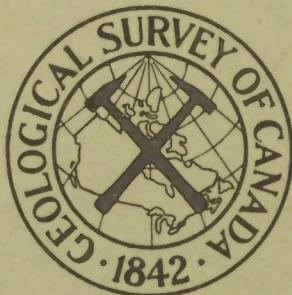


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GEOLOGICAL
SURVEY
OF
CANADA

DEPARTMENT OF ENERGY,
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PAPER 68-55

GEOLOGY OF JENNINGS RIVER MAP-AREA,
BRITISH COLUMBIA (104-O)

(Report, figure and Map 18-1968)

H. Gabrielse

**MANUSCRIPT AND
CARTOGRAPHY**

SEP 4 1969

SECTION



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OF CANADA

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BRITISH COLUMBIA (104-O)

H. Gabrielse

DEPARTMENT OF ENERGY, MINES AND RESOURCES

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ABSTRACT

The map-area, bounded by latitudes 59° and 60°N. and longitudes 130° and 132° W., lies mainly within Cassiar Mountains and Stikine Plateau.

In the northeastern part of the map-area stratified rocks range in age from Proterozoic to Carboniferous and possibly Permian. Pre-Mississippian rocks are nonvolcanic whereas the younger rocks include abundant volcanics.

Southwest of Cassiar Batholith the map-area is underlain by a great thickness of Carboniferous and Permian cherts, slates, quartzites, limestones, and volcanics in part regionally metamorphosed. Locally these rocks are overlain unconformably by Triassic volcanics and minor sedimentary rocks and by Lower Jurassic(?) greywacke and slate.

Large bodies of granitic rock ranging in age from possibly Jurassic to Late Cretaceous and Early Tertiary, and ranging in composition from diorite to granite have intruded the stratified rocks.

Late Tertiary, Pleistocene, and Recent volcanic centres have produced numerous flat-topped and conical volcanoes and gently-dipping flows.

Regional deformation occurred during post-Permian and pre-Late Triassic time and later deformation or deformations involved Upper Triassic and Lower Jurassic(?) strata.

