MEMOIR 268

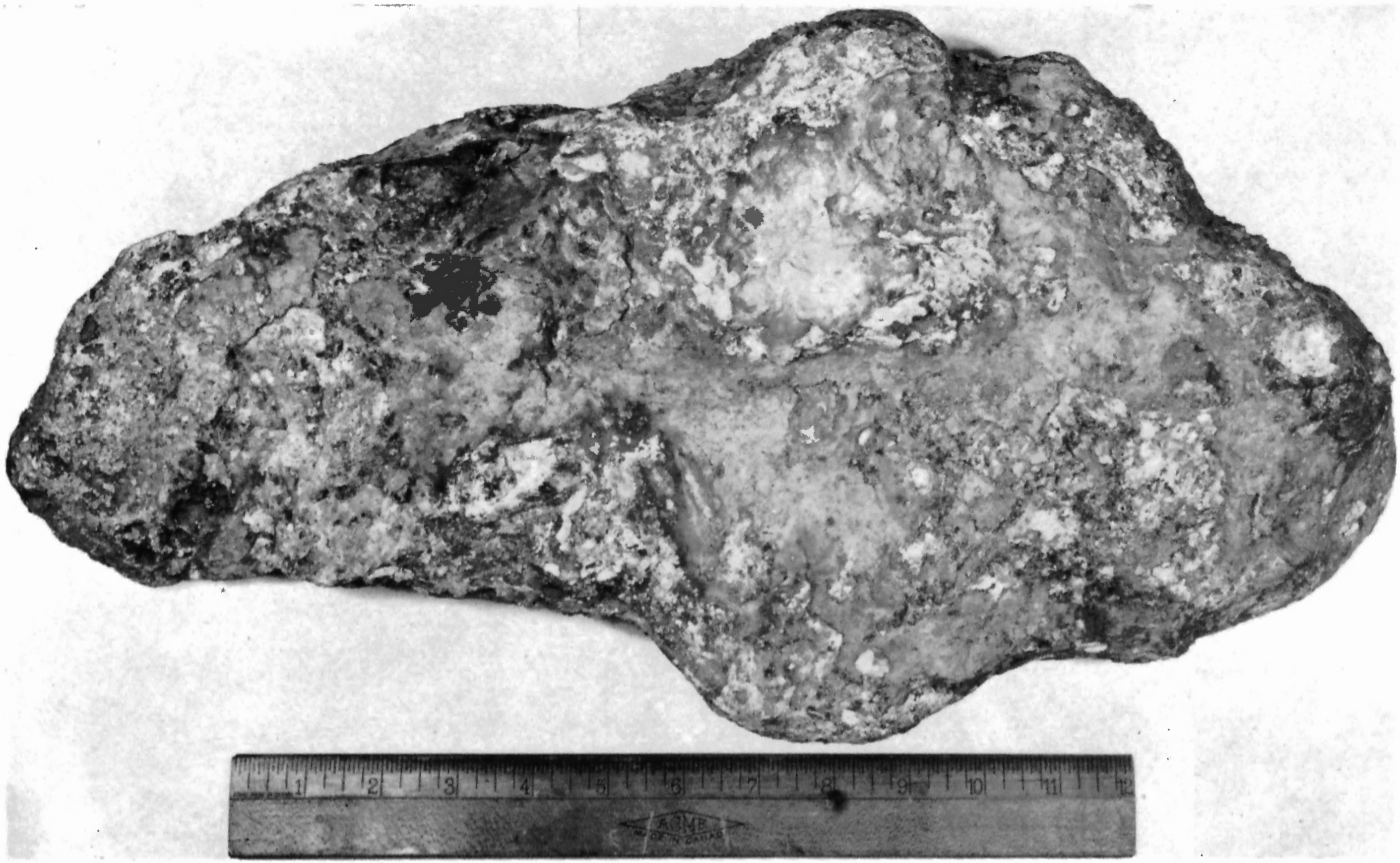
DEZADEASH MAP-AREA, YUKON TERRITORY

BY

E. D. KINDLE

GEOLOGICAL SURVEY
DEPARTMENT OF MINES AND TECHNICAL SURVEYS
OTTAWA
1952

PLATE I



99452 Native copper nugget from Beloud Creek, weighing 28 pounds. (Pages 34, 49.)

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

MEMOIR 268

DEZADEASH MAP-AREA, YUKON TERRITORY

BY

E. D. Kindle

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1952

Price, 75 cents No. 2508

60412—1

CONTENTS

CHAPTER III—*Continued*

CHAPTER IV

CHAPTER V

Illustrations

PREFACE

Dezadeash map-area comprises more than 4,800 square miles of mountainous terrain in southwest Yukon Territory about the junction of the Yukon Plateau with the Coast and St. Elias Mountains. Recent construction of the Alaska Highway and Haines Road across the northern and western parts of the area, respectively, have permitted ready access to this hitherto little known region, and have encouraged more systematic prospecting where formerly only small-scale placer operations had been attempted. The area is known to be metalliferous, and its geological mapping, based on field work by the author during five successive seasons, should afford material aid to its future exploitation.

The report deals at length with the physical features of the area, its glacial history, and the character, origin, and extent of its Quaternary formations, and with the lithology and structural and stratigraphic relations of the bedrock formations. The latter range in age from Precambrian to Tertiary, and comprise abundant volcanic as well as sedimentary materials. With them are associated intrusive bodies that range in composition from ultrabasic to granitic and in age from late Mesozoic to Tertiary, and that are believed to represent the source of the mineral occurrences in the area. These consist mainly of gold placers, but further search for economic lode deposits is warranted, and attention is directed to the conditions most favourable for their occurrence. Some thin coal was discovered by the author in a great series of Lower Cretaceous strata, and further prospecting may reveal thicker seams.

The report is illustrated by a multicoloured, geological map of the area on a scale of 1 inch to 4 miles.

GEORGE HANSON,
Chief Geologist, Geological Survey of Canada

OTTAWA, March 12, 1952

Dezadeash Map-Area, Yukon Territory

CHAPTER I

INTRODUCTION

SUMMARY STATEMENT

Dezadeash map-area occupies about 4,800 square miles in southwest Yukon between latitudes 60 and 61 degrees and longitudes 136 and 138 degrees. The map-area is named in part after the centrally located Dezadeash Lake (*See* Plate II A), a body of water 12 miles long and from 1 mile to 5 miles wide, and in part after Dezadeash River, which drains from the north end of the lake and flows for 75 miles across the area, first northeasterly, then westerly, and then southerly to join Alsek River.

The present report is based on work by the writer during the field seasons of 1946 to 1950 inclusive. He was capably assisted in this work by L. O. Gouin, A. K. Roberts, L. S. Fraser, and D. H. Tait, in 1946; by R. B. Scott, J. M. Churchill, A. K. Roberts, A. D. Hall, and M. C. Robinson, in 1947; by C. A. Burns, W. H. Poole, R. G. McCrossan, and W. M. Little, in 1948; by H. Gabrielse and J. J. Purdie, in 1949; and by W. N. Plumb, P. M. Nolan, and D. W. MacDonald, during the 1950 field season. Information supplied by guides Alex Van Bibber, Walter Smith, and Frank Chambers of Champagne was very useful in facilitating travel by horses away from the roads.

Many of the streams in Dezadeash map-area were tested for placer gold some 50 years ago by miners en route to the Klondike, and a limited amount of placer mining has been carried out from time to time since then on many of the original discoveries. During recent years, placer mining has been confined to Shorty, Beloud, Sugden, Iron, Dollis (Squaw), and Silver Creeks. Barker and Ray Limited of Whitehorse have been the only important producers; they mined 1,125 fine ounces of gold, worth $39,868, in 1946, and 1,015½ fine ounces of gold, valued at $35,374, in 1947, from the gravels of Shorty Creek. That no large placer deposits have been developed may be ascribed to the fact that valley glaciation has scattered most of the preglacial gravels.

Little prospecting for lode deposits has been attempted in Dezadeash map-area, and only a few metallic mineral deposits have been discovered to date. During the course of present geological mapping, evidence of copper mineralization was discovered in two places; first, in 1948, on the south side of the Mush Creek-Fraser Creek pass, and, in 1950, on a small creek 2 miles southeast of Sockeye Lake. At the first locality, Jurassic volcanic rocks are altered and replaced by chalcopyrite at their contact with granodiorite adjacent to a strong fault; at the second locality, several small bornite-rich veins occur in the same belt of volcanic rocks. Other mineral occurrences will undoubtedly be found in these rocks when they are more thoroughly prospected.

Thin coal seams seen in argillites near the base of the Lower Cretaceous sedimentary section northwest of the mouth of Dezadeash River are too small to be of economic value, but the possibility that thicker seams may occur elsewhere in this zone should not be overlooked.

MEANS OF ACCESS AND TRANSPORTATION

The 1,523-mile Alaska Highway extends westerly across the north half of Dezadeash map-area. Mile-post 956 marks the east edge of the area and mile 1039 is a short distance west of its western boundary. The 159-mile Haines Road runs north from the seaport town of Haines, Alaska, to connect with the Alaska Highway at mile 1016, some 23 miles northwest of Dezadeash Lake. Mile 94, Haines Road, is about $\frac{1}{3}$ mile south of the Yukon-British Columbia boundary, and mile 42 is near the boundary between British Columbia and Alaska. Whitehorse, largest town and principal supply centre for the Yukon, is at mile 917, Alaska Highway, that is, 917 miles from the southeast end of the road at Dawson Creek, British Columbia, and 39 miles by road east of Dezadeash map-area. Whitehorse is strategically situated at the northern terminal of the White Pass and Yukon Route railway, which connects with ocean steamships at Skagway, Alaska, and is at the head of river navigation to the mining districts farther north.

The Canadian sectors of the Alaska Highway and Haines Road are maintained by the Canadian Army and are kept in good condition. The Alaskan sector of the road was 'black-topped' during the summer of 1950. The highway is kept open the year round, but to date traffic has not been maintained on the Haines Road during the 3 coldest months of the year.

The southeast part of the map-area is readily accessible from Kusawa Lake, which is 45 miles long. A truck road, 15 miles long, extends south from mile 959, Alaska Highway, to connect with the north end of the lake.

A natural route into the southwest part of the area follows Mush and Bates Lakes, which are connected by a short stream. A waterfall, 8 feet high, at the outlet of Mush Lake is the only impediment, necessitating the use of a 400-foot portage. The east end of Mush Lake is reached by way of a truck road that runs west from Beloud's Camp at mile 125, Haines Road. From the south end of Bates Lake, a tractor trail leads south to placer workings on Iron Creek and to placer workings on Bates River 2 miles west of the mouth of Iron Creek. Bates River is not navigable.

From mile 143, Haines Road, Kathleen and Louise Lakes provide a boat route extending 12 miles west. The channel between these lakes is navigable for small boats powered with outboard motors, but there is a 150-foot stretch where the stream is split into two channels and where the main channel may carry only 12 to 18 inches of water during late summer.

Large freight canoes can generally be used safely on Kathleen, Dezadeash, and Kusawa Lakes, but these waters are lashed by frequent and sudden windstorms. At intervals, too, cold, strong, incessant winds may blow east across Kathleen Lake, and north across Dezadeash and Kusawa Lakes, for as much as 2 weeks at a time; such storms are commonly followed by periods of calm during which perfect boating conditions may prevail for many days.

Dezadeash River is navigable for shallow-draught river boats or canoes powered by outboard motors, but care must be taken to avoid large boulders that occur at intervals in the stream bed. West of the Haines Road the Dezadeash splits into several channels, and for 8 miles even the main channel is difficult to navigate. About 2 miles upstream from where it leaves Shakwak Valley the river is widely spread and occupies four or five channels, and the gravel bars in the main channel are only 12 to 15 inches below water in late summer when the river is low. The 7-mile stretch of the Dezadeash from its mouth north to the 90-degree turn easterly at Shakwak Valley is readily navigable. A truck road 8 miles long that runs south from Bear Creek touches Dezadeash River on the west side ½ mile south of the big bend.

Alsek River is navigable with difficulty by shallow-draught boats as far south as Lowell Glacier. Four short rapids occur within 3 miles of the glacier, but these can be run by one adept at dodging boulders. The 6-mile stretch of the Alsek south of the mouth of Dezadeash River is very difficult to navigate as there the Alsek is spread over a wide area and occupies more than a dozen braided channels (*See* Plate II B). The main channel is on the west side, but even it carries as little as 10 inches of water over some of the gravel bars. Rubber boots or waders are a necessity in getting by these shallow places. The writer used a 22-foot freight canoe equipped with a 16 h.p. Johnson motor in making the trip down to Lowell Glacier and return during the 1950 season.

The water-level of Alsek River fluctuates daily due to the great quantities of glacial melt waters contributed by Dusty and Kaskawulsh Rivers. At the mouth of Park Creek, the river level was found to be highest between 6 and 8 o'clock in the morning during a period of warm sunny weather, and to fall off gradually during the late morning and early afternoon so that a loss of 6 inches was registered by 3 p.m. Farther south, near Lowell Glacier, where the river is confined to one channel, there is a 12- to 15-inch daily rise and fall of river level during the summer months. Boating is much safer and easier in the early morning when the water-level is high.

Little is known of the Alsek south of the mouth of Bates River, but it is a swift-flowing stream as there is a fall of more than 1,600 feet along its 100-mile journey to the ocean.

The old Dalton trail, used 50 years ago by placer miners en route to the Klondike, crosses the map-area, and is followed in several places between Dalton Post and Haines by the present road. The trail follows the west side of Klukshu River from Dalton Post to Klukshu, and from there leads northeasterly on the east side of Dezadeash Lake and Dezadeash River to Champagne. The trail continues due north from Champagne to Hutshi, then northeasterly to Nordenskiöld River Valley, which it descends to connect with the present road to Dawson 27 miles south of Carmacks, near Montague. Pack-horse trails also lead from Champagne to Taye Lake and to the north end of Jo-Jo Lake. A tractor road, constructed in 1948 by Jurgeleit Brothers from Dalton Post to their placer ground on Silver Creek, gives access to the country on the west side of Tatshenshini River. Prior to the building of the Haines Road, supplies were taken to the placer workings on Dollis (Squaw) Creek along a pack-horse trail that ran south from Dalton Post around the west side of Beaton Mountain. Tatshenshini River at Dalton Post can only be forded in the early spring and autumn when the water is low.

Another old trail leads north from Dalton Post along the east side of Village Creek and Nesketaheen Lake to Fraser Creek. It crosses the Mush Lake road at Dalton Creek and then leads northwest via the pass at the head of Victoria Creek and the valleys of Cottonwood and Raft Creeks to Alsek River. The Alsek may also be reached with pack-horses by a route southwest from Campsite Lake.

A trail that leads easterly along the north side of Blanchard Creek gives access to the territory east of the Haines Road along the south border of the map-area. An old Indian foot-trail follows up the valley of Takhanne River and along the west side of Frederick Creek to Frederick Lake, then leads west along the north side of Kluhini River to connect with the old Dalton trail.

W. Muncaster of Haines has constructed a 16-mile tractor trail to his placer workings on Dollis (Squaw) Creek from near mile 88 on the Haines Road, and this trail connects at the British Columbia-Yukon boundary with the old pack-horse trail around the west side of Beaton Mountain to Dalton Post.

In general the valleys are fairly open, so that the country is well suited for the use of pack-horses in exploratory work back from the roads. Horses may be hired at Champagne. Float-equipped planes could also be used advantageously; landings could be made on Kusawa, Jo-Jo, Taye, Moraine, Pine, Dezadeash, Kathleen, Louise, Sockeye, Mush, Bates, Onion, and Frederick Lakes. Both trucks and float planes are available for hire at Whitehorse. The British Yukon Navigation Company maintains a semi-weekly bus service along the Alaska Highway and a weekly service (each way) along the Haines Road.

NATURAL RESOURCES

VEGETATION AND CLIMATE

Most of the valley bottoms in Dezadeash map-area are forest covered, and the mountain slopes are forested to an elevation of about 4,000 feet. White spruce is the most plentiful and most valuable tree. It attains a diameter of 2 feet in favourable localities such as the river flats where water is plentiful. Other native trees include the lodgepole pine, alpine fir (balsam), paper birch, balsam poplar, and trembling aspen. Alder and willow grow profusely in small areas of damp or swampy ground throughout the area, and in the southwest corner they are an impediment to travel by foot. There is an exceptionally heavy rainfall and snowfall along the valleys of Bates and Alsek Rivers and, as a result of the weight of snow and the prevalence of snow slides, alders and willows have replaced the evergreen trees as the dominant flora. A few devil's-club shrubs and some mountain ash also grow here. Dwarf birch or 'buck-brush' has a wide distribution, being found in both the lower valleys and on the upper slopes above timber-line, in all parts of the country.

Northern cranberries carpet the ground in shady groves where sandy soil is prevalent and high-bush cranberries are found along many of the streams and lakes. Tasty red currants, blueberries, and raspberries thrive in many places. A species of wild onion grows in abundance in damp ground at both ends of Onion Lake.

A remarkable grassy plain roughly 6 miles long and a mile wide lies at the headwaters of Wolverine Creek. The plain is formed by the overlapping of two great alluvial fans built by the streams leading from the front of the glaciers on the west side of the valley. The grassy expanse is broken by an occasional tree and by small areas where willow, alder, and 'buck-brush' have taken root. Another grassy plain, about a mile wide, extends south along the east side of Bates River between Wolverine and Iron Creeks. Extensive grassy plains also abound along the valley of Cottonwood Creek and for several miles south along the south fork of Cottonwood Creek. Still another grassy plain, possibly 5 miles long and from 1 mile to 2 miles wide, lies at the head of Fraser Creek, and grass-covered flats bound this stream for 2 miles above its mouth at Mush Lake. Grassy bottom lands reach for miles along the course of Alsek River north of Lowell Glacier and up Dezadeash River for some miles along what was the floor of Recent Lake Alsek (*See* Map 1019A). These bottom lands are sparsely wooded in places with trees that are all less than 50 years old.

Although Dezadeash Valley is wooded, grassy meadows are sufficiently numerous throughout its length to comprise good pasturage for horses. The greater part of the valley is floored by glacial silts (*See* Plate IV B) that were deposited in Glacial Lake Champagne (*See* page 16). The silts are quite fertile, but rainfall is too scanty for optimum forest growth. Less fertile deposits of sand outwash overlie or replace the silts near Champagne, and sand dunes fringe the mountains along the north side of the valley north of Champagne. As there is a comparatively light snowfall along Dezadeash River Valley, horses are able to reach food by pawing the snow aside, and subsist through the winters in Dezadeash and Aishihik River Valleys in spite of low temperatures, provided that they are in good condition before the onset of severe weather.

The Dominion Experimental Farm has established a station at mile 1019, Alaska Highway, to test the agricultural possibilities of the district. More than a dozen acres have been cleared at Pine Creek and field crops have been successfully grown there since 1945. Garden produce such as peas, beans, carrots, turnips, potatoes, and cabbage have been grown for many years at Bear Creek trading post, where the proprietor, Mrs. D. Mackintosh, has secured optimum results through installation of a miniature irrigation system.

Luxuriant rhubarb plants, with stalks up to 5 feet long and leaves 3 feet in diameter, were seen in a small garden at placer workings 3 miles up Dollis (Squaw) Creek in 1949.

Rapid growth is promoted by almost continuous daylight during the months of May, June, and July, and the weather is generally warm until September. Autumnal frosts begin normally about the last week in August, and the leaves of deciduous trees take on their brilliant colouring during the first week in September. The map-area is evidently south of the permafrost belt as no permanently frozen ground was encountered.

FAUNA

Grizzly bears, black bears, and brown bears are indigenous to all parts of the map-area. The grizzly is an unpredictable and dangerous animal: a local Indian guide was mauled and left for dead by a grizzly bear near Champagne in June 1950, when he was unable to get his rifle from its case in time to shoot; and during the 1947 season a member of the writer's field party was rushed by one of these animals above timber-line, and escaped injury only by 'playing dead'.

Alaska moose, mountain goats, and intergrade varieties of Dall and Stone sheep inhabit the district, and some record-size heads have been taken by trophy hunters. Timber wolves inhabit all parts of the country but are seldom seen. They occasionally annoy and kill horses during the winter, when game is scarce. Fur-bearing animals such as the fox, mink, muskrat, weasel, red squirrel, fisher, martin, beaver, lynx, red fox, cross fox, silver fox, and wolverine are trapped by the Indians when fur prices are high. Ground squirrels are plentiful and a few porcupine and rabbits were seen.

That part of the Yukon west of the Haines Road and south of the Alaska Highway has been created a National Park and Game Preserve, and game has become abundant within it, as no hunting is allowed. There is a constant overflow of big game from the confines of the park to neighbouring areas.

National Museum Bulletin No. 100, by A. L. Rand (1945)[1], lists all of the mammals found in Yukon Territory, and is a useful record for interested persons.

