZ, HARLAN. *The Satsop Formation of Oregon and Washington*, Jour. Geol. Vol. 26, pp. 446-458, 1917.

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land and therefore high water *as* shown by the elevated beaches at Hoalwater Bay and also inside the capes of the Columbia, both on the north shore and on the south, along streams emptying into Young's Bay near Astoria.

Bretz throws out all of this evidence for post-glacial waters and claims the elevated beaches of Oregon belong to the Satsop formation which he *says* "long antedates the Champlain epoch." In claiming the elevated beaches as being cut in Satsop or again as being Satsop, Bretz also claims the correlated Willamette Valley fill, and then remarks : " Condon has priority of publication, but, so far as we can learn, his conclusion cannot stand **on his** own presented evidence. It *is* purely a coincidence that there *was* such a submergence *as* he names." Bretz then reconstructs a second body of static water over practically the same area as before, but places his evidence for the same almost entirely on the great number of erratic boulders found **in** the Columbia and Willamette valleys, indicating that they had been dropped by icebergs floating over the extensive body of water south of Chelan Glacier and Okanogan Lobe in Northern Washington. He then remarks:

Russell and Diller independently discovered the evidence which establishes the existence of the water body under discussion. They are to be credited accordingly, though neither saw as broad a vision as did Condon.

We have no positive evidence that Professor Condon had discovered the erratic boulders as early as 1871, but in reading over an old lecture delivered in Portland in 1883 and published in the Portland Oregonian in February of that year, we find he refers to supposed erratics near Portland and postulates an iceberg journey to account for their presence, thus indicating that he probably recognized the true nature of the erratics upon which Bretz is postulating his Willamette Sound. This was in 1883.*

So far as the writer is aware, there has been but one Pleistocene formation discovered in the Willamette Valley, and it lies directly upon the marine Tertiary or upon volcanic flows of basalt. Professor Condon and Dr. Diller believed this valley filling to be post-glacial. Bretz says it "long antedates" that time. Either, then, we will have to consider the mammalian fauna of the Willamette Valley as belonging to the Satsop or Bretz will have to sever the correlation between the elevated beaches and his Satsop gravels of the Columbia gorge. For all agree that the elevated beaches and the Willamette Valley fill, in which our mammalian faunas are found, belong together.

*CONDON, THOMAS, Two Islands, p. 196.

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But there are objections to some of Bretz's claims with regard to the Satsop which we wish to record.

The flora discovered by Winstanley on Buck Creek, near the Sandy River, indicates a warmer climate than now. *Cheney, of the University of Chicago, states that in one exposure of the Satsop four genera and at least seven species of plants are represented. The list includes the oak, willow, walnut, and the sequoia. The latter is apparently identical with the living redwood of California. Both the oak and the willow likewise closely resemble their living relatives in that sister state at the south. Again the Upper San Pedro with which the elevated beaches of the Northwest coast are more particularly correlated are believed to indicate a warmer climate than that of the present time.

It has also been suggested by E. L. Packard, of the University of Oregon, that Bretz introduces a period of mountain upfolding into the Pleistocene of the Northwest coast which has heretofore been considered a period of almost horizontal lines. Of course there was great activity of a volcanic nature during the Pleistocene in the outpouring of lava and building up of volcanic cones, but the upfolding of the earth's crust into mountain ranges seems to have spent its force in the Pliocene. Bretz records that after the Satsop gravels had been deposited in the then low Columbia gorge there was a great upfold of the Cascade Mountains which elevated the gravels in one locality to a height of 3700 feet above tide, producing a great anticline and two secondary anticlines to the eastward.

But the greatest objection to Bretz using the elevated beaches as Satsop is the coast elevation. Diller, after discussing the peneplain to which the Coast Mountains of Oregon had been reduced during Tertiary times, refers to its later elevation, and then says :

The upward movement continued until the land was raised above its present position. At that time the coast of Oregon was farther westward, and the land included a strip about five miles in width that now lies beneath the ocean. Across this border the rivers once flowed and cut channels to the sea. The numerous soundings made by the United States Coast and Geodetic Survey along the coast of Oregon show that an old channel of the Columbia still exists beneath the sea from the present mouth of the river to a point where the bottom falls off rapidly and the deep sea begins. My information upon this point was derived from Professor George Davidson, who for many years had charge of the work on the Pacific coast.

