BRITISH COLUMBIA DEPARTMENT OF MINES

HON. E. C. CARSON, *Minister* JOHN F. WALKER, *Deputy Minister*

BULLETIN No. 19

THE TUYA-TESLIN AREA

NORTHERN BRITISH COLUMBIA

by

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1944

VICTORIA, B.C.:
Printed by CHARLES F. BANFIELD, Printer to the King's Most Excellent Majesty.
1944.

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SUMMARY.

THE Tuya-Teslin Area, 1,600 square miles in extent, is situated in the Stikine and Atlin Mining Divisions of Northern British Columbia, partly within the western margin of the Cassiar-Omineca Mountains. Although the area is accessible by several routes of travel it is, nevertheless, remote and transportation costs, at present, are very high. Because of the cold climate and the presence of snow in all but the summer months, prospecting can be carried on satisfactorily for only about four months of the year.

A large part of the region rises above timber-line, which lies at about 4,500 feet above sea-level.

About one-quarter of the area is occupied by a gently rolling upland known as the Kawdy Plateau. The Tuya Range, a north-westerly-trending belt of mountains in the eastern part of the area, contains several rugged peaks over 6,500 feet in altitude. The north-westerly-trending Atsutla Range, lying in the western half of the region, contains sharp peaks up to 6,500 feet in height in its central and north-eastern parts and lower mountains with flat-topped summits in its south-western part. Large north-westerly-trending valleys or trenches characterized by broad, flat, drift-covered floors and by straight steep walls lie to the east of the Tuya Range, between the Tuya and Atsutla Ranges, and to the west of the Atsutla Range.

In the Tuya Range the Oblique Creek formation, consisting of gneisses, quartzite, schists, crystalline limestone, and volcanics, of undetermined age, has been intruded by two separate granitic batholiths and numerous small intrusives of granite, basalt, and highly altered ultramafic rocks. In the western part of the area the bedded rocks comprise Permian quartzite, argillite, chert, volcanics, and limestone mapped as the Kedahda and Teslin formations and Lower Mesozoic volcanic conglomerate, arkose, argillite, tuff, limestone, and volcanics mapped as the Nazcha and Shonektaw formations. In the Atsutla Range some of these rocks have been intruded by two granitic batholiths and by many smaller bodies of granitic rocks, diorite, gabbro, rhyolite, basalt, and serpentine. Generally, the structural features of the Palæozoic and Mesozioc rocks trend north-westerly and dip at moderate to steep angles. In many places in the area these older rocks are overlain unconformably by late Tertiary (?) and Pleistocene lava, tuff, and agglomerate of the Tuya formation.

During the Pleistocene an ice-sheet moved westerly and south-westerly across the area, but it did not greatly modify the land forms. About one-half of the area is covered with glacial drift and alluvium, which are generally thick and widespread below an elevation of 4,500 feet.

The Tuya-Teslin Area is virtually unprospected for lode deposits. The thick mantle of drift and alluvium and the extensive areas of volcanic rocks of the Tuya formation unfortunately eliminate a large proportion of the area for prospecting. Parts of the remainder, however, are geologically favourable for the occurrence of lode deposits and indications of copper, gold, silver, iron, lead, zinc, tungsten, and tin mineralization have been found. In the north-eastern part of the Tuya Range some of the limestones overlying the flat upper surface of the Parallel Creek batholith have been altered to skarns and, in places, mineralized with tungsten, tin, lead, zinc, and iron.

Parts of the Tuya-Teslin Area have been prospected without success for shallow deposits of placer gold, but little or no testing of the deep ground has ever been done.

CHAPTER I. INTRODUCTION.

LOCATION.

The Tuya-Teslin Area, comprising about 1,600 square miles of uninhabited country, is in the Stikine and Atlin Mining Divisions of Northern British Columbia (Fig. 1). The area extends from the southern end of Teslin Lake (approximately 59° 30′ north, 132° west) to within about 18 miles of the northern end of Dease Lake (approximately 58° 45′ north, 130° west) and is bounded mainly by the Teslin (Whiteswan)* Valley on the south-west, the Jennings River and Parallel Creek on the north and north-east, and the Cottonwood River on the east.

That part of the area draining into Teslin Lake lies in the Atlin Mining Division and that part drained by the Cottonwood and Tuya Rivers lies in the Stikine Division. The locations of Gold Commissioners', Mining Recorders', and Sub-mining Recorders' offices within these divisions are listed in the annual reports of the Minister of Mines.

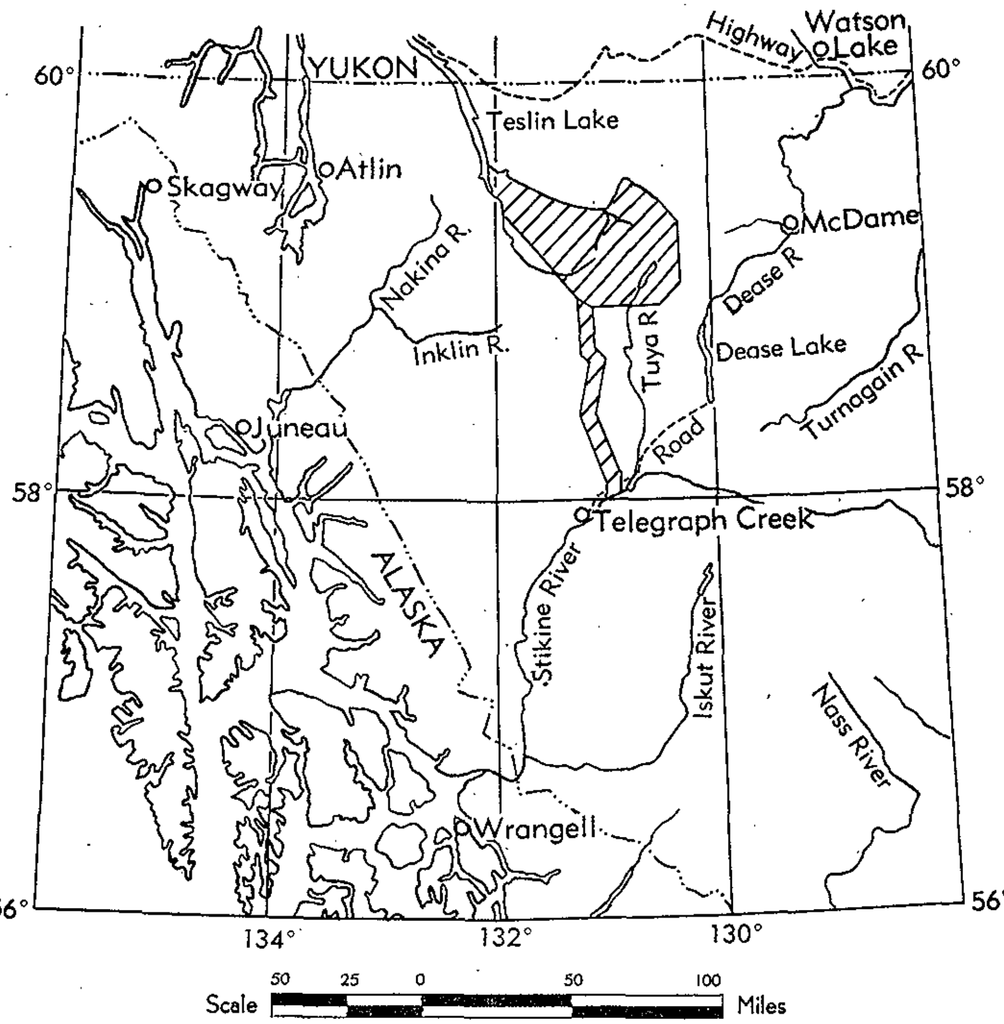


Fig. 1. Key-map of North-western British Columbia, showing location of Tuya-Teslin Area and of traverse to Stikine River.

* The place-names in the Tuya-Teslin Area used in this report have been approved by the Geographic Board of Canada. Unapproved names which have appeared in previous reports or maps or which are used locally are placed in parentheses.

ACCESS.

The writers entered the region via Wrangell in Alaska, Telegraph Creek on the Stikine River, and Dease Lake. Steamships operating on a weekly schedule make the voyage between Vancouver and Wrangell in about two and one-half days. Transportation by river-boat between Wrangell and Telegraph Creek at the head of navigation on the Stikine River is maintained from the end of May until the middle of October. The 150-mile journey up-stream is generally made in two or three days, but it may be greatly prolonged by exceptionally high or low water; the down-stream journey usually requires only one day. A truck-road, 75 miles long, connects Telegraph Creek with Lake House at the southern end of Dease Lake and during the freighting season, when the road is kept in good condition, the trip may be made in four or five hours. Boats are operated on Dease Lake during the period of open water, which usually lasts from early June until December. A poor pack-trail extends along the western side of the lake to Porter Landing. From there, a good trail leads up Thibert and Mosquito Creeks and thence down Defot Creek to its mouth, which is about 3 miles from the south-eastern part of the Tuya-Teslin Area.

During the summer of 1943 the following freight rates were effective: Wrangell to Telegraph Creek, $55 (Canadian) per ton; Telegraph Creek to Wrangell, $40 per ton; Telegraph Creek to Porter Landing, $30 per ton. Pack-horses may be hired at Telegraph Creek. Provisions and general supplies are obtainable at Telegraph Creek and Lake House.

An alternative route from Telegraph Creek to the Tuya-Teslin Area is the trail across Level Mountain and the Nahlin Valley to the Kawdy Plateau (*see* Appendix and Fig. 4). The area may also be approached from Dawson Creek, in North-eastern British Columbia, by the Alaska Highway to Lower Post and thence by the Dease River to Porter Landing. Another route from the south-east is via the Alaska Highway to Teslin Post, in the Yukon Territory, and thence southward on Teslin Lake. Teslin Lake is also accessible by road or water from the terminus of the White Pass and Yukon Route Railway at Whitehorse and by trail from Atlin. A trail leads from the abandoned post of Galbraith (Old Post) near the southern end of Teslin Lake, past Hutsigola Lake, to a point near the head of Charliecole Creek.

FIELD-WORK.

Reconnaissance geological mapping was carried on in the area for about three months during the summer of 1943. In the course of the work, gravels from many of the streams were tested by panning. Locations were made in the field mainly by pace-and-compass traverses and by resection. An unpublished topographic map of the Atsutla Range and the Kawdy Plateau on a scale of 4 miles to 1 inch with 1,000-foot contours was used in the field. This map has been modified for publication mainly by the addition of 500-foot contours. Elevations were based on aneroid readings corrected by barometric data from Atlin. The topographic map of the Tuya Range was made by W. H. Mathews from sextant triangulation, controlled aneroid readings, field-sketches, and photographs.

ACKNOWLEDGMENTS.

The writers wish to thank J. G. Fyles and O. K. Miniato for their capable assistance in the field. Many courtesies were extended to the party by A. E. Roddis, Government Agent at Telegraph Creek, by residents of Porter Landing, and by the General Construction Company. The writers are greatly indebted to S. L. de Carteret, Deputy Minister, Department of National Defence for Air, Ottawa, for supplying the topographic base map of the Atsutla Range and the Kawdy Plateau. Acknowledgment is also made of the co-operation of J. Patterson, Controller, Air Services, Meteorological Division, Department of Transport, Ottawa, in furnishing the barometric data

used in the adjustment of field readings, and of the Geological Survey, Department of Mines and Resources, Ottawa, in identifying fossils.

PREVIOUS WORK.

In 1874 placer prospectors examined the headwaters of the Tuya River and other streams in the region west and north-west of Dease Lake (Johnston, 1925, p. 41 A).

In 1891 C. W. Hayes journeyed north-easterly from the head of Taku Inlet to the southern end of Teslin Lake and included a brief description of the Teslin Valley in the narrative of the expedition (Hayes, 1892, p. 132).

In the same year N. B. Gauvreau traversed along the Teslin Valley, near the south-western margin of the area. His report, which is accompanied by a sketch-map, includes notes on the topography and drainage of the valley (Gauvreau, 1893, pp. 490–491).

Gold-seekers *en route* to the Klondike in 1898 are said to have travelled through the area from Dease Lake and to have descended the lower part of the Jennings River by boat. Other prospectors are reported to have journeyed from Telegraph Creek along the Teslin Valley to Teslin Lake.

In 1898 A. St. Cyr made an exploration of the region between Telegraph Creek and the mouth of the Teslin River, with the main purpose of determining if a pack-trail or wagon-road could be built there at reasonable cost. The report on his work includes a sketch-map and contains information on the regions lying near Hutsigola Lake and along the north-eastern edge of the Teslin Valley (St. Cyr, 1898, pp. 110–113).

In the same year R. G. McConnell made a geological reconnaissance of the shores of Teslin Lake and of the western margin of the Teslin Valley (McConnell, 1898, pp. 53 A–54 A).

According to Gwillim (1899, p. 61 A), who visited Galbraith in 1899, prospectors spent the summer of that year in the region "about Jennings River, between Teslin Lake and Dease Lake and McDame Creek."

In the fall of 1912 placer-gold was reported to have been found on Kedahda (Moosehorn) River and Tanah (Silver), Williejack (Johnson), and Trout Creeks along the south-western flank of the Atsutla Range (Fraser, 1912, p. K 60). This reported discovery caused many prospectors to enter the area in search of gold during the winter and following spring, but apparently none was successful (Fraser, 1913, p. K 67).

In 1925 the areal geology and placer deposits of the Dease Lake Area, which adjoins the Tuya-Teslin Area on the south-east, were investigated by F. A. Kerr (1925, pp. 75 A–119 A) and W. A. Johnston (1925, pp. 33 A–74 A) respectively, of the Geological Survey of Canada.

In 1930 J. H. Gray traversed the south-western part of the Kawdy Plateau and submitted a report, accompanied by a sketch-map and photographs, to the British Columbia Department of Public Works.

In 1935 a field party of the Geological Survey of Canada mapped the Eagle-McDame Area (Hanson and McNaughton, 1936, pp. 1–16), situated 20 miles to the south-east of the Tuya-Teslin Area. In the same season a Geological Survey party mapped the Teslin-Quiet Lake Area (Lees, 1936, pp. 1–30) in the Yukon Territory, lying about 50 miles to the north-west of the Tuya-Teslin Area.

In 1939 the Aerial Surveys Division of the Canadian Pacific Air Lines, Limited, took four oblique photographs showing part of the area along the Jennings River, one showing the region east of Edasp Lake, and one showing part of the Kawdy Plateau.

In 1940 J. H. Mitchell, of the Surveys and Engineering Branch, Department of Mines and Resources, Ottawa, made a reconnaissance traverse along the Teslin Valley and prepared a report which is accompanied by a sketch-map and photographs.

In 1943 a field party of the Geological Survey of Canada did reconnaissance mapping 20 to 30 miles north of the Tuya-Teslin Area, in a belt along the Alaska Highway between Teslin River and Watson Lake (Lord, 1944, pp. 1–20).

CHAPTER II.

TOPOGRAPHY.

The Tuya-Teslin Area lies partly within the western margin of the ill-defined Cassiar-Omineca system of mountains. The area itself comprises two distinct ranges, a plateau, and three broad valleys or trenches.

Kawdy Plateau.

One of the striking features of the region is the Kawdy Plateau (Plate II., A), an extensive upland lying west and south-west of Tuya Lake. Its total area is about 600 to 700 square miles, of which about 400 square miles lie within the area mapped. The plateau reaches an elevation of more than 4,500 feet in its central part and slopes gradually eastward to an elevation of about 3,500 feet near Tuya Lake and the Tuya River. Over the greater part the surface of the upland is gently rolling and has a local relief of merely 200 or 300 feet. Except in the north-western part at the head of the west and middle forks of Blackfly Creek the main drainage is mature, although throughout the plateau small lakes and muskegs are not uncommon on the superficial mantle of drift. Generally the streams flow on the flat surface of the plateau, but locally they occupy canyons rarely more than 10 or 20 feet deep. Near the western rim of the plateau, however, the lower courses of Nazcha Creek and its tributaries have been incised to depths of 500 feet or more.

The main part of the Kawdy Plateau is an old-age erosion surface developed on highly folded Palæozoic rocks. The northern part of the plateau is underlain by nearly flat-lying volcanic rocks. These volcanics may have been laid down as a thin veneer upon the old-age erosion surface or, like the Palæozoic rocks, they may be cut by it. Several flat-topped or conical mountains of young volcanic rocks rise to elevations of 1,500 feet above the plateau and evidently accumulated on its surface.

Trenches.

Noteworthy features of the topography of the Tuya-Teslin Area are three large valleys or "trenches." These are characterized by broad, flat, drift-covered floors and by relatively straight and steep, though not necessarily continuous, walls. They have a general north-westerly trend and are sub-parallel to the regional trend of the bed-rock structures. Two of these valleys, however, converge at an acute angle. Their sizes are conspicuous. Their widths are great with respect to the sizes of the streams occupying them. They are, indeed, much wider than the transverse valleys occupied by larger streams in near-by areas. The term "trench" is used to denote these broad valleys, but no connotation of origin is implied.

Teslin Trench.—The Teslin Trench (Plate IV., B) has a trend of north 25 degrees west and a length of at least 100 miles. For a distance of about 25 miles the eastern margin of the trench lies within the area geologically mapped. This 25-mile section consists of a flat-floored valley, about 8 to 10 miles wide, covered with a multitude of lakes ranging in size from mere ponds to about 3 miles in length. The floor of the valley is remarkably level and lies between 2,400 and 3,000 feet in altitude, except in the immediate vicinity of Teslin Lake. Several bluffs and ridges, composed in part of bed-rock, are found throughout the valley-floor, but few of them rise more than 200 to 300 feet above their immediate surroundings. Hyland Hill, near the eastern wall of the trench, however, stands 1,000 feet above the valley-floor and forms a conspicuous landmark. The drainage within the trench is poor; lakes and muskegs cover much of the area and the Teslin (Whiteswan) River and its tributaries meander northward on the valley-floor with very low gradients. At the outlet of Hutsigola Lake, however, the Teslin River spills over a limestone ridge as a waterfall 35 feet high and then continues for 6 miles to Teslin Lake (elevation, 2,250 feet) in a channel incised to a depth of from 50 to 200 feet.

The low relief of the Teslin Trench may be to a large extent the result of aggradation by ice and streams. The maximum depth of the fill is not known, but along the Jennings River near its mouth there are exposures of 200 feet or more of unconsolidated material. The relief of the bed-rock surface within the trench therefore may be appreciable.

In the part of the Teslin Trench mapped geologically, the bed-rock exposed is mainly limestone, but other parts of the valley are known to be underlain by greenstone, quartzite, and argillite (*see* Appendix). The trench, therefore, is not merely caused by the erosion of soluble limestone.

Jennings Trench.—The Jennings Trench extends in a direction south 65 degrees east for about 40 miles from the Teslin Trench near the southern end of Teslin Lake. In this distance it rises gradually from a general level of 2,500 to 3,000 feet at its north-western end to 4,500 feet at its south-eastern end where it merges with the northern end of the Kawdy Plateau. Throughout its length the floor of the trench is from 4 to 6 miles wide and slopes gradually upwards towards the valley-walls on either side. At the north-western end of the trench a few hills with moderately steep slopes rise several hundred feet above their surroundings, but elsewhere the surface is gently rolling. Generally the slopes are sufficient to promote good surface drainage and lakes are few. Along the centre of the trench, however, within a mile of the Jennings River there are several extensive muskegs. The gradient of the Jennings River is very low in the south-eastern part of the trench, but towards the north-west the grade increases and in the last few miles to Teslin Lake the river drops rapidly through a channel which has been incised into the deep deposits of unconsolidated material mentioned before.

