

THE GLACIAL CAUSE OF CHANGING CLIMATES

By M. B. COTSWORTH, F.G.S.
New Westminster, B. C.



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British Columbia and Canada generally are becoming warmer every year.

The ice-cap in Greenland is causing a gradual movement of the earth's crust, which is changing the climate of every country in the world.

Nearly 40,000 acres of land have been uncovered during the last seventeen years by the retreat of one group of glaciers in Alaska.

Change of climate has deteriorated the races of Southern Europe and is increasing the vigor of the people in China and Japan.

Records of the movements of British Columbia glaciers prove that this province is benefitting by the change of climate.

EDITOR'S NOTE—We are once more indebted to Mr. Moses B. Cotsworth for a most interesting and scholarly article. This time he deals with the improving climate of Canada, due to certain movements of the crust of the earth caused by the ice-cap in Greenland.

Mr. Cotsworth's investigations into glacial action and the general geology of the world have led him to some very important conclusions, which affect the climate of the whole of Canada and particularly of this province. Most of the maps and other illustrations have not been published before and we thank Mr. Cotsworth on behalf of our readers for the time and trouble that he has taken to give us this valuable information.

PROBABLY the most important, and yet the least understood, natural force moulding the destinies of mankind, may be expressed by the words, "Gravitational Changes of Climate," as briefly described and illustrated herein. Simple inspection of Plate I will convince thoughtful readers of the reality of the great climatic change that is most forcibly evidenced by those photographs, which demonstrate the fact that those extensive glaciers in Southern Alaska are receding at the rate of about half a mile per year, as the ice melts back at that rate beyond the regular daily flow of the ice down the Muir and Grand Pacific Glaciers.

Plate II proves by its black areas on the chart of the glaciers surrounding Glacier Bay that around that typical Alaskan bay about 2,054 acres of land per year have recently been released by the "climatic change" from the Alaskan ice-grip. It will be shown on later pages how that sheet of disappearing ice is being wafted over to Greenland by the great forces of Nature,

which unite to bring about that marvellous change, by which the various parts of the world are during the course of ages rested and renewed for fertility, as the thousand leading geologists of the world will better be able to explain when the Geological Congress visits Canada in September, 1913.

Meantime, readers may rest assured of the facts Plates I and II prove, because both the photographs and plan were prepared jointly by the best surveyors and draughtsmen the United States and Canada could produce, whilst the International Boundary was being delineated by them between Canada and Alaska. The originals were most considerately supplied to me by the departments of the United States and Canadian Governments.

2. The limited space available for general description in this *British Columbia Magazine* precludes the possibility of dealing with more than the general aspects of this vast subject, but as it can be studied and verified with more practical advantage in British Columbia than any other country, and will benefit British Columbians more

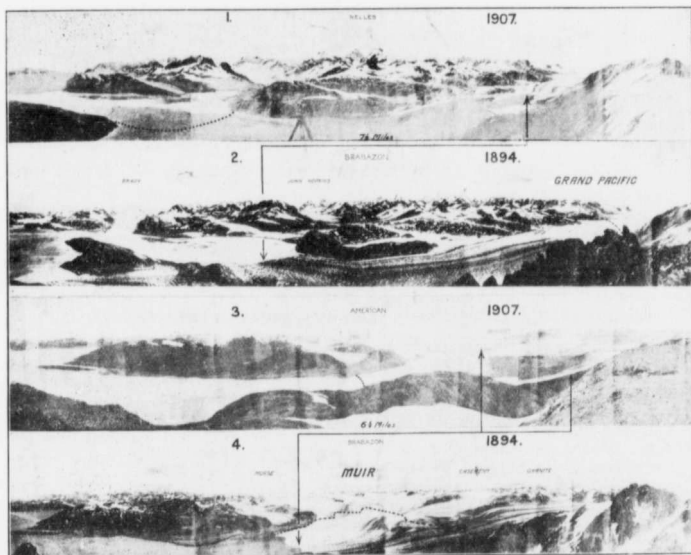


Plate I. Photographic proof demonstrating the recession of the Grand Pacific and Muir glaciers between the years 1894 and 1907. The top photos (1 and 2) show the dotted line and the arrows the distance which the Grand Pacific glacier receded in that period. The bottom photos (3 and 4) illustrate in a similar manner the distance of the recession of the ice of the Muir Glacier. These photos should be compared with Plate II.

These pictures were taken by both the United States and Canadian surveyors of the International Boundary Commission, and they establish the fact that the ice front, which was more than 1000 feet thick at the tongue of those great glaciers, has melted back at the rate of about half-a-mile a year. The berg-like edge of the Muir Glacier (on the lower photograph) was about 400 feet above the water and much more below the water line.

than any other people during the present and succeeding generations, it can most appropriately be explained from this richly endowed country which will surely exert an influence upon humanity—far beyond the proportion its present meagre population of nearly 400,000 people bears to the 1,600,000,000 people on earth—every one of whom is gradually being affected, for better or for worse, by this greatest of the earth's continuous changes.

