CANADA
DEPARTMENT OF MINES
HON. T. A. CRERAR, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

BUREAU OF ECONOMIC GEOLOGY
GEOLOGICAL SURVEY

MEMOIR 200

A Reconnaissance of Pelly River Between Macmillan River and Hoole Canyon, Yukon

BY
J. R. Johnston

OTTAWA
J. O. PATENAUDE, I.S.O.
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
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CONTENTS

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INTRODUCTION

Pelly river, an important headwater tributary of Yukon river, drains an area of approximately 25,000 square miles in the southern part of the interior of Yukon territory. Although a large part of this area can be reached by river transport most of it is unmapped even along the main course of the Pelly. It was, therefore, considered desirable to map the readily accessible country on either side of Pelly river as far as Hoole canyon, the limit of direct navigation. The area selected, and described here, includes all of Pelly River valley between Hoole canyon and the mouth of Macmillan river; or between the intersection of latitude 61°45′ north with longitude 132°00′ west and the intersection of latitude 63°00′ north with longitude 136°00′ west, and is 150 miles long and 20 to 30 miles wide. Mapping of this area was conducted in 1935, topography and geology being compiled from pace and compass traverses based upon a route map of Pelly river made by G. M. Dawson in 1887. Elevations in this work were carried by barometer.

The writer wishes to express his appreciation to H. S. Bostock, who organized the field party and directed the work. G. C. Cummings, W. E. Snow, G. C. Ridland, E. Gautschi, A. M. Ames, W. C. Patterson, and W. B. Reynolds assisted in the field.

Pelly river was discovered in 1843 by Robert Campbell of the Hudson's Bay Company. Fort Selkirk, which Campbell later established at the confluence of Pelly and Lewes rivers, was abandoned by the company in 1852. Following Campbell's regime the region was neglected by explorers until 1887 when G. M. Dawson of the Geological Survey crossed from Frances river to the Pelly and descended the latter river to its mouth. Dawson's report embodies a map of the river, gives the first information on the geology of the region, and records an account of Campbell's travels. Macmillan river was explored in 1902 by R. G. McConnell and Joseph Keele, and in 1907 Keele traversed Ross river after exploring the headwaters of the Pelly. Keele's report on Ross river contains a summary of the geology of the general region. To the south of Pelly river a reconnaissance of the adjoining Little Salmon River area was made by W. E. Cockfield in 1928. Mapping of Carmacks area, which includes Pelly river below Macmillan river, was completed in 1934 by H. S. Bostock.

BIBLIOGRAPHY

Dawson, G. M.: Yukon District, N.W.T., and Adjacent Northern Portion of British Columbia, 1887; Geol. and Nat. Hist. Surv., Canada, Ann. Rept., vol. III, pt. I, pt. B.

McConnell, R. G.: Macmillan River District; Geol. Surv., Canada, Sum. Rept. 1902, pt. A.

Keele, Joseph. Pelly, Ross, and Gravel Rivers; Geol. Surv., Canada, Pub. No. 1097 (1910).

Cockfield, W. E.: Little Salmon River Area; Geol. Surv., Canada, Sum. Rept. 1928, pt. A.

Bostock, H. S.: Carmacks District; Geol. Surv., Canada, Mem. 189.

Pelly river and its tributaries are free of ice and open to travel by boat from the beginning of May until the end of October. Following the spring high-water period, which reaches a maximum in June, the rivers decrease in volume until late in August, reaching a low-water stage that may close these streams to any but boats of the shallowest draught.

The current of Pelly and Macmillan rivers is moderate during normal stages of water. Both rivers, however, are swift in their upper reaches. Small steamers and river launches can be taken up Pelly river as far as Ross river, a distance of 270 miles from Selkirk at the mouth; and up Macmillan river to its forks, a distance of 100 miles from the Pelly. Small boats or canoes equipped with outboard motors can be taken on the Pelly as far as Pelly Banks by making a portage at Hoole canyon, 23 miles above Ross river. The portage is one-half mile long and is on the west side of the river. It is customary to line boats up the last quarter mile below the portage before taking them out of the water. Beyond this point difficulties of travel increase owing to shallow water and to numerous rapids, but, according to Keele,[1] a distance of 180 miles above Ross river can be reached by making a portage of 1¾ miles at Wolf canyon (143 miles from Ross river).

Ross river has been travelled in poling boats at least as far as Sheldon lake, 100 miles upstream. As there are several rapids, it is probable that considerable tracking and some portages would be found necessary with a power boat on this stream.

Tay river, which drains the area between Pelly and Macmillan rivers, is reported to be navigable for 80 to 100 miles beyond the first 10 miles, which are quite impassable.

The only obstacle to navigation on the main Pelly river below Ross river is Granite canyon, 58 miles upstream from the mouth. The river is swift here and confined for 2 or 3 miles between rocky banks. As a rule, during the periods of high water the west side of the river is travelled to avoid heavy swells; in low water the channel most free of rocks is on the east side or left limit.

In overland travel, both in summer and winter, dogs are used by the Indians and trappers of the district either as pack animals or to haul sleighs. The most frequently travelled overland route into the district is by way of Little Salmon River valley. Horses have been taken by big-game hunters from Teslin lake into Pelly mountains and to Ross river, but the use of horses, particularly in the eastern part of the region, is limited owing to a scarcity of feed and to the difficulty of wintering them.

The present population of Pelly River district numbers about one dozen white men and one hundred to two hundred Indians, all of whom are engaged in trapping or in work incidental to fur trading. Trading posts are maintained at Ross river and at Campbell creek (Pelly Banks) on the Pelly. For several years there has been a small trading post at Russell creek on Macmillan river. There were no prospectors in the region in 1935, although at various times in the past prospectors have visited the country, usually in search of ground suitable for placer working.

Precipitation in the Pelly basin is probably somewhat higher than elsewhere in the interior of Yukon due to the presence of several high groups

[1]Keele, Joseph: Pelly, Ross, and Gravel Rivers; Geol. Surv., Canada, Pub. No. 1097, p. 30 (1910).

of mountains and to proximity to Mackenzie mountains. Rain or snow fell on forty-five of the ninety-three days spent by the field party on Pelly river during the summer of 1935, but this season was considered by old timers to be an exceptionally wet one. In summer the days are long and often very hot; the nights are usually cold, but free of frost. For these reasons potatoes and other truck-garden vegetables can be grown successfully in Pelly and Macmillan River valleys. The average snowfall in winter probably does not exceed 3 feet, and although extremely low temperatures are reached during the winter season, the duration of extreme cold is, as a rule, confined to short periods.

