

"Three Composite Glaciological Works of Foreign Authors"

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THREE GLACIOLOGICAL COMPENDIA BY FOREIGN AUTHORS

In connection with the ever-growing development and deepening of glaciological research in the USSR, it is of interest to become familiar with the present level of glaciological knowledge abroad. For this purpose it will be sufficient to consider briefly current compendia of glaciology, without going into the periodical literature or separate papers.

We shall take up three such works, penned by well-known foreign scientists, that have appeared between 1942 and 1948.

In 1942 a book by Drygalski and Machatachek was published in Vienna under the title "Glaciology", [E. Drygalski and F. Machatschek, Gletscherkunde, Wien, 1942, 261 pp] as one of the independent parts of the Geographical Encyclopedia (Enzyklopädie der Erdkunde), in the writing of which many German scientists participated.

Drygalski and Machachek are well known through their works in the field of glaciology. The former is acquainted through personal observation with almost all forms of glaciers in the world, especially in the Antarctic, in which region he actively participated in the research. It would seem that we might count on current glaciological views being fully reflected in this book.

The preface states that the book is a glaciological encyclopedia which reflects the current level of glaciological knowledge, and is meant to replace the similar book of Hess -- "Glaciers" -- which appeared in 1904 and is very much out-dated today.

It remarks incidentally that since 1904 glaciology had developed into an almost independent field of physical geography, with a strong leaning towards physics (which cannot be gainsaid -- G.A.), that the field of glaciology had been broadened not only in a scientific sense but in a territorial sense as well, and that hand in hand with the new work, especially that of the Polar explorations, essential and radical changes in the methods of observation had been introduced and the researches had become more extensive and incomparably more profound.

The book consists of 10 chapters, in which the whole range of questions of current foreign glaciology is surveyed in rather great detail. The discussion of a few separate questions deserves a certain amount of attention. The most interesting chapters are IV -- "Physics of Ice" --; V: "Thermodynamics of Glaciers and Mainland Ice"; and IX: "Geographic Distribution of Glaciers". (In connection with the latter chapter it must be remarked that though the description of South American and Antarctic glaciers is good, that of the Soviet glaciers is poorly done.)

Having noted a few favorable sides of the book, we come now to very substantial faults.

The authors have not used the materials of Soviet Glaciologists, which are very essential for current glaciology, nor have they used the materials in the recent work of Al'man and Demorest. This omission is unfavorably reflected in the quality of the book, both with respect to completeness in reflecting the views of a number of questions, and in the sense of completeness in the presentation of current glaciological research.

The entire book is permeated by the idea that glaciology as a science was developed and is being developed only by the Germans. The work done by investigators of other nationalities, especially by the Russians, is belittled, and, as far as possible, ignored. This idea shows itself not only in the preface, which consists substantially of a short history of glaciology, but runs like a red thread through the whole book. The historical sketch, for instance, fails even to mention the name of P. A. Kropotkin, to say nothing of the Soviet investigators. Thus, the Soviet-German Pamir Expedition of 1928 is termed a purely German one, and it is stated that it was carried out through the efforts of German scientists; there is not a word mentioned about the Soviet investigators who participated in this expedition; and yet the great part played by Soviet research in the Pamirs is common knowledge. As for the glaciers of any other country, it turns out that all substantial steps in their study were taken by the Germans, and so on.

The leading role in the book is assigned to the "Alpine school" of glaciology. Its services in both past and present development of glaciology are extolled and obviously exaggerated. This school, in spite of the historic truth and in complete disregard of the nationality of its many founders, is declared to be purely German since the very moment of its birth. It must also be noted that it is precisely this method of approach of the "Alpine school" to the consideration of various phenomena that is a distinguishing feature of the book and one of its substantial faults. Although the authors have "modernized" many views of this school, they have nevertheless, clearly failed to take due account of the differences in the regularities governing the development of glacial phenomena -- differences re-

sulting from the natural peculiarities of the different geographic regions. To a very considerable degree the "mechanistic" application of the "Alpine" regularities to the interpretation of the glacial phenomena of other countries is an inherent characteristic of this book. The untenability of such constructions has been repeatedly stressed in our literature and is clear to Soviet glaciologists, dealing as they do with the most varied glacial formations located in the various physical-geography regions of our Fatherland.