Lake trout, grayling, and whitefish abound in all of the large lakes, and rainbow trout are caught in small lakes along the course of Kathleen River. Large numbers of salmon are taken by the Indians in traps at Klukshu, and are dried for winter consumption. Salmon come up Tatshenshini River in large numbers and are known to spawn in Klukshu, Blanchard, and Nesketaheen Lakes. It is believed that salmon once ascended Alsek River and its tributaries to spawn in Jarvis, Dezadeash, and Kathleen Lakes, and that they were prevented from doing so only in comparatively recent time when Lowell Glacier (*See* Plate III B) pushed across the path of Alsek River and formed an insurmountable barrier to their up-river migration. This ice-dam was removed some hundred years ago when the ice-front receded, but the salmon running cycle has not yet recommenced. It would probably require the introduction of large numbers of salmon fry into these lakes, over a 4-year period, to re-establish the annual salmon run.

---

[1] Dates in parentheses are those of publications listed in Bibliography at the end of this chapter.

Ducks of several varieties spend the summers on the small lakes of the district. Geese are occasionally seen on Dezadeash Lake during the migration period, but are not known to breed in the area. Ptarmigan and grouse are found everywhere in small numbers; the former were seen in unusual numbers in the vicinity of Onion Lake, in 1949.

A list of the animals and birds found in southern Yukon has been published by Clarke (1946), and Rand (1950) and has recently listed game birds found there. W. E. Godfrey (1951) reported on birds collected in Dezadeash area during the 1950 season on behalf of the National Museum. Anyone interested in the bird life of this region is referred to these publications.

Mosquitoes are a nuisance throughout June and July, but later in the season are seen only near swampy areas where they breed until the onset of cold weather. Black flies give little trouble in June or July, but increase in numbers as the season progresses and are abundant near small swift streams in August and September. In this respect they differ markedly from the black fly met with in eastern Canada, which is most abundant in May, June, and July.

WATER POWER

Alsek River drains a large area and carries a heavy flow of water. It is a river that could produce much electrical power were it dammed and harnessed. Numerous rock-cut gorges more than 500 feet deep occur along its course south of the mouth of Bates River, and these potential dam sites are readily accessible. The effect of wind-driven icebergs on dam structures would have to be considered in building a dam below Lowell or Fisher Glaciers, and transportation routes would have to be carefully chosen to avoid the threat of snowslides from the percipitous slopes of Alsek Ranges.

A still more accessible dam site on Alsek River lies some 6 miles above Lowell Glacier. A road could be quickly pushed through to this site by following the shorelines of Kathleen and Louise Lakes, the gravel flats of Cottonwood Creek, and the Campsite Lake pass to the Alsek. The building of a dam 300 feet high would form a lake comparable in outline to that of Recent Lake Alsek.

Hydro-electric power is readily available at the outlet of Kusawa Lake, where there is a strong outflow of water via Takhini River. Large quantities of sand and gravel are available on the east side of the river for construction purposes. Raising of the level of this 42-mile-long lake would cause little inconvenience as there is no settlement along its shores.

INHABITANTS

Civilian road maintenance crews are quartered in camps the year round at Haines Junction and at Stoney Creek, and linemen are stationed at a telegraphers' repeater station at Canyon. Restaurant service and sleeping accommodation are offered at privately owned establishments at Cracker Creek, Canyon, Haines Junction, Bear Creek, and Beloud's Camp. Gasoline may be purchased at all of these places, and garage service is available at Haines Junction and at Canyon. The Experimental Farm at Pine Creek is the site of another small settlement.

Klukshu is the summer headquarters for about twenty Indian families who live there during August to take part in the salmon harvest. Champagne has been a permanent Indian community since the establishment of a trading post there in 1902. A few additional families live at Dalton Post, Kloo Lake, Bear Creek, Canyon, Cracker Creek, and Stoney Creek.

The district has been inhabited a very long time, a fact attested by the finding of ancient hand-worked stone arrowheads, spearheads, and knives both south of Champagne, about Taye Lake, and at Canyon. At the south end of Taye Lake and at sand bluffs 2 miles south of Champagne, these artifacts were seen to lie beneath a 1- to 2-inch layer of volcanic ash, which, according to Capps (1931) and Bostock (1952), is about 1,400 years old. Douglas Leechman (1951), the first to discover artifacts near Champagne, has recently written a report for the National Museum of Canada dealing with this subject.

PREVIOUS EXPLORATIONS

In 1882, Arthur Krause conducted an exploration, on behalf of the Bremen Geographical Society, of Chilkoot and Chilkat Passes, at which time he reached nearly to the south end of Kusawa Lake, which he named "West Kussowa Lake". In 1890, Messrs. S. J. Wells, A. B. Schanz, E. J. Glave, and Jack Dalton ascended Chilkat River, crossed the Coast Mountains, and explored the length of Kusawa Lake[1].

E. J. Glave (1892) and Jack Dalton made an overland trip, using four pack-horses, from Chilkat River to Kluane Lake in 1892, and this was heralded as the first time that horses had been used in the district. The Chilkat River Indians had for many years used a foot-path by which they travelled between the coast and the interior to trade with the more remote tribes living inland. This trail was made use of by Dalton, who established trading posts at Pleasant Camp on Klehini River and at Dalton House on the Tatshenshini. During the next few years Jack Dalton cut out and improved the old trail, and by 1896 it had been established as far north as the mouth of Nordenskiöld River and had become known as 'the Dalton trail'. J. J. McArthur made a survey of this trail in 1897, and the following year J. B. Tyrrell (1898) made a rapid geological reconnaissance along this route in addition to exploratory work north of the Dezadeash area.

Large numbers of prospectors made their way to the Klondike placer fields over the Dalton trail between 1896 and 1900, and some prospecting for placer gold was undertaken in the Dezadeash area at that time, as Tyrrell (1898) states that "Specimens of coarse gold were shown to the writer as having been taken from Alder Creek". During the summer of 1899, W. J. Peters and Alfred H. Brooks (1900) made an overland trip from Pyramid Harbour, on Lynn Canal, to Eagle City in Alaska for the United States Geological Survey. The route followed was via the Dalton trail to Dalton Post and then northwesterly to Kluane Lake by way of the valleys of Fraser and Cottonwood Creeks. Brook's map (1900) of the region records the occurrence of placer gold on Shorty Creek.

[1] Report on the Population and Resources of Alaska, 1891; 11th Census, p. 9.

R. G. McConnell (1905) visited the Kluane Lake area in 1904 to report on the geology and placer deposits of the district for the Canadian Geological Survey. His geological map of the Kluane district (No. 894) includes the northwest tip of Dezadeash map-area. He mentions the existence at that early date of a wagon road between Whitehorse and Kluane Lake, constructed to serve the newly discovered Kluane and Ruby placer camps. Ten years later, D. D. Cairnes (1915) made a traverse along this same road from Whitehorse to Kluane and reported on placer mining developments in the Kluane, Ruby, and Nansen districts. His explorations are recorded on Geological Survey Map 152A (Kluane Lake, Yukon Territory) and Map 154A (Southwestern Yukon).

W. E. Cockfield carried out geological exploration in the Aishihik Lake area in 1926. His report (1927) and Map 192A (Aishihik Lake Area) cover the area between Aishihik Lake on the north and Dezadeash River on the south, and from Canyon on the west to Mendenhall River and Sifton Mountains on the east. In the following year, Cockfield (1928) mapped the rocks along the Dalton trail from Champagne to the British Columbia boundary, and explored the shores of Kusawa Lake, as shown on Geological Survey Map 205A (Dezadeash Lake Area).

J. T. Mandy (1932) made a geological reconnaissance of the Dalton trail route between Rainy Hollow and the Yukon boundary in 1932, and reported on the placer mining activity on Squaw (Dollis) Creek. He revisited Squaw Creek the following year for the British Columbia Department of Mines and prepared a second short report (1933) on the mining operations. On this occasion he entered the country via the Whitehorse route, proceeded to Champagne by car along a rough truck road, thence by boat up Dezadeash River to Dezadeash Lake, and by saddle-horse from the south end of the lake to Squaw Creek.

The threat of a Japanese invasion of Alaska in 1942 brought about the building of the Alaska Highway from Dawson Creek, British Columbia, to Fairbanks, Alaska. The pioneer road was constructed in 1942 by United States Army Engineer troops, and the road was converted to a gravelled highway in 1943 by the United States Public Roads Administration and the United States Engineers Department. The Haines Road, 159 miles long, that connects with the Alaska Highway in the northwest part of the map-area, was built at the same time and was made available to the public in 1944.

During the 1945 and 1946 field seasons, the Squaw Creek-Rainy Hollow area, south of Dezadeash map-area, was visited and mapped by K. DeP. Watson (1948) for the British Columbia Department of Mines.

H. S. Bostock of the Geological Survey carried out reconnaissance geological mapping of a belt along the Alaska Highway from the Alaskan boundary east to Champagne, in 1945. He also visited the Bates and Iron Creek placers and traversed the shores of Mush and Bates Lakes. His report (1952) deals with the country contiguous to the highway, northwest of Dezadeash map-area.

SELECTED BIBLIOGRAPHY

Bostock, H. S. (1948): Physiography of the Canadian Cordillera, with Special Reference to the Area North of the Fifty-fifth Parallel; Geol. Surv., Canada, Mem. 247.

———(1952): Geology of Northwest Shakwak Valley; Geol. Surv., Canada, Mem. 267.

Bostock, H. S., and Lees, E. J. (1938): Laberge Map-area, Yukon; Geol. Surv., Canada, Mem. 217, pp. 1-28.

Brooks, A. H. (1900): Reconnaissance from Pyramid Harbour to Eagle City, Alaska; U.S. Geol. Surv., Twenty-first Ann. Rept., 1899-1900, pt. II, pp. 337-391.

Capps, S. R. (1931): Glaciation in Alaska; U.S. Geol. Surv., Prof. Paper 170-A.

Cairnes, D. D. (1910): Lewes and Nordenskiöld Rivers Coal District; Geol. Surv., Canada, Mem. 5.

———(1912): Wheaton District; Geol. Surv., Canada, Mem. 31.

———(1915): Exploration in Southwestern Yukon; Geol. Surv., Canada, Sum. Rept. 1914, pp. 10-33.

———(1916): Wheaton District, Southern Yukon; Geol. Surv., Canada, Sum. Rept. 1915, pt. A, pp. 36-49.

———(1917): Saline Incrustations between Takhini and Canyon, Y.T.; Geol. Surv., Canada, Sum. Rept. 1916, pt. A, pp. 33-34.

Clarke, C. H. D. (1946): Biological Reconnaissance of lands adjacent to the Alaska Highway in Northern British Columbia and the Yukon Territory; Lands, Parks and Forests Branch, Dept. Mines and Resources, Ottawa.

Cockfield, W. E. (1927): Aishihik Lake District, Yukon; Geol. Surv., Canada, Sum. Rept. 1926, pt. A, pp. 1-13.

———(1928): Dezadeash Lake Area, Yukon; Geol. Surv., Canada, Sum. Rept. 1927, pt. A, pp. 1-7.

Cockfield, W. E., and Bell, A. H. (1926): Whitehorse District, Yukon; Geol. Surv., Canada, Mem. 150.

Glave, E. J. (1892): Pioneer pack-horses in Alaska; The Century Magazine, vol. XLIV, Nos. 5 and 6, September and October 1892.

Godfrey, W. E. (1951): Notes on the Birds of Southern Yukon Territory; Ann. Rept. Nat. Mus. for the Fiscal Year 1949-50.

Hayes, C. W. (1892): An Exploration through the Yukon District; Nat. Geog. Mag., vol. IV, May 15, 1892, pp. 117-162.

Holland, Stuart S. (1950): Placer Gold Production of British Columbia; B.C. Dept. of Mines, Bull. No. 28.

Krause, Arthur (1882): Die Expedition der Bremer Geographischen Gesselschaft nach der Tschuktschen-Halbinsel und Alaska; Deutsche Geographische Blatter, bd. V, heft 3 and 4, 1882.

Leechman, Douglas (1951): Notes on Southwest Yukon; Ann. Rept., Nat. Mus. for the Fiscal Year 1949-50.

Mandy, Joseph T. (1923): Tatshenshini River Section; Ann. Rept. Min. of Mines, B.C., for 1932, pp. 74-79.

———(1934): Tatshenshini River Section; Ann. Rept. Min. of Mines, B.C., for 1933, pp. 90-93.

McConnell, R. G. (1905): The Kluane Mining District; Geol. Surv., Canada, Sum. Rept. 1904, pp. 1-18.

———(1906): Head Waters of the White River; Geol. Surv., Canada, Sum. Rept. 1905, pp. 19-26.

———(1909): The Whitehorse Copper Belt; Geol. Surv., Canada, Pub. No. 1050.

Moffit, Fred H. (1938): Geology of the Chitina Valley and Adjacent Area, Alaska; Geol. Surv., Bull. 894, U.S. Dept. Interior.

Rand, A. L. (1946): List of Yukon Birds and Those of the Canol Road; Nat. Mus., Canada, Bull. No. 105.

———(1950: H. B. Conovers Bird Work in Yukon; Can. Field Nat., Nov.-Dec., vol. 64, pp. 214-220.

Tyrrell, J. B. (1901): Yukon District; Geol. Surv., Canada, Ann. Rept. 1898, vol. XI, pp. 36-46.

———(1899): Glacial Phenomena in the Canadian-Yukon District; Bull. Geol. Soc. Am., vol. 10, pp. 193-198.

Watson, K. DeP.: The Squaw Creek-Rainy Hollow Area, Northern British Columbia; B.C. Dept. of Mines, Bull. No. 25, pp. 1-70.

CHAPTER II

PHYSICAL FEATURES

PHYSIOGRAPHY

Dezadeash map-area includes parts of three primary physiographic subdivisions of the Canadian Cordilleran region. The St. Elias Mountains occupy the southwest part of the area; the Boundary Ranges of the Coast Mountains cover the southeast part; and the area north of Dezadeash and Frederick Lakes comprises the southeast part of the Kluane Plateau, which is a part of the greater Yukon Plateau. Kluane Plateau is separated from the St. Elias Mountains by Shakwak Valley, a prominent trench-like valley that trends northwesterly from the mouth of Takhini River, along an arm of Kusawa Lake, and along a course occupied by the valleys of Frederick, Dezadeash, Kathleen, Kloo, and Kluane Lakes. Bostock (1948, p. 73) states that Shakwak Valley has an overall length of more than 200 miles, as it continues northwest to and beyond White River.

The Icefield Ranges, which comprise the main mass of the St. Elias Mountains, lie west of Alsek River so that only their eastern fringe lies within Dezadeash map-area. These ranges are in large part a high plateau surmounted by great peaks the highest of which Mount Logan has an elevation of 19,850 feet. The central area west of the Alsek is covered by almost continuous snowfields with occasional projecting peaks of rock, and the whole area is dissected by deep, ice-filled valleys such as those occupied by Lowell (*See* Plate III A) and Fisher Glaciers.

The Alsek Ranges form the front of the St. Elias Mountains east of Alsek River and south of Bates River. Mount Beaton, whose peaks rise somewhat above 6,500 feet, forms the northeast bastion of these ranges, and all mountains to the south that lie west of the Haines Road belong in the group. West of Tatshenshini River these rugged mountains are dissected by seven, deeply cut valley glaciers, which range from 3 to 6 miles in length. Several of the peaks are between 7,500 and 8,000 feet in height, and one peak on the south side of Wolverine Glacier has an elevation of more than 9,000 feet.

The northwesterly trending valley occupied by the upper part of Tatshenshini River, along with the valleys occupied by Fraser, Mush, and Cottonwood Creeks and Kaskawulsh River, occur along a northwesterly trending depressed belt that Bostock (1948, p. 96) has named the Duke Depression. It is an isolated plateau-like belt where the mountains are characterized by broad, smooth slopes. All of the area north of Bates River between the Alsek and the Kluane Ranges to the east is included in the Duke Depression.

The Kluane Ranges rise abruptly on the northeast side of the Duke Depression to form the outer front of the St. Elias Mountains. These ranges extend southeast from Kluane Lake to Dezadeash Lake and end 12 miles farther south at Nesketaheen Lake. They have a width of about 12 miles west of Dezadeash Lake, and are 8 miles wide north of the mouth of Kaskawulsh River. They exhibit precipitous slopes, and most of the peaks range in height from 7,000 to 8,000 feet. Alpine glaciers are abundant, particularly on the north and northeast slopes beneath the high peaks.

The group of peaks contained by Shakwak Valley and the valleys of Kathleen and Louise Lakes and Alsek and Dezadeash Rivers was named the Auriol Range in 1951 in commemoration of the visit to Canada of Vincent Auriol, President of France.

The Boundary Ranges in the southeast part of the map-area are typical of the Coast Mountains. The granitic terrain is developed into high, precipitous slopes with jagged, knife-edge ridges and pointed peaks that exceed elevations of 7,000 feet in many places. Alpine glaciers occur on the north sides of all peaks more than 6,500 feet high. In the southeast corner of the area, most of the peaks east of Kusawa Lake rise above 7,500 feet, and one peak is more than 8,000 feet high. Several hanging, U-shaped valleys join the main Kusawa Lake Valley in this vicinity, Nevin Creek Valley affording one of the best illustrations of such valleys. Large numbers of cirques and several matterhorn peaks occur between Kusawa Lake and Takhanne River.

The Yukon Plateau north from Dezadeash Lake is an upland area of interlocking valleys enclosing mountain groups and ridges, few of which rise more than 3,500 feet above the valley bottoms. Dezadeash Valley, which extends westerly across the area from Takhini River on the east to where it merges with Shakwak Valley at Pine Lake on the west, is the largest single valley in the map-area. It is 50 miles long and between 4 and 6 miles wide. Farther east, this valley is continuous with the easterly trending Takhini River Valley and its overall length east to Lewes River is 80 miles. Within Dezadeash map-area the valley floor is a gently undulating, silt-covered plain whose surface ranges from an elevation of 1,950 feet near the mouth of Kathleen River to 2,500 feet along the valley walls.

DRAINAGE

Nearly all of the territory east of a line running north and south through Champagne is drained by Takhini River and its tributaries. The Takhini flows northeast for 20 miles from the north end of Kusawa Lake, from there east to Lewes River, and thence via Yukon River to the sea. Kusawa Lake has an overall length of 35 miles from north to south, but its zigzag course adds another 10 miles in actual travel. The lake occupies a glacially deepened valley, and its waters are generally deep, clear, and cold except in the vicinity of silt-laden inflowing streams such as Primrose and Kusawa Rivers. Primrose River has built a great alluvial fan at its mouth, and the lake basin has been filled at its narrowest point to within 4 or 5 feet of the surface. The south end of the lake has been sand filled for a distance of 2 miles north of the junction of Hendon and Kusawa Rivers, and the wide sand flats at the present river mouth are covered by only 6 or 8 inches of water.

Dezadeash Lake is the second largest in Dezadeash map-area. It lies near the centre of the map-area, and occupies about 14 square miles. This lake basin was scooped out by valley glaciers during Pleistocene time.

The lake iteself is comparatively shallow, and its waters are generally somewhat turbid as a result of wave action on the sands and silts at the bottom (*See* Plate II A). A large area north and south of Frederick Lake drains westerly to Dezadeash Lake by way of Kluhini River, and Dezadeash Lake is in turn drained by Dezadeash River, which flows northeasterly for 20 miles to Champagne, where it swings westerly along Dezadeash Valley for more than 30 miles to where this valley merges with Shakwak Valley near the mouth of Kathleen River. The Dezadeash continues its course for another 12 miles westerly across Shakwak Valley, then turns abruptly south through a gap in the Kluane Ranges and joins the Kaskawulsh 7 miles farther south. The combined Kaskawulsh and Dezadeash Rivers form Alsek River.

The Kaskawulsh is a strong-flowing stream, as it receives a large volume of water from Kaskawulsh Glacier and from large tributary streams such as Jarvis and Dusty Rivers. Alsek River (*See* Plate IVA), with the combined volumes of Kaskawulsh and Dezadeash Rivers, is a fast and powerful stream. It has displayed great erosive force in carving a passage through the Alsek and Icefield Ranges on its tumultuous course south to the Pacific Ocean. Steep canyon walls roughly 1,000 feet high that hem in Alsek River for 5 miles below the mouth of Bates River are evidence of its erosive power. It carries a heavy load of rock flour and silt, which is deposited in broad tidal flats at the river's mouth.

Kathleen and Louise Lakes occupied a single ice-carved basin at the close of the Glacial period, but this larger lake was bridged by a great fan of sand and gravel deposited at the mouth of Victoria Creek. The damming action of the fan has raised the level of Louise Lake some 5 or 6 feet above the level of Kathleen Lake. The waters of Louise Lake are milky from the inflow of glacial melt waters, but Kathleen Lake waters are very deep and clear. There is a strong flow of water north to Dezadeash River by way of Kathleen River.

Bates and Mush Lakes, in the southwest parts of the map-area, drain southwesterly via turbulent Bates River to the Alsek. Both lakes occupy basins in glacially deepened valleys. They are deep lakes, and their waters are clear and cold. Alder Creek, a large tributary of Mush Lake, heads near Dezadeash Lake, and only a low, gravel-covered divide separates it from the south end of Dezadeash Lake.

