This is a reproduction of a library book that was digitized by Google as part of an ongoing effort to preserve the information in books and make it universally accessible.

Google books

https://books.google.com

QE
195
.H42

B 534055

An Expedition through the Yukon District.

By
Chas. Willard Hayes.

Digitized by Google

GENERAL LIBRARY
—OF—
UNIVERSITY OF MICHIGAN.

PRESENTED BY

189

Digitized by Google

No Cards

Digitized by Google

Digitized by Google

QE
195
.H42

Digitized by Google

Digitized by Google

University of Mich. Library
from the author.
15618
Nov. 2 92
Through Prof. Russell

VOL. IV, PP. 117-162, PLS. 18-20 MAY 15, 1892

THE

NATIONAL GEOGRAPHIC MAGAZINE

AN EXPEDITION

THROUGH

THE YUKON DISTRICT

CHARLES WILLARD HAYES

WASHINGTON
PUBLISHED BY THE NATIONAL GEOGRAPHIC SOCIETY

Price, 50 cents.

Digitized by Google

Digitized by Google

VOL. IV, PP. 117-162, PLS. 18-20 MAY 15, 1892

THE NATIONAL GEOGRAPHIC MAGAZINE

AN EXPEDITION THROUGH THE YUKON DISTRICT.

BY CHARLES WILLARD HAYES.

(*Presented before the Society February 5, 1892.*)

CONTENTS.

Digitized by Google

Introduction.

An expedition in the interest of a syndicate of newspapers was organized in the spring of 1891 by Mr Frederick Schwatka for exploring portions of the Yukon basin in the British Northwest Territory and Alaska, particularly the region lying north of the St Elias mountains. A request was made to the director of the United States Geological survey for a geologist to accompany the expedition, and it was the good fortune of the writer to be detailed for that duty.

Under the conditions of travel only a hasty reconnaissance of the region traversed was possible, but so little has been known of it geologically or otherwise that such observations as were made possess a value out of proportion to their completeness. It is the object of this paper to give in systematic form the main facts of scientific interest observed during the journey. A full account of the journey itself, which is not without interest, cannot be given here, but will appear elsewhere through its appropriate channels. Enough of the narrative will be included, however, to indicate the route and means of travel and something of the conditions under which the scientific observations were made.

Mr Schwatka's original plan was to go over Chilkoot pass and down the Lewes, following the regular miners' route to the interior; but on reaching Juneau, at the request of the citizens, backed up by their substantial assistance, it was decided to go in by way of Taku river, with a view to determining whether a trail for pack-animals could be constructed over that route.

Considerable information of an indefinite sort was available concerning the country to be traversed before reaching Lewes river. The pioneers of the Western Union Telegraph company crossed the upper portion of the Taku basin in passing from the Stikine to the Lewes, but the map which resulted from their explorations is only a very crude approximation to the topographic facts, and must have been drawn largely from memory.

Dr Dawson obtained from a prospector named Boswell some information concerning Teslin river and lake Ahklen which he embodied in the map accompanying his report on the Yukon district. The location and form of the lake proved to be remarkably accurate, though the regularity of the topographic

Digitized by Google

features of the region is such that a clear idea of their relations is easily obtained even without instruments.

The whole of the route from Taku inlet to the Lewes was traversed in the spring and summer of 1890 by a party of eight miners, among whom Mark Russell, a member of our party, was a leading spirit. They started from Juneau before the ice was out of the river, hauling their outfit on hand-sleds so long as the snow lasted, and then packing them. It required eighty days to reach the lake, where the party built a number of boats. After prospecting the Nisutlin and other streams on the eastern side of Ahklen valley they went down the Teslin and back to the coast by Lewes river and Chilkoot pass. This is an example of the many unheralded expeditions which the Alaskan prospectors have carried out, facing dangers and privations which appear incredible to one who is not familiar with the men themselves. Less arduous or novel expeditions have brought fame to explorers better versed in the art of advertising than these unassuming miners. Unfortunately, however, geography is but slightly the gainer from the work of the prospector, since he usually has neither the training nor the inclination to use instruments even if he should be supplied with them, which is rarely the case, and ordinarily the map which he draws from memory, unassisted by notes of any sort, is not a model of accuracy.

At the head of Taku inlet a "track survey" was begun and carried continuously to the mouth of Teslin river, where it connected with the line surveyed by Mr Ogilvie in 1886. The instruments used were a prismatic compass for determining direction, and a sextant for latitude. Distance was obtained during the boat journey on the Taku, lake Ahklen, and Teslin river by time and eye estimates, and on the portage between Taku river and the lake by pacing. Altitudes were determined from the mean of four aneroids with synchronous readings of a base barometer at Juneau, for which we are indebted to the kindness of Mr E. S. Willard. The route was plotted in the note book and relief indicated by sketch contours; all prominent points within sight along the line of travel being approximately located by compass bearings. While such a survey does not, of course, possess the precision of an instrumentally measured line, still, when carefully executed, it represents the character and relations of the topographic features of a country with a fair degree of accuracy.

Digitized by Google

Between Yukon river and the St Elias mountains lies a large area, embracing the whole of White river and its tributaries, as well as the headwaters of the Copper and Tananah, which has been geographically a blank. So far as can be learned it had never been penetrated by a white man, and the lakes, rivers and mountains which appear on many maps are products of the geographer's imagination. Across this unknown region a track survey was made similar to the one already described. Excepting about fifty miles traversed by water, the whole distance of 330 miles from Selkirk on the Yukon to the junction of Chittenah and Nizzenah rivers was carefully paced; and the two ends of the line being located by astronomic observations, the former by Ogilvie and the latter by Allen, the location of intermediate points cannot be far out of the way.

The portion of our route between the mouth of the Teslin and Selkirk, at the junction of the Lewes and Pelly, had already been twice surveyed, first by C. A. Homan, the topographer of Schwatka's party in 1883, and more accurately by Ogilvie in 1887. Chittenah and Copper rivers had been surveyed by Allen in 1885, so that no continuous survey of these rivers was undertaken though numerous observations were made to supplement those embodied in Allen's map.

Narrative of the Expedition.

Our party consisted at the start of three white men—Mr. Schwatka, the prospector Mark Russell, and the writer—with seven Indians engaged as boatmen and packers for the first stage of the journey. After a few days spent in completing the outfit and waiting for the river to become free of ice, we left Juneau May 25, 1891.

The large two-ton dugout canoe in which we embarked was well adapted for navigating the deep waters of the inlet, but we found it poorly suited to the swift and shallow river. When the wind blew up stream rapid progress was made in spite of the current by spreading two large sails wing and wing, but when the wind failed our progress, by poling or tracking wherever the banks permitted, was painfully slow. Seven days were spent in reaching the head of canoe navigation, eight miles above the South fork and about eighty from Juneau. During this part of the journey little opportunity was afforded for studying the

Digitized by Google

geology of the region traversed, since the boatmen generally kept to the middle of the valley and we usually made camp at night on one of the small islands which separate the river into many channels.

While Taku river is far from being an ideal highway to the interior, still a flat-bottomed steamer of light draft and good power would probably have no serious difficulty in reaching the mouth of the South fork, less than a hundred miles from a point on lake Ahklen which could be reached by steamer from the mouth of the Yukon. The country intervening between these points is practicable for pack-animals with the expenditure of comparatively little labor in constructing a trail. It is probably only a question of time when some better way of reaching the upper Yukon basin than Chilkoot pass will be demanded, and the Taku route is, so far as yet known, the least objectionable.

At the head of canoe navigation our outfit was made up into twelve packs of about one hundred pounds each for the portage of eighty-five miles to the head of lake Ahklen. As there were but six packers, each was obliged to make two trips; so that our progress was extremely slow. The first twenty miles of the portage are in the narrow canyon-like valley of an eastern branch of the river, and the next fifty in broad valleys of the upper Taku basin, from 3,500 to 5,000 feet above sea level. The last fifteen miles are in the densely wooded Ahklen valley among innumerable small lakes and ponds. We reached lake Ahklen June 16, and from this point the Indians were sent back to the coast. It was with a feeling of great relief that we watched them disappear on their homeward journey and knew that we were no longer dependent on their caprice.

Setting up the two portable canvas canoes which had been packed in from the coast, we continued our journey toward the northwest, down lake Ahklen and Teslin river, which forms its outlet. The Lewes was reached June 24 and Selkirk, at the junction of the Lewes and Pelly, four days later. The original plan had been to continue down the Yukon to the mouth of White river and up that stream so far as possible by boat, but the Indians whom we found at Selkirk told us the easier route to the head of White river was overland, keeping southeast of the main river valley; and this route we decided to follow.

A store has recently been established on the site of old fort Selkirk, the Hudson Bay company's post, which was burned by

Digitized by Google

the coast Indians in 1848. The trader, Mr Harper, was down the river and we found only a couple of Indians whom he had left in charge. These were dispatched up the Pelly to collect the natives in the vicinity and we soon had about forty of them camped around us. Only a few of them, however, were able-bodied men, and it was extremely difficult to persuade these to go with us; and when they had promised it was only to back out the next day. After laboring with them for over a week it seemed that the attempt to secure the necessary packers was hopeless, and we were preparing to go down to the mouth of White river and try the ascent by boat, when the tide was turned by the opportune arrival of a prospector, Frank Bowker. He had come up the river from Forty-mile creek, intending to spend the summer prospecting in White River basin. With him were two natives from further down the river, muscular and willing fellows, very different from the wretched specimens from Pelly river. Bowker's arrival, as he came with authority from Mr Harper, who has great influence over the natives, put new backbone into our enterprise. Five packers were soon secured, who promised to go with us to the country of Scolai, beyond the mountains. Dogs were obtained to carry the remainder of the outfit, from twenty-five to forty pounds being packed upon each in panniers of birch bark or moose skin.

On July 9 our combined party of four white men, eight Indians, and eleven dogs left Selkirk. Our course lay toward the southwest, over the great interior plateau which stretches from the Yukon to the St Elias mountains. The headwaters of Selwyn river were crossed and several eastern tributaries of White river.

The country is very scantily peopled, and although we probably saw most of the natives inhabiting the White River basin they only numbered alogether between fifty and sixty persons. The first party, consisting of six families, was camped on the Nisling, making a fish trap in anticipation of arrival of the salmon, which was anxiously looked for. These Indians are closely related to those living on the Pelly. They are similar in appearance and mode of life, and apparently speak the same language. They have no permanent dwellings, but several substantial log caches were seen, which they use for storing their winter's supply of dried fish and moose meat. The country seems to be fairly well supplied with game, goats on the highest

Digitized by Google

rocky summits, moose and bear in the river valleys, and reindeer or barren-grounds caribou on the plateau above timber line. Several of the latter were killed by members of our party, and our supply of provisions was also helped out by the dried meat which we obtained from the natives. On the Kluantu was found a second party of Indians, most of whom had never before seen a white man. Obtaining a number of rafts from these natives we descended the river about fourteen miles to its confluence with the Donjek, since both the Kluantu and Donjek were too deep and rapid to ford. The Klutlan was also found to be unfordable, and we were compelled to go around its head and cross upon the glacier from which it flows. Although this was not attended by any special danger it caused great dismay among the Indians, who regard a glacier with superstitious terror.

About twelve miles beyond Klutlan glacier we reached a small stream called the Klet-san-dek, or Copper creek, coming from a narrow gorge in the mountains. This is where the Yukon Indians have been accustomed to come for supplies of native copper. It was as far as any of our packers had ever been from home and they knew of the country beyond only by report. They refused to go with us further, assuring us that it was quite impossible to get through the mountains at that season since the pass was only traveled by Indians in the winter on snow-shoes. Bowker had already come further than he originally intended, so that he turned back with the Indians. It was something over two hundred miles back to Selkirk, and although through an unknown country a considerably shorter distance to an Indian village on the other side of the mountains. Trusting in our ability to reach the latter inside of two weeks, a period for which we had provisions, we decided to push forward. Discarding everything not absolutely essential our packs still amounted to seventy-five or eighty pounds apiece, so that progress was necessarily slow. The weather since leaving the coast in May had been very warm, with little rain except local thunder showers, but from this time until we again reached the coast rain was falling most of the time. As we had no tent, this added greatly to our discomfort.