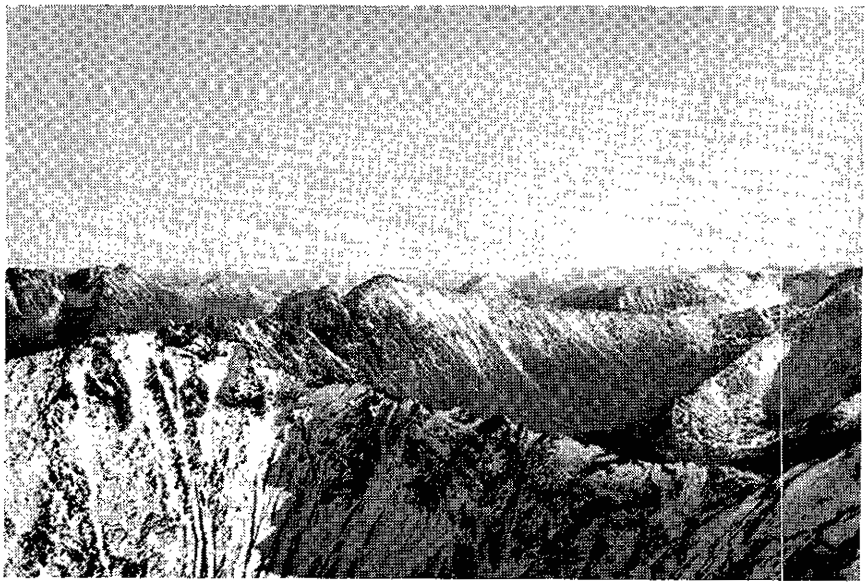
Outcrops are scarce on the floor of the Jennings Valley. The only outcrops known in the central part of the trench occur near the mouth of Kahan Creek where fresh flat-lying volcanic rocks are exposed. Judging from the abundance of basalt boulders in the drift in the eastern part of the trench, much of this area may be underlain by similar volcanic rocks. It is not known, therefore, to what extent the present flat floor of the Jennings Trench is a result of erosion and to what extent a result of deposition of both volcanic rocks and drift.

Parallel and Cottonwood Trenches.—A valley occupied by Parallel Creek trends south 50 degrees east along the north-eastern edge of the area for 15 miles. Over this distance it has a flat floor 2 to 3 miles wide and about 4,500 feet in elevation. Most of the valley is well drained. The walls are abrupt. At its upper or south-eastern end the valley splits into three branches, each a mile or less in width, one extending southward, a second south-eastward, and a third eastward. A distance of 2 or 3 miles farther, the south-eastern and eastern branches open into another trench, drained by the upper part of the Cottonwood River.

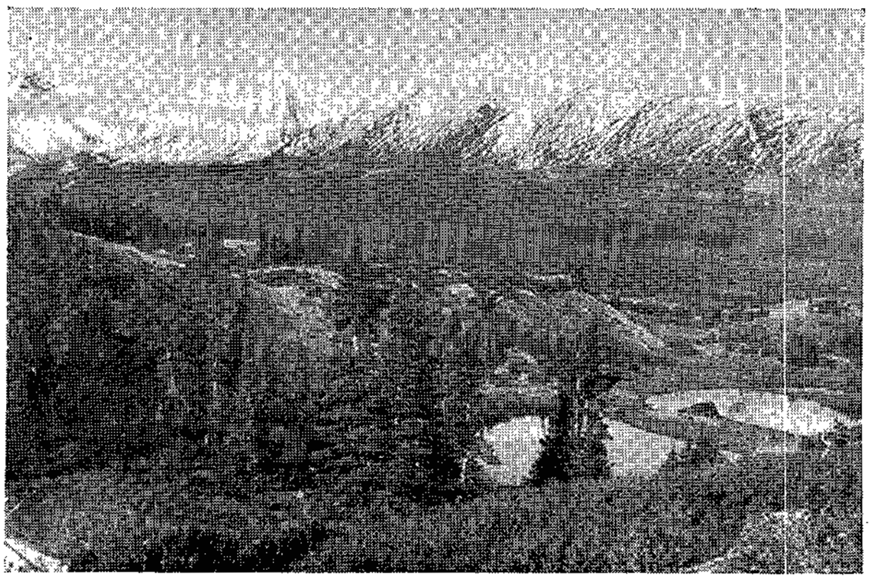
The Cottonwood Trench extends in a direction south 20 degrees east along the eastern edge of the area for 20 miles. Its width is from 5 to 6 miles and the elevation of its flat floor is between 3,500 and 4,000 feet. The surface of the trench is covered with extensive terraces of sand and gravel which, for the most part, are well drained. The Cottonwood River meanders southward on the valley-floor to a point about 3 miles north of its junction with Edasp Creek. Below this point the Cottonwood River and its tributaries flow in narrow canyons cut into the trench-floor. A distance of 5 or 10 miles down-stream, the Cottonwood River turns sharply to the east and leaves the trench by a narrow steep-walled valley which extends eastward through the Cassiar Mountains towards the Dease River. The Cottonwood Trench itself, continuing to the south-east, rises gradually and loses its identity within a few miles.

No outcrops were found on the floor of the Parallel Creek Trench and the depth to bed-rock is unknown. The same is true of the northern part of the Cottonwood

PLATE I.



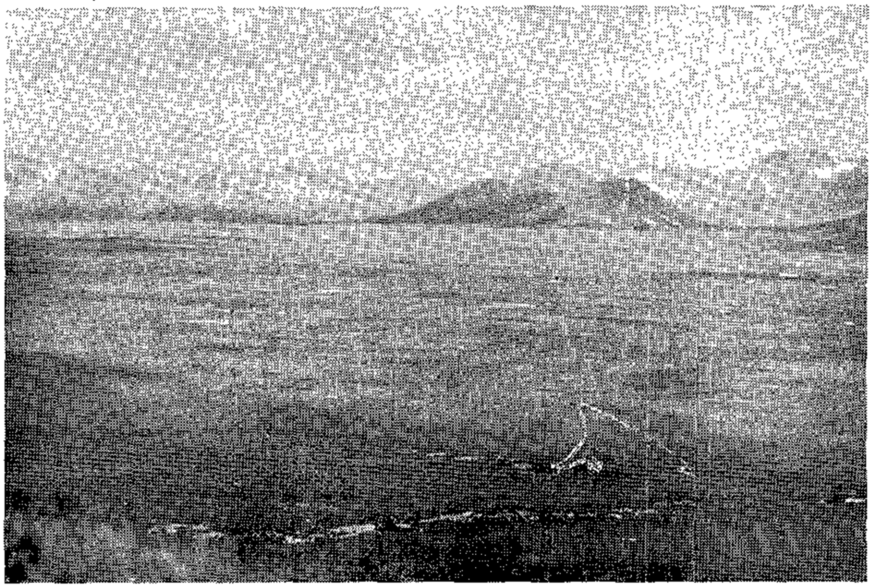
A.—Mountains near head of Parallel Creek, Tuya Range.



(Courtesy J. G. Fyles.)

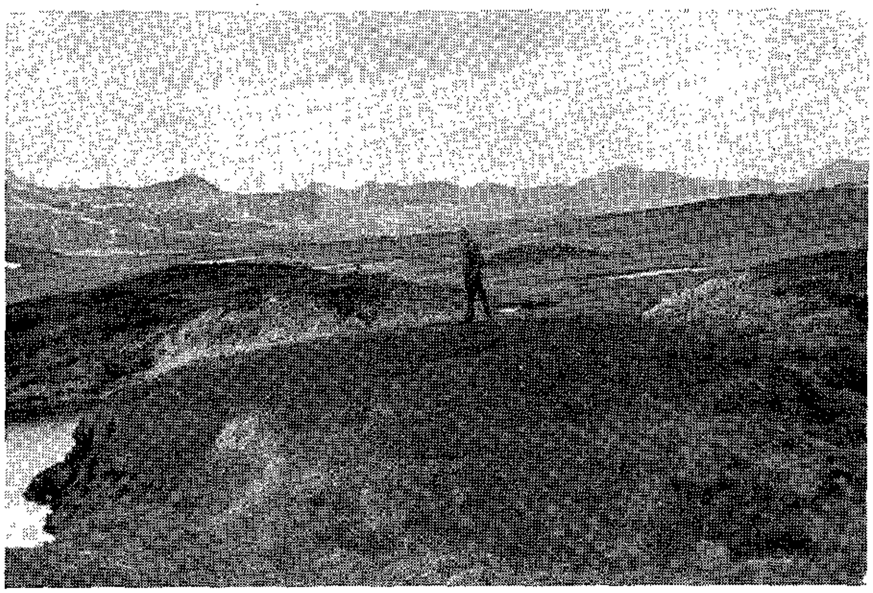
B.—Lower part of Oblique Creek Valley, Tuya Range.

PLATE II.



(Courtesy J. G. Fyles.)

A.—Part of Kawdy Plateau and Atsutla Range. The distance to *the mountain front is about 4 miles.*



B.—Mounds in peat-bog; Nazcha Hills.

Trench within the area mapped. In the southern part, however, Edasp Creek and, apparently, the Cottonwood River have cut into bed-rock through a comparatively thin veneer of drift. In Edasp Creek Canyon folded sedimentary rocks, similar to those exposed on the western walls of the trench, crop out.

ATSUTLA RANGE.

The Atsutla Range (Plate II., A), lying between the Teslin Trench, the Jennings Trench, and the Kawdy Plateau, is about 40 miles long in a direction north 50 degrees west and up to 12 miles wide. In its central and north-eastern part it consists of a series of sharp peaks, about 6,500 feet in elevation, linked by narrow ridges. The southern and western slopes of these peaks and ridges are generally smooth and strewn with talus and scree, but the northern and eastern slopes are steep and cut by cirques. Along the south-western margin of the range and at its north-western extremity the mountains are lower and many have relatively flat summits scalloped by cirques. The general level of these flat-topped summits declines to the south and merges with a plateau which extends westward from the Kawdy Plateau at Nazcha Creek to the upper part of Tanah Creek.

The drainage pattern within the range is dendritic. The valleys have, in general, U-shaped cross-sections and, in their central and lower parts, comparatively low gradients. Lakes are common on the hummocky mantle of drift on the valley-floors. Most of the valley-floors lie between 3,500 and 4,500 feet above sea-level; that is, from 2,000 to 3,000 feet below the mountain-tops. The range is cut by two transverse valleys, one occupied by Glundebery and Kahan Creeks, the other by the Kedahda River, Kedahda Lake, and Shonektaw Creek.

The flat-topped summits of the south-western part of the Atsutla Range may be relics of an uplifted erosion surface preserved in the plateau to the south and south-east. It seems probable, too, that in the central and north-eastern part of the range erosion by streams with further modification by ice has been so extensive that no part of the uplifted plateau surface is left. The axis of the range is composed of granitic rocks and the flanks of Palæozoic and Lower Mesozoic sediments and volcanics, but the extent to which the distribution of these rocks has influenced the topography of the range is unknown.

TUYA RANGE.

The Tuya Range (Plate I., A and B), lying between the Parallel Creek and Cottonwood River Valleys on the east and the Kawdy Plateau on the west, is between 30 and 35 miles long in a direction north 30 degrees west and up to 10 miles wide. The peaks of the central and eastern parts of the range reach elevations of over 6,500 feet and are, generally, somewhat more rugged than those of the Atsutla Range. Along the western edge of the range, however, the mountains are lower than in the central and eastern parts and are characterized by long, smooth slopes which sweep down to the level of the Kawdy Plateau.

The pattern of the valleys and their form is more diversified than is the case in the Atsutla Range. In places a rectangular stream pattern is suggested; elsewhere it is dendritic. Some of the valleys show distinct U-shaped cross-sections; others are narrow and V-shaped. The elevations of their floors vary from 4,000 to over 5,000 feet. Lakes are not as numerous as in the Atsutla Range. Two large valleys, each of which drains in two directions, cut across the Tuya Range.

Several conical or flat-topped piles of young volcanic rocks occur within the Tuya Range and on the Kawdy Plateau. Inasmuch as the forms of these mountains are determined mainly by their modes of accumulation, they will be discussed more fully on a later page.

CLIMATE.

In keeping with its high latitude (59° 00′–59° 30′ north), the Tuya-Teslin Area has a cool climate. Judging from the meteorological records (Burton, 1943) taken at Atlin, about 80 miles to the west, and at Dawson and Mayo in the Yukon Territory to the north-west, average monthly temperatures range from about 50 degrees in the warmest month, July, to below zero in the coldest month, January. On the same basis, the mean annual temperature is about 25 or 30 degrees Fahrenheit.

Precipitation is light, probably averaging 10 to 15 inches a year. In this general region it is apparently greatest in the autumn months and much of it therefore is in the form of snow. In the summer long periods of steady rain are uncommon, but showers are frequent. During 1943 some rain or snow fell on fifty-three out of eighty-five days spent in the area. In September snow fell even at intermediate elevations and frosts were common. It is reported that during the winter the snow is only a few feet deep.

Because of the cold climate and the presence of snow in all but the summer months prospecting can be carried on satisfactorily for only about four months of the year.

AGRICULTURE.

The cool climate, the short growing season, and the occurrence of frosts during the summer do not favour agriculture in the area, even though these handicaps are partly overcome by the length of the summer days. However, at Dease Lake to the south-east and at Atlin to the west hardy varieties of vegetables are grown for home use. Doubtless the same could be done in the lower parts of the Tuya-Teslin Area should the need ever arise.

VEGETATION.

A considerable proportion of the Tuya-Teslin Area lies above timber-line, which is about 4,500 feet above sea-level. Much of the higher surfaces consist of rock outcrop, talus and scree, or on the flatter parts a mantle of frost-riven angular fragments of bed-rock, either barren or supporting a very sparse growth of lichens and arctic herbs. Much of the Area is covered with drift which supports a vegetation in which grasses predominate. Large parts of the Kawdy Plateau are grass-covered and provide excellent grazing for game, but in badly drained parts the vegetation consists of bog-moss (*Sphagnum*), sedges (*Carex*), etc.

At intermediate elevations, from timber-line down to about 3,000 feet, the vegetation is of three contrasting types, one characterized by evergreen trees, a second by the shrubby "dwarf birch" or buck-brush, and a third by bog-moss and marsh plants. The evergreen timber consists essentially of alpine fir (*Abies lasiocarpa*) and white and black spruce (*Picea Canadensis* and *P. mariana*), but a few jack-pine (*Pinus contorta*) are found locally. The timbered areas are commonly confined to moderately sloping ground or to hill-tops. The dwarf birch (*Betula glandulosa*) occurs in nearly pure stands, covering enormous areas, as a dense shrubby growth up to 4 feet high. These are found within the mountains, on the gently sloping valley-floors, and on the surfaces of gravel terraces, as well as over large areas of the Kawdy Plateau and on the lower slopes of the adjacent ranges. Bog flora, including such plants as the willow (*Salix*), Labrador tea (*Ledum grœnlandicum*), and shrubby cinquefoils (*Potentilla palustris* and *P. fruticosa*), as well as cotton-grass (*Eriophorum*), sedges, and peat-moss, occur on the marshy valley-floors and on the poorly drained parts of the Kawdy Plateau.

At elevations below about 3,000 feet, on the floors of the Teslin and Jennings Trenches, the greater part of the area is, or has been, timbered. Spruce usually predominates, but on the well-drained gravel terraces jack-pine (*P. contorta*) occurs in nearly pure stands. Some of the trees reach a diameter of 18 inches. Forest fires have in recent years taken their toll, however, and large areas, especially around Mount Charliecole, are now covered with a dense growth of alder (*Alnus sinuata*) and a tangled mass of fallen logs. Poorly drained areas are covered with typical bog flora and scattered spruce-trees.

To within a short distance of its upper limit the timber is adequate for fuel and tent-poles. Only at lower elevations, however, is it of suitable size and quality for construction material. Even below 3,000 feet the better timber is too scattered to constitute commercial stands, except for supplying any small local demand which might arise for poles, fuel, etc.

Feed for pack-horses is scarce, even at lower elevations, before the middle of June and after the end of September.

Peculiar dome-shaped mounds of peat-moss were observed in several swamps in the area (Plate II., B). The mounds vary from about 20 to 200 feet in diameter and from 3 to 15 feet in height. The surfaces of the mounds are composed of firm and dry, brown but apparently undecayed peat-moss, commonly showing a regular pattern of cracks. The mounds tend to occur in closely-spaced clusters in flat, swampy areas. In many cases the individual mounds are partly or completely separated by open water. Within any one cluster all the mounds are comparable in size, shape, and spacing. The mounds occur in swamps lying at or near timber-line. None were seen below an elevation of 3,300 feet, although similar swampy areas were common at much lower levels. Porsild (1938, pp. 46–58) has described two types of mounds of similar external appearance, though of much greater size, occurring in the unglaciated areas of northern Alaska and at the Mackenzie Delta, and has concluded that they have originated as a result of permanent freezing of subsoil. However, in the Tuya-Teslin Area frozen ground has not been recognized except at one place on Ash Mountain, in the Tuya Range, at an elevation of 6,000 feet, and Johnston (1925, p. 38 A), referring to the Dease Lake Area, a few miles to the south-east, reports that "the ground is not permanently frozen except locally."

A collection of plants, comprising over 200 species, was made during the field season. This has been submitted to the Provincial Museum, Victoria, B.C., for further study.

GAME.

Game is sufficiently plentiful in the area to satisfy the needs of prospectors. Mountain-caribou range throughout much of the area at and above timber-line and moose inhabit the lower timbered areas. Mountain-goat and mountain-sheep are found in the Atsutla and Tuya Ranges, but are not abundant, and were noted most commonly on the volcanic mountains of the Tuya formation. Grizzly and black bear are found occasionally. Trapping for fisher, marten, mink, weasel, otter, beaver, muskrat, fox, and wolf is carried on in parts of the area. Coyote, wolverine, ground-hog (marmot), gopher (ground-squirrel), porcupine, and rabbit are also found, and lynx have been reported. Ptarmigan are numerous and grouse, ducks, and geese are locally plentiful. Grayling and whitefish are found in the streams and lakes.

CHAPTER III. GENERAL GEOLOGY.

INTRODUCTION.

The Tuya-Teslin Area lies along the western margin of the Cassiar Mountains. In the eastern part of the area gneisses, quartzite, schists, crystalline limestone, and volcanics of the Oblique Creek formation are intruded by two granitic batholiths. In the western part of the area Permian quartzite, argillite, chert, volcanics, and limestone of the Kedahda and Teslin formations and Lower Mesozoic volcanic conglomerate, arkose, argillite, tuff, limestone, and volcanics of the Nazcha and Shonektaw formations are intruded by several stocks and batholiths. In many places these rocks are unconformably overlain by Late Tertiary (?) and Pleistocene lava, tuff, and agglomerate of the Tuya formation, and by glacial drift and alluvium.

OBLIQUE CREEK FORMATION (1, 1a, 1b, 1c).*

The rocks which have been mapped as the Oblique Creek formation underlie an area of approximately 115 square miles within the Tuya Range. The formation consists principally of highly folded and metamorphosed sedimentary and volcanic rocks of undetermined age.

In the eastern and central parts of the Tuya Range quartzites and schists, which constitute a large part of the Oblique Creek formation, occur in a north-westerly-trending irregular belt ½ mile to 5 miles in width. Most of the rocks of this belt are thinly bedded, light grey to white micaceous quartzites and mica schists. These rocks consist essentially of quartz, muscovite, and biotite in various proportions. In places, beds of light-coloured quartzite up to 8 feet thick occur within the thinly bedded rocks.

Generally, the rocks of this part of the Oblique Creek formation strike north-westerly and dip at high angles. Between the upper parts of Parallel and Oblique Creeks, however, the rocks strike easterly and dip northerly at angles of 20 to 50 degrees (Fig. 3). The detailed structure of the belt of quartzites and schists is very complex because, in many places, the incompetent thinly bedded rocks are highly contorted.

Lenses of grey to white crystalline limestone are interbedded with the quartzites and schists of the Oblique Creek formation in several places. The larger of these lenses and the areas in which smaller lenses are abundant have been mapped as a separate unit (1a). In the north-western part of the Tuya Range a belt of steeply dipping limestone with a maximum width of about 1,000 feet crops out almost continuously for 4½ miles.

Gneissic volcanic rocks and greenstones of the Oblique Creek formation are exposed in two small areas totalling 3 square miles lying to the south-east of Tuya Lake. Narrow belts of similar altered volcanic rocks too small to be represented on the map occur elsewhere in the quartzites and schists of the formation.

Although the rocks included in this group are somewhat varied, all have a greenish colour and a distinctly foliated or banded structure. Most specimens examined microscopically contain abundant chlorite, albite, epidote, and quartz. Several samples contain major amounts of actinolite, carbonate, and biotite, and minor amounts of magnetite. One specimen collected on the ridge 3 miles south-east of Tuya Lake shows large augen of plagioclase (about An_{50}) in a foliated aggregate consisting of alternate biotite-rich, actinolite-rich, and epidote-rich layers.