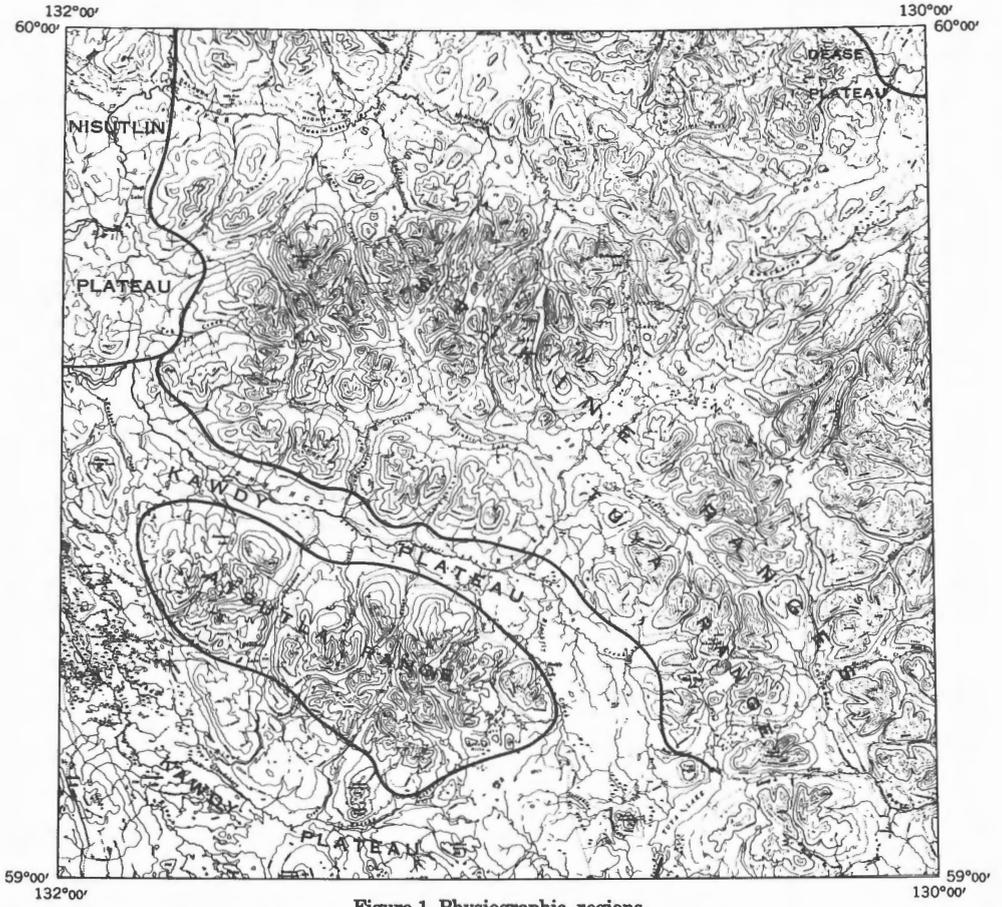


Figure 1. Physiographic regions

INTRODUCTION

Jennings River map-area (lat. 59° to 60° N., long. 130° to 132° W.) was mapped during parts of the 1965, 1966, and 1967 field seasons. The total time spent in the area was about 7 weeks.

Able assistance in the field was provided by S. L. Blusson, T. M. Gordon, R. C. Handfield, R. B. Helm, R. Ludvigsen, U. Upitis, and M. V. H. Wilson in 1965; M. A. Bjarnason, S. L. Blusson, R. G. Cavanagh, D. W. Darrah, D. G. Perry, M. E. Robinson, and D. J. Tempelman-Kluit in 1966; and S. L. Blusson, W. J. P. Crawford, C. J. Dodds, R. A. Farley, and D. G. Perry in 1967. In 1965 and 1966 transportation in the field was provided by a Bell G3 helicopter provided by Associated Helicopters, Ltd., Edmonton, Alberta and by Beaver aircraft, supplied by Watson Lake Flying Services, Ltd., Watson Lake, Yukon. In 1967 Spartan Air Services Ltd., Calgary, Alberta supplied a Bell G3B helicopter. These companies and their crews are commended for their excellent support.

Watson Lake was used as a base for supplies and communications. The northern part of the area was worked from base camps on the Alaska Highway at the west end of Swan Lake and at Mile 701 in southeastern Wolf Lake map-area. Work in the southern part of the area was facilitated by a base camp at the Cottonwood River bridge on the Cassiar-Stewart Road in southwestern McDame map-area. The town of Cassiar can also be used as a base for easy access to the southeastern part of Jennings River map-area.

Except in areas of swamp in Teslin Valley and, locally, on Kawdy Plateau, travel in the map-area is relatively easy. For prospecting purposes numerous lakes allow the efficient use of fixed-wing aircraft and the large tracts of open valleys and uplands provide pack horses with abundant routes.

PREVIOUS WORK AND ACKNOWLEDGMENTS

Great benefit was derived from previous investigations within the map-area and in adjoining map-areas. An excellent account of the geology southwest of Jennings River and southwest of Parallel Creek and Cottonwood River is contained in a report by Watson and Mathews (1944). Although most parts of this region were re-examined only minor changes have been made to Watson and Mathew's map and some of their work has been incorporated directly in the present compilation.

The geology of adjoining areas is included in reports by Aitken (1959) on Atlin map-area (104N), Mulligan (1963) on Teslin map-area (105C), Poole (1956) and Poole et al. (1960) on Wolf Lake map-area (105B), Gabrielse (1963) on McDame map-area (104P), and Gabrielse and Souther (1962) on

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Ottawa 4, Ontario.

Dease Lake map-area (104J). In particular, Poole's work along the British Columbia-Yukon Territory boundary (1956), including some mapping near the Alaska Highway in northwestern Jennings River map-area, contributed much useful information on the late Paleozoic stratigraphy of the region. Poole (1956) also recognized the unconformity below Lower Jurassic(?) strata north of McNaughton Creek and described in some detail the shear zone along the western border of Cassiar Batholith.

