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Article IX.—NOTES ON ALASKAN MAMMOTH EXPEDITIONS OF 1907 AND 1908.

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Plates XVII–XXV.

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I. Introduction.

In the summer of 1907 the American Museum of Natural History sent the writer to Alaska primarily to examine into certain reports relative to the finding of an entire mammoth, and secondarily to make a reconnaissance in search of fossil vertebrates. A second expedition was sent out in 1908 to

continue the work already begun. These expeditions were planned by Professor Henry Fairfield Osborn and Director H. C. Bumpus. They were maintained through subscription of two of the trustees of the Museum, Messrs. J. Pierpont Morgan, Jr., and Percy R. Pyne.

During the first season the writer was accompanied as far as Nome by Mr. Madison Grant, Secretary of the New York Zoölogical Society, to whom he is much indebted for taking a personal interest in the expedition and rendering assistance in many ways. Special thanks are also due to Mr. C. R. Corbusier for the use of his canoe to make an excursion to the Palisades on the Yukon River, and to Mr. T. C. Noyes of Candle, Alaska, who loaned the only light boat in that region and without which it would have been impossible to make any progress on the rivers flowing into Eschscholtz Bay. A fine bison skull was donated to the Museum by Mr. George T. Coffey, through whose kindness the writer was enabled to examine the mine where it was found; and excellent specimens of fossil horse and bison teeth were presented by Mr. Arthur Gibson, C. E., Mr. George T. Reichenbach, Mr. W. S. Thompson, and Mr. Curtt H. Evern.

Map II (Plate XXV), showing the distribution of Pleistocene mammal deposits in Alaska and the Klondike region, has been plotted from all available sources of information and is practically complete[1] to date. Professor Henry Fairfield Osborn furnished records of several new localities as well as a map made, at his request, through the kindness of Dr. William H. Dall. The writer is indebted to Professor James F. Kemp for the identification and discussion of some samples of rock and silt from Eschscholtz Bay, and to Dr. Arthur Hollick who has undertaken the study of some specimens of Pleistocene plants from the same locality. Mrs. Elizabeth G. Britton has been kind enough to determine several mosses taken from the silts at Elephant Point and on the Buckland River. The assistance of Mr. Walter Granger, of the Museum staff, in the determination of fossils and in other ways has been greatly appreciated.

II. Itinerary.

We left New York on July 5, 1907, proceeding via Seattle and Skagway to White Horse, at the head of navigation on the Yukon River, and arrived at Dawson on July 19. Three days were spent in and about Dawson

[1] A reported occurrence (Nome Semi-Weekly Nugget) of mammoth remains on Snow River, at the head of Lake Kenai, Kenai Peninsula, Alaska, has been omitted. See also accounts of bones of mammoth and bear on the Pribilof Islands: Dall (3), p. 858; Dall and Harris, p. 266; Stanley-Brown, p. 499; Lucas (1), p. 718; and of mammoth teeth and tusks on Unalaska Island: Stein, pp. 382, 383. (For literature see appendix.)

examining several collections of fossils which had been found in this vicinity; we then continued our journey and reached Fort Gibbon on July 25. From here Mr. Grant visited Fairbanks while the writer made a trip in a canoe to a high cut bank, known as the Palisades, on the Yukon River thirty-five miles below the mouth of the Tanana. Four days later we met again on a river steamer and proceeded to St. Michaels, several stops giving an opportunity to examine a number of fossils which had been brought to the small settlements along the Yukon. On August 4 we departed from St. Michaels on a tug and a fifteen hour run took us to Nome where Mr. Grant left the expedition. The writer spent five days in and near Nome and also made a short trip up the Solomon River, thirty miles east.

The persons concerned in the reported mammoth find would make no reasonable agreement as to showing the body and, feeling pretty well satisfied that there was nothing in their various stories, it was decided to visit the well known fossil deposit on Eschscholtz Bay. On August 13 the writer left Nome on the steamer 'Corwin' and sailed to Keewalik at the eastern end of Kotzebue Sound, from here visiting Candle, a few miles up Keewalik River, and then returning to 'the spit.'

As there is no regular means of travel north of Keewalik it becomes absolutely necessary in exploring this region to have two boats — one adapted to coasting, and a canoe for use on the rivers. In this part of Alaska quick travelling on rapid rivers is not understood hence light river-boats are not to be found and a clumsy, waterlogged canoe was finally secured only by chance. For cook and helper, the services of James Hoffman were engaged and his fishing boat hired for the coasting; Keewalik's three launches were under contract and could not be procured at any price. Unfortunately the boat was not fitted with a centerboard, which made it impossible to sail in any wind ahead of the beam and caused considerable loss of time.

After several unavoidable delays we got away from Keewalik on August 24 and proceeded first to Elephant Point. From two camps near the point we searched the bluffs on the south side of Eschscholtz Bay, and the cut banks on the lower part of Lost River. On September 1 we entered the Buckland River but ascended only fifteen miles for it had become evident that, owing to the unusually early fall, it would not have been possible to make a thorough exploration in the short time remaining. We therefore turned about and went to the Ah-weeng-nuk River which enters the northeastern corner of Eschscholtz Bay; this small stream was explored for twenty miles or more but only three bones were found and it did not seem worth while to go any further. The bluff on the north side of Eschscholtz Bay was next examined from one end to the other. Adverse winds and an exceptionally heavy gale, which lasted three days, having put an end to the

idea of further exploration, we sailed to Elephant Point and went over this ground once more. Several fossils had been washed out of the bluff during our absence, and some interesting results of the storm are noted below.

On September 19 there was considerable ice around the edge of the Bay, the bluff had begun to freeze, and even the exposed clay flat was solid; upon returning to Keewalik it was found that mining operations in the interior had ceased and that nothing more could be accomplished. Passage was therefore secured on the first trip of the 'Corwin' to Nome and thence on the first boat to Seattle, but owing to the inevitable delays in Alaskan travel New York was not reached until November 2.

During this expedition portions of a mammoth skeleton together with some skin and hair, were found imbedded in the bluff near Elephant Point in such a manner as to afford very good reasons for the belief that the entire skeleton, with a large part of the covering, would be found in place. In 1908 the writer was sent on a second expedition the main object of which was the excavation of this specimen, but also to make such further reconnaissance as time would permit. Accordingly he left New York toward the end of May, proceeding to Seattle and thence direct to Nome where he arrived on June 21 after ten days' delay in the ice. Seward Peninsula was crossed by train as far as Shelton and by wagon the rest of the way to Candle. Here James Hoffman, with his fishing boat, was again engaged, and we rowed down the river to Keewalik where an outfit was purchased for a preliminary trip to Elephant Point, the writer expecting to return to Candle for another assistant and a steam thawing apparatus.

We left Keewalik on July 1 and reached Elephant Point on the third, having worked through pack-ice which closed up immediately after our arrival and did not finally break up and blow out of Eschscholtz Bay until the tenth. Excavation was commenced with picks and a few days' work proved the skeleton to be incomplete; we therefore continued digging and were able, by very hard labor, to get out all the remains by hand. After going over the ground near Elephant Point we crossed the bay to examine the bluffs near Choris Peninsula, and then returned to Keewalik. In the meantime the first boat of the season had arrived and delivered a light canoe which had been shipped to this place.

On July 20 we left Keewalik in the dory, with the canoe in tow, and two days later anchored eight miles up Buckland River. From here the river was ascended in the canoe to a point about eighty-six miles above the mouth but the water was so low, on account of a drouth, that no further progress could be made. Returning to Eschscholtz Bay we again examined the bluffs along the south side, and then crossed to the north shore about opposite Elephant Point; leaving the boats in a safe spot we walked, with light packs,

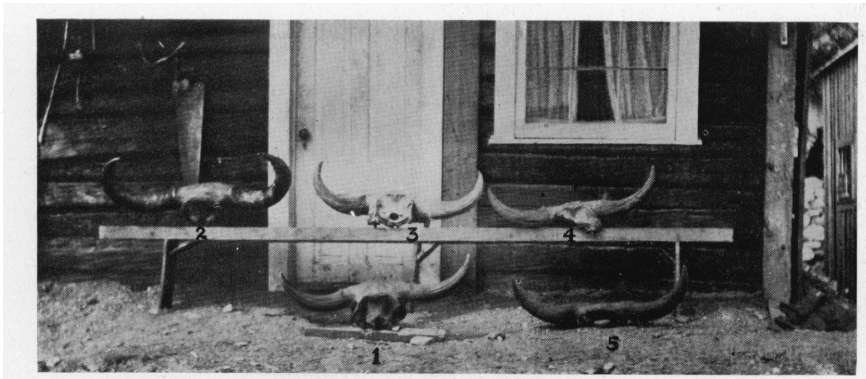

Fig. 1. Bison skulls from the muck of Fox Gulch.

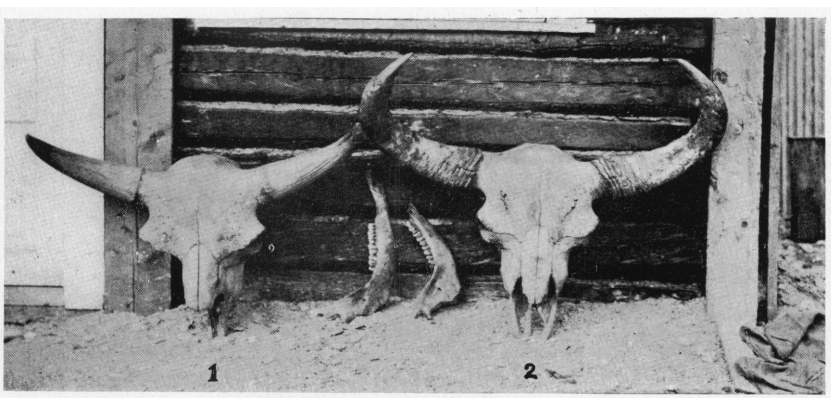

Fig. 2. Two of the skulls shown in Fig. 1.

across the narrow peninsula and spent several days along the southern shore of Selawik Lake and the southern and western shores of Hotham Inlet. Recrossing the peninsula to Eschscholtz Bay, we sailed back to Keewalik on August 20.

The writer returned by boat to Nome and Seattle, and arrived in New York on September 23.

III. Fox Gulch,[1] Klondike District, Canada.

Fox Gulch is a short, steep draw, worn down into solid bed-rock, containing in ordinary seasons a small stream flowing into the left side of Bonanza Creek, a tributary of Klondike River. Upon the bed-rock there rests from four inches to four feet of gravel which is covered with twenty feet or more of muck capped with the tundra. Some layers of pure ice are exposed in the muck.

A small mammoth tusk was seen projecting from this deposit just above the gravel, near the head of the gulch, and the radius of a large bear was found within a few feet of it, on the same level. Thirty-three bison bones and one fragmentary pelvis of a horse were collected on the 'tailings,' or washed gravel, below the mine. A collection of fossils preserved here consisted of a mammoth skull, two molars, and several imperfect tusks; also seven bison skulls and two separate rami of the lower jaws (containing the teeth) of animals of the same genus. Two of the skulls were almost complete: of these one retained the horn-sheaths in good condition, the other (No. 13721, Am. Mus. Nat. Hist. See skull numbered 1, Plate XVII, Figs. 1 and 2) contained three teeth. Four of the remaining skulls were apparently of the same species, *Bison* (*occidentalis* ?), while the seventh skull had slenderer and straighter horn cores.

Mr. George T. Coffey, who has charge of the hydraulicing operations, gave the information that all the fossils are found, in a small area near the head of the gulch, lying in the muck on the top of the gravel or partly imbedded in the latter.

Pleistocene mammals found in Fox Gulch: — *Elephas, Ursus, Equus, Bison,* and *Alce.*[2]

IV. The Palisades, Yukon River.

A high, cut bank on the Yukon River, thirty-five miles below the mouth of the Tanana, has been described in detail by several geologists [3] under the

[1] See Gilmore, pp. 15–17.

[2] Gilmore, p. 15.

[3] Russell, p. 122. Spurr, pp. 200–221. Collier, (2), pp. 18, 43. Maddren, pp. 17–18. Gilmore, pp. 17–22.

name "Palisades," or "Bone-yard." Only a few scattered and fragmentary bones of the mammoth and bison were seen here, a collector having been over the ground shortly before the writer's arrival.

Pleistocene mammals recorded at the Palisades: — *Elephas, Bison, Equus,*[1] *Ovibos yukonensis.*[2]

V. Nome Coastal Plain.

Marine shells are abundant in the Quaternary deposits of the Nome coastal plain, but no mammalian remains have hitherto been recorded from this locality[3] though they are found in the coastal plain deposits on the Arctic side of Seward Peninsula. With the exception of some badly decayed fragments of bone (whale ribs?) from the third beach line, only the following specimens were seen: — small piece of walrus tusk, said to have been found in the 'pay sand' on Center Creek, 55 ft. below the surface; part of a caribou antler, also from Center Creek, 72 ft. below the surface; and a complete walrus skull with the teeth and 8-inch tusks.

This skull was found by a miner who states that it was dug out of a prospect hole on the second beach line, three quarters of a mile back of the present beach, one mile east of Fort Davis, near Nome. The section was given as follows: — tundra 2 ft.; gravel, rocks, and muck 25 ft.; gray sand 18 in.; ruby pay sand 6 in.; gray sand 2 ft.; ruby pay sand 8 in.; clay bedrock. This entire section was frozen solid, and the skull lay in the lowest layer of ruby pay sand. A number of bones were found close to the skull and the prospector believes that much of the flesh was also preserved (although he did not actually see it) since the steam thawing caused a "horrible stench." The prospect had been abandoned and, owing to the caving in of the walls of the pit, could not be examined. The skull was not much discolored and retained no traces of skin or flesh; in its cavities, however, was a quantity of sand containing many plainly visible particles of gold.

It is known that thawing muck often gives off strong odors which are entirely due to decaying vegetable matter, and the preservation of flesh here is doubtful.

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[1] Gilmore, p. 31.
[2] Gilmore, pp. 19, 35. Gidley, p. 681.
[3] Collier, Hess, Smith, and Brooks, p. 87.

VI. Keewalik River, Alder Creek, and Native Gulch.[1]

Candle Creek, a branch of Keewalik River, has been pretty well prospected and fossils have been taken from both valley- and bench-claims. The miners agreed in stating that the fossils are found deep in frozen muck or resting on underlying broken schist bed-rock or gravels, or occasionally imbedded in the gravels. All the specimens seen were in good condition and not at all waterworn, but there seems to be no authentic record of the finding of skeletal parts in association. Isolated bones, teeth, etc., have also been collected in the upper part of Keewalik River, and a musk-ox[2] skull is recorded from a tributary called Quartz Creek.

Keewalik Lagoon, or estuary, is bordered on both sides by silt bluffs about 15 ft. high; on the beaches at the foot of the bluffs there were found a few remains, for the most part fragmentary, of mammoth, bison, and caribou. It might be assumed that these fossils had been washed down Keewalik River and transported to the shores of the lagoon by ice, but a mammoth tusk has been found projecting from the bluff on the west side of the estuary, and, during the summer of 1908, the lower jaw of a mammoth was dug from the muck bank of a branch of Minnehaha Creek which flows into the lagoon near Keewalik. Fossils have been recorded from other places in the coastal plain deposits of the north side of Seward Peninsula, especially in the vicinity of Good Hope Bay[3] and Schismareff Inlet.[4] A trader exhibited a large mammoth tooth which he found on the Serpentine River, and stated that he had seen other teeth and tusks along the high mud banks cut by this stream; also on Schismareff Inlet near the mouth of the river.