History proves that the mightiest ancient races of Assyria, Phœnicia, Greece, Rome and the Byzantine Empires prospered where we now find the feebler races of Slavs, Greeks, Italians and Spaniards waning. On the other hand we find along the corresponding latitudes on the opposite side in Asia that the Chinese and Japanese are

increasing in vigor as their climate is getting cooler.

3. The explanation for that relative deterioration of Southern Europeans and the increasing vigor of the Chinese and Japanese as herein submitted, is less in the racial proclivities and propensities of the intervening generations, than in the stupendous gravitational climate-changing force, always dominating the vitality of mankind, continuously exerted by the Polar ice-cap of Greenland, which causes the crust of the earth to gravitate round the earth's denser core through the absence of adequate counter-balance on the opposite side of the Polar area, across which Dr. Nansen drifted in the "Fram" during the years 1893-96, proving that Polar ice on the North Polar Sea area only averaged *about 30 to 40 feet thick*, whereas when he and

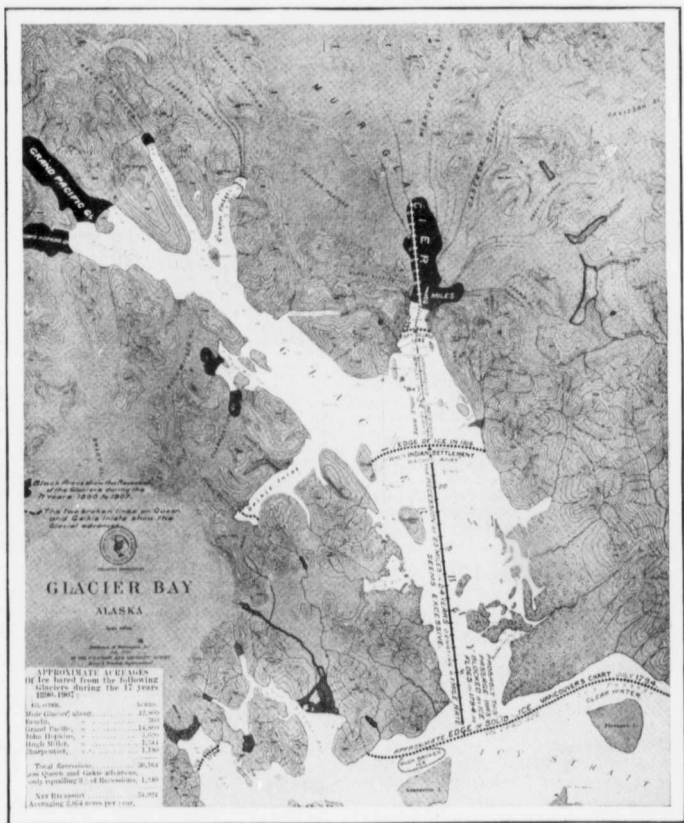


Plate II. The black areas upon the above chart of Glacier Bay, Alaska, cover the areas which, though covered by ice (apparently 500 feet thick) when the Alaska Boundary Commission surveyed around Glacier Bay during the years mid-dating 1890, were found to be bare of ice in the year 1907, having melted back at the extraordinary rate of about half-a-mile per year in the case of the two largest glaciers, the "Muir" and the "Grand Pacific," both of which receded at the rate of about eight-and-a-half miles during those seventeen years. The other glaciers varied as detailed on the chart.

The dotted lines marking the new positions of the edge of the ice as recorded in the years 1794, 1818 and 1882 further illustrate the steady retreat of the Alaskan glaciers due to the changing climate of Canada.

This is the first time this interesting chart has been published in a popular journal.



Plate III. Map of the Glaciated Areas in North America and Europe, from Professor Wright's book, "Man and the Glacial Period."

The large cross X which Mr. Cotsworth has inserted to the east of the present position of the North Pole shows where the pole was 5,000 years ago, as indicated by the slope of the Great Pyramid in Egypt.

"C," to the right of the map, marks the probable latitude of England when the English coal beds were formed in Equatorial swamps.

"P" on the top of the map, marks the probable position of the North Pole when England was in latitude "C," where Central Africa now grows the thick mass of tropical marsh-grown trees, sudd and other dense vegetable matter now choking the equatorial swampy waters of the Nile and that vast territory south of Kordofan—the potential coal beds of the remote future.

