NOTES ON THE GEOLOGY OF THE McCALL VALLEY AREA

Charles M. Keeler*

THE close relationships between diverse types of terrain make the McCall Valley area a particularly interesting one for the ecologist, geologist and geomorphologist. The McCall Glacier, which occupies the upper part of the valley, heads in a region of high serrate granite peaks (2,290 to 2,740 m. above sea-level) and ends in a narrow V-shaped valley that opens into the wider Jago River valley. The tundra, characterized by its vegetation and lack of sharp relief, begins approximately 5 km. from the glacier terminus on the north side of Marie Mountain (see map Fig. 7) at an altitude of 900 m. This rapid transition from icy peaks to vegetated plain within short walking distance is extremely attractive, both scientifically and scenically.

Previous explorations

It is not known if the McCall Valley had been visited prior to 1957; however, in the early 1900's a prospector, T. H. Arey, travelled along the Jago River from its mouth at the arctic coast to its headwaters, bringing back reports of glaciers existing in its western tributary valleys. E. de K. Leffingwell (1919) travelled extensively in the Canning River region during the years between 1906 and 1914 and described the bedrock and surface geology. One such trip was made along the Okpilak River, which is the first major stream to the west of Jago River. A U.S. Geological Survey party (Wittington and Sable 1948) spent a short time on the Okpilak River in 1948 and did a reconnaissance survey of the bedrock.

Present work

The writer spent two weeks studying the McCall Valley during the summers of 1957 and 1958. Further observations were made in the course of the regular glaciological work. Mr. E. G. Sable, who was conducting an investigation of the bedrock geology between the Jago and Hulahula rivers during these two summers deserves credit for his many helpful suggestions. Mr. Austin S. Post of the McCall Glacier Project also contributed to this work.

* Now serving with the United States Navy.