The banding of the altered volcanic rocks strikes north-westerly and dips at intermediate to high angles.

A broad discontinuous belt of gneiss containing numerous sills of granite crops out over an area of approximately 45 square miles in the western and southern parts

* These numbers and letters correspond to those of map-units.

of the Tuya Range. Most of the gneisses are grey foliated rocks consisting essentially of quartz, muscovite, and biotite. In places, in the southern part of the Tuya Range, however, there are dark grey gneisses which contain garnet, oligoclase, and orthoclase in addition to the quartz, biotite, and muscovite. Other dark-coloured gneisses in the same locality are composed chiefly of quartz, biotite, hornblende, and andesine.

The granite occurs within the gneisses as persistent sills from 2 to 50 feet thick. A typical specimen of the granite from a sill north of Ash Creek is a light grey massive rock consisting of quartz, albite (An_8), microcline, muscovite, and biotite.

The occurrence of persistent, well-defined, alternating bands, several inches to several feet thick, of gneiss of different character and the presence of highly siliceous varieties resembling quartzite, indicate that the gneisses are highly metamorphosed sedimentary rocks. The gneisses form a broad anticline with a north-westerly-striking axis and moderately dipping limbs.

Fossils have not been found in the rocks of the Oblique Creek formation. The part of the formation consisting of quartzite and micaceous schist with minor amounts of interbedded limestone and greenstone represents a metamorphosed group of rocks similar to that of the Kedahda formation of Permian age, which occurs in the Atsutla Range and the Kawdy Plateau. Some of the rocks of the Oblique Creek formation are similar in lithology to those mapped by Lord (1944, pp. 6–7) as Group A in an area along the Alaska Highway to the north.

The contact metamorphic effects of the Tuya and Parallel Creek granitic batholiths which intrude the rocks of the Oblique Creek formation are very local (*see* pages 27 and 28). The widespread metamorphism of the micaceous quartzite, mica schists, crystalline limestone, and greenstones cannot be attributed to either of these exposed intrusives. The intense metamorphism of the gneisses, on the other hand, may be related in part to the numerous granite sills which have intruded them.

KEDAHDA FORMATION (2, 2a, 2b)

The Kedahda formation is exposed throughout an area of approximately 175 square miles in the Tuya-Teslin region. The rocks of this formation crop out extensively on the Kawdy Plateau and in the area between the south-western flank of the Atsutla Range and the Teslin Valley. Outcrops of the formation also occur in abundance along the north-eastern slope of the Atsutla Range, mainly between the upper parts of Snook and Shonektaw Creeks. A narrow belt of the Kedahda formation extends along the south-western flank of Mount Charliecole. Other small areas of the formation lie to the north-west and north of Mount Charliecole, on the upper part of Charliecole Creek, near the head of the south-west fork of Nazcha Creek, in the Nazcha Hills, and at the north-western end of Ichthyosaur Mountain.

The Kedahda formation consists of quartzite, argillite, and chert, and small amounts of interbedded volcanic rocks and limestone.

The quartzites are light grey or white in colour and are usually thickly bedded. The argillites are dark grey to black rocks which, locally, display delicate laminations. Generally, the argillites are rusty on their weathered surfaces; in many places they were found to contain small crystals of pyrite. The cherts are white, greenish-grey, or black, thinly bedded sediments which commonly show ribbon banding. In addition to these clearly defined varieties of sedimentary rocks, argillaceous quartzites and quartzose argillites occur in abundance in the Kedahda formation.

The three main areas of volcanic rocks in the Kedahda formation are situated: (1) to the west of Glundebery Creek near the contact of the batholith, (2) near Glundebery Creek about 6 miles from its head, and (3) about 4 miles west of the lower part of Josephine Creek. These rocks are dark green and are generally massive. Locally, however, schistose or banded varieties are common. The rocks probably represent altered volcanics interbedded with the sediments.

Most of the limestone of the Kedahda formation occurs in the vicinity of the southern end of Kedahda Lake and in the neighbourhood of Christmas Creek. The limestone bands of these two localities lie along strike and may be at the same stratigraphic horizon. The limestone which crops out in the vicinity of Kedahda Lake is generally light grey or white and is locally fossiliferous. The limestone occurring along the contact of the Christmas Creek batholith has been converted to light grey marble which contains small masses of lime silicates.

In most places in the Tuya-Teslin Area the rocks of the Kedahda formation strike north-westerly. However, in the two large areas of outcrops lying about 6 miles east and about 5 miles north of Kawdy Mountain respectively, and in the smaller area 2 miles east of Isspah Butte, the rocks strike only a few degrees to the north of west. Generally, the rocks of the Kedahda formation dip at moderate to steep angles. In many places the incompetent beds of the formation are highly contorted and small isoclinal folds are numerous. These contortions and isoclinal folds suggest that complex major structures may also be present, but the absence of conspicuous horizon markers would prevent their recognition if they did occur.

The total thickness of the Kedahda formation is not known. However, a section approximately 10,000 feet thick is well exposed along the upper part of Shonektaw Valley. The rocks cropping out on the precipitous northern wall of this valley dip south-westerly at angles of 50 to 80 degrees and, although faults occur, they are nearly parallel to the bedding and have caused little repetition in the section.

Fossils collected from limestone on the eastern shore of Kedahda Lake, ½ mile north of the outlet, were submitted to the Geological Survey, Department of Mines and Resources, Ottawa, for identification. According to Dr. A. E. Wilson, the specimens contain a stromatoporoid, an unidentifiable gastropod, crinoid stems, and the coral *Lonsdaleia* ? sp. "The longitudinal section of this coral . . . is not well preserved, but as far as can be ascertained it seems very similar to a form from the island of Timor, in which case the rocks would be of Permian age." According to Dr. R. T. D. Wickenden, the collection contains "foraminifera belonging to the family Fusulinidæ, and show characteristics of Permian genera." Thus, it seems that the fossiliferous limestone of the Kedahda formation is probably Permian in age. Since there are no apparent unconformities within the formation, it appears likely that it is entirely Permian.

The Kedahda formation corresponds in lithology and in age to a part of the Dease series occurring to the south-east in the Dease Lake (Kerr, 1925, pp. 80 A–84 A) and Eagle-McDame (Hanson and McNaughton, 1936, pp. 4–6) Areas. It also shows lithological similarity to the Taku group of the Whitehorse district (Cockfield and Bell, 1926, pp. 11–12) in the southern Yukon and to the rocks of Group B in an area along the Alaska Highway to the north (Lord, 1944, pp. 8–9).

TESLIN FORMATION (3, 3a).

The Teslin formation, consisting mainly of limestone, crops out as several small north-westerly-trending elliptical hills and ridges which protrude from the drift on the floor and on the north-eastern wall of the Teslin Valley. The formation is also exposed in two places in the extensive, drift-covered area between Mount Charliecole and the upper part of Charliecole Creek. Within the Tuya-Teslin Area, therefore, the formation occurs mainly in a narrow belt which extends for 22 miles in a north-westerly direction. Beyond the limits of the area mapped, rock which appears to be limestone similar to that of the Teslin formation crops out as a few small ridges across the entire width of the Teslin Valley and apparently extends for many miles to the north-west.

The limestone is light grey weathering rock which is dark grey on fresh surfaces. It is generally massive but locally, ill-defined north-westerly-striking beds, 6 inches to 2 feet thick, are apparent on weathered outcrops. In a few places the limestone contains thin non-persistent beds and small lenses of dark grey to black chert. Black argillaceous beds occur locally in the formation.

The volcanic rocks of the Teslin formation are exposed near the lower part of Charliecole Creek. The volcanics are principally dark green rocks which show fine banding. Apparently these represent altered tuffs which are interbedded with the limestone. A band of massive amygdaloidal greenstone was seen at one place and thin beds of chlorite schist were observed at others.

In most places in the region the Teslin formation is separated from the Kedahda formation by extensive areas of drift and, therefore, the relationship between the two formations is obscure. Along the south-western flank of Mount Charliecole and on the large hill to the north-west, however, limestone of the Teslin formation appears to rest conformably upon the Kedahda formation. The rocks of both formations in this region strike north-westerly and dip south-westerly at moderate angles. In places in this locality thinly bedded micaceous schists of the Kedahda formation are highly contorted, whereas adjacent limestone of the Teslin formation has a uniform attitude. However, this relationship does not necessarily indicate an unconformity, for it may be attributable to the incompetency of the mica schists and their proximity to the Charliecole stock.

Fossils were obtained from the limestone at several places in the Teslin formation and were submitted to the Geological Survey, Department of Mines and Resources, Ottawa, for identification. According to Dr. A. E. Wilson, specimens collected from Hyland Hill contain crinoid stems and the coral, *Waagenophyllum* ? sp. "A longitudinal section of the specimens shows very little of the structure, but the tangential section and the description correspond. If this coral is *Waagenophyllum* the rocks . . . are probably Permian in age, or at least, not older than Pennsylvanian." Dr. R. T. D. Wickenden reports that "The specimens . . . all contained foraminifera belonging to the family Fusulinidæ, and show characteristics of Permian genera. . . . A species of Schwagarina and one of Yabeina (?) are fairly common. There is also a nearly spheroidal form which may be close to the genus Paraschwagarina. These genera are all confined to the Permian."

The Teslin formation is, therefore, Permian in age and corresponds to a part of the Dease series which occurs to the south-east in the Dease Lake (Kerr, 1925, pp. 80–84 A) and Eagle-McDame (Hanson and McNaughton, 1936, pp. 4–6) Areas. It also bears similarity in lithology and in age to at least a part of the limestone which overlies the Taku group in the Whitehorse district (Cockfield and Bell, 1926, pp. 12–14).

NAZCHA FORMATION (4, 4a).

A group of volcanic conglomerates, argillites, tuffs, arkoses, and limestone, mapped as the Nazcha formation, is exposed on Ichthyosaur (Conglomerate) Mountain at the south-eastern edge of the area, and in the Nazcha Hills, 20 miles to the north-west. The outcrop area of the formation is only 5 square miles.

The most common and most characteristic rock of the Nazcha formation is a conglomerate, made up of an assortment of angular to partly rounded fragments, usually up to about 2 inches in diameter, mainly of feldspar porphyry and tuff. The matrix is generally similar in composition to the fragments, but in a few places it is calcareous or argillaceous. Pebbles of limestone are widely, though sparsely, distributed through the conglomerate and the pits remaining where they have been partly or completely dissolved on the weathered surfaces are generally conspicuous. The conglomerate varies in colour from a dark blue-green where mafic minerals are common in the porphyry and tuff fragments, as well as in the matrix, to a light grey where feldspars predominate. In places where fragments are scarce or wanting the rock may be described as arkose. Fine-grained non-fragmental green tuff or greywacke is much less common than the volcanic conglomerate. Also present in the formation are a few beds of black argillite and, along the eastern side of Ichthyosaur Mountain, one prominent band of limestone. The limestone was mapped by Kerr (1925, Map No. 2104) with a group of rocks older than the conglomerate, but it is here considered to be a part of the Nazcha formation because it lies between beds of typical conglomerate and in a few places contains conglomerate lenses. One lens of porphyry, a flow or sill, was seen ⅓ mile east of the summit of Ichthyosaur Mountain, in the Nazcha formation. Except for the argillite, the rocks of the formation are almost invariably blocky-jointed.

The most common rock occurring as fragments in the Nazcha conglomerates is feldspar porphyry, composed of slightly altered and generally euhedral phenocrysts of feldspar, usually labradorite or calcic andesine, but in some cases albite, in a fine-grained matrix of alkali feldspar and chlorite, actinolite, or both. Phenocrysts of augite, or, less commonly, of hornblende may also be present, and in some specimens these predominate over the feldspars. Small clusters of shreddy biotite, apparently secondary, occur in some fragments. In most cases the augite and hornblende are not appreciably altered, but in some cases they are partly to completely changed to chlorite, epidote, and, in rare cases, carbonate.

Fragments of feldspathic tuff, closely resembling the feldspar porphyry, are also very common in the conglomerate. In this tuff, however, the feldspar laths usually have ragged or broken terminations and they show a complete gradation in size from the smallest, which form the matrix, to the largest, which superficially resemble phenocrysts. Moreover, in some fragments both andesine and albite can be recognized. A rough orientation of the feldspar crystals is present in many fragments and in a few the rock is clearly stratified. The matrix contains, in addition to the smaller feldspar laths, minute grains of untwinned alkali feldspar, and chlorite, actinolite or both.

Other rock fragments, found less commonly, include chlorite schist, hornfels, quartzite, and apparently vein quartz.

The matrix of the conglomerate is composed mainly of minute fragments of the feldspar porphyries and tuffs, and of individual broken crystals of feldspar, augite, and rare grains of quartz.

The alteration of the conglomerate as a whole is remarkably slight. As described above, the mafic minerals of some fragments are completely altered to chlorite and epidote, but these fragments may lie adjacent to others in which the same minerals are completely unaltered. Such alteration as exists has apparently taken place prior to the accumulation of the conglomerate. In a few localities, where the matrix of the conglomerate is calcareous, a carbonate alteration of many of the fragments is conspicuous.

The greater part of the material making up the Nazcha conglomerate is believed to have been derived from the sub-aerial disintegration of porphyries and tuffs. This volcanic detritus was transported only a comparatively short distance, as is indicated by the more or less angular form of nearly all the rock fragments, as well as of the crystals making up the matrix of the conglomerate. It was then deposited rapidly in waters with little sorting, in association with limestone, containing marine fossils, and argillite. Because extensive areas of volcanics are not known in the pre-Nazcha rocks of this vicinity, the source of much of the material in the conglomerate is believed to have been contemporaneous volcanoes.

In most places stratification in the conglomerates is indistinct, except on the higher parts of Ichthyosaur Mountain where differential weathering of the calcareous matrix makes it conspicuous. In this locality several large drag-folds with northerly- to north-westerly-pitching axes are clearly defined. The steeply dipping band of limestone on the eastern slope of the mountain strikes north-westerly obliquely across the trend of the drag-fold axes. These structures are interpreted as parts of a much larger north-westerly-pitching anticline with the limestone occurring in its eastern limb. On this basis it is regarded that the limestone band is overlain by the conglomerates on its north-eastern side and these in turn by volcanics of the Shonektaw formation on Coulahan Mountain. To the north-west the conglomerates and limestone terminate along strike against schistose argillite and quartzite of the Kedahda formation, perhaps along a transverse fault.

In the Nazcha Hills the Nazcha formation is apparently confined to three north-westerly-trending synclines. Dips, where observed, average about 60 degrees. Near the northern end of the easternmost of the four Nazcha Hills conglomerate dips south-westerly over argillites of the Kedahda formation. At this contact the rocks of both formations have the same strikes and dips. The argillites are, however, much more closely folded. Farther to the north-east, near the base of the hill, the Nazcha conglomerate is also exposed. At this point the conglomerate dips south-westerly under closely folded and overturned argillites and quartzites. Minor faulting was observed at this contact. The conglomerate is believed to form a syncline overturned to the north-east. In this area the presence or absence of an angular unconformity between the Nazcha and Kedahda formations is masked by the difference in the competence of the rocks and, consequently, in the degree of folding. However, because the Nazcha formation rests directly on the Kedahda formation rather than on the Teslin limestone, a time interval between the deposition of the Nazcha and Kedahda formations is indicated. The abrupt change in lithology as well as palæontological evidence also indicates an unconformity of some nature.

Fossils found in the Nazcha limestone ½ mile east of the summit of Ichthyosaur Mountain were submitted to the Geological Survey, Department of Mines and Resources, Ottawa, for identification. Dr. A. E. Wilson reports that some of the specimens contain unidentifiable "*Lingula*-like fragments." Dr. C. M. Sternberg reports the presence of teeth of a fish of an undetermined genus and states that "two of the specimens represent caudal vertebræ of an ichthyosaur which suggests *Delphinosaurus perrini* Merriam from the lower or shaly horizon of the Hosselkus Limestone, Upper Triassic, of California." The marine reptile, ichthyosaur, is known to range from the Middle Triassic to the early Upper Cretaceous (Berry, 1929, p. 248).

The rocks of Ichthyosaur (Conglomerate) Mountain were described by Kerr (1925, p. 90 A) as being the basal member of the McLeod series which he reports to overlie unconformably Upper Triassic limestone in the Dease Lake Area. In south-western Yukon, Upper Triassic limestones are overlain by the Laberge series (Cockfield and Bell, 1926, pp. 14–22; Bostock, 1936, pp. 21-27; Bostock and Lees, 1938, pp. 13–15; Lees, 1936, pp. 11–13), a succession of conglomerate, volcanic conglomerate, argillite, sandstone, arkose, tuff, and, in rare localities, limestone. In the Carmacks Area (Bostock, 1936, p. 26) the Laberge series appears to rest conformably on the Upper Triassic limestones, but in the Teslin-Quiet Lake Area (Lees, 1936, p. 11) the evidence suggests an unconformity between the two. The Laberge series is known to range in age from the early Lower Jurassic to early Middle Jurassic. The Nazcha formation corresponds very closely lithologically and stratigraphically to the rocks of the Laberge series and may be correlated with them.

SHONEKTAW FORMATION (5)

The volcanic rocks of the Shonektaw formation are exposed on Coulahan Mountain, at the south-eastern edge of the area mapped, and, as isolated masses in the Glundebery batholith in a discontinuous belt along the north-eastern edge of the Atsutla Range from a point 3 miles south of Blackfly Lake to Aconitum Lake. The outcrop area of this formation is about 20 square miles.

The rocks of the Shonektaw formation consist mainly of massive greenstone, dark green augite porphyry, and some dark green tuffs, agglomerates, and flow breccias. Pillow lava occurs 2½ miles south of Blackfly Lake and bedded greywacke is exposed in the same locality. A conglomerate containing well-rounded pebbles of medium grained diorite is exposed 4 miles south-east of Aconitum Lake. This diorite is highly altered and does not resemble that of the Christmas Creek batholith. In one locality midway between Shonektaw and Tahoots Creek gneissic greenstone occurs close to a body of intrusive quartz diorite.

A microscopic examination of a typical porphyry from Coulahan Mountain shows that the rock consists of phenocrysts of plagioclase and of augite in a fine-grained dark green matrix containing actinolite, oligoclase, chlorite, epidote, and magnetite. The feldspar phenocrysts are partly altered to epidote and the augite is partly to completely uralitized.

The rocks of the formation are generally massive and rarely show stratification. West of Shonektaw Creek bedding in tuff indicates folding along westerly-trending axes. Here the volcanics terminate abruptly along strike against north-westerly-striking sediments of the Kedahda formation. The contact, which itself strikes north-westerly, is believed to be a fault. On the lower slopes of Coulahan Mountain adjacent to Ichthyosaur Mountain volcanics of the Shonektaw formation are considered to overlie the Nazcha formation (page 18).

No fossils have been found in the Shonektaw formation. The volcanics of Coulahan Mountain, along with the conglomerates of Ichthyosaur (Conglomerate) Mountain, were included by Kerr (1925, p. 87 A) in the McLeod series. The Shonektaw formation may correspond to the volcanics either in or above the Laberge series of south-western Yukon (Lees, 1936, pp. 12–13; Bostock and Lees, 1938, pp. 15–16) and to Group D in an area along the Alaska Highway to the north-west (Lord, 1944, pp. 10–11).

INTRUSIVE ROCKS.

Introduction.

Intrusives make up approximately one-half of the bed-rock exposed in the Tuya-Teslin Area. Two bodies of batholith size and several stocks, dykes, and small outcrops occur in the Atsutla Range. Two separate batholiths and numerous sills and dykes also occur in the Tuya Range. Large masses of granitic rocks to which some of the intrusives of the Tuya-Teslin Area may be related extend for at least 160 miles to the south-east and 70 miles to the north. These have been referred to as the Cassiar batholith (Kerr, 1925, p. 90 A; Hanson and McNaughton, 1936, p. 10; Hedley and Holland, 1941, p. 40; Lord, 1944, pp. 12–13).