The writer is grateful to J. E. Reesor for observations and discussions on granitic rocks and to J. W. H. Monger for information concerning late Paleozoic stratigraphy of Stikine Plateau.

PHYSICAL FEATURES

The map-area lies mainly within the Stikine Ranges of Cassiar Mountains, and Kawdy Plateau, a subdivision of Stikine Plateau (Holland, 1964) (see also Fig. 1). In the northwest the area includes a small part of Nisutlin Plateau and in the northeast a small part of Dease Plateau. Atsutla Range forms a distinct mountain group within Kawdy Plateau.

Cassiar Mountains, underlain to a large extent by granitic and metamorphic rocks, are characterized by moderately rugged topography, strongly sculptured by alpine glaciation. The general aspect of ruggedness is modified somewhat, however, by the numerous, high-level open valleys. Maximum local relief is about 3,500 feet and the highest peak, located southeast of Iverson Creek, is just over 7,500 feet.

Kawdy Plateau is a remarkable broad, rolling upland area of very subdued topography sloping gently to the west, north, and east from a maximum general elevation of about 5,000 feet between Tuya Lake and Teslin Valley. Where characteristically developed west of Tuya Lake the plateau, with local relief commonly less than a few hundred feet, is essentially a mature erosion surface truncating tightly folded strata of the Kedahda and Teslin formations. Flat-lying volcanic rocks have been extruded onto the erosion surface and several flat-topped or conical volcanoes have produced the only significant relief.

Streams incised only a few feet commonly reveal bedrock and on the higher parts of the plateau the drift appears to be relatively thin. Because of the low relief, however, good exposures of bedrock are mainly confined to stream valleys and canyons cut into the western part of the plateau flanking Teslin Valley.

The gentle northerly slope of Kawdy Plateau is continuous with the extensive flat-bottomed high-level valley at the divide between Jennings and Little Rancheria rivers in Cassiar Mountains. Much of the divide is probably underlain by flat-lying volcanic flows. A view southwestward up Little Rancheria Valley from a point 6 miles east of McNaughton Lakes shows the striking contrast between a U-shaped valley to the northeast and the higher level flat-bottomed valley underlain by volcanic flows to the southwest.

Atsutla Range, the core of which is underlain by granitic rocks of the Christmas Creek and Glundebery Batholiths, rises from Kawdy Plateau to a maximum elevation of slightly more than 7,000 feet. The central part of the range is moderately rugged, having been strongly sculptured by alpine

glaciation. The southwestern flank of the range, however, although deeply incised by streams, retains remnants of the gently sloping erosion surface typical of Kawdy Plateau farther southeast.

The divide between Pacific and Arctic drainage lies within Cassiar Mountains. The westerly draining Swift, Jennings, and Teslin rivers occupy broad, open valleys that contain the only extensive tracts of forest in the map-area.

Teslin Valley, one of the remarkable linear trenches in the northwestern Cordillera, extends northwesterly from the headwaters of Teslin River for about 250 miles to Yukon River. In Jennings River map-area the entire valley appears to be underlain by strata of the Kedahda and Teslin formations.

The easterly draining Tootsee, Little Rancheria, Blue, and Cottonwood rivers, except near their headwaters, flow in much narrower and more deeply incised valleys than do the streams flowing westerly. All cut directly across the rugged axial core of Cassiar Mountains.

GLACIATION

The distribution of glacial erratics and the orientation of striae and drumlinoid ridges suggest that the divide of an extensive ice-sheet ran diagonally across the region from near Tuya Lake to the northwestern corner of the map-area. Evidence for possible earlier glaciations has been largely obliterated by this latest advance which appears to have covered all of the peaks in the area.

Watson and Mathews (1944) have shown that ice moved in a direction about south 70 to 80 degrees west across Kawdy Plateau and the southern part of Atsutla Range whereas in the northwestern part of Atsutla Range the general movement was about south 45 degrees west. A general northeasterly movement of high-level ice took place in Tuya Range and in the northern and eastern parts of the map-area. Possibly during the waning stages of glaciation ice moved north-northwesterly down Teslin Valley.

