on occasion by the sympathetic, but they can not be easily seen by the typical tourist.

Carrier and Chilcotin Indians, who both belong to the Athapascan linguistic stock, visit Bella Coola and camp at several places in the valley during the summer. Each group stays several weeks and some of them return a number of times in the season, producing a picturesque subject for observation and study. Much yet remains to be done on the ethnology, archeology, folk-lore, physical anthropology and linguistics of these people.

In 1895 a colony of about 200 people of Norwegian extraction settled in the Bella Coola valley. These fine, sturdy, hospitable Canadians still occasionally prepare Norwegian dishes, do Norwegian carving, painting and embroidery and a few still have examples of the old country costume and jewelry. Here is opportunity for the study of folk-lore, carving and painting.

To the literary man, the district presents many features of interest. There are two types of Indians, one a sea coast communal sedentary folk, the other horsemen of somewhat nomadic habits. There is all the charm of the Norwegian fishermen living on farms, and the loggers engaged in hand, horse and railroad logging. All the races meet in the salmon canneries with their cosmopolitan crews of Norwegians and Chinamen, Japs and Indians, to say nothing of the Scotch engineer, the French-Canadian and the "American." There is also the romance of the trappers and prospectors that has not yet been adequately told. The cowboy life that drifts down from the interior and may usually be seen in evidence at Bella Coola and the Indian horse-men and horse-women are perhaps less modernized than anywhere else in Canada.

All the subjects of such great interest to the student and literary man have an equal attraction for the artist, the movie operator and the artist-photographer. Within or adjacent to the park are strange and wonderful types of men, glaciers and waterfalls. Within the forests are vast green roofed "cathedrals," pillared with tree trunks, carpeted with moss and illuminated by sunlight strained through green leaves and lending a glamor to the scene that can not be simulated by the man-made stained glass.

This region is reached by a weekly steamer from Vancouver for Bella Coola at a cost of $20.20, one way, including meals and berth. The traveler usually leaves Vancouver Wednesday night and reaches Bella Coola sometime Sunday, and has a good opportunity to see intimately the natural resources, industries and life of the coast as the steamer stops at Indian villages, salmon canneries and logging camps, often for a considerable time. Wholesome meals may be had throughout the Bella Coola valley at fifty cents and bed at the same rate.

The western edge of the park and part of the northern edge can be viewed from motor or sail boats on North and South Bentinck Arms. The next section of the northern edge of the park is adjacent to the automobile road, locally known as Mackenzie Highway, which now extends up Bella Coola valley for forty-one miles. Beyond this is a good pack trail for horses. Along the land route mentioned are post offices at Bella Coola, Hagensborg and Atnarko. There is telegraph communication with the outside world from Bella Coola and Atnarko. One may live in delightful simplicity and comfort at various places along the Bella Coola valley road with telephone and weekly mail service and yet walk in the park area to some glaciers and many waterfalls and return home in time for supper.

Here one may live in comfort among a picturesque and primitive pioneering people with unequalled scenery of mountains, glaciers and virgin forests at his very door. The person who longs for a complete change and yet hesitates to break connection with his business may enjoy all the wilderness that his heart calls for and yet be within telegraphic communication with the world of affairs. As a location for the summer field work conducted by many of the universities, Mackenzie Park is unequalled, since here is presented opportunity for study of several lines of natural history. Contributions to such study will be to the benefit of the park proper and to the country in general.

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THE UNSATISFACTORY STATUS OF THE GLACIAL CONTROVERSY*

INTEREST is revived in the problems of the cause or causes of "glacial periods" by the conclusions expressed in the well-written "Text-book of Geology," by Professors Pirsson and Schuchert.[1]

There are no more controverted and widely discussed problems in geology and terrestrial physics than those connected with the cause or causes of the glaciations, which, during short intervals throughout geologic time and at widely separated latitudes, have left their traces in and upon the crust of the earth. From the earliest Proterozoic to the present time tillites and tills mark glacial action.

In this latest authoritative text we find the following unsatisfactory conclusion, which fully expresses the general consensus of opinion on the subject, both as to the separate and combined causes.

* See also, "Ancient climates," *Scientific Monthly*, May, 1925, pp. 459–479.