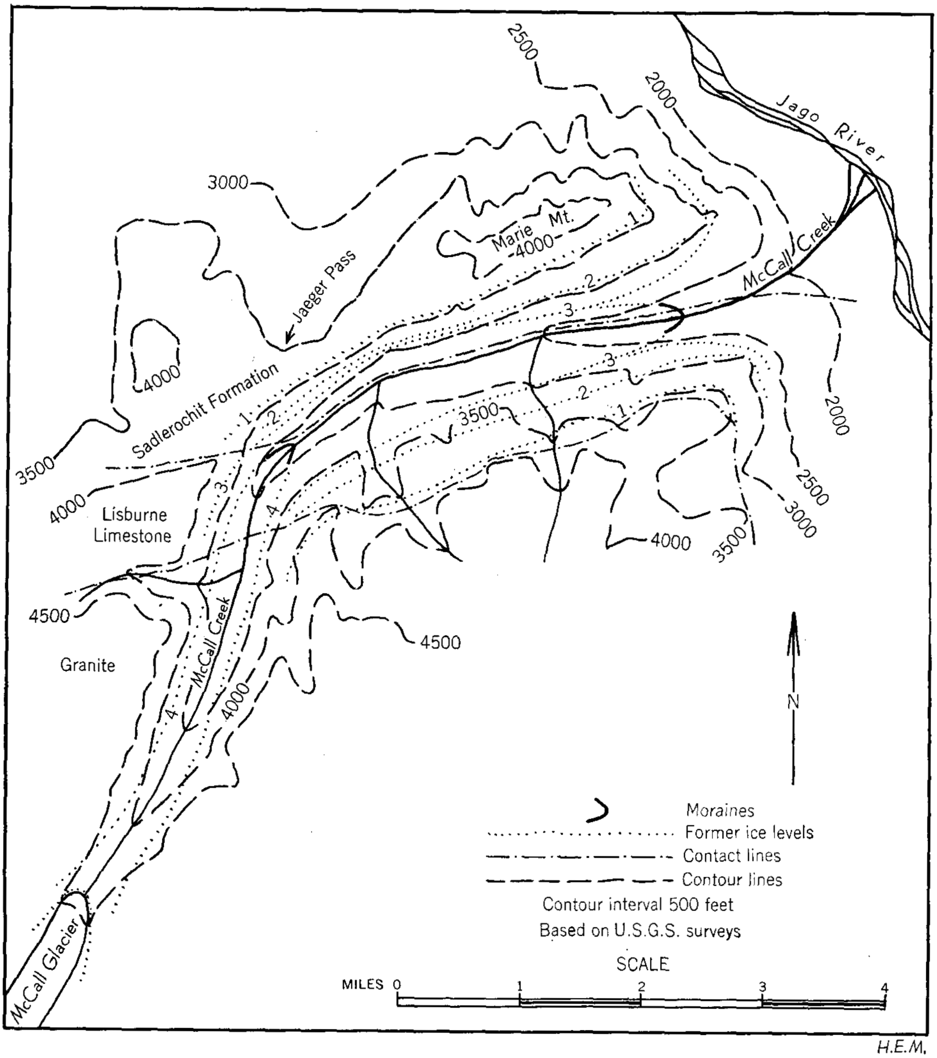

Fig. 7. Map showing McCall Creek from the terminus of McCall Glacier to Jago River and its surroundings. (Note: the names Marie Mountain and Jaeger Pass have not been recognized officially by the Board on Geographic Names and are used here for ease of reference only.)

The McCall Valley

The area most intensely studied is the part of the McCall Valley between the McCall Glacier and the Jago River. It is roughly 10 km. long and 800 m. across at its widest point. The walls from the glacier terminus to the pronounced easterly bend in the valley (see map Fig. 7) are nearly 450 m. high from valley floor to ridge top and have an average slope of 30 degrees. From the bend to the valley mouth the walls are less steep and covered with a sparse moss and grass vegetation, in contrast to the bare talus slopes farther up stream. It is in this lower vegetated area that traces of past glacier fluctuations are best preserved. The valley floor is covered with stream-carried debris of boulder size and patches of clay and silt (glacier flour). The stream occupying the valley floor is as much as 30 m. wide, but generally braided so that no channel is more than 6 or 9 m. wide. The average stream gradient is 4 degrees. As the water is mainly derived from melting of the McCall and other glaciers the stream volume is regulated by the same factors that affect glacier ablation. For example, the water level was noticeably higher during thaws than during cold periods. Both the McCall Creek and its tributaries have built up alluvial fans where they debouch to compensate for glacial deepening of the master stream valleys. The fan of the McCall Creek is nearly 1.6 km. wide along the Jago River and has a gradient of 4 degrees. The creek bed is well incised in the fan. This reflects a change from aggrading to degrading conditions, which is the result of an increased volume of water due to the present high rates of glacier ablation.

Bedrock

The bedrock in the area consists of a sequence of north-dipping sediments abutting against a granite mass of an estimated areal extent of 650 sq. km. The contact between sediments and granite in the McCall Valley area is believed to be a normal fault with upward movement on the southern or granite side.

Lisburne Limestone

This formation was first described by Collier at Cape Lisburne on the northwest coast of Alaska; it is continuous along the Brooks Range. It crops out approximately 3.2 km. below the terminus of the McCall Glacier, where it crosses the creek as a belt 400 to 1200 m. wide, trending east-west along the ridge west of the creek and continuing for 6.4 km. down the creek valley. The predominant rock type is a dark-grey, fine-grained, massive limestone, which weathers light-grey to buff. The section in this area is believed to be 240 to 300 m. thick and probably corresponds to the Alapah member of the Lisburne Limestone that is found in the central part of the Brooks Range. Its age is generally agreed to be Upper Mississippian.

Sadlerochit Formation

The Sadlerochit Formation was originally named by Leffingwell (1919) and the type section is found on the south slope of the Sadlerochit Mountains. The contact between it and the Lisburne Limestone is buried under alluvial deposits in the McCall Valley; however, it overlies comformably the Lisburne Limestone on the Okpilak River (Wittington and Sable 1948).

The formation crops out on the south slope of Marie Mountain and Jaeger Pass in a belt 800 m. wide. There it consists of slaty shales and siltstones, brownish in colour and greatly contorted; it is Permian in age.

Granite

The granite of the area is part of a small batholithic mass with an estimated extent of 650 sq. km., which lies between the Jago and Hulahula rivers. In the McCall area its predominant composition is quartz, microcline feldspar, and biotite, with small traces of muscovite, galena, and molybdenite. Both pegmatic and aplite dykes are found.