Game animals are, generally speaking, abundant in the vicinity of Pelly, Ross, and Macmillan rivers. Moose are to be found everywhere in the district. Woodland caribou are most common in the plateau areas of Anvil mountains and on the slopes of Mackenzie mountains. Mountain sheep of the saddle-back variety are plentiful in Glenlyon and Pelly mountains, and in smaller numbers in other mountains bordering the area. The region is ideal for the big-game hunter as good hunting areas, particularly in the case of sheep, can be reached within a few hours travel of the rivers.

Grayling are found in nearly all the streams and trout in a few of them. Other fish such as whitefish, pike, and lake trout are present in the lakes and rivers, and salmon run up the main streams.

The forest growth of this region consists largely of white and black spruce with some jackpine and balsam fir. Jackpine (*pinus murrayana*) were seen along Pelly river as far upstream as Blind creek (longitude 133°10′ west). None was seen east of this point although carefully looked for. Balsam fir occur in a few places, usually high up on the mountain sides. Good stands of spruce suitable for cabins and mine timbers occur in places on the valley bottoms. Balsam poplar are to be found on the river bars and flats, but are increasingly scarce towards the upper reaches of the rivers. Timber-line is about at 4,500 feet above sea-level, but varies considerably in places. Large areas of the forest growth, particularly along the lower section of Pelly river, have been burnt over, making travel difficult in these areas.

PHYSIOGRAPHY

Southern Yukon includes parts of the three major physiographic provinces of the Western Cordillera. The two mountain provinces, the Coast range on the southwest, and the Mackenzie mountains on the northeast, are separated by a region of moderate relief called the Yukon plateau. Mackenzie mountains, a high, rugged group of ranges, trend northwest and form the main watershed between Yukon and Mackenzie rivers. They consist of folded sedimentary rocks. The Yukon Plateau province embraces a mature upland surface interrupted above by occasional isolated peaks and mountain groups and below by river valleys and various lowland areas. Old metamorphic rocks, folded sediments, volcanics, and intrusives are characteristic of this province.

Pelly river rises in Mackenzie mountains, but the greater part of the river system lies in the Yukon plateau and the region between the plateau and the mountain province. West of the mouth of Macmillan river Pelly

river lies entirely in plateau country. The upland surface here slopes west, from an elevation of about 5,500 feet above sea-level near Macmillan river, to close to 3,000 feet above sea-level near Selkirk. The greater part of Pelly River basin, lying east of the mouth of Macmillan river, occupies a belt of broken country with mountain groups, occasional areas of plateau and lowland, and numerous wide and deep valleys. The topography of this belt is intermediate between that of the Yukon plateau and Mackenzie mountains, and rocks characteristic of both provinces occur here. The mountain groups trend northwest, as a rule, and are separated from each other by plateau and lower areas. The higher peaks are believed to reach elevations of 7,000 to 8,500 feet above sea-level. In general they rise by transition from the plateau and valley levels; in places, however, their boundaries are sharp, well-defined escarpments.

The highest elevations near the map-area are the peaks of Glenlyon and Pelly mountains which reach elevations believed to be over 8,000 feet above sea-level in the case of the former group and 8,500 feet or more in that of the latter. These two groups of mountains border the map-area on the southwest.

Glenlyon mountains are separated from Pelly mountains by a deep depression occupied by Magundy river and Little Salmon lake. The general aspect of both these mountain groups is precipitous and rugged, the peaks being sharp-profiled and separated from each other by a confusion of deep valleys. Viewed from Pelly river Pelly mountains appear to consist of inclined stratified rocks; the Glenlyons largely of granite, many of the higher points here having pedestal-like shapes typical of granitic peaks.

Bordering the north side of the map-area is an irregular area of mountains collectively called the Anvil Mountains group. This group extends east from the mouth of Tay river across the headwaters of Anvil and Blind creeks, and of Orchay river. It is probably bordered on the north by the upper part of Tay river. The group consists of a succession of elevated masses separated by wide and flaring valleys. Each mass rises to a number of culmination points, none of which exceeds 7,500 feet above sea-level. The summits of Anvil mountains appear to be pendants and inclusions of metamorphic rocks in a base of granite.

Pelly River valley, which occupies a medial position in the map-area and is the dominant topographic feature of the area, is a trench-like depression trending 55 degrees west of north. It is remarkable for its straightness and for its continuity across southern Yukon, and has been the scene of drainage changes of magnitude. As noted by McConnell,[1] this valley is occupied in different parts of its course by Pelly river, a branch of Kalzas river, Crooked creek, part of Stewart river, Clear creek, Flat creek, and part of the North Fork of Klondike river. Within the map-area the floor of this depression varies from one to several miles in width. Near Macmillan river the valley bottom stands at 1,700 feet above sea-level, and near Hoole canyon at 2,250 feet above sea-level.

Pelly River valley is immediately bordered, in places, by lowland areas (up to 700 feet above the river), but near Pelly, Glenlyon, and Anvil mountains the valley sides rise steeply to the summits of border-

[1]McConnell, R. G.: Geol. Surv., Canada, Ann. Rept., vol. XV, pt. A, p. 24.

ing hills and ridges. These summits stand at from 4,500 to 5,500 feet above sea-level, are for the most part flat, and collectively form an upland surface co-extensive with the Yukon plateau. This upland surface slopes gently back for several miles to a second rise where its continuity is broken by the superior elevations of the mountains.

With the exception of Magundy river, which drains into the Little Salmon, all the streams of the map-area are confluent to Pelly river. The drainage is asymmetrical, there being a great disparity in size between streams entering Pelly river from the north and those from the south. The tributaries from the north, such as Ross, Orchay, Tay, Earn, and Macmillan rivers, and Anvil and Blind creeks, reach back to distant sources, occupy valleys of mature erosion, and have easy grades through the greater parts of their courses. Those from the south, such as Ketza, Lapie, and Glenlyon rivers, and Old Danger and Harvey creeks, are relatively short, swift streams which debouch from the mountains in deep, canyon-like valleys.