The "dot and dash" line .-.-.- indicates the supposed course of the Pole from Behring's Straits. The arrows show the present direction of the Gulf Stream. The "hit and miss" line - - - , curving across the Atlantic from the American glacial boundary deposit to its corresponding boundary deposit in Europe, marks the limit of the glacial ice-cap when the North Pole turned south of Greenland.

Note the parallel character of the lines marking the boundary of the glacial deposit in America and Europe with the line indicating the supposed course of the North Pole when it moved across from Behring Straits. Apparently at one time the centre of Hudson's Bay was the site of the North Pole. The changing climate of Canada, therefore, tends to make Hudson's Bay more free from ice every year.

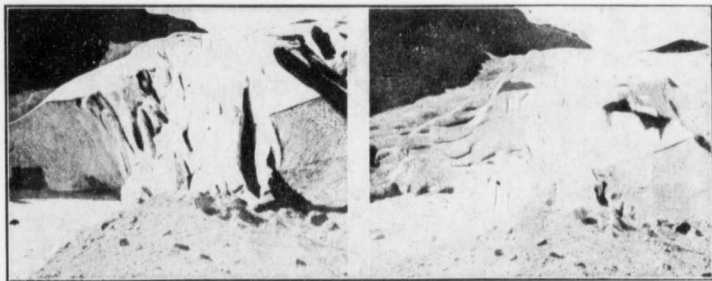
other reliable investigators explored the opposite latitudes of Greenland they found that (excepting its southern point and the northeast tip) that continental area, approximately 500,000 square miles, is practically buried under the lop-sided Polar ice-cap averaging about 9,000 feet thick.

4. That enormous mass of glacial ice, if spread over North America, would cover the whole of the United States, Mexico, Canada and Alaska with a layer about 500 feet thick. As now accumulated in Greenland it exerts an eroding pressure of more than 200 tons per square foot towards the Atlantic, as by the vertical pressure of its interior it is pressed outward and flows towards Greenland's coasts at the rate of about 40 feet per day throughout every

year, as a mass of pitch placed on a table would by gravitation similarly flow outwards on all sides.

The out-creeping ice is thus forced down the coast fiords, where it breaks off in those huge icebergs which, by floating southwards, are increasingly developing dangers to the trans-Atlantic steamships, as forcibly brought to our notice by the Titanic disaster.

5. The immensity of the Greenland ice-cap is beyond comprehension, as Greenland has about 3,600 miles of iceberging coastline. Through Dr. Rink's observations, made during more than thirty years, we are enabled to gather a mental glimpse of Greenland feeding the Atlantic with ice down the typical fiord of "Jacobshavn,"



Plates IV. and V. These photos were taken from a point 79.3 feet south of the bottom point of the thick, irregular line shown in Plate VI. The photo on the left shows the appearance of the ice in 1906. The photo on the right, taken from exactly the same spot in 1907, shows how rapidly the ice is melting and exposing the rock-floor and the foot of the rocks in the background.

which discharges 4,092,000,000 tons of ice per year, whilst its understream washes out more than 7,000,000 tons per year of sand and gravel (like the material that formed the Canadian and American prairies) by its torrential waters. These, together with the roll-wash from the immense "calving icebergs" and vast extent of the ice-front, preclude the possibility of even the largest of cameras conveying any practical impression of even that single out-fall of one of the many hundreds of fiords fringing the mightiest ice-cap of the world that during uncalculated thousands of years has been ceaselessly burying Greenland, whose icy mountains are being resurrected by the gradual dissolution of that most momentous climate-diverting force wielded by the Greenland ice-cap, which levers the whole earth's crust around.

GLACIAL ICE IS THE MOST DEFLECTING FORCE ON EARTH

6. Whilst the general forces of gravitation concentrate towards the centre of the earth, the greatest exrescence on the earth's crust is the 800,000 cubic miles of Greenland ice, which gravitates its mighty force southward towards the middle of the Atlantic Ocean, but as the Greenland territory to which the ice clings is part of the continuous crust of the world, the whole crust is gradually turned in that direction, sliding over the denser core as the strain of overcoming the equatorial protuberance is eased by earthquake adjustments at various times, as explained in my paper (read before the British Association for the Ad-

vancement of Science at their 1906 meeting) on "The Continuous Glacial Period."

7. That leverage of the Greenland ice results in the world-wide climate change, which is slowly making North America and Europe warmer, whilst the northern part of Asia (especially Siberia) is becoming colder, as the Greenland ice-cap trends to dip more below the Arctic Circle and will continue that southerly progression until equilibrium will be reached when about half of the Greenland ice-cap is melted backwards. Then it will be diverted during later centuries by the corresponding accumulations of glacial ice in another direction as the climatic change (vide the geological path of the North Pole traced by the dot-and-dash line on Plate III) does not recur in cycles, like the seasons, but is deflected by the gravitational force resulting from the stupendous difference in weight between the massive glacial ice that accumulates upon mountainous land in contrast with the thin ice formed on the sea in the Polar region weighed by gravitation balanced in the ethereal poise of the earth, where every ton of matter tilts the scale of changing climate as measured by altitude and latitude.