The map-area contains abundant, spectacular features resulting from alpine and valley glaciation. Most of the major lakes are ponded by glacial deposits. Eskers, esker complexes, kame-and-kettle topography, moraines, shorelines of glacial lakes, abandoned deltas, and terraces are widespread.

GENERAL GEOLOGY

In the northeastern part of the map-area stratified rocks range in age from Proterozoic to Carboniferous and possibly Permian. The stratigraphic succession is very similar to that in the continuation of McDame synclinorium to the southeast in McDame map-area (Gabrielse, 1963). Pre-Mississippian rocks are nonvolcanic whereas the younger rocks include abundant volcanics.

Southwest of Cassiar Batholith the map-area is underlain by a great thickness of Carboniferous and Permian cherts, slates, quartzites, limestones, and volcanics in part regionally metamorphosed. Locally these rocks are overlain unconformably by Triassic volcanics and minor sedimentary rocks and by Lower Jurassic(?) greywacke and slate.

TABLE OF FORMATIONS

Era	Period or Epoch	Group or Formation	Map-unit	Lithology	Thickness (feet)	
Cenozoic	Pleistocene and Recent		28	Unconsolidated glacial, fluvioglacial and alluvial deposits		
	Tertiary(?) Pleistocene and Recent	Tuya Formation	27	Lava, tuff, agglomerate		
Mesozoic	Upper Cretaceous	Glundebery Batholith	26	Hornblende granite, miarolitic granite porphyry, aplite, pegmatite, syenite; dioritic inclusions		
	Mid-Cretaceous	Tuya and Parallel Creek batholiths	25	Biotite granite, hornblende-biotite quartz-monzonite		
		Klinkit Batholith	24	Foliated biotite quartz monzonite		
		Cassiar Batholith	23	Biotite quartz monzonite, muscovite quartz monzonite, granodiorite		
	Lower(?) and Middle(?) Jurassic	Simpson Peak and Nome Lake batholiths	22	Hornblende-biotite quartz monzonite, granodiorite; hornblende monzonite		
		Christmas Creek Batholith	21	Quartz diorite, diorite, minor quartz monzonite		
		Charlie Cole Stock	20	Foliated quartz diorite		
		Plate Creek Stock	19	Quartz diorite, granodiorite, diorite		
	Lower Jurassic(?)		18	Feldspathic quartzite, greywacke, grit, argillite, slate	1,000 +	
	Upper Triassic	Shonektaw Formation	17	Augite porphyry, agglomerate	1,000 +	
		Nazcha Formation	16	Volcanic conglomerate, tuff, agglomerate, feldspar porphyry, siltstone, hornfels	500 +	
	Paleozoic	Permian		15	Greenstone, tuff, breccia, pillowed lava	
			Teslin Formation	14	Limestone, minor pillowed basalt	500 +
Carboniferous(?) and Permian		Kedahda Formation	13	Chert, quartzite, argillite greenstone, limestone, hornfels	7,500 ±	

TABLE OF FORMATIONS (Cont'd)

Era	Period or Epoch	Group or Formation	Map-unit	Lithology	Thickness (feet)
Paleozoic	Carboniferous (mainly Pennsylvanian(?))		12	Chert, argillite, slate, quartzite, greenstone, limestone and dolomite, conglomerate, hornfels	7,000+
	Carboniferous		11	Meta-tuff, tuff, argillite, hornfels, chert, limestone, conglomerate, quartzite	5,000+
		Oblique Creek Formation	10	Gneiss, schist, meta-chert, quartzite, meta-diorite, crystalline limestone, greenstone, granitic sills and dykes, hornfels	
	Carboniferous (mainly Mississippian(?))	Big Salmon Complex	9	Quartz-albite-mica gneiss, albite-actinolite schist, quartz-chlorite-epidote-albite gneiss, meta-chert, limestone, skarn, hornfels, dolomite	
	Mississippian(?) and later		8	Serpentinite, dunite, peridotite, steatite	
	Mississippian (in part or entirely)	Sylvester Group (upper part)	7	Massive greenstone, agglomerate; minor chert, meta-diorite	1,500 +
	Upper Devonian and(?) Mississippian	Sylvester Group (lower part)	6	Slate, argillite, chert, siltstone, chert arenite, greywacke, chert-pebble conglomerate; minor limestone	3,000 +
	Middle Devonian	McDame Group	5	Fetid dolomite and limestone	300 +
	Silurian and Devonian		4	Upper division: laminated dolomite Lower division: sandy dolomite, sandstone	700 +
	Ordovician and Silurian	Kechika Group (in part)	3	Black, graptolitic shale, platy siltstone	100-200 +
	Cambrian and(?) Ordovician	Kechika Group (lower part)	2	Thin-bedded calcareous phyllite, phyllitic limestone, hornfels, skarn	1,000
Paleozoic and Proterozoic	Cambrian and Hadrynian	Atan and Good Hope groups	1	Cordierite-biotite hornfels dolomite, limestone, skarn quartzite	2,000 +