There is little doubt that geological structure has played an important part in determining the trend of the river valleys as well as the ridges of the area. The drainage pattern is a trellis type. The main direction of drainage is that of Pelly river and this direction is paralleled by many of the tributary streams in parts of their courses. Two other directions are prominent; one at 45 degrees west of north, the other at 45 degrees east of north.

Pelly River area lies entirely within the glaciated part of Yukon territory, and the lower elevations, at least, have been greatly affected by glaciation. Erratic boulders were found up to an elevation of 5,500 feet above sea-level on Rose mountain and up to the same elevation in Glenlyon mountains. As higher points examined were found to be covered with heavy accumulations of frost-riven rock debris of local origin, it cannot be said with certainty whether or not the ice-sheet completely covered the highest points in the area.

The effects of glaciation are most apparent in the valleys. Pelly valley, in its narrower parts, and most of the tributary valleys are typically V-shaped and devoid of interlocking spurs. These valleys also contain thick accumulations of glacial and glaciofluvial materials into which the rivers have cut to various depths down to 250 or 300 feet.

No glacial striæ were found at a sufficiently high elevation to indicate the direction of regional movement of the ice-sheet during stages of maximum accumulation. A few striæ found at lower elevations show that the lower levels of the ice moved in directions closely coinciding with the modern drainage. The master glacier of the area was that of Pelly River valley, and this was evidently fed from its sources in Mackenzie mountains as well as from tributary glaciers following the valleys of modern streams which flow into Pelly river. It is to these glaciers that the valleys owe their U-shaped profiles.

A few cirques were seen in Pelly and Glenlyon mountains. These, however, are relatively scarce and modified in form, suggesting that local alpine glaciation was of short duration.

A number of minor topographic features developed during the recession of the ice. Glacial marginal channels are common along the sides of Pelly valley; in places these are occupied by creeks, in places they are abandoned and dry. Parts of Pelly river occupy channels cut into bedrock, as at Hoole canyon, the Detour, and at Fishook rapids. The abnormal position of the river in these localities is believed to be due to the same processes that resulted in the development of marginal channels elsewhere in the valley. Terraces of gravel occur at various elevations on the sides of Pelly valley and the larger tributary valleys. Terraces of silt are exposed at intervals all along Pelly river within the map-area. The marginal channels and the gravel terraces probably resulted from streams flowing along the borders of ice that persisted in the valley bottoms during the later stages of its recession. The silt deposits were probably laid down during the ponding of some of these ice-margin streams.

GENERAL GEOLOGY

General Statement

The oldest rocks of Pelly River area are quartzites, argillites, and limestones which are everywhere schistose and show little of their original character. This assemblage of sediments is placed in the Yukon group. Apparently overlying the Yukon group is a great thickness of sediments believed to be of Palæozoic age. These strata are divided into three cartographic divisions: a lower group of thin and massive-bedded quartzites, argillites, cherts, tuffs, and limestones, which may be, in part, equivalent to members of the Yukon group; a middle group, of crystalline limestone, cherty quartzites, and argillites, which conformably overlies strata of the preceding group but may itself include an unconformity; and an upper group, of squeezed conglomerate and grit beds. The division of the Palæozoic (?) sediments leaves much to be desired, but represents as exact a degree of stratigraphic division as the information obtained warrants. Associated with the Yukon group and the Palæozoic (?) strata are greenstone schists that are probably volcanic rocks contemporaneous in age with the sediments. The Mesozoic era is represented by a group of altered basic igneous rocks, two great bodies of granitic rock—the batholiths of Glenlyon and Anvil mountains, and a series of clastic beds believed to be of Upper Cretaceous age. The youngest rocks are undisturbed conglomerates, basic and acidic dykes, and lava flows, all of probable Tertiary age. Overlying all these rocks are Pleistocene and Recent superficial deposits.

Table of Formations

Modern	Recent and Pleistocene	Superficial deposits: alluvium, volcanic ash, and glacial drift
Tertiary		Basalt, andesite, dacite, trachyte, rhyolite
Tertiary (?)		Conglomerate Quartz-feldspar porphyry
Mesozoic	Upper Cretaceous (?)	Conglomerate, grit, sandstone, shale
		Granodiorite; syenite, monzonite
Mesozoic (?)		Andesite, basalt, tuff, breccia, diorite, serpentine, gabbro, and hornblendite
Palæozoic (?)		Upper group: conglomerate and grit Middle group: crystalline limestone, cherty quartzite, and argillite Lower group: quartzite, cherty quartzite, cherty tuff, limestone, argillite, slate, phyllite, and greenstone schist
Precambrian and, or Palæozoic		Yukon group: quartzite, mica schist, chlorite schist, graphite schist, and crystalline limestone

Yukon Group[1]

Metamorphic rocks classed with the Yukon group occur at intervals along Pelly valley between Macmillan and Ross rivers. With few exceptions the areas mapped are on the north side of Pelly river, and much of the country north of the mapped area is believed to be underlain by these rocks.

The lithology of the metamorphic rocks varies. Most common types are grey, micaceous quartzites, fine-grained, massively bedded quartzites commonly displaying colour banding, and banded gneissic quartzites. Interbedded with these are chlorite, mica, and graphite schists, crystalline limestone, and greenstone schists. The quartzites, which make up the bulk of these rocks, were found to be best developed in the basal parts of the several sections examined.

[1]The lithological data in this and succeeding descriptions are from observations taken in the field and from an examination of hand specimens.

All the members of the Yukon group have been recrystallized, and in most places their original fabric has been destroyed. However, some of the quartzites show bedding, and this fact, as well as the presence of graphite schists and limestones, leads to the belief that the greater part of the group is sedimentary. Some of the chlorite schists and greenstone schists intimately related to the other metamorphic rocks appear to be of igneous origin. Several large areas of these were found, but as they could not be separated from identical rocks associated with the lower group of the Palæozoic (?) strata they were mapped with the latter group.

The main trend of folding in the schistose rocks near Pelly river is northwest. Most of the strikes recorded are in this direction, particularly in the areas that border the north side of Pelly river between Orchay and Ross rivers. Northeast-trending structures were found in places, and are most common in the areas along the lower part of the river within the map-area. The folding is exceedingly complex and is complicated by excessive and repeated faulting. Most of the dips are nearly flat, due to recumbent and overturned folds and to thrust faults, but steep to vertical dips were found in numerous places.