About half-way up the glacier there is a shear zone, roughly 2.6 sq. km. in extent, which has undergone hydrothermal sulfide enrichment. No sulfides were crystallized to a sufficient extent to permit field identification. In the upper cirque of the McCall Glacier there are three mafic dykes, which strike northeast and dip south. They are extremely fine-grained and contain inclusions of coarse-grained granite along their borders.

As the nature of the contact between the granite and the country rock is not fully determined it is difficult to give an age for the granite. E. G. Sable (personal communication) reports that along the Jago River there are blocks of Kayak quartzite (Lower Mississippian), which have undergone metamorphism due to emplacement of the granite, hence the granite cannot be pre-Mississippian.

Both sediments and granite are much sheared and there is a strong cleavage trending northeast. The sediments north of the granite are locally folded and overturned.

Glacial geology

Evidence of multiple glaciation in the McCall Creek valley is fairly abundant despite the wide-spread destruction of surface features by talus slides and solifluction. Past advances of the McCall Glacier are marked by lateral and end moraines in the lower part of the valley and by trimlines and truncated spurs in the upper part. The relationship of these features to the moraines of the Jago River valley is best expressed in terms of similar elevations above the valley floors.

Extensive erratic-free areas at high altitudes strongly suggest that glaciation was of the alpine-valley type. Investigators in the central Brooks Range have also remarked on the lack of a regional ice cap (Detterman *et al.* 1958).

The highest glacial features in the lower valley are found at an altitude of 390 m. above the present valley floor. The highest evidence of glaciation in the upper valley is 300 m. above the present glacier. For ease of reference the various stages of glaciation will be referred to by numbers in order of decreasing age (see Figs. 8 to 10).

First advance. The first glaciation in the McCall Valley reached and joined the Jago River valley glacier. The most distinctive feature connected with this glaciation is a plane surface on the south side of McCall Creek opposite Marie Mountain. This surface slopes downstream with a gradient of 5 degrees and is continuous from the bend in the creek to the Jago River valley, except where it has been dissected by north-flowing tributary streams. It lies between an altitude of 225 and 390 m. above the stream and is slightly tilted toward the centre of the valley. Its upper altitude is concordant with that of Jaeger Pass and the top of the Jago River lateral moraines. It has no surface relief and is covered with boulders, predominantly of granite, and thin tundra vegetation. The bench is being encroached on by talus slides from the slopes above it. This is probably not a glacially carved feature as neither ice nor a marginal stream would cut laterally into bedrock on a level with the top of a glacier. A more likely explanation is that this is a raised erosion surface similar to those seen along the west side of Hulahula River valley. The bench is important in terms of glacial geology in that erratics and other glacial features are not found above it, so that it makes a very distinct marker of the upper limits of glaciation.

Erratics are not found on Marie Mountain above an altitude of 1,100 m. indicating that, whereas ice did cross Jaeger Pass, it was not much more than 60 m. thick. As erratics are also found on the north side of Marie Mountain at the same altitude it would appear that Marie Mountain stood as a nunatak above the ice that flowed around it from Jaeger Pass and the Jago River valley.

In the upper valley the highest signs of glaciation are truncated spurs whose summits stand at 275 to 300 m. above the present glacier surface. All features of this stage are well covered with tundra. Individual boulders are lichen-covered and have weathering rinds 1.25 cm. thick.

Second advance. The second distinct glaciation in the McCall creek area reached the Jago River valley where it joined with the Jago Glacier. This glaciation left trimlines in the upper valley and lateral moraines below the present glacier. The trimlines stand 225 m. above the present glacier and are marked by outcrops above and talus slopes below, indicating an attempt to compensate for glacial steepening of the lower slopes.

Little is left of the lateral moraines due to extensive mass-wasting. A fairly prominent patch of moraine is found on the ridge of Marie Mountain where the McCall Valley joins the Jago River valley, but farther upstream the only remains are noticeable concentrations of granite boulders at an altitude of 275 m. above the valley floor. The moraines are thinly covered with tundra and all boulders are lichen-coated.