Leaving the Kletsan, our party now reduced to three, we continued toward the northwest through the densely wooded valley, with the White river on our right and the steep mountain face on the left. At the end of the third day we came out upon

Digitized by Google

White river, flowing from the south in a deep narrow valley. This we concluded must be the pass of which the Indians had told us, and our belief was strengthened by meeting a high wind, amounting almost to a gale, blowing through from the south. A couple of miles back from its mouth a wall of moraine-covered ice stretched across the valley, the river emerging from a tunnel on the extreme western side. This was undoubtedly the ice which the Indians said it would take us at least four days to cross. As usual, however, their statement was wide of the truth. Crossing a couple of miles of rough moraine-covered glacier with a gradual ascent toward the south, we came to a long stretch of firm white ice upon which walking was a positive luxury after our days of floundering in the deep moss and alder thickets of White River valley. We continued to ascend gradually for about ten miles, directing our course toward a low saddle in the mountains on the south which we supposed to be the pass. Toward evening, however, we were surprised to find the surface of the glacier descending and a little later discovered a deep narrow gorge turning off to the right almost at right angles with our former course. We had crossed the divide, and in a short time were off the ice and camped on a stream flowing into the Pacific. This was the Nizzenah, a tributary of the Chittenah, or eastern branch of Copper river.

The next four days we continued our journey down the narrow canyon which this stream has cut through the mountain range and encountered the most difficult traveling we had yet found. The vegetation on the southern side of this range rivals in luxuriance that of the coast. Forcing our way through the dense growth of alder and spruce which covers the steep slopes at the base of canyon walls was extremely slow and painful work. A mile in four or five hours was counted fair progress.

At length, after having been compelled to ford the river several times, we reached a point at which it appeared not wholly impracticable for boating, and it was decided to stop and build a boat. Our tools consisted of a very dull axe and our pocket knives, but with these we hewed out a keel and gunwales from spruce saplings and fashioned ribs from willow poles, lashing the structure together with twine ravelled from our pack ropes. Over this frame was stretched the canvas in which our bedding had been wrapped and finally the covering was smeared liberally with spruce gum. In this craft our progress was more rapid and

Digitized by Google

not without excitement. The river has a fall of about twenty feet to the mile, so that it is practically a continuous rapid from the point where we embarked thirty-five miles down to its confluence with the Chittenah. For seven miles above the confluence the river flows through a canyon with rocky walls from 350 to 500 feet high. It is extremely narrow and crooked; the water, which above the canyon frequently spreads out half a mile or more in breadth, being compressed into a channel in places only a few yards across.

We were presumably on a part of the river descended by Lieutenant Allen in 1886 with a crew of natives, but thus far had been unable to make the country fit his map and were in doubt until we reached the lower end of the canyon, when it was of less interest to know that another had been through than it would have been before we started in. After endeavoring with poor success to learn something of the character of the canyon from the top of the bluffs, we decided to attempt its passage. Our boat was tossed from side to side like a shuttlecock, whirled around sharp projecting points of rock and through narrow chutes with a velocity that fairly took our breath. Twice more the canyon wall was scaled, but the river could be seen only a short distance ahead. Several times we came uncomfortably near disaster, and that we got through in safety is largely due to the coolness and skill with which Mark Russell navigated our craft.

Continuing down the Chittenah about forty miles to its confluence with Copper river, we reached Taral, a few miles below the confluence, August 12, just fourteen days after the natives left us on White river. We had come through exactly on schedule time, with three pounds of flour and a handful of tea remaining of the provisions with which we left Selkirk.

At Taral we found Nicolai, or "Scolai," as the Yukon Indians call him, the autocrat of the Copper river country. He gave us a most hospitable reception and supplied us with provisions so far as his limited stores permitted. Salmon, both fresh and dried, were abundant, so that we had no further apprehension of famine. The Copper river Indians have an unenviable reputation for treachery and hostility to the whites; but we saw nothing to justify it. They are greatly superior to the Yukon natives, physically at least, and have a much more elaborate family and tribal organization.

Digitized by Google

We were so fortunate as to reach Taral just as Nicolai was preparing for his annual visit to the coast, and after a delay of four days we embarked in a large skin boat manned by ten of his vassals. A couple of days brought us down to Miles glacier, where the river tumbles over a dam of huge moraine bowlders. It is necessary to make a portage here sometimes across both moraine and glacier. Crossing about two miles of moraine covered with a dense alder thicket, we came out upon a high ridge of freshly deposited bowlders. Immediately in front was a broad expansion of the river in front of the glacier, which formed an ice cliff along one side nearly four hundred feet in height. Bergs were almost constantly falling, with reports like thunder, dashing the spray high above the top of the cliff. The current of the river sets across the lake toward the front of the glacier, and where it meets the swell produced by a falling mass of ice the water is thrown into enormous breakers which, with the grinding icebergs, would swamp a boat instantly. Nicolai decided that we might get past by waiting for a lull in the falling of the ice and for a wind from the right direction to open a passage through the floating bergs. The right moment came after a wait of nearly a day, and tumbling things into the boat we were soon past the dangerous spot, to the evident relief of Nicolai and his crew. A short distance below we passed the front of Childs glacier, running within a stone's throw of the lofty wall of ice, and found ourselves at the head of the river delta, with the blue Pacific in sight far to the southward. It lacked a few days of being three months since we had left the coast at Juneau, and in that time we had travelled almost exactly a thousand miles, nearly half the distance being on foot.

Nicolai intended going to Eyak, where two salmon canneries are located on a narrow neck of the peninsula between the Copper River delta and Prince William sound. When within a few miles of that place we were met by a native with the report that the Eyak canneries had closed and the traders had left. This report, which we afterward found to be the invention of a rival trader, turned us back to the head of the delta and down one of the eastern channels fifty miles out of our way and delayed our arrival at Eyak about four days. On account of this delay we missed the August mail steamer from the sound by twelve hours and were obliged to wait there a month for the

Digitized by Google

September steamer. Thanks to the abundant hospitality of Captain Humphrey, superintendent of the Pacific Steam Whaling company's cannery, our detention there was rendered far from unpleasant, and the opportunity was afforded of examining this little known region. Taking passage September 21, on the mail steamer *Elsie*, from Nutchek, we reached Sitka four days later, connecting there with the steamer *Mexico* for Puget sound.

Topography.

Cartographic Data.

The topographic data embodied in the accompanying map sheets (plates 19 and 20) are from the following sources:

On sheet i the region from the head of Taku inlet to the mouth of the Teslin, embracing Taku river, lake Ahklen, and Teslin river, is mapped from my track survey made in 1891, which I have already briefly described. The relief is indicated by sketch contours with an approximate vertical interval of 250 feet.

The portions of Pelly river shown on sheets i and ii are from the track survey made in 1887 by Dr Dawson. The region from the mouth of the Lewes, shown on sheet ii, across Chilkoot pass to Pyramid harbor, at the head of Lynn canal, is from the instrumental traverse made by Mr W. Ogilvie in 1887 and embodied, together with Dawson's track surveys, in the map of a portion of the Yukon district which accompanies the report on an expedition to the Yukon district, Northwest Territory, and adjacent northern portion of British Columbia, in 1887, by Dr George M. Dawson.*

The region embracing the head of Lynn canal, Chilkat river, and the sources of Altsek and Tahkeena rivers is from the Karte des Tschilkat-Gebietes mit dem Pässen zum Yukon.† Lake Arkell and Tahkeena river are from data furnished to the Census office by Mr E. J. Glave from surveys made by him in 1891. Muir glacier is from a planetable survey made by Professor Harry Fielding Ried in 1890, embodied in the map accompanying a paper entitled Studies of Muir glacier, Alaska.‡

* Ann. Rep. Geol. Survey Canada, pt. B; Montreal, 1888.

† Nach eigenen Aufnahmen im Jahre 1882 von Dr Arthur Krause, Berlin, 1883.

‡ Nat. Geog. Mag., vol. iv, 1892. pl. 14.

Digitized by Google

The coast from Taku inlet to cape Spencer, and also from Icy bay to the western edge of sheet ii, is from the general chart of Alaska, number 900, issued by the United States Coast and Geodetic survey, Washington, 1891. The topography of the region shown on sheet ii between Selkirk, at the confluence of the Pelly and Lewes rivers, and the mouth of the Nizzenah is from my track survey, the greater part of which was a paced traverse.

The Yukon from Selkirk to the edge of sheet ii is from the sketch survey by Charles A. Homan, published as sheet 5 of map accompanying the report of a military reconnoissance in Alaska, made in 1883 by Lieutenant Frederick Schwatka (Washington, 1885).

Chittenah river and the mount Wrangell region are from the survey made by Allen in 1885; sheet 2 of map accompanying the report of an expedition to the Copper, Tananá and Koyukuk rivers, in the territory of Alaska, in the year 1885 by Lieutenant Henry T. Allen (Washington, 1887).

The coast from Icy bay to Yakutat bay, with the region toward the north including mount St Elias, is from the surveys of Kerr in 1890 and Russell in 1891, embodied in the map of the mount St Elias region accompanying a recent paper on mount St Elias and its glaciers by Israel C. Russell.*

Orographic Features.

From the vicinity of Frazer river, in southern British Columbia, the western mainland range of the Cordilleran mountain system follows the coast toward the northwest as far as the head of Lynn canal. Here it becomes an interior range, while to the westward its place next the coast is taken by the St Elias range. The southern Alaskan coast mountains form a broad elevated belt with many scattered peaks, of which none perhaps have an altitude of more than 8,000 or 9,000 feet, while there is no dominant chain. The southwestern front of the range rises abruptly from the waters of the inland passage, forming a rugged barrier to the interior. A few rivers have cut their channels through the range, and it is penetrated varying distances by numerous deep fiords. From the head of Lynn canal northwestward the range decreases in altitude and probably spreads out and merges in the broken

* Am. Jour. Sci., 3d series, vol. xliii, 1892, pl. iv.

plateau which occupies the eastern part of White River basin. This region is practically unknown, however, and the precise relation of the Coast range to the St Elias range has not yet been determined. Where the former range is cut through by Taku river its northeastern face, like its northwestern termination, is not sharply defined, but the mountain range merges with the high plateau lying to the eastward between the Coast range and the Rocky mountains.

The St Elias range appears to be due to a separate and more recent uplift. Its continuation southward is partially submerged and forms the islands of the Alexander archipelago. Still further southward, in Queen Charlotte and Vancouver islands, it has been called by Dawson the Vancouver range, the westernmost member of the Cordilleran system. Like the southern coast range, it is a broad elevated belt with numerous peaks and short ridges, probably the highest being along its southern border, culminating in mount St Elias. Westward from this peak the range is separated into two divergent ranges by the valley of Chittenah river. The one continuing toward the northwest contains the high volcanic peaks of the Wrangell group. The southern divergent range follows the coast toward the west and, bending round Prince William sound, continues toward the southwest in the Kenai peninsula and perhaps Kadiak island.

The eastern limit of the Coast range may be fixed approximately at the junction of the northern and southern forks of the Taku, the region east of this being a high plateau which extends to the Cassiar range, the northern representative of the Gold ranges of British Columbia. The elevation of the interior plateau, where it is crossed in passing from the Taku to lake Ahklen, is about 5,000 feet above sea level. From this point it descends gradually toward the northwest, its altitude at the junction of Lewes and Pelly rivers being less than 3,000 feet. Southwest of Selkirk the same plateau extends with gradually increasing altitude to the base of the St Elias mountains. It is only in a general way, however, that these areas are to be regarded as plateaus. When considered in detail the surface is extremely rough and broken. The river valleys lie from 2,000 to 2,500 feet below the general plateau level, while broad and rounded dome-like summits and a few sharp peaks rise from 700 to 1,200 feet above it; but there appear to be no well defined ridges or chains of peaks. For about 150 miles southwest of Selkirk the

Digitized by Google

contours are generally smooth and flowing, and the surface, except in the southern and glaciated portion of the region, shows the effect of long continued exposure to the action of subaërial agencies. While rock decay has made little progress, so that the surface is practically free from soil, rock disintegration has been extremely active and the country is thickly mantled with rock débris of varying degrees of coarseness. Projecting through this mantle of débris, above smooth gentle slopes, are many isolated pinnacles and towers of rock rendered especially conspicuous by contrast with their moss-covered talus slopes. Surface degradation is greatly retarded by the luxuriant growth of moss which covers practically the entire surface of the country. The annual precipitation is largely confined to the winter months, and the water from the melting snow is held by the sponge-like moss, which remains saturated throughout the short but hot and dry summer. Thus, with a rainfall which in lower latitudes would condition an arid region, a large part of the surface is swampy, quite irrespective of slope; that is, wherever the material composing it is sufficiently compact to become impervious to water by freezing. On account of this slow and imperfect surface drainage the slopes are not cut into the ravines and arroyas so characteristic of arid regions. The plateau extends west of White river, though it is there rather more diversified than toward the east by a number of high sharp peaks, probably of volcanic origin.