The Yukon group in Pelly River area is separated from the lower group of the Palæozoic (?) measures on the basis of the former's greater metamorphism. From field relationships at least part of the lower members of the Palæozoic (?) group seems to overlie the schistose Yukon group unconformably, but in such places the actual contact was either not observed or found to be a fault. The possibility exists that the Yukon group may represent, in part, the metamorphosed equivalent of basal sections of the Palæozoic (?) group.

No fossils were found in the Yukon group rocks and they may be Precambrian. For this reason, and on a basis of their lithological character and pronounced metamorphism, they are correlated with the Yukon group of other districts. The name Yukon group was suggested by Cairnes[1] to include the older, metamorphosed, schistose, and gneissoid rocks, of both sedimentary and igneous origin, at the Yukon-Alaska boundary. The name has since been applied to numerous areas of similar rocks in various parts of Yukon, and Cairnes' belief that the group is probably of Precambrian age has, as a rule, been adhered to. Certain members of the group have been definitely established as being of Precambrian age in Alaska.[2] As conflicting evidence of the Palæozoic age of some of these rocks has arisen in Yukon, it has been considered best, in recent years, to class them as probably of Precambrian and Palæozoic age.[3]

Palæozoic (?) Sediments

Rocks of the lower group of the Palæozoic (?) sediments have a greater areal distribution in Pelly River area than those of any other group with the exception of the granitic rocks. They are extensively developed in a wide belt coincident with the northeastern front of Pelly mountains. This belt, followed northwest along its strike, crosses Pelly river near Glenlyon

[1]Cairnes, D.D.: Geol. Surv., Canada, Mem. 67, pp. 40-44 (1914).
[2]Mertie, J. B.: U.S. Geol. Surv., Bull. 827, p. 13 (1931).
[3]Bostock, H. S.: Geol. Surv., Canada, Mem. 189, pp. 14-19.

river and crosses Macmillan river near Kalzas creek. Roof pendants of these rocks are prominent in Glenlyon mountains, and small, synclinal areas occur on the north side of Pelly river east of Anvil creek.

The group consists mainly of thin, alternating beds of quartzites, chert, cherty quartzites, argillites, and limestone. In addition, there are various more massive, black and greenish argillites, slates, phyllites, and quartzites. Tuffs occur interbedded in thin layers with the chert and cherty quartzites, and some of the greenish slates may be tuffaceous. Certain greenstone schists were grouped with these rocks because they were found to be intimately associated with the sediments, occurring as interformational lava flows or as sills.

The definite stratigraphic succession and aggregate thickness of the lower member of the Palæozoic (?) sediments was not established. The similarity of beds of different horizons, the fact that no fossils were found, and the presence of volcanic members which thicken and thin along their strike made it difficult to correlate different sections. To facilitate description the group is divided into an upper member of thin-bedded sediments and a lower member of predominantly massive-bedded sediments. In general the thin-bedded sediments overlie the sub-group of massive beds, but some thin-bedded strata are interbedded with the latter. Schistose volcanics occur with both, but are most commonly found with the sediments of the lower member.

The lower massive member is composed of massive argillite, quartzite, cherty quartzite, slate, and associated greenstone schist. It occurs along the north side of Pelly river between Macmillan river and Rose mountain. The best sections were seen on Rose Mountain ridge and on the southwest slopes of Tay mountain. Here beds of impure quartzite underlie greenish and grey argillites and slates. In a few places greenish quartzites, resembling tuffs in texture, were found on top of the slates. In places, in this vicinity, the strata of the lower member are metamorphosed almost to schists.

West of Tay river similar rocks occur on the hills between Tay river and the Detour, on the north side of Pelly river west of Earn river, and between Pelly and Macmillan rivers near longitude 135°30′ west. In these areas they are relatively highly metamorphosed, folded into complex structures, and embody a greater development of schistose greenstone than elsewhere in the map-area.

South of Pelly river parts of the lower member occur on Harvey creek, and in Pelly mountains. A section on the east side of Harvey creek, 5 miles from its mouth, consists of finely banded greenish tuff (?) interbedded with crystalline and arenaceous limestone and overlying dark phyllites and slates. The observed thickness of this section is approximately 2,500 feet. On the opposite side of Harvey creek thin-bedded argillites underlie thin-bedded quartzites. The thickness of these argillites was not determined, nor was their relationship to the strata on the east side of the creek. Both sections on Harvey creek are intruded by granodiorite and are isolated from other bodies of sediments.

The northeastern front of Pelly mountains, from several miles east of Lapie river to a point opposite the mouth of Blind creek, consists of interbedded argillites, quartzites, and limestones. These strata strike

nearly parallel to the valley, dip gently south and southwest, and the hills bordering Pelly valley exhibit a synclinal structure, the major axis of which parallels Pelly valley and plunges gently to the northwest. Opposite the mouth of Orchay river a section reveals several thousand feet of sediments consisting of massive, black argillites overlying fine- to medium-grained quartzites interbedded with layers of limestone and calcareous argillite. This section probably represents only a part of the aggregate stratigraphic section in Pelly mountains.

The majority of the sediments of the lower, massive member are silicified and hardened; locally they have been altered to schists.

The thin-bedded sediments, which apparently occupy an upper position in the lower Palæozoic (?) group, consist of a lower series of interbedded quartzites, argillites, and limestones overlain by an upper series of finely bedded, cherty tuff.

The best exposures of the lower series occur in north-facing cliffs at the northwest end of the ridge extending northwest from Pelly mountains and separating Pelly and Magundy rivers. The beds here dip at a low angle to the southwest, and apparently overlie the more massive sediments to the southeast in Pelly mountains. A total thickness of 500 feet was observed, but the top and bottom of the section were not seen. The same sediments occur on the ridge between Glenlyon and Pelly rivers. In this locality they are steeply and repeatedly infolded with the upper cherty tuff series, and owing to their complex structure the thickness of neither series was ascertained. Similar thin-bedded, calcareous argillites and quartzites were seen in small synclinal areas on either side of the lower end of Orchay river. The areas of thin-bedded sediments, previously described as occurring on Harvey creek and on the north side of Pelly river west of Earn river, may belong wholly, or in part, to this series.