Pleistocene mammals[5] from Keewalik River drainage basin and lagoon: — *Elephas, Equus, Bison, Rangifer,* and *Ovibos.*

Mr. George T. Reichenbach showed the writer two large bison horns, retaining the outer sheaths in good condition, which were found two feet below the surface, in gravel, on Alder Creek. This stream enters Kotzebue Sound about ten miles west of Keewalik. Native Gulch is a small draw, near Alder Creek, filled with fifty feet of muck resting upon gravel; two bison teeth, found here in the base of the muck, were also examined, and fragments of caribou antlers are said to occur in both localities.

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[1] See Map I (Plate XVIII).

[2] Moffit, p. 42.

[3] Moffit, p. 41.

[4] See also Gilmore and Maddren, maps.

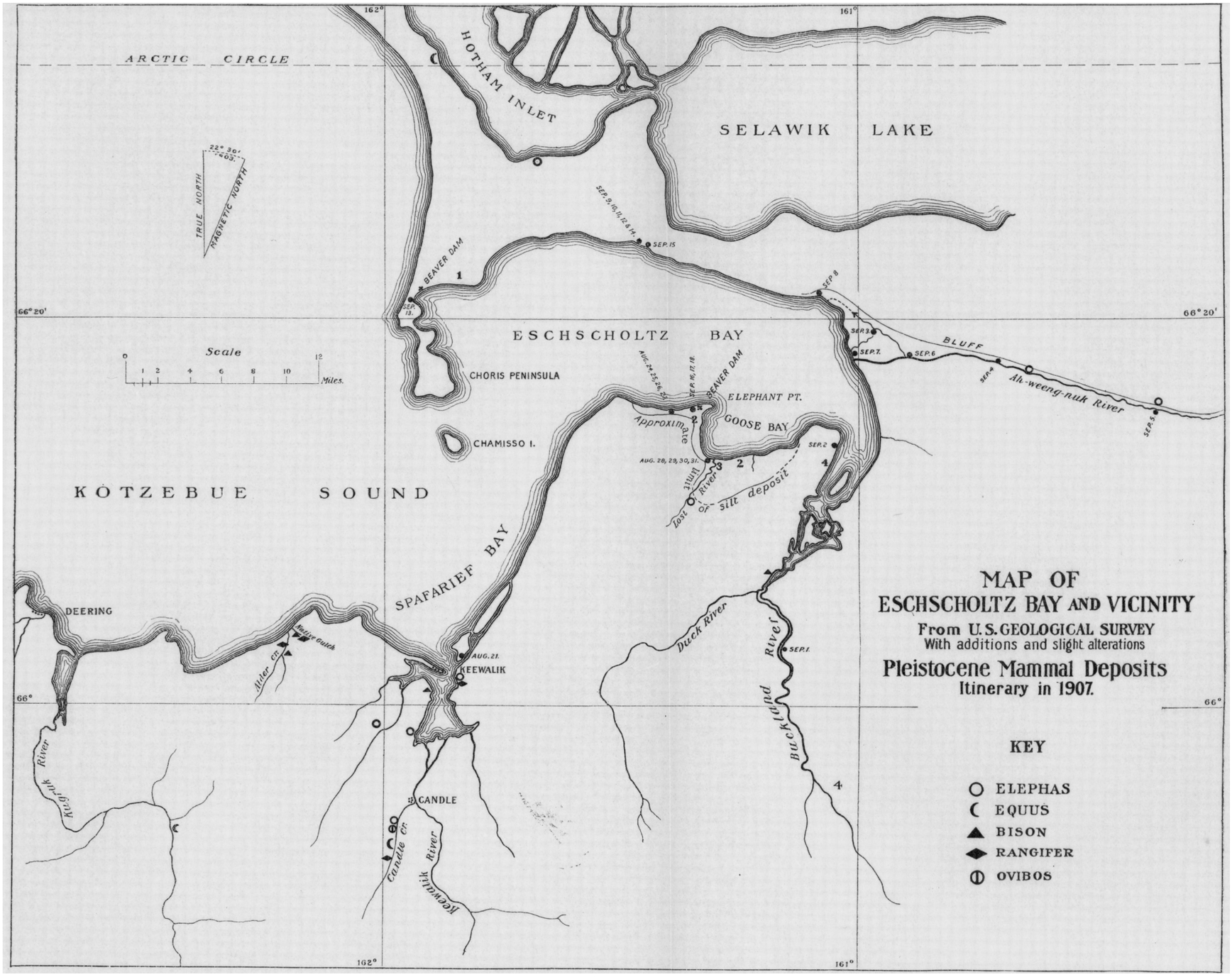
[5] A miner claims to have taken the tusks, with parts of the skull, of a "boar" from a layer of gravel, resting on bed-rock and covered with twenty feet of frozen muck, on Candle Creek. Capt. Conrad Siem, Secretary of the Alaska Pioneers Association, also states that he saw a boar tusk which was found by a native at Tasekpuk Lake, near the Arctic coast of Alaska, long. 153° W.

VII. Eschscholtz Bay.

Eschscholtz Bay (see Map, Pl. XVIII) is about twenty-five miles long, east and west, by ten miles across in a north-south direction. The channel runs from the mouth of Buckland River, at the southeastern extremity of the bay, considerably nearer the south than the north shore and splits to enter Kotzebue Sound on both sides of Chamisso Island. The whole bay is extremely shallow, the channel itself being not more than fifteen or twenty feet deep off Elephant Point.

High bluffs face the water all around except at the wide Ah-weeng-nuk delta and for a few miles to the westward of the mouth of Buckland River. Several small deltas, covered with vegetation, lie in embayments in the bluffs opposite the mouths of streams, and at other places, least affected by waves or currents, swamp-loving sedges, etc., have secured a hold on low flats formed by mud washed down from bluffs which have subsequently become entirely overgrown. Large quantities of driftwood are stranded on these deltas and flats and even for some distance up the stream valleys at a level far above an ordinary high tide; most of this wood consists of tree trunks, probably brought down from Buckland River, but it also includes lumber and wreckage. The deltas near Elephant Point are favorite camping places for Eskimos travelling to and from the river, and little driftwood has been left on them. A sloping sandy beach averaging about fifteen feet wide fringes the south shore of Eschscholtz Bay eastward to Elephant Point and southward along Goose Bay to the mouth of Lost River. The Point is a low sandspit, half a mile in length, with a broad marsh on its protected, southern side. Along the north shore, except near Choris Peninsula, the beach is steep and high, which accounts for the fact that the bluff here is not being cut away.

The tides of Eschscholtz Bay deserve mention: the rise and fall probably averages about three feet but it is so erratic that one cannot depend on calculations. Owing to the shallowness of the bay and shape of the coast local winds have an immediate effect, but there are other, unexpected, changes due to storms in the Arctic Ocean and Behring Sea. Thus southeast or southwest gales in Behring Sea produce a strong northerly current through the Strait and raise the water in Eschscholtz Bay, contrary local winds notwithstanding, several hours before the arrival of the storm wind. The slope of the bottom of Eschscholtz Bay is so gradual that at an average low tide a quarter of a mile of clay flat is exposed all around its shores; at times the tide does not drop in the least and, again, the water recedes fully a mile from the beach. We were held at camp near the mouth of Lost River for a day and a half after preparing to move by the draining of Goose Bay which remained absolutely dry for forty-eight hours.



MAP I.

1 Eschscholtz Bay, north. *Elephas, Equus, Bison, Ovibos, Rangifer, Castor* (dam), *Canis* (Eskimo dog ?).

2. Eschscholtz Bay, south. (a) Historic bluff, west of Elephant Point; *Elephas, Equus, Bison, Symbos* ?, *Ovibos, Rangifer, Rangifer* sp. nov., *Alce, Canis* (wolf), *Ursus, Castor* (dam). (b) Goose Bay (west and south); *Elephas, Equus, Bison, Ovibos, Rangifer, Rangifer* sp. nov., *Alce.*

3. Lost River. *Elephas, Rangifer.*

4. Buckland River. *Elephas, Equus, Bison, Ovibos, Rangifer, Alce, Ursus, Canis* (wolf).

The tides are strong and no doubt carry out quantities of fine silt but erosion of the bluffs, at present, is altogether due to wave-action and atmospheric agencies. Where average high tides reach the deposits around Eschscholtz Bay steep or even perpendicular bluffs result, but the low beaches partially protect a large proportion of the cut bluffs so that waves barely wash their base and work into them only during exceptionally high water; in these places the bluffs slope back at an angle since the softened surface-layer, with its mantle of vegetation, is broken up by slides which allow further thawing, and washing by rain, to gain on wave-erosion.

a. The historic bluff.

At the entrance to Eschscholtz Bay, on the south, there is a vertical rocky cliff which terminates, about four miles from the extremity of Elephant Point, at the western margin of a Pleistocene deposit of very fine, grayish, micaceous silt, or clay. Between the rocky cliff and the base of Elephant Point is the historic, fossil-bearing bluff,[1] about three and one half miles in length, discovered by Kotzebue in 1816 and described also by several later explorers. The bluff does not end, however, at Elephant Point but bends to the south and continues around the western, and part of the southern, shores of Goose Bay.

The approximate limits of the deposit are shown on Map I (Plate XVIII) and in Fig. 1, Plate XIX. It will be seen that on Eschscholtz Bay and the western side of Goose Bay there is only a narrow strip along the base of a low ridge which is the termination of the Keewalik-Buckland divide[2]; to the south of Goose Bay the deposit extends several miles up a V-shaped valley lying between this ridge, on the west, and a spur of the divide, near Buckland River, on the east. Descriptions of the bluff west of Elephant Point are so variable and contradictory that one must come to the conclusion that rapid changes have taken place during the past century; at the present time the details of these accounts are no longer recognizable and another description is called for.

At the base of Elephant Point the bluff is about fifteen feet high rising, less than a mile to the west, to the altitude of one hundred and twenty feet and gradually descending to a height of twenty feet at the opposite end (Plate XIX, Fig. 2). Several small streams have cut deep valleys well back

[1] See Maddren. In an appendix (pp. 67–113) Maddren gives a list of the literature on this deposit, and a complete series of extracts. Since the latter are collected in a convenient form, references will be made to Maddren's paper rather than to the original works. Fig. 2, Plate VII, p. 48, is a reproduction of Kotzebue's illustration of the ice-cliff.

Seemann, Berthold. Vol. I, Botany, 1852. Plate i (view of the "ice-cliffs").

Beechey, Vol. II, Zoölogy, 1839. Plate i (geological map of Eschscholtz Bay).

[2] See Moffit, geologic map, plate iii.

toward the ridge and divide the bluff into five main hills which, for the purpose of description, are numbered 1 to 5. (Plate XIX, Fig. 2.) Besides these streams there are several rivulets on hill 2, and two near the western end of hill 5. The two latter rivulets show, each, a small exposure, and there is another cut on the face of the 5th hill but with these exceptions the sloping faces of hills 3, 4, and 5, and the valleys between them, are completely overgrown with willows, alders, grasses, and various small flowering plants. From the top of the bluff the surface of the deposit slopes gradually upward to the ridge, where the grade becomes steeper, and the whole is covered with an unbroken carpet of tundra.[1] At the foot of the bluff, opposite the mouths of streams, there are four small deltas which are more or less swampy and support growths of alder and willow-bushes along the base of the bluff and sedges and water plants further out. Hill 1, from the beaver dam west, hill 2 entire, and the 3rd hill as far as the eastern end of the delta at its base are at present being rapidly worn away. The bluff is perpendicular only at the beaver dam and for a few yards on either side of the rivulet just west of it (Plate XIX, Figs. 1, 2, and 3), the eastern end of hill 3 is very steep, but partly overgrown with grasses, etc., and the slope of hill 2 does not average much over thirty degrees.

The face of hill 2 is very rough, being studded with knolls and ridges left standing between numerous land-slips which occur irregularly over the entire hill. There are many parallel, crescentic — or cirque-shaped — cracks, often gaping six inches in width, in and at the heads of these slides which show that the two or three feet of thawed surface is working bodily downward. A number of masses of pure ice (Plate XIX, Fig. 3) are exposed in the face of this hill, and there is usually a low-grade slope of soft, flowing or sliding mud extending for several yards below them. Four small rivulets flow down from the first rise back of the bluff through steep gulches whose sides are mostly concealed by vegetation. This rough, broken incline is almost entirely covered with a rank growth of grass from two to four feet high, the only exceptions being the fresh slides — including the soft mud slopes below the glaciers — and the scattered, small, cut surfaces above and at the sides of the glaciers and at the cut sides of some of the knolls and ridges.

[1] The characteristic tundra plant is the "Alaska cotton," a sedge growing in closely set clumps or tussocks which stand about one foot above the general level of the ground, and which make travelling in summer so difficult that it is rarely attempted except on beaten trails or by the waterways. *Sphagnum* and other mosses flourish in the meshwork of narrow spaces between the "niggerheads," as the tussocks are popularly known, and sometimes crowd out the sedges altogether. The lichen *Cladonia* grows in many places, especially on the ridges, and there is also quite a variety of low, flowering herbs. This vegetation serves, like a sponge, to retain water and make a species of 'bog' of the entire surface of the country except on the summits of high hills and mountains. The ground thaws in summer to the depth of about three feet, but when the tundra is removed thawing penetrates deeper, and the surface layer of mud begins to flow away wherever there is an outlet.