G. M. Dawson, the Canadian geologist, states with reference to the fiord region of Western America, that the land in the Pliocene stood relatively to the Pacific about 900 feet higher than now, and he concludes that the fiords were shaped and enlarged locally during the following Glacial period, when the amount of elevation was still further increased.

*WILLIAMS, T. Ore. Bureau of Mines and Geology No. 3.
DILLER, RALPH, op. cit. p. 82,
Ann. Bur. Geol., J. S., op. cit. p. 490.
DANA, J. P. Manual of Geology, 3a ed., p. 843, 1894.

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According to Chamberlin and Salisbury, the increased elevation of land just before the Glacial period probably did not produce the Glacial climate as usually supposed. In the Ellensburg region of Washington, elevation came at the close of the Pliocene or late Pliocene, or subsequent time.

In answer to a request made by the writer for information concerning the continental shelf of the Pacific Coast states, the United States Geological Survey responded with a letter full of information from which we quote as follows :

Along most of the Pacific Coast of the United States the continental shelf, that part of the sea bottom lying not more than about 100 fathoms below sea level, is very narrow, and not more than eight to ten miles broad. In one or two places, notably off the coast of Monterey and, San Luis Obispo counties in California, there is no shelf In other places, especially opposite the Golden Gate, just north of the Umpqua River, and off the mouth of the Columbia River, the shelf broadens to twenty or even thirty miles. From the margin of the continental shelf the sea bottom everywhere falls rapidly.

Many years ago W. S. Ladd, of Portland, the pioneer so well known to older Oregonians, decided to drill for artesian water on a farm covering a part of what is now known as East Portland. This historic old well, 2000 feet deep, was drilled close to the intersection of East 39th and Glisan streets in the center of what is now Laurelhurst. Fortunately Mr. Ladd made a large drawing of the different strata through which the well was bored, and through the kindness of the sons of Mr. Ladd the writer has had an opportunity to study a photograph of the chart. The well passed through over 1000 feet of valley fill, all of which was soft, then came the old Tertiary rocks in which fossil shells and ferns were found, and at about 1700 feet they struck igneous rock through which they drilled until a depth of 2000 feet had been reached. Professor Condon, who at the time was much interested in the result of the drilling, explained the conditions as follows : He thought the Columbia River during the Glacial period occupied a deep gorge which extended far out beyond its present mouth, as the coast was then much higher than now. Later in the post-glacial period of depression the land sank and the gorge was filled to a great depth with lighter drift and wear and it was through this filling material that the first 1300 feet of Ladd's artesian well was drilled.

Osborn,* in speaking of this widespread period of elevated land, says :

As in Europe, the grand climatic changes of North America were ushered in and perhaps partly caused by great changes of level which altered the proportions of land and sea, and left a whole chain of biotic results in their