The upper, cherty tuff series constitutes the best defined horizon of the lower Palæozoic (?) group. A nearly continuous belt follows the south side of Pelly valley from the mouth of Tummel river to the vicinity of Lapie river, a distance of approximately 90 miles. Small areas of outcrops, which represent remnants of the formation infolded with older rocks, were seen on the north side of Pelly river at a point near Blackfox bend, on the ridge just west of the mouth of Ross river, on the south slope of Tay mountain, and on the ridge opposite the mouth of Harvey creek and east of the Detour.

The series is easily recognized because of its lithological character and its peculiar jointing. The beds are pale green, very thin, and cherty, with thin, discontinuous layers of coarser, tuffaceous grains. Along the strike of the formation various amounts of limestone, argillite, and quartzite occur interbedded with the cherty tuff. The rocks in the outcrops were invariably found to be jointed into rectangular blocks of from 1 to 2 inches in diameter, and in places they were so broken as to resemble a breccia.

The main belt of the cherty tuff series, on the south side of Pelly river, is repeatedly folded and faulted, so that the thickness could not be determined. It probably, however, does not exceed 2,000 feet. Several hundred feet of greenish slate, believed to be of tuffaceous origin, was found in several places overlying the cherty tuff beds in apparent conformity.

Schistose greenstones similar to those found in association with the basal members of the lower Palæozoic (?) group also occur interbedded and infolded with the cherty tuffs and greenish slates. Some of these greenstones may be of sedimentary origin, but many show remnants of volcanic and intrusive textures. They are particularly common in Pelly valley above Ross river and below Tay river. It should be noted that no greenstones were found in association with the lower Palæozoic (?) group in either Glenlyon or Pelly mountains.

The members of the lower Palæozoic (?) group are intruded by the Mesozoic granitic and basic igneous rocks and overlain by Tertiary lava flows. They are conformably overlain by the middle Palæozoic (?) group. The relationship of the group to the Yukon group was not definitely established. As previously mentioned, the two may be, in part, equivalent. Four miles below Blind creek, on the south side of Pelly river, south dipping beds of the cherty tuff series appear to overlie gneissic quartzite of the Yukon group with angular unconformity. The actual contact is covered, and as the cherty tuffs probably occur near the top of the sequence of the lower Palæozoic (?) group sediments, this may be a fault contact. On the south slope of Tay mountain the Yukon group and lower Palæozoic (?) group are in contact along faults. East of Orchay river two small areas of thin-bedded sediments are infolded with schistose rocks. They are believed to be unconformable to the underlying schists which may belong to the Yukon group or be metamorphosed strata of lower horizons in the lower Palæozoic (?) group. Where traces of original texture occur in the Yukon group the rocks appear, in many cases, to resemble those of the lower Palæozoic (?) group, a circumstance that supports the theory that the two groups may be, in part, identical.

The middle Palæozoic (?) group consists of crystalline limestones, cherty quartzites, and argillites which extend along the south side of Pelly river from Hoole canyon to 2 miles west of longitude 133°00′ west, a distance of 45 miles. Similar rocks occur on either side of Pelly river west of Tummel river.

These rocks are mapped as a separate unit wherever limestones predominate in them; the limestones being taken as a guide to their areal extension. White marble, interbedded with thin-bedded grey and black cherty quartzites, is exposed in Hoole canyon. Along the lower part of Lapie river, and to the west, grey, crystalline limestone predominates and apparently overlies thin- and massive-bedded, grey, black, and white cherty quartzites, red and green argillites, and white marble. Some of the argillite beds are massive, and in texture appear to be tuffaceous. West of Tummel river the outcrops, as mapped, are largely grey crystalline limestone, but in places are interbedded with massive, blue and white, cherty quartzite, and with black slates and argillites. Small areas of cherty quartzite and argillite, resembling beds of the middle Palæozoic (?) group, were found on either side of the lower end of Blind creek and on the east side of Rose mountain. Limestone is interbedded with these strata, but in limited quantity, and the areas were not separated from the lower Palæozoic (?) group with which they occur.

Structures in these rocks trend in a northwesterly direction. The belt extending northwest from Hoole canyon appears to occupy the trough of a

synclinal structure the axis of which is marked by grey, crystalline limestone. The areas shown on the map west of Tummel river represent parts of the limbs of wide, northwesterly trending folds. The members of the group were found to thicken and thin rapidly along their strikes, and no estimate of their aggregate thickness was arrived at. The group may not represent a conformable succession as the relationship of the grey crystalline limestone to the other members, in the belt extending northwest from Hoole canyon, was not definitely established.

G. M. Dawson[1] notes that the quartzites of Hoole canyon precisely resemble the Cache Creek quartzites of southern British Columbia. Limestones associated with cherts and argillites have been found in Upper White River district,[2] near Tagish lake,[3] on the Yukon-Alaska boundary,[4] and in other parts of Yukon, and have usually been thought to be of Carboniferous age. McConnell[5] considered limestone on the south side of, and near the mouth of, Macmillan river to be Carboniferous. A few fragmentary fossils were found by the writer in the limestone mentioned by McConnell. These were submitted to E. M. Kindle for examination, and he reports as follows: "In this lot I find only crinoid columns. From these alone it is impossible to offer any opinion of value concerning the position of this horizon in the general geological section." A few miles east of Lapie river cherty quartzites and argillites of the middle Palæozoic (?) group underlie conglomerates and shales believed to be of Upper Cretaceous age. This fact and the presence of the fossil remains dates the group as pre-Upper Cretaceous (?) and post-Precambrian. Lacking more definite evidence, and on the basis of the correlations given above, the group is here considered to be probably of Palæozoic age.

Elongate areas of conglomerate and grit occur infolded with the Yukon group and the lower Palæozoic(?) group on Rose mountain and at a few points to the east as far as Ross river. The conglomerates are massive, and consist of rounded and semiangular pebbles and cobbles, up to 2 inches in diameter, of chert, cherty quartzite, argillite, crystalline limestone, schistose greenstone, and schists. The matrix is siliceous and of the same material as the fragments. The pebbles and cobbles are squeezed to a varying degree and fractured along with the groundmass. On Rose mountain beds of grit are interbedded with the upper part of the conglomerate series, and are of the same materials as the coarser clastics. Similar conglomerate, grit, and quartzite outcrop on Pelly river about 15 miles above Macmillan river. The beds in this locality are somewhat more metamorphosed than in the other places and the matrix of the conglomerate is sericitic.