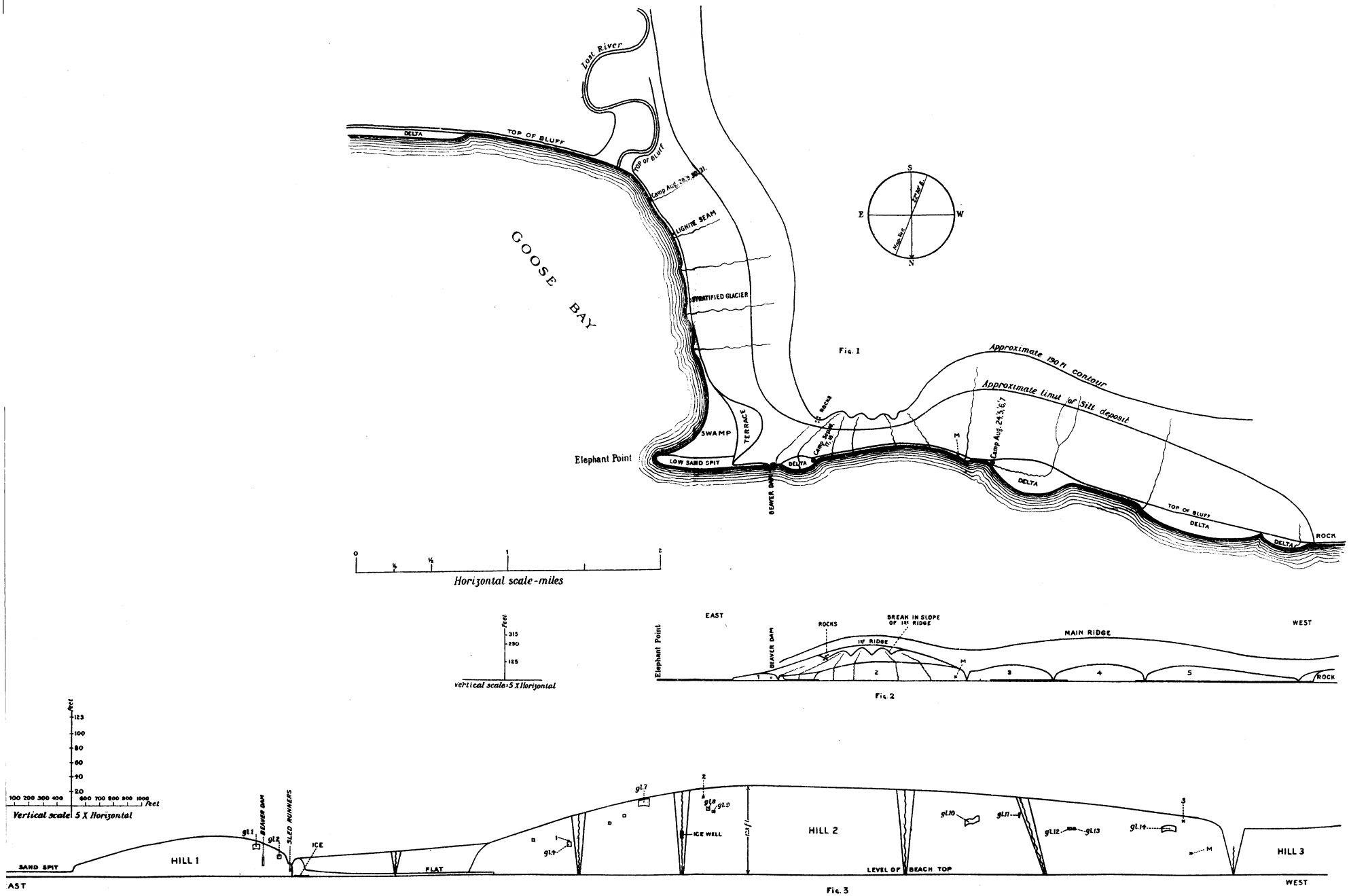


Fig. 1. Sketch map of Elephant Point and vicinity.

Fig. 2. Diagrammatic face view of the historic bluff.

Fig. 3. Enlarged view of hills 1 and 2, showing ice exposed in 1907 and location of fossils, etc., found actually imbedded in the bluff in 1907 and 1908.

1. Mammoth scapula imbedded above glacier No. 4.
2. Phalanx and two sesamoids of the horse; and caribou antler.
3. Horse astragalus.

M. Part of mammoth skeleton with skin and hair. Also bones of wolf, caribou, and horse; and small droppings.

The narrow stream between hills 2 and 3 has exposed several small, clean sections of the deposit, and numerous small angular fragments of red andesite-porphyry can be seen at the base imbedded in silt and sand. The stream-bed contains partly rounded fragments of this rock and the beach west of it as far as the neighboring delta is littered with sharply angular blocks of the same material which are falling out of the base of this portion of the bluff. Some of the blocks appear to have been broken off of polygonal columns and it is probable that they are talus-fragments from a rocky cliff, or an island, buried under the silt close to the present beach. Near the western end of hill 2 the edge of a stratum of more or less angular gravel is seen in the face of the bluff (see Figs. 3 and 4) at a height of twenty-eight feet above the beach, and a layer of coarse sand containing very fine pebbles, several feet thick, can be traced along the base of the bluff at intervals between the beaver dam and Elephant Point (see Fig. 5). Other details are described below.

A small willow tree was found imbedded in hill 1 near the beaver dam (*q. v.*). Sticks and twigs, often retaining the bark, show in some of the cut surfaces, and they are also found on the slides; the largest limb observed, which was six inches in diameter and about three feet long, appeared from the bark to be an alder while some of the smaller branches were plainly birch.

About three hundred yards back of the face of hill 2 the slope takes a sudden upward trend to the top of a hill two hundred and fifty feet above water level and from here rises more gradually to the summit of the main ridge three quarters of a mile or more from the bay. On the steep slope of the first rise there is a sharp break (Plate XIX, Fig. 2) forming a low bluff into which the heads of the rivulets of this hill are cutting back. At one point in this break a number of angular fragments of andesite-porphyry, like that of the rock-fragments mentioned above, were found weathering out through the tundra, and there seems to be no doubt that the ridge is composed of this material [1] and not "chiefly of solid ice" as Dall [2] assumed.

Remains of the following mammals [3] were found either imbedded in the historic bluff, or upon its slides, or on the beach and clay flat below: *Elephas, Equus, Bison, Symbos*?, *Ovibos, Rangifer, Rangifer* sp. nov., *Alce, Canis* (wolf), *Ursus, Castor* (dam).

b. Ice in the historic bluff.

Fig. 3, Plate XIX, is an enlarged, diagrammatic view of hills 1 and 2 to show the amount and distribution of the ice exposed in 1907, and the location

[1] Cf. Moffit, geologic map, plate iii.

[2] Maddren, pp. 104, 105.

[3] The reported occurrence of fossil *Ovis* from this locality, by Seemann (see Maddren, p. 93), is an error. Gilmore, p. 36.

of the fossils, etc., found actually imbedded in their undisturbed places of deposit. It should be noted that the vertical scale is five times the horizontal scale and that the ice therefore appears five times its true proportional thickness, also that differences in level are multiplied by the same factor.[1]

There are fourteen masses of pure ice or 'glaciers,' [2] for want of a better term, exposed in these two hills, one on either side of the beaver dam in hill 1 and the rest in hill 2. The largest is about one hundred feet in length and the smallest fifteen feet; in vertical thickness they vary from one to eight feet — that is, this amount is exposed. They average about five or six feet in height in the middle and *appear* to be thinner at the ends, though they are represented in the diagram as of the same thickness throughout One (gl. 11) is a wedge-shaped mass, which may be called a 'dike,' seven feet high, two feet wide at the bottom, and five feet across the top. The faces of the glaciers are nearly vertical and as seen from above may be represented by a curved line with the concavity toward the bay. This is to be explained by the fact that the crescentic cracks caused by landslips — which cracks probably extend occasionally down into the frozen material and thus expose the ice — have the same relation to the face of the bluff Possibly the glaciers melt back more rapidly in the middle — in any case when viewed from the front they appear to be arched and thinner at the ends, since the center is further back from the sloping face of the bluff than the extremities. In walking on the soft slopes under the glaciers one sinks into the mud to the depth of a foot or more and comes to rest, below most of them, on solid ice; by tramping in the mud and pushing it away the ice can be seen and traced continuously forward from the base of the glacier for a horizontal distance often of several yards, or to a point near the foot of the mud slide. Below this point the slide is dry and firm — probably having no ice beneath it to retain the water — and takes the steeper general slope of the face of the bluff on either side of the glacier (see Figs. 1, 2, 5, and 6). The ice melts faster than the frozen material above which overhangs a foot or two and, breaking off in large lumps, falls to the base of the glacier where it quickly thaws to add to the mud. This heap of partly frozen talus protects the base of the glacier so that as the latter melts back into the bluff less and less ice remains exposed, the glacier is finally covered to the top and becoming again overgrown with grass remains dormant until a new landslip starts the melting afresh. The appearance of a number of slides suggests that this covering process has taken place and that there are, therefore, more masses of ice in the deposit than those now visible.

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[1] Distances and heights, in all the figures, are estimated by pacing etc., and not measured.

[2] In Alaska the term 'glacier' is used indiscriminately by the miners to describe anything frozen — from pure ice to mud banks — and does not usually convey the idea of motion.

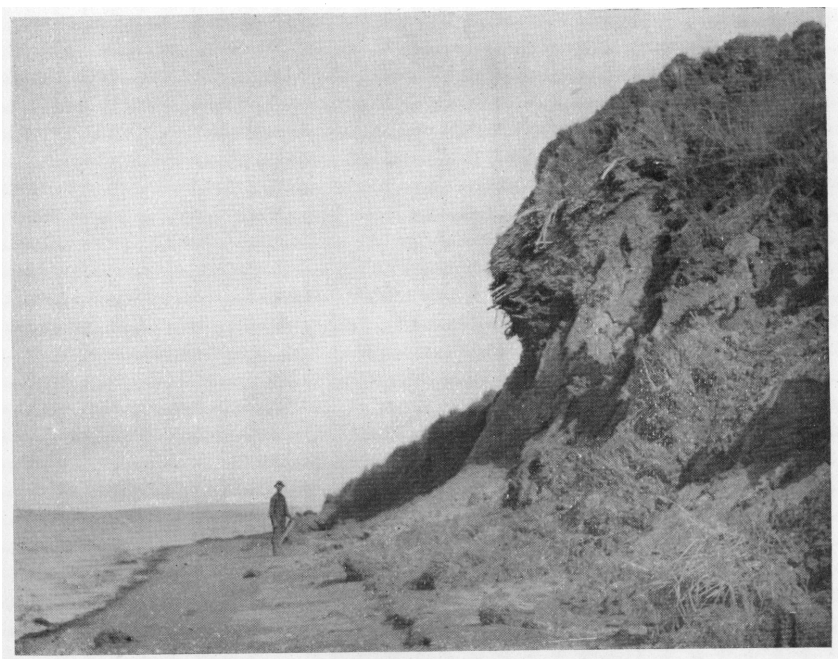

Fig. 1. Beaver dam imbedded in the historic bluff, seen from the west.

Fig. 2. A glacier (**G**) in hill 2, historic bluff.

One of the largest ice-layers (gl. 7, Plate XIX, Fig. 3), is situated just under the tundra though there is no sign which would indicate its presence from above. Its length is about seventy-five feet; beneath the mud slide solid ice was traced forward to the horizontal distance of thirty feet and, taking the angle of the mud slope into consideration, it appears that the entire thickness of pure ice is at least eighteen feet, of which the upper eight feet is exposed in the form of a 'glacier.'

The remaining glaciers are imbedded in the bluff at various elevations, though most of them are seen to be contained within a comparatively narrow zone toward the top of the deposit. The largest glacier observed (gl. 14, Plate XIX, Fig. 3) is about two thirds the height of the bluff above the beach; it is one hundred feet in length and its vertical face, which has the usual curved and arched form, is seven feet high in the middle and somewhat thinner at the ends. The mud slide is firmer than the average and no ice could be traced forward beneath it. Glacier no. 10 is of an irregular shape since it has been exposed by two separate slides one of which extends further up the hill than the other. Two more ice-masses to the west of Elephant Point must be described: the first is seen in the bottom of the second gulch from the eastern end of hill 2 (ice-well, Plate XIX, Fig. 3) at a distance of one hundred and twenty-five yards back of the beach. It is ten feet in thickness and its horizontal base rests on silt at an altitude of fifty feet; it is covered with ten feet of frozen mud, and the rivulet, falling from the top of this mud has worn a hole fifteen feet in diameter through the ice, running out below on the silt through a subterranean — or rather sub-ice — channel and reappearing further down in the gulch. The second ice-mass (ice, Plate XIX, Fig. 3) was exposed by a gale which raised the tide and undercut the western end of hill 1 to a depth of ten feet, showing at the back of the cut a layer of pure ice one foot thick and nearly one hundred feet long; but whether it extended downward below the level of the beach top could not be determined.

A stratified glacier consisting of alternate layers of ice and frozen muck is described below (see Figs. 1 and 2).

At present (1907), therefore, the maximum dimensions of the different glaciers are: — length (east and west, along the face of the bluff) one hundred feet; breadth (north and south, glacier no. 7) thirty feet; and vertical thickness (glacier no. 7) eighteen feet; but these are the visible or traceable dimensions and the glaciers may be more extensive. The ice is distributed in apparently isolated masses at various elevations from the beach to the top of the bluff, but some of these glaciers are very nearly on the same level and may have been connected in the portion of the bluff now washed away, and they may also be still connected within the remaining deposit. The

ice is not confined to the face of the bluff where it might have formed in cracks but in the cases of the ice-well, glacier no. 7, and the ice-layer exposed by the gale at the rear of the cut in the base of the bluff, it evidently extends back into the frozen silt.

All the water flowing from the bluff seems to come from the tundra above or from the superficial thawed layer on its face, there are no underground streams issuing from it.

In the spring and summer of 1908 there was almost no rain in this region and the snowfall of the previous winter had been very light, hence the bluff had become dryer and firmer, most of the glaciers were more or less covered, and some of the smallest had been entirely buried. On the other hand several small, new ones had appeared. Other changes noted were the complete disappearance, by melting, of the vertical exposures of the two glaciers at the sides of the beaver dam, which left clean walls of frozen silt in their places; these ice-masses could therefore not have been more than two or three feet thick (horizontally) in 1907. The stratified glacier on Goose Bay had also melted back a couple of feet and no longer contained horizontal ice-layers though the vertical ice-dike and upturned strata abutting against it were still to be seen in clean section. A very brief, chronological summary of the ice conditions in the historic bluff, as noted by all the persons [1] who have examined it, is given here for comparison: —

Aug. 8, 1816.— Bank almost perpendicular.

Pure ice 100 ft. high. (Kotzebue [2]).

July 29, 1826.—Cliff in some places vertical, in others slightly inclined (Beechey[3]). Large masses sometimes seen rent off and standing out from the body of the cliff (Collie [4]).

Only a few insignificant patches of ice remain (Beechey [5]).

Sept. 18, 1827.— Cliffs broken away considerably.

Frozen surface (ice) in smaller quantities than before (Beechey [6]).

1849.— Cliff perpendicular; structure exposed (Seemann [7]). Large chasm in bluff; great landslides; structure exposed (Goodridge [8]).

Enormous portions of ice separated from the main body. Below, ice 20-50 ft.; clay, sand, bones, 2–20 ft.; on top, peat 2–5 ft. (Seemann [9]). Ice 60 ft. high (Kellett [10]). Ice 50–80 ft. high (Goodridge [11]).

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[1] See Maddren, pp. 67–117.
[2] *Ibid.*, p. 68; and fig. 2, plate vii, p. 48.
[3] *Ibid.*, p. 69.
[4] *Ibid.*, p. 76.
[5] *Ibid.*, p. 70.
[6] *Ibid.*, p. 73.
[7] *Ibid.*, p. 92; and Seemann, Vol. I, plate i.
[8] Maddren, pp. 99, 100.
[9] *Ibid.*, pp. 92, 93.
[10] *Ibid.*, p. 102.
[11] *Ibid.*, p. 100.

July 16, 1880.— Bluff nearly perpendicular for about one mile.

Ice half a mile in length; smaller patches in several places. Ice 30 ft. thick in holes on face of bluff at top (Hooper [1]).

Sept. 2, 1880.— Cliff rough and hummocky; considerable talus.

Two layers of ice — one near beach, the other close to top. Large, perpendicular ice-faces. Immense ice-cakes irregularly disposed in the clay. (Dall [2]).

Sept. 7, 1881.— Bluff inclined and covered with talus.

Two ice-layers,— one at bottom, the other close to top. (Nelson[3]). Ice remains the same from year to year (Hooper [4]). [*Cf.* above.]

From this review it will be seen that the bluff was vertical, or nearly so, from 1816 until 1880 since which date it has become inclined, and that the ice appeared to be most abundant while the cliff was perpendicular except in 1826–27 when the ice patches were insignificant. This would seem to prove that any very deep ice-masses were comparatively thin, horizontally, and separated from one another and that they were not portions of "icebergs" as Kotzebue and Seemann imagined. Collie [5] thought that some of this deep ice was formed from snow or water in fissures more or less parallel with the face of the bluff and that it became exposed by the falling away of the retaining wall of frozen earth. In this case it would belong to the Recent period.