No information is available regarding the exact ages of any of the intrusives in the Tuya-Teslin Area. Some of the granitic bodies intrude rocks of probable Lower Mesozoic age and several of them are overlain in places by the Tuya formation of Late Tertiary (?) and Pleistocene age. The lower limit of age of other granitic intrusives in the area can be said only to be post-Permian. It is possible, however, that all the granitic rocks may be related and that all may be of post-Lower Mesozoic age. The ultramafic rocks in the area were intruded after the Permian and probably before the emplacement of at least some of the granitic rocks. Basalt dykes which occur in a few places in the area may be related to the volcanic rocks of the Tuya formation.

The intrusives range in composition from highly altered ultramafic rocks to fresh granites which consist almost entirely of light-coloured minerals. The system of naming granitic rocks, used in this report, is that adopted by the British Columbia Department of Mines. According to this system, rocks in which the ratio of potash to soda-lime feldspar ranges from 5 to 3 to 3 to 5 are called granodiorite; those with higher ratios are granite and those with lower ratios are quartz diorite.

Serpentine and Talcose Alterations (6).

Several steeply-dipping conformable bodies composed of serpentinized ultramafic rocks and their talcose alterations intrude rocks of the Oblique Creek and Kedahda formations. A mass, 1½ miles long and 200 to 400 feet wide, occurs in the Atsutla Range, about 3 miles to the north-east of the head of Kedahda Lake. Another body, 100 to 200 feet wide, is exposed intermittently for a distance of 2 miles in the Tuya

Range, south of Edasp Creek. Several other elongate masses of lesser length occur to the south of Edasp Valley and along the flank of the Tuya Range between Butte Lake and Ash Creek. On the Kawdy Plateau two small bodies of sheared serpentine crop out 1½ miles west of the lower part of Josephine Creek. A few irregular masses, too small to be represented on the map, occur as inclusions in granodiorite 2 miles to the north-east of the head of Tuya Lake.

It is noteworthy that the serpentine bodies in the Tuya-Teslin Area are much smaller and, generally, more highly altered than those occurring in the Teslin-Quiet Lake Area (Lees, 1936, pp. 14–15) to the north-west and the Dease Lake (Kerr, 1925, pp. 84 A–86 A) and Eagle-McDame (Hanson and McNaughton, 1936, pp. 9–10) Areas to the south-east. In the eastern part of the Eagle-McDame Area and in the adjoining territory (Hedley and Holland, 1941, pp. 32–33) a belt of serpentine with an average width of 4 miles and a maximum width of 8 miles is known to extend for at least 40 miles.

In most places in the Tuya-Teslin Area the serpentinized rocks and their alterations form barren reddish-brown ridges and hills which rise 20 to 30 feet above the surrounding country.

The north-western part of the ultramafic body in the Atsutla Range consists mainly of massive serpentine. The rock is generally light grey on a weathered surface and dark green to black on a fresh break. It contains a few large relic grains of partly serpentinized olivine occurring in a fine-grained ground-mass of serpentine and magnetite. Locally, where the serpentine has been sheared, it is light green and waxy in appearance. In a few places the serpentine is intersected by narrow veinlets of cross-fibre chrysotile asbestos. The south-eastern part of the body lies relatively close to granite of the Glundebery batholith. The serpentine in this locality has been altered to a coarse-grained rock consisting essentially of reddish-brown weathering talc and rusty weathering, buff-coloured carbonate.

In the Tuya Range no unaltered serpentine was observed. Massive rock composed mainly of actinolite, olivine, and talc commonly forms large parts of the ultramafic bodies. The actinolite occurs as prominent light green prisms up to 4 inches long, which are generally grouped into radiating clusters. The olivine, present as grains 5 to 10 mm. in diameter, is cut by a network of microscopic veinlets of serpentine. Talc and small amounts of carbonate and magnetite also occur.

A more highly altered type of rock occurring in the Tuya Range contains large quantities of coarse-grained talc and carbonate in addition to actinolite. Little or no serpentine and olivine remain unchanged in the rock.

In a few places in the Tuya Range the ultramafic rocks have been altered to an orange-brown-weathering assemblage of fine-grained carbonate and quartz. Conspicuous bright green flakes of fuchsite, a chromium-bearing mica, are usually present in the rock and irregular veinlets of white quartz and buff carbonate are common.

The ultramafic body, 2 miles long, which lies to the south of Edasp Creek, is composed mainly of actinolite-talc-carbonate rock. Near its midpoint, however, hornblende, biotite, and garnet occur along its margins.

The serpentine bodies of the Dease Lake Area were interpreted by Kerr (1925, pp. 84 A–86 A) as highly altered lavas and tuffs underlying fossiliferous limestone. The serpentine and limestone in this area were mapped together as the Thibert series of Upper Triassic age. In contrast to this view the serpentine bodies in the Eagle-McDame Area, which include several of those previously mapped by Kerr in the eastern part of the Dease Lake Area, were regarded by Hanson and McNaughton (1936, pp. 9–10) as altered peridotite intrusives of probable Jurassic age. The serpentine masses in the Teslin-Quiet Lake Area were considered by Lees (1936, pp. 14–15) to be stock-like intrusives of altered peridotite of Jurassic or younger age.

It is believed that the ultramafic rocks of the Tuya-Teslin Area represent peridotites which have been highly serpentinized and, in most places, further altered to rocks consisting mainly of talc, carbonate, and actinolite. Because of their spatial relationships, the bodies are considered to be intrusive into the Oblique Creek and Kedahda formations and are, therefore, post-Permian in age. The alteration of the serpentinized peridotite to talc-carbonate-actinolite rock is probably attributable to the action of solutions related to granite. This interpretation of the alteration and the occurrence of probable inclusions of ultramafic rock in granodiorite north-east of Tuya Lake suggest that the intrusion of the ultramafic bodies in the area occurred prior to the emplacement of the granitic rocks.

During the course of the field-work no commercially significant concentrations of chromite, asbestos, or talc were observed in the ultramafic bodies.

QUARTZ DIORITE, DIORITE, GABBRO (7).

Most of the rock exposures in this map-unit are in the form of small hills surrounded by extensive areas of drift. Because of this isolation, little is known of their relationships to the other rocks of the area.

A group of hills composed mainly of quartz diorite, diorite, and gabbro lies 4 to 8 miles north-west of Mount Charliecole. The positions of these outcrops suggest that they are parts of a single body which underlies an area of at least 10 square miles. The prevalent type of rock is a grey, medium-grained quartz diorite containing about equal amounts of light and dark minerals. Microscopically, it is seen to consist of slightly saussuritized calcic andesine, green hornblende partly altered to actinolite and chlorite, brown biotite, quartz, and accessory zircon and apatite. Gabbro, in which irregular streaks of black amphibolite occur locally, and diorite are associated with the quartz diorite.

Four isolated hills composed of quartz diorite occur between Mount Charliecole and the upper part of Charliecole Creek. The rock in this locality is generally lighter coloured and coarser-grained than the quartz diorite occurring to the north-west of Mount Charliecole.

Near the south-eastern corner of the Tuya-Teslin Area gabbro crops out over an area of 5 square miles on the north-eastern part of Coulahan Mountain. A smaller exposure of gabbro occurs near the south-western end of the ridge which lies about 3 miles to the south-east of Tuya Lake. The typical gabbro on Coulahan Mountain is a dark grey, medium-grained, fresh-appearing rock containing a slightly greater amount of dark minerals than light ones. However, local occurrences of varieties composed chiefly of mafic minerals or of feldspar are common. Microscopically, a typical specimen is seen to consist mainly of labradorite (An_{64}), hypersthene, augite, and hornblende. Biotite, magnetite, and quartz occur in small amounts and apatite is present as an accessory.

The gabbro 3 miles south-east of Tuya Lake is more highly altered than that on Coulahan Mountain. The rock is mainly a dark grey to dark green assemblage of saussuritized labradorite, and secondary green hornblende, chlorite, actinolite, and magnetite.

The gabbro on Coulahan Mountain was mapped by Kerr in the Dease Lake Area as part of the Cassiar batholith. The contact of the batholith with the older volcanic rocks on Coulahan Mountain, observed by Kerr, is stated to have a very steep dip (Kerr, 1925, p. 91 A). Elsewhere in the Tuya-Teslin Area the relationships of the gabbro are unknown, because of its isolation by drift.

GRANITE, GRANODIORITE (8).

The rocks which have been mapped in this group occur to the north-west of Mount Charliecole, near the upper part of Charliecole Creek, between Snook and Kachook Creeks and between Shonektaw and Tahoots Creeks. Those occurring to the north-west of Mount Charliecole are mainly light grey, medium-grained granites which crop out as a few small hills in an extensive drift-covered area. A specimen of granite from an outcrop 6 miles north-west of Mount Charliecole consists of quartz, sericitized orthoclase, albite, and a small amount of muscovite. In most places the relationships of the outcrops could not be determined, but 3 miles to the north-west of Mount Charliecole hornblende granite was observed to be intrusive into rocks of the Kedahda formation.

Near the upper part of Charliecole Creek granite crops out chiefly in a fairly continuous belt across the end of the Christmas Creek batholith. The granite in this locality varies from buff-coloured medium-grained rock, consisting mainly of quartz, highly sericitized orthoclase, and chloritized green hornblende, to grey porphyritic granite containing abundant biotite. The spatial relationship suggests that this granite is intrusive into the diorite of the Christmas Creek batholith.

A group of closely spaced outcrops of granite occurs about midway between Snook and Kachook Creeks. The granite is a light grey, medium-grained variety composed principally of quartz, sericitized microcline, albite (An_5) and muscovite. Biotite, chlorite, and allanite (?) are present in small amounts.

Between Shonektaw and Tahoots Creeks granodiorite intrudes greenstones of the Shonektaw formation. The granodiorite is a grey, medium-grained, highly gneissic rock consisting mainly of quartz, feldspar, biotite, and chlorite.

Charliecole Stock (9).

Foliated quartz diorite crops out in abundance throughout an area of approximately 15 square miles on Mount Charliecole. Only the western contact of the intrusive is exposed; therefore, the extent of the body is unknown.

The quartz diorite is a grey, medium- to coarse-grained rock consisting of strained and crushed calcic oligoclase and quartz, shreds of brown biotite, and small amounts of epidote, chlorite, and sphene. In the southern and north-western parts of Mount Charliecole the gneissic structure generally strikes due north and dips vertically. In the central and north-eastern parts of this area, however, the strike swings to the east of north, but the dips remain vertical. A linear structure made apparent by the parallel arrangement of shreds of biotite lies in the plane of the foliation and, in most places, pitches northerly at 10 to 15 degrees.

Along the western margin of Mount Charliecole the quartz diorite is intrusive into the Kedahda formation. Close to the contact, the rocks of the Kedahda formation have been converted into highly contorted schists and gneisses. These rocks consist mainly of quartz, biotite, and muscovite in various proportions and, presumably, have resulted from the metamorphism of argillaceous quartzites.

Christmas Creek Batholith (10a, 10b).

The Christmas Creek batholith, consisting of a diorite margin and a quartz diorite core, underlies an area of approximately 45 square miles in the north-western part of the Atsutla Range. It extends from the valley 3 miles south-east of Kedahda Lake, north-westward for almost 15 miles, as a belt 3 to 4 miles wide.

Where observed, the north-eastern and south-western contacts of the batholith strike approximately parallel to the bedding of the intruded rock and dip vertically or very nearly so. Along the north-eastern margin the gneissic structure of the diorite and the bedding of the sedimentary rocks dip vertically. Near the south-western border of the intrusive the foliated diorite and the sedimentary rocks dip vertically or steeply to the north-east. At the northern end of the body the dip of the sedimentary rocks is 45 to 60 degrees north-easterly.

The diorite margin of the batholith grades into the quartz diorite core. The width of this border is about 4 miles at the north-western end of the batholith and at least 2 miles at the south-eastern end. Along the south-western margin the diorite zone varies from ½ to 1 mile in width, but along the north-eastern edge it is much narrower. The diorite is grey, medium- to fine-grained gneissic rock composed mainly of feldspar and slightly chloritized green hornblende. Most of the feldspar is andesine (An_{35}), but a little orthoclase is also present. Small amounts of quartz, epidote, sphene, apatite, and a black opaque mineral are observable in thin section.

The quartz diorite of the core is a grey, medium-grained rock in which foliation is not apparent except within a short distance of the diorite border. The rock is composed mainly of plagioclase, quartz, orthoclase, and hornblende. Andesine (An_{35} and An_{40}) occurs in two specimens collected near the diorite margin and oligoclase (An_{15}) occurs in a sample obtained well within the core. All the specimens examined contain apatite and black opaque minerals; most contain small amounts of clinopyroxene, chlorite, and sphene; and a few contain biotite, epidote, and sericite.

The Christmas Creek batholith intrudes the Kedahda formation and is itself intruded by granite offshoots of the Glundebery batholith to the east of Kedahda Lake. Metamorphism of the rocks adjacent to the Christmas Creek batholith is not intense. Along the contacts, micaceous quartzites consisting of quartz, muscovite, brown biotite, and small amounts of sodic plagioclase and magnetite are common. In a few places along the north-eastern contact small irregular masses of pegmatite are abundant in the diorite. Along the south-western contact, in the vicinity of Christmas Creek, limestone has been converted to marble and, locally, to rocks composed mainly of lime silicates.

GRANITE, GRANODIORITE (11).

Three large bodies composed mainly of granite and granodiorite are exposed (1) in the south-eastern part of the Atsutla Range, (2) in the central and south-western parts of the Tuya Range, and (3) in the north-eastern part of the Tuya Range. Inasmuch as the two masses in the Tuya Range are almost identical in lithology and both are somewhat similar in lithology to the mass in the Atsutla Range, it seems probable that all are related. For convenience in description, the bodies are referred to as the Glundebery, Tuya, and Parallel Creek batholiths.

GLUNDEBERY BATHOLITH.

Granite, Granodiorite (11).—The main part of the Glundebery batholith, exposed over an area of approximately 110 square miles, forms a large portion of the Atsutla Range. It extends north-westerly from the Nazcha Hills and Blackfly Lake to the valley occupied by Kedahda Lake and by Shonektaw Creek. Small masses and isolated outcrops of granitic rocks which occur to the north-west in the vicinity of Aconitum Lake are similar to the rocks of the Glundebery batholith.

The greater part of the batholith is composed of granite and granodiorite which have been mapped as a separate unit (11). Within the granite and granodiorite, however, there are local occurrences of quartz diorite, syenite, and gabbro which have not been distinguished on the map. Parts of the batholith in which inclusions of diorite are abundant and a part in which fine-grained graphic and miarolitic granite occurs have been mapped as distinct units (11a and 11b) and are discussed later.

The granite is a medium- to coarse-grained, pink- to buff-coloured massive rock which is locally porphyritic. In many places the coarse-grained granite is greatly disintegrated and has yielded large quantities of cream to reddish-brown gravel and sand which form conspicuous scree slopes. In several localities the weathering of jointed coarse-grained granite has formed distinct spheroidal surfaces. Specimens of typical granite consist chiefly of quartz, perthite, and green hornblende. Most samples contain oligoclase, apatite, and magnetite, and a few contain brown biotite, microcline, interstitial micropegmatite, zircon, and sphene.

A specimen of typical granodiorite collected about 2 miles west of the head of Kahan Creek is a light grey, medium-grained rock composed chiefly of quartz, perthite, orthoclase, oligoclase, green hornblende, and brown biotite. Apatite, magnetite, and zircon are present in minute amounts.

In the main part of the Glundebery batholith, quartz diorite occurs between Chokatah and Kahan Creeks along the side of the Jennings Valley, and between Kahan and Tahoots Creeks near the contact with the Shonektaw formation. The quartz diorite occurring east of Kahan Creek is a light grey, medium-grained, foliated variety consisting mainly of quartz, andesine (An_{38}), slightly sericitized orthoclase, green hornblende, and brown biotite. Small amounts of micropegmatite occur interstitially and sphene, apatite, and pyrite are present as accessories.

Syenite was observed in considerable amounts ½ mile and 2 miles south-east of the lake at the head of Glundebery Creek. It is not known whether these two occurrences are parts of a continuous mass or are smaller isolated bodies. The syenite in both localities is pink, medium- to coarse-grained rock consisting chiefly of perthite. The perthite is a microscopic intergrowth of microcline and plagioclase (An_{10}). Small amounts of brown biotite, green hornblende, chlorite, quartz, apatite, sphene, zircon, and magnetite occur in the syenite.

Hornblende gabbro occurs locally at the contact of the batholith with the Kedahda formation near the head of the south-west fork of Nazcha Creek. The gabbro is a grey, medium- to coarse-grained rock composed of bytownite and green hornblende and small amounts of biotite, carbonate, epidote, chlorite, apatite, and magnetite.

The granite and granodiorite which form the main part of the Glundebery batholith are intrusive into the rocks of the Kedahda, Nazcha, and Shonektaw formations and the diorite of the Christmas Creek batholith. Four miles to the west of Blackfly Lake the batholith is overlain by volcanic rocks of the Tuya formation. Where exposed, the contact between the batholith and the intruded rocks is steeply dipping. In general, the rocks adjacent to the batholith show little or no metamorphism. In a few places in the Kedahda formation, however, contorted gneisses and micaceous quartzites consisting chiefly of quartz, muscovite, and biotite, have been formed. Generally, the argillite appears to be unaffected, but near the head of the south-west fork of Nazcha Creek it has been locally converted to hornfels. The hornfels is a white, fine-grained rock which retains the delicate lamination of the argillite. Microscopically, it is seen that most laminæ consist of orthoclase, diopside, and small amounts of sericite and biotite. Clinozoisite and prehnite (?) occur abundantly in some bands.

The volcanic rocks of the Shonektaw formation which occur in places along the north-eastern margin of the batholith generally show no contact metamorphism. Between Kahan and Tahoots Creeks, however, offshoots from the batholith are prominent and biotite, garnet, and epidote have developed within an inch of the contact. The margin of the batholith in this locality is a light grey, medium-grained quartz diorite composed mainly of quartz and calcic oligoclase occurring in part as a graphic intergrowth and of small amounts of green hornblende, brown biotite, apatite, magnetite, sphene, and zircon. For about ¼ inch from the quartz diorite the greenstone contains abundant brown biotite, green hornblende, and plagioclase (An_{30}), and a little quartz, sphene, and zircon. About 1 inch from the contact, otherwise normal appearing greenstone contains irregular aggregates ¼ to ½ inch in diameter, composed mainly of brownish-red garnet, epidote, and quartz. Small amounts of muscovite, calcite, and chlorite occur within these aggregates.

Granite and Granodiorite with Abundant Diorite Inclusions (11a).—Several areas of the Glundebery batholith in which diorite inclusions are abundant lie between the upper parts of Sheephorn and Tahoots Creeks. Other zones of diorite inclusions occur to the south of the south-west fork of Nazcha Creek, along the eastern wall of the upper part of Kahan Creek Valley, and in the vicinity of Blackfly Lake.

The zones consist mainly of blocks of recrystallized diorite, a few inches to over 100 feet in diameter, separated by networks of irregular granitic dykes. Generally, the diorite blocks are about equidimensional, but on the northern wall of Sheephorn Creek Valley they are tabular and have a parallel orientation. Commonly, the granitic dykes are composed of coarse-grained porphyritic granite which grades into the recrystallized diorite. In most places the zones of inclusions are surrounded by similar coarse-grained porphyritic granite which grades into the normal granitic rocks of the Glundebery batholith. Generally, the areas of abundant inclusions merge with the surrounding granite by a gradual decrease in the number of diorite blocks. To the south of Blackfly Lake, however, there are several gently dipping parallel sheets from 10 to 100 feet thick containing numerous inclusions, which are separated by sharply defined sheets of diorite-free granite from 10 to 50 feet thick.

The recrystallized diorite is a dark grey, fine-grained rock which commonly contains feldspar metacrysts with mafic rims and hornblende metacrysts with feldspar rims. In the vicinity of Blackfly Lake the diorite, in places, contains cavities which are generally lined with crystals of hornblende and feldspar. Microscopically, most specimens of the diorite consist chiefly of intergrown plagioclase, green hornblende, brown biotite, clinopyroxene, apatite, and magnetite. The plagioclase is mainly unzoned andesine; commonly, however, it forms zoned crystals with cores of sodic labradorite and rims of andesine or with cores of andesine and rims of oligoclase. In some thin sections, small amounts of quartz, orthoclase, perthite, zircon, and sphene were observed.