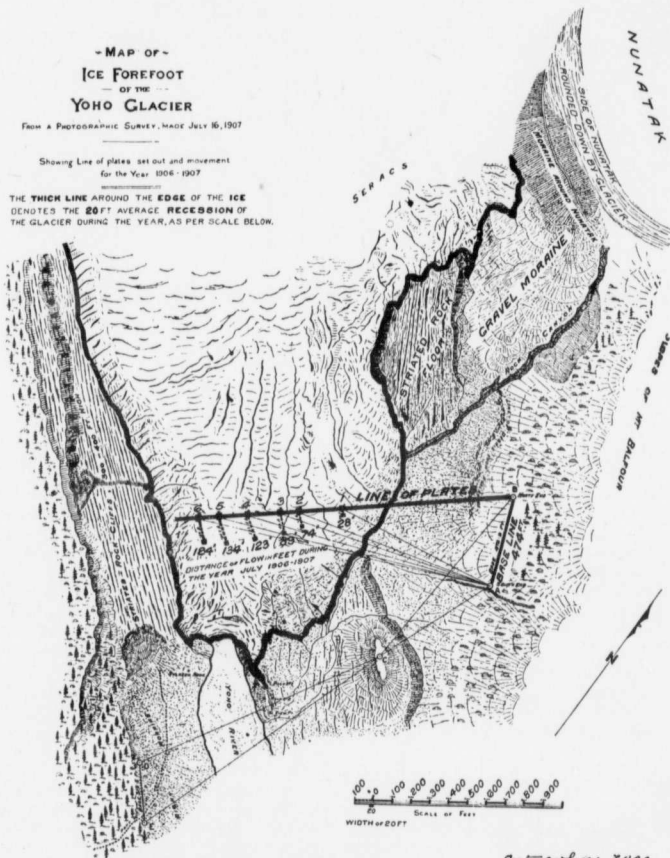
8. We all know that for every degree of latitude travelled from the Equator, we increasingly reach cooler climates, and those of us who have studied ancient astronomy know that the climatic degree as measured by latitude was derived from the equinoctial diameters of the sun and moon combined, so that on March 21 and September 23 the noon-sun shining any

- MAP OF -
ICE FOREFOOT
OF THE
YHOH GLACIER

FROM A PHOTOGRAPHIC SURVEY, MADE JULY 16, 1907

Showing Line of plates set out and movement
for the Year 1906-1907

THE THICK LINE AROUND THE EDGE OF THE ICE
DENOTES THE 20 FT AVERAGE RECESSION OF
THE GLACIER DURING THE YEAR, AS PER SCALE BELOW.



EMPHASIZED BY H. B. COLTWORTH TO SHOW THE RECESSION AND NUNATAK

*Arthur D. Wheeler F. R. G. S.
June 15th 1908*

Plate VI. By comparing the photographs shown in Plates IV and V, the changing appearance of the ice tongue of the Yoho Glacier in British Columbia may be strikingly seen.

These photos were taken from the same spot in the years 1906 and 1907 respectively. We can distinctly see how the thickness of the ice has been reduced by melting and how the glacier is annually receding.

Not very long ago the ice filled the valley to about 400 feet higher (along the tree line) as the striated cliffs shown in Plate VII clearly prove.

In this diagram the thick line around the edge of the glacier, drawn to scale, marks the yearly retreat of the glacier by twenty feet. The movement of the line of plates planted in 1906 also shows that one of the plates had travelled 124 feet in twelve months. The recession, therefore, of the nose of the glacier in one year is represented by 124 feet plus 20 feet.

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where along the 49th parallel of latitude (which denotes the boundary between British Columbia and United States) will be 49 sun + 49 moon diameters south of the zenith—and at the same time 60 sun + 60 moon diameters down the celestial meridian line for the points along the northern boundary of British Columbia.

The latitudinal difference between those northern and southern boundaries is 11° , whereas the climatological difference along the coast between Victoria (50°) and Skagway (35°), measured by the isothermal lines of "equal mean annual temperatures," is 15° . Therefore, if some world-tilting force could tilt the earth southwards 11° along the Prince Rupert (130°) meridian line, Victoria would have its climate changed to the warmer one of San Francisco, and correspondingly Skagway would (apart from the effects of the Pacific currents which may be considered later) gain the climate advantages now enjoyed by Victoria, so far as the major basis of differential climates mainly controlled by the divergent angles of the sun's rays is concerned.