Klukshu Lake, 2 miles south of Dezadeash Lake, drains south via Klukshu River to Tatshenshini River. The latter flows southwest from Dalton Post and reaches the Alsek possibly 30 miles farther southwest in what is still unmapped territory. The Tatshenshini is, like the Alsek, a very fast, silt-laden stream, and it carries a strong flow of water. It is enclosed by canyon walls 600 feet high along much of its course within the map-area. The canyons have been cut in bedrock since the period of glaciation, a fact attested by the presence of a succession of river-cut benches covered by undisturbed gravel deposits lying one above the other along the walls of Tatshenshini River Canyon below the mouth of Pirate Creek. The upper benches are cut in glacial debris.

60412—2½

GLACIATION

During Pleistocene time great masses of ice accumulated in the Icefield Ranges of the St. Elias Mountains, and moved east, northeasterly, and north, down slope, into the valleys of Kaskawulsh, Dusty, and Alsek Rivers. South of the map-area, lower Alsek Valley was quickly choked with ice that precluded further escape in that direction; as a result the glacial ice moved northwest, north, and easterly up the existing valleys, according to the records left by the glaciers in the form of glacial striæ, glacial grooving, moraines, eskers, kames, and terraces. Thus, ice brought down by a greatly magnified Fisher Glacier moved northeast up the valleys of Bates River and Bates Lake. At Mush Lake, part of the ice-mass continued north along the Duke Depression, but most of it moved easterly via Mush Lake and Alder Creek Valleys to the Dezadeash Lake gathering grounds. There it was joined by valley glaciers pushing north along Klukshu and Takhanne River Valleys, and the enlarged ice-fields continued moving northerly, principally by way of Shakwak Valley, but in part by way of the northeasterly trending valley of Dezadeash River. At the time of maximum ice-flow, all of the mountains north of Dezadeash Lake were overridden up to elevations of 6,000 feet, whereas the Kluane Ranges west of the lake protruded well above the ice-fields. The same alpine glaciers that exist below their peaks today were probably much more active at that time, and they contributed their ice load to the moving ice-fields below them.

Lowell Glacier (*See* Plate III A) fed great masses of glacial ice into Alsek River Valley at that time, and the resultant valley glacier moved northerly up the Alsek and reached Shakwak Valley by way of the gap at Kathleen Lake and the gap occupied by the lower part of Dezadeash River. Another great valley glacier moved north along Dusty River, and was diverted into two channels on reaching the valley of Kaskawulsh River. Part of this ice-mass moved northeasterly across Kaskawulsh Valley, merging with the glacier flowing north along Alsek Valley, and passed with it through the Dezadeash River gap to Shakwak Valley. A second lobe of the Dusty River glacier moved northwesterly across Kaskawulsh Valley and reached Shakwak Valley by way of the valley of Jarvis River. The cluster of mountain peaks lying north of Kaskawulsh River and around which this valley glacier was diverted rises above 8,000 feet in several places. North of the mouth of Dusty River, glacial striæ and rounded slopes show that the ice-sheet overrode these mountains up to elevations of about 6,000 feet as it passed around their western slopes. On both east and west sides of the gap occupied by Dezadeash River north of the mouth of the Kaskawulsh, there is also evidence of glacial scouring up to elevations of about 6,000 feet.

The valley of Tatshenshini River is wide and low for a long way south of Bridge River. This great valley formed a natural gathering ground for ice moving down from the Alsek Ranges on the west and the Squaw Range on the east. The resulting valley glacier moved northerly along the valley of the Tatshenshini on the west side of Mount Beaton and fed both the Klukshu Valley Glacier and the ice-fields that occupied Fraser Creek Valley. These glaciers were further augmented by a large valley glacier that flowed northwesterly down the valley of the upper part of Tatshenshini River, along the east side of Mount Beaton. Most of this ice originated among the high mountains at the head of Parton River 20 miles south of the Yukon-British Columbia boundary. Judging from the evidence of glacial striæ observed by Watson (1948), some of the Parton River glacier moved east around the north slope of Datlasaka Mountain (west of mile 84, Haines Road) and then southeasterly towards the head of Kelsall River on the Pacific slope.

Small ice-fields abound on the high mountains of the Boundary Ranges both east and west of Kusawa Lake. These may be remnants of the greater fields that persisted there during the Glacial period. Glacial grooving and striæ disclose that the former ice-sheet spread northerly filling all of the valleys and scouring and rounding off all peaks that did not rise above an elevation of 6,500 feet. The steep-walled valley occupied by Kusawa Lake was considerably deepened by valley glaciation at this time, judging from the formation of hanging valleys at the south end of the lake.

At the time of greatest glacial activity, Dezadeash Valley was ice-filled to an elevation of about 6,000 feet above sea-level, and this ice-sheet spread northerly and covered the greater part of the Aishihik district. The presence of well-developed kame terraces between elevations of 3,500 and 4,500 feet on the mountain slopes northeast of Canyon and on the mountains between Jo-Jo Lake and Dezadeash River may indicate that the ice persisted between these levels for a long time following a period of more active glaciation when the higher slopes up to 6,000 feet were ice covered. Glacial Lake Champagne was formed towards the close of the Ice Age, when valley glaciers still occupied the large valleys of the Kluane Ranges west of Shakwak Valley and Takhanne and Klukshu River Valleys south of Dezadeash Lake. Evidence of very recent advance and retreat of the Lowell Glacier is given below in the description of Recent Lake Alsek. This lake, formed by the glacial damming of Alsek River, disappeared some 100 years ago.

PLEISTOCENE OVERBURDEN

GLACIAL LAKE CHAMPAGNE

Towards the close of the Glacial Epoch, when the valley glaciers had retreated to the outer edge of the Kluane Ranges, glacial meltwaters filled Takhini Valley from Shakwak Valley on the west to Takhini River on the east. This great glacial lake also extended far to the east of the map-area along the valley occupied by Takhini River, though just how far has not been determined. It extended north of the map-area along the valley occupied by Mendenhall River and Taye Lake, but probably for only a short way. The lower end of Aishihik River Valley formed another northerly reaching arm. There were also three southern arms of the lake: one of these extended southwest from the present site of Champagne up the valley of Dezadeash River to Dezadeash Lake; another arm joined with the waters of a greater Kusawa Lake; and both Kusawa and Dezadeash Lakes were united by a connecting channel along the valley now occupied by Frederick Lake. The glacial lake also reached southerly up the valley of Kathleen River to Dezadeash Lake.

The writer proposes the name Glacial Lake Champagne for this old, glacial lake to facilitate its identification. The name is derived from the village of Champagne, oldest post within the perimeter of the extinct lake basin.

Beach deposits of sand and gravel that mark the old shorelines of Glacial Lake Champagne are widespread along the valley walls that retained the lake, and on islands that existed at that time. The beaches are best developed on steep, exposed slopes between elevations of 2,300 and 2,800 feet, where wave action was most pronounced. A few of the best developed beaches encountered during the course of geological mapping have been plotted on the accompanying geological map (in pocket). However, where one beach is indicated on the map, there may actually be as many as four or five well-developed beaches, one above the other, and too closely spaced to map separately. It should, with time for the task, be possible to trace the old shorelines almost continuously from place to place, as these old shoreline deposits have been little disturbed except where they are crossed by younger streams. They are concealed beneath sand dunes in several places north of Champagne.

An unusually well-incised beach lies 365 feet above the present level of Kusawa Lake, and is visible for miles along the west side of the lake. Where examined southwest of the mouth of Primrose River, it is 75 feet wide, gently sloping with an abrupt drop at its outer edge. The present lake level is nearly 2,200 feet above sea-level, so that this particular beach lies at an elevation of 2,565 feet. Another, well-defined beach lies 140 feet above present lake level at an elevation of 2,340 feet, but is not as deeply cut as the higher shoreline.

Takhini Valley is floored with glacio-lacustrine sediments, from Pine Lake on the west to Takhini River on the east. The beds are largely stratified silts (*See* Plate IV B) that settled from the glacial meltwaters of Lake Champagne. Sand occurs near the mouths of incoming streams or near the old shorelines, from where it was distributed by wave action. Some of the finer sands have since been whipped by the prevailing wind into northeasterly migrating sand dunes. The silts are generally finely stratified, but also occur in beds ranging from an inch or so to as much as 2 feet thick. The beds are of an even light grey colour, and do not exhibit the seasonal colour banding that characterizes the glacio-lacustrine banded clays that are widely known as varved clays. A few icebergs cruised the waters of the lake, and pebbles and boulders dropped from them are sparsely distributed throughout the stratified silts.

These silt beds have been deeply eroded by streams that now cross the old lake floor. Mendenhall River has excavated a cut more than 125 feet deep at a point where it is crossed by the Alaska Highway. West of the river, the plain formed by the uppermost lake beds lies at an elevation of about 2,300 feet. Near the junction of Aishihik and Dezadeash Rivers these sediments have been eroded to a depth of about 200 feet.

Glacio-lacustrine beds also occur in low ground below the 2,500-foot contour along the valley of Kathleen River, along Aishihik River Valley, along the valley occupied by Taye Lake, and up Takhini River Valley to Kusawa Lake. As neither lacustrine nor beach gravels were seen south of Klukshu Lake, nor west of the south end of Dezadeash Lake, it is concluded that both Klukshu River and Mush Lake Valleys were filled with glacial ice during the lifetime of Glacial Lake Champagne. Most of Takhanne River Valley was also occupied by glacial ice at that time, and its meltwaters drained northwest into a greatly enlarged Dezadeash Lake. A great outwash fan of sand and gravel deposited by this stream lies a short way above the 2,500-foot contour 2 miles east of the north end of Klukshu Lake. The fan originates 2 miles farther southeast in the vicinity of a group of eskers.

At Kathleen Lake, beach gravels may be seen about that part of the lake encompassed by Shakwak Valley, but they are missing about the west half of the lake west of the mountain front. This is evidence that the valley of Kathleen Lake west of the mountain front was ice-filled throughout the lifetime of Glacial Lake Champagne.

GLACIAL LAKE JO-JO

A series of well-defined lake beaches are exposed about Jo-Jo Lake. The present elevation of this lake is about 2,915 feet above sea-level, and the old shoreline deposits occur along both sides of the valley between elevations of 75 and 225 feet above the present lake level, or up to an elevation of 3,140 feet. They extend for 2 miles north of Jo-Jo Lake and for 6 miles south, or almost to Kusawa Lake. The overall length of the former lake was nearly 15 miles, but its average width was only 1 mile, as it occupied a narrow, steep-walled valley. The present lake is ½ mile wide and 7 miles long.

The beach gravels about Jo-Jo Lake were formed in a glacially dammed lake. Two miles north of the present lake, Jo-Jo Valley was blocked by a great kame moraine 225 feet high at its lowest point. The kame consists of stratified sand, gravel, and silt that were evidently deposited at the mouth of a large glacial stream during a pause in the retreat of the ice-front. With further retreat to the south, the glacial lake was formed, contained on the north by the kame moraine and on the south by the glacier. The glacial meltwaters drained north at this time across the kame, and normal stream erosion gradually deepened a cut across these sand and gravel deposits, with consequent lowering of the level of Glacial Lake Jo-Jo. But the water level was maintained at a high level for a long time, as the upper beach levels between 3,100 and 3,150 feet are the best developed of any of the shoreline features and extend to within a mile of Kusawa Lake. Normal drainage to the south was not restored until the retreat of the Kusawa Lake valley glacier and the subsequent drainage of Glacial Lake Champagne.

It is proposed that the name Glacial Lake Jo-Jo be applied to the glacial lake described above.

GLACIAL LAKE KLOO

The basin occupied by Sulphur and Kloo Lakes was also the site of glacially impounded waters during the wane of the Ice Age. Drainage to the south was impeded by an ice-dam near the junction of Jarvis River and Kimberley Creek, and the glacial meltwaters were backed up to form a lake that rose to an elevation of about 3,000 feet. The bottom of this former lake is blanketed by stratified silt exposed in many places along an old trail that leads south from Sulphur Lake to Kimberley Creek. One of the old beaches crosses the Alaska Highway 2 miles southeast of the Jarvis River bridge.

The full extent of this old glacial lake basin, tentatively named Glacial Lake Kloo, has yet to be ascertained.

GLACIAL LAKE FISHER

Stratified silts more than 200 feet thick form the north bank of Bates River for 4 miles, from a point 2 miles east of Alsek River to the canyoned sector of the Bates 4 miles farther upstream. These silt beds are also exposed for several miles along Clay Creek and along Helen Creek (east fork of Clay Creek). They are capped by sand and coarse gravel beds about 20 feet thick. The silts were obviously derived from glacial meltwaters and were deposited on the bottom of a glacial lake that filled a shallow basin. The lake basin probably originated as a result of strong valley glaciation by an enlarged Fisher Glacier during the days of active glaciation, and the lake formed as the Fisher Glacier slowly withdrew to its present position just west of Alsek River. The beds of sand and gravel were deposited by Bates River following the draining of the glacial lake.

Some of the thickest stratified silts seen in the map-area are exposed for more than a mile on the west side of the Alsek south of Lowell Glacier, and for a distance of about a mile along the east bank of the Alsek, 2 miles south of Lowell Glacier. At the latter locality they are believed to extend southeasterly along the valley of Clay Creek, and to be continuous, in part at least, with the silts of the lower Bates River basin. The glacial lake from which these silts were precipitated is believed, therefore, to have occupied Alsek Valley between Fisher and Lowell Glaciers and to have reached south along Clay Creek Valley to Bates River. It is proposed that this late-Glacial lake be named Glacial Lake Fisher to aid in its identification. A detailed study of the Alsek Valley beds of this old lake basin should reveal interesting data on the longevity of Glacial Lake Fisher, as they are at least 500 feet thick.

ESKERS AND KAME MORAINES

The long, narrow, sinuous ridges of sand and gravel along the Haines Road a mile south of Takhanne River, near mile 102, are eskers. They are best developed west of the road, to as far as the canyon cut by Tatshenshini River; other eskers lie west of this river. The eskers occur in clusters, and some are more than 2 miles long. The ridges generally range from 50 to 100 feet in height, but their continuity is broken by occasional gaps. The crests of the eskers are smooth and hummocky, and the sides are steep. They are composed of material that varies from well-bedded, water-laid sand and gravel to poorly sorted pebbles and boulders.

The eskers all have a northerly trend roughly parallel with the direction of ice movement. They are generally considered to represent accumulations of sand and gravel deposited by glacial meltwaters in under-ice tunnels at the base of the glaciers at a time when the ice was thin and stagnant, and so they represent one of the final phases of deglaciation. They commence abruptly, probably at places where surface meltwaters first reached the subglacial tunnels through crevasses or other openings. As the grit, pebbles, and boulders of the eskers are well rounded, it seems probable that most of the gravels were collected by streams flowing over the ice prior to entering the subglacial tunnels.

The eskers along the Haines Road are of economic interest, as they comprise great deposits of gravel that are readily available for road building. In addition to the eskers west of mile 102, a group of eskers lies near mile 123, and others were observed north of the road near mile 146, north of Kathleen Lake. No eskers were seen along or adjacent to the Alaska Highway in the map-area, and it is believed that they are concealed along Takhini Valley by the silts laid down by Glacial Lake Champagne.

An unusually well-developed cluster of eskers, 1 mile northeast of the north end of Kusawa Lake, covers an area 3 miles long and 1½ miles wide. In it, the larger eskers are joined by tributary branching eskers that form patterns similar to those formed by branching streams. Another large group of eskers rests on the low divide at the head of Takhanne River and is strung out along the valley of Takhanne River for 12 miles, as far south as Pass Creek. Both the Kusawa Lake and Takhanne River esker clusters, as well as the group of eskers west of mile 103, Haines Road, terminate on the north against broad flat terraces of sand and gravel that accumulated along the ice-front at the mouths of the glacial streams. These are kame moraines. They are formed mainly of sand and gravel, but may contain minor amounts of clay and boulders. Much of this material was water sorted and stratification is generally in evidence, but in most places the sand and gravel lacks any semblance of structure, particularly in the vicinity of kettle-holes, where slumping has followed the melting of buried isolated ice masses. All of these kame moraines pass on the north into areas of sand outwash. The best developed of these sand plains is that at the head of Frederick Creek, which has a length of about 5 miles along Frederick Creek Valley and which extends westerly to within 2 miles of Klukshu Lake.

Esker Creek, a northeasterly flowing tributary of Fraser River, was so named on account of the large number of esker ridges adjacent to its east bank. Eskers are also well developed along the west side of Fraser Creek south of the mouth of Esker Creek. They were noted in three places near the north border of the map-area, on the northeast side of Taye Lake, along the west side of Moraine Lake, and 3 miles northeast of Kloo Lake. Kettle-hole topography and kame moraine sands and gravels abound at both the north and south ends of Moraine Lake. A group of eskers, with associated kame moraines, was also noted on the west border of the map-area, a mile west of the mouth of Dusty River.

KAME TERRACES

Streams that flowed along the sides of the great valley glaciers during the period of ice recession left accumulations of water-sorted sand, gravel, and boulders. These deposits are in the form of narrow, gently sloping benches or terraces that lie well up on the mountain sides. They are well developed near an elevation of 4,000 feet on the sides of the large basin 7 miles northeast of the mouth of Aishihik River, and also at an elevation of 4,500 feet near the head of the west fork of Cracker Creek. On the mountain slope 3½ miles south of Champagne, one of these terraces extends easterly for 3 miles, commencing 1½ miles east of Dezadeash River and rising gradually from an elevation of 3,500 to 4,000 feet on the east shoulder of the mountain. It then swings southwesterly and continues to rise, following the east slope of the mountain, for an additional 2 miles above Pond Creek, and terminates near an elevation of 5,000 feet. The easterly trending part of this terrace is readily seen from the Alaska Highway.

At the south end of Jo-Jo Lake on the west side of Jo-Jo Valley, three distinct kame terraces were seen, each about 100 feet above the other, the lowest lying just above timber-line. Well-developed kame terraces also occur on the mountain slope 3 miles east of Six Mile Lake. They extend for more than 7 miles northeasterly between elevations of 3,500 and 4,000 feet.

TERMINAL MORAINE AT CHAMPAGNE

Champagne lies on the west side and at the foot of a ridge 4 miles long that extends from a point 1 mile north of the village to Kelvin Mountain 3 miles to the south. The ridge is arcuate in outline, with the convex side facing westerly. It ranges from ¼ mile to a mile in width and rises between 100 and 200 feet above the valley bottom. The ridge is composed of sand, gravel, and boulders that exhibit water sorting where excavations have been made for road gravel at its northern end. It is believed to be a terminal moraine that formed at the melting front of an ice-lobe that extended westerly from the Kusawa Lake valley glacier during a lull in the retreat of the ice-sheet. The original outline of the ridge has been somewhat modified by the erosive action of Dezadeash River along its base on the west side, by the washing it received from the waves of Glacial Lake Champagne, and by the sand dunes that now mantle it.

DRUMLINS AND GROUND MORAINES

Drumlin ridges composed largely of boulder clay are exposed along many of the higher valleys. They are concealed along the lower valley bottoms by a mantle of glacial-lake silts. The drumlins are generally in the form of elongated ridges, with smooth, gently rounded sides, and they are commonly fluted, with grooves pointing in the direction of last ice-flow. A large part of the drift in the drumlin-field areas can be classified as ground moraine to include the swales between the drumlins as well as the low, gently rolling hills.

A great field of boulders, coarse gravel, and sand north of Mount Beaton accumulated at the junction of two ice-sheets, both of which moved northerly up the valleys on either side of the mountain. Prominent boulder moraines also occur along the upper part of Cracker Creek Valley and about Moraine Lake.

ICE-BLOCK RIDGES

Ice-block ridges lie astride the Alaska Highway between miles 1030 and 1032, but were not noted elsewhere in the map-area. They are narrow ridges, only a few feet high and rarely more than 1,000 feet long. The ridges trend northeasterly parallel with the direction of ice movement, and rest upon glacial till. They are composed of gravel, sand, and silt. These ridges probably mark the former location of longitudinal cracks or glacial crevasses in a stagnant ice-sheet, and formed from material that slumped along the crevasses between the large blocks of melting ice.

ALPINE MORAINES

Recessional alpine moraines abound in all of the high mountains in the map-area. They are particularly conspicuous along the northeastern slopes of the Kluane Ranges, where there is at least one of these moraines for every 2 linear miles of mountain front. They comprise thick accumulations of angular blocks of bedrock derived from the valley walls higher up the mountain and brought to their present sites by the alpine glaciers. Many of these morainal trains are more than 2 miles long, and they range from 1,000 feet to as much as a mile in width. Small alpine glaciers lie at the heads of all but a few of these moraines.

Outlines of the largest alpine moraines are sketched on the accompanying map to illustrate their relative abundance in relation to topography and rock type. Ice-free cirques are abundant in the granitic terrain between Takhanne Creek and the south half of Kusawa Lake, but most of the alpine moraines there are too small to map, due in part to the harder bedrock. West of Dezadeash Lake, the lower ends of the alpine moraines reach to the main valley bottom at an elevation of 2,500 feet; this proof of a profound retreat of the alpine glaciers since the Glacial age.