The authors underestimate the role of the conditions of physical geography in the peculiarities of the formation and development of glaciers, and they also give only faint and far from complete expression of the complex dynamic interaction and interrelation of these formations with the geographical milieu of which they constitute a part. The interrelation of the separate parts of glaciers is also given inadequate consideration.

For these basic reasons, it seems to us that the general constructions of the authors as well are not deserving of entire confidence, especially, for instance, on the questions of the evolution of glacial formations. The faults we have enumerated, however, do not prevent the book from reflecting the condition of current glaciological knowledge abroad.

We point out, finally, that the book of S. V. Kalesnik entitled "General Glaciology," which was published in the USSR in 1929, and is analogous in purpose and content to the book of Drygalski and Machatschek under review, is unquestionably superior to it in all respects and gives a far truer picture of the real situation, in spite of the fact that it appeared three years earlier.

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The second book which we shall briefly discuss is by R. Koechlin, and is entitled "The Glaciers and their Mechanism" [R. Koechlin. Les glaciers et leur mecanisme, Lausanne, 1944, 177 pp.] It appeared in Lausanne in 1944 and is divided into two parts: the first, consisting of six chapters, elucidates the general questions of glaciology, while the second part contains seven chapters and is devoted to a more detailed analysis of the mechanism of glaciers and a comparison of this mechanism with that of the stream of water.

According to the introduction, written by Picard, the book fills in an existing gap in glaciology by supplying a profound and complete examination of the mechanism of glaciers, and also furnishes exhaustive information on glaciers; and is of great interest to all those interested in mountainous regions, especially for specialists in glaciology and geology.

The fairly numerous references to this book encountered in the current glaciological literature of foreign countries, the very table of contents of the book, and, finally, the fact that the author is a noted hydraulic engineer, called it to our attention. In addition to a general summary of current glaciological opinion, formulated from the engineering approach (which presupposes a critical evaluation from the practical point of view) we had also hoped to find in this work, if not a solution, at least an original treatment of the fundamental questions connected with the mechanisms of glaciers -- questions that still remain open for discussion. As is generally known, the development and solution of these questions is of very great current interest both for theoretical glaciology and for the possibility of their practical application.

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The book arouses interest on a rapid examination. The chapter headings and the list of the subjects discussed in them compels the assumption that the book has a significant content. But after going through it carefully and systematically, the reader is left with a feeling of disappointment. In the first part the author essentially does nothing more than repeat glaciological hypotheses which have long been common knowledge and some of which are already obsolete, setting them forth without substantiation and without adding anything new. Many questions are set forth in a primitive manner, and sometimes the exposition is simply untrue. The author has made no use of the glaciological work of recent years that has made fundamental modifications in the study of these questions. The book on the whole is written around the materials of a small number of widely known, classical Alpine glaciological investigations, mainly around the data pertaining to the Rhone, Aletach and Khantereysferner (Chanter-aisferner) glaciers.

Without belittling the value of these investigations in their time, or their significance for the historical development of glaciology, we may point out that modern glaciology as a whole has advanced a considerable distance past that stage, and that there is consequently not the slightest reason for basing new work on the antiquated "classic Alpine theses."

We turn now to the second part of the book, which analyzes the mechanisms of glaciers. The author maintains that first of all there are two forms of motion possessed by glacier. The first form is a sliding motion of the entire ice-mass (we emphasize "entire ice-mass"), similar to that of a solid body on an inclined plane. The second form, properly speaking, is really a flow of the ice, imposed on it by its

plastic properties. The first form of motion performs the work of grinding down the mountain rocks, that is, the erosion that appears throughout the entire extent of the glacier. The second form -- the flow --- does not perform this work. The existence of these two forms of motion is not proved by the author; he asserts it, and that is all.