* OSBORN, H. F., *op. cit.* p. 442,

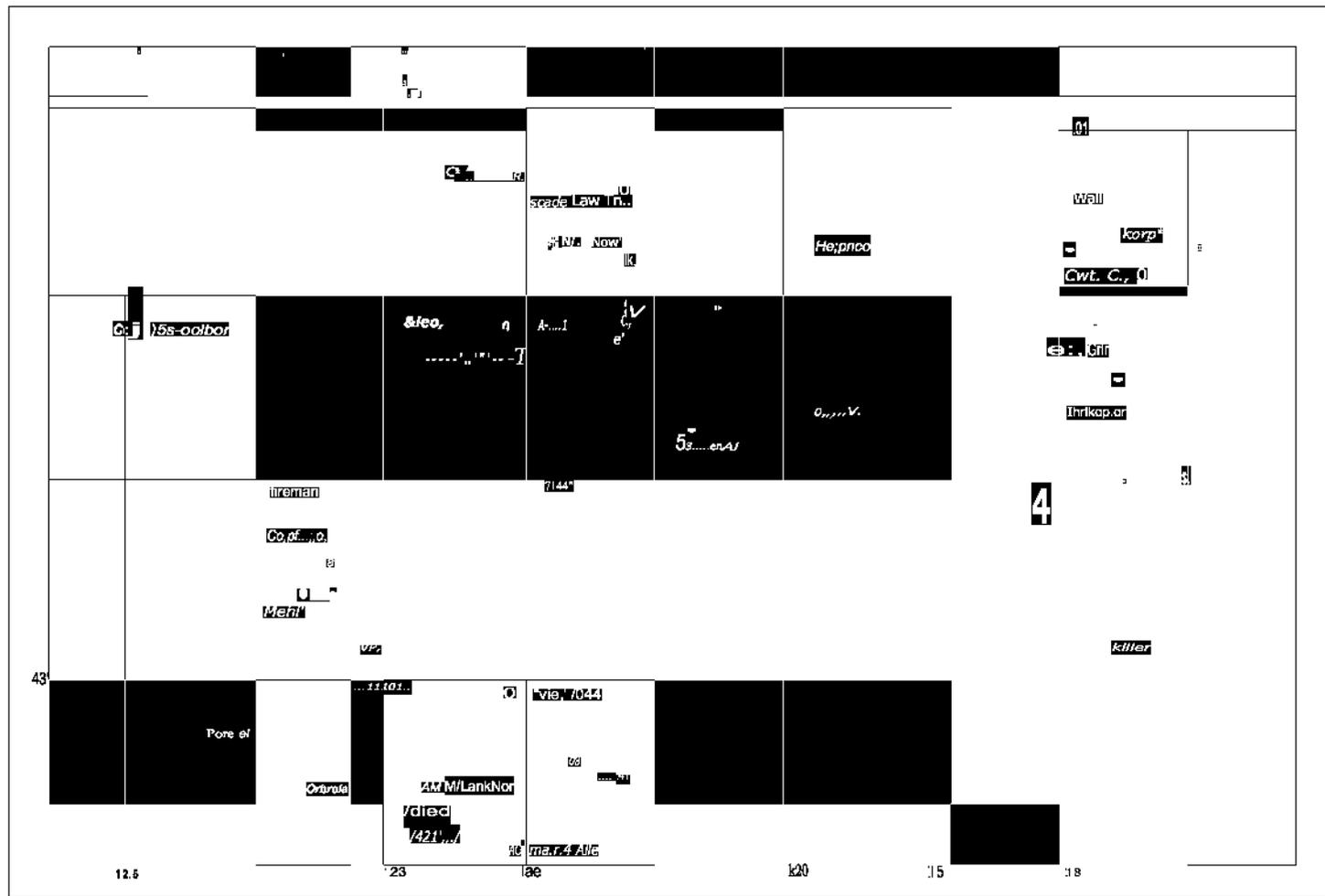


FIG. 2 IMPORTANT PLEISTOCENE VERTEBRATE LOCALITIES OF OREGON

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train. Briefly, they are as follows: elevation, beginning in the Pliocene and reaching a maximum in late Glacial times; depression, in post-Glacial times; re-elevation, to present levels.

Now Bretz places the Satsop formation in the Pleistocene "long antedating" the post-glacial. The Satsop must, then, be preglacial, glacial, or interglacial, and in the quotations given below the whole time from late Pliocene through preglacial and glacial time to near its close is considered a time of elevation, and near the mouth of the Columbia a broad continental shelf representing a coast line from five to twenty or thirty miles extended farther seaward than now. And yet it is just at this time of elevation that Bretz introduces his period of submergence which he claims accounts for all the elevated beaches on the coast of Oregon and Southern Washington, and also the Willamette Valley fill. This position seems to the writer quite untenable, so much, so that we see no reason for discarding the original evidence for the Willamette Sound. The elevated beaches from the coast of Washington and Oregon represent only a few links from a very long chain of such evidence extending from Alaska to Lower California. They are also correlated with evidence of the same depression on our Atlantic Coast and in Europe. The displacing of a short section of this long chain of evidence would seem to require an explanation of unusual local conditions that could make their transfer a possibility.

THE PLEISTOCENE LIFE OF OREGON

If we turn from the marine chapter to land life we find that the localities on the Pacific Coast in which Pleistocene mammals have been found are scattered from Alaska to Los Angeles. One of the most northern of these faunas is from Lake Washtucna, Franklin County, Washington. This fossil bed is a few miles north of the union of the Columbia River with its eastern tributary, the Snake River. The fauna was published by Cope in the American Naturalist in 1889.* According to Osborn it contained a large proportion of forest and mountain types and appears to belong to the Equus-Myloodon-Gainelops zone just before the glacial period.