The coarse-grained porphyritic granite which forms aureoles around the zones of inclusions and commonly forms the dykes separating the diorite blocks contains prominent feldspar phenocrysts consisting of large pink cores of perthite and white rims of oligoclase (An_{26}). The ground-mass is composed of quartz, oligoclase, brown biotite, and small amounts of sphene, apatite, and magnetite.

The parts of the Glundebery batholith containing the abundant diorite inclusions may represent zones in which an early facies of the batholith consisting of diorite was intruded and metamorphosed by the later granitic phase.

Graphic Granite, Miarolitic Granite (11b).—In the vicinity of the lake on the north-east fork of Nazcha Creek, pink, medium- to fine-grained, graphic and miarolitic granite crops out over an area of approximately 4 square miles. The spatial relationship of the pink granite suggests that it forms a small stock intrusive into the main part of the Glundebery batholith.

The granite is composed almost entirely of pink feldspar and quartz. Commonly, it contains miarolitic cavities which range from ½ to ¾ inch in diameter. The miarolitic cavities are lined with well-formed crystals of quartz, feldspar, and, in some cases, fluorite. Typical specimens of the pink granite consist mainly of a micrographic intergrowth of quartz and microcline-albite perthite. Quartz and albite also occur in the rock as distinct grains. Small amounts of muscovite, green biotite, monazite, magnetite, fluorite, and hematite are present in some specimens.

Pink porphyritic granite, bearing some mineralogical and textural similarity to that described above, occurs along the main contact of the batholith, 3 to 4 miles south-east of Glundebery Creek. The porphyry contains phenocrysts of perthite, quartz, and oligoclase in a fine-grained ground-mass composed mainly of a micrographic intergrowth of quartz and potash feldspar. The ground-mass also contains small amounts of oligoclase, biotite, apatite, and magnetite.

Rhyolite Dykes.—In several places in the Atsutla Range small rhyolite dykes cut the Glundebery batholith or rocks of the Kedahda formation close to the batholith.

Dark greenish-grey, fine-grained rhyolite dykes cut the batholith near the head of the north-east fork of Nazcha Creek and about 2 miles south of Blackfly Lake. Talus of similar rock was observed a few hundred feet north of the 5,100-foot pass between the headwaters of Glundebery and Sheephorn Creeks. The margins of the dykes show regular flow-bands of light grey and dark green colour oriented parallel to the contacts. The centres of the dykes contain abundant dark green coalescent spherulites commonly aligned into parallel bands in a light greenish-grey ground-mass. Between the regularly flow-banded margins and the spherulitic centres of the dykes there are zones showing highly contorted flow-bands. Study of thin sections and stained specimens reveals that both the flow-banded and spherulitic portions of the dykes are composed mainly of quartz, potash feldspar, and riebeckite.

About 1½ miles west of Glundebery Creek, buff-coloured rhyolite dykes occur in rocks of the Kedahda formation close to the batholith. Some of the dykes have wide, highly spherulitic central zones and narrow non-spherulitic margins; others are either entirely non-spherulitic or display imperfect spherulites only near the margins. Generally, the buff-coloured rhyolites are very fine-grained and consist chiefly of quartz and potash feldspar. In some dykes, however, riebeckite is also an important constituent, and medium-sized euhedral crystals of quartz and perthite form the nuclei of spherulites.

Tuya Batholith.

Granite, Granodiorite (11).—The Tuya batholith is intermittently exposed in a north-westerly-trending belt 28 miles long and 2 to 6 miles wide in the western part of the Tuya Range. The batholith consists mainly of granite and granodiorite which are somewhat similar to the rocks of the Glundebery batholith in the Atsutla Range and almost identical with those of the Parallel Creek batholith in the north-eastern part of the Tuya Range. The Tuya and Parallel Creek batholiths are separated at the surface by a belt of sediments of the Oblique Creek formation, but they may be connected at greater depth. Parts of the Tuya batholith in the vicinity of Edasp Creek contain abundant inclusions of schist and have been mapped as a separate unit (11c).

The granite of the Tuya batholith is generally a little finer-grained than the typical Glundebery granite. Spheroidal weathering and readily disintegrating varieties are not prominent. The typical granodiorite of the Tuya batholith differs from that of the Glundebery batholith in that it contains abundant biotite and no hornblende. This granodiorite, forming the ridge north of Edasp Lake, is a grey, medium-grained rock composed mainly of quartz, orthoclase, perthite, oligoclase (An_{25}), and brown biotite. The rock also contains small amounts of muscovite, chlorite, apatite, zircon, magnetite, and micropegmatite. An unusual type of granodiorite, containing small crystals of red garnet, crops out over a small area about 4 miles to the south-east of Edasp Lake. This granodiorite is a light grey, medium- to fine-grained variety consisting chiefly of quartz, plagioclase (An_{30}), and orthoclase. In addition to the garnet, small amounts of muscovite, biotite, chlorite, and zircon are present. Within the main part of the Tuya batholith, quartz diorite was observed in large amount about 3 miles to the south of Edasp Lake. Andesine (An_{40}), quartz, biotite, and orthoclase constitute most of the rock and apatite and magnetite are present as accessories.

Granodiorite and Quartz Diorite with Abundant Schist Inclusions (11c).—A part of the Tuya batholith, approximately 5 square miles in area, in which schist inclusions are abundant, lies to the north of Edasp Creek. Two much smaller zones of inclusions lie to the south of Edasp Lake.

Generally, the granitic rocks containing the inclusions are similar to those of the adjacent parts of the batholith. In the area north of Edasp Creek the inclusions occur mainly in granodiorite; south of Edasp Lake, they occur chiefly in quartz diorite. The inclusions are pieces of quartz-mica schist ranging in size from blocks about 10 feet to huge irregular pendants over 50 feet in thickness. Generally, the inclusions are unoriented. To the north of Edasp Creek, however, they occur in places as gently dipping sheets of tabular blocks in parallel orientation separated by sheets of inclusion-free granodiorite. Although the tabular blocks forming the sheets are gently dipping, the bedding within them dips at widely varying angles.

The Tuya batholith intrudes rocks of the Oblique Creek formation and is overlain in several places by volcanic rocks of the Tuya formation. Where exposed, the south-western contact of the batholith with the intruded rocks is vertical and the north-eastern contact dips north-eastward at a high angle. In general, the metamorphism of the rocks of the Oblique Creek formation is widespread and has no apparent localization at the contacts of the Tuya batholith. Near the northern end of the batholith, however, prisms of andalusite up to ½ inch in length occur abundantly in mica schist within a few feet of the contact. The schist contains large amounts of sodic oligoclase and magnetite.

PARALLEL CREEK BATHOLITH (11).

Within the Tuya-Teslin Area the Parallel Creek batholith crops out in the north-eastern part of the Tuya Range as a north-westerly-trending belt 10 miles long and 2 to 5 miles wide. The batholith consists mainly of granite and granodiorite which are somewhat similar to the rocks of the Glundebery batholith and almost identical with those of the Tuya batholith. A typical specimen of granite collected at the base of the eastern part of Ash Mountain is a grey medium-grained rock composed chiefly of quartz, perthite, and sodic andesine. Small amounts of brown biotite, green hornblende, apatite, and zircon are also present.

The Parallel Creek batholith intrudes the Oblique Creek formation and is overlain in one place by volcanic rocks of the Tuya formation. To the south of Ash Mountain the contact of the batholith, where exposed, dips almost vertically. To the north of Ash Mountain, however, the flat undulating upper contact of the batholith and its cover of gently to moderately dipping sedimentary rocks are exposed on some of the peaks, ridges, and high passes. In several places limestones in this cover have been converted to skarns composed of various proportions of garnet, idocrase (vesuvianite), diopside, calcite, and quartz (Fig. 3). In a few places, these altered limestones have been slightly mineralized with zinc, lead, iron, tungsten, and tin. The mineralized skarns are described on page 43.

BASALT DYKES.

In a few places in the area, dark grey to black basalt dykes cut rocks of the Glundebery batholith and of the Oblique Creek formation. The dykes are very regular and are generally 2 to 4 feet wide; their dips are steep and they are undeformed. Judging from their composition and from the absence of alteration and deformation, these dykes are related to the volcanic rocks of the Tuya formation.

GRANITIC INTRUSIVES IN OBLIQUE CREEK FORMATION.

A description of the granitic sills and dykes which occur abundantly in the gneiss of the Oblique Creek formation has been given on page 15.

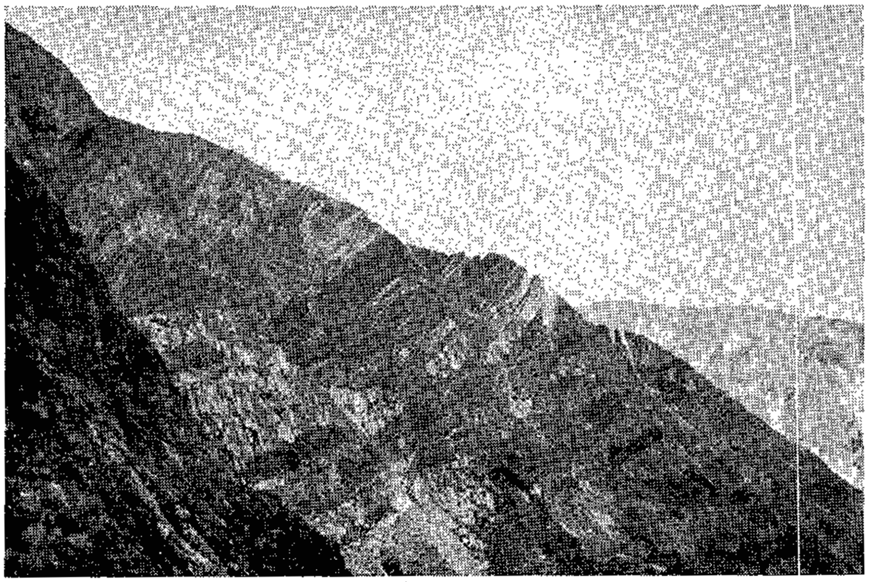
TUYA FORMATION (12).

The Tuya formation, consisting mainly of lavas, tuff, and agglomerate, is exposed throughout an area of approximately 100 square miles in the Tuya-Teslin region. These volcanic rocks crop out in several extensive areas and in many smaller areas on the Kawdy Plateau. Near the mouth of Kahan Creek in the Jennings Valley, a few small outcrops occur in the widespread drift. Judging from the abundance of basalt boulders in the drift elsewhere in the south-eastern part of this valley, much of this region may be underlain by similar volcanic rocks. Rocks of the Tuya formation make up one small peak in the eastern part of the Atsutla Range and several mountains in the Tuya Range. Small exposures of the formation occur in the Kedahda, Glundebery, Nazcha, and Edasp Valleys.

Most of the volcanic rocks which crop out on the gently rolling surface of the Kawdy Plateau are flat-lying flows of basalt and trachyte. The flows, generally 5 to 15 feet thick, commonly display excellent columnar structure. The upper surfaces of the flows are highly vesicular and somewhat glassy; in most cases, the bases are slightly vesicular. Several of the flows have vesicles throughout their entire thicknesses.

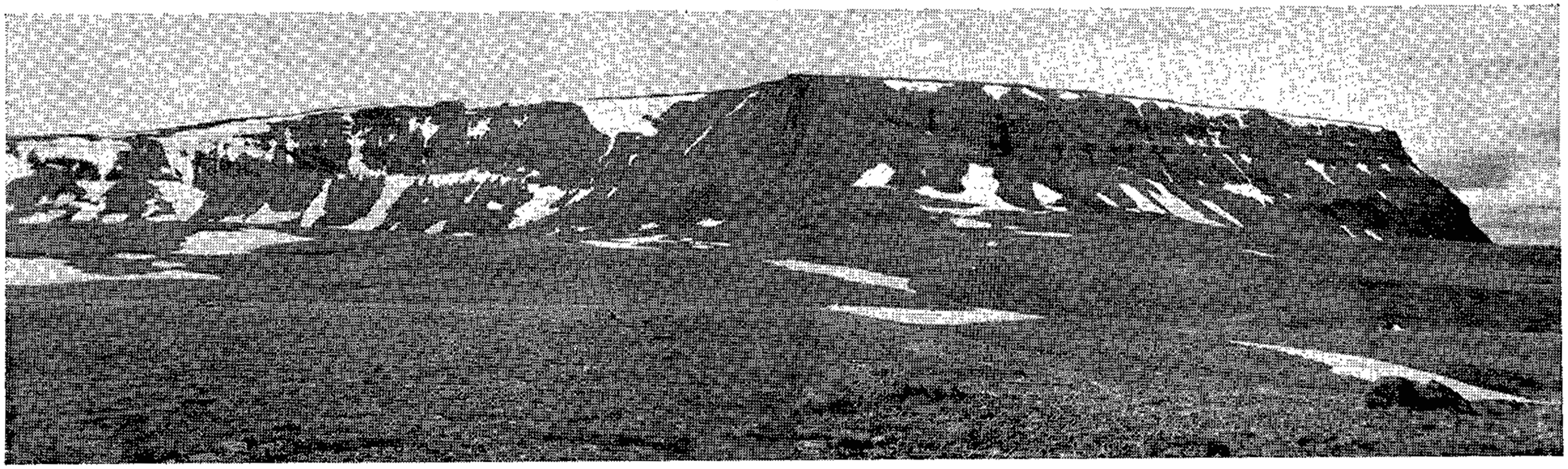
The basalt is a dark grey to black rock which contains phenocrysts of yellowish-green olivine in a fine-grained ground-mass. In one locality a few large phenocrysts

PLATE III.

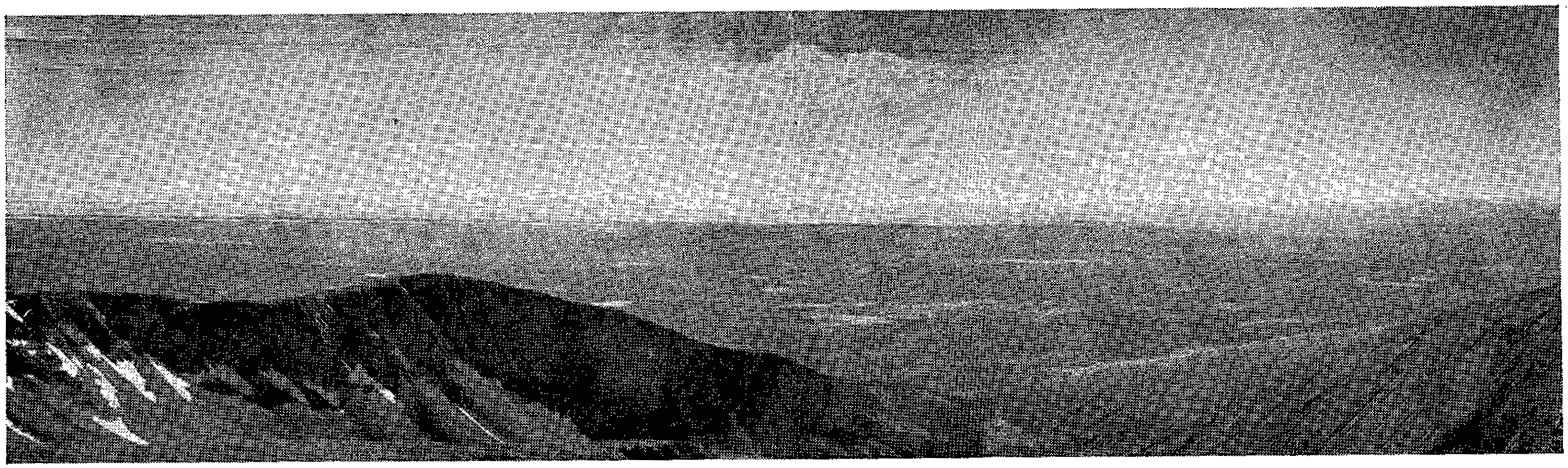


A.—Schists of Oblique Creek formation cut by granodiorite sills and dykes; north of Edasp Creek, Tuya Range.

B.—Pillow basalt; south-western base of Ash Mountain, Tuya Range.



A.—North-western ridge of Kawdy Mountain, showing flat-lying lava overlying dipping agglomerate.



B.—Teslin Valley from head of Christmas Creek, Atsutla Range.

of amber-coloured labradorite (An_{60}) up to ½ inch long also occur in the basalt. The ground-mass is a holocrystalline, felty or intergranular assemblage of intermediate labradorite, olivine, clinopyroxene, and black opaque grains. In some specimens the clinopyroxene is mainly augite and in others it is chiefly pigeonite. Generally, the vesicles of the basalt are unfilled, but in one place many large amygdules of aragonite were observed; in a specimen from another locality, small amygdules containing chlorite and calcite were seen microscopically.

Specimens collected on the two 4,800-foot hills, respectively 8 miles north 82 degrees west and 8½ miles north 60 degrees west from the summit of Mount Josephine, have been identified microscopically as trachyte. The extent of the trachyte is not known, but lava which appears similar in hand specimens to that identified as trachyte occurs between these two hills. The trachyte is lighter grey than the basalt and, in places, the highly vesicular tops of the flows are stained red. The ground-mass of the trachyte consists of a fine-grained holocrystalline aggregate of potash feldspar, clinopyroxene, and black opaque grains. Usually, tabular crystals of glassy alkali feldspar up to ¾ inch long occur in the trachyte. Less commonly, the trachyte contains nodules, ¼ to 1 inch in diameter, which are composed of olivine, enstatite, diopside, spinel, which appears brown in thin section, and black metallic grains. A few crystals of lamprobolite (basaltic hornblende) up to 1 inch in length, and skeletal crystals of ilmenite up to ¾ inch in diameter, were observed in the trachyte.

The outcrops of the Tuya formation occurring in the south-eastern part of the Jennings Valley are flat-lying flows of basalt and gently-dipping beds which consist of abundant cobbles and boulders in a rudely stratified matrix of black tuff. The cobbles and boulders range from a few inches to a few feet in diameter; some are faceted and striated. Although boulders of basalt are the most numerous, a few of granite, greenstone, quartzite, and quartz are also present.

An extensive area of basalt flows which dip westerly at low angles occurs in the western part of the Tuya Range about 2 miles north of Ash Creek. These lavas rest upon a surface, mainly granitic, which slopes gently westward. A typical specimen of this basalt is a dark grey, slightly vesicular rock which contains numerous phenocrysts of olivine and a few of labradorite and augite in a fine-grained, holocrystalline ground-mass with intergranular texture. The ground-mass is composed principally of labradorite (An_{64}), olivine, augite, and black opaque grains.

Volcanic rocks of the Tuya formation make up several prominent, barren, black mountains which rise above the surface of the Kawdy Plateau or which occur in the Tuya Range and the eastern part of the Atsutla Range. These mountains represent accumulations of material formed by central eruptions. In most cases, they appear to have been modified by erosion to only a moderate extent since the time of their formation.

Tuya Butte, Isspah Butte, Kawdy Mountain (Plate IV., A), and an unnamed mountain 6 miles north of the head of Edasp Lake are all flat-topped volcanic mountains of somewhat circular plan. The lower parts of these mountains are composed essentially of beds of black basaltic agglomerate and tuff having dips, probably initial, of 15 to 30 degrees. In some mountains these rocks dip radially outward from the centre, suggesting that they form the flanks of a cone. Near the tops of most of these mountains the beds of agglomerate and tuff are truncated by remarkably level surfaces, presumably formed by erosion, and are capped with flat-lying lavas which commonly reach 300 to 400 feet in thickness. In many places around the tops of the buttes these lava-flows form vertical cliffs, in most of which excellent columnar structure is revealed.

Within the Tuya-Teslin Area there are a few somewhat conical mountains composed chiefly of outward-dipping beds of agglomerate and tuff which are not capped with lava-flows. These mountains include the peak 4 miles west of Blackfly Lake, Metah Mountain, Badman Point, the small mountain 3 miles south-west of Ash Mountain, and the large mountain 5½ miles north of the head of Tuya Lake. In a few places the pyroclastic rocks composing these mountains form relatively smooth dip-slopes; in other places they form an irregular pattern of jagged ridges and steep cliffs. Commonly, the lower parts of these mountains are mantled by smooth slopes of talus and scree.