[1] 1924, 2nd Edition, Jno. Wiley & Sons, Inc.

GLACIAL CLIMATES

As yet there is no accepted explanation of why the earth from time to time undergoes glacial climates, but it is becoming clearer that they are due rather to a combination of causes than to a single cause. Probably the greatest single factor is the high altitude of continents, with great chains of new mountains (the hypsometric causes) which disturb the general direction and constitution of the air currents (the atmospheric causes) and the ocean currents as well.[2]

It is permissible to state, however, that the glacial climates are irregular in their geologic appearance, are variable latitudinally, as seen in the geographic distribution of the tillites between the poles and the equatorial region, and finally that they appear in geologic time as if suddenly introduced.[3]

Now, there is no adequate evidence that the earth as a whole has ever gone through a glacial climate. Local and alpine glaciations have recorded themselves time and time again in all latitudes between polar and equatorial regions; and there have undoubtedly been two great glaciations, that of Permo-Carboniferous and that of Pleistocene time. These were widely apart in latitude, and neither encroached upon the glaciated latitudes of the other, although there was a notable lowering of the snow line in tropical and equatorial latitudes in the final chill of Pleistocene time.

These glaciations were separated in time by the vast interval between the Paleozoic and the dawn of the Postglacial or Human Epoch. The former, with its maxima localized between latitudes $\pm$ 15° and 35°, and the latter with its maxima in about latitudes $\pm$ 50° to 55°.[4]

These maxima approximately coincide respectively with the arid and the north and south temperate rain belts of to-day, the former at the beginning, and the latter at the close of the vast geologic interval above mentioned.

There is abundant evidence that during all these glaciations, except the last, the oceans remained genial, and in this last glaciation the chill was restricted to oceans in polar and mid-latitudes; equatorial and adjacent oceans remained genial or similar to the genial and mild ocean temperatures which were so widely distributed throughout geologic time.[5]

But locally and at widely separated latitudes temperature fluctuations upon continents were far different. "The hypsometric causes" probably operated actively in most of the known instances of glaciation, but in the great zonal glaciations of the Permo-Carboniferous and of Pleistocene time these causes do not appear to have exercised any effective control, for the glacial flows seem to have overridden mountain ranges and extended to and, in some instances, into oceans remote from the centers of dispersion.

Realizing that the ratio of ocean areas to continental areas is and probably within geologic time has not been far from 3 to 1 and that the two great zonal glaciations were separately restricted to less than half the remaining continental areas, it is difficult to see how it can be said that "the earth from time to time undergoes glacial climates." It appears rather that glaciations, even in these great extensions, were local phenomena, which from time to time were imposed upon restricted portions of continents; and were imposed upon oceans but once, and were then restricted to polar and mid-latitude regions. There is, therefore, a manifest need, even in this latest text, for a thorough reconsideration of the subject, not only of the causes of glaciation, but of the long and widespread genial conditions which were interrupted by short local glaciations as recited in the text under consideration.

Referring to variation in solar radiation as a cause of glaciation, the authors say:

> Moreover, Huntington states that five authorities on glaciation have concluded that if the mean temperature of the earth were to fall 9 degrees to 11 degrees F. and were to remain thus low for a sufficient length of time, meteorological conditions would be so altered that a large part of North America would be covered with ice down to about the fortieth degree of latitude and Europe would suffer a corresponding glaciation.[6]

This is not borne out by existing facts; the mean temperature of North America and Europe in the latitudes named is about 40° F. A reduction of from 9 to 11 degrees F. would bring the mean temperature of these regions down to about 30 degrees F. Portions of North America, Europe and Asia are now at or below this mean annual temperature, and have been under these general meteorological conditions for a long period in the past, and are not glaciated. Furthermore, it is found by all observers that the mean annual temperatures of Antarctic and Arctic regions are below this temperature, and that these regions are being deglaciated.[7]

It is difficult to accept deductions that North America and Europe down to 40° latitude would be reglaciated at a mean temperature higher than that now deglaciating Antarctica, unless the insolation

[2] p. 660.

[3] p. 662.

[4] Pub. 192, Carnegie Institution, p. 285, Fig. 266, p. 649; "Text-book of Geology." Pirsson and Schuchert, p. 431.