The surfaces of the glaciers are coated with a thin film of mud which runs down from the melting material above, but the ice within is clean though often yellow-tinged. One small, clear glacier imbedded in silt showed a distinct line of stratification running horizontally across the middle. Pieces of ice cut out from the different glaciers at a space of a foot or more from the exposed surfaces were full of round, oval, or much elongated air-bubbles or cavities. Some ice, eighteen inches thick, tapering down into a layer of gravel under the mammoth remains (i, at left, Fig. 4) was likewise vesicular and contained a few thin sheets of dirt. A vertical crack two inches wide passing between parts of this skeleton was filled with ice (i, at right, Fig. 4) which contained thin laminæ of dirt parallel to the walls; the bubbles in this ice were minute. Fragments of ice taken from the glaciers, ice-dikes, and ice-cracks melted, when exposed to the sun, so as to show a polyhedral, granular structure at the surface, and these granules could usually be easily rubbed off with the finger; they were very small, and somewhat indistinct, in the narrow, vertical crack just mentioned but in other places averaged about three sixteenths or one quarter of an inch in diameter, though in

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[1] Maddren, pp. 103, 108.

[2] *Ibid.*, pp. 104, 105.

[3] *Ibid.*, pp. 111, 112. Figure 3 (p. 112) is a section of the bluff through the beaver dam.

[4] *Ibid.*, p. 111.

[5] *Ibid.*, pp. 77, 78. *Cf.* Gilmore, pp. 20–22.

different parts of a single mass of ice they might show plainly or be apparently not formed.

Owing to the poor exposures in 1907–08 it was impossible to arrive at any final conclusions concerning the origin of the ice-masses, but a few remarks may be of interest. Some of the small glaciers may have been recently produced from snow or water in crescentic cracks at the heads of cirque-shaped slides but other glaciers are too thick, horizontally, to have been formed in this manner, moreover they are covered with the same material on which they lie and this covering is in some cases undoubtedly in an undisturbed position. At one place a mammoth scapula and some small sticks were found horizontally imbedded in silt a few inches above the middle of a layer of ice (see Figs. 8 and 9) and other mammoth bones lay at the base of the glacier, and on the slide below, making it seem probable that part of a skeleton had been buried here in a primary position of entombment. In two other places (×, Figs. 1 and 5) bones were found which must have dropped from silt above glaciers, and in one of these cases (Fig. 5) there is no doubt that the sediment had not been moved since deposition. Even the narrow ice-dike, gl. no. 11, was overlaid with silt. On the Buckland River a broad, wedge-shaped mass of ice was seen imbedded in silt which was unquestionably in its original place of deposition for the bluff above it was vertical to the top.

The fact that most of the ice at Elephant Point is imbedded in sediment differentiates it from ice-beds hitherto described in other parts of Alaska and has led Dall and others to the conclusion that it has been formed from interstratified snow-banks or frozen ponds and streams. The two ice-filled cracks exposed in excavating the mammoth skeleton were evidently formed by the infiltration of water *after* the ground had become frozen for otherwise they would not have contained laminæ of dirt parallel with the walls, moreover the vertical crack passed through the middle of the skeleton and intersected a rib. This ice is therefore comparatively new and since its granular structure was well shown, this structure is not necessarily proof of snow origin for other granular masses of ice. The ice-dike in the stratified glacier on Goose Bay was plainly formed since the deposition of the beds through which it cuts, but it may be as old as the period when the ground was originally frozen,— assuming that the freezing occurred after elevation or drainage of the deposit and not progressively as the latter was laid down. It does not seem likely that these sediments could have withstood, before freezing, the amount of undermining necessary upon the assumption that the larger ice-beds were subterranean streams; it is therefore probable that some of the ice-masses represent various forms of underground water frozen at different times ranging from the beginning of the cold period to the present,

but it is not impossible that other masses may have been interstratified on a flood-plain. On the other hand in the single case in which the contact of ice with underlying silt could be clearly seen the glacier was as clean at the bottom as everywhere else and not even a leaf or twig was to be found imbedded in it, nor in the silt; if the ice had been formed by the freezing of ponds or streams one might expect to find gravel or sticks, etc., on the bed. Since the material covering the ice is the same as that below, there is no reason to assume that it was derived from the adjacent ridge as Maddren [1] thought might be the case; in fact it is probable that this fine silt was transported from the very head of Buckland River for it contains considerable mica which is rare in andesites, of which this ridge is composed, and in basalts, which form the rocky banks of the greater part of the river.

c. Bluffs and ice on Goose Bay.

The bluffs on Goose Bay have apparently been entirely neglected by writers although they are continuous with the historic bluff and contain most of the species of fossil mammals found at the latter place. From the base of Elephant Point the bluff rises, southward, to the maximum height of seventy feet and, descending again, forms a bank twenty-five feet high at the first bend of Lost River. It is intersected by several small streams whose valleys are all overgrown and afford no sections; the face, sloping at an average angle of about thirty-five degrees, receives the full benefit of the morning sun and is almost completely covered with grasses and thickets of low willow bushes. The base is slightly cut all along but there are only a few small exposures higher up.

Three glaciers are visible, one of which — located in the steepest and highest part of the bluff about midway between Elephant Point and Lost River — has a remarkable structure (see Figs. 1 and 2). Its entire length is sixty-five feet, and the vertical face has a height of six feet at one end while it tapers out at the other. The high end consists of half-inch layers of pure ice alternating with muck containing considerable plant remains; the layers are grouped into five thick strata and a vertical dike of pure ice, running through the middle of the stratified portion of the glacier, separates the upwardly bent ends of these strata which match on opposite sides of the dike. The latter is about two and a half feet wide in the middle, being slightly narrower below and broader above. Next the end of the stratified portion there is another wedge-shaped mass of pure ice four feet wide at the bottom and five feet across the top. Adjacent to this dike there is a section, averaging four feet in width, formed of nearly *vertical* layers — one half inch thick —

[1] Maddren, p. 62.

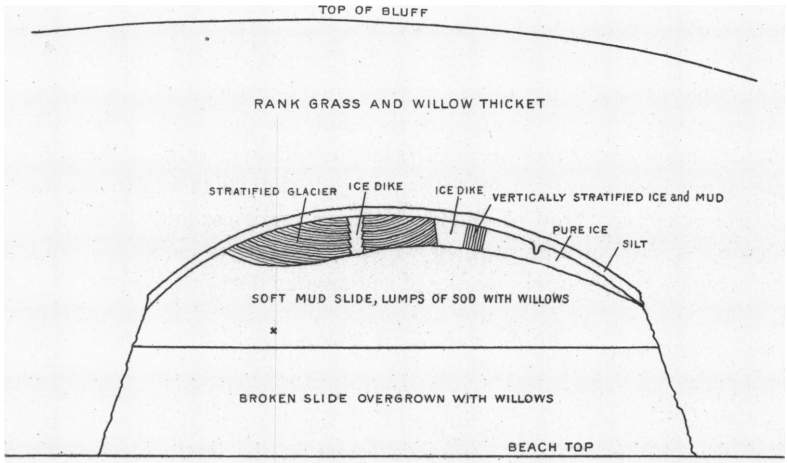


Fig. 1. Stratified glacier in the bluff on Goose Bay near Elephant Point. ×, Mammoth tibia imbedded in block of silt fallen from above the glacier.

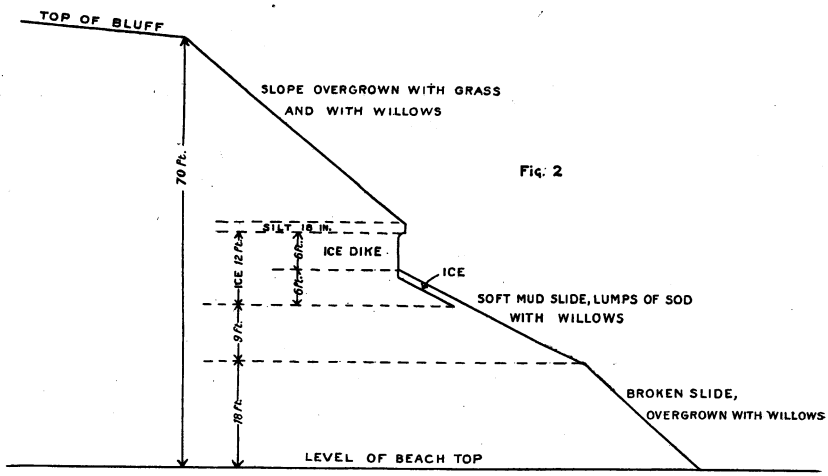


Fig. 2. Section of bluff passing through ice-dike in stratified portion of the glacier.

of pure ice and muck alternately. The remainder of the glacier consists of pure ice, at one point in the top of which there is a small hole filled with the silt which overlies the glacier. Solid ice extends downward below the first described dike and forward under the mud slide adding at least six feet to its total vertical thickness. The silt here seems to have been deposited unconformably upon the top of this curious glacier though slides may have modified the upper contact. The lower contact is concealed. Fossils are certainly contained in the upper part of the bluff for a broken mammoth tibia (×, Fig. 1) was found imbedded in a large block of silt which had overturned in falling from above the glacier to the mud slide below, where it was held together by the roots of a willow bush upon which it rested.

The silt deposit along the west side of Goose Bay extends downward below water level and at one place the soft clay beach — which is covered with only a thin layer of sand — contains a large quantity of small, round quartz pebbles. Five eighths of a mile north of the mouth of Lost River a horizontal seam of black lignite appears in the base of the bluff at high tide level. This 'mine' has been staked but the small prospect holes have caved in and it was impossible to see much of the coal; the layer seemed to be at least two feet thick and a quarter of a mile long, and to be covered with a finer and lighter colored clay than that composing the main thickness of the bluff.

The mammoth tibia above mentioned was the only fossil found on this stretch of the bluffs; remains of the following genera were collected on the beach and broad clay flat which is exposed at low tide: — *Elephas, Equus, Bison, Rangifer, Rangifer* sp. nov., *Ovibos.*

Along the bends in the lower part of Lost River there are several small cut banks and, on the beaches below them, parts of *Elephas* and *Rangifer* were collected.

The bluff is interrupted at the mouth of Lost River by a low marshy plain but rises again to a height of thirty feet and, gradually lowering toward the east, runs out altogether a couple of miles beyond. For one mile from the river mouth its steep face is directly cut by the waves, the remaining portion being protected by a narrow strip of marsh and entirely hidden by vegetation. The material is similar to the rest of the deposit, and no ice was exposed. There is no beach east of Lost River but at low tide a very wide clay flat slopes gradually away from the foot of the cut bank: fossils collected here belong to the genera *Elephas, Equus, Bison, Rangifer,* and *Alce.* Several specimens of horse and bison bones were also found on the face of this bluff.

Some small patches of cut bank are seen around the edge of the broad point lying on the west side of the mouth of Buckland River and a few

fragmentary bones and teeth were collected on the clay flats below them; one badly decayed mammoth tusk lay on the talus below a mold in the bank from which it had recently fallen. The following genera were observed here: — *Elephas, Equus, Bison, Rangifer.*

d. North side of Eschscholtz Bay.

A bluff stretches without a break from Choris Peninsula eastward along the north shore of Eschscholtz Bay and is continued up the Ah-weeng-nuk valley in the form of a terrace. For a distance of seven miles the bluff is being cut by the waves and its structure, beginning at the rocky hill on the base of Choris Peninsula, is as follows: — 1st, yellowish, sandy silt, without trace of stratification, half a mile long, fifty feet high tapering down to eighteen feet; 2nd, flat terrace, eighteen feet high and one and three quarters miles long, composed of fine dark bluish-gray silt containing a few small irregular layers of peat,— this terrace extends across the base of Choris Peninsula and several miles north along the shore of Kotzebue Sound; 3rd, fine light colored sand and silt, stratified, three quarters of a mile long, seventy feet to thirty-five feet high; 4th, fine grayish silt (like that at Elephant Point) four miles long, thirty to forty feet high; 5th, a section one hundred and fifty feet long exposing several alternating strata of sand, coarse gravel, sand-and-fine-gravel, overlaid with a thick deposit of fine, light colored silt; the coarse gravel stratum and some of the others are sharply cross-bedded. From this point east the beach is broad and high and the bluff is almost entirely overgrown with grasses, moss, and low willow bushes. The few bare slopes near the top, and the material brought to the mouths of numerous spermophile burrows, indicate that this part of the bluff, averaging about thirty-five feet high, is formed of a deposit of sand containing many small, round pebbles and overlaid with from five to fifteen feet of yellowish silt. No fossils were found east of the cut sections.

The terraced section of the bluff near Choris Peninsula is vertical and there is a soft clay flat in front of it, the remainder of the steep, cut portions is bordered by a low sandy beach. Some trifling patches of ice which had been formed in fissures near the surface were exposed in the fourth section.

Fossils were collected on the flats and beaches at the bases of all five sections of the cut bluff, and two specimens were found on the talus of the third section. A mass of sticks cut by the teeth of beavers was seen imbedded near the top of the bluff at the western end of the second section.

List of genera: — *Elephas, Equus, Bison, Ovibos, Rangifer, Canis* (Eskimo dog?), and *Castor* (dam).

VIII. Fossil Remains found imbedded in the Historic Bluff.

a. Part of mammoth skeleton with some skin and hair.

On the face of hill 2, one hundred yards from the western end, there is a small knoll (see Figs. 3 and 4) which was cut clean and nearly vertically on one side by a fresh muddy slide extending down to the beach; with the exception of this slide and the one below a large glacier exposed nearby, but at a higher level, the face of the bluff at this place is thickly overgrown with grass. The distal end of a mammoth femur projected from a little loose material near the foot of the cut knoll and a perfect tibia lay on the mud slide a few yards below. Pieces of soft flesh and tendon adhered to the femur when it was drawn out of the thawed ground and it was subsequently found upon digging into the knoll that part of a mammoth skeleton (M, Plate XIX, Figs. 1, 2, and 3) was imbedded here in its primary position of entombment. The femur was broken near the head but the proximal end was held in its socket in the innominate bone by tendons and flesh; the distal end, and the fibula, were found in the loose earth which had begun to move downward.

A cut was first made into the face of the knoll in order to get an idea of the position of the skeleton and a clear vertical section of the deposit in which it lay; horizontal layers of the frozen silt were then removed successively from the top of the knoll downward, the result of the excavation being a rectangular shelf cut into the bluff and bounded on two sides by vertical walls at right angles to one another thus exposing two more sections of the deposit. The skeleton unfortunately proved to be incomplete and only the following parts were found: — the right innominate bone, femur, tibia and fibula; four of the small foot bones; lower jaw with the teeth; two tusks; a quantity of small fragments of the skull; six thoracic vertebræ; several caudal vertebræ, and the end of the tail encased in skin and hair; several broken ribs; and a small quantity of flesh, skin, hair and wool. These remains were crowded together in an area about ten by seven feet alongside the cut face of the knoll, and the missing parts of the skeleton were no doubt imbedded in that portion of the hillock which has been carried away by the slide.