Approaching the northern base of the St Elias range the plateau character is almost wholly lost, giving way to steep and rugged though not lofty mountains separated by rather wide river valleys. There is, however, no merging of the plateau in the St Elias mountains, but south of a well marked limit the whole character of the topography suffers a complete change. Between the southern limit of the interior plateau and the northern base of the St Elias mountains is a depression running parallel with the mountain range and having an altitude of about 4,000 feet. It contains the upper part of White river for a distance of about thirty miles, and probably also in its northwestern continuation the headwaters of the Tananah. Southward across this depression was seen the abrupt northern face of the St Elias mountains, with many sharp and rugged peaks rising to altitudes of 10,000 to 12,000 feet. Only the steepest slopes were free from snow, and the region presented a striking

Digitized by Google

contrast to the green moss-covered plateau country toward the north. The range here occupies a belt about eighty miles in width from north to south. Mr Russell saw the same region from the eastern flanks of mount St Elias, and he describes it as "A vast snow-covered region, limitless in its expanse, through which hundreds and probably thousands of barren, angular mountain peaks project. There was not a stream, not a lake, not a vestige of vegetation in sight. A more desolate or a more utterly lifeless land one never beheld. Vast, smooth snow surfaces, without crevasses or breaks, stretched away to seemingly limitless distances, diversified only by jagged and angular mountain peaks."*

Drainage.

The Taku, like the Stikine and other rivers toward the south, is flowing in a deeply buried channel excavated when the land stood relatively much higher than at present. Its valley, which is a continuation of Taku inlet, is from one to two miles wide with steep sides rising in many places almost vertically from 3,000 to 5,000 feet. The river, interrupted by many sand bars and low, wooded islands, meanders over a gravel floodplain between the high walls of the valley. Its current is rapid and it is transporting to the inlet great quantities of sediment from its upper course. Beyond the junction of the northern and southern forks, which may be regarded as approximately at the eastern limit of the Coast range, the valley sides are rather steep to an elevation of about 1,500 feet from the river, while above that elevation the slopes are gentle to broad, rounded summits of the interior plateau. The upper branches of the Taku flow in open valleys from 3,000 to 4,000 feet above sea level, indicating a long period of erosion during which the land stood at a much lower level than at present. Similar broad valleys at the upper courses of many rivers in British Columbia have been referred by Dr Dawson † to long-continued erosion in middle Tertiary time, and it is probable that the same conditions prevailed far to the north-

* Mount St. Elias and its Glaciers: Am. Jour. Sci., 3d series, vol. xliii, 1892, p. 171.

† On the later Physiographical Geology of the Rocky Mountain Region in Canada, with special reference to changes in elevation and to the history of the Glacial Period: Trans. Roy. Soc. Can., vol. viii, sec. iv, 1890, pp. 17–21.

Digitized by Google

ward, producing the broad valleys of the upper Taku tributaries. The deep canyon-like valleys in the lower portion of the river basin represent a part of the erosion due to uplift in late Tertiary and Pleistocene time.

The divide between the Taku and Yukon drainage basins is on the edge of an escarpment by which the surface drops from the high plateau 2,600 feet to the level of Ahklen valley. The altitude of the pass is 5,100 feet, which corresponds very nearly with the average altitude of the interior plateau at this point. The valley is from twelve to twenty miles broad, and on its eastern side is the steep edge of a plateau corresponding to the one on the west and extending eastward to the base of the Cassiar range, forty or fifty miles beyond. Bounded by these approximately parallel plateau escarpments, the valley extends in an almost perfectly straight line for at least 250 miles in a northwest-southeast direction. The upper, that is, the southeastern, half of the valley is occupied by lakes. From one point on the escarpment, affording only a partial view of the valley, fifty-four were counted. Of these lakes, Ahklen* is the northernmost and by far the largest. This lake is ninety-five miles in length and from six to ten in breadth. Several small streams enter the upper end, but its main feeder comes in from the northeast about midway between the head of the lake and its outlet. This stream, the Nisutlin, enters the head of an inlet about ten miles in length which extends at right angles to the direction of the lake. According to Mark Russell, who has prospected the stream, its current is very sluggish for seventy-five or one hundred miles above the head of the inlet.

Beyond the lake the valley continues with little change, except that the bounding escarpments draw somewhat closer together and decrease in height with the decreasing altitude of the plateau toward the north.

A consideration of the name to be applied to the river which

---

*Among the various names which have been applied to the lake, *Ahklen* is undoubtedly the one which should be retained. It is the name in common use among the Taku Indians. One branch of this tribe claims the country about the southern end of the lake, spending a part of the year there and coming out to the coast during the salmon season. The name is a T'linket word, meaning "big water." I have changed the spelling of the word from "Aklene," as it appears on some maps, to Ahklen, which more nearly represents the native pronunciation.

Digitized by Google

forms the outlet of lake Ahklen brings up the whole subject of the nomenclature of the Yukon and its tributaries. The subject has received very thorough treatment by Dall, Dawson, and Russell, so that the history of discovery in the Yukon basin and the origin of the names applied to the Yukon tributaries need not be discussed here. From a consideration of the physiography of the basin, its main axis must be regarded as coinciding with the Ahklen valley; but I can hardly agree with Russell that this is sufficient ground for disregarding well established usage, as he has done in continuing the name Yukon up to the lake.* Inasmuch as the rivers in question lie almost wholly within Canadian territory, the final authority upon the nomenclature must be the Canadian board of geographic names, and as Dr Dawson has given the subject the most thorough consideration I have followed him,† with a few minor changes in the most of which he has signified his concurrence. The name *Yukon* is applied to the river from its mouth to Selkirk. The name *Pelly* is confined to what has been called the "Upper Pelly," *i. e.*, from Selkirk to its head. The name *Lewes* is applied to the river from Selkirk to lake Lindemann, called the "Yukon" by Schwatka. Finally the river flowing from lake Ahklen is called the *Teslin*, that being the native name as determined by Schwatka and Dawson, with the generic portion dropped. Thus Schwatka ‡ gives "Tesel-hina" (more probably Tes-el-in-hina) and Dawson, "Teslin-too;" but "hina" and "too" are generic terms for river, so it is properly Teslin river. The name *Newberry*, applied to the river by Schwatka in 1883, has never come into general use, and the name *Hotalinqua*, which is commonly used by the miners, was, as Dawson has shown, transferred through misapprehension from another tributary of the Lewes.

The floodplain of Teslin river is something over a mile in width, between high bluffs of silt and gravel which will be more fully described under the head of glacial phenomena.

* Notes on the Surface Geology of Alaska: Bull. Geol. Soc. Am., vol. 1, 1889, p. 107.

† Report on an Exploration in the Yukon district, N. W. Territory, and adjacent northern portion of British Columbia, in 1887: Ann. Rep. Geol. Surv. of Canada for 1887–88, vol. 3, pt. i, 1889, pp. 14B–18B.

‡ Report of a Military Reconnoissance in Alaska made in 1883, Washington, 1885, map (pt. i, sheet 4).

Digitized by Google

The current is from four to six miles per hour and, except for a few sluggish expansions near the lake, is quite uniform throughout. The water was exceptionally high in the spring of 1891, however, and this would tend to increase the uniformity and velocity of the current. There are no shoals or rapids which would prevent the passage of a river steamer from its mouth to the head of the lake.

The course of White river, except for a short distance near its mouth, has hitherto been entirely unknown. Some miners are said to have spent a winter at the first fork, about sixty miles from the Yukon, but beyond this they have failed to penetrate, probably because of the unpromising character of the stream, for it is difficult to conceive physical obstacles sufficiently formidable to turn back these hardy explorers.

The White River basin was entered by the writer fifty miles southwest of Selkirk. From the high land between the Nisling* and Donjek the main valley could be seen for a long distance north and south, with the river pursuing its extremely tortuous course among innumerable low islands and bars. At one point above the mouth of the Nisling the river passes through the point of a mountain spur by a narrow canyon, probably a case of superposed drainage due to the occupation of the valley by ice. Further northward it turns sharply toward the west and enters a deep narrow valley, in which, by native report, there are many dangerous rapids.

For the first seventy miles in the White River basin only clear tributaries were crossed. The largest of these, the Nisling, probably drains the greater part of the large area bounded on the east by the Tahkeena and Lewes, occupying very nearly the position which Dawson has assigned for the main White river, but receiving no part of its waters from the high Coast range. Evidently the greater part of the northward-flowing drainage of the St Elias mountains is carried off by other tributaries of the White river, which show ample evidence of glacial origin in their extreme turbidity. The Donjek is the largest eastern tribu-

* In naming the tributaries of White river I have followed usage among the native Indians so far as possible. Some of the names required slight modification to render them pronounceable, and in most cases the generic part of the name has been dropped, as "too," meaning river, and "dek," creek. The names, however, are near enough to their indigenous forms to be recognized by the natives themselves.

Digitized by Google

tary, and receives the northward drainage from the greater part of the St Elias mountains east of the 141st meridian. There was some question as to which branch should be regarded as the main river and which the tributary, but the western is more nearly in the axis of the main valley and is probably also somewhat larger than the Donjek, although no satisfactory comparison could be made as the confluence was not seen. The western branch rises in Scolai pass from the northward-flowing lobe of Russell glacier. In the fifty miles of its course lying west of the international boundary it receives a number of tributaries from the south, all of which flow from glaciers. This part of the river is in unstable condition. It flows in many channels, constantly shifting its position upon a wide gravel plain which is being built up by contributions of coarse sediment from the overloaded stream.

Scolai* pass is a low gap cut through the range which extends northwestward to the Wrangell group. Russell glacier, from the southeast, flows into the pass against the steep western wall, which turns a part of the stream northward into White river basin and turns a smaller lobe toward the south, so that for about ten miles the pass is filled with ice at least several hundred feet in depth. The altitude of the divide, which is near the northern edge of the range, is 5,040 feet, or about 1,000 feet higher than the upper White River valley. The southern lobe of the glacier gives rise to the Nizzenah river, which flows at first westward through a deep canyon-like valley for fifteen miles, and then nearly southward about twenty miles, emerging into the valley between the two divergent mountain ranges already described. At the point where the river makes its sharp bend toward the south, a glacier coming into the valley from the northwest has dammed its waters so as to form a lake several miles in length. Pushed out of its old channel by the ice, the stream flows a short distance across a rocky point and then plunges into a tunnel in the ice from which it emerges half a mile below. After leaving the mountains it flows nearly westward for thirty miles, to its confluence with the Chittenah, and the latter stream continues in the same course about fifty miles further to Copper river. These eighty miles are in a rather broad, open valley,

* "Scolai" is the name by which the Copper river chief, Nicolai, is known among all the Yukon natives.

Digitized by Google

though the floodplain is bordered by gravel bluffs about a mile apart and from 200 to 400 feet high.

The course of Copper river from the mouth of the Chittenah to the coast is nearly due south. The river has cut through the Coast range a valley which closely resembles that of the lower Taku. Its walls are high and rugged, and the stream meanders from side to side over a floodplain of coarse gravel.

Miles glacier, which is the largest of several ice streams tributary to Copper river along its lower course, has pushed across the valley, forming slack water several miles up the river. The glacier is now retreating, but its northern lateral moraine remains as a dam, over which the river tumbles in a series of rapids. The lake formed by this dam is almost entirely filled with gravel in its upper portion and with fine sand and mud below, so that the water is for the most part only a few inches in depth.

A short distance below Miles glacier is the head of the delta, which reaches thirty miles southward to the line of bars or keys at the edge of deep water. Excepting a few sand dunes, the delta consists of broad, level meadows and still more extensive mud flats exposed at low tide. Deposition is going on at a rapid rate over this considerable area, and it is interesting to note that subsidence also is taking place. There are no trees growing upon the delta now, but the remains of many large spruce trees were observed standing several feet below tide-water.

Vegetation.

The vegetation of the Yukon basin presents a marked contrast to that of the coast, the luxuriance of which is too well known to require description. This contrast consists more in the amount of vegetation than in the difference of species. Cut off by high mountains from the abundant supplies of moisture which the coast enjoys, the interior supports a comparatively scanty growth, especially of arboreal vegetation, while some of the moisture-loving species of the coast are absent. Excepting surfaces covered by snow or ice throughout the year and the steepest rocky cliffs and screes, practically the whole Yukon basin, as well as the Alaskan coast strip, is covered by a more or less luxuriant growth of moss. Meadows of coarse grass were seen in a few of the interior valleys and some of the gravel terraces along Teslin and Lewes rivers are covered with sage brush, but

Digitized by Google

these areas are wholly insignificant when compared with those which are covered with moss. The black alder, so abundant on the coast, is also very common in the interior, but in a dwarfed form, decreasing in size with increasing altitudes from ten or twelve feet in the valleys to a few inches on the higher parts of the plateau. The upper limit of the spruce forests is reached along the coast at an altitude of about 1,800 feet, but this limit, along with the snow line, gradually ascends toward the interior. The high valleys of the Taku tributaries have considerable spruce timber, although the trees are not close together and the largest are seldom over a foot in diameter. Taku pass, with an altitude of 5,100 feet, is approximately at the timber line and only a few stunted trees manage to exist there.