Third advance. The third glaciation also reached the Jago River valley, but was only 150 m. thick in the lower McCall Valley. End moraines near the mountain front in the Jago Lake area suggest that the ice in the Jago

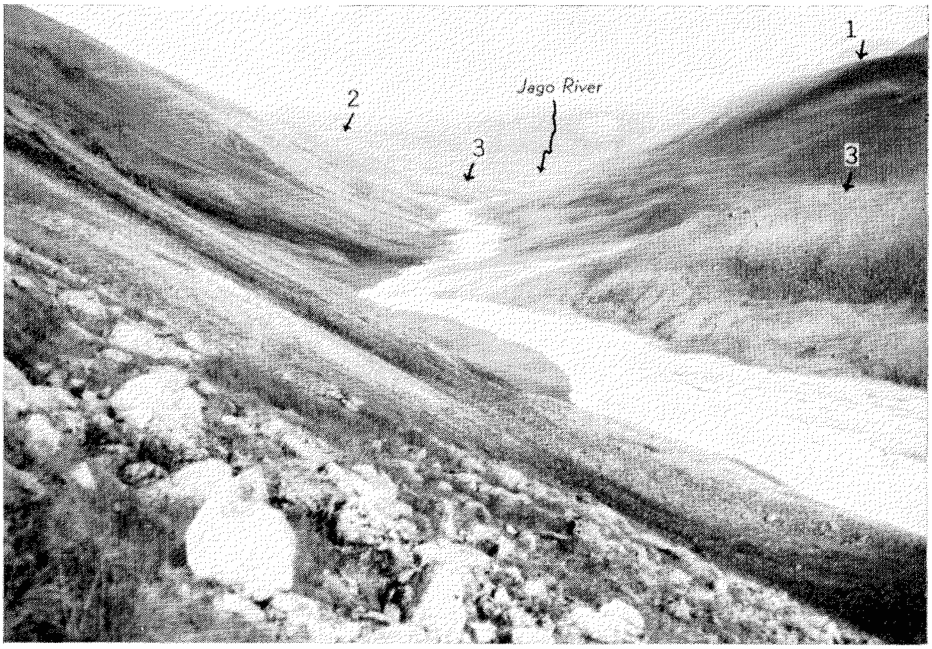

Fig. 8. Looking east toward Jago River from Jaeger Pass. Note: (1) slight bench of first advance, (2) lateral moraines of second advance, (3) lateral moraine and end moraines (near Jago River) of third advance.

River valley was not much thicker and did not extend as far as the coastal plain.

This advance is represented in the McCall Valley by lateral moraines (see Fig. 8) and a recessional moraine found 1.6 km. upstream from the confluence of the McCall Creek and the Jago River. The moraine is a mound, steeply banked up stream, more gently so down stream, which swings out from the north side of the valley. It is composed of boulders 15 to 30 cm. in diameter and is thinly covered with a mat of tundra. Up stream from this moraine are found lateral moraines of a similar appearance. Individual boulders of this stage are lichen-covered, but are not much weathered.

Fourth advance. The fourth and last glaciation of major significance in the McCall Valley reached the bend in the valley where it left an end moraine (see Fig. 9), which has since been greatly dissected by the creek. The moraine stands 75 m. above the stream and is composed of very loosely packed boulders 15 to 22 cm. in diameter. Up stream from it are lateral moraines of similar composition. Down stream there is an extensive but thin drift cover, which has been terraced by the creek leaving two sets of paired terraces. The upper and older terrace is covered with small willows and underwent dissection during the period following the fourth glaciation.