RECENT OVERBURDEN

RECENT LAKE ALSEK

In comparatively recent years Alsek River was dammed at least twice by an advance of Lowell Glacier across its path. The glacial ice became tightly packed against the steep west face of Goatherd Mountain (*See* Plate III B) through a depth of some 500 feet, and this ice-dam caused Alsek River waters to back up and form an elongated lake. The lake extended 25 miles up Alsek River and an additional 27 miles up Dezadeash River Valley to a point midway between the mouths of Marshall Creek and Aishihik River. It reached 3 miles north along Bear Creek, and an arm extended east from Bear Creek to Pine Lake. Another arm of the lake reached 8 miles up the valley of Kaskawulsh River, and Dusty River Valley was invaded by a deep bay of the lake that extended 4 miles south from Kaskawulsh Valley.

The approximate outline of this Recent lake basin is shown on the accompanying geological map. As the depth and volume of water in the lake were greatest in Alsek River Valley, it is proposed that this lake be named Recent Lake Alsek.

The old shorelines of Lake Alsek are marked almost everywhere by beach deposits of sand, gravel, and boulders (*See* Plate VA). West of the big bend on Dezadeash River, the beaches are cut on a long steep talus slope that reaches almost down to present river level at an elevation of 1,970 feet. The topmost beach is at an elevation of 2,240 feet or 265 feet above present river level (elevations by aneroid barometer), and a total of thirty-six distinct, wave-cut benches may be counted between the river and the topmost strand line, each beach representing a pause in the level of the lake waters. Driftwood left on the lower lake beaches in sheltered bays is still in a good state of preservation (*See* Plate V B). The highest driftwood-littered beach seen by the writer is on the northwest side of the right-angle bend of Dezadeash River, 125 feet above the river at an elevation of 2,095 feet. No driftwood was seen above an elevation of 2,105 feet, and the beaches are covered there by a heavier growth of forest trees. The existence of normal forest growth on older upper beaches between elevations of 2,105 and 2,240 feet is even more apparent farther down river along the Alsek, where the slopes are more gentle. Trees up to 165 years of age occur on these upper beaches, but no fallen rotted timbers or humus such as may be seen littering normal forest floors. It is evident that these upper beaches are the older, and that they were formed at an earlier stage of Recent Lake Alsek.

There is comparatively little vegetation below the 2,100-foot contour (*See* Plate II B), and trees are growing well only in favoured localities that are sheltered from wind, or where moisture is plentiful along the banks of the rivers. The largest tree seen by the writer in low ground close to the present river's bank was a spruce 8 inches in diameter at the base. This spruce was 42 years old in 1950. McConnell (1905, p. 4) was the first to note these lake beaches. He described the trees occurring on the lower beaches in the year 1904 as rarely exceeding 3 inches in diameter, and states:

"Judging from the character of the beaches themselves, the undecayed driftwood, the young vegetation and the stories current among the Indians, it is probable that the lake which produced these beaches existed less than a hundred years ago."

The 42-year old spruce found near the present water's edge had not yet taken root at the time of McConnell's visit to this region in 1904. The prevalence of grassy slopes and flats indicates that trees take root very slowly on these gravel beaches, and a minimum of 50 or 60 years should probably be allowed in estimating the time required for the trees presently growing there. If so, the age of the last phase of Recent Lake Alsek would be approximately 100 years in 1950. As growth rings show an age differential of 125 years between trees growing on the younger beaches and those growing on the older beaches above the 2,100-foot contour, the older beaches were probably built along the shores of Recent Lake Alsek prior to 1725.

Large blocks of granite, gabbro, and pyroxenite litter the floor of Recent Lake Alsek, having been dropped there from icebergs that were blown up Alsek Lake from the Lowell Glacier by the prevailing winds. Some limestone, slate, and quartzite boulders were also dropped, but are far less plentiful than those of the igneous rocks.

A set of vertical air photographs taken by the Royal Canadian Airforce in 1948 shows the Lowell Glacier ice-front to be a good mile west of Alsek River. An unusually heavy snowfall during the winter of 1948-49 was reflected in a re-advance of the Lowell Glacier, and at the time of the writer's trip down the Alsek in 1950 the ice on the north side of Lowell Glacier had advanced to within 100 feet of the rock bluffs of Goatherd Mountain and was threatening to again dam the waters of the Alsek. But the ice-front was only 75 feet high, and the river seemed quite capable of controlling any further attempts of so thin an ice-sheet to advance.

FLUVIAL BEDS

Fluvial beds include all those of silt, sand, gravel, and boulders that have been transported by streams. They may be divided roughly into three age groups. The oldest are those that form the flat, fan-shaped gravel terraces that lie highest on the lower mountain slopes and in which the stream beds are now deeply entrenched. Many of these fans were built in late Pleistocene time by the streams entering Glacial Lake Champagne. Those of the second age group comprise the secondary sand and gravel fans deposited below the hillside terraces by the entrenched streams. Recently formed gravel benches and gravel plains along either small streams or large rivers are also included in this group. The third group embraces those accumulations of sand, gravel, and silt found in the present stream channels or in bars along their watercourses.

The gravel deposits are of economic interest because of their placer gold content, and are discussed on later pages of this report. The larger occurrences of sand and gravel have been outlined on the accompanying geological map.

MARL

Marl occurs beneath shallow water at the west end of Pine Lake, and marl beds up to 2 feet thick were seen half-way up the 10-foot banks of Marl Creek where the latter enters the west end of Pine Lake. Thin beds of marl are also exposed just above the present level of Pine Lake where the outlet stream (Pine Creek) leaves the lake. These marl beds are of a pale yellow-grey hue, and consist of as much as 75 per cent calcium carbonate in a mixture of clay, silt, and decayed vegetation. They contain a few, small, freshwater shells. The lime precipitating plant, Chara, flourishes in the shallow water at the west end of the lake and takes an active part in the precipitation of the marl.

VOLCANIC ASH

Nearly all reports on southern Yukon record the presence of a single, widespread layer of white volcanic ash that in most places ranges from 2 to 4 inches in thickness. This layer was noted in many places in low ground in the north part of the map-area, particularly in the cut-banks along Dezadeash and Takhini Rivers. It was consistently between 1 inch and 3 inches thick wherever it was examined, but is known to increase in thickness north of the map-area. H. S. Bostock (1952) has recently drawn a map that depicts the known extent of the ash layer. The ash bed is covered nearly everywhere in the map-area by wind-blown soil ranging in thickness from a few inches to 2 feet. Capps (1931) has calculated the ash layer to be about 1,400 years old. At the south end of Taye Lake, the ash rests directly upon a layer littered with hand-worked rock chips, among which were found stone arrowheads, spear points, and scrapers.

SAND DUNES AND LOESS

Wind-blown sand has formed sand dunes in numerous places between Champagne and Sanddune Creek and along Dezadeash River 5 miles west of the mouth of Sanddune Creek. Dune sands cover the floors of all of the mountain passes north of Champagne. The dunes migrate slowly in a northeasterly direction, impelled by the prevailing winds. Dune sands were also noted on high bluffs overlooking Dezadeash River east and west of the mouth of the Aishihik. They occur in several places along the lower mountain slopes at the north end of Dezadeash Lake, where they have been swept by winds that blow northeasterly across the lake. Dunes were also noted along the valley of Takhini River immediately north of Kusawa Lake.

Wind-blown soil or loess is widely distributed throughout the map-area. The following, in descending order, is a cross-section of the surface soil seen 3 miles south of Champagne: grey silt, 5 inches; dark silt, 2 inches; white volcanic ash, 1 inch; brown soil, admixed with some yellow soil, and containing charcoal, bone fragments, and artifacts, 8 inches; and yellow silt and sand, with minor clay, 14 inches.

The daily rise and fall of Alsek, Kaskawulsh, and Dusty Rivers during the summer months creates ideal conditions for deposition of fine glacial silts over the wide river flats near the junctions of these streams. These glacial silts are often whipped into white dust clouds by the prevailing northerly winds. Great dust clouds formed in this way at the mouth of Dusty River are easily visible on warm summer days from the mouth of Dezadeash River, 5 miles east of Dusty River.

Minor dust clouds often arise on the north side of the right-angle bend of Dezadeash River 4 miles south of Bear Creek, where silts are deposited over a broad fan by the glacial stream that drains the northeast slopes of Mount Archibald.

CHAPTER III

GENERAL GEOLOGY

SUMMARY STATEMENT

Granitic rocks of the Coast Range batholithic mass underlie the greater part of the east half and northern parts of Dezadeash map-area. Large areas of the older, metamorphic rocks of the Yukon group are also found there. These intruded rocks include a variety of schists and gneisses of sedimentary origin, and crystalline limestone, slate, and quartzite. Hornblende and chlorite schists derived from the intense metamorphism of volcanic rocks, mainly lavas, occur in some places with the schists and gneisses.

The east front of the Kluane Ranges on the southwest side of Shakwak Valley is composed of a thick series of sedimentary rocks of Lower Cretaceous age. Some thin coal seams occur in a thick conglomerate bed at the base of this sedimentary series, and in argillite, slate, and tuff beds immediately above the conglomerate member. These rocks are underlain on the west by a thick band of volcanic strata with which some sedimentary beds are intercalated. The volcanic rocks are composed largely of andesite, basalt, dacite, rhyolite, and volcanic breccia, and the sedimentary members consist mainly of crystalline limestone, argillite, and slates. This series of volcanic rocks with intercalated sedimentary strata is thought to be of Jurassic and Triassic age.

The volcanic rocks of Sifton Mountain, northeast of Taye Lake, are mostly dacite, latite, andesite, and rhyolite flows and flow breccias, with some tuff beds. They are likewise probably of Jurassic or earlier Mesozoic age.

A belt of crystalline limestone, with intercalated quartzites and black and brown slates, underlies the Jura-Triassic? volcanic series. This limestone belt is of Carboniferous or Permian age, and is best exposed between Kaskawulsh River and Kimberley Creek. Similar rocks also outcrop west of Sockeye Lake and along Silver and Dollis Creeks.

In the mountains west and southwest of Bear Creek the Mesozoic volcanic and sedimentary successions are intruded by stocks and dykes of peridotite and serpentine. Stocks and dykes of granite and granodiorite invade all of these rocks at widely scattered intervals throughout the St. Elias Mountains.

Flat-lying and gently folded conglomerate, sandstone, and shale beds of Paleocene age overlie older strata on the east side of Bates Lake and at the west end of Mush Lake. A profound unconformity separates the Paleocene beds from the older strata. The former are intruded by a stock of white weathering soda syenite on the east side of Bates Lake.

The youngest rocks in the area are comparatively flat-lying or gently folded lavas, flow breccias, and tuffs of Tertiary age that blanket several mountains adjacent to Alsek River and form the banks of Dusty, Kaskawulsh, and Alsek Rivers at their confluence. Five miles northwest of Mush Lake, the Tertiary volcanic rocks overlie Paleocene conglomerate, grit and shale beds.

TABLE OF FORMATIONS

Age	Name, and thickness in feet	Lithology
Quaternary (Pleistocene and Recent)		Silt, sand, clay, gravel, boulder clay, volcanic ash
	Unconformity	
Tertiary	5,000 ±	Volcanic breccia, tuff, rhyolite, dacite, andesite, basalt, sandstone
	Unconformity	
Post-Paleocene		Soda syenite
Paleocene	5,000 ±	Conglomerate, sandstone, shale
	Unconformity	
Lower Cretaceous		Granite phorphyry, quartz porphyry
and later	Coast intrusions	Granite, granodiorite, diorite, porphyritic granite, augen-gneiss, gabbro
		Peridotite, serpentine, dunite
Lower Cretaceous	Dezadeash group 12,000 ±	Sandstone, slate, greywacke, argillite, quartzite, chert, tuff, conglomerate, coal
	Unconformity	
Jura-Triassic (?)	Mush Lake group 7,000–20,000 ±	Andesite, basalt, tuff, dacite, rhyolite, volcanic breccia; crystalline limestone, slate, greywacke, argillite

Unconformity

Carboniferous or Permian	Kaskawulsh group 9,000±	Limestone, marble, slate, quartzite, argillite, chert, andesite, schist

Unconformity

In part Palæozoic or later but mainly Precambrian	Yukon group 12,000±	Quartz-mica schists, gneiss, slate, quartzite, crystalline limestone, greenstone; hornblende, chlorite, and garnetiferous schists

YUKON GROUP

The rocks mapped as Yukon group consist largely of quartz-mica schists, quartz-biotite-feldspar gneisses, crystalline limestone, slate, and quartzite, with minor areas of quartz-sericite-andalusite schist, hornblende schist, sericite-cordierite schist, garnetiferous schist and gneiss, and some chlorite schist, greenstone, and andesite. The larger part of the Ruby Range and Dezadeash Mountains is composed of these rocks, and they outcrop along many of the mountain slopes in the southeast quarter of the map-area. They are widely invaded by granitic intrusions, and in many places form roof pendants surrounded by granite and granodiorite. The schists and gneisses are commonly interbanded with limestone and quartzite and are obviously derived from the intense alteration of sedimentary rocks. These rocks are not known to carry any fossil remains. The Yukon group is generally regarded as, at least in part and probably for the most part, of Precambrian age.

Some andesite is interbedded with quartz-mica schists at the north end of Kusawa Lake on the west side, and a mountain top consisting largely of andesite and chlorite schist lies 2 miles east of the north end of the lake. A few stringers containing copper minerals were noted in these latter rocks, which constitute a roof pendant enclosed in granite. Andesite and chlorite schist associated with greywacke and quartz-mica schists outcrop about Klukshu Lake. At an elevation of 3,800 feet on the mountain east of the south end of Klukshu lake, chlorite schist is converted in several places to a coarsely crystalline, dark green to black amphibolite. Some specimens of apple-green jade found on this slope by Klukshu Indians probably originated in the amphibolite. The jade specimens seen by the writer were thought to be nephrite, a variety of tough, compact, fine-grained, green actinolite.

Greenstone schists outcrop for several hundred feet along Tatshenshini River and along a small tributary stream that flows westerly in a canyon-like valley from Haines Road at about mile 98·5. The schists are about 150 feet thick, and intercalated with them are bands of well-bedded crystalline limestone ranging from 1 foot to 6 feet thick. These rocks are overlain by 100 feet of thin-bedded black slates, which are in contact with gneissic granodiorite.

Crystalline limestone exposed on the east slope of the mountain 8 miles northwest of Champagne has a thickness of well over 1,000 feet. It is a white, coarsely crystalline rock, greatly silicified at its contacts with the granite, near which, also, garnetiferous zones are plentiful. Crystalline limestone outcrops on the mountain 2 miles east of the north end of Six Mile Lake as bands up to 20 feet wide interbedded with wider zones of quartz-biotite and quartz-biotite-garnet gneiss, the whole about 600 feet thick. The beds are severely contorted. Two bands of white crystalline limestone, each more than 200 feet thick and separated by 1,000 feet of quartz-mica schist and gneiss, outcrop on a low ridge 2 miles north of Taye Lake. Limestone also outcrops in some abundance both northeast and southeast of this lake. It occurs in thin bands on the east side of Kusawa Lake, and, as noted by Cockfield (1928), is fairly common on the hills east of Frederick Creek.

Garnetiferous quartz-mica schists are particularly abundant about the headwaters of Marshall Creek, and for this reason the principal east-flowing tributary of Marshall Creek has been named Garnet Creek. Schefferite-biotite schists occur as an aureole about a small granodiorite stock on the mountain between the headwaters of Garnet and Cripple Creeks, 3 miles from the north border of the map-area. Schefferite, a manganese pyroxene of brown to reddish brown hue, occurs here both in the schists and in the nearby granodiorite. The schefferite crystals are well developed and stand out prominently on weathered rock surfaces; they generally range from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter, but forms more than an inch across are not uncommon. They exhibit repeated twinning, and some of the larger forms, of circular outline, are six-rayed twinned crystals.

The dominant trend of the Yukon group rocks is northwesterly, but some folding was along northeasterly trending axes, particularly in the area between Dezadeash and Kusawa Lakes and east of the latter lake.

Wherever the rocks are schistose or gneissic and where remnant beds of quartzite, limestone, slate, or greywacke occur, the strike and dip of both bedding and schistosity are generally about the same. On the ridge east of Cracker Creek and in many places in the Dezadeash Mountains, the gneisses are so highly contorted and granitized that all remnants of original structures have been obliterated. The Yukon group strata are separated from the Mesozoic rocks of the Kluane Ranges by major faults that lie concealed along the course of Shakwak Valley and by lesser faults along the valley of Klukshu River. They are in faulted contact with Mesozoic volcanic rocks 3 miles northeast of Taye Lake, along the southern slopes of the Sifton Range. Some 12,000 feet of schists and gneisses, with some intercalated black slate and thin limestone beds, are exposed along the mountain ridge that extends southerly towards the southeast end of Taye Lake. No basal beds have been recognized, but the true thickness of the Yukon group, judging from available exposures, is probably in excess of 12,000 feet.

The schists and gneisses are cut in many places by small quartz veins and by granite and pegmatite dykes. Small quartz veins containing tourmaline were noted in several places on the ridge 2 miles northwest of

Canyon, and several small shear zones impregnated with finely crystalline pyrite were seen a mile west of Aishihik River and a mile south of the north border of the map-area in quartz-biotite-plagioclase gneiss.

KASKAWULSH GROUP

Sedimentary rocks consisting largely of crystalline limestone, but with intercalated zones of black and brown slates, quartzite, and argillites, form rugged northwesterly trending mountain slopes along the north side of Kaskawulsh River north of the mouth of Dusty River. These rocks occupy a belt about 2 miles wide: they strike northwesterly, generally dip northeasterly, and probably form the northeast limb of a major northwesterly trending anticline. It is proposed that this group of sedimentary rocks be named the Kaskawulsh group as they are best exposed on the north side of Kaskawulsh River.

No complete section of Kaskawulsh group rocks is exposed in the map-area. Its lower beds are concealed by Tertiary lavas 2 miles west of Sugden Creek, and there the lowermost beds seen along a small mountain stream are green andesitic schists cut by a peridotite dyke. Black and brown weathering, thin-bedded slates outcrop at an elevation of 3,300 feet, just above the dyke, and are exposed along the creek bed for ½ mile up to an elevation of about 4,000 feet, where bands of grey and white crystalline limestone form the dominant rock.

Some of the limestone beds grade into grey and brown weathering calcareous argillites. At an altitude of 4,600 feet, an elliptical body of brown amygdaloidal andesite, about 100 feet long, is enveloped by the crystalline limestone, and a small body of yellow-brown volcanic breccia breaks through grey limestone 100 feet higher up the steep slope. These volcanic rocks may be of later age, and if so were probably downfaulted into their present positions.

The contact of Kaskawulsh group rocks with overlying Mush Lake group rocks is exposed on less precipitous slopes 1½ miles south of Kimberley Creek close to the west border of the map-area. Here the upper 2,000 feet of the Kaskawulsh group consists of alternating bands of grey and white crystalline limestone, and the limestone is overlain, apparently conformably, by thick andesite flows of the Mush Lake group.

Both formations are overturned in the vicinity of their contact, and they strike northwest and dip 65 degrees southwesterly. A band of brecciated limestone consisting of angular and rounded fragments and blocks of limestone trends northwesterly about 100 feet southwest of the contact, and the limestone beds southwest of this breccia zone dip between 45 and 60 degrees northeasterly. The band is at least 25 feet wide, and probably marks the locus of a strong fault. It is impregnated with a little hematite, which imparts a reddish colour to the rocks.

Reddish weathering zones also occur in many other places among the bands of crystalline limestone. During one stage of mountain building there was evidently widespread minor crushing and fracturing of the limestone, with subsequent introduction of minute veinlets of hematite. About 2,000 feet southwest of the contact, the limestone bands alternate with bands of thin-bedded, platy, black and brown slates, with some thin beds of dark argillite and cherty quartzite. The section is concealed by considerable drift cover, but it may be possible to find other sections suited for more detailed study along canyoned creeks a few miles west of the map-area north from the Kaskawulsh.

Kaskawulsh group rocks form low-lying whitish hills for 7 miles on the east side of Alsek River from the mouth of Raft Creek south to Campsite Lake. They outcrop over a width of 2 miles, are bounded by drift on the east, and are overlain by andesites of the Mush Lake group on the west. Crystalline limestone, which forms the dominant rock unit of these hills, has been so metamorphosed that all traces of bedding have been obliterated by flowage and recrystallization. Northeast of Campsite Lake, the rocks are traversed by abundant intersecting faults. Calcareous mica schists occur in places along the east side of the outcrop area, and suggest the presence of strong, northwesterly trending faults along the valleys of Cottonwood and Raft Creeks. Along the outlet stream from Campsite Lake a few thin bands of andesite schist are intercalated with beds of argillite, slate, and limestone.