The agglomerate of the Tuya formation is generally a dark grey to black rock which contains angular to subangular fragments of basalt and basaltic glass in a fine-grained buff to light brown weathering matrix of vitric tuff. The fragments in the agglomerate of the small cone 4 miles west of Blackfly Lake are chiefly vesicular basalt containing abundant labradorite laths, olivine crystals, and black opaque grains in dark brown basaltic glass. The matrix of this agglomerate consists of partly coalescent fragments of yellow, highly vesicular basaltic glass and a small number of grains of olivine, labradorite, and black opaque material. Chalcedony either encrusts or entirely fills the vesicles in both the fragments and the ground-mass. Gently dipping grey agglomerate is exposed near the south-eastern base of the large cone lying 5½ miles north of the head of Tuya Lake. This agglomerate is composed mainly of small angular to rounded fragments of vesicular olivine basalt and basaltic glass in a fine-grained, dark grey, poorly stratified matrix. Locally, this rock contains abundant faceted and striated cobbles and boulders of basalt and a few of granite. Microscopically, the ground-mass of the agglomerate is seen to consist of small fragments of pale brown basaltic glass and grains of olivine, labradorite, and black opaque material.

Mount Josephine and an unnamed mountain 5½ miles south of Edasp Lake are so extensively mantled with disintegrated volcanic rocks that their structure is doubtful. The talus on Mount Josephine is composed almost entirely of dark grey to black vesicular lava. Near the summit of the mountain, columnar-jointed basalt is poorly exposed. This basalt contains phenocrysts of labradorite (An_{62}) and greenish-yellow olivine in a fine-grained ground-mass consisting of labradorite (An_{52}), pyroxene, and black opaque dust. The talus mantling the mountain 5½ miles south of Edasp Lake is composed mainly of fragments of lava and agglomerate.

Ash Mountain, the highest mountain in the Tuya-Teslin Area, is composed chiefly of partly consolidated ash and of flows of pillow lava. The ash is generally light brown weathering, well stratified material which is composed almost entirely of fine particles of black basaltic glass. Microscopically, it is seen that the glass fragments are somewhat vesicular and jagged and that the ash contains occasional crystals of olivine and plagioclase. A narrow canyon along the south-western base of Ash Mountain exposes a composite section, several hundred feet thick, of approximately flat-lying olivine basalt which exhibits excellent pillow structure (Plate III., B). Near the summit of Ash Mountain pillow lavas, which appear to be remnants of once extensive flows, are exposed in several places. Elsewhere in the Tuya formation pillow lavas were observed at the eastern base of Metah Mountain and along the south-western base of the unnamed mountain lying 5½ miles south of Edasp Lake.

The pillows exposed at the base of Ash Mountain range from 1 foot to over 6 feet in length. They have thin bread-crusted rims of basaltic glass which grades into dark grey, fine-grained vesicular basalt containing abundant crystals of olivine. Microscopically, the ground-mass of a typical specimen of this basalt is seen to consist of a holocrystalline felty assemblage of calcic labradorite, olivine, clinopyroxene, and black opaque dust. The pillows display well-developed radial columnar joints and, near their margins, concentric zones which contain radially elongate vesicles. The spaces between the pillows are either entirely empty or contain only a slight amount of debris spalled from the rims. In many cases the bottoms of the pillows conform to marked irregularities in the surfaces upon which they rest.

The pillow lavas at the base of Ash Mountain contain numerous light-coloured inclusions, usually ½ inch to 3 inches in diameter, derived from older rocks in the area. Mineralogical, textural, and chemical similarities indicate that the majority of the inclusions are partly vitrified granite fragments and that a few are pieces of partly vitrified quartzite. The principal changes induced in the fragments by the lava are severe crackling of the feldspar and quartz and the formation of abundant colourless glass of refractive index 1.495. A few of the feldspar grains have inverted to sanidine and in one inclusion studied a small proportion of the quartz has inverted to tridymite. An elongate mass of partly fused granite about 3 inches wide and over 2 feet long was observed in agglomerate 4 miles north of the head of Tuya Lake.

The Tuya formation, composed of the youngest consolidated rocks in the area, was deposited on a surface almost identical with that of the present and many of the mountains made up of these volcanics appear to have undergone relatively little erosion since the time of their formation. In the north-western part of the Kawdy Plateau lavas occupy narrow, deeply-incised valleys similar to those now existing near the edge of the Plateau. Also, in the Tuya Range, the volcanic rocks were deposited upon a rough surface of considerable relief resembling the present one.

Several facts show that some of the volcanic activity in the Tuya-Teslin Area occurred prior to a time of glaciation, Outcrops of lava in the Nazcha Valley bear glacial striæ. Boulders of lava are of widespread occurrence in the till. In many places, the volcanic rocks are mantled with deposits of glacial drift. Erratics occur on the slopes of Ash Mountain up to an altitude of 6,500 feet and were also seen on all other volcanic mountains which were climbed. Cirques occur on the northern sides of Tuya Butte and Kawdy Mountain.

On the other hand, there is evidence that some volcanism took place subsequent to a time of glaciation. At the north-eastern base of Ash Mountain, partly consolidated ash rests upon a polished surface of unweathered granite which presumably owes its smoothness and freshness to glacial scouring. Glaciated boulders occur in the ash in this locality and in well consolidated pyroclastic rocks which occur in the Jennings Valley and 4 miles north of the head of Tuya Lake.

From the foregoing facts, it seems that in the Tuya-Teslin Area part of the Tuya formation was deposited before a time of glaciation and part was deposited after a time of glaciation. No evidence was found that volcanic activity has occurred since the latest glaciation. On the other hand, no information was obtained regarding the exact time at which the volcanic activity began. The volcanics are identical in most respects with those occurring in the Dease Lake Area, to which the name "Tuya formation" was first given by Kerr (1925, Map No. 2104). He (Kerr, 1925, p. 96 A) considers that the rocks of the Tuya formation are related to the lava-flows exposed in the Stikine Canyon and that several features "suggest that some of the flows are younger than Miocene, to which they were referred by G. M. Dawson." It was thought by Kerr (1925, p. 96 A) that "the lavas and cinder cones within the (Dease Lake) area are very late Tertiary or early Pleistocene and it would seem probable that they represent only part of a period of volcanic activity which in the general region of northern British Columbia began in the Tertiary and continued into the Pleistocene."

DRIFT AND ALLUVIUM (13).

Almost half the Tuya-Teslin Area is covered with thick and relatively continuous deposits of glacial drift and some alluvium. This mantle of superficial deposits is particularly thick and widespread below an elevation of 4,000 to 4,500 feet throughout the area. Above this level it becomes thinner until at elevations of 5,500 feet or more there are only widely scattered erratics. The highest erratic found was at 6,500 feet above sea-level on the slopes of Ash Mountain. No moraines or any abrupt thinning of drift at high levels exist to mark an upper limit of glaciation. All the till examined was of about the same degree of freshness and is, therefore, referred to a single period of glaciation.

At two places on the southern wall of the Jennings Trench between Aconitum and Kahan Creeks drift deposits occur at an exceptionally high elevation, 6,000 to 6,300 feet, and appear to be at least several hundred feet in depth. The reason for these concentrations of drift is not known.

Deltas of sand and gravel, built by streams into Late-Glacial ice-dammed lakes, occur throughout the area, though generally at the lower elevations.

The significance of these deposits of glacial drift is discussed more fully under Glaciation (pages 34 to 40).

Recent deposits of alluvium, chiefly stream-gravels, cover a very small part of the area.

CHAPTER IV. STRUCTURAL GEOLOGY.

The known structure of each formation and intrusive body has been described previously. This section of the report deals with two inferred structures of great magnitude which involve rocks of more than one age.

Evidence suggests that a fault extends from the divide between Glundebery and Kahan Creeks, north-westerly, to at least within 3 miles of Aconitum Lake. West of Shonektaw Creek, as described on page 20, westerly-striking volcanics of the Shonektaw formation (5) terminate abruptly along strike against north-westerly-trending sedimentary rocks of the Kedahda formation (2). The contact between the two formations, which itself strikes north-westerly, is considered to be a fault. On the opposite side of the Shonektaw Valley, to the south-east along this same line, the contact between the Glundebery batholith and the Kedahda formation changes abruptly in strike from north 75 degrees east to north 30 degrees west. Most of the granite in this vicinity is of a somewhat readily-disintegrating variety but that along the north-westerly-trending contact is remarkably incoherent. These facts suggest that the north-easterly-trending intrusive contact terminates against a north-westerly-trending fault. On the ridge 1 mile farther to the south-east, readily-disintegrating, coarse-grained, pinkish granite is separated from coherent, medium-grained grey granite by a narrow gully containing abundant scree. Still farther to the south-east, on the ridges and spurs between the headwaters of Tahoots Creek, the distribution of batholithic rocks containing diorite fragments and those which are inclusion-free is suggestive of a discontinuity. Still farther to the south-east, the deep narrow valley breaching the north-western wall of the Glundebery Valley may lie along the fault.

The fact that the trace of the fault is relatively straight even where the relief is considerable, indicates that the fault surface is steeply dipping. The direction and amount of displacement along the fault are unknown. There is a correspondence in the sections of the Kedahda formation exposed on both sides of the Shonektaw Valley and the fault seems to be at approximately the same stratigraphic position in both places. The faulting occurred after the intrusion of the Glundebery batholith which is known to have been emplaced in post-Lower Mesozoic time.

One of the most prominent topographic features of the area is the scarp which forms the north-eastern wall of the Teslin Valley. Between Kedahda River and Charliecole Creek the scarp is 1,000 to 1,500 feet high and has an average slope of 30 degrees. The valley wall trends north 30 degrees west intersecting at a small angle the regional strike of the Kedahda formation, the contact between the Christmas Creek batholith and the Kedahda formation, and the projected trend of probable strike ridges of the Teslin limestone cropping out on the valley-floor. The rocks of the Kedahda formation which lie close to the scarp are generally highly contorted and somewhat sheared. Several faults of diverse attitudes and small displacements were observed in the valleys cut through the scarp by Williejack and Tanah Creeks, just before they flow out onto the floor of the Teslin Valley. Thus, several features, other than the topography, suggest that the scarp represents a discontinuity which may be the result of faulting or of an abrupt monoclinal flexure.

CHAPTER V.

PHYSIOGRAPHY.

The surface of the Kawdy Plateau, 600 to 700 square miles in area, is a gently rolling upland of low relief developed by erosion, mainly on highly folded Palæozoic rocks. A large area lying near the south-western flank of the Atsutla Range has broad, flat summits. These extensive flat areas are the surface of a peneplain and the gently sloping summit surfaces of the mountains in the south-western part of the Atsutla Range may be relics of a peneplain. In the past, this peneplain may have extended over a much greater area. Presumably, it was uplifted differentially and subsequently eroded in places to give rise to the larger-scale features of the present topography. The Kawdy Plateau was apparently raised relative to the floor of the Teslin Trench. The south-western front of the plateau, which may be situated along a fault or sharp monoclinal fold (page 33) was dissected by the rejuvenated streams. Parts of the peneplain may have been raised relative to the Kawdy Plateau to form the Atsutla and Tuya Ranges. The flat summits of the mountains in the south-western part of the Atsutla Range may, as stated, be relics of this warped peneplain. In the rest of the mountainous areas, however, the summits are sharp, rugged peaks and if a peneplain did exist there formerly, it has been completely dissected.

On the Kawdy Plateau, conical or flat-topped mountains of agglomerate, tuff, and lava, of the Tuya formation built by central eruptions, rest on the peneplain. Part of the lava of the Tuya formation was extruded, after the uplift of the peneplain, as flows which occupy narrow, deeply-incised valleys near the western edge of the Kawdy Plateau. The time of deposition of part of the Tuya formation relative to the development of the peneplain is less certain. It is unknown whether the flat-lying lavas found in the northern part of the Kawdy Plateau form a thin veneer on the peneplain, or whether they, like the Palæozoic rocks, are cut by it.

In the Tuya and Atsutla Ranges volcanics have been laid down on a surface almost as rugged as that of the present day.

Some of the volcanics of the Tuya formation are associated with glacial deposits and at least a part of the volcanism is evidently of Pleistocene age. Other events in the physiographic history such as peneplaination and uplift, however, cannot be dated definitely as Pleistocene, but may be Late Tertiary and, perhaps, Early Pleistocene. Some of the dissection which followed the uplift may have been the work of Late Tertiary or Early Pleistocene streams, but a part of the sculpturing of the land surface has been the work of ice.

GLACIATION.

INTRODUCTION.

At least once during the Pleistocene, the Tuya-Teslin Area was invaded by an extensive ice-sheet which rose to an elevation of at least 6,500 feet as shown by the presence of erratics. It is believed that, at its climax, the ice-sheet buried all the peaks of the area, possibly to great depths. Signs of multiple glaciation have been found in the Dease Lake Area to the south-east (Johnston, 1925, pp. 46 A–48 A), but not in the Tuya-Teslin Area. At some periods, probably before the development of the ice-sheet and after its disappearance, valley glaciers existed in the mountainous parts of the area, contributing to ice erosion and to the drift deposits.

Very little information has been recorded concerning glaciation in the surrounding region. The following reconstruction of the glacial history, based mainly on observations made during the reconnaissance survey of the Tuya-Teslin Area, is incomplete. Information on the advance of the ice-sheet has been obliterated or concealed by later erosion and deposition. However, once the ice-sheet reached its climax, signs were left which make it possible to outline its history from then on.

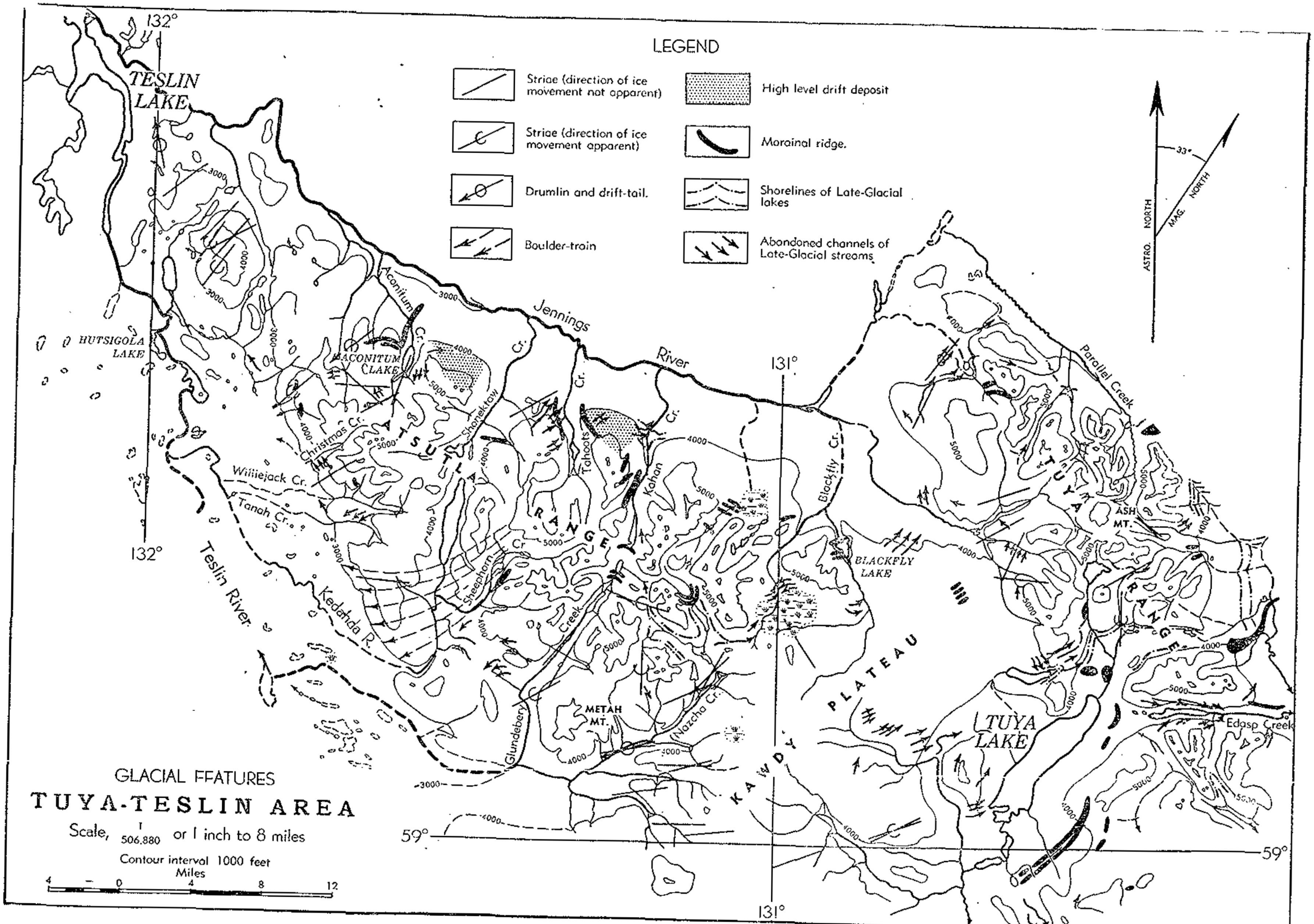

LEGEND
Striae (direction of ice movement not apparent)
Striae (direction of ice movement apparent)
Drumlin and drift-tail.
Boulder-train
High level drift deposit
Morainal ridge.
Shorelines of Late-Glacial lakes
Abandoned channels of Late-Glacial streams
ASTRO. NORTH
MAG. NORTH
33°
TESLIN LAKE
HUTSIGOLA LAKE
ACONITUM LAKE
Jennings River
Teslin River
Kedahda R.
Willlejack Cr.
Tanah Cr.
Christmas Cr.
Shoneklaw
Aconitum Cr.
Tahoots
Kahan Cr.
Blackfly Cr.
BLACKFLY LAKE
Sheeharn Cr.
Glundebery Creek
Nazcha Cr.
METAH MT.
KAWDY PLATEAU
TUYA LAKE
TUYA RANGE
ASH MT.
Parallel Creek
Edasp Creek
132°
131°
59°
GLACIAL FEATURES
TUYA-TESLIN AREA
Scale, 1/506,880 or 1 inch to 8 miles
Contour interval 1000 feet
Miles
4 0 4 8 12

Figure 2

Direction of Movement of Ice-sheet.

Where striæ and some other evidence, such as stoss and lee effect or drift tails indicated the strike and the direction of movement, the striæ have been shown by the conventional symbol on the accompanying map (Fig. 2). Where striæ were found but conclusive evidence of the direction of movement was absent, the strikes of the striæ have been indicated by means of straight lines.

Across the Kawdy Plateau and the southern part of the Atsutla Range the ice-sheet which striated the surfaces had a general movement of about south 70 to 80 degrees west, though it was deflected to a considerable extent close to and within the mountains. In the north-western part of the Atsutla Range the general movement of the ice was about south 45 degrees west. The ice-streams thus converged towards the south-west, heading apparently for the valleys of the Inklin and Nakina Rivers (Fig. 1) which would afford channels through the Coast Mountains. Whether or not these ice-streams can be related to two distinct centres of ice accumulation somewhere near the axis of the Cassiar Mountains is not known.

Two cases of intersecting striæ were noted. Both could be accounted for by an increasing influence of the mountains as a barrier to ice movement as the ice-sheet became thinner in the early part of its retreat. One striated outcrop, 1½ miles north-east of the outlet of Hutsigola Lake, indicates ice movement parallel to the Teslin Trench and was probably formed when the ice-sheet had shrunk so much that it was confined entirely to the trench.

In the Tuya Range a striated outcrop, 7 miles north of the head of Tuya Lake, is littered with basalt boulders apparently derived from a volcanic cone 1½ miles to the south-west. Another striated outcrop, 21 miles north 30 degrees west of the head of Tuya Lake, is likewise littered with basalt boulders which may have been derived from the upper part of the Jennings Trench to the south-west or from the Kawdy Plateau to the south. Several other striated outcrops were observed in the Tuya Range, but no evidence regarding the direction of ice movement was found.