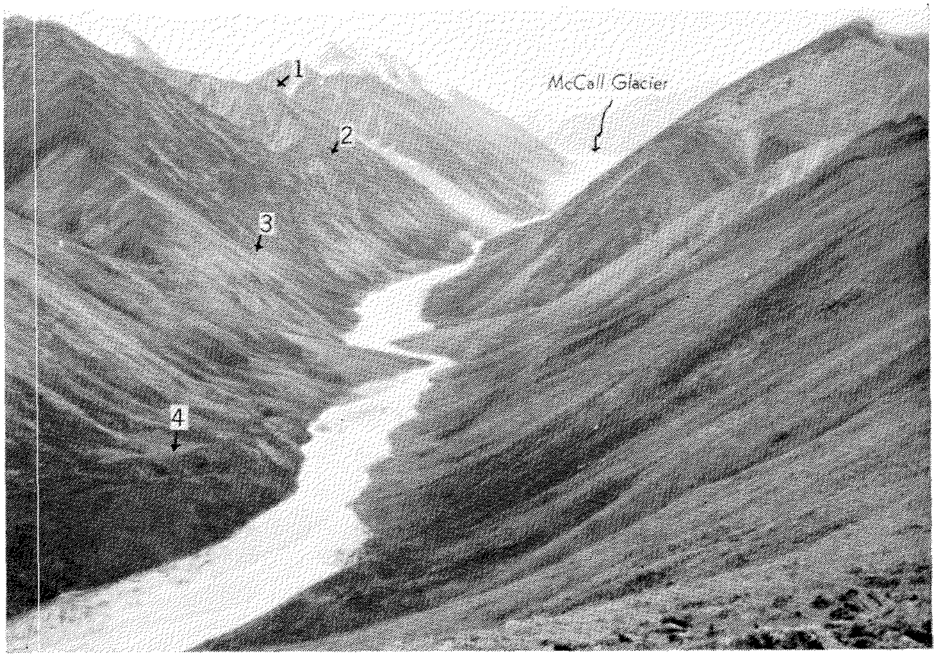

Fig. 9. Looking south toward McCall Glacier from Jaeger Pass. Note: (1) truncate spur of first advance, (2) trimlines of second advance, (3) trimlines of third advance, and (4) end moraine of fourth advance.

Fifth advance. The most recent glaciation was very slight and its deposits are hard to differentiate from those now being formed along the present glacier. They consist of unweathered material found as end and lateral moraines, which stand 15 to 23 m. above the present ice level. From the McCall Glacier terminus these moraines extend down valley for 180 m. (see Fig. 10). A small glacier, whose terminus is less than 90 m. from the McCall Glacier, is completely blocked off by lateral moraines of this stage, indicating how small this advance must have been. Drift from this glaciation has been carried down stream and is currently being terraced. In the upper part of the valley the lateral moraines are replaced by trimlines; above them the bedrock is lichen-covered and below them it is bare.

Correlation of glacial sequence

Correlation of the glacial sequence of the McCall Valley area with that of the central Brooks Range (Detterman *et al.* 1958) can be made on the basis of the morphology of the deposits and their geographical distribution. The oldest glaciation is comparable to either the Anaktuvuk or Sagavanirktok glaciation of the central Brooks Range in that it had a piedmont phase and the deposits are well covered with tundra. The second glaciation is comparable to the Itkillik glaciation farther west as it was the last advance to pass beyond the mountain front. Deposits of the third advance are very similar in character to those of the Echooka glaciation. The deposits of the fourth advance occupy a geographical position similar to those of the Alapah Mountain glaciation and the fact that they are tundra-covered supports this correlation. The fifth glaciation appears to be entirely similar in its geography and physical expression to the Fan Mountain glaciation.

No material suitable for carbon-14 dating was found, as was to be expected in a narrow arctic valley. A lichenologist would probably be able to date the moraines of the region more accurately.

Geomorphology

The large grain size and porous nature of the unconsolidated sediments in the McCall Valley is unfavourable for the extensive development of patterned ground; however, some features of this are not entirely lacking. Poorly sorted, high-centred polygons with an average diameter of 1.5 m. were observed on the high bench above McCall Creek. Similar polygons were seen on the top of the recessional moraine of the third advance. Small stone steps (non-sorted steps, Washburn 1956) occur on the slope leading from the high bench to the mountain-side above. These steps have