Near Washtucna are boggy springs from which *Elephas columbi* and a species of *Bison* have been obtained, and associated with these are remains of distinctly forest types including two species of

* Com. En. The Vertebrate Fauna of the Pacific Northwest. The American Naturalist, Vol. 23, p. 160, 1889.
FolsBoaN, F., Op. cit. p. 466.

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moose (*Elaphus*) and of Virginia deer (*Odocoileus*) as well as mountain sheep (*Ovis montana*). Among felids we find the puma (*Felis concolor*) and a large leonine cat (*Felis imperialis*) as well as the lynx, (*Felis canadensis*). About thirty miles south of Washtucna the astragulus of a horse of the equus type was identified by Professor Condon in 1866. It was found after digging for water through 86 feet of gravel half way between the Touchett River and Palouse Landing on Snake River. Mammoth bones have been found in the same southeast corner of Washington at Dayton, and Walla Walla, and camel bones, of a doubtful age, were found in digging wells near Walla Walla and in Yakima Valley.

Lingren of the United States Geological Survey reports an old Pleistocene lake caused by a fault on the east side of the Elkhorn Mountains, near Baker, Oregon. In the accumulation of fine detritus in the southern end of the lake he found *Mastodon americanus*, and *Elephas columbi*. *

Professor Condon reported in 1871 finding the mammoth, the horse, and the ox (probably bison), on the southern border of the John Day Valley, and years later a ground sloth and an almost complete skeleton of a mammoth were reported from the same region by J. C. Merriam. The vicinity of The Dalies, especially along the creeks that empty near the mouth of the Deschutes River, has long been a rich field for *Bison antiquus* and for mammoth bones and teeth.

One of the earliest Pleistocene fossil beds is that of Fossil Lake, east of the Cascade Mountains. This unique desert fauna was discovered by Governor Whiteaker in 1876, and visited by Professor Condon the following summer. The Fossil Lake fauna is believed to be preglacial and a little earlier than that from Washtucna Lake. When Professor Condon visited this locality in 1877, he went with friends on a camping trip, and as they sat beside the evening bonfire he wrote a sketch of his daily experiences and impressions. After outlining their road through the Cascade Mountains and the monotonous stretches of sage brush, the record says:

We reached the home of a ranchman on the shores of one of those strange alkali lakes, whose flats at this season are covered with a thick inflorescence of alkali. Here we left our wagon and the next morning started on horseback for the fossil beds. After traveling about eight miles we saw from the eminence of a sand dune an apparently circular depression four or five miles across, in the lowest portion of which was a small pond or lake surrounded

*LINDGREN, WALIIMER, The Gold Belt of the Blue Mountains of Oregon, 22 Ann. Rept. U. R. Geol. Surv. pt. 2, p. 583, 1e00.

tGoNnaN, THOMAS, The Rock of the John Day Valley, Overland Monthly, May, 1871, P. 488, and Two Islands, 1902.

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by grass and tule rushes. Perhaps two miles to the leeward this depression was bordered by a line of sand dunes unquestionably formed from sands blown from the bed of the lake that once occupied the whole of this depression. Here we staked our horses and went to work. The fossils were often found lying on the surface bare of any covering. The sand and dust that had covered them were blown to the leeward and this uncovering and drifting process was still visibly going on.

This trip was made in 1877. Later **in** the same year Sternburg made collections for Cope and two years later Cope himself collected at Fossil Lake. As there *was* a large collection of Pleistocene bird bones at Fossil Lake, *as well as* a most interesting mammalian fauna, much of the material finally found its way into the hands of Schufeldt, for expert classification of the avifauna. The list of mammals, studied by Cope and published by Schufeldt in 1892, has since been revised by Osborn and others and shows a remarkably rich collection of Pleistocene mammals and birds belonging to the early Pleistocene. The list of mammals includes two genera and three or four species of *cameloids*, differing somewhat from any of the camel family now living. There was *Camelops hesternus* and *Camelops vitakerianus* and one member of the genus *Eschatius*. There are two species of *peccary* (*Platygonus*), a *Mylodon* or *Megalonyx*, *Mammoth columbi*, *Equus pacificus*, *Equus occidentalis* and other *Equidae*. There are also wolves, coyotes, a prong-horned antelope and many smaller animals. But the most valuable part of the collection was the bird bones, several hundred of which were collected, and from these Schufeldt describes about fifty species of birds which lived on or near the shores of this old lake.* They included five species of gulls, two of terns, eleven species of ducks, four of geese, one of which must have been nearly as large again as our common wild Canada goose. There were also a large species of swan, great horned owls, black birds, coots, herons, crows, eagles, grouse, prairie hens, a great cormorant, and a flamingo.