At the same time reference to a geographical globe will make clear that such a tilt would divert Nova Zembla to the climate location of the North Pole, whilst Russia, Persia and Egypt would become correspondingly cooler, by being diverted northwards. On the other hand, South Africa would become much warmer, as it would be tilted closer to the Southern Tropic.

9. The earth's crust is now being very slowly tilted southwards by the weight of the continental ice on Greenland, consequently the glaciers of Europe and North America are collectively and steadily receding, because the slightly warmer climate every year melts both the glacier tongues and thickness away, as may be seen by comparing Plates IV and V, showing the photographs of the Yoho Glacier's tongue (near Field, B. C., on the C. P. R.) as it was in the years 1906 and 1907.

The contrast in the thickness of both the tongue and the upper part of the glacier, as evidenced by the gauges furnished by the mountain shoulder and pack behind, will convince the most sceptical, especially when he notes by Plate VI that the bulk of the glacier has moved forward 123 feet during the year—and yet the whole front has

receded about 20 feet, so that 143 feet have been melted.

Further, examination of Plate VII, showing a side view of the Yoho Glacier's tongue with the eroded side of the mountain beyond, proves to the experienced eye, by the bared striated natural rock-side 300 to 400 feet high, that the glacier was within comparatively recent years 300 to 400 feet thicker, as indicated below the tree-line.

10. As the Illecillewaet Glacier, close by Glacier Station on the C. P. R., is the most easily accessible, it has been most closely observed, as may be noticed upon the inspection of Plate VIII, which by its "top section" charts a cross-section through the glacier along the straight line permanently located by survey points on both side-rocks by Messrs. George and William S. Vaux, of New York, who yearly place copper plates secreted in the ice along that line, to test the progressive rate of flow by which the ice sags down that valley.

The bent lines, next below, record the located positions in July 1900, 1902 and 1903 of the plates they had put along the top line on July 31, 1900, proving that the ice had bodily moved forward about 700 feet in four years, or about 175 feet per year.

The lower hit-and-miss line locates the position of the ice-tongue in 1888, and the heavy solid line denotes the edge of the ice in 1906. The distance of about 800 feet between them demonstrates that during the eighteen intervening years the rate of recession averaged 44 feet per year. Between 1888 and 1898 the 500 feet of recession averaged 50 feet per year, because the ice was flatter spread out on the "ground moraine," as shown on Plate VIII. Those rates of recession are faster than the 20 feet flow of the Yoho, and are partly due to the steeper declivity down which the Illecillewaet Glacier slides and partly to the thinning over the bed-rock now being bared more rapidly.

11. One most exceptional feature of the Illecillaewaet during the winter of 1908-1909 was the accessible condition of its beautiful "ice cave" (located to the right above the stream source of the Illecillewaet River) which enabled the writer to get underneath and watch the massive ice grinding the bed-rock to the "rock flour"



Plate VII. Panorama of the Yoho Glacier from the north end of the base line shown in Plate VI. The striated rocks 300 to 400 feet high beyond the ice-tongue show where the glacier formerly ground down those rocks below the tree-line when the ice was about 400 feet thicker there. The rock-floor, from which the ice has more recently melted back between the ice and the white gravel moraine, is seen to be striated, grooved and fluted where not covered by the white pieces of fallen ice.

which, during the warmer seasons, is washed out by the under-stream, giving the water that milky appearance which always denotes the glacial sources of British Columbian rivers.

The ice under enormous pressure was grinding over the rock, continuously working forward, till it projected far beyond the rock it grooved away, as shown by Plate IX, showing the outward view from the ice-cave. The flutings on the right resulted from the intense pressure of the ice as it was forced over the grooved bed-rock, which shaped those flutings like a mould. The holes in the ice-roof held stones that had fallen down crevasses as the ice had more rapidly moved down the steeper parts of its path. They had been rolled along till jammed in the lower ice by pressure and thence forward they acted as grinders over the bed-rock beyond the terminal one of which they projected till the release of pressure and slight thaw released them to fall on the cave's floor.

The gradual drifting of that and similar glacial silt and material down the Fraser Valley can be realistically traced mile after mile as the C. P. R. trains pass down the river-side until they approach Vancouver.

12. The crystal-like photograph of the Illecillewaet Glacier, shown upon Plate X, conveys a vivid impression of the glacial erosion and morainic materials conveyed by glacial gravitation.

The 1,600-ft. width of that glacier's tongue across the straight-plate line, shown on Plate VIII, for the year 1899, dating this photograph, may enable the reader to mentally convey this ice-tongue to Plate III, and imagine the flowing ice with nearly 3,000 miles frontage, as during the American glaciation it spread from the

Columbia River to New York, whilst scattering the sand, gravel and silt over what now forms the prairie wheat lands of Canada and the United States, just as the glaciating ice-cap of Greenland is spreading like materials in tremendous quantities by glacial rivers and icebergs over the North Atlantic, where the icebergs are increasing as Greenland is being tilted southwards below the Arctic Circle, along which the most-extensive moraines are being deposited by the melting ice.