The bluff at this point is about eighty feet in height. A layer of gravel two feet thick is exposed at an elevation of twenty-eight feet above high water mark and can be traced along the face of the bluff through the base of the knoll and for some distance on either side of it. The sections showed that the surface of this stratum slopes up at a small angle as it is followed inward at right angles to the face of the bluff (Figs. 3 and 4). The gravel

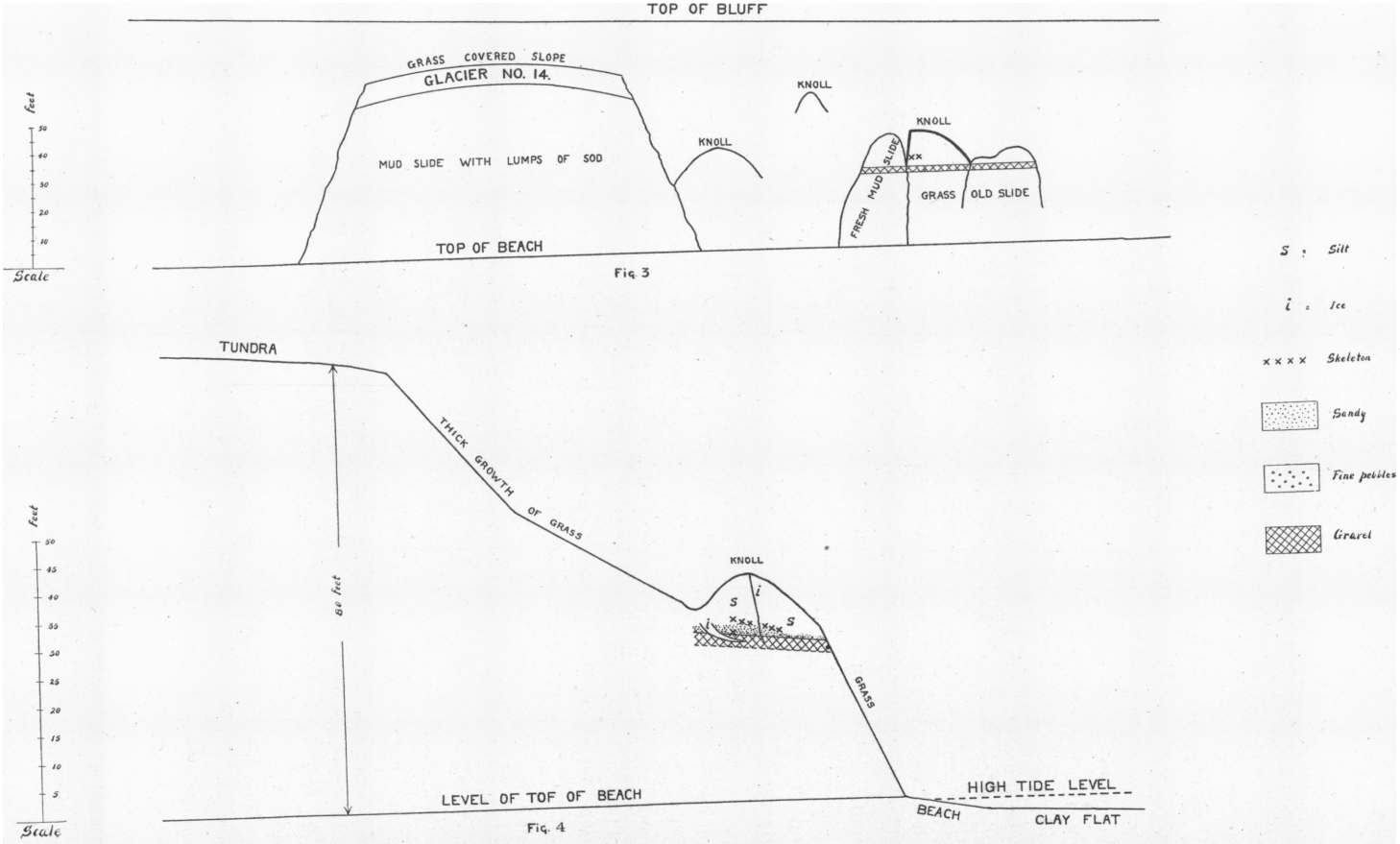


Fig. 3. Diagram of face of bluff in vicinity of mammoth skeleton (× ×).
Fig. 4. Section of bluff through mammoth skeleton.

consists of small fragments of andesite-porphyry which are only slightly rounded and water-worn, and the interstices are filled with a coarse red sand. Directly below the knoll the section could not be seen but it will be recalled that angular blocks of the above-mentioned rock are falling out of the base of the bluff a short distance away, and that the banks of the stream just west of the knoll exhibit smaller angular fragments of the same material thickly imbedded in coarse reddish sand, and also in silt, at a level slightly above the present beach. Silt is exposed below the gravel in the old slide (see Fig. 3) close to the knoll. The sloping surface of the gravel stratum is sharply marked off from the deposit above it which consists, first, of sand containing some fine gravel; grading into a mixture of sand and silt with an occasional small round or angular pebble; and lastly into a very fine gray silt, or clay, in which are a number of small thin lenses of coarse reddish sand. Irregular lines of stratification dipping slightly to the southwest were shown in the sections above the skeleton. The upper part of the bluff probably consists entirely of fine silt.

The bones were imbedded in a sloping plane, at an average height of two feet above the gravel, partly in the base of the fine silt and partly in the top of the mixture of silt and sand which was somewhat elevated under the middle of the skeleton; but one tusk had sunk down until its convex surface rested on the gravel, while the other lay horizontally in the silt three feet above it. The lower jaw, vertebræ and ribs, innominate bone, and limb bones followed, in this order, down the slope (Fig. 4). The largest piece of the skull was imbedded close to the higher tusk while many small skull-fragments were scattered from this point through the knoll above the skeleton and even beyond the limb bones; this proves conclusively that the animal could not have been bogged, moreover the lenses of sand in the silt above the skeleton showed no traces of the disturbance which would have been caused by an animal sinking through them. It might of course be assumed that after being bogged the skeleton had been uncovered and then re-covered, but in this case one would hardly expect to find any traces of flesh, skin, or hair.

Small pieces of skin with black or brown hair attached, and wads of long black hair, were scattered among the bones. Shreds of tendon still adhered to the ribs and vertebræ. The innominate bone had fallen so as to rest upon its posterior surface and preserved *beneath* it some flesh and a large sheet of skin from the buttocks; there was also considerable flesh about the head of the femur and its socket. Some pieces of skin with long hair were found partly surrounding the femur. The caudal vertebræ and end of the tail encased in skin were imbedded close to the innominate bone; the tip of the tail bore a thick tuft of long black hair as well as a thin covering of

reddish underwool. The wool and hair had rotted out of the skin under the innominate bone and could only be handled in very small sheets. The covering of the mammoth, then, consited of a soft reddish underwool about 1½ inches long and two kinds of hair,— one coarse, wiry, black, as much as 18 inches in length; the other brownish, much finer, and 6 or 8 inches in length.

Small sticks [1] and twigs and rounded lumps of dark brown peat containing leaves, grasses, and rootlets were found among the bones, and beneath the skeleton there was a considerable quantity of bunches of grass some of the stalks of which were slightly green. Some scattered tufts of moss [2] were found in the silt a few feet above the bones. Blackened willow leaves were taken out of the frozen silt both above and below the skeleton, a few small twigs were found above it, and as the vertical walls of the excavation gradually thawed many fine grass stems and rootlets hung out but these were soft and rotten and could not be preserved. A small, thin sheet of chewed grass cut out of the frozen sandy silt close to the lower jaw was as brilliantly green as on the day it grew.

The mammalian remains found in excavating the mammoth skeleton were: a fragment of a caribou tibia; some fragments of a wolf skull with three teeth; one phalanx of a horse; and four small oval droppings.

It is very probable that this mammoth died — or was stranded in the flesh by high water — on a sloping muddy shore near the edge of a sluggish river which had only a short time before swung away from its beach of gravel, derived from the neighboring ridge, and already commenced to cover the stones with fine sediment; that this shore or a meadow just above it was overgrown with grasses — on which the animals fed — and willow bushes; and that as the carcase lay and rotted with the head pointing up the slope the posterior parts first became buried while the skull disintegrated and its fragments were washed down above the rest of the skeleton to be covered later. The irregular, inclined bedding of the silt above the remains, though not conspicuous, the direction of dip *toward* the neighboring hills, and the interstratified lenses of sand tend to prove that this is a flood-plain deposit rather than a lacustrine formation as indicated on Maddren's [3] map; and the presence in the bluff of a beaver dam and tree about on a level with the mammoth add to the probability of the conclusion which applies at least to a portion of the thickness of the deposit. The latter might, however, be assumed to consist mainly of a temporarily drained lacustrine sedi-

[1] A spruce, *Picea.*

[2] *Dicranum elongatum* Schleich., identical with the form now living in arctic America, or at high altitudes as far south as the mountains of New England.

[3] Maddren, Plate III, p. 26.

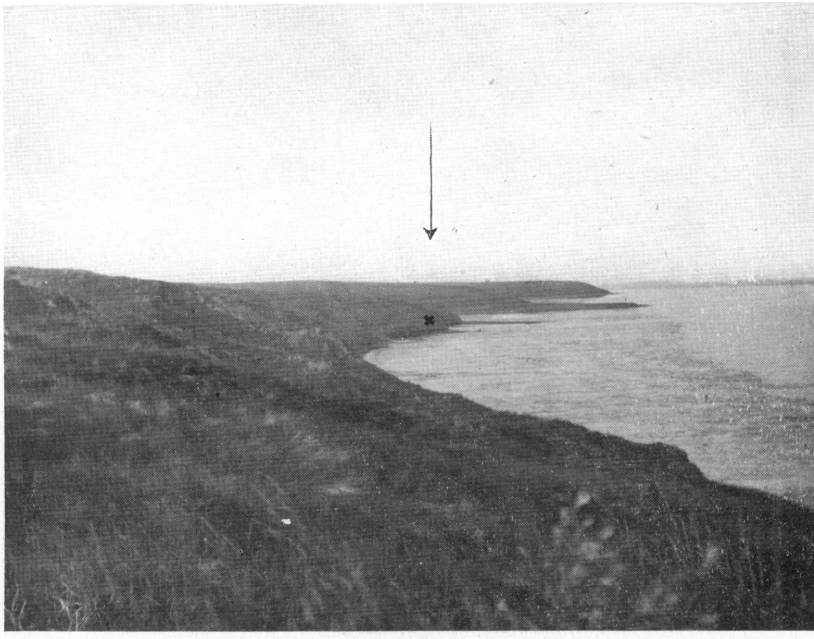


Fig. 1. Part of historic bluff, looking west. ×. Position of mammoth skeleton with hair.

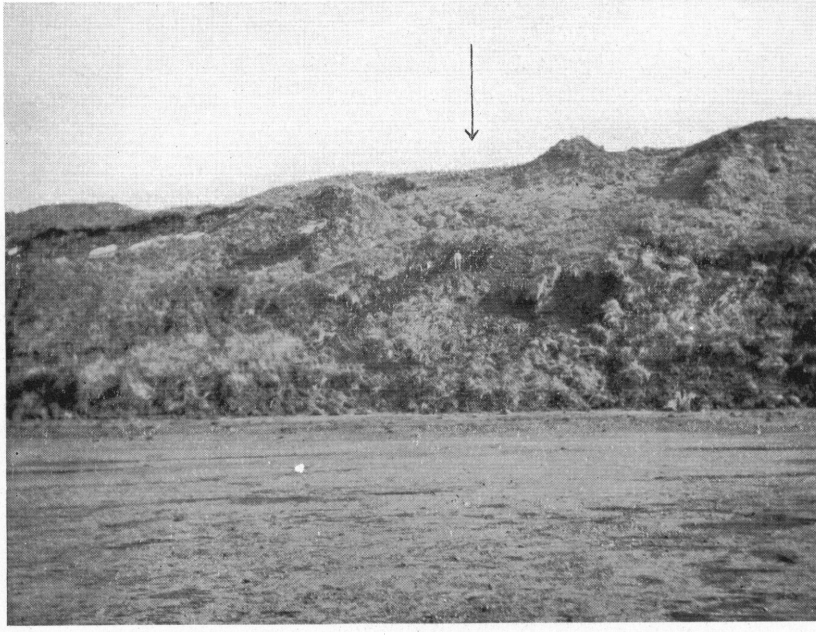


Fig. 2. Bluff and mammoth excavation, as seen from the clay flat at low tide.

Fig. 1. Mammoth excavation, looking west.

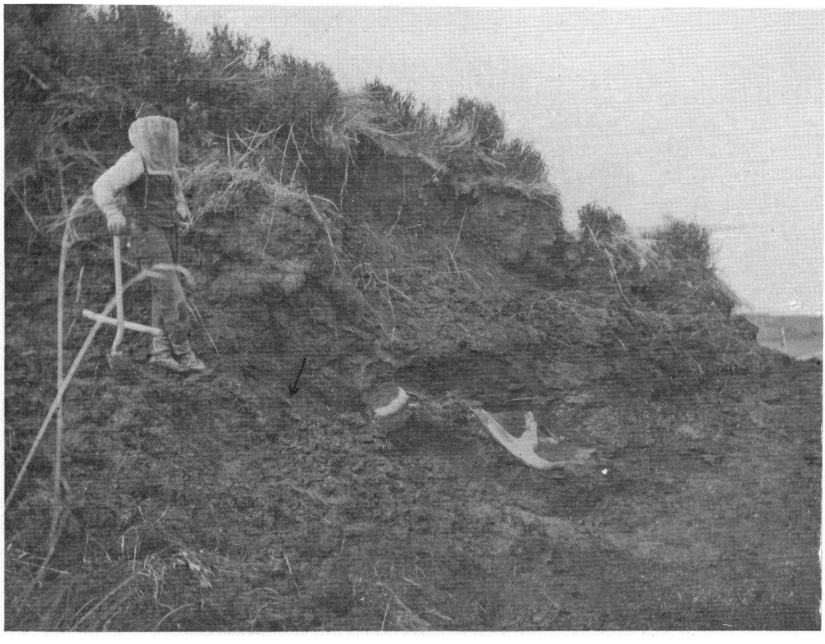
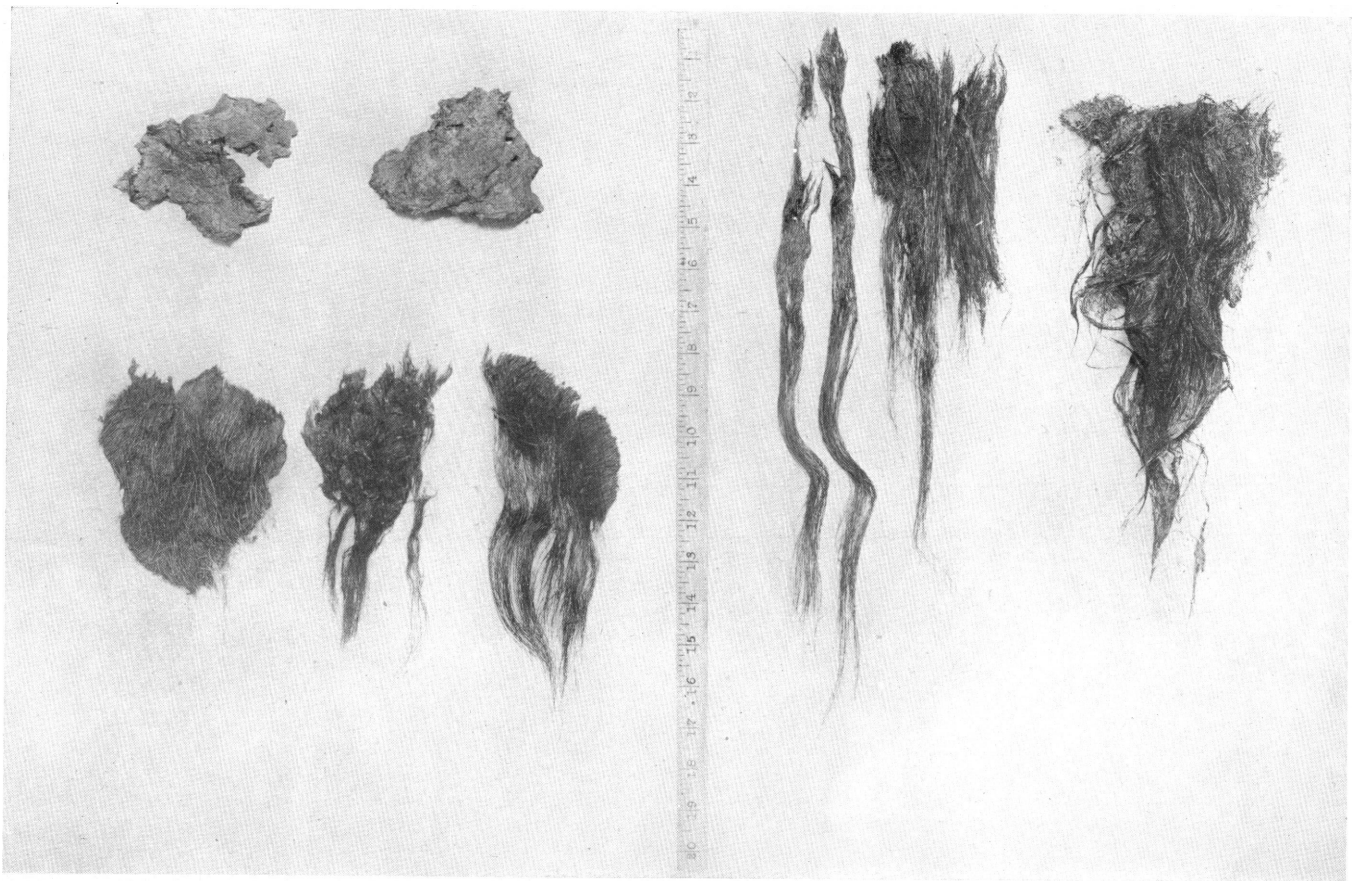