It is further stated, again entirely without argumentation, that during the stationary condition of glaciers and during their periods of recession, one of these forms of motion, namely sliding, is absent, and only the second form -- the flow -- is acting. During the epochs of advance, on the other hand, the first form -- sliding -- dominates, over the second form. Thanks to the sliding of the entire ice-mass during an advance of the glacier, moraines of pressure are formed, the plowing-up action of the glacier is manifested in the friable layers, and the entire (we emphasize the word "entire") erosional work of the glaciers takes place during these periods.

The author then goes on to say that, in effect, no one has yet succeeded in observing the sliding motion, since all exact measurements had been made during periods of glacial recession. Consequently the whole sliding motion is a "reconstruction", of which the basis is unknown to us. Soviet glaciologists cannot accept such axioms for truth. We have personally observed glaciers during periods of advance, but did not note any signs of the ice sliding as a whole. On the contrary, we noted such motion not for the entire glacier as a whole, but for individual blocks of dead ice at the terminals of receding glaciers.

As far as we have been able to notice, the plasticity of the ice increases in advancing glaciers. Thus what we have succeeded in

observing stands in direct contradiction to the hypotheses of the author of the book. Moreover, we never noted any appreciable plowing up by the advancing ice in friable rock layers, and we never succeeded in discovering any indications pointing to the formation of "moraines of pressure." On the contrary, even the vegetation covering the old moraines, upon which the glacier was advancing, still persisted. Apparently the mechanism of motion and the "forms" of motion of the ice in glaciers are in fact different from what the author surmises them to be.

When he analyzes the mechanics of glaciers, the author fails to consider certain phenomena that exert an extremely substantial influence on this "mechanics" and constitute important elements thereof. Such phenomena include, for instance, the recrystallization of the ice, its temperature conditions and, in general, all questions of the state of glacial ice and of its physics. By the mechanism of the glacier, in the last analysis, the author means the motion of a certain material with certain properties (given by the author and connected to an unknown extent with the real ice of glaciers) under certain conditions (again laid down by the author and differing from those which are actually observed). Under these circumstances it is very simple, by using the well-known relations of mechanics, to work out a calculation of the mechanism of motion and of the results of the work of that motion. The simplicity of these actions, however, is equivalent to their uselessness.

Moreover, the consideration of the mechanism of glaciers is confined to only a single part of the body of the glacier, namely to its "collector" or "central portion," according to the author's terminology; and this portion is in effect unconnected with the other re-

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gions of the glacier. Incidentally, the author divides a glacier into three parts; the region of accumulation, or firm, the central portion, or collector, and the tongue proper. The collector is characterized by mutual proximity of accumulation and ablation, as well as by the insignificant rate of both processes. In this part proceeds mainly the mere transport of material from the firm to the tongue. In space, the collector occupies the position from the snow line down to the very beginning of the glacier. The tongue is a region of dominant and very considerable ablation, while the firm is a region of dominant and very considerable accumulation. Thus the author defines the other two parts of the glacier. We cannot agree with the correctness of so essentially artificial and decidedly indefinite a division of a glacier into parts.

As for analysis of the mechanism of movement in the other parts of the glacier, this is entirely omitted for the tongue, while for the region of the firm it is indicated that the parts have two forms of motion: a downward movement, or subsidence, and a forward movement toward the terminus of the glacier, which is illustrated by a diagram. The mechanism of the movement of the glacier as a whole is in fact represented by only a single diagram, which reproduces this movement in accordance with Sebastian Finsterwalder's geometrical theory of flow in a stationary glacier. As is commonly known, this theory gives an unsatisfactory explanation of the movement of a glacier, as has been most distinctly shown by glaciological research in recent years, and at the present time is obsolete.

From all that has been said, we have every reason to consider that the author, at best, has examined the mechanism of movement of

only a single part of the body of the glacier, under certain definite conditions, and abstracted from the entire glacier as a single whole, which is of real interest, has not been analyzed at all by him. The present work can thus hardly be useful in the development of glaciology.