[5] p. 69.

[6] p. 663.

[7] SCIENCE, N. S. Vol. XLVI. Dec. 28, 1917, pp. 639–640.

were intercepted to a greater extent than at present. With no agreement whatever as to what the causes and conditions of glaciation are, it is not possible satisfactorily to predicate the conditions which would reglaciate any given region.

Summarizing the possible causes of glaciations, the above-quoted authors present the following:

Conclusions: Briefly, then, we may conclude that the markedly varying climates of the past seem to have been due primarily to periodic changes in the sun and in the topographic form of the earth's surface, plus variations of the amount of heat stored by the oceans. The transformed face of the earth altered the configuration of the continents and oceans, the air currents (moist or dry), the ocean currents (warm, mild or cool), and the volcanic ash content of the atmosphere. The causation for the warmer interglacial climates may lie in oscillations of solar energy.[8]

The members of this group of heterogeneous causes have individually been included in the unacceptable explanations given in the citations from page 660, and it is not shown that the group as a whole is any more acceptable than the individual causes which compose the whole.

Conceding that a transformed face of the earth would really alter the configuration of the continents and oceans, it must be also conceded that such transformations, at the close of long periods of crustal stability, would accelerate denudation of warm strata and the exposure and alteration of fresh radioactive materials, as well as expose new mountains reaching above the snow line of the period to glaciation. The appeal to oscillations of solar energy, when applied to warm interglacial periods of Permo-Carboniferous glaciation, during which genial conditions prevailed in polar latitudes, is, to say the least, not in harmony with the distributions of temperatures now maintained by solar energy, and can not readily be ascribed to oscillations of solar energy not accompanied by similar climatic oscillations elsewhere and particularly with the climatic anomalies of coincident polar geniality and subtropical glaciation.

These citations and the remarks thereon are not made in a spirit of adverse criticism, but to point out that what is now taught on the subject does not afford an adequate basis for an acceptable explanation of the admitted facts or even for a reasonable belief.

The student who would venture upon this sea of assumptions and of heterogeneous causes must embark in a ship whose center of gravity is above its meta-center. The deck-load of assumptions must be jettisoned and a ballast of facts and sound principles substituted therefor. A distribution of glaciation latitudinally ranging between the poles and the equatorial region appears to be contradictory of solar control and manifestly indicates that some essential factors have been overlooked or omitted in the consideration and presentation of the problems of paleoclimates; and that "other factors" must be utilized in place of those which have been strained beyond their limits of elasticity.[9]

This is the great outstanding problem of geologic history. It is of more importance and more far-reaching than any other, and geologists have turned their attention to the minor problems of mineralogy and paleobiology and have let the great problems of the causes and conditions of paleoclimatology fall by the wayside.

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[8] p. 663. For relative constancy of solar energy see Curtis's address, SCIENCE, February 18, 1925, pp. 471–472.

[9] "Radio activity and earth history," Holmes, *Jour. of Geog.*, June, 1925, pp. 529–532.

WILLIAM ALBERT HAMILTON

WILLIAM ALBERT HAMILTON was born May 9, 1869, near Zanesville, Indiana. He died at Delaware, Ohio, June 25, 1925. He received his bachelor degree from Indiana University and his doctorate from the University of Chicago.

In 1902 he was called to Beloit College as professor of astronomy, and was later transferred to the headship of the department of mathematics. For twenty-one years Dr. Hamilton gave his best thought and service to the upbuilding of his department and to the support of Beloit College. He was an ideal teacher of mathematics, because he was precision and accuracy personified and he studied constantly to keep abreast of his developing science.

Dr. Hamilton was not willing to leave teaching for administrative work. Nevertheless, when Beloit College requested his assistance as recorder, registrar, director of the summer school and finally chairman of the administrative committee, which was to function during the interval of six months when Beloit College had no president, he consented to serve. In each and every administrative position he was an example of loyalty to high ideals, to unremitting toil and to sacrifice. This sacrifice became supreme when he severed his connection with Beloit College, which he had served for twenty-one years and into which he had put his best endeavors. He resigned because of the treatment accorded one of his intimate associates by the Board of Trustees at the commencement of 1923.

During the summer of 1923 Dr. Hamilton was