The California caves and the berea beds have many of the same large animals found at Fossil Lake which is believed to be preglacial and therefore, a little earlier than most of the Pleistocene faunas of the Coast. Perhaps the most striking difference is in the greater number of horse and camel fossils. At Fossil Lake there were not only many individuals, but they represented several species of *Equus* and *cameloids*. On the other hand, the California faunas are far richer in number and variety of ground sloths. It has been

*SCHUFELDT, R. W. Collection of Fossil Birds from the Equus beds of Oregon. Am. Nat., Vol. 25, pp. 369-62, 1891. A study of the fossil avifauna of the Silver Lake Region, Oregon. Phil. Acad. Nat. Sci., 2d ser., Vol. 9, pp. 389-425, 1892. See also Miller. H. Additions to the avifauna of the Pleistocene Deposits at Fossil Lake, Ore. Univ. Calif. Publ. Bull. Dept. Geol. Vol. 6, pp. 79-88, 1911.

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suggested that this may be due **in** part to the more northern field being in a grazing district and the caves being in the forests of the mountainside,

While the life of Fossil Lake is of absorbing interest, and represents the largest and richest Pleistocene fauna of Oregon, the mammals of the Willamette Valley are of even more scientific interest at this time as evidence in solving some of the geological problems of our Pacific Northwest. Wherever the rich deposit of silt, sand, clay, and gravel remains undisturbed by the wanderings of the Willamette River, tusks, bones, and molar teeth of the elephant are often found. Very few remains of the mastodon have been found **in** the valley, for that animal apparently preferred the region of the seashore, but the mammoth must have been very abundant in Oregon and Washington during the Pleistocene.

One mammoth tusk was found about ten miles northeast of Eugene beside a mountain stream in cement and clay gravel, eighteen feet below the surface of the bank. Another tooth was taken at Albany from a ear of gravel hauled from Canby, which is on the Molalla River in Clackamas County.

In 1905 Dr. D. G. Clark reported a fossil pocket east of Silverton. There were about 100 pieces in all, well preserved tusks, twelve teeth, with a grinding surface of about eight inches, and weighing about twelve pounds each, showing the minutest markings on the teeth. The shoulder blade was about three feet across and there was also the greater part of a skull.

In one locality near Dayton, in the banks of the Yamhill River, were found a beautiful mammoth tooth having 27 plates, a part of the jaw of a mastodon with one molar tooth in place, two toe bones of *Ufyloclon* near *harlani*, * and a well-preserved upper molar of Equus. Part and perhaps all of these were found in silt superimposed upon sand and clay resting in turn upon several feet of gravel.

In the business center of Portland an excavation was made on Washington Street near West Park and at a depth of 22 feet through undisturbed silt two bison teeth were found. J. **B. Win-**stanley sent a cast of the teeth to Dr. O. P. Hay of Smithsonian Institution who found they belonged to an extinct species of bison probably living in interglacial times. Another Portland specimen was taken from an excavation in the bottom of a reservoir in one of the city parks. It was a badly worn tooth, found 41 feet below the surface. Frederick Lucas, then of Smithsonian Institution,

*Determined by Dr. Chester Stock.

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believed it to be a camel tooth. A fossil horse tooth was found in digging a well 25 feet deep through gravel on the river bench in the town of Gladstone, near Portland. Other horse teeth have been found on the plowed fields and other localities in Yamhill County, Linn County, and *as far south as Eugene*.