Crystalline limestone and argillites of the Kaskawulsh group outcrop at intervals for 3 miles along Tatshenshini River from Dollis Creek to Bridge River. Similar rocks outcrop along the valley of Silver Creek for 14 miles northwesterly from Tatshenshini River to the junction of Silver and Mush Creek Valleys. At a point 5 miles up Silver Creek, some finely laminated beds of white chert are interbedded with marble and limestone. A few thin beds of sheared and slickensided carbonaceous slates are associated with the argillite and limestone beds that outcrop along, and strike across, Mush Creek at the head of Silver Creek Valley. The limestones are in faulted contact with Paleocene strata a short way up Mush Creek from its junction with Silver Creek Valley. Dollis or Squaw Creek Valley is underlain mainly by dark, thin-bedded argillites, limestone, and marble, with some small bodies of intercalated greenstone and chlorite schist. Some of the argillites are brown weathering siliceous rocks; some are calcareous; and some grade into dark, fine-bedded slates. In a few places shearing has converted the argillaceous beds into graphitic schists. The valleys of Silver and Dollis Creeks lie along the axial region of a major anticlinal fold that brought these rocks up into their present positions.

As there are no rock exposures in the map-area where a complete section of the Kaskawulsh group may be studied, the writer is unable to present an accurate measurement of its thickness. However, in the northwest part of the area, between Kaskawulsh River and Kimberley Creek, the succession, from the top down, is approximately as follows:

	Thickness in feet (approximate)
Limestone, marble, argillite	3,000
Argillite, slate, marble, quartzite	2,500
Marble, argillite, slate, andesitic schist, quartzite (base of group not seen)	1,500
	7,000

In the adjoining Rainy Hollow map-area to the south, Watson (1948) was unable to define the total thickness of Permo-Carboniferous rocks, but states that along the southern side of Nadahini Mountain a section that may be of the order of 10,000 feet in thickness is exposed.

Fossil-bearing horizons are apparently rare among rocks of the Kaskawulsh group, and the writer did not find any in the map-area. Some fossils were found, however, by Watson (1948) in similar rocks on Scottie Mountain, 10 miles south of the map-area. According to W. A. Bell of the Geological Survey, the collection contained an unidentifiable productid (?), which indicated only Carboniferous or Permian time. McConnell (1905) managed to collect some coral fragments from limestones on Bullion Creek, about 20 miles northwest of Dezadeash map-area, and these also indicated a Carboniferous age.

Numerous small quartz veins and a few large ones were seen in the limestone beds adjacent to and along Squaw Creek near the British Columbia boundary, and some of these carry gold, judging from the presence of placer gold on this stream. Quartz veins were also seen from a distance in the limestone bluffs on the lower part of the mountain 3 miles northwest of the mouth of Silver Creek. The mineral deposits at Rainy Hollow, south of the map-area, are chiefly replacement deposits of these Permo-Carboniferous beds, which have been invaded and metamorphosed by a large body of granodiorite and quartz diorite.

MUSH LAKE GROUP

The name Mush Lake group is here proposed for a thick assemblage of volcanic and sedimentary rocks that extends as a continuous belt for 67 miles southeasterly across the map-area, from the south side of Kimberley Creek, in the northwest, to Mount Beaton a few miles west of the Haines Road on the British Columbia-Yukon boundary. The belt is 1½ miles wide south of Kimberley Creek and 8 miles wide at Mush Lake. As the rocks of this belt outcrop for several miles along both north and south shores of Mush Lake, that name is considered appropriate for their identification.

Fine-grained flows of green andesite, spotted with small dark hornblende crystals and with scattered calcite-filled amygdules, compose the most easterly outcrops on the north shore of Mush Lake. Westward, on the east side of the second bay, fine-grained green andesites are cut by a 20-foot dyke of granite porphyry. At the second point on the north shore, finely laminated light green tuffs and slates about 100 feet thick are intercalated with andesitic flows. Within the 100 feet of sedimentary strata are two narrow andesite flows; one is 3 feet thick, the other 6 feet. These formations strike north 45 degrees west and dip 70 degrees southwest. Some green tuff beds outcrop in the next bay to the west and along the next mile of beach are alternate areas of drift and outcrops of green andesitic lavas. Most of the latter are finely crystalline and of massive character; some are basaltic. A belt of greywacke, tuffaceous sandstone, and black slates, 75 feet wide, is intercalated with the andesitic rocks 1 mile northeast of the mouth of Mush Creek, and beds of talc and chlorite schist are associated with green tuffs and andesitic flows due north of the mouth of this creek. The most westerly outcropping of these rocks, on the north shore, is a 100-foot band of brown weathering, thin-bedded slates a mile from the west end of the lake. These beds also strike northwest, but dip 60 degrees northeast and may be overturned.

Between ½ mile and 2 miles east of Mush Lake, the road to the lake skirts a low mountain ridge composed of thick, massive flows of light green and black, basaltic lavas. Some of the basaltic rocks exposed along the road a mile east of the lake exhibit small spotted zones that are stained green with malachite as a result of the weathering of a little contained chalcocite. Several samples of epidotized andesite obtained from the top of the ridge contained finely disseminated native copper.

Limestone beds were not seen about the shores of Mush Lake, but are associated with the lavas in several places in the mountains north of the lake. A thick band of limestone was seen on the west side of Beloud Creek 1½ miles southwest of its junction with Victoria Creek. It crosses the ridge west of the creek between elevations of 4,900 and 5,000 feet. Neither the limestone nor associated thin tuff and quartzite beds were observed to carry any fossils. A 50-foot limestone band crossing Victoria Creek about a mile above the mouth of Beloud Creek is in contact with schistose andesite on the southwest and on the northeast passes into a zone several hundred feet thick of bedded tuffs and black and grey slates. The contact relationships of Mush Lake group rocks are fairly well exposed along Sugden and Kimberley Creeks in the northwest part of the map-area. There, the upper beds of the group consist of purple to red weathering, fine-grained, andesitic flows. These pass downward into green weathering andesites that rest on grey limestone beds some 300 feet thick, and the limestone in turn is underlain by black carbonaceous slates at least 200 feet thick. Beneath the slates, the lower 1,500 feet of the section is composed largely of andesitic and basaltic lavas, with some associated tuff beds. These formations strike northwest and generally dip steeply to the northeast, but are overturned to the southwest where they are in contact with Permo-Carboniferous limestone 1½ miles southwest of Kimberley Creek. Near the creek, the andesites are intruded by a mile-long dyke of feldspar porphyry and by a small peridotite stock; nevertheless, the section is thought to be fairly complete. The sharp contact of red andesites with overlying basal conglomerates of the Dezadeash group is exposed in several places along Kimberley Creek commencing 3 miles upstream from its junction with Jarvis River. The massive character of the flows at the contact makes it difficult to determine whether the break marks an angular unconformity or not, but the unusual red, purple, and yellow colours of the andesites near this contact may indicate prolonged exposure to subaerial weathering prior to deposition of the conglomerate.

Another belt of Mush Lake group rocks outcrops for 8 miles along Alsek River from a point 1 mile below the mouth of Raft Creek, south to the mouth of Marble Creek. These rocks consist of bands of andesitic and basaltic lavas alternating with bands of tuff, greywacke, quartzite, argillite, slate, and limestone. Some rhyolite flows occur near the top of the group on the east side of the river opposite the mouth of Marble Creek. A band of limestone and marble that trends northwesterly from the junction of Marble Creek and Alsek River is about 3,500 feet thick (*See* Plate

IVA). Thin beds of dark slate occur with thick beds of white crystalline limestone near the river. They strike north 55 degrees west and dip 80 degrees southwest. Small, yellow-brown coloured trap dykes invade the marble beds at an elevation of 2,100 feet north of Marble Creek. Some beds of calcareous schist are intercalated with the crystalline limestone beds at an elevation of 3,200 feet, and at 4,000 feet there are some beds of sericite schist and a band of limestone-conglomerate 20 feet thick. The limestone beds give place to dark grey and black, finely laminated slates at an elevation of 4,400 feet, and at 4,750 feet the slates are overlain by fine-grained, brown weathering, flat-lying trachyte, andesite, and basalt flows of Tertiary age. The crystalline limestone and marble generally form thick, white to yellow-white weathering beds, but some very thin-bedded limestones are also represented. No single fossil fragment was seen in any of these strata. It is possible that the thin-bedded slates that overlie the limestone are of the same age as strata of the Dezadeash group, but neither the basal conglomerate of this group nor the red and purple andesites that mark the top of the Mush Lake group 15 miles farther north are represented here. The absence of the lavas, however, is explainable, as the break between the two rock groups is marked by a major erosional unconformity and the lavas may well have been removed prior to the deposition of the Dezadeash strata. Another possibility is that the lavas were never deposited over the limestone beds at the top of the Mush Lake group in this vicinity.

The limestone band that trends northwesterly from the junction of Marble Creek and Alsek River also outcrops for 10 miles southeasterly from the mouth of Marble Creek, and for most of this distance lies along the south side of a granite stock. In this distance some change was noted in the character of the rocks of this band. On the limestone mountain 3 miles east of the Alsek, thin beds of grey, brown, and white crystalline limestone are found, and these beds are separated by numerous brown weathering layers of quartzite and chert from $\frac{1}{4}$ to 1 inch thick, which exhibit evidence of considerable contortion and flowage of the enclosing marble beds. Small crenulated folds and drag-folds abound, and the thin beds pinch and swell; they are missing for a few feet in places but reappear.

The greater thickness of limestone in the western part of the map-area suggests deeper water conditions of sedimentation at the time of their deposition.

The belt of volcanic and sedimentary rocks that outcrops along Alsek River for 8 miles north from Marble Creek forms the southwest limb of a major anticlinal fold that trends northwesterly across the map-area, and the belt 67 miles long, that reaches from Kimberley Creek to Mount Beaton, forms the northeast limb of this anticline. The older, Permo-Carboniferous strata of the Kaskawulsh group that lie between the two belts outcrop along the axial region of the fold.

Sedimentary and volcanic rocks of the Mush Lake group also outcrop along Alsek River from Goatherd Mountain south to Bates River. They extend easterly across the south end of Bates Lake and form the northeast front of the Alsek Ranges south of Bates River. They form an anticlinal structure that trends northwesterly, and plunges northwesterly towards

Alsek River. Here, again, are great thicknesses of alternating bands of sedimentary rocks and lavas, the latter mainly of andesitic and basaltic types and the former composed largely of bedded tuffs, greywacke, slate, argillite, quartzite, and crystalline limestone. One outcrop of pillow lava is exposed along the east side of Iron creek a mile south of Bates River. Other outcrops in this vicinity are mostly of fine-grained, green, porphyritic andesite, the green rock being spotted with white feldspar phenocrysts about ½ inch in diameter.

A prominent band of white crystalline limestone and argillite that extends westerly from the south end of Bates Lake is about 3,000 feet thick on the mountain 2 miles west of the lake and appears to thicken towards the west. Andesitic flows intercalated with these sedimentary beds near the lake, thin out and disappear 5 miles farther west. The few shell fragments found in the limestone beds by the author proved useless for age determination. At least 3,000 feet of intercalated volcanic and sedimentary strata of the Mush Lake group overlie the crystalline limestone band west of Bates Lake. At their contact with rocks of the overlying Dezadeash group on the banks of the Alsek a mile below Lowell Glacier, a 10-foot band of limestone is overlain by dark slates. The limestone layer overlies 20 feet of green, carbonatized volcanic breccia, which is underlain by a normal succession of lavas and sedimentary rocks.

The thickness of the Mush Lake group varies in different parts of the map-area. South of Kimberley Creek it is about 7,000 feet thick, but along Alsek River and in the Alsek Ranges south of Bates River, a continuous section of more than 20,000 feet of Mush Lake strata is exposed.

No fossils of diagnostic value were found in the Mush Lake rocks. Because of their stratigraphic position below Lower Cretaceous sedimentary rocks and above Permo-Carboniferous strata, they are tentatively considered to be of Triassic or Jurassic age. A few crinoid stems were collected by Watson (1948) from very similar rocks south of the map-area, but they were identified only as Mesozoic. Dark shales on Burwash Creek in which McConnell (1906) found the Upper Triassic fossil *Monotis subcircularis* may be of the same age as one or more of the sedimentary units of the Mush Lake group.

Copper nuggets discovered during placer mining operations on Beloud Creek (*See* Plate I) are thought to have originated from veins in andesites of the Mush Lake group south or upstream from the workings. On the south side of the pass between Mush Creek and Fraser Creek Valleys, sheared and altered volcanic rocks of the Mush Lake group contain nearly 1 per cent of chalcopyrite across a width of 75 feet in one place close to the north end of a large stock of granodiorite. A small silver-lead vein occurs in andesites of like age on the west side of Iron Creek Glacier a mile south of the ice-front. During the 1950 field season, the writer found six small bornite-rich veins in Mush Lake group andesites on a small creek 2 miles southeast of Sockeye Lake.

Andesites and tuffs that outcrop along the north bank of Alsek River 2 miles northwest of the mouth of the Dezadeash have undergone intense shearing and alteration. They have been converted in part to carbonate, and are now weathered in dull red and yellow-brown hues. The plagioclase phenocrysts in the andesites are locally altered to a greenish product, and fractures up to $\frac{1}{8}$ inch wide in the altered lavas are filled by a pale greenish blue chlorite, which somewhat resembles malachite. A specimen of this mineral, tested by S. C. Robinson[1], was identified as penninite, a variety of chlorite. It has no commercial value.

SIFTON MOUNTAINS

Sifton Mountains are composed mainly of hard, massive, brittle, volcanic rocks that stand high above the surrounding country because they are unusually resistant to weathering processes. They are largely light grey, pale green, and pale purple lavas that include latite, dacite, andesite, and some rhyolite. Thin beds of volcanic breccia and some greywacke and bedded tuffs are intercalated with the flows. One thin limestone band was also seen. These rocks are intruded by porphyritic granite, of probable Cretaceous age, on the east and west flanks of Sifton Mountains, and on the southern slopes they appear to be in faulted contact with Yukon group gneisses and schists. They much resemble the volcanic and sedimentary rocks of the Mush Lake group, and they may be of like age.

DEZADEASH GROUP

The mountain front on the southwest side of Shakwak Valley, from Dezadeash Lake northwest to the border of the map-area, is composed largely of sedimentary rocks, with minor intrusive bodies of peridotite, serpentine, and granodiorite. The sedimentary rocks comprise slate, greywacke, argillite, quartzite, chert, impure limestone, grit, conglomerate, tuffaceous sandstone, and bedded volcanic tuffs. These rocks have been folded along northwesterly trending axes, and are cut by many northwesterly trending faults, so that the succession and true thickness of the series are not readily apparent, but the latter probably exceeds 12,000 feet. McConnell (1905) noted these rocks at the time of his visit to Kluane district in 1904. He referred to them as a great series of tuffaceous beds fully 10,000 feet thick, and he named them the "Dezadeash Series".

The basal member of the Dezadeash group between Jarvis River and the mouth of Dezadeash River is a band of conglomerate that ranges from 200 to 500 feet in thickness. It rests upon reddish hued andesite. A few seams of coal less than an inch thick are contained in the conglomerate beds along Kimberley Creek, where the beds dip vertically. Along a small stream a mile east of Sugden Creek and 2 miles north of the Kaskawulsh, the conglomerate beds are 500 feet thick. At an elevation of 3,550 feet, the conglomerate is overlain by 150 feet of carbonaceous slates and argillites, with which are associated abundant thin coal seams, very few of which are more than 2 inches thick. The coal-bearing beds are overlain by several hundred feet of altered tuff, which in places has been silicified and now forms a hard white rock. The tuff beds are cut here by a 50-foot dyke of quartz diorite. At an elevation of 4,200 feet, the altered tuff beds give place to thin-bedded sandstones and argillites that range from yellow to brown to grey in colour. These are succeeded by black platy slates, and the slates in turn are overlain by thick beds of heavy, grey,

[1]Mineralogist, Geological Survey of Canada.

tuffaceous sandstone. There are many repeated alternations of slate, sandstone, and argillite towards the peak of the mountain, but the uppermost beds of the group have been eroded. The higher beds of the group are more friable and softer than the basal, sedimentary units and in some places the shales have not been converted to slates.

There is a marked change in the character of the stratified rocks along their strike. The basal conglomerate is missing in the section exposed along Marble Creek, and the tuff, sandstone, and argillite beds are represented there by a great thickness of stratified slates, with some quartzite and greywacke beds. The conglomerate is also believed to be missing at the base of the Dezadeash group southeast of Sockeye Lake, but it might take considerable detailed work to prove this in view of the numerous northwesterly trending faults that occur in that direction near the contact, most of them concealed by heavy drift-cover. The Dezadeash beds are in faulted contact with Yukon group rocks along Shakwak Valley. A parallel fault extends up Alder Creek and is exposed for some distance on the east side of this stream near the mouth of Shorty Creek. Another parallel fault cuts the strata a mile west of the south end of Dezadeash Lake.

Fossils are sparsely distributed in the rocks of the Dezadeash group. A few specimens of poor diagnostic value have been collected at widely scattered points throughout the Kluane Ranges. The best collection was made in 1948 on the east side of Alder Creek 1,000 feet north of the south end of the canyon. This lot contained species of *Aucella,* which have been listed as follows by J. A. Jeletzky of the Geological Survey:

Aucella cf. *gigas* Crickmay
Aucella cf. *terebratuloides* Lahusen
Aucella crassicolis Keyserling
Aucella crassicolis Keyserling var. *americana* Sokolon
Aucella crassicolis Keyserling cf. var. *gracilis* Lahusen
Aucella cf. *crassicolis* Keyserling
Aucella sp. indet. (cf. *crassicolis* Keyserling)
Aucella? sp. indet.

According to Jeletzky, the lot was undoubtedly taken "from beds of Neocomian (earliest Lower Cretaceous) age".

Slates and quartzites of the Dezadeash group are highly metamorphosed for several miles along the east bank of Alsek River south of the mouth of Marble Creek. They are crinkled, contorted, and closely folded and are converted in some places to quartz-mica and cordierite schists.

Some of the schists and gneisses mapped as part of the Yukon group south of Klukshu Lake may represent in part highly metamorphosed sedimentary rocks of the Dezadeash group that have been engulfed by the Coast Range batholith. But the presence of altered andesites about the south end of the lake suggest the occurrence also of older rocks, equivalent in age to the volcanic rocks of the Mush Lake group, or perhaps still older.

Quartz veins occur sparingly in the strata of the Dezadeash group and seem to favour the slates. More quartz float was seen at the mouth of Marble Creek than elsewhere, and an abundance of granite boulders there suggests the presence of an intrusive body towards the head of the stream.

The following is a partial section of the Dezadeash group as exposed on the peak north of the west end of Kathleen Lake. There the strata form the east limb of a northwesterly trending syncline, and dip southwesterly at angles of from 10 to 50 degrees for 3 miles in the steep mountain slopes above the lake. The uppermost beds of the group are nowhere exposed in the area.

Top of Section	*Approximate thickness* Feet
Sandstone, grey, and thin black shale beds	800
Sandstone, brown to grey, with some thin black shale and grey argillite beds	1,500
Shale, black, with a few thin sandstone beds	500
Sandstone, coarse, grey to brown weathering	500
Conglomerate; pebbles of quartz, limestone, slate, and sandstone	20
Sandstone, coarse, grey; some black slate beds	400
Slate, black; thin beds with minor sandstone	100
Sandstone, coarse, brown weathering	400
Sandstone, grey to brown; some black slate	1,000
Tuff, white to greyish yellow, fine-grained	20
Slate, black; some sandstone and argillite beds	1,000
Sandstone, argillite, tuff, and slate beds	5,000
(Basal beds of group concealed by Kathleen Lake)	
Total exposed thickness	11,240

MESOZOIC INTRUSIVE ROCKS

PERIDOTITE AND SERPENTINE

An elongated body of partly serpentinized peridotite intrudes sedimentary strata of the Alsek group along the mountain front on the southwest side of Shakwak Valley between Jarvis and Dezadeash Rivers. The intrusive mass ranges from 1 mile to 2 miles in width; it has been traced for 12 miles to Jarvis River and may continue farther. The rock is mainly finely crystalline, and all gradations between dark peridotite and green serpentine are to be seen. In many places the peridotite has been sheared to form both talc schist and green serpentine schist, the planes of schistosity striking northwesterly and dipping about 75 degrees southwest. Near Jarvis River, shearing appears to have affected the greater part of the peridotite stock, but the central core of the intrusion is massive and coarsely crystalline for a width of about 800 feet. Several small dykes of pyroxenite cut the peridotite on the mountain slope south of Summit Creek. These dykes are partly altered to carbonate. The peridotite is traversed by numerous small carbonate veins and by a few small quartz veins.

A second body of peridotite, a mile wide, lies 4 miles south of the other on the west side of Dezadeash River. It trends northwesterly parallel with the peridotite body described above and is known to be at least 5 miles long; it may terminate where small bodies of peridotite intrude the Kaskawulsh group rocks on the south side of Kimberley Creek 2 miles east of the west border of the map-area. This peridotite stock is very coarsely crystalline where examined on the west side of Dezadeash River, being formed of large, pale green, tabular crystals of chrome diopside intergrown with large, dull, black-hued olivine crystals; in many places these crystals exceed 3 inches in length. The dark colour of the olivine results from a contained charge of countless minute magnetite particles. These coarsely crystalline phases pass abruptly into dark-hued, fine-grained ones or segregations of irregular shape that contain a higher percentage of iron-rich olivine. One of these zones lies 300 feet from the south contact of the stock and about 50 feet west of the tractor trail leading to Sugden Creek. It is a 'plumb' of dark, heavy, fine-grained rock of lenticular outline. The lens extends 25 feet up the steep rock face and is 3 feet wide. A $4\frac{1}{2}$-pound grab sample collected from this lens by the writer, and tested by the Mines Branch at Ottawa, contained: iron, 13·05 per cent; Cr_2O_3, 0·50 per cent; TiO_2, 0·32 per cent.