In a few cases the sources of ice-borne erratics were determined. A syenite boulder found in the lower part of the Glundebery Valley was transported from a body about 6 miles to the north-east. A trail of granite boulders extends for at least 5 miles westward and south-westward across several ridges from a source on the upper part of Sheephorn Creek. Serpentine boulders have been carried southward and uphill for at least ¼ mile from the outcrop north of Kedahda Lake. The deep masses of drift on the southern wall of the Jennings Trench between Aconitum and Kahan Creeks contain a considerable amount of material that may be derived from areas of metamorphic rocks east and possibly north of the Jennings River. Numerous basalt boulders on the ridges to the east of Kahan Creek may have been derived from parts of the Jennings Valley to the north or east. Two cases of the transportation of boulders in the Tuya Range have already been described. In a third place, a trail of boulders extends northward from Ash Mountain for at least 2 miles along the western wall of Parallel Creek Valley. This trail, however, may have been formed by a valley glacier.

Drift tails, built in the lee of rocky knolls, and drumlins occur at a few places in the Tuya-Teslin Area. Four miles east of Metah Mountain on the floor of Nazcha Creek Valley, drift tails were found in association with striated outcrops clearly indicating a westward movement of the ice. In the Glundebery Valley several hillocks had drift tails on both their north-eastern and south-western sides, suggesting a reversal in the direction of ice movements along the valley. High on the western wall of Kahan Creek Valley several moraines or drift tails extend northward from the ends of rocky spurs. Drumlins extending north 20 degrees west from rocky knolls are found near the north-western end of the area mapped and may belong to the same period in the glacial history as the striæ east of Hutsigola Lake.

The criteria used to determine the direction of ice flow indicate, therefore, that much of the ice movement across the Tuya-Teslin Area was to the west and south-west.

In the Dease Lake Area to the south-east, according to Johnston (1925, p. 46 A) the ice moved to the south. The centre of the ice-sheet may, therefore, have been situated along the axis of the Cassiar Mountains somewhere north-west of McDame. Some features in the Tuya and Atsutla Ranges suggest a movement of the ice towards the north or north-east. Such a reversal may be accounted for by a shift of the ice centre westward or south-westward across the area. This hypothesis is in accord with the observations, discussed later, on the retreat of the ice-sheet.

Erosion by Ice-sheet.

Extensive modification of the land forms of the Tuya-Teslin Area by the ice-sheet is not evident. The mountain valleys of the area appear to have been widened and deepened, but it is believed that much of this erosion was accomplished by local glaciers which existed before and after the ice-sheet. The numerous cirques and small hanging valleys on the northern and eastern slopes of many of the mountains are likewise attributable to local glaciers. The ridges which apparently were not buried by these glaciers show little or no rounding, although the presence of erratics testifies that they were covered by the ice-sheet. Two valleys, east and north-east of the head of Tuya Lake respectively, penetrate the Tuya Range and show hanging valleys, truncated spurs, and broad flat floors. Inasmuch as these valleys do not head in mountains, it seems probable that they have been modified by tongues of ice which extended through the Tuya Range from an ice mass situated elsewhere.

Ice Retreat.

Moraines.—Well-formed recessional moraines are abundant in the area and some of them appear to be almost continuous. The most prominent of these lies to the south-east of Tuya Lake (Fig. 2), where two parallel ridges, up to 100 feet in height, extend north-eastward from the north-western end of Ichthyosaur (Conglomerate) Mountain for 5 miles. Intermittent moraines can be traced north-eastward for another 6 or 7 miles. It appears from the position of the abandoned stream channels associated with the moraine that the ice occupied the area to the north-west. Another distinct moraine belt crosses the floor of the Cottonwood Trench in a north-easterly direction. A group of small but well-developed crevasse fillings occurs in a southward-draining valley, 4 miles south of Edasp Lake.

A series of moraines or of crevasse fillings was found 10 miles north 60 degrees west of the head of Tuya Lake; the individual ridges trend north-easterly but the belt of ridges extends north-westerly for almost a mile. The material composing the ridges has been derived from the Tuya Range. Several moraines, some concave to the south, the rest of irregular outline occur in the Glundebery Valley. At the head of Glundebery Creek a prominent moraine, over 100 feet in height, ponds to the north of it a lake 2 miles in length, which drains northward across a former divide to the Jennings River. An extensive moraine lies to the west and north of Aconitum Lake, apparently built at the edge of an ice-sheet occupying the lower part of the Jennings Trench. Another morainal belt extends for about 2 miles eastward from the lakes on Shonektaw Creek. On both sides of Tahoots Creek Valley there are well-marked lateral moraines extending parallel to the creek for over 2 miles. At numerous places these two moraines are cut by abandoned stream channels which followed the edge of an ice-sheet which occupied the Jennings Trench and buried the lower ends of the moraines themselves, which therefore are not the latest glacial deposits of that area.

Morainal ridges, formed by local valley glaciers, are common throughout the Atsutla and Tuya Ranges.

Abandoned Channels.—Throughout the area there are numerous abandoned stream channels and abandoned lake terraces which, in places, are even more conspicuous than the moraines. At the close of the last ice age the Tuya and Atsutla Ranges evidently became free of much of their ice while the adjacent trenches and plateau were still deeply buried. At that time the drainage from the mountains and from the melting ice flowed directly along the margin of the ice-sheet or was dammed back against the ice front to form pro-glacial lakes. Some of these lakes drained either through ice-free passes or along the ice front itself to lower ice-free ground. The streams flowing along the margin of the ice-sheet or draining the pro-glacial lakes through ice-free passes cut distinct channels into the drift and, in some cases, into the underlying bed-rock. Most of these channels show no signs of former lakes at their heads; in some cases lakes may have been too short-lived to leave recognizable shore lines and deltas.

The abandoned channels range in width from a few feet to over 100 feet. The majority are less than 30 feet deep but a few exceed 50 feet in parts. The walls are almost invariably steep. Their floors are flat and generally covered with boulders too large to have been removed by the former streams. The channels may have very gentle gradients across a pass or along a hillside or they may run with high gradients directly down a slope. The channels may head at important passes, or low points on a ridge, or, for no apparent reason, on broad spurs or smooth hillsides. They terminate at their lower ends in existing watercourses or at the shores of extinct pro-glacial lakes. In the latter case the debris excavated from the channels is left at the levels of the former lakes as abandoned deltas.

Along some hillsides, notably east of Aconitum Lake and on the southern wall of the Jennings Trench east of Tahoots Creek, there are several shelves or terraces, 10 to 20 feet wide, floored with boulder pavements. These are evidently the channels of streams which flowed along the ice front with the drift-covered hillside serving as one wall and the ice as the other. That the streams did not cut downward into their floors until both walls were in drift may have been because of lack of time or because the drift contained abundant boulders. Elsewhere, channels were cut well into drift, and in a few cases into bed-rock.

As suggested above, two distinct types of channels can be recognized. The first, which may be referred to loosely as a *direct overflow* (Kendall, p. 481, 1902), heads at a low point on a ridge or divide and continues directly down the slope. Evidently on the iceward side of the ridge there was a pro-glacial lake or an ice-diverted stream which overflowed across the lowest accessible gap in the ridge and cut a channel down the ice-free slope.

The second type of channel, the *lateral overflow,* has been cut diagonally across a hillside or across a spur between two tributaries entering the side of a main valley. Evidently, here, the lower part of the hillside or the main valley was occupied by ice and the water from the melting of the ice as well as from the adjacent ice-free land flowed along the ice front. Many of these lateral overflow streams were evidently interrupted by pro-glacial lakes formed in re-entrants on the hillside or valley-wall, for their channels lack continuity; others may be a mile or more in length.

The abandoned channels occur as a rule in successions. In one characteristic grouping, a *parallel sequence,* a hillside is cut by a succession of parallel lateral overflows, each one lower and younger than its predecessor, and formed along an ice front which retreated either continuously or intermittently. An excellent example of this grouping occurs on the first spur south of Christmas Creek on the north-eastern wall of the Teslin Trench. Here nine successive outlets, of which three have been represented on the map (Fig. 2) occur between the 4,500-foot and the 3,500-foot levels. A similar group exists on the lower slopes of the mountain north of Edasp Lake, where four successive streams ran easterly and south-easterly along the edge of an ice lobe occupying the valley-floor. In a second characteristic grouping, also a *parallel sequence,* a succession of direct overflows head at lower and lower gaps along a single ridge. Examples of this type occur on a spur on the western slope of the Tuya Range, 2 to 3 miles south of Ash Creek, and across the north-western horn of the 4,700-foot crescent-shaped ridge east of the head of Josephine Creek. Another grouping, an *aligned sequence,* is a succession of channels which were the connecting links in a chain of contemporaneous pro-glacial lakes. All the channels drain in the same direction and the lower end of one corresponds in level to the upper end of the next in the chain. One example of this sequence occurs along the eastern end of the Atsutla Range between the upper Nazcha Valley and the middle part of the west fork of Blackfly Creek. Another aligned sequence, not fully studied, was found along the western side of the Tuya Range and across its northern extremity.

The abandoned channels were useful in interpreting the conditions of deglaciation throughout the area. As with present ice-diverted streams, most of the channels drained either parallel to or away from the ice front.

Within the Cottonwood Trench there is record of diversions of the Late-Glacial streams northward along the eastern foot of the Tuya Range. Evidently the ice mass occupying the trench sloped northward. However, it must have almost or completely disappeared while there were still ice lobes penetrating the Tuya Range from the west for there was apparently free drainage along the north and south sides of the Edasp Lake ice lobe (page 38) and down Edasp Creek towards the Cottonwood River.

In the Tuya Range the channels drained either eastward through the mountains or, at a later stage, northward or southward along the western slope and then eastward across either extremity. Apparently at that time lower ice-free land lay to the east of the range, and the plateau at the foot of the mountains on the western side must have been covered with ice of considerable depth.

On the Kawdy Plateau the glacial diversions of the streams have been almost invariably to the north-east. The ice front in that area apparently extended in a north-westerly direction and withdrew to the south-west. South of Tuya Lake, however, the diversions were to the east or south-east and in that part the ice front may have extended north-easterly, parallel to the moraine described on page 37. To the east of Blackfly Lake there is a series of lateral overflows running north-easterly on a northerly facing slope. Probably a mass of ice lay to the north or north-west of these channels, deflecting them eastward from the normal course of drainage. Perhaps this mass of ice was the eastern limit of the one occupying the Jennings Trench.

Along the south-eastern flank of the Atsutla Range the Late-Glacial drainage was to the north or north-east and along the south-western flank the drainage was to the north-west. Evidently the ice mass covering the flanks sloped northward and retreated southward. Probably the last mass of the ice-sheet to remain in the Tuya-Teslin Area lay within the Teslin Trench towards its south-eastern end.

A parallel sequence of direct overflows crosses the ridge between Williejack and Tanah Creeks. Unlike any of the other overflows seen along the walls of the Teslin Trench these drained southward and cannot be explained by southward ice retreat.

Pro-Glacial Lakes.—Abandoned shore-lines and deltas found in a few places in the Tuya-Teslin Area are evidence of pro-glacial lakes. The shore-lines are narrow terraces which are very continuous in some cases, but are generally concealed in places by talus or by heavy vegetation. The deltas found at the intersections of watercourses with the shore-lines are of considerable size and, in some places, are the only conspicuous relics of the extinct lakes. The deltas are composed mainly of foreset and topset beds of sand and gravel. Their upper surfaces are generally flat, but some are pitted with kettles and many are scored with abandoned stream-channels.

Several conspicuous shore-lines occur around the head of Nazcha Creek, in the valleys of the north-eastern and south-western forks. In the south-western valley there is a high-level shore-line which may correspond to an outlet draining north-westerly to the Glundebery Valley. A very well marked shore-line occurs in the valleys of the north-eastern and south-western forks at a slightly lower level, though more than 500 feet above the valley-floor. This shore-line can be traced continuously to a pass, marked by a distinct abandoned channel, leading eastward to the head of the west fork of Blackfly Creek. The shore-line extends up the valley of the north-west fork as far as a series of moraines, concave to the west, about 3 miles from the head of the valley.

It is not clear whether the lake extended beyond this point and the hillside was too rocky to permit the development of recognizable shore features, or whether a mass of ice above this point terminated this arm of the lake. In any event it is clear that the deglaciation of the eastern Atsutla Range was almost complete while the adjacent plateau at the mouth of Nazcha Valley was buried to a depth of at least 500 feet by ice.

Abandoned deltas are common in the valleys of Parallel Creek and the Jennings River around the northern end of the Tuya Range. These deltas were formed in a series of lakes occupying these valleys and apparently draining at first eastward through the Cassiar Mountains to the tributaries of the Dease River, and perhaps at a later date, northward.

A succession of terraces occurs in the valley north and north-east of the head of Tuya Lake. The extent of the lakes in which these terraces were formed and the positions of the ice dams are, however, unknown. A large number of terraces occurs a few miles to the east, in the Cottonwood Trench, but here, too, the extent of the lakes and the direction of their drainage are not known.

Other terraces occur on the floor of the Teslin Trench, but they are generally discontinuous and concealed by vegetation and were not studied.

CHAPTER VI. PROSPECTING POSSIBILITIES.

INTRODUCTION.

There has been no production from lode deposits and very little from placer deposits in the Tuya-Teslin Area. The Atlin district, situated about 50 miles to the west, has produced more than $350,000 in lode gold and $12,000,000 in placer gold since the discovery of deposits in 1898. The region including Dease, Thibert, and McDame Creeks, lying 15 to 50 miles south-east and east of the Tuya-Teslin Area, has produced placer gold totalling almost $5,000,000 in value since 1873. In 1935, many quartz veins containing visible gold were found in the vicinity of McDame Creek, and considerable exploration work has been done on some of them. The sources of the placer gold recovered from Dease and Thibert Creeks and from the streams in the Atlin region are unknown.

LODE DEPOSITS.

The Tuya-Teslin Area is virtually unprospected for lode deposits. In most of the valleys of the region thick deposits of drift and alluvium would make prospecting very difficult. However, in the mountains of the Atsutla and Tuya Ranges and on parts of the Kawdy Plateau there are excellent exposures of bed-rock.

Several parts of the area appear to be geologically favourable for the occurrence of lode deposits. The sedimentary and older volcanic rocks of the Atsutla and Tuya Ranges have been intruded by relatively small and irregular granitic batholiths which have diversified compositions and textures. In many places erosion has removed the roofs and hoods of the batholiths, exposing their cores and steeply dipping marginal contacts which are generally regarded as less favourable for the occurrence of mineral deposits. However, in the north-eastern part of the Tuya Range the flat undulating upper contact of the Parallel Creek batholith and its cover of gently to moderately dipping sedimentary rocks remain in some of the peaks, ridges, and high passes (Fig. 3). In this locality some of the limestones adjacent to the intrusive have been highly altered and, in several cases, slightly mineralized.

In contrast to these geologically favourable regions, parts of the Tuya-Teslin Area offer little possibility for the discovery of lode deposits and others are definitely unfavourable. For example, the rocks of the Teslin formation are extensively drift-covered and, in the few places where they are exposed, the limestones show little or no alteration. Moreover, extensive areas of young volcanic rocks mapped as the Tuya formation are themselves unmineralized and, unfortunately, cover older rocks in which mineralization may occur.

The field-work gave evidence of copper, gold, silver, lead, zinc, iron, tungsten, and tin mineralization in a few places in the region. Although no bodies of large size or of commercial grade were found, the discoveries are briefly described because they offer some suggestion of the types of deposits which may occur in the area.

Copper float was noted at two places along the south-eastern side of Christmas Creek Valley, within the batholith. A small piece of malachite-stained white quartz containing chalcopyrite was found in diorite talus at an altitude of 4,000 feet, ¼ mile north-east of the south-western contact. An assay of this material showed that it contained 0.06 oz. of gold per ton and 2.10 oz. of silver per ton. One and one-half miles farther to the north-east, at an elevation of 4,500 feet, a small amount of bornite was found in a narrow pegmatite within a block of quartz diorite talus.

In the 5,100-foot pass between the heads of Glundebery and Sheephorn Creeks large pieces of magnetite float are abundant. Near-by, a lens of massive magnetite a few inches thick and a few feet long occurs in silicified coarse-grained granite.

Narrow veinlets of massive magnetite, only a few inches long, were observed in pegmatitic granite at an altitude of 5,000 feet on the spur 6½ miles east of the head of

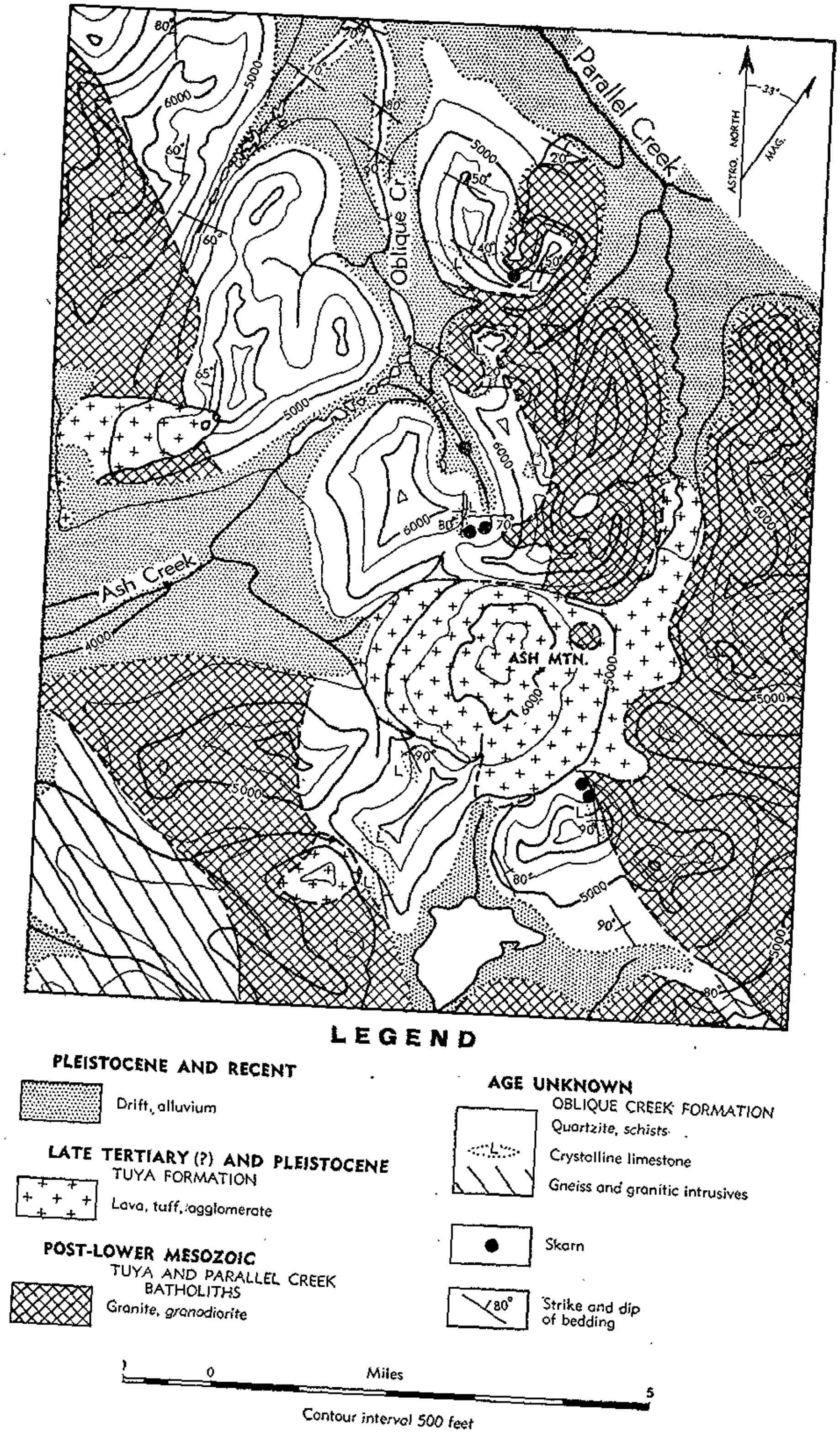


Fig. 3. Geological map of north-eastern part of Tuya Range.

Kedahda Lake. The diorite adjacent to the granite contains large disseminated grains of magnetite.

On the north-eastern slope of Coulahan Mountain, at an altitude of about 5,000 feet, float of rusty pitted quartz containing a little pyrite occurs in the greenstone talus.