Large bodies of granitic rock ranging in age from possibly Jurassic to Late Cretaceous or Early Tertiary, and ranging in composition from diorite to granite have intruded the stratified rocks.

Late Tertiary, Pleistocene, and Recent volcanic centres have produced numerous flat-topped and conical volcanoes and gently-dipping flows.

HADRYNIAN AND LOWER CAMBRIAN

Good Hope and Atan Groups (Unit 1)

Very little information can be obtained on these rocks within the map-area. The strata occur within the contact-metamorphic aureole of the Cassiar Batholith with the result that carbonate rocks are represented by coarsely crystalline limestone and skarn, argillaceous rocks by hornfels, and sandstones by completely recrystallized quartzites.

The thickest exposed sequence of these rocks outcrops on a northwest-trending ridge east of the headwaters of Iverson Creek. There, a monotonous sequence of rusty weathering hornfels and quartzites with one or two thin ribs of carbonate rocks comprises a section possibly as much as 2,000 feet thick. The sequence dips steeply south but whether it is overturned is not known.

CAMBRIAN AND ORDOVICIAN

Kechika Group, lower part (Unit 2)

Poorly exposed, thin-bedded, grey, buff, and cream weathering calcareous phyllites and argillaceous limestones outcrop locally along a large easterly flowing creek in the northeast corner of the map-area. Thinly banded calc-silicate and hornfelsic rocks occur along the eastern border of Cassiar Batholith west of Tootsee River. In places some limestone of the Lower Cambrian Atan Group may be included in the map-unit.

To the southeast in McDame map-area correlative rocks on the northeast flank of McDame synclinorium are about 1,000 feet thick but to the north in southeastern Wolf Lake map-area they may be considerably thicker (Poole, 1956).

The age of unit 2 can only be stated with reference to older and younger strata - the strata are regionally underlain by Lower Cambrian limestones and overlain by Lower Ordovician shales. The writer previously considered these strata to include Middle Cambrian rocks on the basis of a trilobite collected in the southern part of McDame map-area (Gabrielse, 1963, p. 39) but further examination of the fossil by A. R. Palmer (personal communication, 1966) has confirmed a Trempealeauan (Upper Cambrian) age and thus nowhere is the presence of Middle Cambrian rocks proven in the Kechika Group.

ORDOVICIAN AND SILURIAN

Kechika Group, in part (Unit 3)

Black, graphitic, incompetent shales (upper part of Kechika Group) overlain by well-bedded platy siltstones outcrop on both limbs of the McDame synclinorium in the northeast corner of the map-area. The rocks are generally not well exposed except where they have been hornfelsed near Cassiar Batholith northwest of Tootsee River. The most complete unmetamorphosed sequence is probably the one exposed along the large creek in the northeast-ernmost part of the area.

The black shales are thin-bedded and friable thus producing abundant fine talus. Locally, probably because of a significant silt content, the beds are platy.

Blocky, metamorphosed, very well bedded siltstones overlie hornfelsed black shales northwest of Tootsee River. The rocks weather dark grey and are extremely compact and tough. The total thickness of the siltstones and the underlying shales can be little more than 100 feet.