Two easterly flowing mountain streams that dissect the peridotite stock have formed a large fan composed largely of peridotite gravels and green chrome diopside sands. The fan reaches from the foot of the mountain east to Dezadeash River. A few cobbles washed from the mountain side by the more northerly stream were seen to be jet-black and entirely free of diopside. An analysis of one of these black, heavy cobbles by the Mines Branch at Ottawa, showed: iron, 11·45 per cent; chromium, 19·82 per cent.

Mr. F. J. Fraser of the Geological Survey made a spectroscopic analysis of a sample of dark, iron-rich olivine from this stock, with the following results: magnesium, high; silicon and iron, medium; manganese, low; chromium, nickel, and cobalt, traces. The specimen tested was one from a coarsely crystalline phase of the intrusion that contained about equal amounts of the green diopside and dark olivine.

A panning test made on the stream gravels at the foot of the mountain indicated the presence there of some very fine placer platinum. Platinum has previously been reported as recovered along with placer gold by placer miners on Sugden Creek. The platinum is believed to have originated in the peridotite body, and to have been released into the streams under normal conditions of weathering and erosion.

The peridotites intrude strata of Lower Cretaceous age, and they have undergone intense shearing in some places, a feature in contrast everywhere with the fresh, massive appearance of granodiorite stocks that invade the same group of sedimentary rocks. They are believed to be older than the granite stocks, and were probably intruded in mid-Cretaceous time.

The central island of a group of three islands 2 miles south of the north end of Bates Lake is composed of peridotite. The island is roughly 200 feet in diameter and rises 50 feet above the surface of the lake. The peridotite is massive and finely crystalline and is traversed by many small picrolite asbestos veins that have been developed along irregular intersecting fractures. Few of the veins are more than 1 inch wide, though widths of 6 inches were noted for a few feet near the intersections of fractures. The picrolite asbestos is pale grey to white and the fibres are stiff and brittle. This occurrence, though of doubtful economic importance, suggests the possibility of finding the more valuable chrysotile asbestos (distinguishable by its flexible, easily separating fibres) in the large peridotite bodies in the Kluane Ranges.

DUNITE

Two low-lying hills on the east side of Shakwak Valley, 3 miles southeast of the junction of Dezadeash and Kathleen Rivers, are formed of dunite. The hills are about ½ mile apart, and if the dunite underlies the drift-filled valley between these hills, it forms a stock about a mile in diameter. The dunite is light greenish grey on fresh surfaces, but weathers in dark reddish tones. It is composed of small, colourless grains of olivine and a liberal sprinkling of magnetite, which stands out prominently on weathered surfaces. The magnetite occurs as small, euhedral crystals in scattered segregations, or, where the rock is sheared, as thin filmy plates that follow the cleavage lines and lend a somewhat bedded appearance to the dunite.

A sample collected from an iron-rich segregation in the dunite by the writer, assayed: Fe, 19·62 per cent; Cr, 0·11 per cent. Normally the dunite contains only 3 or 4 per cent iron.

GRANITIC INTRUSIONS

Much of the east half of Dezadeash map-area is underlain by granitic rocks, which form part of the great complex of Coast intrusions that extends south along the entire length of the Coast Mountains of British Columbia. The main western contact of these intrusions runs approximately north and south from Dezadeash Lake, but outlying stocks occur as far west as Alsek River in the map-area, and there is considerable granite in the St. Elias Mountains west of the Alsek, judging from the abundance of boulders and blocks of granite and granodiorite that are brought down to the Alsek by the Lowell Glacier. North of the map-area, the contact swings northwest towards Kluane Lake via the west fork of Aishihik River. The east boundary of the granitic complex lies east of the map-area; it extends northwesterly from Lake Bennett, 40 miles east of Dezadeash map-area, to the south end of Aishihik Lake, 25 miles north of Canyon. The Whitehorse copper deposits, and the gold-silver, antimony-silver, and silver-lead veins in the Wheaton area lie in this contact zone. Copper deposits also occur near the north border of the complex north of Hutshi, 25 miles north of Champagne; at Giltana Lake, 3 miles east of Aishihik Lake; and on the west side of Kluane Lake. South of the map-area, copper, lead, and zinc ores occur at Rainy Hollow near the western contact. Within the map-area, Alsek volcanic rocks contain copper veins, most of them small, in many places north and south of Mush Lake, and a few quartz veins containing copper minerals have been noted in the granodiorite stock that intrudes the Alsek volcanic rocks 7 miles south of Mush Lake. The gold of the placer deposits in Dezadeash map-area and in the Kluane Lake and Kloo Lake placer camps was derived from gold-bearing veins thought to be genetically related to the Coast intrusions.

The granitic areas include rocks of several different varieties, the most common being grey biotite granodiorite and a grey to pink porphyritic granite. Grey, coarsely crystalline, biotite granodiorite forms the bulk of the intrusive rocks in the eastern half of the map-area. This rock is of variable composition, but usually contains from 5 to 10 per cent of both biotite and hornblende, 10 to 20 per cent quartz, 60 to 70 per cent andesine feldspar, and from 5 to 15 per cent orthoclase. The rock is mottled by glistening black faces of biotite flakes. Outcrops are generally massive, but in places near its contacts with older rocks the granodiorite has a gneissic structure. Near the roof pendant of crystalline limestone, 8 miles northwest of Champagne, the granodiorite approaches a quartz diorite in composition. Dioritic phases of the granodiorite were also seen on the east shore of Kusawa Lake southeast of the mouth of Jo-Jo Creek, and granodiorite and diorite also outcrop on the west side of Kusawa Lake. But for the most part the granodiorite shows no discernible change in composition near its contacts with older rocks.

The granite body lying between the Aishihik road and Moraine Lake consists largely of grey to pink, porphyritic granite. The principal characteristic of the rock is the presence of plentiful pale pink orthoclase phenocrysts up to 1 inch or more in length. Microscopic examination of a thin section of a specimen obtained 3 miles northeast of the junction of the Alaska Highway and the Aishihik road disclosed about 35 per cent quartz, 5 per cent biotite, 50 per cent orthoclase, and 10 per cent oligoclase. The intrusive rocks in the mountains to the northeast of Taye Lake are of very similar porphyritic granite, but the ferromagnesian mineral in the thin sections examined is hornblende. The granite mountain lying west of Mush Lake is also porphyritic. In most places it is a pale pink granite containing abundant pink orthoclase phenocrysts, most of which are more than 1 inch long and which range in many places up to 3 inches in length. This granite contains about 10 per cent hornblende in well-formed phenocrysts, some of which measure up to an inch in length. The quartz has a glassy semi-transparent appearance, and small brown zircon crystals can be seen in the rock with the naked eye.

A stock of light-coloured, coarsely crystalline, acidic granite intrudes the granodiorite mountain on the west side of Kusawa Lake about 4 miles south of the north end of the lake. This stock extends westerly for 4 miles between Kusawa and Jo-Jo Lakes and for 7 miles south to the westerly trending shoreline of Kusawa Lake. On the higher slopes, above 5,000 feet, this granite is deeply weathered, forming thick deposits of coarse, light-coloured sand. The granite consists roughly of 35 per cent quartz, 50 per cent orthoclase, and 10 per cent oligoclase, with about 2 per cent each of hornblende and biotite, and as much as 1 per cent magnetite. The quartz of this granite generally has a dark or smoky hue that contrasts sharply with the lighter, white to pale pink feldspars. Another body of very similar acidic granite outcrops on both sides of Kusawa Lake, south of the most westerly jog at Frederick Lake Valley.

The fact that the acidic granite is more susceptible to weathering than either the granodiorite or porphyritic granite has been investigated by John Fyles (1950) as a thesis study at the University of British Columbia. Fyles studied samples collected from the northwest quarter of Whitehorse map-area, and in his work refers to the acidic granite as the smoky-quartz granite. He found that the medium-grained smoky-quartz granites contain larger intergranular openings than the granodiorites or the granite-porphyries, and came to the conclusion that this explains their susceptibility to weathering.

Stocks of grey granodiorite intrude Lower Cretaceous strata in the mountains west of Dezadeash Lake. As the grey granodiorite is cut elsewhere by both the porphyritic granite and the acidic granite, it follows that the bulk of the granite in this area is of Lower Cretaceous or later age.

Several dykes and stocks of quartz porphyry and granite-porphyry intrude the Cretaceous sedimentary strata south and southwest of Kathleen and Louise Lakes and northwest of Louise Lake. These porphyry intrusions are of light colour, but weather rusty as a result of oxidation of a small amount of contained pyrite. They contain variable amounts of oligoclase feldspar and quartz phenocrysts in a finely crystalline groundmass of quartz and feldspar, and from 3 to 5 per cent altered biotite. Several of these dykes are impregnated with pyrite where they cut the granite 6 miles south of the most westerly bay of Kusawa Lake. A 5-pound grab sample of the pyritized dyke rock collected 2 miles west of where Devilhole Creek empties into Kusawa Lake assayed: gold, 0·005 ounce a ton.

DIORITE AND GABBRO

A stock of hornblende gabbro about 1,000 feet in diameter intrudes Mesozoic sedimentary rocks on the west side of Dezadeash River, 5 miles above its confluence with the Alsek. Half a mile farther east, on the east bank of the river, quartzite, slate, and conglomerate beds are cut by narrow gabbro dykes. The gabbro in both places contains about 1 per cent magnetite and pyrite and oxidation of the pyrite produces some rust on weathered surfaces.

One gabbro dyke that cuts Lower Cretaceous sedimentary rocks 5 miles south of Louise Lake is more than 3 miles long and ranges up to 300 feet in width.

Small, brown weathering, diorite-porphyry dykes intrude peridotite and sedimentary rocks in the vicinity of Mount Decoeli on the north side of Summit Creek, and a 20-foot dyke of augite porphyry cuts the peridotite on the mountain south of Summit Creek.

Two small stocks of highly fractured and altered diorite intrude Mesozoic slates and greywacke on Shorty Creek. These diorite stocks are impregnated with finely disseminated pyrite that has largely oxidized as a result of deep surface weathering, and outcrops are now covered by thin films of reddish brown limonite.

These intrusions are probably of about the same age as the granitic intrusions previously described. Both bear the same intrusive relationships towards Mesozoic sedimentary rocks, and are generally considered to be of Lower Cretaceous or later age.

Some large diorite boulders were noted in the morainal debris on the north side of Lowell Glacier near Alsek River, and numbers of hornblende boulders were also brought there by the glacier. One large boulder was composed of about 95 per cent euhedral hornblende phenocrysts, many of which were an inch in diameter and measured up to 6 or 7 inches in length.

PALEOCENE SEDIMENTARY ROCKS

Paleocene sedimentary rocks composed of flat-lying and gently dipping beds of conglomerate, sandstone, and shale outcrop between Mush and Bates Lakes and form the mountain ridge that trends southeasterly from the north end of Bates Lake. They have been traced for 20 miles southeast and 13 miles northwest of the stream connecting Bates and Mush Lakes. The belt ranges from 2 to 5 miles in width, and displays a maximum thickness of about 3,500 feet of sedimentary strata. Four miles north of Bates Lake, the basal conglomerate beds are exposed resting unconformably upon porphyritic granite along the canyon walls of Shaft Creek. Paleocene conglomerate beds, 1,500 feet thick, form the peaks of the mountain ridge northwest of Onion Lake and rest upon a very irregular northeasterly sloping erosion surface of volcanic and sedimentary strata of the Mush Lake group. Eight miles south of Mush Lake, on the east side of the belt of Paleocene strata, the conglomerate beds are in faulted contact with Mush Lake volcanic rocks. Northwest of a point about 6 miles northwest of Mush Lake, the Paleocene succession begins to thin perceptibly, and is overlain by a thick mantle of Tertiary volcanic strata. On the mountain east and southeast of Bates Lake it is intruded by a small stock and by numerous sills and dykes of white weathering soda syenite.

Most of the conglomerate occurs in thick, massive beds separated by well-layered sandstone and shale. Most of the conglomerate cobbles are less than 6 inches in diameter, and are well rounded. They represent a wide variety of rock types, including granite, quartz, greywacke, slate, quartzite, limestone, greenstone, red andesite, and schist. The conglomerate generally breaks around the pebbles in the sandy matrix. The sandstone beds range from grey to brown, and the shales from grey or brown to black. Coal seams less than an inch thick occur in places in this formation.

Fossil plants gathered from brown weathering shales interbedded with grey sandstone and conglomerate beds at an elevation of 4,000 feet, some 5 miles northwest of the north end of Bates Lake, were examined by W. A. Bell, of the Geological Survey, who records the following species:

Angiosperms

Pterospermites ? auriculaecordatus ? Hollick
Acer arcticum Heer
Dillenites sp. cf. *D. ellipticus* Hollick

"Although the number of species is few, the age is considered to be probably Paleocene."

Another fossil collection was obtained at an elevation of about 4,000 feet, a mile east of the north end of Bates Lake, from flat-lying sandstone and shale beds. Dr. Bell's identification of this lot follows:

Conifers

Elatocladus (*Cryptomerites?*) *nordeskieldi* (Heer)
Sequoia langsdorfii (Brongniart) Heer

Angiosperms

Trochodendroides arctica (Heer)
Corylites ? fosteri ? (Ward)
Alnus sp.

"The age is considered to be probably Paleocene."

H. S. Bostock examined these rocks on the mountain southeast of the portage between Mush and Bates Lakes in 1945, and he collected fossil plants there at an elevation of 4,500 feet 2 miles southeast of the portage. Dr. Bell identified the following species in this lot, which he stated were likewise indicative of a Paleocene age:

Conifers
- *Sequoia langsdorfii* (Brongniart) Heer
- *Taxites olriki* Heer

Angiosperms
- *Pterospermites ? auriculaecordatus ?* Hollick
- *Trochodendroides arctica* (Heer)
- *Hicoria antiquora* (Newberry)
- *Hamamelis ? clarus* Hollick

TERTIARY INTRUSIVE ROCKS

SODA SYENITE

An irregular-shaped body of soda syenite intrudes Paleocene sedimentary rocks east of Bates Lake. The intrusive rock outcrops close to the lake shore, immediately north of the peninsula midway of the east shore of the lake, and from there has been traced southeasterly for 7 miles. Its average width is somewhat less than 1 mile. Soda syenite intrudes Paleocene strata 5 miles southeast of the south end of Bates Lake in the form of a giant sill that ranges in thickness from 100 to 500 feet. The sill trends northwesterly for almost 3 miles to near an elevation 4,500 feet on the east side of Wolverine Creek, and from there swings northeasterly for 2 miles on the south side of a high mountain valley overlooking the head of the west fork of Mush Creek. Both sills and dykes of soda syenite invade the Paleocene strata on the steep slopes northeast of Onion Lake, but most of these are less than 50 feet wide.

Another soda syenite stock, about a mile in diameter, intrudes the volcanic and sedimentary rocks on the west side of Bates Lake, 4 miles northwest of the outlet of the lake, and dykes of soda syenite up to 20 feet wide cut pink porphyritic granite on Shaft Creek, the stream flowing southeasterly into the north end of Bates Lake.

The soda syenite is ordinarily a fine-grained, massive, dull pink to white, crystalline rock; on weathered surfaces this colour is masked in many places by deeply penetrating, light rusty brown hues. In some places the sill and dyke rocks display a banded appearance, with alternate white and pale rusty bands. It is not unusual to find radiating clusters of paper-thin, black, pyrolusite seams replacing the white rock along joint planes.

A microscopic study of two sections of the soda syenite revealed the following mineral composition: quartz, about 1 per cent; orthoclase, about 20 per cent (as small phenocrysts enclosed within larger oligoclase phenocrysts); oligoclase, about 60 per cent (as phenocrysts averaging 0·1 inch in diameter); and groundmass, about 20 per cent, largely cryptocrystalline, but with some small orthoclase laths. Some rust-coloured kaolin is derived from alteration of the feldspars.

TERTIARY VOLCANIC ROCKS

Tertiary volcanic rocks cap the mountains north of Marble Creek on the west side of the Alsek (*See* Plate IVA) and extend north for 15 miles to Kaskawush River. They also cap the mountains west of the lower end of Dusty River. A rugged mountain, 6½ miles long and nearly 4 miles wide on the east side of the Alsek, east of the mouth of Marble Creek, is the only other mountain of Tertiary volcanic rocks in the map-area.

These Tertiary rocks consist of agglomerate, volcanic breccia, tuff, rhyolite, dacite, andesite, and basalt. The mountain south of Campsite Lake is composed dominantly of rhyolite breccias and rhyolite tuff, light-coloured rocks, with predominant dull white, pale green, and purple hues. The tuffs and breccias are well bedded, and the succession, although flat lying in many places, also shows dips that range up to 30 degrees, perhaps representing the original dip at the time of deposition. The andesites weather in bright shades of orange, yellow, red, and brown, due to oxidation of contained iron minerals to hematite and limonite. Sandstone lenses were seen interbedded with andesites on the south side of the Kaskawulsh a mile below the mouth of Dusty River, and one 2-foot sill of obsidian traverses the sedimentary rocks there 75 feet above the river. A dyke of obsidian 3 feet wide intrudes the Tertiary lavas 2 miles farther east on the south bank of Kaskawulsh River some 200 feet up a small stream bed.

On the volcanic mountain south of Campsite Lake the volcanic rocks are about 3,500 feet thick. Some of the peaks formed of these rocks west of the Alsek reach to more than 6,500 feet above sea-level, but the cores of these mountains are formed of much older rocks, and 4,000 feet is the maximum thickness displayed by the overlying volcanic material.

At the first narrows on Alsek River, 6 miles south of the mouth of the Dezadeash, the rock bluffs along the river comprise gently dipping beds of volcanic breccia and tuff. A mile farther south these volcanic rocks unconformably overlie folded beds of Palæozoic crystalline limestone. The Paleocene conglomerate that underlies the Tertiary volcanic rocks 10 miles farther southeast is missing here, suggesting a period of profound erosion between the Paleocene epoch and the time of deposition of the thick series of younger Tertiary volcanic rocks. The latter are considered to be of about Miocene age.

RÉSUMÉ OF TERTIARY HISTORY

Paleocene beds were deposited during an epoch of subsidence, in valleys previously incised about as deeply as present day drainage. Subsidence and accompanying sedimentation were followed by an epoch of mountain building, marked by the intrusion of soda syenite stocks, sills, and dykes and by widespread elevation of the coastal region. There followed an epoch of renewed rapid erosion, at which time the Paleocene strata were in large part eroded. An epoch of volcanism followed, at which time all valleys and mountains in Alsek River region were buried beneath 3,000 to 4,000 feet of ash, volcanic breccia, and lava. The geological column indicates alternating periods of volcanism and sedimentation during this epoch, but volcanism was dominant. Continued normal erosion in late Tertiary and Quaternary time has developed today's drainage pattern.

The Tertiary volcanic rocks are interesting from an economic viewpoint, in that they may have protected gold-bearing placer gravels from ice erosion during the Glacial period.

CHAPTER IV

STRUCTURAL GEOLOGY

SOUTHWEST SECTOR

The general strike of the Mesozoic and older sedimentary and volcanic rocks is northwest, and beds generally dip at angles greater than 45 degrees to the southwest or northeast. Mesozoic and older rocks of the Kluane Ranges are overturned in some places, particularly at intervals along the south side of Kimberley Creek and along the mountain front on the southwest side of Shakwak Valley. They are traversed by many faults that trend north by west.

SILVER CREEK ANTICLINE

A great northwesterly trending anticlinal fold, which has been named the Silver Creek anticline, forms the major structural unit in the mountains southwest of Shakwak Valley, and extends northwesterly along the full length of the valley of Silver Creek. The axial plane of this great anticline extends northwest for 62 miles across the map-area from Dollis (Squaw) Creek on the south to the mountains north of Kaskawulsh River on the northwest. The approximate position of the axial region of the fold is marked by limestone and marble of the Kaskawulsh group along Dollis and Silver Creeks, along the low ridges north of Campsite Lake, and on the mountains between the Kaskawulsh and Kimberley Creek. Younger strata that lie along the outer limbs of the major fold are warped into many minor anticlines and synclines. Most of these are gentle folds, but close folding, with associated thrust faulting, is prevalent; some of the best examples occur along the mountain front on the south side of Quill Creek, and may be seen from the Haines Road.

The east limb of the Silver Creek anticline has been interrupted by the intrusion of several granodiorite stocks that now occupy the cores of the mountains that lie between Mush Lake and Mount Beaton. Another granite stock invades its west limb northwest of Bates Lake, and this limb is further obscured by a thick mantle of Tertiary lavas west of the head of Alsek River, by Tertiary lava and Paleocene conglomerate beds between Campsite Lake and Mush Lake, and by Paleocene sedimentary rocks and associated sills and stocks of soda syenite east of Bates Lake. Copper mineralization is in evidence along its east limb at several places between Mush Creek Pass and Sockeye Lake.