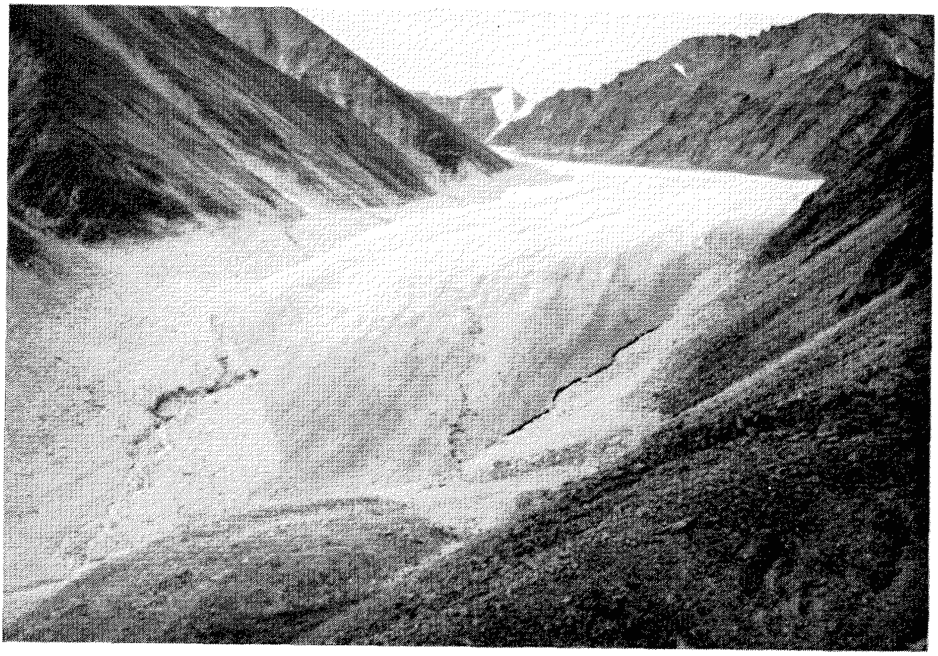

Fig. 10. Terminus of McCall Glacier. The light-coloured rocks are unweathered deposits of fifth advance.

an arcuate ground plan, with risers 15 cm. high and treads from 30 to 90 cm. wide. Stone circles 1.5 to 7.5 m. in diameter are arranged in rows on the McCall Creek fan; the rows are separated by marshy areas.

Small solifluction lobes are fairly common on the north side of the valley on slopes that have gradients of 15 to 20 degrees. A typical lobe has a 15-metre wide arcuate (in plan) scarp, which is 60 cm. high and well vegetated. The lobe is roughly wedge-shaped with a great concentration of boulders in troughs along the sides. A few boulders are scattered on its upper surface and some of the flatter ones were seen to be standing on end. The presence of willows on the scarp suggests that at present movement is slight or non-existent.

Fig. 11. Terminus of McCall Glacier with aufeis field in foreground. Note large boulders on glacier surface, and track in right foreground for scale.

Aufeis

A rather extensive aufeis field has developed below the terminus of the McCall Glacier (see Figs. 11 and 12) and extends for 400 m. down stream to where McCall Creek enters a narrow gorge. The ice in the field is nearly 6 m. thick in places and shows an alternation of large-grained white ice and dense blue ice resulting from refreezing of pure melt water and recrystallization in the snow cover due to alternate freezing and thawing.

Fig. 12. Looking down stream from the terminus of McCall Glacier. Note lateral moraines and aufeis field.

At the beginning of summer, surface streams flow over the field in an anastomosing pattern until one channel cuts through the ice to the underlying gravels, after which the pattern becomes dendritic. The main channel is enlarged by block stoping as the master stream undercuts its banks.

In April 1958 there were no traces of any channels remaining and the field had become perfectly healed, suggesting that a great quantity of water had frozen. At this time running water was issuing through cones on the surface of the field. It is this water that apparently regenerates the field after the summer melt. The fact that the water was rising vertically indicates that it is backed by considerable pressure.

It is hard to conceive of a likely source of the water, since April is well in advance of the ablation season. The heavily fractured granite could act as reservoir for the ground water. However, it is to be expected that it would be frozen during the winter unless there is a source of heat in the granite fairly near the surface. Another possibility, which is more likely, is that sub-glacial streams are becoming dammed up in early fall by surface freezing at the glacier terminus. Their volume gradually builds up until the pressure increases sufficiently for the water to burst through or under the dam and flow through the terminal outwash and rise some-where in the ice field. This mechanism is similar to that cited by Leffingwell (1919) as the process acting in river icing.

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