Ahklen valley is quite heavily timbered, and some trees eighteen inches in diameter, the largest seen anywhere in the interior, were among the drift from Nisutlin river.

In the White River basin only the valleys are wooded, the timber extending less than a thousand feet up their sides, while the greater part of the plateau surface is practically treeless. The timber line on the northern side of the St Elias mountains has an altitude of about 4,500 feet.

The Chittenah and Copper river valleys feel the influence of the coast climate, and their vegetation is consequently much more luxuriant than in the valleys of White River basin.

Hard Geology.

Character of the Observations.—Any attempt to solve the many difficult problems connected with the geology of the region traversed would necessitate detailed study of large areas. The opportunities afforded by a hasty reconnaissance along a single line of travel are obviously inadequate to the solution of these problems, particularly when the greater part of the geologist's energy is absorbed in overcoming the physical obstacles to his progress and in making even the crudest topographic map to which to refer his observations.

The most satisfactory information on the hard geology of any portion of this region is contained in Dawson's report, already cited, on the geology of the Yukon district. Dr Dawson had the great advantage of familiarity with similar rocks and geologic problems from previous study in British Columbia. He was also

Digitized by Google

in a position to control the movements of his party, and so was able to give more than a passing glance to points of special importance. Since the writer was without previous acquaintance with the rocks of the Cordilleran system and had no opportunity for observation, except as it was afforded along the route or at stops selected without reference to the geology, the information obtained is offered only as supplementary to the observations made by others and as preliminary to the more thorough study of those who may hereafter visit the region.

Rocks of Taku Valley.—The section afforded by Taku river as it cuts through the Coast range is quite similar to those described by Dawson on Stikine river and Chilkoot pass. After leaving the argillites of the coast, which extend to near the head of Taku inlet, a broad belt of gray hornblende granite is crossed; this is called the Coast Range granite by Dawson. The belt is about forty miles in width, extending nearly to the South fork of the Taku. In addition to the granites, this belt also contains altered eruptive rocks in horizontal or undulating and sometimes highly contorted beds.

Rocks of the interior Plateau.—Forming the high plateau between the Coast range and Ahklen valley is a somewhat broader belt, containing a great variety of rocks, both eruptive and sedimentary but all highly altered. The sedimentary rocks consist of limestones and marbles, shales and slates with conglomerates, sandstones and quartzites. The least altered members of this series are along the western side of the belt. At the junction of the North and South forks of the Taku, near the eastern limit of the Coast Range granites, there are black slaty shales and, apparently overlying them with a dip of from 25° to 50° northeastward, are compact bluish limestones. Still farther eastward there are siliceous shales with large conglomeratic pebbles of the underlying limestone. The pebbles contain some obscure fossils, probably Carboniferous, which would indicate a Mesozoic or later age for the shales. These slightly altered rocks occupy a belt about eight miles wide, east of which lies a region traversed by many dikes that have converted probably similar shales and limestones into talcose slate and highly crystalline marble.

Among the non-sedimentary rocks of this plateau belt there are many basic eruptives largely altered to serpentine, and also considerable areas of granite. A portion at least of the granite is older than the sediments as indicated by basal conglomerates

Digitized by Google

at the contacts. The basic eruptives are confined to a narrow strip less than a quarter of the width of the plateau belt and lying along its western side. The sequence of these rocks, as well as their relation to the Coast Range granite, is extremely involved, and much further study will be required in order fully to determine these relations. Their age is probably upper Paleozoic and Mesozoic, though very few fossils were found and none except in the less altered western portion of the belt.

East of Ahklen valley there is another belt of granite, quite distinct in character from that of the Coast range. It is free from hornblende and contains a large amount of pink feldspar, giving a decided red color to the rock in mass. The granite has in some places a well developed gneissoid structure, the cleavage being approximately parallel with the direction of the lake. Teslin river flows in a valley deeply filled with silt and gravel, so that not more than two or three rock exposures occur throughout its whole length; but so far as could be determined at a distance the escarpments on both sides of the valley are composed of rocks similar to those forming the plateau west of the lake. About thirty miles above the mouth of the river the hills toward the northeast are composed of bright red sandstones with yellow and gray shales, probably less altered and perhaps younger than any of the sandstones above described.

The extensive plateau region between the Yukon river and the northern base of the St Elias mountains is composed of various kinds of crystalline rocks with small areas of highly altered sediments. Gray hornblende granite similar to that forming the Coast range of southern Alaska occurs in a somewhat narrow belt just north of the St Elias mountains. The prevailing rock of the greater part of the region north of this belt is a reddish granite quite free from hornblende and frequently containing large porphyritic crystals of feldspar. Both kinds of granite are cut by numerous dikes or covered by sheets of eruptive rocks, from the most recent vesicular basaltic lavas to highly altered diabase. The red granites, at least, appear to be Archean, deposited upon which are small areas of sedimentary rocks that have been infolded with the granite and penetrated by the basic dikes and thus so completely changed from their original condition that no clue is afforded as to their age. They consist of arkose-conglomerates, slates and marbles. North of the Kluantu valley the only clastic rocks seen were a few exposures of con-

Digitized by Google

glomerate and schist. The district between the Donjek and Koidern rivers is composed almost entirely of white marble and talcose schist, and is the largest observed area of sedimentary rocks between the St Elias mountains and the Yukon.

Rocks of Scolai Pass.—As already described, two slightly divergent ranges, separated by the Chittenah valley, extend toward the west and northwest from mount St Elias. The geology of the northern range is simple. In the walls of Scolai pass, by which the range was crossed, its stratigraphy and structure are magnificently displayed. The rocks are comparatively recent, for the most part Carboniferous, Triassic, and Cretaceous. A bed of limestone about 500 feet thick contains many crinoids and corals, probably of Carboniferous age. Above it are red sandstone and jasper and a great thickness of black shale. Collections of fossils from the limestone and the black shale were made, but before reaching the coast they unfortunately were lost, with the exception of a single small piece of shale; this, however, contained several tolerably perfect impressions and was submitted to Professor Alpheus Hyatt for identification. He says: "The fossils in the shale are clearly the remains of a *Monotis* of a Triassic type, allied to *M. subcircularis*, Gabb, a characteristic Triassic form in California. This one seems to be distinct specifically, but is evidently of the same age."

Interbedded with these sedimentary rocks and penetrating them as dikes are fine-grained, greenish amygdaloid lavas forming perhaps half of the whole rock-mass. The structure of the range consists essentially of a broad, gentle synclinal, with a highly contorted belt on either side.

Excellent examples of typical fan structure were seen in the intensely plicated rocks which form the abrupt northern face of the range. This structure is remarkably well shown in the sides of the gorge from which Kletsan creek issues. The 500-foot stratum of white limestone above referred to is folded in with dark greenish-black eruptive rocks so as to form a double V; the overturned southern synclinal limbs dip southward about 30° and 45°, while the normal northern limbs are nearly horizontal.

This plicated belt on the northern side of the mountains is about six miles wide, and south of it the synclinal in which the beds are practically horizontal (coinciding with the axis of the range) occupies a belt from twenty-five to thirty miles in width.

Digitized by Google

On the southern side of the range there is a region of disturbed rocks similar to that on the north, but somewhat wider and less minutely plicated. The structure is well shown in the lower portion of the Nizzenah canyon, whose walls rise from 2,000 to 3,000 feet vertically above the river. One excellent example of faulting was observed. A bed of white limestone about 500 feet in thickness, probably a continuation of the one in which the fan structure was observed on the northern side of the range, has been broken across and thrust over upon itself a distance of half a mile. Within this space there appear to be two conformable beds of limestone in place of one. The diagramatic form in which the fault is displayed on the canyon wall confirms certain theories as to the mechanism of such faults derived from much more obscure phenomena in other regions. Evidently folding, due to lateral compression, had been only slightly developed when a shearing fracture took place across the rigid bed. The fracture did not extend far on either side of the limestone, but the thin-bedded black shales above and below are intensely plicated, having taken up the lateral compression by folding instead of faulting. Apparently the conditions which determined the formation of a fault rather than a series of folds in the limestone were, first, the great difference in rigidity between that bed and the adjacent shales and, second, the absence of a heavy load upon the beds during the compression.

Nizzenah river, for about seven miles above its confluence with the Chittenah, flows in a narrow canyon with rocky walls from 400 to 500 feet high. For a short distance above the canyon the gravel bluffs are replaced by cliffs of calcareous black shale apparently very recent and only slightly affected by the compression which has disturbed the rocks lying on the north. At the upper end of the canyon the black shale contains beds of extremely coarse conglomerate, and is succeeded by black slate and mica schist, the latter containing many small quartz veins. An east-and-west line through the upper part of this canyon appears to be the approximate limit of the little altered rocks forming the northern range.

Rocks of Copper River Valley.—Several massive dikes intersect the course of the Chittenah a few miles above its junction with the Copper, forming high cliffs, and a number of rocky islands in the river channel. The dikes are composed of a very com-

Digitized by Google

pact greenish-black rock, traversed by many streaks of lighter green serpentine and white veins apparently of calcite. The rocks of the southern range which extends westward from St Elias differ widely from those exposed in Scolai pass. About Taral they consist for the most part of siliceous talcose schist with gray hornblende granite, which is apparently eruptive. Between Taral and the coast the prevailing rocks are bluish-gray quartzite or quartzite-schist. The moraines of glaciers along the lower course of Copper river flowing from the eastward are composed largely of eruptive granites and granitoid gneiss containing inclusions of black slate and schist. All the sedimentary rocks between the Chittenah and the coast have been so thoroughly metamorphosed that their original bedding is wholly obliterated, and no statement can yet be made as to their probable age.

Rocks of Prince William Sound.—Forming the shores about Prince William sound there is a series of black shales and thin-bedded dark-brown sandstones. They are highly contorted and somewhat altered, especially the shales. The strike, wherever any regularity can be detected, is about north-and-south, and the dips are generally steep, often vertical. They bear a strong resemblance to the rocks of the Yakutat series described by Russell,* and it is not improbable that they are the continution westward of that series. Fossil plants are reported to occur in these rocks at some points on Prince William sound, but none have yet been collected. While the series is perhaps all Mesozoic or younger, any statement as to its age made at the present time must be regarded as purely hypothetic.

Mineral Resources.

Gold.—Placer gold occurs widely disseminated throughout the Yukon basin, though only in a few places has it been found in sufficient quantity to make profitable working. The most important of these are bars along the Lewes between Teslin and Little Salmon rivers and on Forty-mile creek, a southern tributary of the Yukon emptying near the 141st meridian. Ten men were located on the bars of the Lewes, and, although the water

* An Expedition to Mount St Elias, Alaska: Nat. Geog. Mag., vol. iii, 1891, p. 167.

Digitized by Google

was very high when we went down, they are said to have done well in the latter part of the season.

One member of our party, Mark Russell, was equipped with long experience in prospecting both for placer and vein gold, and while the necessity for getting through the country as rapidly as possible prevented anything like an exhaustive examination, still enough was done to give a fair idea of the resources of the region traversed. While in White River basin we also had the benefit of Mr Bowker's experience. A few "colors" were found on most of the branches of White river which we crossed, but it was all fine gold and afforded nothing which could be regarded as a good prospect. The indications of gold-bearing quartz were even less encouraging. Practically no vein quartz was seen between Selkirk and Scolai pass, either in place or among the stream gravels. Along the lower portion of the Nizzenah and thence southward to near the mouth of Copper river considerable quartz occurs in small stringers through the schist, so that there is a possibility of this region containing gold-bearing veins.

Copper.—Native copper has long been known to exist in the Copper River basin, but exactly where or in what quantity has never been ascertained through actual examination by a competent observer. Its occurrence in White River basin also has been suspected from the presence of native copper among the Yukon Indians, although they were known to trade with those living on Copper river from whom they might have obtained the metal. The Pelly Indians whom we secured at Selkirk for packers promised to show us the source from which in the past they had secured copper for making arrow-heads and more recently for making bullets, which are still used to some extent when lead cannot be obtained. While still at Selkirk they told us of great masses of copper as large as houses on a stream called the Klet-san-dek, or Copper creek, flowing into White river near its source. As we approached this locality, however, the masses of copper rapidly decreased in size, first to pieces as big as a man and then to bowlders of such size that they could be lifted by prying with a stout stick, and finally what they actually showed us consisted of small nuggets, the largest only a few ounces in weight.