BATES RIVER ANTICLINE

The Bates River anticlinal fold, which trends northwesterly across Bates River in the southwest part of the map-area, has not been completely delineated, but is known to form a well-defined anticline.

The anticline is formed of Mush Lake group volcanic and sedimentary rocks. The southwest limb forms the rugged northwest slopes of the Alsek Ranges, and the north limb extends westerly from the south end of Bates Lake to Alsek River. The structure appears to plunge northwesterly at about 45 degrees on nearing the Alsek. The northeast limb is faulted off at the south end of Bates Lake, and does not continue southeast of the lake. In most places along the southwest limb, the strata dip from 40 to 75 degrees to the southwest and, on the northeast limb, from 45 to 80 degrees to the northeast. The anticline is cut by many faults and, in view of the presence of granite stocks that invade parts of the southwest limb, constitutes ground that should favour mineral deposition.

Shales, slates, and quartzites of Lower Cretaceous age that outcrop along Alsek River from Lowell Glacier north to Marble Creek mark a belt of synclinal folding that lies between the Bates River and Silver Creek anticlines. This synclinal belt trends northwesterly. It narrows towards Bates Lake and is cut off a mile west of the lake by a fault that strikes northeast.

The peridotite at Jarvis River and on the lower mountain slopes east of Mount Decoeli is strongly sheared in a northwesterly direction, suggesting major faulting along the mountain front on the southwest side of Shakwak Valley. The Yukon group rocks and Coast intrusions on the northeast side of Shakwak Valley probably underwent early uplift, followed at a much later period by folding, faulting, and overthrusting of the softer Mesozoic beds on the southwest side of this valley.

NORTHEAST AND EAST SECTORS

The Yukon group rocks in the east and northeast parts of Dezadeash map-area are generally closely folded and highly metamorphosed. In most places the strike and dip of the schistosity lie parallel with those of remnants of the original bedding, as represented by intercalated beds of marble and beds of micaceous quartzites. In many cases the attitudes of the schists and highly altered sedimentary rocks are the same across a mountain top, whereas on a closely adjoining peak they may diverge by as much as 90 degrees. The original folds can be determined in places, but in most instances close folding, faulting, and intense metamorphism make this impossible.

Many large faults in the southeast part of the map-area strike either northeast or northwest, and the zigzag shape of Kusawa Lake probably evolved through the erosive action of streams and valley glaciers that followed such prevalent faults. Northerly trending faults prevail about the north end of Kusawa and Jo-Jo Lakes and about Moraine Lake. Many of the faults shown on the accompanying geological map are clearly defined on the air photographs from which their positions have been plotted. Only a few have been examined in the field. The one on the east side of Jo-Jo Lake was seen from a distance to be marked by some iron stain towards its southern end.

CHAPTER V

ECONOMIC GEOLOGY

PLACER DEPOSITS

GENERAL STATEMENT

Gold placer mining has been carried on intermittently in the Dezadeash area since 1896, when the Dalton trail was first used by miners en route to the Klondike. Small-scale placer operations are known to have been conducted on the following streams: Kimberley Creek, Sugden Creek, Victoria Creek, Beloud Creek, Goat Creek, Shorty Creek, Mush Creek, Iron Creek, Bates River, Wolverine Creek, Silver Creek, Tatshenshini River, Squaw Creek, Marshal Creek, Granite Creek, Primrose River, and Sandpiper Creek. The most extensive operations completed in the area were by Barker and Ray on Shorty Creek, in 1945, 1946, and 1947. Production at Shorty Creek was 738 ounces of gold during 1945, 1,125 fine ounces of gold, worth $39,868, in 1946, and 1,015½ fine ounces of gold, valued at $35,374, in 1947. Some placer mining has been done each year on Squaw (Dollis) Creek since the discovery of coarse gold there by Indians in 1927. Watson (1948) estimates the gold production of the British Columbia section of Squaw Creek at about 5,000 ounces. Production on the Yukon sector of this stream would be much less, and might be as little as 100 ounces.

During the Glacial period, all of the main valleys in Dezadeash area were choked with glacial ice that moved northerly away from the gathering grounds of the high St. Elias Mountains. These valley glaciers scoured many stream beds that may have contained workable gold placer deposits and scattered the enriched gravels over a wide area. Those pre-Glacial placer deposits that remain owe their survival to local physical features that protected the gravel beds from erosion. Thus, mountain streams that headed in high mountains on the south (as does Squaw Creek) and flowed northerly were protected from the valley glaciers, which flowed around such obstructions. Gravel deposits along all such streams in Dezadeash map-area are probably worth testing for placer gold, as they may include remnants of Tertiary gravels.

Some of the Tertiary gravels along stream beds adjacent to Alsek River were protected from ice scouring by a covering of Tertiary lava flows. Where recent streams have cut through shallow coverings of these flows to reach underlying gravels, they may reveal workable grades of placer ground. Some of the Sugden Creek placer gold was undoubtedly covered by Tertiary flows at one time and was released by post-Glacial stream erosion.

In many places, such as on Iron Creek and on Bates River, there has been an important reconcentration of placer gold since the Glacial age. Much glacial debris has been water sorted and carried down such streams and the gold content concentrated on low-lying gravel benches and rock benches and in the beds of the streams. These are the most common type of placer deposits found in the area.

SHORTY CREEK

The occurrence of placer gold on Alder Creek was recorded by Tyrrell in 1898, and it is probable that placer gold was found on Shorty Creek, its principal tributary, at about the same time. The gravels on Shorty Creek (*See* Plate VI B) have been worked periodically with hand shovels for almost 50 years, but large-scale operations were first undertaken by Barker and Ray, Limited, in 1945. Production amounted to 738 ounces of gold in 1945, 1,125 ounces of gold in 1946, and 1,015½ ounces in 1947. The present owner, H. Vass of Whitehorse, did a little work there in 1949 and 1950.

Shorty Creek is a short, easterly flowing stream that rises in a high basin in the mountains 5 miles west of Dezadeash Lake. It empties into Alder Creek, which occupies a very narrow and deeply cut valley that trends southerly. Stagnant ice probably occupied Shorty Creek basin during the Glacial period, and as a result its gold-bearing placer gravels were not subjected to scouring action. Alder Creek Valley was undoubtedly choked with ice at that time due to the pressure of ice from the south, but there was probably little or no movement of ice up Alder Creek owing to its steep gradient and very narrow profile. Two small diorite stocks that intrude the Mesozoic sedimentary rocks on Shorty Creek are thought to have provided some of the placer gold. These stocks are highly fractured and contain numerous small quartz stringers. Both altered diorite and quartz stringers are impregnated with a little pyrite. Some of the gold was probably derived from veins in the granodiorite stock, 2 miles in diameter, at the head of the south fork of Shorty Creek.

BELOUD CREEK

Beloud Creek is a 3-mile-long mountain stream that flows into Victoria Creek in the mountains north of Mush Lake. It joins Victoria Creek 11 miles south of Louise Lake, into which Victoria Creek empties. Although only a small stream, Beloud Creek has cut through gravel deposits 140 feet thick near its confluence with Victoria Creek. A low gravel bench 50 to 75 feet wide and 300 feet long on the west bank of Beloud Creek about 1,500 feet south of Victoria Creek was worked by B. Beloud of Whitehorse in 1938 and 1939, and considerable placer gold was recovered. Operations were suspended early in 1939 when the son of one of the owners received fatal injuries as the result of a landslide.

During the course of placer mining, about forty copper nuggets were recovered. These ranged from a few pounds up to 28 pounds in weight (*See* Plate I) and, according to Beloud, were found in the sand layer on bedrock, and were most plentiful where gold was concentrated in greatest amount. Both gold and copper nuggets are believed to have originated in veins in rocks of the Mush Lake group towards the head of Beloud Creek, and were concentrated on the bedrock by stream action, possibly as long ago as Tertiary time.

During the Glacial Age, valley glaciers failed to invade the valley of Victoria Creek in strength. They moved northerly up the valley that extends from the west end of Mush Lake to Sockeye Lake, and also moved easterly up Mush Lake Valley towards the Dezadeash Lake gathering grounds. A little thin ice also moved up Dalton Creek Valley towards Victoria Creek, but became largely stagnant on reaching the high mountains that lie on the north side of the westerly bend of that creek. There is evidence that alpine glaciers occupied the upper parts of the valleys of Virgin and Beloud Creeks and the stream west of Beloud Creek at that time, but it is thought that, judging from the topography, the ice-fronts of each of these local glaciers remained a mile or so south of Victoria Creek. For these reasons it seems probable that the gravels along the headwaters of Victoria Creek and those that occur near the mouths of the tributary streams are in part of preglacial origin.

SILVER CREEK

Oscar F. Jurgeleit and Duke Jurgeleit of Haines constructed a 12-mile tractor trail from mile 106 Haines Road to their placer ground on Silver Creek in 1948. An attempt was made to work this ground in 1949, but without much success as it was a year of exceptionally high water.

Silver Creek has cut a canyon 600 feet deep in glacial debris, and the placer gold found in the bed of this stream is thought to have been derived as a residual concentration from the glacial tills and gravels that once filled the canyon. The gold is said to occur in flattened particles and in small flakes, some of which range up to $\frac{1}{4}$ inch across.

SQUAW (DOLLIS) CREEK

Squaw or Dollis Creek is a stream 8 miles long that heads in British Columbia and flows northwest to join Tatshenshini River in Yukon Territory, 3 miles north of the boundary line. The creek rises in the Squaw Range on the northwest side of Talbot Creek Pass, at an elevation of 5,025 feet. The Squaw Creek placer workings are most easily reached by way of a tractor road that leads west from mile 88, Haines Road, and crosses the upper Tatshenshini River at a point where the river is split up into several channels. Four miles west of the Haines Road, the tractor road swings northerly across Blizzard Creek and continues northwesterly to cross the Squaw Range via the pass at the head of Talbot Creek. This road was built in 1946 by W. Muncaster, W. Ainge, and G. Gray.

Coarse placer gold was discovered on Squaw Creek in 1927 by Paddy Duncan of Klukshu, and by the end of the following year the stream was staked along almost its entire length. A great number of the claims were located and worked by the Indians from Klukshu and Champagne. Between 1928 and 1940, some twenty to forty-five people worked each summer on Squaw Creek, but during the past 10 seasons the number working has generally been less than ten. At the time of the writer's visit to this stream in 1949, only Francis and William Muncaster and William Ainge were working their claims. The Muncasters have worked a little here each summer since 1928, and Ainge has put in 15 seasons.

The placer gold from this stream is generally coarse, and has provided many large nuggets. In most cases the coarse gold is featured by an admixture of vein quartz. J. T. Mandy (1933) visited the stream in 1932 and reported as follows:

"The largest nugget found on the creek was valued at $216.00, found on No. 4 [claim] above 'Discovery' in 1931. During the 1932 season the largest nugget reported up to the end of August was one valued at $130.00 from No. 3 above Discovery. During this season, several from $20.00 to $75.00 in value were also found."

Mandy (1934) reported further that at the close of 1933 about 600 ounces of gold had been recovered and that individual recoveries had been quite satisfactory, with more large nuggets being taken from Squaw Creek than on any previous year. About fifteen nuggets were reported, weighing from 4 to 9 ounces each.

One nugget weighing 46 oz. 5 dwt. was found in 1937 on the Discovery claim[1] by E. Peterson and B. Turbitt (*See* Frontispiece, Minister of Mines, B.C. Ann. Rept. 1937).

Watson (1948) states that official records show a production from the British Columbia section of Squaw Creek, of about 3,500 ounces of gold, but that the actual production has been estimated as approximately 5,000 ounces.

W. Muncaster reported the discovery of a nugget weighing 8·32 ounces during the 1949 season. The gold of this nugget (*See* Plate VI A) was intergrown with both quartz and calcite, and the mass contained several limonite aggregates in cubic form, pseudomorphic after coarse pyrite. Some of the cubes were rimmed by thin layers of gold, indicating an association of the coarse gold and pyrite, with gold deposition later than that of pyrite.

An average of four assays of Squaw Creek gold, representing about 60 ounces from the Muncaster claim, gave the following results:

	Per cent
Loss by melting	5·0
Gold fineness (855)	85·5
Silver fineness (122·5)	12·25
Total	97·75

W. Muncaster reports that the gravels in the British Columbia sectors of Squaw Creek, including the appreciable volume of large boulders, generally average about $1.50 a cubic yard. The gravels along the lower 2 miles of this stream in Yukon Territory carry less gold. Work done there some 20 years ago disclosed about 90 cents a cubic yard (gold at $35 an ounce).

Squaw Creek is at the southern end of the Silver Creek anticline, and the Permo-Carboniferous rocks of the Kaskawulsh group, consisting mainly of limestone, marble, slate, argillite, andesite, and schist, are well exposed

[1] Discovery claim lies in British Columbia 1,600 feet upstream from the British Columbia-Yukon boundary, and Squaw Creek flows westerly across it between 600 and 800 feet south of the boundary.

along its course. The overlying Mush Lake group of volcanic and sedimentary rocks is exposed along the southwest side of Mount Beaton where it is invaded by acidic granite that forms the core of the mountain. The limestone beds are intruded by small diorite stocks. Narrow quartz veins, some of which contain a little pyrite, occur in many places in the bed of Squaw Creek and in the surrounding mountains. Some large quartz veins visible from a distance of 2 miles may be seen high on the mountain on the south side of Squaw Creek a mile south of the Yukon boundary. It is possible that gold-rich shoots occur in places in some of these veins even though much of the quartz appears barren on casual examination. The Squaw Creek placer gold is believed to have been derived from local gold-bearing quartz veins, and to have been concentrated in the stream gravels during a long period of erosion and weathering that extended back into late Tertiary time.

The placer gravels of the upper part of Squaw Creek in British Columbia were protected from valley glaciation throughout Glacial time. Valley glaciers moved northerly up the main Tatshenshini Valley and for a time filled this great valley to a depth of at least 5,000 feet. At that time, lateral ice pressure must have produced a flow of ice southeasterly up the valley of Squaw Creek until it and tributary valleys were filled. Once Squaw Creek Valley became ice filled in this way, there would have been no further movement of ice, due to the encirclement of high mountain ridges on the southwest, south, east, and north, and the ice would have lain stagnant during Glacial time. The scouring action of ice moving up Squaw Creek Valley was unimportant. The placer gravels were apparently carried only short distances up the valley and their gold content was largely reconcentrated in the bed of Squaw Creek after the passing of the Ice Age. If the hypothesis outlined above is correct, then some of the shallow, boulder clay deposits found along Squaw Creek may have contained some pay gravels picked up at the time the ice moved up the valley. The discovery of large nuggets in the surface gravels and in the boulder clay close to the present stream bed of Squaw Creek supports this theory. It also invites the question as to whether some of the shallow boulder clays of the upper part of Squaw Creek might be workable.

At one stage during the wane of glaciation, kame moraines were deposited along the edge of the melting ice-sheet on the southwest slope of Mount Beaton. These high gravel terraces are pitted by numerous kettle-holes along their outer edge. They lie on the mountain slope between elevations of 3,000 and 3,500 feet, and are best developed for 2 miles along the mountain front north of Squaw Creek on the Yukon side of the border.

For some time immediately following the withdrawal of ice from Tatshenshini Valley, Squaw Creek drained southwesterly on emerging from the mountain front 3 miles east of Tatshenshini River. The large fan that it formed at that time is clearly visible in air photographs. Some gold may also have been deposited toward the head of this bench.

TATSHENSHINI RIVER

During the summer of 1933, B.C. Prospectors Limited drilled a few holes in the gravel bench at Dalton Post on the north side of Tatshenshini River, but found only a little fine placer gold. Later in the year this company drilled three shallow holes in the gravel fan at the mouth of Squaw (Dollis) Creek. According to W. Muncaster, the deepest hole, drilled some 600 feet east of Tatshenshini River, went down 48 feet without reaching bedrock.

On the west side of Tatshenshini River, opposite the mouth of Squaw Creek, are three gravel terraces lying on bedrock one above the other. It might be worth while to prospect these benches to see if any fine gold has been concentrated there on bedrock.

IRON CREEK

Iron Creek is a northwesterly flowing glacial stream about 3 miles long that joins Bates River 4 miles south of Bates Lake. This powerful stream has eroded a gorge some 400 feet deep and about 1,000 feet wide between the front of the Iron Creek Glacier and Bates River. The gorge is incised in a great field of glacial till that was left at the close of the Glacial period by retreating valley glaciers. Placer gold is reported to occur in the present stream bed and is generally found in the gravels near or on bedrock or resting on the glacial clays. Most of this placer gold represents reconcentrated gold, derived from the washing of the till that once occupied the canyon. Some additional gold has undoubtedly been brought down by the stream issuing from beneath the Iron Creek Glacier and by the stream flowing from the West Fork Glacier. H. S. Bostock (personal communication) postulates that in pre-Glacial time, Wolverine Creek flowed directly into Iron Creek and that some of the gold was brought down at that time by Wolverine Creek.

Frank McDougall of Whitehorse tested the gravels on the upper part of Iron Creek about a mile below the tip of Iron Creek Glacier in 1945. Heavy equipment was brought in via the Mush Lake road and transferred across Mush and Bates Lakes, through the use of large oil-drum rafts. The mining operation was evidently not profitable, as Mr. McDougall removed his equipment in 1946.

BATES RIVER

Bates River is confined within a narrow, rock-walled canyon for 3 miles, commencing a mile above the mouth of Iron Creek and extending downstream for 2 miles below the mouth of this creek. At the foot of the canyon the river bursts forth from between confining walls 25 feet apart, and auriferous gravel bars occur along its banks for 1,000 feet or more, or as far west as the first tributary stream on the south. The surface gravels at the canyon's outlet contain an abundance of fine placer gold. The writer carried out panning tests of the coarse surface gravels along the south side of the river for 300 feet below the mouth of the canyon, and found that every pan yielded gold, and in some places the yield was as high as seventy colours of gold a standard or large pan, with some of the larger 'colours' measuring $\frac{1}{20}$ inch in diameter. Some coarse pyrite was invariably found with the black sand in each pan.

This placer ground has been investigated from time to time during the past 15 years by B. Beloud and associates of Whitehorse, but no large-scale placer mining has been undertaken to date. A tractor trail leads to the property from the south end of Bates Lake.

Some gravel-covered benches occur along the north side of Bates River opposite the mouth of Iron Creek and extend downstream for at least half a mile. The gold content of these bars has not been tested.

In pre-Glacial time, Bates River may have been confined to a channel that is now hidden by glacial till south of its present course for 1 mile or 2 miles southwest from Iron Creek. Such a channel, if present, might contain remnants of gold-bearing Tertiary placer gravels.

The deep, narrow canyon in which Bates River is confined for 2 miles easterly from the Alsek, was incised in post-Glacial time, as its high, narrow walls are not modified by glacial ice. In late Tertiary time, Bates River reached the Alsek through a gap in the low mountain ridge 2 miles north of the present mouth of Bates River, or reached the Alsek by flowing northwest along the valley of Clay Creek. These old channels of Bates River are concealed now by glacial silts and till. They may contain gold-bearing gravels in places where there was shallow ice erosion.

ALSEK RIVER

Most of the tributary streams of Alsek River and many of the bars along the Alsek contain appreciable amounts of placer gold, according to the reports of prospectors who have travelled its banks. The writer found colours to be particularly plentiful on Marble Creek (*See* Plate IV A) and suggests that this stream is probably worth further testing. The north-westerly flowing part of Goatherd Creek, the stream that flows around the north side of Goatherd Mountain, should, theoretically, be worth investigation, as its gravels were protected from valley glaciation.

SUGDEN CREEK

Sugden Creek is a fast glacial stream that flows south to join Kaskawulsh River 4 miles west of the mouth of Dezadeash River. The upper part of the creek is confined within a steep-walled canyon, but the stream breaks forth from these walls at the head of a great gravel fan 1½ miles north of Kaskawulsh. The gravels at the head of the fan have for many years been known to contain placer gold. They are reported to have been first prospected by a Mr. Sugden some 40 years ago, and several successive owners have conducted small-scale placer mining operations since that time.

According to Pete Peterson of Whitehorse, who worked this ground for a time in 1938, the placer gold of Sugden Creek contains considerable platinum. He reports taking out 23 ounces of platinum-rich gold dust, some of it fine and some coarse, that assayed about one-third platinum. The platinum is thought to have been derived from small amounts of this metal liberated from the peridotite bodies along the upper reaches of Sugden Creek during the course of natural weathering processes.

It is highly probable that some of the gravels along the upper part of Sugden Creek are in part of Tertiary age. The stream bed of the upper part of Sugden Creek, within the mountain front, was protected from the scouring action of the large valley glaciers by the high mountains about its headwaters. Such ice as entered this stream valley would have lain largely dormant throughout the Glacial Epoch.

A broad gravel bench on the east side of Sugden Creek, just above the canyon's outlet and at least 125 feet above the present stream bed, may contain some additional auriferous gravels. Another, much smaller gravel bench lies at the north end of the one just described, but at about 50 feet higher elevation. This bench might also be worth examining for paystreaks.