Fig. 2. Tusk, jaw, and innominate bone of mammoth in situ. Arrow points to tip of tusk.

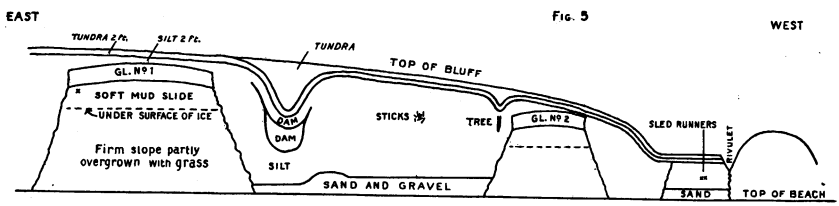


Hair and pieces of skin found with mammoth skeleton.

ment, but its location at a point which can not have been far from the mouth of the Pleistocene river, and the apparent lack of any barrier which could have retained a body of water in this position, seem to negative the lacustrine theory altogether.

b. Beaver dam.

A beaver dam, discovered by a member[1] of Captain Hooper's party in 1881, is imbedded in hill 1 (Plate XIX, Figs. 1, 2, and 3) at a point where the bluff is now vertical and the section clean. It is constructed of sticks[2]



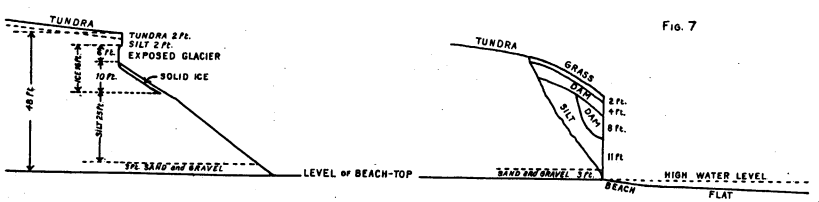


Fig. 5. Diagram of face of bluff, showing beaver dam, etc. × Bison phalanx found at base of glacier No. 1.

Fig. 6. Section of bluff through glacier No. 1.

Fig. 7. Section of bluff through beaver dam.

two or three inches in diameter and from six inches to four feet long all of which show plainly the marks of beaver teeth. The bluff on either side of the dam slopes steeply back from the beach leaving a projecting point preserved on account of the rigidity afforded by the imbedded mass of sticks. The dam (Figs. 5 and 7; and Plate XX, Fig. 1) is about twelve feet thick measured vertically on the face of the bluff, and lies two feet below the surface; it is surrounded by silt, eleven feet thick below the dam, and the base of the section is formed of a three foot stratum of sand and fine gravel.

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[1] See Maddren, p. 112. (Nelson's diagram and description).

[2] Two beaver-marked sticks from this dam have been identified as belonging to the genus *Salix* (willow).

A side view shows that the dam is continued back under the curved surface of the point in which it is imbedded and that the rear end is thinner and several feet higher than the end overhanging the beach, where it is built in two layers.

In 1907 a small glacier was exposed on each side of the dam, one being a trifle higher and the other somewhat lower than the level of the rear end — but both extending down, as shown in Figs. 5 and 6, several feet below the base of the exposure — making it appear as if we had here sections of the frozen stream itself. This seemed the more probable since it might readily be imagined that the ice connecting these glaciers and passing through the dam had melted away allowing the latter to sink at the forward end, and it is difficult to give any other explanation of the drooping position assumed by the dam for no trace of cracks or displacement were observed anywhere above or around it. As if to confirm the supposition the forked trunk of a tree[1] six inches in diameter was found imbedded vertically in the bluff close to the end of one of the glaciers (TREE, Fig. 5) suggesting that it had grown on the bank of the stream. Half way between the dam and tree a few scattered beaver sticks were weathering out of the bluff. The tree stump was traced by digging down into the frozen silt and its spreading roots followed for three or four feet; bark[2] surrounded the stem below the line of frost and, from all appearances, the tree had grown *in situ.*

According to Nelson's description the relations of ice to the dam were the same in 1881 as when the writer first saw it, although in his diagram the 'nest' is shown imbedded in a layer of ice. The glaciers were only two or three feet thick (horizontally) in 1907 for in the following season they had entirely disappeared and, as stated above, vertical, frozen walls of silt remained in their places; but, if the two ice-layers which Nelson described were continuations of the glaciers shown in Fig. 5, it is plain that during the interval of twenty-six years, melting must have removed many feet and the ice must have originally been too extensive (horizontally) to be accounted for by the freezing of water in vertical fissures. The evidence here seems to point more toward than against the theory of interstratification of the ice for the glaciers were overlaid with the same silt in which they were imbedded, and a bison phalanx (×, Fig. 5), found on the mud slide close to the base of glacier no. 1, undoubtedly fell from the silt above (unless we assume that it was contained within the glacier itself — and there is no record of such an occurrence). The beaver dam is positive proof of the existence, on the *surface,* of a small stream of running water such as one

[1] Identified from sections as a *Salix,* or willow.

[2] The bark was more heavily coated with a brilliant blue powder (phosphate of iron?) than any of the fossil bones.

might expect to find, together with trees and other vegetation, on a river flood-plain or drained lake bottom, but if there is any connection at all between the beaver dam and ice it is more reasonable to assume that the latter was interstratified, along with the dam, on a flood-plain rather than covered with sediment at the bottom of a lake.

It may be of interest to mention that a pair of primitive wooden sled runners hewn from solid logs were found projecting from the vertical bluff by the side of a rivulet near the beaver dam (sled runners, Fig. 5). This rivulet falls to the beach from a channel in one side of a small, flat-bottomed, marshy valley which has been eroded down to the layer of sand showing in section just above the beach and re-filled with a dark, brownish 'muck' containing many small (alder?) sticks imbedded at every angle. The floor of the valley is fifteen feet above the beach, and the runners were lying horizontally in the frozen muck seven feet below the surface, but although their age must be great they probably belong to the Recent period and can not be considered contemporaneous with the Pleistocene fossils.

c. Other fossils.

The caribou, wolf, and horse bones, and small droppings found imbedded along with the mammoth skeleton have been mentioned above; to these must be added a few other specimens, the most important being some parts of another mammoth skeleton. The scapula, broken into several pieces, was found lying horizontally six inches above the middle of glacier no. 4, in the overhanging wall of silt, at an altitude of forty-six and one half feet above the beach (1, Plate XIX, Fig. 3; and a, Figs. 8 and 9). Some small sticks were imbedded with it. The broken humerus (c, Fig. 8) lay close to the base of the glacier where it had just fallen and two carpals (d and e, Figs. 8 and 9) were found on the slide some distance below. After an interval of three weeks, during which the glacier had melted back and become partly covered by material from above, a tooth (f) was found on the fresh talus almost touching the ice, but nothing more was revealed by digging. It seems safe, however, to conclude that these are associated bones belonging to a skeleton which had been imbedded here in its original place of deposition.

At the point marked 2 (Plate XIX, Fig. 3) the tip of an almost complete caribou antler protruded from the bluff at a height of one hundred and eight feet above the water. Within a few feet of it a horse phalanx and two sesamoids were dug out of the silt, another phalanx having been found on the surface; these four bones belong together.

Two more bones of the horse may possibly be associated. An astragalus was found imbedded close to the top of the bluff (3, Plate XIX, Fig. 3) a

little to one side of a vertical line passing through the mammoth skeleton (M), and a phalanx lay on the surface a few feet below it.

This completes the list of fossils seen actually imbedded in the bluff, but mammoth, bison, horse, and caribou bones were found in the stream

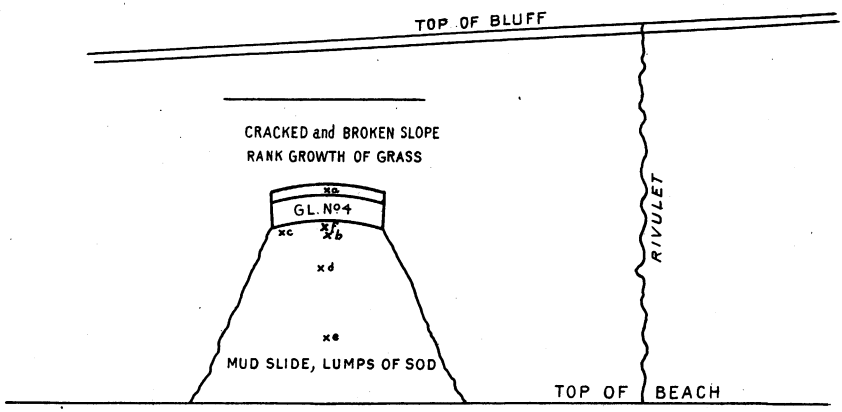

Fig. 8

Fig. 8. Diagram of face of bluff at glacier No. 4, showing position of imbedded mammoth scapula and other bones on the surface.
a. Scapula. b. Large fragment of scapula. c. Broken humerus. d. Carpal. e. Carpal. f. Tooth.

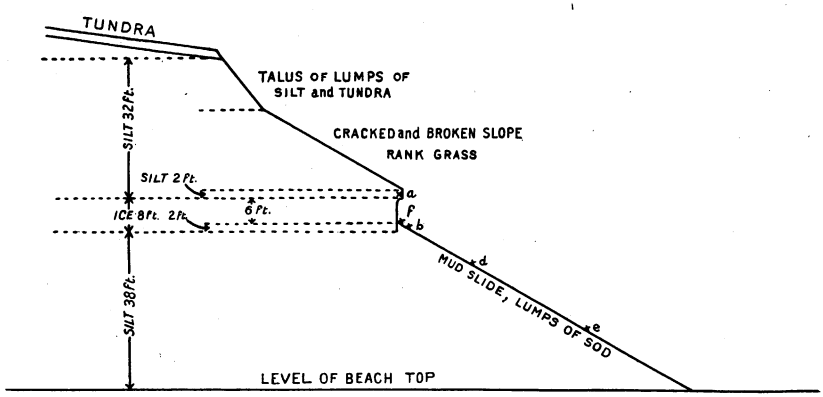

Fig 9

Fig. 9. Section of bluff through mammoth scapula. Lettering as in Fig. 8.

between hills 2 and 3 (Plate XIX, Figs. 1, 2, and 3) far above the reach of any tide or storm, and bones of the same genera were gathered on the face of the bluff at various heights.

IX. Remarks on the occurrence of Fossils and Recent Bones on the shores of Eschscholtz Bay.

There are only two or three references to fossils found in or upon the historic bluff. The preceding section has demonstrated that the deposit at Elephant Point contains remains of the beaver, mammoth, horse, bison, wolf, and caribou, but most of the fossils around Eschscholtz Bay are found in a narrow zone along the edge of the clay flats below the sloping beaches, where the latter exist, and this fact has given rise to the statement that the bones have not been derived from the bluffs but were transported by ice from Buckland River. Nevertheless the writer believes they have all fallen from the beds of silt close to where they lie and that their position on the flats is obviously to be explained as follows: — as the face of the bluff is eroded away thawing proceeds gradually inwards to a depth of two or three feet and the surface layer of wet and more or less muddy clay slides or flows downhill over the still solidly frozen interior. At the limit of frost the bones fall one by one into the loose covering and are often broken by the shearing stress in this plane. Since the surface material seldom holds together in solid blocks — excepting lumps of the superficial sod — and consequently does not roll downhill, the fossils remain underneath the surface and first appear when they slide out onto the top of the beach. In this manner the parts of an associated skeleton become separated. They are then washed by the waves, at high tide, down the sloping beach, as was observed in the case of two large mammoth teeth, and carried out a few yards on the flat where they become partly or wholly buried in the clay. In other words only the small proportion of fossils which drop out of cut surfaces above glaciers and on the sides of knolls, etc., are seen on the face of the bluff. Several specimens, which could not have been originally overlooked, were found on beaches after intervals during which we had been to other parts of the bay,— for instance, a musk-ox cranium appeared at the base of a fresh slide near Elephant Point some time between August 28th and September 16th, 1907. There is no evidence of transportation by ice for not a single fossil was found, anywhere about the shores of Eschscholtz Bay, opposite an uncut bank, nor were any of the river rocks seen on the beaches or flats.

Fossils found on the bluffs, and sometimes those on the beaches, are light-brown in color and generally coated with a bright blue powder, phosphate of iron,[1] but this powder easily rubs off and does not remain on bones which have been exposed on the flats to washing by waves; the latter are mostly very dark, in fact almost black when wet, but some are still light

[1] Sir John Richardson (Maddren, p. 23). See also Gilmore, p. 29.

colored and these have evidently not been long in the water. The jaw and some antler fragments of a moose, found near the mouth of Lost River, were all thickly coated with the blue powder which may be taken to prove that they had recently fallen from the bluff. Musk-ox and moose do not range at present in the territory drained by waters flowing into Eschscholtz Bay and there can be hardly any doubt that remains of both of these mammals, found in this locality, had been imbedded in the Pleistocene deposits.