Kletsan creek issues from a narrow gorge in the steep northern

Digitized by Google

face of the St Elias mountains, flowing from numerous small glaciers a mile or two back from and several thousand feet above the valley of White river. At a former stage, probably when the glaciers descended to a much lower level, the stream deposited a broad alluvial cone about the mouth of the gorge. This deposit of gravel is now being cut away and in its lower portions or in crevices of the bed rock numerous small nuggets of native copper are found. This seemed to be the only locality for the metal known to the Indians who were with us, though pieces which had been cut from a larger mass were shown us by those whom we met on Kluantu river. It is not probable, however, that any of the Yukon basin Indians are acquainted with extensive deposits of native copper, since they have very little of the metal in their possession and hold a greatly exaggerated idea of its value. Some time was spent in searching for the source of the copper on Kletsan creek but without success as we soon reached the snow line, beyond which, of course, further search was impracticable. It appears to have been brought by glaciers from the region toward the south which is still covered by snow and ice. It is associated with greenish-black amygdaloid lava and red sandstone and jasper, rocks which resemble, superficially at least, those of the copper-bearing series of the lake Superior region.

A small quantity of what appeared to be azurite, pulverized and used as a pigment, was shown us by the Yukon Indians. They said it came from the country beyond Scolai pass, but we were unable to learn its exact source or how they obtained it.

According to Allen's account, the chief of the Copper river Indians told him of the existence of native copper and also of copper ores in the upper Chittenah valley between the two main streams, but he did not visit the locality. We expected to find Indians on the Nizzenah near the point where it emerges from the mountain pass and to be able to examine the copper of this region, but unfortunately Nicolai and his tribe were at their summer fishing station, Taral, and it was too late in the season to return to the copper region which we had passed.

Doubtless this interesting region on both sides of Scolai pass will be found on careful examination to contain considerable mineral wealth, but the extreme difficulty of access together with the unfavorable climatic conditions will greatly retard, if not wholly prevent, the development of its resources.

Digitized by Google

Volcanic Phenomena.

Active Volcanoes.

Volcanic activity in the United States within historical times has been confined wholly to Alaska, and, excepting somewhat mythical eruptions of mount Calder on Prince of Wales island in 1775, and of mount Edgecumbe in 1796 it has been confined to the southwestern extremity of the territory. The most easterly known crater which shows any activity at present is mount Wrangell. This was observed for several days during August, 1891, from Taral, at the confluence of Chittenah and Copper rivers. It lies about fifty-five miles nearly north of Taral, and only the top of the mountain, a sharp black cone, appears above the intervening broad snow-covered dome of mount Blackburn. From this cone masses of densely black vapor were constantly rising. At intervals of about half a minute a cloudy pillar would rear itself to a height of several thousand feet and, floating off toward the east, quickly disappear, to be replaced by another burst of vapor from the crater. No illumination of the vapor was noticed at night and, so far as I could learn from the chief Nicolai, no appearance of fire was ever seen. According to the diary of John Brenner,* a miner, who spent the winter of 1884-'85 at Taral, the volcano was at that time in a state of somewhat violent eruption. He says:

> "The volcano has been very quiet a good while, but today it is sending out a vast column of smoke and hurling immense stones hundreds of feet high in the air. The masses it is throwing up must be very large to be seen here. * * * It has made no loud reports, only a sort of rumbling noise."

It is possible that an active volcano may exist east of mount Wrangell in the upper White river basin, but our information as to its existence depends on the vague and unreliable statements of the Yukon natives—statements that may refer to mount Wrangell. Some sharp cones were seen northwest of lake Wellesley and also some in the St Elias mountains between Klutlan glacier and Scolai pass. Their volcanic origin, however, could only be inferred, and any present activity would

---

*The Shores and Alps of Alaska, H. W. Seton Karr: London, 1887, p. 219.

Digitized by Google

have been concealed from us by the clouds which hung about their summits.

Recent volcanic Activity.

The most striking effect of recent volcanic activity in this region is the wide-spread deposit of volcanic ash, or tufa, which covers the southeastern portion of the Yukon basin. This deposit was first noted by Schwatka in his reconnaissance of 1883. It was more fully described as it occurs on the Pelly and Lewes by Dawson in his report of the Yukon expedition of 1886, and was noted by McConnell in 1887 and Russell in 1889 on the Yukon and Lewes.

It was first seen by our party on Teslin river shortly after leaving lake Ahklen, and from this point northward it forms a conspicuous and nearly continuous white band in cut banks of the river nearly down to Selkirk, at the confluence of the Lewes and Pelly. Where first seen the layer of tufa was less than an inch in thickness, and from this increased to a maximum of nearly a foot near the mouth of the Teslin, with some local accumulations of two or three feet. The alluvium which has accumulated upon the layer of tufa is generally about a foot in depth, but it occasionally varies from nothing to three or four feet. A foot, however, probably represents the normal accumulation of soil under the prevailing conditions since the deposit of the tufa.

The first point at which the tufa was noticed in the White River basin was about one hundred miles southwest of Selkirk, on the divide between the Nisling and Donjek, eastern tributaries of White river. It is altogether probable that the deposit was continuous over the whole of this country, but no localities favorable for its preservation and display were seen on the high land traversed. A layer much heavier than that appearing on the Lewes would in a short time be wholly lost on a surface almost entirely destitute of soil and composed of rock fragments of varying degrees of coarseness.

In the banks of the Kluantu and Donjek the tufa does not form a distinct layer as along the Lewes, but is probably represented by certain stratified beds of white sand, which were regarded at the time as lake deposits. They are indistinguishable from the sediments carried and deposited by the river at the present time, except in being somewhat coarser.

Digitized by Google

The original thickness west of the Donjek must have been at least several feet, and the increase is very marked toward the southwest. The white tufa is washed down from the steep slopes and forms considerable alluvial fans at the mouths of the ravines closely resembling the cones of snow which form in similar position. After passing the Koidern the narrow valleys were found deeply filled with tufa which had accumulated from the steep mountain slopes. From the divide the upper White River valley was seen stretching forty miles to the westward, and appeared almost completely covered with drifts of snow. On reaching the valley the drifts proved to be tufa, which forms a deep mantle over the country north of the St Elias mountains, and for twenty miles west of the Klutlan forms a desert of drifting snow-white sand into which one sinks from four to twelve inches in walking. A scanty growth of dwarf alder and blueberry bushes has gained a precarious foothold in some places, and a few stunted spruce trees grow in protected spots along the streams. The tufa extends up the mountain sides on the south, covering every surface where the slope is not too steep for it to lie and finally merging with the névé snow, which begins about 1,500 feet above the valley or 6,000 feet above sea level. The valley was covered with a sheet of glacial drift before the deposition of the tufa, and in consequence the drainage is very imperfect. Many small lakes and ponds, usually without outlet, occur scattered over the surface.

The greatest observed thickness to which the tufa deposit attains is between 75 and 100 feet. This was seen on the western bank of the Klutlan, where there is no reason to suppose that its original thickness has been increased at the expense of surrounding regions except, perhaps, by wind drift.

Toward the upper end of the valley the thickness of the deposit decreases very rapidly, and at the entrance to Scolai pass, less than forty miles from its maximum, it appears as a narrow white streak in the freshly cut river banks, exactly as it does along the Lewes and Pelly, 300 miles to the eastward. The deposit also appears to decrease in thickness rapidly toward the north, and there is no indication of any considerable accumulation on the gentle slopes of the valley or on the mesas north of White river.

The gradual increase in thickness of the deposit from east to west is accompanied by an increase in the size of the fragments.

Digitized by Google

As described by Dawson* from the Yukon, "It is a fine, white, sandy material * * * consisting chiefly of volcanic glass, * * * the greater portion of which has been drawn out into elongated shreds, frequently resembling the substance known as 'Pele's hair.'" Where first noticed between the Nisling and Kluantu it had the appearance of sand which results from the disintegration of a rather coarsely crystalline marble, the individual fragments being from 0.5 mm to 1 mm in diameter. The average dimensions increase to the westward, and in the Klutlan valley the deposit contains many fragments of white vesicular pumice from two to ten centimeters in diameter, though the greater part is much finer, perhaps from 1 mm to 5 mm in diameter. Nothing in the nature of true volcanic bombs was seen in the tufa, though their presence may have been overlooked.

Taking the approximate limits of the deposit, as observed on the Yukon by McConnell, on the Pelly and Lewes by Dawson, and on the Teslin and at Scolai pass by the writer, it will be seen to cover an oval area, with the maximum thickness near the western extremity. The oval area (which is depicted on plate 18) is about 370 miles from east to west and 220 from north to south, or about 52,280 square miles. Assuming the deposit to be in the form of a flat cone with the above base and a vertical height of but fifty feet, its volume amounts to 165 cubic miles of material.

From the facts of distribution, as above stated, a fairly safe inference may be drawn as to the source of the deposit. The explosive eruption which produced the tufa probably occurred in the northern part of the St Elias mountains, near the source of Klutlan glacier. As already stated, it was impossible to tell whether there is any present volcanic activity in this region. One conspicuous peak, of which the top remained hidden by clouds, was pointed out by the natives as having some unusual characteristics of which they seemed to stand much in awe. The name by which they called the mountain was Nat-azh-at, meaning, as near as I could make out, "shape of a man;" but, owing to native reticence and lack of an interpreter, it was impossible to obtain any satisfactory information concerning the mountain. Mount Wrangell has been suggested as the source of the tufa,

* Report of an exploration in the Yukon district, N. W. T., and adjacent northern portions of British Columbia, 1887; Ann. Rep. Geol. Surv. Canada, Montreal, 1889, p. 46B.

Digitized by Google

but this is clearly impossible, as it lies wholly beyond the area covered by the deposit.

The strong winds prevailing in the upper White River valley during August, 1891, were from the west and were evidently in the same direction during the great eruption. It would be interesting to fix the date of the eruption, but it is impossible to do so with any degree of certainty. From a study of the relations of the tufa bed on the Pelly and Lewes Dr Dawson says: "While the eruption must have happened several hundred years ago, it can scarcely be supposed to have taken place more than a thousand years before the present time." A similar conclusion is reached from a study of the deposit in the White River basin. As already stated, for ten miles on either side of the maximum thickness the surface tufa is unconsolidated and supports only a very scanty vegetation; but the tundra moss covers with great readiness even the most barren surfaces, wholly independent of soil, so that it seems impossible this should have remained bare for any great length of time.

From its position near the greatest thickness of the deposit a vast quantity of the tufa must have fallen on the surface of the Klutlan glacier as well as on the névé fields at its source. The fact that this has nearly all been deposited in the terminal moraine and remains only on the surface of the stagnant ice a short distance back from its front indicates an interval since the eruption sufficiently long for ice which then formed the névé to flow the whole length of the glacier and deposit its burden in the terminal moraine. Neither the length of the glacier nor the rate of motion of its different parts is known, but the time required for the transfer of material on the névé fields to the terminal moraine must be at least several hundred years. The time since the eruption has also been sufficient to permit the recession of the glacier front about three miles.

The color of the waters of White river has been noted by all travelers on the Yukon who have passed its mouth. Schwatka* describes it as resembling "a river of liquid mud of almost white hue," and McConnell† says: "The turbid character of the White river is famous, and sufficient sediment is brought down to change the color of the whole Pelly-Yukon flood from a pale

* Along Alaska's Great River: New York, 1885, p. 240.

† Report of an exploration in the Yukon and Mackenzie basins, N. W. T.: Ann. Report Geol. Surv. Canada, Montreal, 1891, p. 144D.

Digitized by Google

green to a milky white." This turbidity has been attributed to the glacial source of the river, but glaciers could scarcely supply such an enormous quantity of mud unless acting under peculiar conditions. The presence of this great deposit of unconsolidated material, which is being ground up by the ice and removed by the englacial streams, affords a ready explanation of the turbidity of the water. The highly vesicular character of the tufa permits a much larger amount of it to be held in suspension than of sediment derived from compact rocks.

Tertiary volcanic Activity.