We imagined that the author, being a well-known hydraulic engineer, would give an original, mathematically-grounded interpretation of the mechanism of glaciers. And, as a matter of fact, we do encounter a rather large number of formulae in the book, especially in its second part. But these formulae are merely of an abstract character, and, from our point of view, fail to reflect the phenomena that actually take place. Most of them have been obtained by substituting a few new values of constants for the original values in formulae in use for currents of water, without properly taking into account the peculiarities and the essential nature of the ice-stream as such, i.e., in the whole procedure there is visible the mechanical transformation of the formulae for water currents in order to apply them to the glacier. It is therefore not surprising that in consequence basic formulae have been obtained which are identical with those previously found by Lagalle and Somil'yan and distinguished from these latter only in the fact that this author expresses the coefficient of friction in different units. The author notes the coincidence of these formulae, and sees it as a confirmation of the correctness of his deductions with respect to the character of the mechanism of glaciers. We consider that this coincidence speaks only for the accuracy of the mathematical work; for premises, materials and conclusions were identical in both cases.

Moreover, the formulae derived by the author are based on arbitrary and completely unexplained assumptions relative to the

primary elements defining the mechanism of movement.

Finally, as has already been recalled above, Koechlin derives his formulae for the mechanism of movement of a glacier only for a single portion of the glacier, namely for its central portion, without connection with the remaining parts of the body of the glacier, and he also fails to examine this mechanism for the glacier as a whole.

Even for such an investigation of the mechanism of a glacier, the author narrows it and limits it by a series of conditions. Firstly, this central portion of the glacier must be of uniform breadth throughout its entire extent, it must be rectilinear, must have an almost parabolic cross section and a uniform surface slope. The second condition is that the glacier be in a stationary condition. As we see, these restrictions move this abstract central portion of an ideal glacier still further away from reality. Apropos of this, Somilyan and Lagalle also posited similar restrictions and conditions in deriving their own formulae. All this compels us to consider the formulae proposed by Koechlin as not warranting attention.

In consequence of these circumstances we cannot consider that the dependence obtained by the author between width, thickness and surface slope of a glacier is accurate (he uses this dependence to calculate the thickness of glaciers). Thus the mathematical side of the work is likewise of no interest.

In foreign book reviews, tendentiously benevolent, it has been indicated that the principal achievement of the book under discussion is the deduction of a parallel between the processes taking place in

a stream of water and those that occurring in a glacier, and in the pronouncements of the author to the effect that movements may be seen in the mechanism of the glacier which are similar to those which have shaped and are still shaping the strata of the rocks. It is the latter circumstance, in the opinion of the author (and of some foreign reviewers), which should attract the special attention of geologists to glaciers as the key to the understanding of the fundamental geological questions.

The idea of comparing the motion of a glacier with that of a stream of water is not in itself a new one; and as for the parallel treatment of these processes, it is in this case devoid of significance and of no particular value, since all the author has done is to make a mechanical change in the formula for water streams to apply it to ice streams. Other such parallel treatments, obtained by visual observations, have long been known. The idea of comparing glaciers with rocks is likewise not new, and, among other things, has long since been expressed by many Soviet investigators. As for the study of the mechanism of glaciers with the object of reconstructing the past movements of rocks and determining their contemporary relocations, it seems to us that in this case the matter is far more complicated and that the difference between the mechanism of motion of glaciers and that of rocks lies not alone in the quantitative phenomena -- in the incomparably lower velocity of rock and in the different value for the coefficient of friction. The quantitative difference of these two values must under all circumstances be accompanied by qualitative changes of the entire process, of the entire "mechanism of movement." There is therefore no ground for seeking analogies between them, not to mention the fact that what the author proposes is

the purely mechanistic identification of these two phenomena, having only differences of "scale," which is obviously incorrect.

Thus the theoretical, mathematical, mechanical, physical, and descriptive parts of the work do not deserve attention. Can the actual material of Koechlin's own observations, then, be of interest? There is no such material; evidently the author never worked on glaciers. The entire book as a whole leaves the impression of an amazing eclecticism while still observing formal connections. The work suffers from the mechanistic interpretation of natural phenomena, from the absence of due consideration of the factors of physical geography, from abstraction from reality.

We do not agree with Ricard, who wrote the introduction to this book, giving a high estimate of its achievements; and do not consider it a progressive appearance in the field of glaciology. Its only positive features may be considered to be the magnificent illustrations, the excellent typography and binding, and the very good, clear language in which it is written.