KIMBERLEY CREEK

Kimberley Creek flows northwest and joins Jarvis River about a mile west of the map-area. It is reached by a good trail that leads south from Sulphur Lake and crosses Jarvis River at the mouth of the creek. It is a swift glacial stream with a strong flow, and can be crossed on foot only towards its lower end where it spreads out into several channels that traverse a wide gravel fan. There is no evidence of any placer mining being done along the course of this stream in recent years, but at the time of McConnell's visit to the area in 1904 placer gold was being won from two claims at the head of the gravel fan.

LODE DEPOSITS

SUMMARY

Copper occurs in many places in Dezadeash map-area along the east limb of the Silver Creek anticline, in volcanic rocks of the Mush Lake group. Many small epidotized zones in the andesites near Mush Lake contain chalcocite stringers and veinlets, and in one zone a fine impregnation of native copper was noted. Six miles south of Mush Lake, altered andesites adjacent to the north end of a granodiorite stock are mineralized with chalcopyrite. The deposit occurs in a fractured zone along a major fault. A few quartz stringers seen within the intrusion carry small amounts of chalcopyrite and galena and a little gold. Some copper mineral is also associated with the granitic intrusion on Shorty Creek, judging from small malachite-stained pebbles of quartz and chalcocite found there in the sluice-boxes during placer mining operations. Native copper nuggets found on Beloud Creek suggest the presence of copper-bearing veins towards the head of this stream. Several bornite-rich veins occur 2 miles southeast of Sockeye Lake on the south side of Bornite Creek.

The Bates River anticline forms a structure that should theoretically be worth close examination in view of the granitic intrusions associated with it.

The peridotite stocks that invade Mesozoic strata in the mountains west and southwest of Bear Creek are not known to contain asbestos, but should be prospected, as similar peridotite bodies form the host rock for asbestos in McDame map-area in northern British Columbia[1]. Some black cobbles picked up at the base of the peridotite stock 4 miles north of the mouth of Dezadeash River contained 19·82 per cent chromium and 11·45 per cent iron, the equivalent of about 45 per cent chromite, which suggests the possibility of finding chromite deposits within the peridotite intrusion west of Dezadeash River.

A specimen of augen-gneiss collected 12 miles north of Champagne and 3 miles west of the Hutshi trail was tested for radioactivity by H. V. Ellsworth of the Geological Survey, who reported its activity as approximately 0·005 per cent U_3O_8 equivalent, or somewhat above the average for granites. None of the granites tested showed any radioactivity. Two specimens of soda syenite collected 4 miles northwest of Onion Lake indicated a content of about 0·002 per cent U_3O_8.

IRON CREEK

A quartz vein on the west side of Iron Creek Glacier, a mile south of the ice-front, contains a little galena and pyrite. The vein, which occurs in andesite, strikes north 30 degrees east and dips 80 degrees southeast. It ranges from 2 to 4 feet in width, and is well exposed on a steep slope for 200 feet between elevations of 3,600 and 3,800 feet. Below 3,600 feet the vein is drift covered. Above 3,800 feet, the fault along which the vein occurs continues strongly up a slope too precipitous to climb. In places the quartz vein contains abundant galena and pyrite, but most of the exposures are sparsely mineralized. A 4-foot channel sample taken across the vein by the writer at an elevation of 3,700 feet, assayed: gold, a trace; silver, 1·03 ounces a ton; lead, 3·10 per cent. Another sample collected 30 feet higher, across 4 feet of quartz and rusty carbonate, assayed: gold, a trace; lead, nil.

Pyritized limestone outcrops on the west side of Iron Creek Glacier at the ice-front. One small sample brought in by K. Roberts, assayed: gold, a trace.

Narrow quartz veins occur in abundance in steep andesite bluffs on the east side of, and 2 miles below, the head of Iron Creek Glacier.

MUSH CREEK-FRASER CREEK PASS

On the south side of the Mush Creek-Fraser Creek Pass, copper mineralization is associated with a strong fault zone that is clearly defined in air photographs as extending for more than 3 miles southerly across the mountain. This fault zone is also known to extend for at least 2 miles north of the pass, but has not been examined in that direction. South of the pass, it extends up a small U-shaped canyon that rises along a 17- to 20-degree slope.

On the west side of this canyon, small divergent faults trending southwesterly into tuff and andesite rocks between elevations of 3,250 and 3,400 feet are quartz filled in some places near the main fault zone, and contain a little chalcopyrite. Between elevations of 3,450 and 3,900 feet the rocks are silicified and carbonatized, are bleached to a pale yellow-white

[1] Personal communication from L. L. Price. Geological Survey of Canada, who found asbestos there during the 1949 field season.

to pink colour, and carry occasional small seams of chalcopyrite adjacent to the main fault zone. At an elevation of 3,900 feet, the fault zone enters the granodiorite, which forms the core of the mountain. There the andesites on the west side of the fault zone are more highly shattered, and are traversed by a network of intersecting faults across a zone 90 feet wide and at least 100 feet long on a steep 30-degree slope. The sheared and altered andesite is replaced by a network of small chalcopyrite veinlets and by small amounts of pyrite. A chip sample obtained by the writer across a width of 75 feet of this mineralized rock assayed: gold, a trace; copper, 0·46 per cent. Should drilling prove this zone to continue to depth adjacent to the granite contact, then a workable, low-grade orebody might materialize.

Further work in this vicinity should include a close examination of these rocks adjacent to the major fault zone throughout its length both north and south of the pass. Smaller parallel faults should also be examined for evidence of mineralization.

BORNITE CREEK

Small, bornite-rich veins occur in andesite on the south side of Bornite Creek 2 miles southeast of Sockeye Lake. Two intersecting veins were noted there at an elevation of 3,550 feet, about 50 feet above the bed of the stream; one strikes south 60 degrees west and dips 70 degrees southeast, the other strikes north 55 degrees west and dips 65 degrees northeast. Both are less than 50 feet long and range from 3 to 15 inches in width. They occur along small faults in massive, fine-grained, green andesite. They are sulphide veins composed largely of bornite, with minor pyrite and chalcopyrite and in places some vein quartz. The northeasterly trending vein disappears as a fan-shaped shear zone, which is sparsely mineralized with bornite across widths of up to 5 or 6 feet.

About 100 feet farther east, another diverging shear zone is exposed in the andesite. This zone also strikes south 60 degrees west and dips steeply southeast. It ranges in width from 6 inches, where it emerges from drift cover, to 6 feet, 30 feet along its strike. Bornite is heavily concentrated in the narrow part of the shear zone, but becomes more sparsely disseminated as the zone widens.

At 100 feet still farther east and 50 feet higher on the slope, a massive sulphide pod about 12 feet long and 2 feet wide is composed of bornite and brecciated partly replaced andesite. A 2-pound representative sample of this ore, assayed by the Mines Branch at Ottawa, gave: gold, a trace; silver, 1·62 ounces a ton; copper, 29·92 per cent. About 30 feet higher up the slope, a quartz vein that ranges from 3 to 12 inches in width is exposed for 20 feet. The quartz contains from 5 to 25 per cent bornite. Both veins strike north 60 degrees west, dip vertically, and are arranged *en échelon*.

A strong, vertical fault strikes north 60 degrees west across Bornite Creek at an elevation of 3,575 feet and passes on the southeast a few feet east of the last described vein. The rocks east of this fault are mostly fine-grained, brown to light yellow and purple weathering andesites. About 50 feet of intercalated slate, argillite, and quartzite beds strike across the creek at an elevation of 3,500 feet just west of the andesite flow in which the veins are found. The veins are evidently localized in the 400-foot-wide body of green andesite that lies between the strong fault and the sedimentary beds.

Although the veins described above are small, it is possible that further work in this vicinity may reveal more substantial deposits.

COAL DEPOSITS

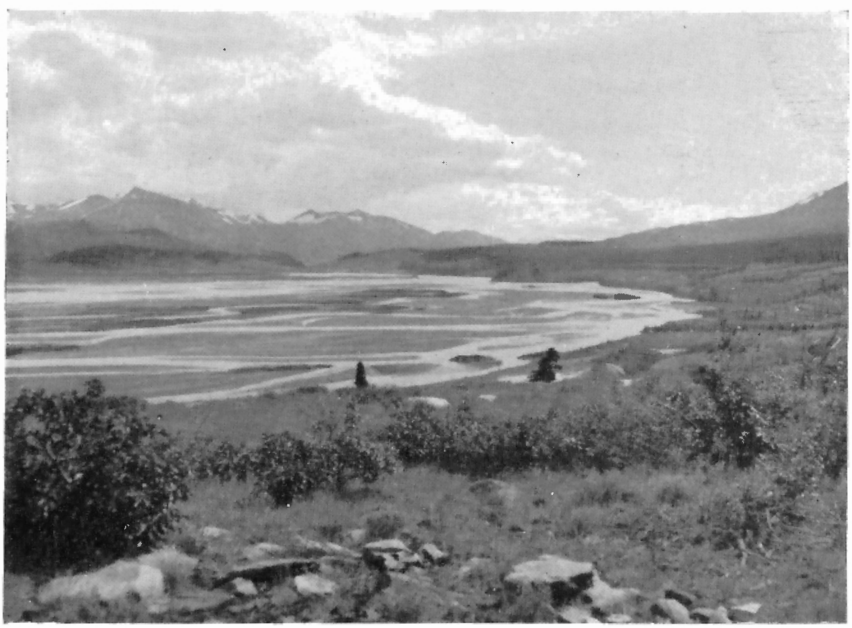
Thin coal seams occur in conglomerate beds along the north side of Kimberley Creek between 2 and 4 miles above its confluence with Jarvis River. This conglomerate belt forms the basal member of the Dezadeash group of Lower Cretaceous age. The conglomerate pebbles are derived largely from Mush Lake group lavas, and consist of red andesite, green andesite, rhyolite, chert, granite, quartz, limestone, greywacke, aplite, and volcanic tuffs. The conglomerate rests directly on the red-hued andesite in this vicinity, and both formations dip steeply. At the first outcrop on the north bank of Kimberley Creek the beds strike northwest and are overturned to dip 65 degrees southwest; farther upstream the dip is vertical. The coal seams seen by the writer in the conglomerate were all narrow and lenticular. They range from ¼ inch to 2 inches in thickness, and are, consequently, of no commercial value.

The same conglomerate zone was examined 9 miles farther southeast, about a mile east of Sugden Creek and 2 miles north of Kaskawulsh River. There it is about 500 feet thick, and contains lenticular coal seams, some of which reach a thickness of 6 inches. The conglomerate is overlain by 150 feet of interbedded argillite, slate, and carbonaceous shale beds, with many coal seams, most of which are less than 3 inches thick but several of which reach thicknesses of 6 or 7 inches. The strata strike northwest and dip from 75 to 85 degrees northeast. Mountain building processes have resulted in some crushing and shearing along most of the coal seams. Although no coal of commercial value was seen, there is a possibility that better seams will be found elsewhere when the basal beds of the Dezadeash group are thoroughly prospected.

PLATE II

E.D.K. 1-2, 50

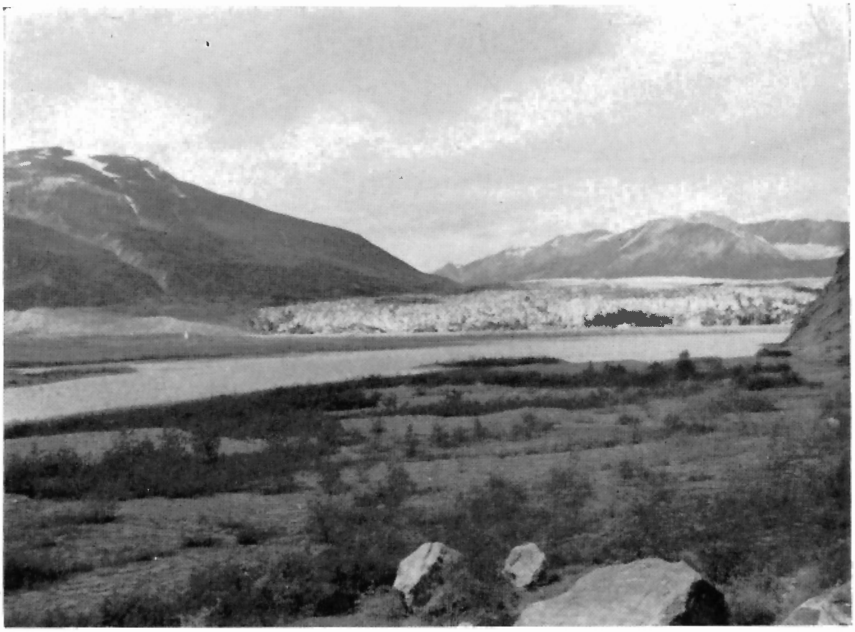
A. Dezadeash Lake, looking southwest across Shakwak Valley. (Pages 1, 13.)



E.D.K. 2-1, 50

B. Alsek River showing braided channels; view looking south on west side of river, a mile north of Park Creek. (Pages 3, 22.)

PLATE III



E.D.K. 3-6, 50

A. Lowell Glacier, looking northwest across Alsek River. (Pages 11, 14.)

E.D.K. 2-9, 59

B. Goatherd Mountain, looking southeast across the north front of Lowell Glacier. (Pages 6, 21.)

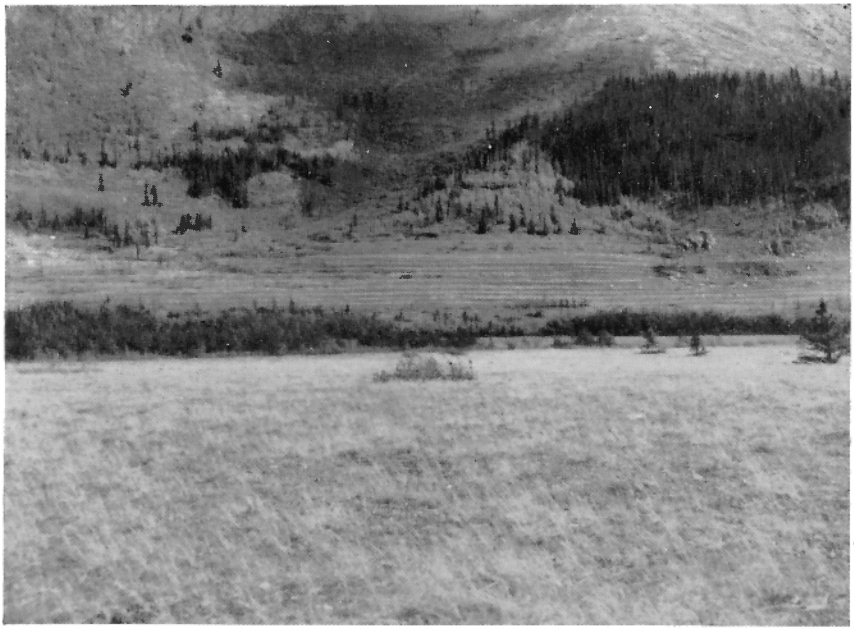
E.D.K. 1-7, 50

A. Alsek River, looking west toward outcrops of crystalline limestone, with Marble Creek Valley in the background. (Pages 13, 33, 44, 54.)

E.D.K. 1-5, 48

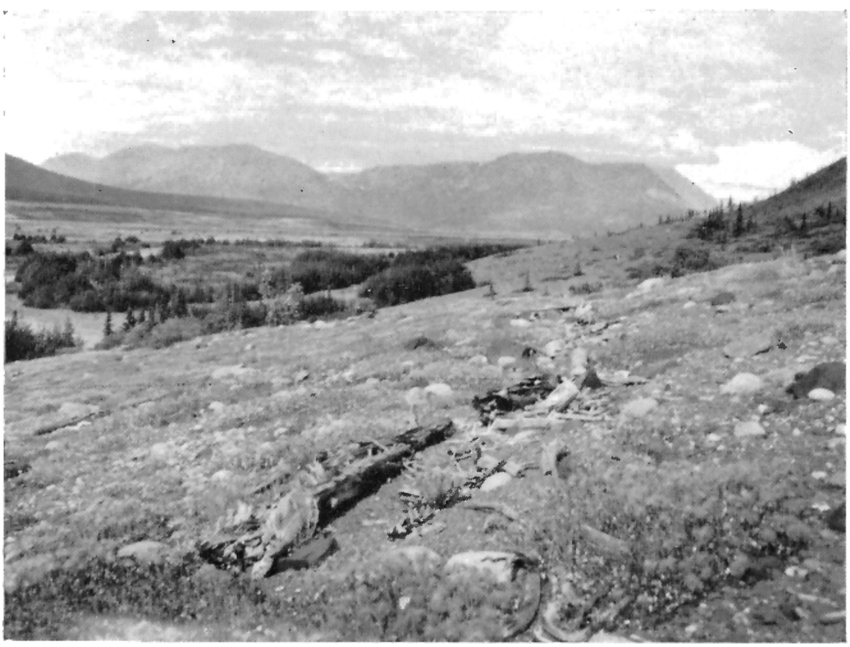
B. Stratified silts, Alaska Highway, 5 miles west of Champagne. (Pages 5, 16.)

PLATE V



E.D.K. 4-11, 50

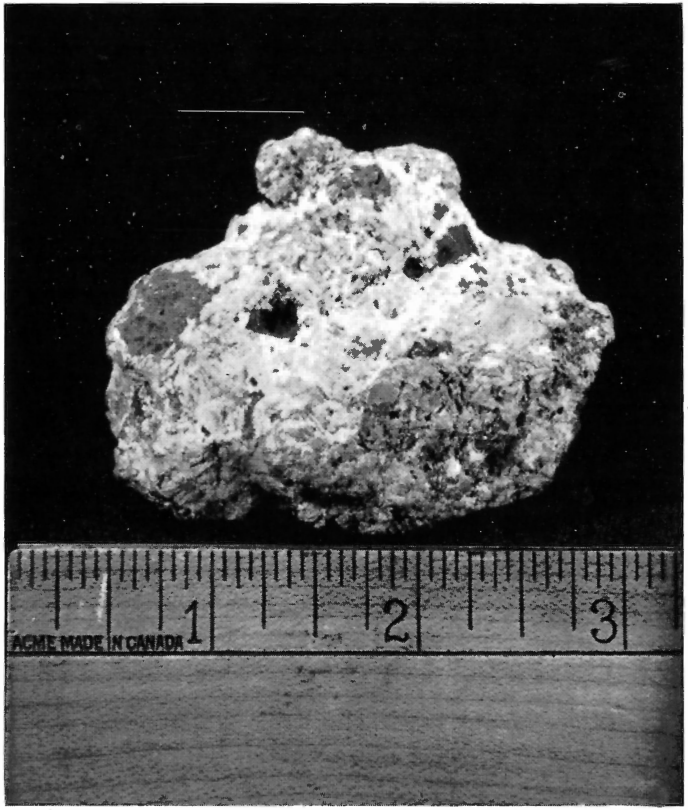
A. Beaches of Recent Lake Alsek, east side of Dezadeash River, 5 miles above the Alsek. (Page 22.)



E.D.K. 2-8 46

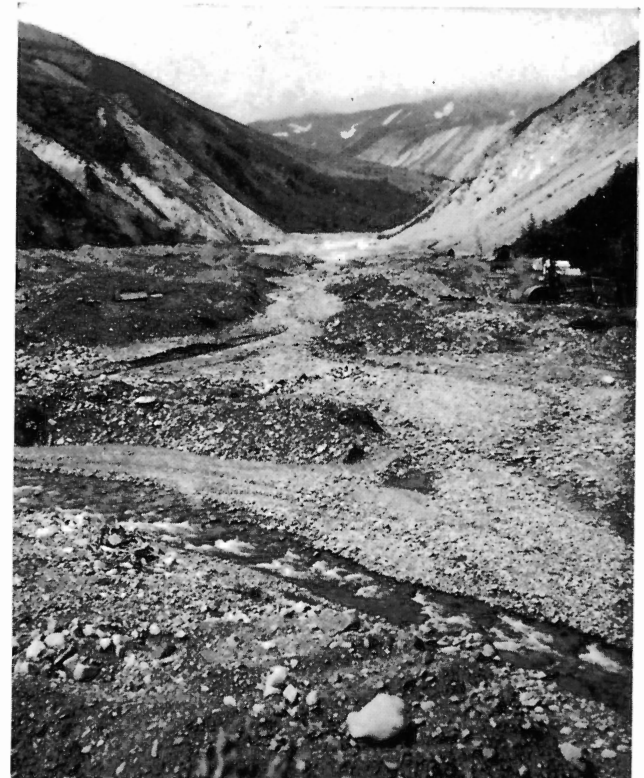
B. Driftwood on beach of Recent Lake Alsek, view looking north, east side of Alsek River, near first canyon. (Page 22.)

PLATE VI



10346

A. Gold and quartz nugget found by W. Muncaster on Squaw Creek, 1949 (weight 8·4 ounces). (Page 51.)



E.D.K. 3-4, 48

B. Shorty Creek placer workings, 1948. (Page 49.)

INDEX