Evidence of volcanic activity, geologically recent though very much more remote than the eruption of the tufa deposit, is somewhat abundant. Perhaps the most striking example of such activity is seen in the basaltic mesa at the junction of Pelly and Lewes rivers. This lava flow took place after the river valleys had been eroded perhaps below their present levels and extended entirely across the valley. The river has since cut through the barrier, leaving only a few fragments of the basalt resting on the granite on the western side of the channel. This lava flow probably came from two or more vents; one about ten miles north of Selkirk still retains the form of a symmetrical cone, and according to the native accounts has a small lake upon its summit, probably occupying the crater. A second vent was the high hill on the western side of the Yukon, about four miles northwest of Selkirk. Between the Yukon and St Elias mountains black vesicular lava was seen at a number of localities, and north of the upper part of White river are broad mesas which appear to be formed of black lava. These are all probably of Tertiary age.

Glacial Phenomena.

Existing Glaciers.

So far as known the existing glaciers of Alaska are confined to a narrow belt along the southwestern coast. Although the highest land lies in the coast belt, this is not the sole or chief reason for the notable absence of glaciers in the interior, except in so far as climatic conditions are thereby modified. There are numerous points in the Yukon basin from which practically all

Digitized by Google

snow disappears in summer, although they have an altitude of from 6,000 to 7,000 feet and a mean temperature much lower than any portion of the southern coast. The explanation must be found in the very much greater precipitation and prevalence of clouds along the coast than in the interior.

The glaciers farthest removed from the coast are those flowing from the mountains of the Wrangell group, where the moisture-laden winds of the north Pacific are able to pass up the Copper River valley and across the coast range, which is here much lower than toward the east.

Four considerable glaciers descend to or nearly to tide level on Taku inlet and river, though only Taku glacier, entering the head of the inlet, discharges bergs. A few miles up from the mouth of the river are two glaciers which come down into the valley nearly opposite to each other. Neither quite reaches the river, but, like the Norris* glacier on the inlet, they spread out into fan-shaped expansions with low wooded deltas of moraine material in front. Along the steep sides of the river valley above these glaciers a slight but distinct terrace has been cut about 150 feet above the river. It is probable that Wright† glacier, pushing across the valley to its northern side, dammed the stream for a short time after the main valley was clear of ice. Above Wright glacier only a few small masses of ice or glacierets occur in the Taku basin in cirques about the higher mountain summits. No parts of the high interior plateau, either in the Taku or Yukon basins, carry glaciers, and probably very little, if any, snow remains throughout the year between the Coast and Cassiar ranges, though much of the surface is fully 3,000 feet above the snow line at the coast. The reason for this rapid rise of the snow line toward the interior is the dry climate, with short but hot summers prevailing throughout this region. In like manner the high plateau east of White river is wholly free from summer snow, and the first glaciers seen in the Yukon basin were those flowing northward from the St Elias range. Kluantu and Donjek rivers undoubtedly head in glaciers, but these were not seen, since they lay too far east of the route traveled. Three large glaciers flow into the White River basin west of the Alaskan boundary, and numerous streams crossed while following the southern bank of the upper White river

* Named in 1886 for Dr Basil Norris, surgeon United States Navy.

† Named by the writer for Professor G. F. Wright of Oberlin college.

Digitized by Google

rise in small glaciers which do not descend to the level of the valley.

The largest glacier known to discharge wholly in the Yukon basin is one which lies approximately on the 141st meridian, called the Klutlan from the native name of the river to which it gives rise. Its source is in the great snow fields between mount St Elias and the high peak on the northern border of the range called Nat-azh-at by the natives. It extends several miles beyond the foot of the range, though it is rapidly receding at the present time, and is between four and five miles broad where it enters the valley. The stagnant ice at the front of the retreating glacier is buried under a great accumulation of moraine material continuous with the terminal moraine, so that it is impossible to determine the exact limits of the ice. The heavy mantle of vegetation which covers the terminal moraine continues a mile or more beyond the outer edge of the ice, becoming gradually less abundant as the active portion of the glacier is approached.

The moraine in front of the Klutlan is the largest accumulated by any of the interior glaciers. It is composed very largely of the white volcanic tufa already described, but with this are mingled many angular fragments of amygdaloid lavas and a few of granite and gneiss. Much of the moraine has been removed by streams flowing from the glacier, but remnants 200 feet or more in thickness extend nearly across to the high land north of the valley.

The second of the White river glaciers is about midway between the Klutlan and Scolai pass. It is much smaller than the Klutlan and does not push out into the valley, but its front forms a wall of ice something over a mile in length from side to side of the narrow valley in which it lies.

The third and largest of the interior glaciers flows from the high mountains northwest of St Elias down into Scolai pass, and from the divide sends a lobe of ice toward White river and a smaller one toward Copper River basin. This was named in honor of Mr I. C. Russell, whose exploration and study of the St Elias region during the past two years have added very largely to our knowledge of Alaskan glaciers and to the science of glaciology. The northern or White river lobe of Russell glacier is buried under a heavy accumulation of moraine, bearing some vegetation, while the southern lobe is almost wholly free from moraine material and the exposed ice has melted down to the

Digitized by Google

smooth convex surface and feather edge characteristics of stagnant ice at the front of a retreating glacier.

Taken altogether, the ice flowing northward from the St Elias mountains is insignificant in amount when compared with that flowing southward. The Seward glacier alone probably contains a greater volume than all of those flowing into the White river basin combined. The great difference in climatic conditions, on which the formation of glaciers depend, is indicated by the difference in altitude of the lower limit of the névé snow on the north and south. According to Russell's observations about Yakutat bay and my own on Prince William sound, that limit on the seaward side of the mountains is at an altitude of about 2,000 feet, while on the north the altitude of the lowest névé observed was 6,300 feet. This rise in the snow line toward the north, over 4,000 feet in a distance of about eighty miles, is an important fact in the consideration of the causes of glaciation, either local or general.

The Nizzenah river rises from one lobe of Russell glacier and in the upper part of its course is fed by a number of glaciers coming in from the high mountains on either side of Scolai pass. One of these, the Frederika, possesses a peculiar interest in that it appears to be the only well marked case among Alaskan glaciers of active advance at the present time. Flowing southward in a lateral valley which joins that of the Nizzenah at right angles, its front is parallel with the river and about three-quarters of a mile distant, the intervening space being a smooth gravel plain. The glacier terminates in a nearly vertical ice cliff stretching across the lateral valley a mile in length and about 250 feet high. Its surface is free from moraine, but is extremely rough and broken, wholly unlike the surface of stagnant ice at the end of a retreating glacier. At the foot of the cliff there is a small accumulation of gravel and ice fragments, apparently being pushed along by the advancing mass.

Since the same climatic changes must affect all the glaciers of the region alike, the cause of this anomalous advance must be sought in some peculiar local condition affecting this glacier alone. A simple explanation is suggested, though it must be regarded merely as a suggestion since no means of verification are at hand. Ten miles to the westward of the Frederika another and much larger glacier flows into the valley of the Nizzenah. This is formed by the union of three separate streams, and of

Digitized by Google

these the eastern appears to be retreating much more rapidly than either of the others; but this eastern branch probably has its source in the same basin as the Frederika glacier, and it seems not improbable that by some means the drainage of the basin has been diverted from the western to the eastern outlet, thus causing the rapid retreat in the former glacier and advance in the latter.

The large triple glacier above referred to flows from the high mountains forming the eastern members of the Wrangell group. After the union of its three branches the combined stream occupies the valley of the Nizzenah for about six miles, crowding the river out of its channel and forming a berg-filled lake above the ice barrier. Its great volume, together with the distance which this glacier pushes down into the valley, indicate an increased precipitation, due to proximity to the Copper River valley through which pass the warm winds from the ocean.

No glaciers flow into the Chittenah valley from the ranges on either side, though all the upper portions of the Wrangell group are snow-covered and doubtless the high ravines are filled with ice. Several large glaciers flow into the Copper River valley from the Coast range, although its altitude is not so great as that of many portions of the interior plateau, which is entirely free from summer snow. The largest of these Coast range tributaries of Copper river are Miles and Childs glaciers, named by Lieutenant Allen in 1885. Several others of considerable size higher up the river do not appear on Allen's map, probably because he passed up the river while the surface was still covered with snow. Miles glacier is quite comparable in size with those of the St Elias region and is formed under essentially the same climatic conditions. It is evidently retreating at present, and the river spreads out in a lake-like expansion along its front in a part of the glacial channel from which the ice has receded. This expansion of the river is about a mile in width and one side is formed by the glacier front, a cliff of ice 350 feet above the water and over five miles in length. Although the ice no longer reaches entirely across the valley, there remains a heavy lateral moraine, indicating its former position and damming back the river as already described. The fact that the river has cut only part way through the moraine indicates a very recent recession of the glacier.

Digitized by Google

Former Glaciation.

In common with other parts of the coast region, the Taku basin shows signs of intense glaciation from the westward-moving portion of the Cordilleran ice sheet. Evidence of this in the way of glacial deposits is wanting along the lower portion of the river, while the polished and striated rock surfaces so abundant there may be due to the action of a glacier occupying simply the river valley. The evidence of an ice sheet becomes more abundant, however, toward the upper part of the basin. Thus, on a spur of the high plateau east of the forks of Taku river, bowlder clay and stratified gravels were seen 3,100 feet above the river. The movement of the ice in the greater portion of the Taku basin was apparently in the same direction as the present drainage. The high broad valleys of the upper Taku branches are deeply filled with a mantle of bowlder clay and gravel. In most cases this is spread out in a comparatively even layer over the surface, but also many narrow ridges occur from ten to fifty feet in height, with the longer axes in the direction of the present valleys. These, however, probably mark a phase of deposition by a greatly diminished and waning ice sheet, so that they afford little if any indication of the direction of ice movement during the maximum glaciation. A much better indication is afforded by the transportation of bowlders. From the head of canoe navigation on the Taku to a point nearly half way across to Ahklen valley, increasing numbers of bowlders were observed composed of a peculiar granite containing large porphyritic crystals of black hornblende. At this point their source was found in a range of hills composed of the same granite, and no bowlders of this rock were seen to the northeastward. At the summit of the divide but little evidence was seen which would indicate the direction of the ice movement, though it seems probable that it was toward the northwest, as it certainly was in Ahklen valley.

Some deposits of true bowlder clay occur at various points along the lake, and a single occurrence was noted on the Teslin river about five miles from its mouth. Among the many lakes in the upper part of the valley are ridges and mounds of rounded bowlders and gravel, which, with terraces of the same material about the head of Ahklen, were evidently deposited by

Digitized by Google

a rapidly retreating glacier and the streams to which it gave rise. These gravels are younger than the bowlder clay which they overlie and also younger than the silt of the river bluffs toward the north.

Among the most interesting deposits associated with the second period of glaciation in the northwest are those forming the river bluffs along the Teslin and other tributaries of the Yukon. Bluffs are continuous throughout the whole length of the Teslin river, increasing slightly in height from about 100 feet at the lake to 150 feet at the mouth, and frequently cut into a number of terraces. The materials of which they consist are light colored silts or fine sand interbedded with layers, one to three inches in thickness, of tough bluish clay. The layers of sand are often cross-bedded and contain sufficient clay to give the material considerable tenacity. At some places intermediate beds are highly contorted, while those above and below are undisturbed. Although the deposit differs widely from the true bowlder clay which it was seen to overlie, yet it contains occasional large angular bowlders, evidently brought to their present position by floating ice. The bluffs are usually capped by a bed of coarse gravel, ten feet or more in thickness, but sharply separated from the underlying silt formation. More rarely, layers of coarse sand and gravel a few feet thick occur, interbedded with the silt, usually toward the top.

This deposit undoubtedly belongs to the wide-spread "white silt" formation which Dr Dawson has described as occurring at many localities in British Columbia and the upper Yukon basin. He regards the white silt as a deposit laid down in estuaries by waters containing glacial mud supplied by streams from the retreating or stationary ice front. The altitude of Ahklen is 2,500 feet, and hence the upper limit of the silt in the bluffs at the lower end of the lake is about 2,600 feet. The upper limit of the white silt, as observed by Dawson at various points in British Columbia and the Yukon basin, is between 2,400 and 2,700 feet, indicating a subsidence to that extent for a considerable period toward the close of the second epoch of glaciation. During this period of subsidence the present lake basin was doubtless occupied by a lobe of the retreating glacier which prevented the silting up of the portion of the valley so occupied. On its withdrawal at the close of the stationary period, the lake was left

Digitized by Google

much as it appears at present, only somewhat larger, its waters being held by the dam of silt which had been laid down in front of the ice.