To the north in southeasternmost Wolf Lake map-area Poole (1956) described a section of platy, thin-bedded and laminated dolomitic siltstone at least 200 feet thick correlative with the siltstones of unit 3 in Jennings River map-area. Poole lists the following fauna identified by T. E. Bolton:

Monograptus priodon (Bronn.) group

M. vomerinus (Nicholson) group

M. bohemicus (Barrande) group

Monograptus sp. (n. sp. ?)

Bolton concluded that the fossils were of Silurian, probably late Llandovery age. Late Llandovery or early Wenlock graptolites were collected from similar, homotaxial siltstones on the northeast limb of McDame synclinorium in McDame map-area (Gabrielse, 1963, p. 48).

Poorly preserved biserial graptolites were noted in shales of the lower part of unit 3. Early and Middle Ordovician graptolites are present in homotaxial strata in McDame map-area where an unconformity occurs at the base of the overlying siltstones.

SILURIAN AND DEVONIAN

Unit 4

A distinctive sequence of light grey weathering, resistant, very well bedded dolomites, sandy dolomites, and dolomitic sandstones, comprising two well-defined, unnamed formations outcrops on the limbs of McDame synclinorium overlying the mainly recessive rocks of unit 3. These rocks, changing very little in lithology and thickness, can be followed southeasterly in Stikine Ranges for more than 100 miles.

The lower formation of unit 4 comprises as much as 400 feet of sandstone, dolomitic sandstone and sandy dolomite. This unit is informally referred to as the 'tapioca-sandstone' with reference to the common occurrence of rounded, translucent, 'floating' sand grains in a carbonate or silica matrix. The sand grains are remarkably uniform in size averaging perhaps less than 2 mm in diameter. Bedding is conspicuous in part because of

contrasting amounts of sand in adjacent beds, and ranges from a few inches to several feet thick. Crossbedding on a scale of 6 inches to 18 inches between topset beds is strikingly developed in places.

The upper formation of unit 4 consists of very well bedded and laminated grey dolomite. The dolomite, apparently gradational with the underlying sandy rocks, is several hundred feet thick.

Northwest and south of Tootsee River rocks of unit 4 are cut by greenstone dykes locally as much as 10 feet wide. The dykes are in part highly schistose where they coincide with fault zones.

No fossils have been found in these rocks or homotaxial strata in Cassiar Mountains. In many respects they resemble Upper Silurian(?) and Lower Devonian strata exposed in parts of Mackenzie and Rocky Mountains.

MIDDLE DEVONIAN

McDame Group (Unit 5)

Dark grey, fetid dolomites and limestones of the McDame Group represent the uppermost beds of the Devonian carbonate sequence in Cassiar Mountains. The group forms an excellent marker because of its distinctive lithology and fauna.

Characteristically the McDame Group comprises light and dark grey to almost black, finely crystalline dolomites and calcitic dolomites in beds from a few inches to several feet thick. Abundant, poorly preserved fossils consist of white dolomite and in places give rise to beds of 'spaghetti stone' in which the white dolomite remains of rod-like organisms occur in a dark grey or black dolomite matrix. White dolomite also is ubiquitous in vugs and fractures. Near the contact with the overlying Sylvester Group along the large stream in the northeasternmost part of the map-area, vugs are locally filled with translucent barite crystals.

Dolomite breccia, probably of intraformational origin, is not uncommon in the McDame Group. The presence of dolomite fragments may be emphasized by the contrasting colours of matrix and fragments - the matrix commonly being lighter in colour.

As in McDame map-area the contact between the McDame Group and the overlying Sylvester Group is almost invariably a fault. This might be why the twofold division of the McDame Group comprising a lower dolomite formation and an upper limestone formation, typically exposed near McDame, is not apparent in Jennings River map-area. The alternative is that the limestone was originally not as continuous as the underlying dolomite.