The conglomerate and grit beds are commonly tightly folded. Those on Rose mountain appear to lie in a syncline, the limbs of which are nearly vertical. If the interpretation of structure is correct the series is about 2,000 feet thick in this vicinity.

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[1]Dawson, G. M.: Yukon District, N.W.T., 1887; Geol. and Nat. Hist. Surv., Canada, Ann. Rept., vol. III, pt. I, pt. B, p. 121.
[2]Cairnes, D. D.: Geol. Surv., Canada, Mem. 50, pp. 71-83 (1915).
[3]Cairnes, D. D.: Geol. Surv., Canada, Rept. No. 982, pp. 26-30 (1908).
[4]Cairnes, D. D.: Geol. Surv., Canada, Mem. 67, pp. 84-103 (1914).
[5]McConnell, R. G.: Geol. Surv., Canada, Sum. Rept. 1902, p. 29.

Greenstones, believed to be of Mesozoic age, intrude the conglomerate and grit on Rose mountain. In different places the conglomerate and grit beds overlie different horizons of the lower and middle Palæozoic (?) groups. No angular unconformity was observed, however, between the conglomerate series and underlying rocks; and, as the series exhibits the same degree of metamorphism as the underlying Palæozoic (?) strata, it is tentatively considered to be of Palæozoic age.

Basic Igneous Rocks

Areas of basic igneous rocks are common along the north side of Pelly river from one end of the map-area to the other. A few small areas also occur on the south side of the river.

The volcanic types are andesite, diabase, and basalt. Associated with these are bodies of deep-seated basic rocks such as diorite, gabbro, and hornblendite. The andesites and diorites predominate. The andesites are fine grained, greenish, or porphyritic, with phenocrysts of feldspar, hornblende, or mica in an aphanitic groundmass. The diorites are medium to coarse grained, and are composed largely of hornblende and feldspar. Varieties intermediate between the typical andesites and diorites also occur.

All the basic igneous rocks are altered and commonly exhibit a greenstone habit. A peculiar coarse-grained gabbro, intrusive into andesitic greenstone, occurs on the south side of Rose mountain and at a point one mile west of the mouth of Orchay river. This rock consists of white feldspar and a pale green serpentine which appears to have been derived from pyroxene. Several small bodies of serpentine were found near, or within, areas of other basic igneous rocks. Some of these are undoubtedly altered ultrabasic intrusives; the origin of others was not apparent.

That the basic igneous rocks have been subjected to considerable fracturing is evident from slickensiding, brecciation, and veining, which are common features. Minor areas were also found to be schistose. No evidence of the attitudes or major structures of these rocks was found. The majority of areas of basic igneous rocks are elongated in directions parallel to the strikes of the sediments they intrude or overlie. It seems probable that they are involved in the same major structures as these sediments.

The undifferentiated basic igneous rocks intrude and overlie members of the Yukon group and the lower and middle Palæozoic (?) groups. They are intruded by the granitic rocks. That they represent several periods of igneous activity is evident from the relationships they show among themselves. In other Yukon districts similar igneous rocks have, as a rule, been considered to be of Mesozoic age. As no definite evidence of the age of these rocks was found in Pelly River area, they are tentatively classed as Mesozoic.

Granodiorite

Two large areas of granitic rocks occur in Pelly River area; one coincident with Glenlyon mountains, the other coincident with Anvil mountains. Both bodies are of batholithic dimensions. The Glenlyon batholith, reaching a maximum width of about 16 miles in Glenlyon

mountains, extends from Magundy and Little Salmon rivers[1] in a northwesterly direction along the south side of Pelly river and across the northeastern corner of Carmacks map-area.[2] The northeastern boundary of the batholith is well defined. It follows the northeastern front of Glenlyon mountains from Glenlyon river to Tummel river, and is exposed at various points along Pelly river as far as Macmillan river. The southwestern contact of the Anvil batholith extends from the vicinity of Tenas creek, on Ross river, along the north side of Pelly river to the vicinity of Tay river. The main mass of exposed granodiorite occupies the drainage areas of Tenas creek, Orchay river, and Blind creek. Farther west much of the batholith is roofed by sedimentary and schistose rocks; it may, however, underlie these as far west as Dromedary mountain. The northern limits of this body are unknown, but they probably coincide with the headwaters of Tay river.

Two small areas of granite are exposed along the south side of Pelly river on the north slope of the ridge separating Pelly and Magundy rivers. These bodies appear to be laccolithic in structure and may be satellites of the Glenlyon batholith. The rock in each is similar in composition to the Glenlyon granodiorite, but pronouncedly foliated in a northwest-southeast direction.

Part of Pelly mountains near Hoole canyon appears to be of granitic rock. This area was not touched by traverses, however, and nothing is known of its areal extent or composition.

The granitic rock of Anvil mountains is, in hand specimens, identical with that of the Glenlyons. In both areas the rock is uniformly grey, coarse to medium grained, and composed of quartz, white feldspar, hornblende, and a lesser amount of biotite. Much of the feldspar appears to be plagioclase, so the rock is considered to be probably a granodiorite. The uniformity of the rock in texture and composition is a marked feature of both batholiths. Small areas of the intrusive in Glenlyon mountains, however, contain a considerable percentage of pinkish feldspar which may be orthoclase.

A marked disparity is apparent between the northeastern and southwestern contacts of the Glenlyon batholith. The former is sharp, well defined, and steeply sloping; the latter is ragged and dentate, and slopes gently under its roof of sedimentary rocks. The southwestern contact of the Anvil batholith has a similar gentle dip, especially in its western parts. In this connexion it should be noted that no difference in degree of metamorphism was noted in the sediments intruded on steep and gently dipping contacts of either batholith. The only evidence of actual contact metamorphism with the development of contact metamorphic minerals, however, was seen in sediments adjoining the gently dipping contacts.