Finally, the third book which we shall briefly discuss here is the book of G. Ahlmann "Glaciological Research on the North Atlantic Coasts," published in 1948 by the Royal Geographical Society in London. [H. Ahlmann. Glaciological research on the north Atlantic coasts.]

Ahlmann, who is a well known Swedish scientist, is really the only great foreign glaciologist at the present time. He has been doing research on glaciers for thirty years (since 1918). During this period, as organizer or participant in various expeditions, he

conducted his investigations on glaciers located in different parts of the north Atlantic coast (mainly in Iceland, Spitzbergen and Norway), covering all of the most typical regions of the north Atlantic.

Ahlmann's expeditionary work was favorably distinguished from most of the foreign research contemporary to it by its thoroughness, the soundness of the approach to the phenomena under study, the use of the latest methods of observations, and the careful organization of the experiments. As his researches developed, Ahlmann published the materials of the separate expeditions extensively, mostly in the journal "Geografiska Annaler" of Stockholm, briefly elucidating the methods of observation and setting forth in considerable detail the basic conclusions resulting from them. Soviet glaciologists follow Ahlmann's work and are very well acquainted with it.

The conditions of activity and development of the glaciers of the North Atlantic are sharply distinguished from the conditions that exist in most of the regions of the USSR where there is contemporary glaciation. However, besides being of general interest to Soviet glaciologists, the work of Ahlmann, based as it is on factual material of the most recent observations, is also of interest from the viewpoint of possible comparisons and conclusions of general glaciological character.

In the book under review, Ahlmann gives a description of the glaciers of the north Atlantic coast on which he has done research, together with a short sketch of these researches; but this is not its principal content.

Most of our attention is attracted by the review of a wide

range of questions connected with the activities, condition and development of the contemporary glaciers located around the North Atlantic. Incidentally a few fundamental glaciological problems are also set forth, which are no longer regional, but belong to general glaciology, and he also presents some considerations of questions of ancient glaciation. We note that the author, while paying particular attention to the examination of the activities of the contemporary glaciers of the North Atlantic, also devotes very great attention to the climatic and meteorological factors that bear upon the evolution of glacial formations, but does not analyze the questions of the effect of the glaciers themselves on the climate. The neglect of these interactions is a substantial defect of the book, which casts some doubt upon the correctness of certain of the author's conclusions.

The book under review is really a summary of all of Ahlmann's preceding works. In it the author sets forth in condensed form the most substantial of the materials and the fundamental conclusions from all of his investigations. He gives no essentially new conclusions or deductions in this book. It is true that some questions are expounded in somewhat different manner, but these changes relate only to details.

Such a summary has certain positive features. It allows the author to substantiate his conclusions in the best possible way, and gives the best idea of the glaciation of the North Atlantic. Together with this it also affords an opportunity to get a complete idea of all the glaciological work of Ahlmann from this single book. Besides, such a summary, giving as it were a certain accounting of all the work done, most distinctly depicts the tasks and directions of future

researches. At the same time, however, all description of the methods of observation and research is completely omitted in this book, while this side is of great interest, and its neglect is a major lack in the book.

The circumstance is worth while noticing, for instance, that Ahlmann emphasizes the influence of the differences in the geographic milieu on the peculiarities manifested in the activities and development of glaciers. This idea has long been developed, but it was by Soviet glaciologists. In his earlier works Ahlmann paid no particular "attention" to this question.

The question of the role of advective heat and radiant heat on the thawing of glaciers is handled somewhat differently than before. Ahlmann, undoubtedly under the influence of views long since established among Soviet glaciologists, makes a "concession" in favor of recognizing the role of radiation in thawing extensive glacier fields lying high above sea level, and for the glaciers of temperate climates he retains his old views only with respect to those directly on the maritime edges. Ahlmann lays great weight on the temperature conditions of the ice as affecting the activities of glaciers. We are in full agreement with this position, but Soviet glaciology views the question more in detail and more broadly. Ahlmann bases his data on the temperature of ice in glaciers on the temperature in the firn, but not in the ice, and for this reason the data should be considered only for the region of the firn, and not extended to apply to the glacier as a whole. In Soviet glaciological research, observations are also made to determine the temperature in the ice.