The shores of Eschscholtz Bay have formerly been much frequented by Eskimos for numerous signs of old igloos and camps are seen in every favorable situation, and quantities of bones of the beluga, whose meat is highly esteemed by the natives, are strewn about them together with some remains of caribou. The latter animals are found living to-day on the headwaters of Buckland River and they are also occasionally seen throughout the northern slope of Seward Peninsula; it is said that they do not occur on Eschscholtz Bay, but large numbers of domesticated reindeer are herded here, on the north side, every summer. The caribou and beluga bones have become of a light to dark-brown color (but never blue) indistinguishable from that of the fossils and it is therefore impossible to separate them by superficial appearances. Large bears also inhabit the Buckland River region and wolves sometimes appear on Selawik River, just across the divide, hence doubt may remain as to the age of some of the scattered bones of certain extant genera. The living animals whose remains one may expect to find mixed with the scattered fossils are, besides marine species: — bear, wolf, Eskimo dogs, caribou, domesticated reindeer, and smaller mammals.

X. Ah-weeng-nuk River.

The bluff on the north side of Eschscholtz Bay is continued for at least twenty-five miles up the Ah-weeng-nuk valley (see Map I, Plate XVIII), the deposit forming a terrace between the river and a ridge of hills. In spite of many winding curves this small stream flows very swiftly over a gravelly bed, and high gravel bars have been piled up in the bends; it enters the bay by two mouths — one of which is very narrow — flowing across a broad, low, delta sprinkled with many small pools. Old ox-bow channels show that the stream has moved toward the north although at the present time it rarely cuts the terrace. The banks are lined with willows sometimes as much as five inches in diameter and ten feet high; on the bluff are a few small cottonwoods and birch trees besides thickets of willows, alders, and other low shrubs.

Eight miles above its mouth the river flows away from the terrace which is here about seventy feet in height; some bare slides are exposed near this

point and the deposit is seen to consist of sand, containing quantities of small round pebbles, with a six-foot layer of silt lying on the top. Twenty miles up the river there is a short stretch of cut bank (Fig. 10) fifty feet high, the section being as follows: — tundra 2 ft.; silt 20 ft.; thin strata of sand containing gravel, and some thin layers of pure sand, altogether 8 ft.; the lower part is concealed by loose sand. A mammoth phalanx was collected on this talus, and two waterworn, fragmentary, mammoth limb bones were found on gravel bars a few miles downstream but no other fossils were seen

Fig. 10. Cut bank, twenty miles up the Ah-weeng-nuk River.

on the river. A small glacier, formed of alternate layers of ice and muck, is exposed in the top of the cut bank just under the tundra. A couple of miles above, the river flows around a projecting point of lava; the terrace then begins again and extends some distance upstream but it appeared to be entirely overgrown and was not followed further. Exposures of sand and fine gravel are also to be seen on the south side of the valley along a small brook which enters Eschscholtz Bay at the very mouth of Buckland River; no fossils were found here.

XI. Buckland River.

Before the opening of a road from Candle freight was towed in small barges about forty-one miles up the Buckland River to the mouth of West Fork, which flows in from the south, and up this stream to Bear Creek where some gold placers are located. The main river has also been examined by prospectors who asserted that it is navigable for two hundred miles and that numerous fossils are found along its banks.[1] Maddren indicates here an area of elevated, Pleistocene, lacustrine silt and Pleistocene mammal deposit.[2] In view of these facts, and the possibility that some of the fossils at Elephant Point had been derived from deposits on the Buckland, it seemed desirable to explore the river and a light canoe was shipped to Keewalik for this purpose. The water was so low on account of the dry spring season (1908) that we were obliged to do a great deal of wading, and to make many otherwise unnecessary portages over shallow gravel bars; and canoeing had finally to be abandoned at a point estimated at eighty-six miles above the river-mouth. We walked several miles further but, since few good fossils had been seen and as the river was constantly falling and seemed about to dry up altogether, we turned back.

The Buckland River is probably not over one hundred and fifty miles in length from extreme headwaters to mouth. The north and middle forks come together from the northeast and southeast, respectively, about eighty-nine miles, by river, above Eschscholtz Bay; these streams are of equal size and each is no doubt navigable for a few miles by canoe in a season of average rainfall. The foothills of a low mountain range, the Koyukuk-Buckland watershed, extend to within eight or ten miles of the forks, below which the river flows through low rolling hills of lava as far as the head of tidewater, twenty-two miles above Eschscholtz Bay. At this point a bar of lava boulders stretches across the stream forming at low tide an unnavigable cascade which at high water is hardly noticeable. One mile up North Fork the lava overlaps older, stratified, sedimentary rocks exposed in the bed of the stream and in two high hills alongside of it.

For the first twenty-two miles the river flows in a wide valley whose floor is covered with sediments. A sandy bank forty feet high begins at the mouth of Duck River and extends one quarter of a mile downstream; a bear and two bison bones were collected here. A bison vertebra was found on the face of another high, sandy bank one mile below. A third bank,

[1] See also Moffit, p. 42.
[2] Maddren, Map, plate iii.

composed of coarse sand, is exposed on the same side of the river about three miles above the mouth, but there was no evidence that it contained fossils. Mammoth, bison, horse, and caribou bones were collected along a fourth bank (Plate XXIV, Fig. 1), also on the left side of the river, some of the fossils having been found in the bluff itself and others on the beach below it at low tide. The river is rapidly cutting into this bank which extends for nearly two miles around a bend and varies from ten to forty feet in height; the deposit — beginning half a mile from Eschscholtz Bay and proceeding up the river — changes abruptly from one material to another, as follows: — 1st, stratified sand; 2nd, alternate half-inch layers of moss [1] and fine clay; 3rd, muck and peat; 4th, the upstream half of the bank consists mainly of fine silt but some parts are sandy and show traces of stratification; most of the fossils were found along this section. The entire exposure seems to be a section of an elevated delta which contains channels or ponds filled with deposits some of which may be Recent. Just below the bar at the head of tidewater there is a short bank, thirty feet high, of fine light colored silt exposed in a bend where a few fragments of bison and other bones were found.

From the tidewater cascade to the mouth of West Fork the river runs in a narrow, crooked, valley eroded down into lava and frequently cuts the hills, forming vertical cliffs from fifty to seventy-five feet high. West Fork runs swiftly from side to side of a broad, sparsely-timbered valley and enters the Buckland at the lower end of an open basin about five miles in length. At the head of this basin the main river flows out of a winding valley about six miles long and so narrow that it may properly be called a canyon; the walls are in many places vertical and, just above the middle of the canyon, show the columnar structure of the lava very clearly. Half a mile below this point a ridge and some large boulders of lava form an obstruction in the river, which makes it necessary to portage for two hundred yards. The valley widens out again at the head of the canyon to form a long basin extending above the forks to the foothills of the Buckland-Koyukuk divide; the river meanders down in a very tortuous channel — occasionally winding to the hills where it cuts cliffs in the lava — but nevertheless flows swiftly over many shallow riffles between the deeper holes. The valley is timbered at the forks with large groves of fir trees thirty or forty feet high. Numerous ponds and a few old river-channels are seen on the flat surface of the deposits

[1] This part of the bank is about ten feet high; the moss in the lower layers is *Drepanocladus fluitans* (Dill.) Warnst. and that of the upper plant layers *D. scorpioïdes* (L.) Warnst. They are identical with species widely distributed at the present time in northern countries, or at high altitudes, and forming dense growths in stagnant water. Some broken shells of small lamellibranchs and gastropods were also taken from this bank, but the specimens have been lost.

which cover the bottom of the basin. The cut banks, averaging perhaps ten feet high, expose sections of gravels, sands, and alluvium, often irregularly stratified, or unstratified deposits of fine grayish silt.

A large loop of the river is cutting into a thick sedimentary deposit which remains hanging to one side of the basin, near the lower end, and a steep bluff is formed about one hundred feet in height; the silt of which it is composed is without trace of bedding but it rests upon four feet of faintly stratified sand and gravel. The material is coarser than that at Elephant Point and slightly different in color. Minute fragments of plants are contained in a sample but no sticks were found in the bank. Several broad, wedge-shaped 'glaciers' are exposed in the upper part of the bluff but they are imbedded in the silt and certainly do not lie upon the top of the deposit — as described[1] in the case of the Old Crow River ice-beds — nor do they appear to be parts of a continuous layer of ice. Smaller silt deposits are seen against the sides of the narrow valley in several places along the river below the canyon.

The high bluff is being cut for the distance of one quarter of a mile, but a careful search resulted only in the find of a horse calcaneum and a small unrecognizable fragment of bone, both of which might have been brought from higher up the river; the shallow water at the base of the bluff contained no fossils and this deposit seems to be barren. On the other hand a number of fragmentary fossils were found at the lower silt banks in this basin and along the river below the canyon, and a few decayed mammoth tusks and bones were seen at various places in the river-bed. One well-preserved tusk (Plate XXIV, Fig. 2), lacking the tip, lay on the talus of a low silt bank at the middle of the upper basin, but the evidence goes to show that reports are much exaggerated, that the Buckland River is an unpromising locality, and that there is little likelihood of finding important deposits cut by any of its branches. The best specimens were found at the banks near the mouth of the river.

Bones, or fragments, of the following genera were noted: — *Elephas, Equus, Bison, Rangifer, Ovibos, Alce, Ursus, Canis* (wolf).

XII. Hotham Inlet and Selawik Lake.

Hotham Inlet is an arm of non-tidal fresh water separated from Kotzebue Sound on the west and Eschscholtz Bay on the south by a long narrow peninsula consisting of sediments elevated to a height of over one hundred feet above sea level. The low Kobuk delta occupies its inner angle while

[1] Maddren, p. 15.

Fig. 1. Cut bank on Buckland River, near the mouth.

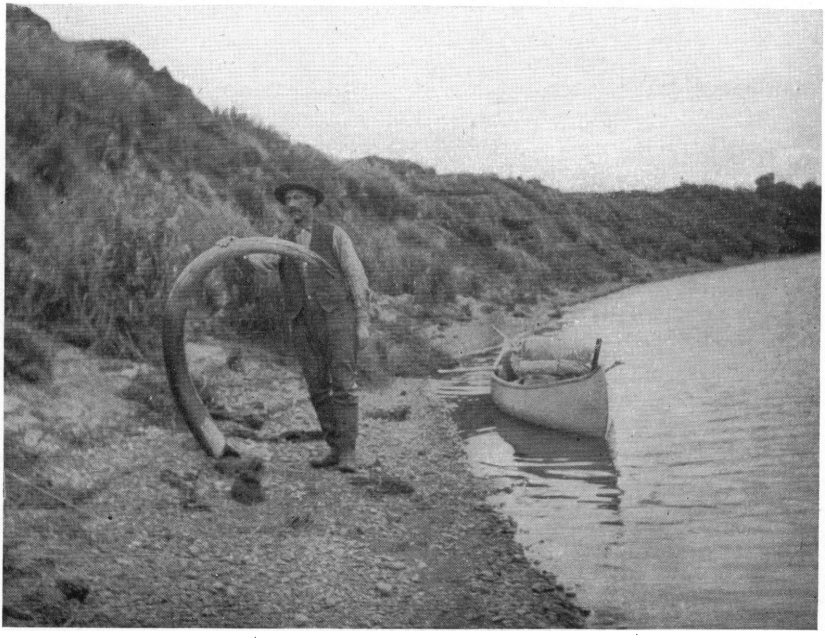

Fig. 2. Mammoth tusk and low silt bank in upper basin of Buckland River.

high bluffs extend all around the outer curve and along the southern side of Selawik Lake.

The bluff is cut in a few places on Selawik Lake for a distance of fifteen miles from the outlet but it appeared to be entirely overgrown with vegetation to the east and was not examined further. The deposit is mostly unstratified sand containing considerable gravel; in some parts silt lies on the top, in others the bluff is composed entirely of silt. A few small fragments of mammoth tusks and caribou bones were found on the gravelly beach but no fossils were seen on the bluffs.

On the south side of Hotham Inlet there are some cut bluffs, one hundred feet in height, composed of silts but containing near the top an ill defined stratum of waterworn gravel and boulders, up to six feet in diameter, which are imbedded in the fine sediment and must have been deposited by floating ice. The gravel consists of quartz, conglomerates, and gneissoid rocks and shows no signs of glaciation; one rounded lump of black, bituminous coal was collected on the talus. In the southwestern angle of the inlet a vertical section shows that this portion of the bluff is sharply divided into very thin horizontal strata, from top to bottom. A steep, continuous bluff of yellowish silt extends along the west side of Hotham Inlet for at least fifteen miles to the north; it varies from fifty to one hundred feet in height and occasionally shows some traces of stratification. Several pieces of mammoth tusks and some small unrecognizable fragments of bone were found on the gravel beaches or in the water along Hotham Inlet, but only one specimen — the metatarsal of a horse — can be definitely stated to have come from these barren deposits; it was found on the talus on the west side of the inlet about on the latitude of the Arctic Circle.

XIII. Summary and Conclusions. List of Pleistocene mammals of Alaska and adjacent Canadian Territory.

The Pleistocene deposits of Alaska and the Klondike region have been divided into dark mucks [1] accumulated in gulches and on the smaller streams, and light-colored silts and sands, frequently with underlying gravels, appearing along the sides of the valleys and in the basins of the river courses. The latest investigator [2] concluded that the former deposits have hitherto

[1] The term 'muck' is rather indefinite though it may usually be taken to mean a dark brownish mixture of sediment and decayed vegetable matter of the nature of a bog or swamp. McConnell (p. 35) says that mucks in the Klondike district are usually massive but sometimes interbanded with layers of sand. Mucks frequently contain sticks (see Gilmore, p. 16), and even large logs have been found in them (Collier (1), p. 27). Trunks and cones of fir trees are said to be found in the base of mucks on Inmachuck River about ten miles above Deering, and at other places on Seward Peninsula.

[2] Gilmore, pp. 25, 26.

furnished the best preserved mammal remains, and that they are the most promising collecting grounds while the silts and sands contain mainly scattered and fragmentary parts. The writer's observations also show that thick beds of *structureless* silts and fine sands both in the interior and on the Arctic coast are either barren or supply only a few isolated bones and water-worn fragments; sticks in their natural condition are likewise rare in these deposits which, however, occasionally contain layers of lignite. The underlying gravels, when present, often appear to be contemporaneous,[1] as, for instance, at the high silt bluff in the upper basin of Buckland River, but no fossils have been recorded from them. The bluffs on Selawik Lake, most of the north side of Eschscholtz Bay, and in the Ah-weeng-nuk valley, all consisting mainly of sand containing pebbles but in some places seen to be overlaid with silt, are as barren as other gravels, in so far as could be determined. In general the probability of finding bones associated or in good condition increases with the fineness of the sediments, but certain banks on Eschscholtz Bay and the lower Buckland consisting of light-colored more or less sandy material *showing stratification* also hold bones in good condition although in these cases there is no evidence of association.