The Glenlyon granodiorite has been correlated by Cockfield[3] with the Coast Range intrusives and has tentatively been considered by him to be Upper Jurassic or possibly Cretaceous in age. No new evidence as to the age of these rocks was found in Pelly River area. It is noted, however, that

[1]Cockfield, W. E.: Geol. Surv., Canada, Sum. Rept. 1928, pt. A, p. 7.
[2]Bostock, H. S.: Geol. Surv., Canada, Mem. 189, pp. 36, 37.
[3]Cockfield, W. E.: Geol. Surv., Canada, Sum. Rept. 1928, pt. A, p. 8.

conglomerates in Pelly valley, believed to be of Upper Cretaceous age, are devoid of granitic fragmentals. Possibly the granites may be of later age than hitherto believed.

Syenite and Allied Types

The Glenlyon batholith along its northeastern boundary, between Glenlyon and Tummel rivers, is bordered by a zone of intrusive rocks of intermediate composition. This zone is uniformly about one-half mile in width. The rocks appear to be syenites and monzonites, are dark grey, medium to coarse grained, and consist of feldspar, a varying amount of quartz, and a dark mineral which was not determined but may be hornblende. The feldspar is white to greyish and alkaline in appearance. Feldspar phenocrysts, of the same colour, give the rock a mottled appearance in places. Quartz is present in small quantities, or absent.

This zone of intermediate intrusives appears to be a marginal phase of the Glenlyon granodiorite and is probably nearly contemporaneous in age with the latter. Gradations were seen in two places between the syenite and the typical granodiorite. Elsewhere the actual contact was not observed.

Quartz-Feldspar Porphyry

A number of feldspathic dykes intrude the syenites, particularly in the vicinity of Tummel river, near Glenlyon river, and on the ridge between Glenlyon and Pelly rivers. These dykes also intrude thin-bedded sediments of the lower Palæozoic (?) group in the last-named locality; they occasionally occur cutting the granodiorite of Glenlyon mountains, and were seen intrusive into the Palæozoic (?) conglomerate of Rose mountain. Nowhere, however, are they as abundant as in the zone of intermediate intrusives, and their presence here was one reason why the zone was mapped as a separate unit.

The dyke rock is typically yellowish brown and has a fine-grained feldspathic groundmass with phenocrysts of quartz and occasional feldspar crystals. Quartz-feldspar porphyry dykes have been found in nearly every district in Yukon, and, in each district, have generally been considered to be the youngest consolidated rocks and probably of Tertiary age. It is possible that these dykes in Pelly valley may be somewhat older. The ridge between Pelly and Glenlyon rivers is capped by andesites of probable Tertiary age, and, although the sediments underlying these volcanic rocks are intruded by numerous quartz-porphyry dykes, none occurs in the volcanics. The dykes, therefore, appear to be older than the andesites. A similar condition has been found in places in Carmacks district.[1]

Upper Cretaceous (?) Sediments

Three small areas of sediments believed to be of Upper Cretaceous age outcrop in the valley of Pelly river. These are opposite the mouths of Ross river, Blind creek, and Harvey creek. The sediments consist of interbedded conglomerate, grit, sandstone, and shale. The conglomerates are composed of rounded pebbles, up to 2 inches in diameter, of argillite, quartz,

[1]Bostock, H. S.: Geol. Surv., Canada, Mem. 189, p. 44.

chert, green slate, greenstone, and schistose quartzite. The first three types listed predominate. The matrix of the conglomerate, and the interbedded grit and sandstone, are composed of the same materials as the conglomerate pebbles, and the cement is argillaceous and sericitic. The shales are black and friable, and contain plant remains.

The strata exposed on the south side of Pelly river, opposite the mouth of Ross river, consist of sandstone overlain by conglomerate interbedded with shale. The thickness of this section is estimated to be about 1,000 feet. The beds strike east-west and dip south, apparently overlying, with a small angular discordance, cherty quartzites and argillites of the middle Palæozoic (?) group. Opposite Blind creek beds of grit predominate in the lower half of a section of interbedded conglomerate, grit, and shale estimated to be about 500 feet thick. The sediments here are exposed for about a mile along the river bank, and lie in folds with northeast-trending axes. They are intruded by dykes of amygdular basalt, and overlain by flows of the same material.

Fossil plants were found in the shales opposite the mouth of Blind creek on Pelly river. A collection taken there was submitted to W. A. Bell who reports on them as follows:

"Collection consists only of fragmentary imprints of dicotyledonous leaves and a species of conifer. The fragments are all too imperfect for specific recognition and for any correlation other than post-Lower Cretaceous. The conifer can only be placed in the form genus *Elatocladus*. It resembles somewhat specimens of *Sequoia rigida* from the Upper Cretaceous. The largest fragment of a dicotyledonous leaf has a platanoid venation."

On the basis of this determination the conglomerates, grits, shales, and sandstones are here considered to be probably of Upper Cretaceous age. The beds closely resemble those of the Tantalus conglomerate of Carmacks area, the age of which is thought to be Jurassic or Cretaceous.[1]

Tertiary (?) Conglomerate

A small area of conglomerate is exposed a mile southwest of the Upper Cretaceous (?) series opposite Blind creek, and a number of outcrops of similar conglomerate occur on the slopes across Pelly river from Rose mountain. The rock consists of rounded grains, pebbles, and boulders varying from $\frac{1}{16}$ inch to 2 feet in diameter, the smaller fragments forming the matrix and being cemented with argillaceous material. The boulders consist of quartz, cherty quartzite, soft black shale, fine-grained yellow quartzite, and the clastic materials of the Upper Cretaceous (?) sediments.

Most of the outcrops are nearly flat-lying, and in a few places were found to be overlain by basalt and andesite lava flows of the Tertiary (?) volcanics. In one instance a conglomerate bed was found between two flows of andesite. In general these conglomerates are believed to be younger than the Upper Cretaceous (?) sediments and to be probably of Tertiary age. They may, however, represent upper members of the Upper Cretaceous (?) series.

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[1]Bostock, H. S.: Geol. Surv., Canada, Mem. 189, p. 28.

Tertiary (?) Volcanic Rocks

Volcanic rocks of probable Tertiary age occur along the south side of Pelly river east of Glenlyon river. These rocks vary from basic to acid types, including basalt, andesite, dacite, trachyte, and rhyolite.