It will be noted that while the valley filling is composed of gravels, sands, clays, and silts, the fossils enumerated are not found exclusively in any one of these, but are bedded as local conditions furnish different kinds of material. As would be expected the *silts* form a deeper deposit in the northern end of the valley near the Columbia. A well at St. Johns, a suburb of Portland, was bored through 150 feet of silt before gravel was struck, while the wells in the southern part of the valley usually pass through sand and clays before reaching gravel or Tertiary sandstone.

We have seen that the vertebrate fauna of Washtucna, Fossil Lake, the caves and berea beds of California are all listed as pre-glacial or interglacial, and if the fauna of the Willamette Valley had been found in a mountain cave or some other locality entirely disconnected with the elevated beaches of post-glacial depression, it too would undoubtedly have been classified as interglacial, for we have *Elephas columbi*, *Mastodon*, *Equus*, *Bison antiquus*, *Myiodon harlani* and a camel. All of these, perhaps identical in species, are also found in the caves and berea beds of California and several of them in the more northern Fossil Lake region. But there seems to be no reasonable doubt that this Willamette Valley fauna continued to live in post-glacial times and that the bones and teeth have remained undisturbed since they were first covered in the sand, clay and silt beneath the waters of that period. No one can look, for example, at the great mammoth tooth with its 27 plates and imagine that it had been carried far by changing formations or by rapidly flowing streams. It would soon have crumbled into small flakes of enamel. The horse teeth too, are some of them fine square-cornered unworn specimens.

We are aware that to claim that the horse, *Bison antiquus*, and the camel lived through and after the glacial period is rather presumptuous, and yet why not? We are not suggesting that these animals survived the glacial age at the bone deposit of Port Kennedy, Pennsylvania, or at Conard Fissure in Arkansas, or even at Fossil Lake in Eastern Oregon. Our claim is confined to Western Oregon and Southern Washington. It will be noted that Eastern Oregon and Eastern Washington are excluded. This is because Oregon and Washington east of the Cascade Mountains are geologi-

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cally a part of the Great Basin province, and their winter climate is largely under the same influences as that of the Middle West and Eastern United States. The dominant factor in all this region is the immense, cold, continental mass of North America. The winter climate west of the Cascade Mountains is now, and must have been during glacial times, controlled not so much by the climatic conditions of the great continental mass as by the vast expanse of comparatively warm water of the Pacific Ocean. There is now often from thirty to fifty degrees difference in the winter temperature east and west of the Cascade Mountains. It is also claimed that Oregon had no glacial ice sheet such as covered most of the temperate zone, although glaciers came far down from the mountains. If Southern Washington, Oregon and California knew no continuous mantle of ice and the great Pacific with its warm Chinook winds were always near, the hardy trees, shrubs, and grasses may have furnished, substantial food supply; but if the valley food became scarce, there was a wide continental shelf beyond the Coast Range which might have afforded even greater shelter and more uniform supply of food. Neither the horse, the camel, nor the bison find a warm climate a necessity if the food is plentiful. A herd of bison is now living in a wild state in the cold barren region of Northern Canada, near the Mackenzie River, and a very reliable authority states that in Northern Idaho a small band of horses was successfully wintered on a bleak, treeless mountain with no possible shelter from wind or storm, where the temperature must often have been as low as forty or fifty degrees below zero. The one saving feature was the dry bunch grass that grew on the mountain top.

We are the more confident in claiming post-glacial age for the mammals from the Willamette Valley because there is an increasing tendency in the latest research to acknowledge that many of the large preglacial animals did survive the ice age both in Southern Europe and in the United States. Why should the horse, the camel, and the ancient bison be excluded from the list when their fossil remains are found in what appears to be a post-glacial deposit

Our knowledge of the Pleistocene flora of Oregon is very meager. We only know that the stumps, cones, and branches of tide land spruce were found often in the elevated beaches near the coast. But thanks to the discovery of Winstanley, we can now clothe the hills and vales along the Willamette Valley of the Pleistocene with a rich flora as well as fauna. Winstanley found his fossil bed near the Sandy River, a small tributary of the Columbia, near Portland.

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Williams in a paper on the Columbia Gorge* writes as follows : "This fossil horizon is exposed three-fourths of a mile back from the Sandy River road, in the south side of the canyon of Buck Creek 25 feet above the water." R. W. Chaney, of the University of Chicago, also made a collection of these fossils and is quoted in the same article that "in this one exposure of the Satsop, four genera and at least seven species of plant life are represented. They include the oak, willow, walnut and sequoia. The latter is apparently the living redwood of California."