13. By measuring the $23\frac{1}{2}^{\circ}$ from those moraines to the Pole we derive the scale by which the probable course of the changing polar locations has been traced, on Plate III, from the moraines left across the middle of North America and Europe during the progress of that "continuous glacial period," which has ever been used by Nature to rest and renew various parts of the world and invigorate races of men.

That great glaciation was about 10,000 times larger than the Illecillewaet Glacier, as the rounded ice-scratched stones spread over the prairies and ice-scoured rocks around the Great Lakes testify, and the walrus heads and tusks dug up by farmers sinking wells in Manitoba prove.

14. The photograph of the Illecillewaet enables us to picture the progression of this mightiest climate-changing force, if we imagine the upper peak is representing the North Pole and regard the mountain to the right as Greenland's mighty range towards which the North American Glacier trended as it was slowly melted, evaporated and drifted northeastward by the prevailing winds. Later the ice-cap drifted to the high mountains of Norway, whence the European glaciation flowed over Northern

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Europe as indicated by the arrows on Plate III.

15. After that it was gradually dispersed, drifting over Northern Russia and the Ural Mountains to the Siberian Tundras vast area more as snow than glacial ice, which can only be formed on a nucleus of mountains upon which moist air currents flow. That snow gradually wafted and redeposited became glacial ice on the mountains around the Siberian Sea of Okhotsk flowing eastwards that rested around Kamchatka, depressing the Behring sea-floor and thence drifted over the vast mountainous area of Alaska—always trending eastwards in that easterly direction, but ever varied a little northward or southward by the glacial masses accumulated successively on the mountain ranges north of the 40th parallel of latitude.

That is now being redrifted towards Greenland by the same climate-changing force as evidenced by the melting back of all glacial ice in Alaska and British Columbia, where the diversion of the warm Japan current by a kindred agency is being beneficially felt.

The numerous earthquake adjustments by which the earth's crust is enabled to expand and contract as it stretches over the equatorial protruberance, which maintains the equilibrium of the world, appears to be largely caused by this great climate-changing force.

16. It is that varying but immense diversion by evaporation and prevailing winds, which slowly transfers the stupendous weight of the Polar ice-cap from one core of vast mountain ranges to another location during the progress of time. This shifts the top-balance of the world to change our climates so gently, by the force of gravitation, that we need not wonder why we have hitherto failed to trace this greatest and most beneficent cycle of Mother Earth.

Every ton of this, its greatest balance-moving weight, is weighed in the ethereal balances so delicately poised that it makes a difference whether, say, one ton is moved from Canada or Alaska to Greenland to yearly accentuate the gravitational stress which is steadily dipping Greenland southward, so that as the toe of Greenland is being tilted south of the Arctic Circle it is being bared of ice which is being drifted elsewhere, tending to complicate the tilt.

POSITION OF THE POLAR AXIS IS CHANGING

17. That the pressure of a finger or weight on a light rubber ball crushes that part in and bulges out an equivalent part is well known; similarly, the over-powering weight of the Polar ice-cap depresses that part of the crust of the earth where the ice-cap is accumulating, submerging the lower parts of the coast. Correspondingly, regions from which the ice-cap is being diverted tend to rise with that wonderful elasticity the earth's crust seems to derive from the compression and release of the viscous lava material between the core and crust, as the tire of a motor-car under certain conditions of leverage or thrust, tends to creep around the rim, so the face of the gravitational weight of the Polar ice-cap turns the earth's crust around.

18. The counter-balance of nearer or more distant localities tends to further complicate the tilt—which the limited space available in this magazine precludes from explaining, beyond the fact that the evidences derived by the writer's investigations into the pyramid observations of the Ancient Egyptians demonstrate, by the subsequent deviation of the Great Pyramid's slope from the sun's ancient equinoctial angle, that the diversion of the Polar ice-cap has during the last 6,000 years been able to drift that part of the world more than 7° southwards, as, when the Great Pyramid was built, the North Pole was then evidently located about the position denoted by the large X on Plate III. As the Polar location changes the Magnetic North, dependent upon the metallic core of the earth, is deflected.