In several places in the north-eastern part of the Tuya Range, where the roof of the Parallel Creek batholith is partly preserved, limestones in the cover of sedimentary rocks have been altered to skarns composed mainly of various lime-bearing silicates. At the head of the cirque, 4½ miles north of Ash Mountain (Fig. 3), skarn consisting essentially of garnet, idocrase (vesuvianite), diopside, and calcite has been sparsely mineralized with galena and sphalerite. The garnet generally occurs as large, well-formed, light brown crystals; the idocrase occurs as aggregates of small, dark brown crystals; and the calcite, which is commonly coarse-grained, appears slightly greenish because it contains numerous minute crystals of diopside.

In the pass about 1 mile north of Ash Mountain (Fig. 3), lenticular beds of grey to white crystalline limestone occur within micaceous quartzite. In several places the limestone has been silicified or converted into various types of skarn. One common variety consists mainly of well-shaped crystals of yellowish green garnet in coarsely crystalline white calcite; another conspicuous type contains pinkish garnet, clusters of radiating prisms of dark brown idocrase, and a fine-grained, bluish green mixture of calcite and diopside; another contains abundant small grains of green pyroxene and minor amounts of garnet, idocrase, and calcite. In a few places, minute grains of scheelite with bluish white fluorescence were detected in the skarns. At one point several scheelite-bearing veinlets of white quartz intersect fine-grained green skarn. Selected samples of this material were found to contain up to 2.2 per cent. of oxide of tungsten (WO_3). Spectrographic analysis of several specimens of skarn from this locality showed that two samples consisting mainly of pyroxene and garnet contained 0.3 and 0.5 per cent. of tin respectively. The tin is apparently distributed in an erratic manner, for other samples of similar material collected near-by were found to be barren or nearly so. The significance of these small amounts of tin as a guide in prospecting is unknown at present.

To the south-east of Ash Mountain skarn has been formed at one place along the contact of the Parallel Creek batholith with the Oblique Creek formation (Fig. 3). Pieces of skarn containing large amounts of magnetite and traces of scheelite were found in the talus at this locality.

At places near the south-western contacts of the Glundebery and Christmas Creek batholiths, quartz float is abundant and veins are common. The veins, occurring mainly in quartzite, are narrow and appear to lack persistence. The quartz is generally white, although locally it is somewhat iron-stained. No metallic minerals were observed, nor were there rusty cavities to suggest their former presence. Veins of glassy quartz, up to 1 foot wide, containing long prisms of black tourmaline were seen in the Kedahda formation at the contact with the Glundebery batholith, in the cirque 3 miles south-west of the westernmost of the Nazcha Hills. Along the south-western flank of the Tuya batholith a few small barren veins of glassy quartz occur in the gneisses and schists.

PLACER DEPOSITS.

Parts of the Tuya-Teslin Area are known to have been prospected for deposits of placer gold at various times in the past. In 1874, " considerable prospecting was . . . done in the region west and north-west of Dease lake; the headwaters of Tuya river and other streams flowing north-west were examined, but nothing of value was found " (Johnston, 1925, p. 41 A).

Prospectors *en route* to the Klondike in 1898 are reported to have journeyed through the area from Dease Lake and to have descended the lower part of the Jennings River by boat. Others are said to have travelled from Telegraph Creek along the Teslin Valley to Teslin Lake. Probably a few of these men panned gravels at various places along their routes, but certainly no thorough prospecting was done.

According to Gwillim (1899, p. 61 A), who visited the south end of Teslin Lake in the fall of 1899, " Prospectors at Teslin had spent the summer about Jennings River, between Teslin Lake and Dease Lake and McDame Creek. They said it showed poor prospects, little bed-rock, and that the country was mostly swamp, granite and volcanic rocks, basalt and scoria."

In the fall of 1912 placer gold was reported to have been found on Kedahda (Moosehorn) River and Tanah (Silver), Williejack (Johnson), and Trout (a tributary of the Kedahda River) Creeks along the south-western flank of the Atsutla Range. The following account of the reported discoveries was published in the Report of the Minister of Mines for 1912 (p. K 60): " In October, ' discoveries ' were claimed by and allowed to some Indians on four creeks, locally known as Silver, Trout, Johnson, and Moosehorn Creeks. . . .

" The discoverers claim to have found gold from the ' grass-roots ' down, but do not pretend to have done much prospecting. Quite a number of Indians have located claims on those creeks, and apparently have done a fairly profitable business locating for and transferring to whites. A number of miners from Atlin and vicinity have gone out there, but at present writing no reports have been received from them.*"

The Report of the Minister of Mines for 1913 (p. K 67) contains the following statement: " The excitement created last winter by the reputed discovery of placer gold on Silver, Johnson, Trout, and Moose Horn Creeks which was unduly enhanced and fostered by designing parties, induced quite a number of strangers to visit that district, but it did not take long for genuine prospectors to discover that there was not sufficient gold there to justify any excitement, or even to pay for mining what there was."

The tributaries of Williejack (Johnson) Creek which head near the margin of the Christmas Creek batholith flow across quartzites and argillites which contain many small quartz veins. Tanah (Silver) and Trout Creeks and Kedahda (Moosehorn) River, on the other hand, drain areas in which few veins were observed. The gold in Tanah (Silver) and Williejack (Johnson) Creeks is said to have been found only in the 2 to 3 miles of their courses above the Teslin Valley and not near their headwaters.

During the field-work in the summer of 1943 surface gravels from several streams in the Tuya-Teslin Area were panned, but gold was obtained in only one sample, taken on the Kedahda River about 3 miles south of the lake.

In view of the amount of prospecting which has been done in the region, it seems improbable that a large number of shallow placer deposits could remain undiscovered. On the other hand, it is unlikely that every stream in the area has been examined and it is certain that most of them have not been prospected on bed-rock except where the gravels are very shallow.

In the Atlin and Dease Lake Areas gold had become concentrated in some valley-bottoms before the beginning of Pleistocene glaciation. In places the gold which had been concentrated was dispersed by the ice, but in a few valleys parts of the pay-streaks escaped erosion and were buried by glacial drift. Large quantities of gold have been recovered from these buried pay-streaks which occur in old, high-level channels along certain present streams. The pre-Glacial gravels found in these channels are, in general, only a few feet thick and, locally, they are cemented. Rich pay-streaks have been formed on the beds and low benches of the present streams where they have cut through these gold-bearing high-level channels. In addition to the pre-Glacial and

" * Note by Provincial Mineralogist.—A private letter received from a prospector who had gone to this ' new ' find from Telegraph Creek confirms the report as given to the Gold Commissioner—in that the Indians produced coarse gold which they claimed to have obtained here; and that the Indians have staked on nearly every creek, and are holding their stakings for sale rather than to work them. This prospector is going in himself again in the spring, but says there is no one's statement—other than the Indians'—to justify any excitement, or, in fact, to guarantee that there is gold in paying quantities. It would be well to await this season's prospecting-work before forming any definite estimate of value of the Indians' stories."

Recent placers, gold is concentrated in the Dease Lake Area in glacial or (and) interglacial gravels which partly fill old stream channels and present valleys.

In the Tuya-Teslin Area no pre-Glacial or glacial stream gravels were discovered, although the search was not exhaustive. Drift-covered rock benches along the present stream-valleys, indicating the presence of old buried channels, were not observed. However, along the north-western side of Metah Mountain there is a broad, partly drift-filled, high-level valley about 4 miles long lying ½ to 1 mile south-east of Glundebery Creek. Pre-Glacial gravels may occur in the bottom of this valley, but the fact that the direction of ice movement was parallel to it does not favour this supposition.

According to Johnston (1925, p. 70 A), "Gravels that are gold bearing, at least to some extent, occur beneath lavas or (and) volcanic tuffs, in places in Stikine River valley and in the Eagle River country east of Dease Lake." In the Tuya-Teslin Area, however, no gravels were observed beneath the volcanic rocks of the Tuya formation.

Abandoned channels which have been cut into drift and, in a few places, into the underlying bed-rock have been discussed previously in this report. These channels were formed by streams flowing along the margin of a melting ice-sheet or draining glacially-dammed lakes through ice-free passes. Even if gold were abundant in the area, probably very little would have occurred in the mantle of glacial drift and shallow depth of bed-rock eroded by the streams to form these channels. Because of this, it seems unlikely that even those abandoned channels with gradients favourable for concentration would contain placer deposits of value.

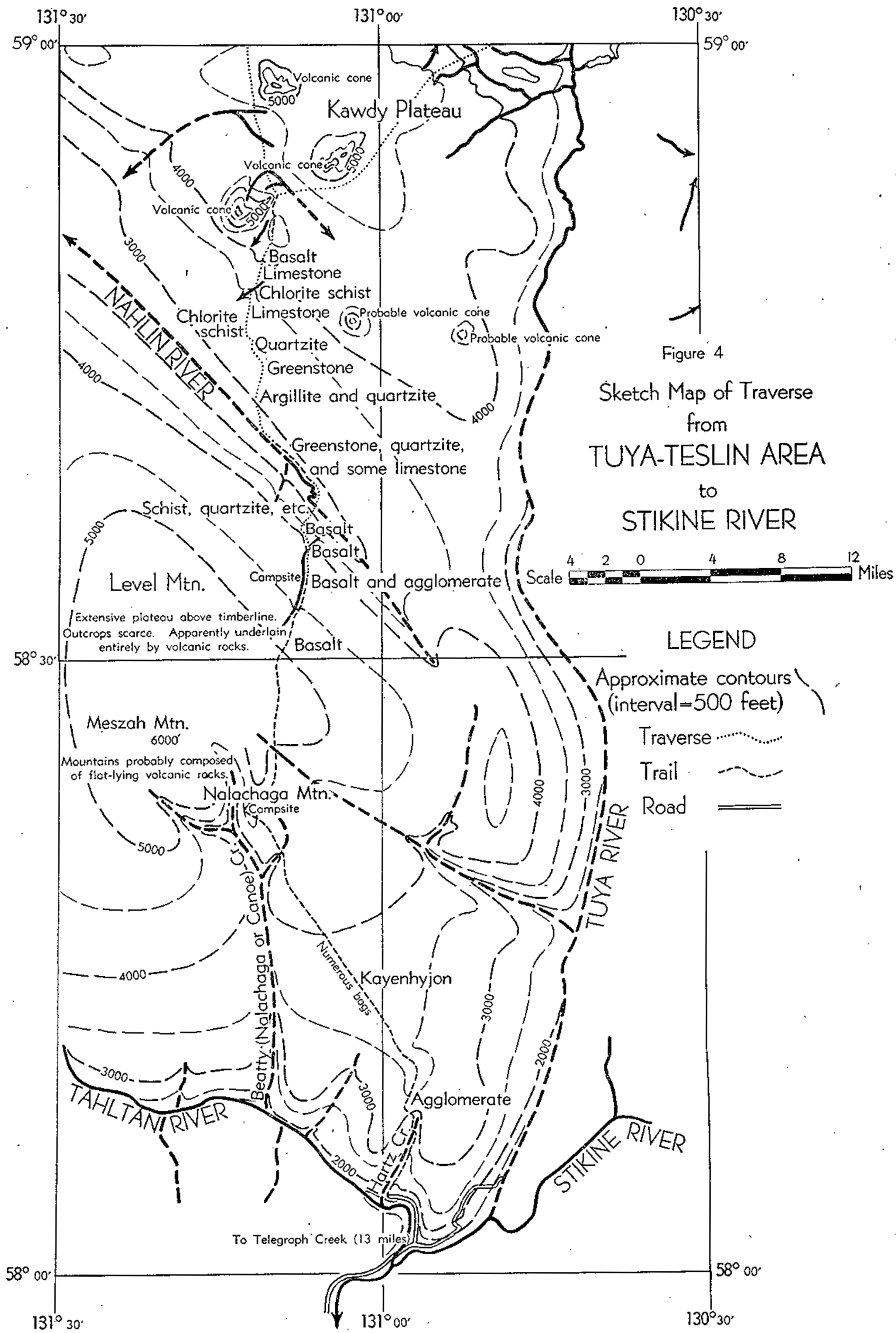


Figure 4

Sketch Map of Traverse from TUYA-TESLIN AREA to STIKINE RIVER

APPENDIX.

TRAVERSE FROM TUYA-TESLIN AREA TO STIKINE RIVER.

At the end of the field season, six days were spent in traversing from the south-western part of the Tuya-Teslin Area (59° north, 131° west) to a point on the Telegraph Creek–Dease Lake road, near the confluence of the Stikine and Tahltan Rivers (58° north, 131° west) (Fig. 4).

The first part of the region traversed lies on the southern portion of the extensive, gently rolling, unwooded area known as the Kawdy Plateau. The greater part of the plateau surface here ranges in elevation from 4,000 to 4,500 feet and is underlain by north-westerly-striking, steeply dipping, quartzites, argillites, and cherts of the Kedahda formation and by flat-lying lavas of the Tuya formation. In the area traversed, three prominent barren mountains composed of mafic pyroclastic rocks and lavas of the Tuya formation rise to heights of 1,500 to 2,000 feet above the plateau surface. Several miles to the south-east two conspicuous black conical mountains rise to elevations of 1,000 to 1,500 feet above the plateau and are probably of similar character.

The Kawdy Plateau is bounded on the south-west by the steep-walled, wooded valley of the Nahlin River, which appears to be a south-easterly continuation of the Teslin Trench. Lava of the Tuya formation was observed down to an elevation of 4,200 feet on the flank of the plateau. Below an elevation of 3,900 feet, north-westerly striking, grey limestones and interbedded chlorite schists are exposed in the valleys of deeply incised tributaries of the Nahlin River. The limestones and chlorite schists are similar in appearance to those mapped as the Teslin formation along the strike to the north-west, but the width of the belt exposed here is much narrower, possibly as a result of the overlap of the Tuya formation.

In the middle of the Nahlin Valley north-westerly-striking, steeply dipping, greenstones, quartzites, argillites, and a minor amount of limestone crop out in abundance.

The south-western wall of the Nahlin Valley rises steeply to an extensive, unwooded plateau known as Level Mountain. Flat-lying mafic lavas and pyroclastic rocks of fresh appearance crop out at an elevation of 3,900 feet on the north-eastern rim of the plateau and are exposed in small stream canyons for about 6 miles to the south-west. Although exposures were absent along the remainder of the traverse on Level Mountain, the nature of the float suggests that volcanic rocks entirely underlie this area. In the central part of the plateau, rugged mountains apparently eroded from flat-lying volcanic rocks rise abruptly to heights of 1,000 to 1,500 feet above the general surface. The report on explorations by Cockfield (1925, pp. 30 A–31 A) along the western margin of Level Mountain indicates that it is underlain there mainly by horizontal flows of andesite and basalt.

From the camp-site east of Nalachaga Mountain to the region near the head of Hartz Creek, the trail crosses a partly wooded, boggy portion of Level Mountain in which no outcrops were observed. At the head of Hartz Creek, gently dipping, fresh appearing agglomerate forms a prominent bluff and a few miles beyond at the Telegraph Creek–Dease Lake road, columnar jointed, horizontal basalt was observed to overlie greenstone.

During the traverse from the Kawdy Plateau to the Stikine River no indications of mineralization were found. Unfortunately, Level Mountain and a large part of the Kawdy Plateau are composed of young volcanic rocks which offer little hope for the discovery of mineral deposits.

Thick seams of bituminous coal occurring in a sequence of moderately folded conglomerates, sandstones, and shales are reported to crop out along the Tuya River, about 25 miles above its mouth (Featherstonhaugh, 1904, pp. G 97–G 98). It is stated that the sedimentary rocks containing the coal-seams extend for about 15 miles along the river and are flanked mainly by granite on the north and by volcanic rocks on the south.

Coal-seams are also reported to be exposed along the West Branch and other deeply incised tributaries of the Tuya River about 6 miles to the west (St. Cyr, 1898, p. 114). Float of "lignite coal" and outcrops of sandstone are said to occur about 20 miles to the south along the Tahltan River near its mouth (St. Cyr, 1898, p. 103).

It is also reported that deposits of placer gold along the lower part of the Tahltan River were worked unprofitably from 1894 until 1896 (St. Cyr, 1898, p. 106).

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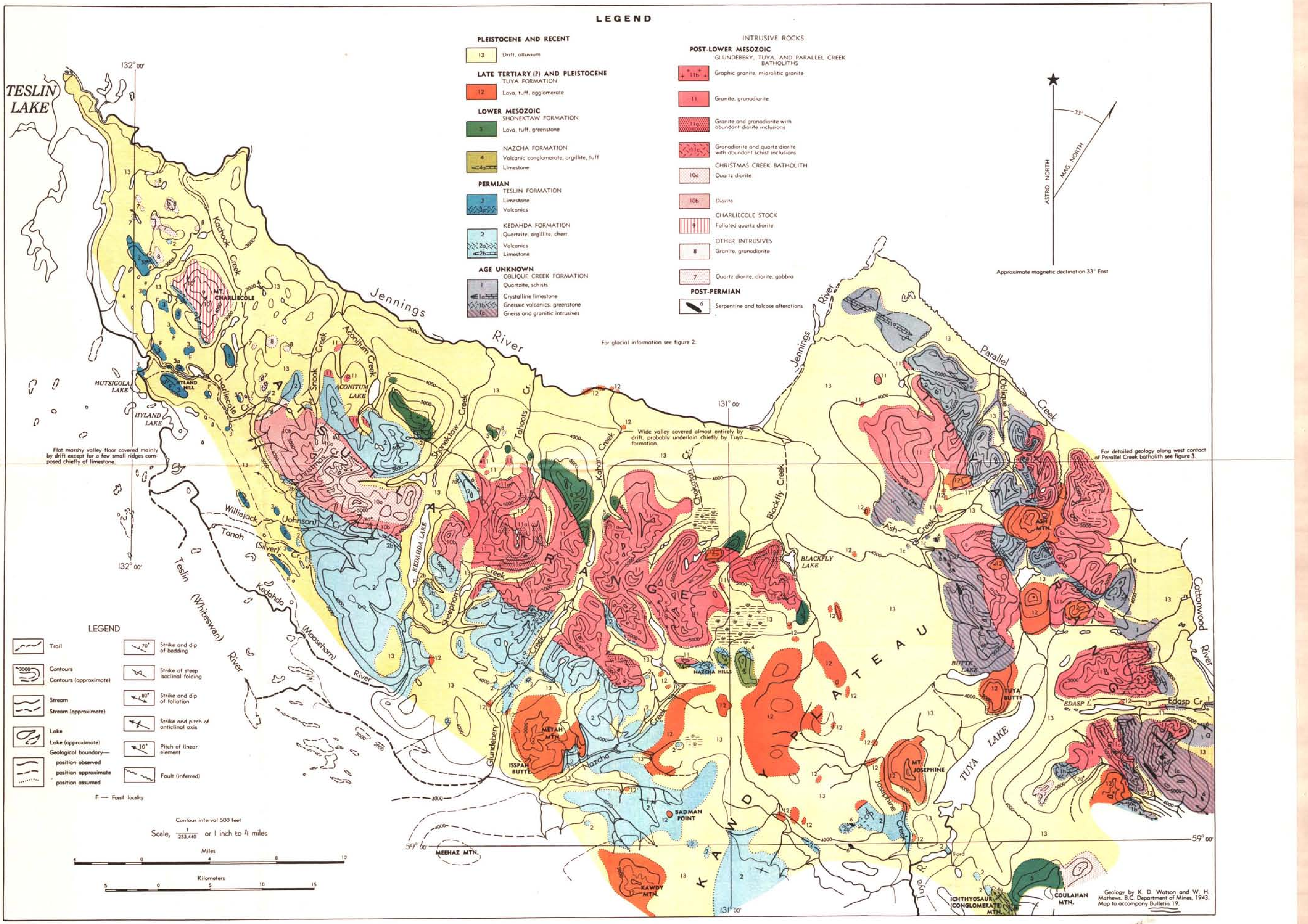
VICTORIA, B.C.:
Printed by CHARLES F. BANFIELD, Printer to the King's Most Excellent Majesty.
1944.

1,250-644-9972

1944
BRITISH COLUMBIA DEPARTMENT OF MINES
Victoria, B.C.



TUYA-TESLIN AREA

NORTHERN BRITISH COLUMBIA