In the work under review, as in his previous works, Ahlmann

pays little attention to the questions of ice movement, since he underestimates the significance of this factor, and this is a substantial shortcoming of the book. He presents some new data on the glaciers of Froy and Kors, but they make no noticeable difference in his general ideas, previously expressed and here repeated.

It may also be noted that in this work, in distinction to previous works, such glaciological concepts as accumulation, ablation, snow line, firn line, etc. are elaborated.

In giving a classification of glaciers, the author repeats, essentially without change, his old pronouncements on these subjects. The Ahlmann classification has been subjected to the criticism of Soviet glaciologists and cannot be considered acceptable in the form in which it was, and still is, proposed. The introduction of a supplementary characteristic by areas occupied by ice or firn in the various altitude zones is a new element in this classification, and deserves attention. This characteristic represents, as it were, the further development of the well-known old glaciological concept of the ratio between the areas of feed and discharge. It seems to us that such a refinement of this concept is not without a certain meaning. For purposes of comparison, glaciers are divided into an equal number of altitude zones (the altitude intervals for each glacier thus being different in absolute value) while the areas of such zones are expressed in percent of the total area of the glacier in question.

Regarding so interesting a question as the causes for the fluctuation of glaciers, and, particularly, for the current sharp recession of glaciers on the North Atlantic, the author stands pat on his

old positions, and considers that the fundamental cause for such fluctuation is change in the temperatures, and that the current recession in the glaciers on the North Atlantic is due to an increase of temperature due to the intensified advection of warm air masses, caused in turn by strengthening in the general circulation of the atmosphere. Thus, according to Ahlmann, the observed shortening of glaciers is forced by the increase in their ablation due to the heat introduced. Intensification of radiation has not been noted.

Ahlmann states further that the shortening of glaciers and the strengthening of ablation is noted only for the coastal regions; as for the interior of Greenland, for instance, there is no reason for speaking of any appreciable increase of ablation or decrease in the thickness of the ice. Thereby the author confines the region of rapid reduction of glaciation to the coastal regions of the Atlantic.

This interpretation of the reduction in Atlantic glaciation is presented by the author only in this book, and we consider it necessary to point this out. On the whole the picture of evolution of north Atlantic glaciation drawn by Ahlmann can apparently be accepted. In particular, improvement in the navigation conditions in the North Atlantic and in the Arctic seas of the USSR depends according to him on the same causes that influence the reduction in Atlantic glaciation, i.e., on the transfer of heat and the related changes in the direction and force of the winds, which in consequence also creates better navigation conditions in these waters.

In concluding his book, Ahlmann says that much still remains obscure in the field of glaciology, and calls for the further study of glacial phenomena, points in particular to the necessity for study

of Antarctic glaciation, since it may throw light not only on many glaciological questions but may also reveal the causes for climatic changes throughout the world.

Ahlmann has attempted to give general concepts, based on his work, by the aid of which condition, activity and evolution of the various glaciers could be characterized; but he has not entirely succeeded in doing this. The Soviet glaciologist B. A. Shumskiy has accomplished this far better. He has proposed in concrete form, for instance, such concepts as the energy of glaciation, and the activity of glaciation, which are susceptible to quantitative expression. In general, Shumskiy's work Energiya i zhizn' lednikov (Energy and Life of Glaciers 1947), by virtue of the generalized conclusions made therein, stands on an incomparably higher level than, for instance, this book of Ahlmann, and is a great achievement of contemporary glaciology.

In concluding this brief review of Ahlmann's book, we must remark that it is still of a certain amount of interest, especially for those who are not acquainted with his previous work. It is based on good factual material, written on a high level of contemporary glaciological knowledge, and fully brings out the peculiarities of the condition, activity and evolution of the glaciers of the North Atlantic. As for the general glaciological views of the author, they are also worthy of attention, though they cannot be accepted without substantial criticism. Soviet glaciology attacks the solution of these general problems far more broadly and universally; the views of Soviet glaciology stand on a higher scientific level and more closely approach an actual understanding of the complex glacial phenomena.

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