19. Since then the Polar location has, by Polar ice-diversion, been levered over in the direction of Behring Sea, forcing upon the Egyptians and Europeans warmer climates than their hardier ancestors endured 6,000 years ago, when they, with the Babylonians and great races surrounding the Mediterranean Sea were more vigorous, because they lived in the more invigorating climate where the British and German nations now thrive. The Romans who lived in Italy, and the Jews then in Palestine, correspondingly enjoyed the more bracing climates Austria and Armenia now experience, enabling them to raise stronger races, whereas those of Southern Italy and Sicily are becoming weaker as their countries, with all Europe, are becoming warmer. That



Plate X. A photograph of the Illecillewaet Glacier, conveying a vivid impression of the glacial erosion and moraine materials transported by glacial gravitation.

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climatic change the retreating European glaciers also prove.

20. The historic evidences from Southern Russia and Siberia confirm that conclusion, as also do the records of the International Boundary Commission for Nigeria, who found the Sahara Desert continuously drifting southwards between their different years of survey, just as the United States and Canadian surveyors found the Alaska ice-cap receding northwards, as demonstrated on Plate III, and conclusively proved by the photographs on Plate I.

ALASKA AND CANADA NOW BEING RELIEVED FROM THEIR SURPLUS ICE AND SNOW, WHICH THE WINDS ARE CONVEYING AND DUMPING UPON GREENLAND

21. It is particularly interesting for Canadians to note that the glacial ice now disappearing yearly from Alaska and Canada is being transported by the prevailing winds to Greenland, because between the ice-clad mountains of Northwest America and Greenland the absence of any intervening mountains enables those winds to convey a large portion of the moisture they absorb as they pass from the Pacific Coast ranges until their clouds, chilled by contact with the vast heights of Greenland ice, have to deposit their moisture as snow. Thus, though winter snow is scattered over Northern Canada, the heavier snowfall is precipitated in Greenland.

22. We are only enabled by adjacent railways and coasting ships to partially trace the vast climatic change that is now improving the climates of the Northwest, as evidenced by the melting back of such glaciers as the Illecillewaet, Yoho, etc., and the remarkable group around Glacier Bay in Southern Alaska (see Plate II). That melting registers continuously the local temperature throughout every moment of the year, hence if the annual snowfall is about equal through a series of years and the glaciers yearly advance, that evidences the advance of that part of the world into a colder climate, whereas if the glaciers collectively retreat (as those of North America and Europe are doing) that indicates climatic progress towards warmer latitudes.

23. Some minor exceptions result as small temporary glacial advances occur when shoulders of mountains are being bared by the melting of the over-capping ice-mass, where the valleys, filled with ice

to the brim, have their ice-mass reduced below the level of the shoulder, which sometimes cut off the flow from one valley, forcing the flow down another glacial direction, as seen on Plate II, where the chain of "Nunataks" (peaks protruding through glacial ice), west of the Muir Glacier, having cut off part of the ice-flow from the Cushing ice plateau, diverted that part towards the Queen Inlet, causing the Cushing Glacier to temporarily advance, although the ice-mass all around evidenced by wide-spread melting that all that area was drifting into a warmer climate.

24. The summary of ice-bared areas around Glacier Bay, inset in the lower-left corner of Plate II, proves that after allowing for those temporary advances, which only amount to 3 per cent., the average area bared of ice merely within the seal-level inlets around Glacier Bay averaged 2,054 acres per year.

It is estimated that the melting and berging of those 2,054 acres of ice yearly implies a clearance of about 8,000,000,000 tons of ice per year from the area surrounding Glacier Bay. As the area of Alaska is 591,000 square miles, or 2,000 times that shown on Plate II, and there is a very large area of Northern British Columbia under glacial ice now yearly being melted, the mass of ice thus swept from Northwest America must be many thousands of millions (American billions) per year, a large part of which is being wafted over towards Greenland without any regret from Canadians and Alaskans, who find that the Alaskan winter frosts now penetrated about 15 to 18 inches less depth into the ground they are constantly mining for gold.

25. That mighty transfer of ice-weight from Alaska and British Columbia, now accumulating on Greenland, includes part of the icebergs and understreams shed from the Northwest and later transferred by evaporation. These together are weighting down Greenland and so changing for the better the wonderful climate of British Columbia, Canada and the dear home-lands of Europe, as the earth's crust is thus tilted in the direction from Greenland down the mid-Atlantic. The same mighty force is likewise tending to make Australia and South Africa warmer, as they are being tilted up towards the Equator.