The top of the ridge that separates Pelly and Glenlyon rivers is capped by flows of andesite at least 500 feet thick. The andesite is dark green and aphanitic, with occasional amygdules of quartz and zeolites. A second variety is mottled with rosettes of feldspar lathes. Such features as columnar jointing and flow structure occur in a few places, but nearly everywhere the andesite is altered to an extent approaching that of the Mesozoic greenstones.

Farther to the east, at a point across Pelly river from Rose mountain, flows of amygdular basalt replace the andesite. Like the latter, these have a greenstone habit in places. Basalt overlies the Upper Cretaceous (?) sediments opposite the mouth of Blind creek, occurs in the form of a volcanic neck or pipe in the same sediments south of Ross river, and outcrops east of Ketza river. Dacite, rhyolite, and basalt exposures are common between Lapie river and meridian 133 degrees west. The dacite is porphyritic, the groundmass being pale green to grey-white and andesitic in composition, the phenocrysts being rounded "eyes" of quartz and crystals of white feldspar. Vugs, partly filled with chalcedony and zeolites, show that the rock is of near-surface origin.

The volcanics of this group and their associated hypabyssal rocks appear to be the youngest consolidated rocks of the area. They overlie the Upper Cretaceous (?) sediments, and overlie and are interbedded with conglomerates that have escaped the folding to which the Upper Cretaceous (?) sediments have been subjected. The volcanics are, therefore, in all probability, of Tertiary age.

Superficial Deposits

Overlying all the consolidated rock formations is a mantle of Pleistocene and Recent alluvium, volcanic ash, and glacial drift. The accumulations are thickest in the valleys, and where they cover considerable areas of bedrock they have been mapped. Typical of the valley deposits are gravels, sands, and silts which can be seen overlying boulder clay and bedrock in the river cuts, and which form terraces on the valley sides. Elsewhere the country is covered by accumulations of glacial till and erratic boulders. Among the most recent deposits is volcanic ash, which is exposed on top of the cut-banks all along Pelly river, and is usually only a few inches thick.

ECONOMIC GEOLOGY

Prospecting activity in Pelly River area has been very limited and no mineral deposits of importance have as yet been found. It is impossible, therefore, to give an accurate estimate of the mineral resources of the area.

Search for placer gold in the area commenced as early as 1882 when pioneer bar miners first entered the region. During subsequent years gold was found on the bars of Pelly river from its mouth to Campbell creek, and on most of the tributary streams entering the river from the south.

The best bars are said to have been those between Hoole canyon and Hoole river (to the east of the map-area), and most of the early work was done here and on south-heading streams in the vicinity. The greater part of the gold taken was fine. Some paystreaks were found; none of these appears to have been sustained, however, and no coarse gold was found on bedrock. In recent years the search has gradually been abandoned, and in 1935 no prospectors were active in the area.

It is noticeable that the distribution of gold colours along Pelly river coincides approximately with the distribution of the older metamorphic rocks, which border the river as far east as Campbell creek. Most of the productive creeks of southern Yukon flow off areas of rocks of the Yukon group, or of metamorphosed Palæozoic sediments, where such areas border or enclose granitic intrusives. The gold originates in quartz veins or mineralized zones in these rocks, and is concentrated by the action of the streams. Creeks in a similar geological setting in Pelly River area are considered to be potential placer prospects and worthy of investigation.

The fine gold, hitherto found on Pelly river and its tributaries, was probably concentrated from glacial wash gravels in which it was disseminated. This is believed to be the case on Hoole, Ketza, and Lapie rivers, and Starr and Horton creeks, all of which flow across an abandoned part of Pelly valley heavily floored with superficial deposits.[1] Coarse gold occurs, as a rule, much closer to its source. As most of the placer gold in Yukon was released from bedrock and concentrated into paystreaks before glaciation commenced, the richer deposits will be found only in positions guarded from the Pleistocene glaciers. Having chosen an area in which the type of rock occurrence is favourable, the prospector should also give attention to the effects of glaciation. Creek valleys that are noticeably modified by ice erosion, as in the case of many of those of the larger streams, have probably lost any paystreaks they may once have contained. The smaller valleys transverse to these are considered to be more favourable localities.

Quartz veins occur nearly everywhere in the rocks of the Yukon group, and in places in the Palæozoic (?) sediments and Mesozoic (?) basic igneous rocks. With few exceptions, however, those seen in the field appeared to be barren of sulphides. Some pyrite and chalcopyrite were seen in such veins on the ridge bordering the north side of Pelly river just west of Ross river, on the ridge between Pelly and Glenlyon rivers, on Rose Mountain ridge, along Pelly river near the upper end of the Detour, and on the east side of Harvey creek. A little galena occurs in the veins at the second locality mentioned. Pyritization is prominent in shear zones in greenstones intrusive into members of the Lower Palæozoic (?) group along the lower part of Anvil creek, and in the andesites of the ridge separating Pelly and Glenlyon rivers. Cockfield[2] has described a vein deposit of quartz and siderite mineralized with pyrite, chalcopyrite, galena, and zinc blende, which occurs in Glenlyon mountains 7 miles northeast of Little Salmon lake. Assay of a sample from this occurrence showed the presence of silver in it. Small quantities of alluvial gold, as already discussed, are of common occurrence in the superficial deposits of the area.

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[1]Keele, Joseph: Geol. Surv., Canada, Rept. 1097, p. 47 (1910).
[2]Cockfield, W. E.: Geol. Surv., Canada, Sum. Rept. 1928, pt. A, p. 9.

These indications, as well as geological conditions comparable with those of better known and productive districts, favour the presence of mineral bodies of value, although none as yet is known in the area. The southwestern border of the Anvil batholith, as well as parts of the northeastern and southwestern contacts of the Glenlyon batholith, cross the map-area. The rocks most likely to contain ore deposits are the members of the Yukon group, the Palæozoic (?) sediments, and the Mesozoic (?) basic igneous rocks in the vicinities of these contacts. Part of the map-area that deserves first attention is the northeastern front of the Glenlyon batholith: (1) because it is readily accessible; (2) because most of the indications noticed in the field occur here; (3) because rock occurrence is most heterogeneous in this zone. A particular locality recommended is the ridge between Pelly and Glenlyon rivers.