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REVIEW

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THE *Geographical Bulletin* is the well-produced journal of the Geographical Branch of the Canadian Department of Mines and Technical Surveys; it is devoted mainly to material produced by the staff and temporary workers at the Branch. This issue consists entirely of glaciological articles.

Two of the papers relate to Baffin Island, a major one by R. B. Sagar "Glaciological and climatological studies on the Barnes Ice Cap, 1962–64", and the other by D. A. Harrison "Recent fluctuations of the snout of a glacier at McBeth Fiord, Baffin Island, N.W.T.". It is to be hoped that these two papers do not represent the end of work of this character in the area, for there is still much to be done, particularly in studying the flow and erosion characteristics of the thin cold ice caps, such as Barnes. J. Ross Mackay writes on "Segregated epigenetic ice and slumps in permafrost, Mackenzie Delta area, N.W.T.". Dr. G. Østrem contributes a paper on "Mass balance studies on glaciers in western Canada, 1965", while G. Falconer, W. E. S. Henoch and G. M. Østrem write on "A glacier map of southern British Columbia and Alberta". These last two papers are probably the first to be published describing new glaciological work being developed under the auspices of the International Hydrological Decade and perhaps other nations will be encouraged by the Canadian vigour.

Sagar's paper on the Barnes Ice Cap effectively follows up the pioneering work of Baird's party in 1950 and describes a three-year run of glacio-meteorological studies on the northern lobe of the ice cap. The year to year variations in the distribution of snow deposition on east–west profiles are of considerable interest. In 1962 the snow pack became progressively deeper from east to west, whereas an opposite tendency was noted in 1963. Another paper is promised on the meteorological implications raised by these apparently systematic variations, but they also raise interesting problems in relation to the ice flow. The year to year variation in the total annual accumulation on the ice cap is surprisingly small, amounting only to some 0·12 per cent of its total mass. The ablation, however, was much greater in 1962 than in 1963 or 1964, indeed at the crest of the ice cap the local mass budget was about zero in 1962. The substantial net loss of about 0·23 per cent of the ice cap mass in 1962, was slightly added to in 1963 and was not replenished by the small gain of 0·01 per cent in 1964. These approximate quantitative results certainly confirm the fact, obvious as a long-term effect at the boundaries, that the ice cap is retreating.

During the melting seasons of 1962 and 1963 observations were made of the weather elements and of the snow and ice temperatures to assess the thermal energy balance at the ice cap surface at its highest point. By far the largest source of energy transferred to the ice cap was due to radiation; it amounted to about 70 per cent of the total in 1962 and almost 100 per cent in 1963, compared to 68 per cent reported by Ward and Orvig on the lower southern lobe in 1950.

D. A. Harrison reports on studies of the chronology of the retreat of the snout of one of the outlet glaciers from the highland ice north of McBeth Fiord by the combined application of air-photograph interpretation, geomorphology, dendrochronology, lichenometry and radiocarbon dating. He comes to the conclusion that the glacier readvanced between 1790 and 1820 to impound a lake in the local valley, which drained from its highest level between 1840 and 1898 and from its middle and lowest levels between 1935 and 1938, and 1949 and 1952 respectively. The various dating techniques gave a reasonable correspondence, except for lichenometry, where the view is taken that local variations in microclimate are probably responsible for considerable variations in lichen growth rate. Harrison's dating for the last advance fits in with the late H. R. Thompson's view that the tributary glaciers in the Pangnirtung Pass last advanced sometime before 1850. It would be interesting for Harrison

to try out his techniques in the ice-dammed Stewart valley some 100 miles (160 km.) to the north of McBeth Fiord where in 1950 there were two lakes with a fine array of shorelines.

One soon discovers in the early part of Mackay's paper, which gives a classification of the various kinds of ground ice, that segregated epigenetic ice is formed in layers by the normal process of frost heaving when freezing temperatures penetrate the surface of ground which has already been laid down for some time in an unfrozen condition. The author has a long word "penecontemporaneous" for that kind of segregated ice which grows in the ground as it is elevated by current deposition, i.e. in flood plains, in areas of peat growth and in terrain being covered by debris from thawing slopes. The classification seems to be reasonable and practical.

A map is given dividing the Mackenzie Delta area into regions according to the occurrence of the various types of ground ice in the author's classification. Descriptions are given of exposures of segregated ice and of its distribution in various areas. When tabular sheets of ice 5–10 ft. (1·5–3·0 m.) thick are described in fine-grained sediments, the writer doubts whether they represent ground ice formed by the normal process of frost heaving out of local ground water and he wonders whether they represent deposits of slush from wet snow avalanches or stranded river rafts of snow and ice.

The paper concludes with some interesting detailed descriptions and measurements of the slumping of steep scarps that contain large volumes of ice. Indeed the amount of ice is sometimes so large that as the scarp retreats by thawing there is virtually no downslope removal of thawed soil. Here the author finds himself in some difficulty to explain the large amount of ice in terms of its origin from the local ground water.

G. Østrem in his paper gives the results of the first mass balance studies on three glaciers in southern British Columbia and Alberta. He describes the techniques of measuring accumulation, ablation, water discharge and simple weather elements and presents the results in tables and diagrams in a manner suitable for comparison with results from other similar projects to be carried out during the Hydrological Decade. An almost balanced budget was found in the Peyto Glacier, which is said to be representative of the eastern part of the Rocky Mountains and has been in retreat since at least 1897. A somewhat negative budget is given by the Woolsey Glacier, near Revelstoke, and a very negative budget by the Place Glacier, near Pemberton in the Coast Mountains. Curiously enough the average total accumulation on the Place and Peyto Glaciers was almost the same, some 1,500 mm. of water, though the former glacier is much farther westwards. However, as the author points out, the peculiarities in the accumulation–ablation patterns on these glaciers were practically unknown and more detailed measurements designed to meet these peculiarities, should lead to improved accuracy of budget assessment and a clearer understanding of the differences in the behaviour of glaciers across the Western mountains. Anyone who is contemplating mass budget studies for the first time in new areas is recommended to read this paper.

The glacier map of southern British Columbia and Alberta on a scale of 1:1,000,000 is contained in a pocket at the back of this issue of the *Bulletin*. It outlines in purple all the glaciers reduced from the best maps available in 1965, and gives the locations of selected meteorological stations and snow courses. On the reverse of the map a list of all source maps and their grid locations is given as well as a list of the names of all the meteorological stations and snow courses. The article describes how the map was compiled and reveals the considerable distortion and generalization given to the outlines of glaciers on many small-scale maps, such as the I.C.A.O. World Aeronautical Charts. We need accurate maps to cover the whole of the world's glacier areas. Topographical surveyors and cartographers should be encouraged to give more realistic attention to the needs of the Hydrological Decade and the interests of glaciologists.

This issue of the *Geographical Bulletin* is worthy of detailed study by glaciologists.

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