Thus whilst the climatic zones are con-

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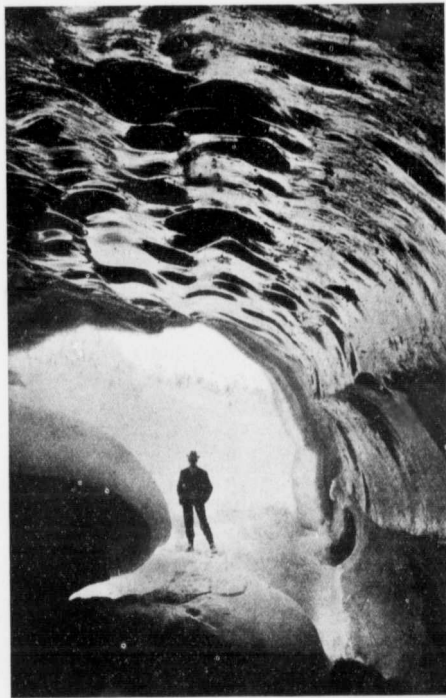


Plate IX. The ice cave on the Illicillewaet Glacier, visited by Mr. Cotsworth in the winter of 1908-09. The flutings on the right resulted from the intense pressure of the ice as it was forced over the grooved bed-rock.

stant, according to their respective angles at which the sun's rays reaches the respective latitudes of the earth, its whole crust under those zones is being tilted around by the ice drifting from Northwest America to Greenland, thereby changing the relative climates of every country very slowly. Few persons realize the far-reaching influences that world-wide change is exerting upon the vitality of nations and all mankind.

GEOLOGICAL PERIODS DEVELOPED BY THE CONTINUOUS GLACIAL PERIOD

26. Those stages of Polar Progression are indicated on Plate III by the bold dot-and-dash line showing the course apparently

taken by the North Pole from the Behring Sea, where it was seemingly located throughout that geological period during which the European coal strata were laid, when Europe was in the latitude now held by Equatorial Africa, where the sudswamps and tropical growth are depositing like formations in their initial stages.

As the North Polar area became deflected eastwards by the gravitational flow of the 6,000-to-9,000-foot-thick glacial ice-cap from the Rocky Mountain area over the present prairie area (that then was a very shallow Polar sea of immense ice-lagoons) towards the south of Greenland and Iceland regions, the northwest of Europe was gradually drifted through the present Sahara zone where the British new red lias sandstone was probably laid, and thence through the Mediterranean area where the shales and limestones of the Jurassic strata were apparently laid.

27. Later, as the Polar Progression turned through the Hudson's Bay area, the British Isles appear to have been deflected into the warm zone where the mid-Atlantic is now depositing animalculæ-formed beds, like the British Oolitic and Coralline strata. When, later, the Polar Progression rounded Labrador dipping southeasterly, the British Isles would be deflected through the great chalk-forming zone where the Atlantic foraminifera in teeming billions are now depositing vast beds of chalk-ooze between Africa and Central America, just as the British chalk-beds of the Cretaceous period were laid.

28. The natural explanation does not necessarily imply that the whole of the British strata between the old red sandstone and the present boulder-clay and alluvial deposits of soil were laid during one unvarying transit of the polar locations from Behring Sea to the present location of the polar axis, neither does it imply

The Glacial Cause of Changing Climates

that the contours of the continents have always remained exactly as now; but it does mean that in a general way what has been hitherto geologically regarded by so many people as periods of climatic conditions, simultaneously affecting the whole earth and brought about by tremendous convulsions of the earth's crust, were much more easily and naturally developed by the simple agency of "changing latitude" briefly traced about through typical strata, to illustrate the overwhelming force so gradually exerted by the ceaseless flow of Polar ice in variant directions, continuously changing the climates of every country on earth, as they have been and are successively drifted through neighboring zones of latitude.

THE CLIMATIC CHANGE IS WORLD-WIDE

If you, reader, will take any geographical globe and tilt it down the axis of Greenland southwards, with three wire rings to represent the Equator, Tropic of Cancer and Arctic Circle, held separately like a cage or fixed screen above and yet near the globe, you can readily gain a definite conception of this great natural climatic change now benefitting Canada, the Northern American States above the 40th paral-

lel, Northern Europe, with China and Japan, at the expense of Syria, Southern Europe and the Southern United States of America, which are becoming too warm, whilst Siberia is becoming too cold for human comfort, because the mighty force of Greenland ice is "creeping" all the earth's crust (like a loose motor-tyre) around down the direction of the mid-Atlantic, and at the same time forcing up Northern Siberia further into the frigid polar zone.

30. Partially corresponding, but less marked, changes are being noticed around the South Polar area, where the wind currents and lesser mountain areas produce the thinner, flatter, South Polar ice, which produces the smaller, flat, table-like icebergs so characteristic of the South Polar Seas, which are in such marked contrast to the gigantic mountain-like icebergs now increasingly "calved" from Greenland's Polar ice-cap.

Whilst icebergs detract from the pleasures of trans-Atlantic travel, they should be regarded as part of the great climate-changing force which is continuously resting and renewing all parts of the world by that infinite variety which should lead us to rejoice in the beauty and fertility that results from this marvellous and beneficent climatic change. M. B. COTSWORTH