That the mucks of small valleys and gulches in various parts of Alaska and the Klondike region contain many well-preserved mammal remains has already been shown, and can be fully confirmed by the writer, but the Elephant Point deposit, formed in an entirely different situation, is at least equally productive and has supplied the best cases known of fossils in primary positions of entombment in the regions under consideration. It is therefore not at all certain that these mucks are the most promising fossil beds, and it may be recalled in this connection, if it is allowable to compare with Siberia, that the best preserved remains yet discovered — namely, the Beresowka and Lena mammoths — were found in open places on large rivers. The writer believes that at least that portion of the Elephant Point beds which contained the mammoth skeleton with hair, etc., is a river flood-plain deposit. There is some doubt as to the exact horizon and nature of the deposits in which the Siberian mammoths were originally imbedded, but there seems to be no more reason for considering them lacustrine than flood-plain sediments; and either kind of formation might have been covered[2] at certain times and places with fossil-bearing bogs, which need not be supposed to have been confined to small valleys either in Siberia or Alaska.

The Elephant Point deposit, like the mucks, contains a considerable

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[1] Maddren, pp. 27, 28.

[2] Gilmore (p. 21) gives a diagram of a basin filled with "alluvium and mucky material" resting on silt at the Palisades on the Yukon River. In this case while fossils were found in the silt it does not appear that any were seen in the overlying muck.

quantity of leaves, grasses, twigs, and sticks some of which are waterworn, but there is a very important distinction between the two: the former is stratified, at least in part, and fossils were found actually imbedded at various heights from the thirty foot level to the top; whereas there seems to be no doubt that whatever may be the depth and location of the mucks, fossils are here always found within a few inches [1] of the underlying gravels or broken bedrocks, or resting upon and sometimes partly imbedded in the substratum.[2] From this Gilmore naturally concluded that the animals were mired in bogs and sank to the bottom before the latter became solidly frozen, and he says: "If mired down in such a place, why is it that the remains should be so universally scattered?"

It seems to the writer that the remains may not be so scattered either in the mucks or certain of the fine-silt deposits as is generally supposed. Most of the mining in Alaska and the Klondike region in Canada is carried on in the smaller valleys and gulches where thick accumulations of muck must be removed in order to get at the gold in underlying gravels; this is accomplished by leading streams over the frozen mud or by means of powerful hydraulic jets directed against it, and neither method is designed for careful exhumation of complete skeletons. Considering the rough treatment by hydraulic power, many bones, found mixed with coarse gravel on the tailings of the Fox Gulch mine, were in remarkably good condition. The fine state of preservation of several bison skulls — one specimen retaining the outer horn sheaths — which had been removed from muck at the head of the gulch can leave little doubt that this is a place of primary entombment and that careful excavation would lead to the finding of associated material. Two cases, mentioned below, are known where associated bones were taken out of deep mucks in widely separated localities by the more gentle method of thawing prospecting shafts by steam.

The frozen deposits of Alaska are preserved by their protecting mantle of tundra vegetation and since there is a minimum of lateral erosion on the smaller headwaters it will be seen that the mucks are rarely much exposed except where extensive mining is in progress. The difficulty in finding fossil

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[1] See Gilmore, pp. 16, 25.

[2] There are a few exceptions to this statement. The writer saw a small mammoth tusk which had been found projecting from the surface of the ground near Imuruk Lake, Seward Peninsula, and heard of similar occurrences in other parts of Alaska. A case of the same kind is recorded by Moffit (p. 41), but in no instance has the material in which the fossils were partly imbedded been determined or examined. Mammalian remains have also been found lying on top of the tundra (see Gilmore, p. 32; Maddren, p. 115 (Townsend); Allen J. A., p. 168, footnote (Dall)). The validity of these latter occurrences seems somewhat doubtful in view of the fact that Eskimos and prospectors frequently collect fossils as 'curios' and transport them for long distances, and that the fossils may have been dropped in the course of travel wherever the load became inconvenient.

remains in frozen river banks is due to a different cause: here lateral erosion produces steep or even overhanging bluffs in the concave sides of bends where deep channels usually swing against the very base of the deposits, and the swift current rapidly removes any recently fallen talus. Fossils therefore drop directly into the rivers or, in the comparatively rare cases where one happens to find a fossil on a fresh slide, there is often such a large quantity of loose material that the remains cannot be traced to their source. At Elephant Point, where the bluff is inclined, the thawed surface layer slides down bodily and separates the hidden bones in a manner already described, but in several cases skeletal parts were found close together and in such positions as to lead to the belief that associated skeletons are not uncommon in this deposit. Collecting in Alaska is a much more difficult matter than bad-land collecting and it seems reasonable to conclude that the conditions alone are responsible for the usual statement that Alaskan fossils are always scattered and in secondary positions. These same conditions together with the muddy state of the surfaces may also account for the fact that no remains of small mammals have yet been seen.

The few authentic records of associated mammal remains found in primary positions of entombment in Alaska and the Klondike region are enumerated below: —

1. Part of a mammoth skeleton, together with some flesh, skin, and hair.
2. Tooth, and some bones of the fore limb, of a mammoth.
3. Two phalanges and two sesamoids of a horse.
4. The beaver dam, discovered by Nelson, may also be mentioned here. These specimens were found by the writer imbedded in the historic bluff near Elephant Point, Eschscholtz Bay, Alaska, and are described above.
5. Mammoth skull with tusks and a quantity of hair and wool. Dug out of the historic bluff at Elephant Point in 1849 (see Maddren, p. 101).
6. "Vertebrae of bovine animals lying in their proper order of sequence." Historic bluff, Elephant Point, 1849 (see Maddren, p. 99).
7. Mammoth bones, fat, and disintegrated muscular tissue. Found in the bank of Naknek River, Alaska Peninsula, in 1894. (Dall, (3) pp. 857, 858; and Dall, (2) pp. 635, 636.) A specimen of the "hard tallow" containing "numerous dried muscular fibres" is preserved in the U. S. National Museum.
8. Portion of a mammoth skeleton. Woodchopper Creek, Alaska. (Gilmore, p. 25). The writer learned that this specimen was found in sinking a thawed shaft deep into the muck in Alice Gulch (tributary to Woodchopper Creek, Yukon River, near Circle) and that the parts secured consist of the skull and lower jaw, with both tusks and all the molars; pelvis; 1 scapular 2 limb bones; 12 vertebræ; 15 ribs; and some small bones.
9. Complete mammoth skull with tusks and teeth; also said to have been surrounded with the bones, which were not preserved. Found 42 ft. below the surface, in the muck on Quartz Creek, near Dawson, Canada. (Gilmore, pp. 5, 6, 25; and pl. VII.) Quartz Creek is tributary to Indian River.

10. Mammoth skull and lower jaw, both nearly complete; tusks and all the molars perfect; 1 femur. Found in the muck on No. 35 Gold Run, branch of Indian River, near Dawson, Canada. On exhibition in Dawson in 1907.

11. Walrus skull complete, with teeth and tusks. The finder stated that the bones of the skeleton were seen close to the skull, but were not collected; he also thought that some of the flesh had been preserved, but this seems rather doubtful. Found about 31 ft. below the surface, in the 'pay sand' of the second beach line (Quaternary), one mile east of Fort Davis, near Nome, Alaska. Skull examined by the writer in Nome in 1907 (see above).

The ice at Elephant Point — in whatever manner and period it may have been formed — is distributed in separate layers or masses throughout the thickness of the deposit and bears no definite stratigraphic relation to the fossil mammals for the latter are also imbedded at different heights from the top down to the thirty foot level, if not to the bottom. While there is doubtless more ice within these beds than can be seen on the face of the bluff the ratio of pure ice to frozen silt is a small fraction, as in all other described exposures in Alaska, and the commonly used term 'ice-cliff' is obviously erroneous. Fossils have never been found imbedded in pure-ice-masses and the term is particularly misleading since it implies that preservation of flesh and hair is due to the ice, whereas this is not the fact in regard to either of the two specimens found at Elephant Point, nor does it appear from descriptions to be true in the cases of the Siberian finds.[1] It seems entirely clear that the flesh, skin, and hair of the mammoth found by the writer were preserved only on account of having been pressed down underneath the larger bones into soft mud, while most of the body remained above the surface of the ground where the soft parts rotted away.

Since there was enough heat for the growth of plants and for exposed flesh to decay, a *sudden* fall of temperature cannot be called upon, as has been frequently done, to account for the extinction of Pleistocene mammals and the preservation of their flesh; moreover they outlived this specimen for associated bones of the mammoth and horse were found in the same bluff at a higher level.

If the sediment above the skeleton represents a flood-plain deposit, as seems most likely, these remains may have frozen soon after burial and continued frozen ever since upon the assumption that the mean annual

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[1] Mr. Adams. Journal du Nord, St. Petersburg, 1807.

Dr. Tilesius. De skeleto Mammonteo Sibirico ad maris glacialis littora anno 1807, effosso, (etc). Memoires de l'Académie Impériale des Sciences de St. Pétersbourg. Printed in St. Petersburg, 1815. Vol. V, p. 406 et seq., plates x and xi. Extracts from Adams' account, p. 445 et. seq.

The essential facts are also quoted by Buckland, see Maddren, pp. 85, 86.

Herz, O. F. Frozen Mammoth in Siberia. Ann. Rep. Smithsonian Inst., 1903, pp. 611–625.

temperature was below 32° F. and that the deposit itself progressively solidified as it was laid down. But, if flesh was preserved only when protected from air, bodies found entire must have been rapidly and completely covered, and it is not evident how this could have occurred otherwise than by their sinking into some kind of soft or boggy ground. The Elephant Point deposit appears to have been too solid for this to have taken place. But that all frozen bogs are not equally promising for the finding of whole carcases in the flesh is shown by the discovery of such a large quantity of well preserved skeletal material, without soft parts, in mucks in small gulches. And associated bones are likely to be found imbedded either in mucks or in fine, more or less stratified sediments of fluviatile origin.

The existence of bogs amounts to a proof that some portions of the surface were thawed to a considerable depth but does not necessarily preclude the possibility of progressive freezing of flood-plain deposits for thawed and frozen grounds exist side by side, and even alternating one above the other, in Alaska to-day, and pure ice is known to occur interstratified [1] in Recent alluviums. Preservation of flesh was no doubt aided by the low temperature of the deposits, but that the Pleistocene climate was somewhat milder [2] than that of the present time seems to be proved by the fact that large trees have been found, associated with horse and mammoth remains,[3] in deposits of muck in regions which are now treeless.

Judging from the number of separate bones, tusks, teeth, etc., collected or examined in 1907 and 1908 mammoth was everywhere the most abundant animal, bison followed closely, horse and caribou — in about half the quantity of the former genera — came next in the order named, and other mammals were comparatively scarce. In the Eschscholtz Bay region the same sequence holds but the numbers of these four genera are more nearly equal.

List of Pleistocene Mammals of Alaska and Adjacent Canadian Territory.[4]

Alaska.	Canada.
Elephas primigenius Blumenbach.	*Elephas primigenius* Blumenbach.

[1] Maddren, pp. 10, 40.

[2] Collier, Hess, Smith, and Brooks, p. 90.

[3] Collier (1), p. 27.

[4] Perhaps *Oreamnos* ought to be included, on the Canadian side, for McConnell (p. 29) says: the "creek gravels" of Klondike River contain "bones of various extinct and still existing northern animals such as the mammoth, the buffalo, the bear, the musk-ox, and the mountain sheep and *goat*."

For brief reviews of the various mammals from Alaska and discussions of several doubtful reports of species not included in the following list, see Gilmore, pp. 26–38 (The Pleistocene Fauna of Alaska).

Alaska.	Canada.
. . . . .	*Mastodon americanus*[1] Kerr.
Equus sp. undet.	*Equus* sp. undet.
Bison crassicornis Richardson.	*Bison crassicornis* Richardson.
Bison occidentalis Lucas.	*Bison occidentalis* Lucas.
Bison alleni Marsh.	. . . . .
. . . .	*Boötherium bombifrons*[2] Harlan.
Symbos tyrrelli Osgood.	*Symbos tyrrelli*[3] Osgood.
Ovibos moschatus[4] Zimmermann.	*Ovibos moschatus*[4] Zimmermann.
Ovibos yukonensis Gidley.	. . . . .
. . . . .	*Ovis*[5] sp. undet.
Alce sp. undet.	*Alce* sp. undet.
Rangifer sp. undet.	*Rangifer* sp. undet.
Rangifer[6] sp. nov.	. . . . .
. . . . .	*Cervus canadensis*[5] (Erxleben).
Ursus sp. undet.	*Ursus* sp. undet.
Canis (wolf) sp. undet.	*Canis*[5] (wolf) sp. undet.
Castor sp. undet.	. . . . .
Odobenus sp. undet. (Quaternary).	. . . . .

[1] T. Obalski (p. 216) says that he saw *Mastodon* remains in the Klondike region, Canada Maddren (p. 7) considers this an error, but there are two unquestionable records of the occurrence of *Mastodon* (see Gilmore, p. 30) on branches of the neighboring Indian River, which Obalski and others include in the Klondike region.

[2] Identified from a very good photograph (in the possession of Professor Henry Fairfield Osborn) taken by Mr. T. Obalski at Gold Run Creek, Indian River, near Dawson, Canada, in July, 1903.

[3] An incomplete skull of *S. tyrrelli*, with perfect horn cores, was seen in Dawson in 1907. The specimen had been found in Magnet Gulch, tributary of Bonanza Creek, Klondike R., Canada.

[4] Gilmore (pp. 35, 38) omits *O. moschatus* on the ground that since a skull from Alaska has been described by Gidley as *O. yukonensis* sp. nov. all musk-ox material may belong to the latter species. But inasmuch as Pleistocene remains which have not been distinguished from *O. moschatus* are found in Alaska and Canada it seems better to include both species for the present.

[5] A number of fossils, which had been found on tributaries of Klondike River, Canada, in the vicinity of Hunker Creek, were examined in 1907. The collection included a fairly complete skull of *Canis* (wolf); an incomplete skull of *Ovis*; and a tine, about 18 inches in length, apparently of the antler of an elk (*Cervus*). T. Obalski (p. 216) also mentions having seen remains of elk, (cerf à grands bois) in the Klondike region.

[6] Several scattered limb bones and the lower jaw of a caribou — found on the bluff and beaches near Elephant Point — are very small, though evidently fully developed, and undoubtedly belong to a new species.

Appendix.

Literature on the Pleistocene Mammals of, and their occurrence in, Alaska and the Klondike region, Canada.

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2. Eschscholtz Bay, south (historic bluff and Goose Bay). *Elephas, Equus, Bison, Symbos* ?, *Ovibos, Rangifer, Rangifer* sp. nov., Alce, *Canis* (wolf), *Ursus, Castor* (dam).
3. (Lost River; see map I, Plate XVIII.)
4. Buckland River, *Elephas, Equus, Bison, Ovibos, Rangifer, Alce, Ursus, Canis* (wolf).
5. Klondike River. *Elephas,* (*Mastodon* ?), *Equus, Bison crassicornis, Bison occidentalis, Symbos, Ovibos, Ovis, Rangifer, Alce, Cervus, Ursus, Canis* (wolf).
6. Indian River. *Elephas, Mastodon, Equus, Bison, Boötherium.*
7. Keewalik River and Lagoon. *Elephas, Equus, Bison, Ovibos, Rangifer.*
8. Alder Creek and Native Gulch. *Bison, Rangifer.*
9. Nowitna (Novikakat) River. *Elephas, Equus, Bison, Ursus, Alce, Castor.*