Fossils collected by C. W. Ball on the Silvertip property about 3 1/2 miles northeast of the east end of Tootsee Lake (Lat. 59° 55' N., Long. 130° 21' W.) were identified by D. J. McLaren as follows:

- Amphipora sp.
indeterminate stromatoporoids
- Coenites sp.
- Dendrostella sp.
- Spongophyllum? sp.
- Stringocephalus sp.

McLaren comments that these fossils are of late Middle Devonian (Givetian) age.

UPPER DEVONIAN AND(?) MISSISSIPPIAN

Sylvester Group, lower part (Unit 6)

The lower part of the Sylvester Group is well exposed east of Tootsee River. There the strata are more than 3,000 feet thick and consist of interbedded slate, argillite, chert, siltstone, chert arenite, greywacke, chert-pebble conglomerate and minor limestone. Typically, the lower part of the unit is fine grained and the basal beds are commonly black slates and argillites, locally graphitic. Ribbon cherts are common. They consist of beds of grey, dark grey, and black chert ranging from less than 1 inch to 6 inches thick interbedded with thinner beds of argillite.

In the upper part of unit 6 argillites are interbedded with greywackes, grits, and conglomerates. Chert grains and pebbles, ranging from angular to subangular in finer-grained clasts to subrounded in coarser-grained clasts, are dominant. Black slate or argillite chips are ubiquitous and in some rocks black, vitreous quartz grains are conspicuous.

Northeast of the peak, elevation 6,446 feet, east of Tootsee River, grey, fine-grained limestone, in part cherty, is interbedded with shale, chert, and phyllite near the top of unit 6. The limestone occurs mainly near the base of a predominantly green-grey argillite or mudstone sequence more than 700 feet thick.

In places, sequences of laminated slate, siltstone and greywacke display graded bedding and sole markings. Poorly preserved plant remains were noted at several localities.

Precise dating of the lower part of the Sylvester Group is not yet available. The unit is post-Middle Devonian (Givetian), and, on the basis of regional correlations, pre-late Mississippian. Much of the sequence may be of late Devonian age as there is no evidence of a marked hiatus at the base.

Mississippian (in part or entirely)
Sylvester Group, upper part (Unit 7)

The youngest sequence of Paleozoic strata in McDame synclinorium includes more than 1,500 feet of massive volcanic rocks, mainly altered to greenstone. The volcanics include flows, breccias, tuffs, and agglomerates, commonly fine- to medium-grained. Reddish and purple weathering varieties are present locally. Volcanic rocks throughout McDame synclinorium have undergone low-grade metamorphism so that pyroxene has been largely altered to chlorite and calcic plagioclase to albite. Relict ophitic textures are common. The pervasive alteration to greenstone masks the recognition of primary structure and partly accounts for the massive appearance of these rocks.

Near ultramafic bodies unit 7 may include medium- to coarse-grained rocks possibly originally of dioritic composition. Strongly gneissic amphibolites have been developed locally along the southern border of the ultramafic body along the east boundary of the map-area north of Blue River.

On the basis of mapping by Poole (1956) in Wolf Lake map-area two areas west of Cassiar Batholith are believed to be underlain by rocks of the Sylvester Group. Chlorite schists, quartz-chlorite schists and metavolcanic

rocks are interbedded with quartz-chlorite-sericite schists, quartzites and meta-cherts along the northwestern border of the batholith. Included in this assemblage locally are highly sheared, medium- to coarse-grained sills(?) of leucocratic granitic rock. East of Smart River a sequence of sheared greywacke, conglomerate, quartzite, greenstone, and banded tuff is more than 2,000 feet thick. The greywacke and conglomerate are characterized by stretched clasts of quartzite, greenstone, chert, and black slate. In places, grey-green, silt-sized greywacke has a distinct platy parting parallel with bedding.