It may be of interest to note that the paleobotanist Knowlton reports that there were in the Upper Miocene of Eastern Oregon nine species of willow, one of walnut, seven of oak, and three species of sequoia. So it is not surprising that some of these still linger in Willamette Valley during the Pleistocene.

One and perhaps two races of men are known to have lived in Europe during glacial times. Osborn gives us an attractive glimpse of the life of these men in the very dawn of human industry. Many of them lived in Northern France on the Somme, where some of the terrible battles of the great war were fought. What a contrast between the primitive flints and other implements of the chase and warfare and the deadly scientific inventions for destruction of our advanced civilization of today. In glacial times men plodded across the narrow valley where the English Channel now rolls and traded implements and ideas with their neighbors living near the present site of London. It was the third and fourth glacial advances that taught those men to clothe themselves in reindeer skins and seek the shelter of limestone caves. This fascinating old story of primitive human life makes us impatient to discover a similar record in the United States and especially on our Pacific Coast where climatic conditions would be less trying during the glacial cold. But as yet our knowledge of primitive man in the United States is very unsatisfactory. Human remains have been found in the Hawver Cave in Sacramento Valley, and also at Ranch Le Brea, near Los Angeles, mingled with the bones of the great extinct Pleistocene mammals. Merriam believes that these remains are undoubtedly very old, but it is impossible to prove that they lived at the same time as did the animals with which they are associated.

*WinaAms. I. A. The Columbia River Gorge. Oregon Bur. Mines and Geol. Min. Res. Ore. Vol. 2, No. 8, p. 128, 1916.

fl(Nowuroiv, F. H. Fossil Flora of the John Day Basin, Ore. U. S. Geol. Surv. Bull. 204, 1902.

#08BORN, F. Men of the Old Stone Age. 1915.

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When the fauna of Fossil Lake in Eastern Oregon was first studied in 1877 many arrow points were found mingled with the fossil bones of the horse, camel, mammoth, mylodon and other Pleistocene mammals. Professor Condon wrote at the time :*

If the sands, the fossils, the arrow points and the fresh water shells were all of the same period, and the fossil bones were early Pleistocene, then the arrow points were fashioned before the Glacial Age and men inhabited the surrounding hills in the early Pleistocene period. But the mixture of these facts may be due entirely to the simple law of gravitation, for both the arrow points and the recent shells may have settled down among the fossils as the dust and sand upon which they rested were gradually blown away.

Copet in writing of these arrow heads said that the abundance of these flints is remarkable, and suggests that they had been shot at the game, both winged and otherwise, that had in former times frequented the lake. He recognized that it was impossible to prove that they had been shot at elephants and camels and other Pleistocene animals, but said. if they had been other than human flints no question of their contemporaneity would have arisen. Schufeldt adds :

This point interested me not a little, and when I came to go carefully over the great *mass* of fossil bird bones, every fragment and bone, was carefully examined for any indications whatever of their former owners ever having sustained any wounds or fractures of the same, but nothing of the kind was discovered. It yet lies quite within the range of possibilities to meet with the fossil bone of some large mammal or bird of Silver Lake, in which may be imbedded the point of a flint arrow-head.

One other link in the unsatisfactory chain of probabilities of early human life on our coast is the finding of a solitary arrow-point in a bored well at the Harris Ice Works, St. Johns. It was the property of J. G. Crawford, of Albany, Oregon. The well is situated in the extreme north end of East Portland, on the narrow peninsula between the Columbia and Willamette rivers. They had already bored through 150 feet of river silt when they struck gravel and in this gravel the arrow head was found. It would be quite easy to overestimate the importance of this piece of human workmanship, but it is certainly worthy to become a part of the slowly accumulating bundle of facts which furnish inconclusive evidence of the very early life of man on the Pacific Coast.

Compost. THOMAS, Oregon Geology, P. 1128.
COPE, E. D. The Silver Lake of Oregon and its Region. Am. Nat., Vol. 28. pp. 970-971, 1889.
SCHUFELDT, R. W. Phil. Acad. Nat. Sei., 2d ser., Vol. 9, p. 898, 1892.