Having in mind the conclusions of Dawson, McConnell and Russell as to the northern limit of glaciation in the Yukon basin, evidence on that point was carefully sought in the plateau region southwest of Selkirk. For the first one hundred and twenty-five miles the evidence was wholly negative. No sign of glaciation was seen, and this too in a country well calculated to retain the marks of ice action. The stream gravels consist of a very small number of rock species, and on following a stream to its head the source of each was usually found, showing that no foreign material had been brought into their basins. While in general the surface contours are smooth and flowing, this is the result of long-continued subaërial rock disintegration, and generally the surface rock is deeply buried beneath great accumulations of fragmental débris, though occasional sharp pinnacles and towers of rock project from the smooth talus slopes. Had this region been subjected to the action of an ice sheet during the glacial epoch, not only would the greater part of the rock débris have been removed but the projecting pinnacles would have been planed down to rounded knobs which would still retain polished and striated surfaces.

Where Nisling river was crossed its broad valley is filled with a deposit of coarse gravel and bowlders, and from their great quantity and variety it was inferred that the stream had its source in a drift-covered region. The first undoubted evidence of ice, however, was found on the divide between Nisling and Kluantu rivers, where the northern edge of a sheet of bowlder clay was passed. From this point southward the character of the surface suffers a marked change. It is no longer composed of the fragments of one or two kinds of rock occurring in place near at hand, but rather of many varieties confusedly mingled with clay and sand. The drainage system is imperfectly adjusted to the topographic surface, so that wide valleys carry small streams, and large streams like the Kluantu and Donjek flow, for considerable distances at least, through narrow valleys.

The ice which has left its records in this sheet of bowlder clay was probably a confluent glacier formed by streams coming from the south through narrow valleys now occupied by Kluantu and Donjek rivers. These valleys do not appear to have been

Digitized by Google

glaciated high up their sides, and it is probable that those detached southern portions of the interior plateau already described were not wholly covered by ice, even when the Cordilleran glacier had its greatest extension. The absence of a terminal moraine along the northern limit of the glaciated area would indicate that the Kluantu valley was filled by ice from comparatively small streams bearing little moraine material.

Southward from the Kluantu valley, records of former ice action continued to the coast, but the glaciation was by no means so intense as one might be inclined to expect from the high latitude of the region and the great altitude of the neighboring mountains. The marks of this former general glaciation have been removed from many of the river valleys, or at least greatly obscured by more recent glaciers which have but lately withdrawn from the valleys.

It seems probable that at the period of maximum glaciation the relative amounts of precipitation on the northern and southern sides of the St Elias mountains were much the same as at present, and then as now by far the greater ice drainage was toward the south. Some measure of the relative volume of the ice streams flowing in the two directions may be obtained from the relative amounts of moraine material which they have left. On the north, as already stated, there is no terminal moraine—only a comparatively thin sheet of bowlder clay. South of the mountains, on the other hand, a deposit of morainal material at least several thousand feet in thickness was accumulated on the sea bottom in front of the glacier and is now shown, according to Russell, in the recent uplift forming the Chaix hills.

Connecting upon the map the points which have been determined by various observers as the northern limit of the glaciated area in the Yukon basin, the position of the Cordilleran ice sheet at the period of its greatest extension is approximately outlined. Striated rock surfaces were observed by Dawson on the Pelly down to the point at which it crosses the 136th meridian and on the Lewes as far north as 61° 40′. Although he does not regard these as strictly limiting points, still, in the light of facts observed on the plateau southwest of the Pelly-Lewes confluence, the former at least may safely be regarded as such. McConnell and Russell considered the limit of glaciation on the Lewes to be near the mouth of Little Salmon river, and my own observations led me to think it is at least as far north

Digitized by Google

as that. The point to which glaciation extends in the White river basin has already been indicated, with the evidence on which the conclusion is based. The extension of the line west of White river is less satisfactorily fixed than its eastern portion, depending on a statement of Lieutenant Allen that he saw no drift north of the Alaskan mountains, as he called the Tananah-Copper river divide. The ice sheet, a part of whose northern limit is thus approximately outlined, had its principal center of dispersion in the high plateau of British Columbia, between the Coast and Rocky mountains. From this center two subordinate lines of dispersion diverged toward the north and northwest, following the axes respectively of the Rocky mountains and the St Elias range, while the non-glaciated area formed a deep embayment in the Yukon basin between these divergent lines. The northern limit of glaciation is shown approximately on plate 18.

It is probable, however, that many lobes from the main glacier extended down the valleys beyond the limit above indicated, while the confluent ice sheet was not sufficiently thick toward its northern border to override the greater inequalities of the surface. Thus the White River valley, at least, must have been occupied by ice well north of the general glacier front even after a considerable amount of recession had taken place. The altitude of the valley at the mouth of the Nisling is about 2,400 feet; so that it must have formed an estuary during the period of subsidence marked by the white silt deposits, and the formation of lake Wellesley is probably analogous to that of lake Ahklen.

Digitized by Google

APPENDIX.

CRYPTOGAMS COLLECTED BY DR C. WILLARD HAYES IN ALASKA, 1891.

BY CLARA E. CUMMINGS.

LYCOPODIACEÆ.

Lycopodium complanatum, L. Taku, June. A small form without fruit.

MOSSES.

Sphagnum acutifolium, Ehrh. Prince William sound, September.
Sphagnum acutifolium, Ehrh., var. *purpurem*, Schimp. Taku, June. A stunted form.
Dicranum fuscescens, Turn. Prince William sound, September. On decayed wood.
Dicranum scoparium, Hedw. Prince William sound, September.
Dicranum majus?, Turn. Prince William sound, September. Sterile.
Tetraphis pellucida, Hedw. Prince William sound, September. Male plants, on wood.
Mnium punctatum, Hedw. Prince William sound, September. Sterile.
Aulacomnium palustre, Schwaegr. Taku, June.
Polytrichum commune, L. Prince William sound.
Polytrichum juniperinum, Willd. Taku, June. Male plant.
Hypnum (Plagiothecium) undulatum, L. Prince William sound, September. Sterile.
Hypnum circinale, Hook. Prince William sound. Sterile.
Hypnum (Pleurozium) splendens, Hedw. Prince William sound. Sterile.
Hypnum (Hylocomium) loreum, L. Prince William sound. Sterile.

HEPATICÆ.

Frullania (probably a new species). Prince William sound, September.
Bassania deflexa, Br. Gr. Prince William sound, September.
Lepidiosa reptans, L. Dum. Prince William sound, September.
Scapania albescens, Stephani. Prince William sound, September. A species not before contained in any American collection.
Mylia taylori, S. F. Gray. Prince William sound, September.

Digitized by Google

LICHENS.

Cetraria artica, Hook. Taku, June. Represented by young and mature conditions.

Cetraria islandica, (L.) Ach. Taku, June. Sterile.

Cetraria cucullata, (Bell) Ach. Taku, June. Sterile.

Cetraria nivalis, (L.) Ach. Taku, June. Sterile; represented by a slender, light colored form.

Cetraria lacunosa, Ach. Prince William sound, September. Sterile.

Cetraria glauca, (L.) Ach. Prince William sound, September. Sterile.

Cetraria glauca, (L.) Ach., b *stenophylla*, Tuck. Prince William sound, September. Sterile.

Alectoria ochroleuca, (Ehrh.) Nyl., a *rigida*. Taku, June. Sterile.

Alectoria ochroleuca, (Ehrh.) Nyl., c *sarmentosa*, Nyl. Prince William sound, September. Sterile.

Nephroma articum, (L.) Fr. Taku, June. Sterile; growing on *Dicranum*.

Peltigera aphthosa, (L.) Hoffm. Taku, June. Sterile.

Peltigera horizontalis, (L.) Hoffm. Prince William sound, September.

Peltigera canina ? (L.) Hoffm. Taku, June.

Lecanora frustulosa ? (Dicks.). Taku, June. Mass.

Cladonia alcicornis, (Lightf.) Floerk. Taku, June.

Cladonia fimbriata, (L.) Fr. Prince William sound, September. Sterile.

Cladonia fimbriata, (L.) Fr., b *tubæformis*, Fr. Prince William sound, September.

Cladonia cornucopioides, (L.) Fr. Taku, June.

Cladonia bellidiflora, (Ach.) Schaer. Prince William sound, September.

Cladonia deformis, (L.) Hoffm. Taku, June. Sterile.

Thamnolia vermicularis, (Sw.) Schaer. Taku, June. Sterile.

Bæomyces æruginosus, Scop. D. C.. Prince William sound, September. On wood.

Buellia parasema, (Ach.) Th. Fr. Prince William sound, September. On dead wood.

Sphearophorus globiferus, (L.) D. C. Prince William sound, September. On earth.

In examining the geographic distribution of the species represented in this list it is interesting to note that the only *Lycopodium* is a common and widely distributed species.

Of the mosses, three are from the upper Taku basin, a locality inside the Coast range, while eleven are from Prince William sound, on the coast. Four of the fourteen species are confined to the western coast. These were all found at Prince William sound. Only one species is alpine or subalpine.

Of the *Hepaticæ*, one has not before been reported from this country, while one is probably an undescribed species.

Eleven lichens are arctic or alpine, while several others reach their best development in mountainous regions. Of the arctic and alpine forms,

Digitized by Google

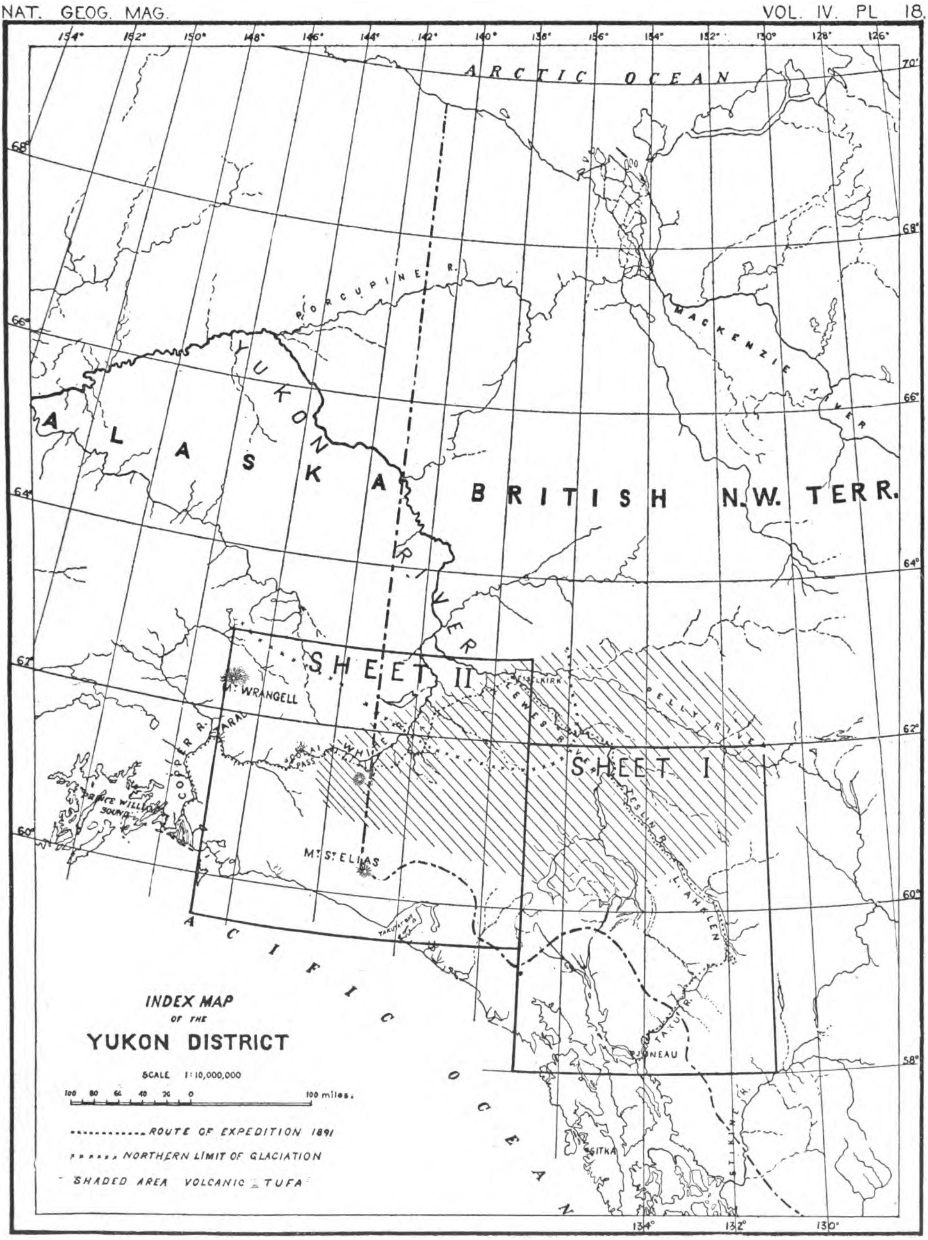
seven are from Taku and four from Prince William sound. The total number of species from Taku is twelve, while eleven were obtained at Prince William sound. It is thus seen that the percentage of arctic and alpine forms from Taku is considerably the larger. Only one of the lichens is confined to the western coast.

