SUBGLACIAL STOPING OR BLOCK CAVING: A TYPE OF GLACIER ABLATION

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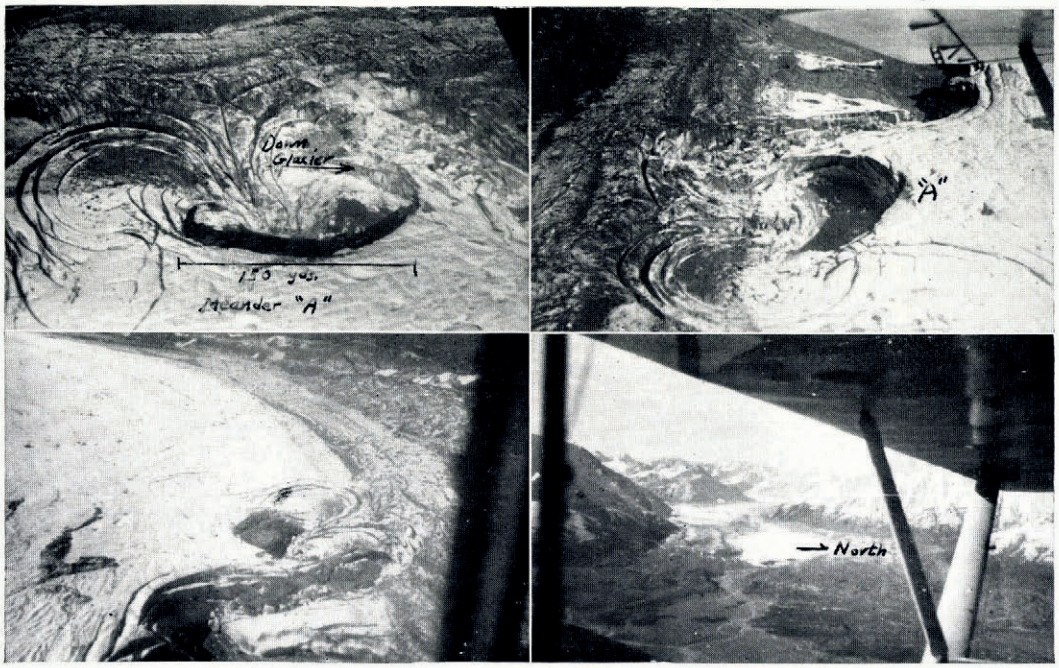
NEARLY twenty years ago the Black Rapids Glacier attracted much attention when it advanced at the unusually high velocity of over 115 ft. (35 m.) a day. Observations during the past year show that part of the glacier is now receding by a method that has probably never been observed or reported. The late Dr. John G. McCall was intrigued by this unusual method of retreat and considered it worthy of further investigation. He and the writer visited the glacier in April 1954 and again in September 1954 to observe this method of retreat.

The Black Rapids Glacier is located in the Alaska Range about 130 miles (208 km.) south-east of Fairbanks, Alaska. It is easily accessible from the Richardson Highway 138 miles (221 km.) south-east from Fairbanks or about 300 miles (483 km.) north from Anchorage. The glacier heads in the high mountains 36 miles (58 km.) west of the Delta River and flows east to the edge of the Delta River valley. The accumulation zone covers about 150 square miles (388 sq. km.) and includes six major tributary glaciers that flow north into the main valley. The high, ragged peaks that surround the glacier confine it to a long, narrow valley less than three miles (4·8 km.) wide at the most. Five miles (8 km.) upstream from its terminus the glacier flows through a narrow,



Black Rapids Glacier

Top left—Looking down on meander "A", showing where the subglacial river emerges from the glacier and the large, concentric crevasses are forming

Top right—Looking down the glacier, showing how the meandering canyon gradually widens downstream

Bottom left—Looking up the glacier, showing the first crescentic crevasses starting to form in the thicker ice above meander "A"

Bottom right—Looking westward up the Black Rapids Glacier, showing the location of meanders on the northern margin of the glacier

Photographs by author

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Black Rapids Glacier
Top—Looking upstream at meandering canyon; Centre—Crevasses forming above meander "A";
Bottom—Looking upstream at meander "A" *Photographs by Richard Smith*

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steep-walled canyon less than a mile wide. This constricting effect, the large accumulation zone, and a period of extremely heavy snowfall several years previously, may account for the glacier's rapid advance in the winter of 1936–37[1].

In the summer of 1936 the terminus of the Black Rapids Glacier was about three miles west of the Delta River valley. The first report of an advance was in December of that year, and during that winter it advanced the three miles eastward to the edge of the Delta River valley. Between September 1936 and February 1937 the average rate of advance was about 115 ft. (35 m.) a day; this unusually high velocity first brought attention to the glacier. In April 1937 the advance was already diminishing, and the first accurate measurements made at that time show an advance of only 70 ft. (21 m.) a day[2]. Later that year the glacier stopped advancing and began to recede.

Ablation of the terminal area progresses by the usual surface melting and small subglacial streams. The center of the terminal area is receding more rapidly than the rest of the glacier because of a large, meandering, subglacial river that accelerates the melting of its sides on the outward curve of each meander. This lateral melting of the ice on the convex side of the wide, crescentic meanders weakens the ice roof and causes a series of concentric, crescent-shaped crevasses to form on the surface. As the thickness of the ice between the surface and the roof decreases, huge, curved blocks of ice drop into the river to be rapidly melted and carried away. Near the end of the glacier, where the ice is thinner, the roof has caved in to form a meandering canyon with crescentic, vertical walls along the outside curves of the meanders and narrow meander spurs on the inside curves. Further up the glacier, where the ice is still thick enough to support itself, the first crevasses that express the gradual weakening of the ice start to form. These crevasses form directly above the river and follow the outline of each meander almost perfectly. Eventually the thickness there will no doubt be decreased by melting, and more large, curved blocks will fall into the river. The caving-in of great masses of ice and the lateral melting of the subglacial river channel widens and extends the canyon up the glacier.

This unusual method of retreat was observed by Dr. McCall and the writer in April and September of 1954. The only accurate measurement made was the paced distance of 150 yd. (137 m.) in a straight line along meander "A" (see photographs pp. 727 and 728). The ice cliff at meander "A" is from 80 to 100 ft. (24 to 30 m.) high. At the time of the two visits the subglacial river was quite low; however, during the warm summer months the river becomes a torrent at least 15 yd. (13·7 m.) wide and of considerable velocity. Examination of aerial photographs shows that as early as 1943 the central part of the terminal area was receding faster than the rest of the ice mass.

McCall proposed the terms *subglacial stoping* or *block caving* for the manner in which the river was melting the ice both downward and laterally to cause the formation of the deep, meandering canyon. McCall also commented that he had never seen any glaciers, even in photographs receding in this unique manner.

The location of the glacier, which is a short walk from the Richardson Highway, offers excellent opportunities to study one of the largest and most interesting glaciers of interior Alaska[3]. One of McCall's future projects was to establish control points and accurately map the glacier for future observations that could be made the year around. His death on 5 November 1954 unfortunately brought this project, and many other projects, to an end. Most of the glacial observations in Alaska have been confined to the coastal regions and there is much need for more detailed study of the numerous interior glaciers. Perhaps in the future others will continue this study in one of the most fascinating regions in Alaska.

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