It is greatly to be regretted that all the valuable collections which Dr Hayes made in the interior had to be abandoned because of lack of means of transportation.

In the determination of these plants I have been indebted for aid to Professor L. M. Underwood, who examined some of the *Hepaticæ*, and to Professor A. B. Seymour, who compared several of the lichens with the collections in the Tuckerman herbarium.

WELLESLEY COLLEGE, *April* 21, 1892.

Digitized by Google

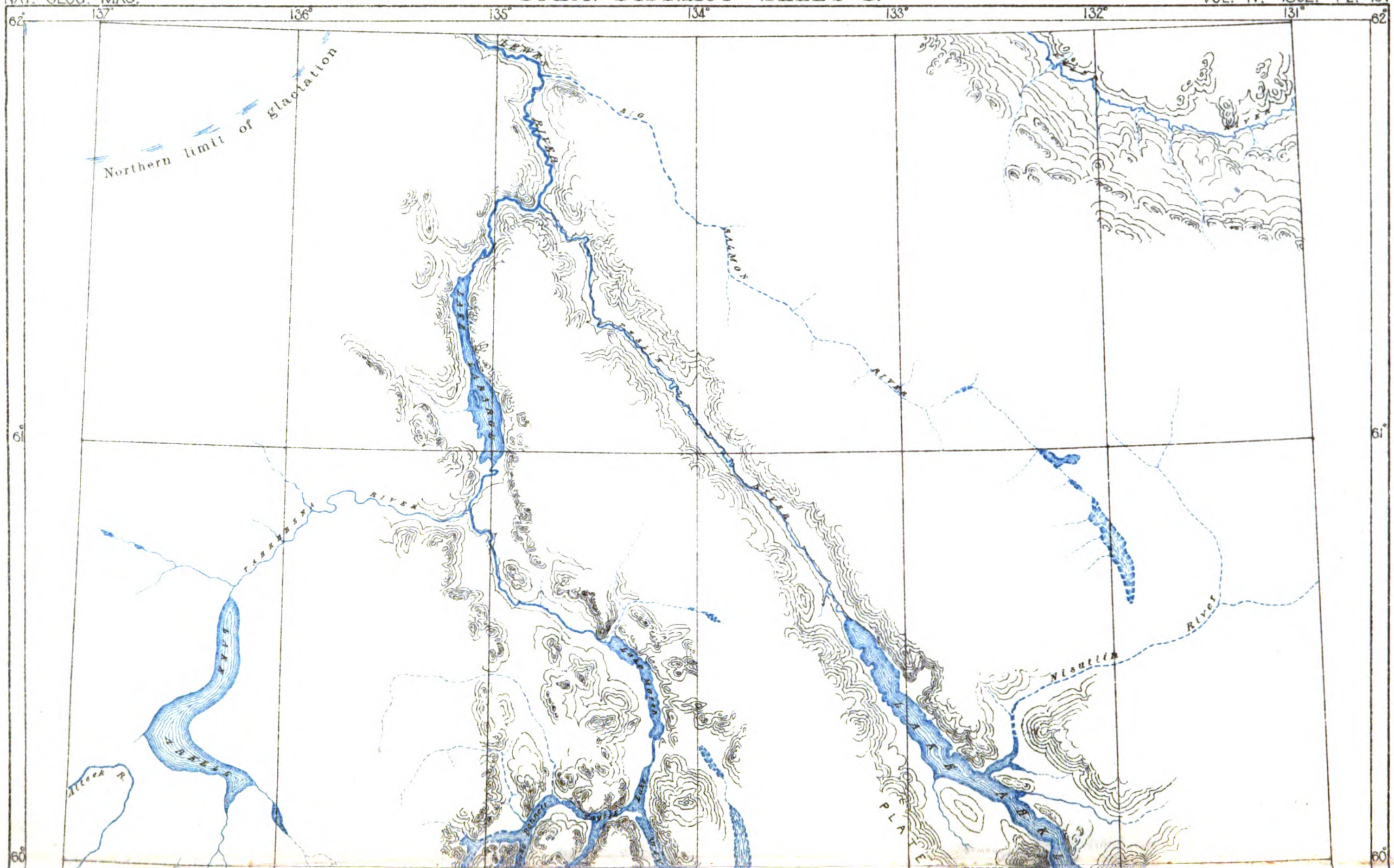


Digitized by Google

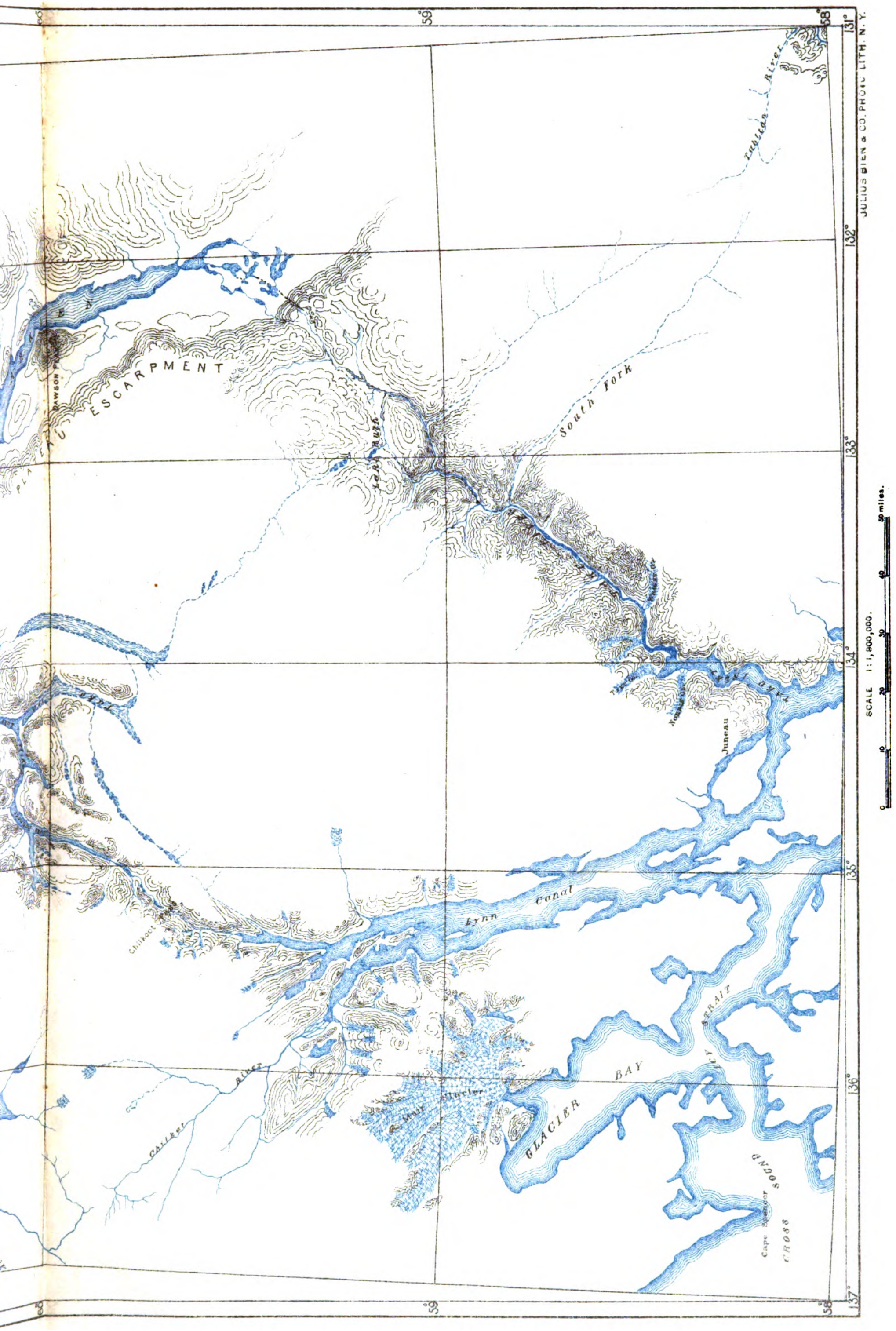
Digitized by Google

Digitized by Google

NAT. GEOG. MAG. YUKON DISTRICT—SHEET 1. VOL. IV. 1892. PL. 19.



Digitized by Google

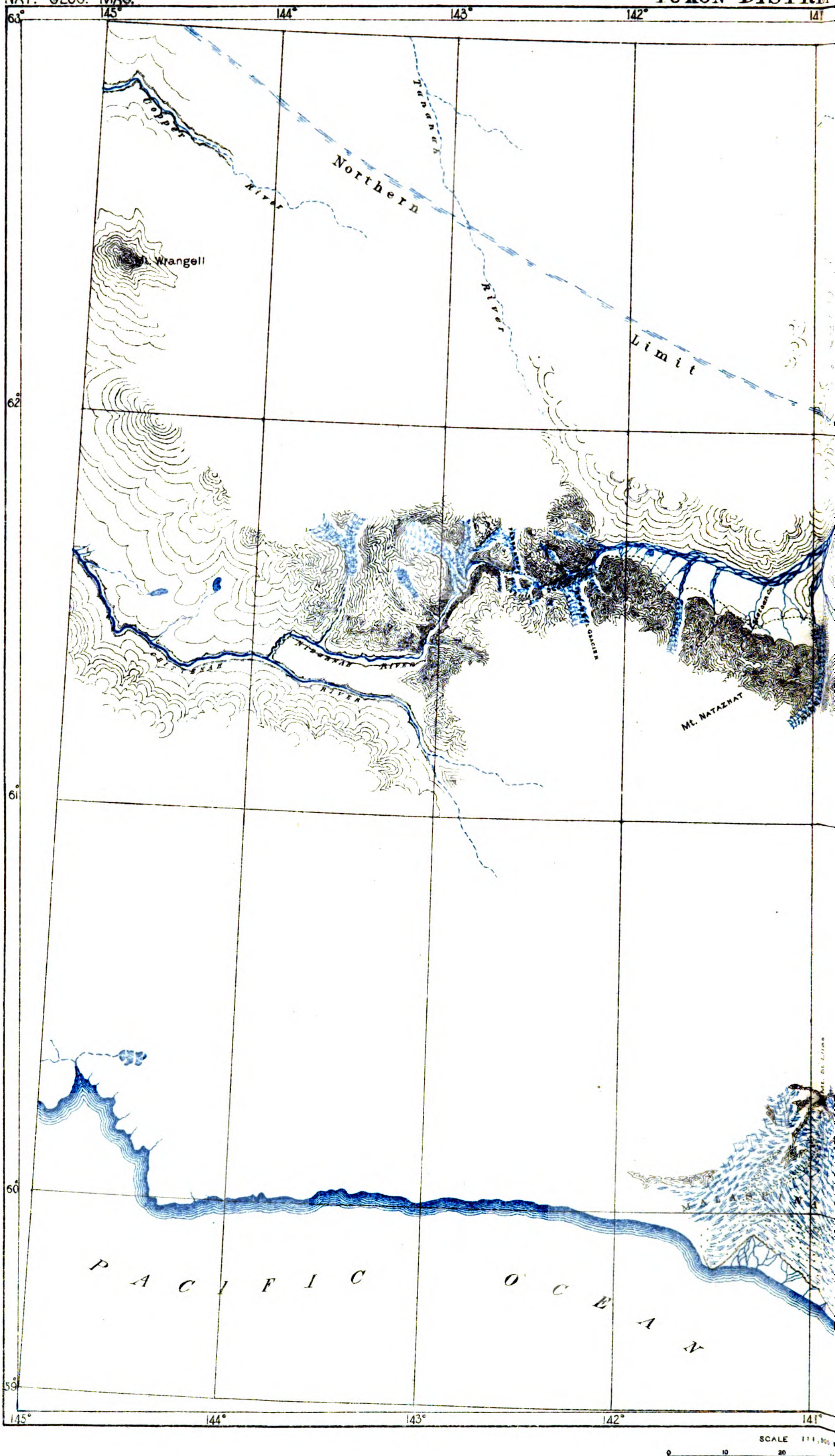


Digitized by Google

Digitized by Google

Digitized by Google

YUKON DISTRI



Digitized by Google

JULIUS BIEN & CO. PHOTO LITH. N.Y.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

UNIVERSITY OF MICHIGAN
3 9015 06691 1705

Digitized by Google