The age of unit 7 can be established only within broad limits. In south-central McDame map-area (Gabrielse, 1963) a very thick succession of volcanic and sedimentary strata assigned to the Sylvester Group is overlain, apparently unconformably, by limestones of Late Mississippian (Chesteran) age (Mamet, personal communication, 1968). A Mississippian age for the underlying volcanic rocks in this area, therefore, is certain. Northwest of Blue River, however, work by the writer (Gabrielse, 1963, p. 13; Wolfe, 1965; and J.W.H. Monger, personal communication, 1967) has shown that a limestone unit containing Late Permian (Guadalupian) fusulinids (C.A. Ross, personal communication, 1967) is overlain by a sequence of andesitic or basaltic volcanic rocks. It is not known how widespread the Permian (or younger?) volcanics are in the northwestern part of the McDame synclinorium. Another unsolved problem is the relationship of Permian to older rocks in this area. Although a major unconformity may be present at the base of Permian rocks, it seems highly unlikely that Permian volcanics in the northwestern part of McDame synclinorium would eventually overlie paraconformably only strata of the lower part of the Sylvester Group over so wide an area. Therefore the volcanic rocks of unit 7 in Jennings River map-area are tentatively considered as Mississippian, belonging to the lower sequence of volcanic rocks in McDame synclinorium.

Mississippian(?) and later (Unit 8)

Highly serpentinitized ultramafic rocks are closely associated with volcanic rocks of unit 7. On the peak, elevation 6,446 feet, east of Tootsee River, a serpentinite flow or sill, possibly about 30 feet thick, overlies a flow of similar thickness comprising fine-grained, green volcanics. Overlying the ultramafic body is a sequence of green and red weathering volcanics with associated chert and minor reddish crystalline limestone. The volcanics form the basal part of the upper Sylvester Group. The serpentinite weathers light green to dark green, is massive, and contains abundant bastite crystals pseudomorphous after rhombic pyroxene. A thrust fault, marked by sheared and slickensided serpentinite, offsets the sequence stratigraphically by about 100 feet.

On the north-south trending ridge about three miles south of the locality described above, a flow or sill of dark green serpentinite, about 100 feet thick, overlies 50 feet of grey to purple-grey fine-grained volcanic rock possibly representing a single flow. Light green, brown weathering, aphanitic to very fine grained volcanic rocks, in part agglomeratic, overlie the serpentinite. In this locality the serpentinite is mainly massive and contains abundant coarse bastite.

Rocks similar to those described above, locally including meta-diorite, outcrop on the ridge to the northeast, and farther south on the northeast trending ridge north of Little Rancheria River.

Ultramafic rocks along the eastern border of the map-area east of Iverson Creek are part of a relatively large body named the "The Blue River Ultramafic Intrusion" by Wolfe (1965). The body is unusual in that it includes abundant fairly fresh dunite and peridotite, displays an amphibolite aureole where in contact with volcanic rocks, and, in places, clearly shows the effects of metamorphism related to the emplacement of Cassiar Batholith. In places metamorphism of the ultramafic rocks has produced talcose dunite and tremolite-bearing dunite and peridotite adjacent to the granitic rocks. In several other localities 'regenerated' dunite has been developed from serpentinite (Gabrielse, 1963; Wolfe, 1965).

In all cases described above the ultramafic rocks occur a short distance stratigraphically above the base of the lowest volcanic units of the Sylvester Group with which they are probably coeval.

Highly altered pods, lenses, and elongate sill-like bodies of ultramafic rocks, ranging from a few feet to a few miles in length and up to 400 feet in width, occur in the late Paleozoic strata west of Cassiar Batholith. Except for the northwest part of the body northeast of Kedahda Lake and the small body southwest of Mount Josephine which include massive and sheared green serpentinite, the ultramafics have been metamorphosed to rocks comprising talc, actinolite, serpentine and carbonate. Although these ultramafic rocks are included in unit 8, no direct correlation with ultramafic rocks east of Cassiar Batholith is demonstrable.

CARBONIFEROUS AND PERMIAN

Probably more than 15,000 feet of sedimentary and volcanic rocks and their metamorphic equivalents, ranging in age from Mississippian(?) through Permian, underlie large areas west of Cassiar Batholith. Although gross aspects of the stratigraphic succession can be established, generally poor outcrop, complex structure, lack of persistent marker units, effects of regional and contact metamorphism, paucity of fossils, and widespread disruption by large granitic bodies, combine to make correlations extremely difficult.

In general, mapping in Jennings River map-area supports the interpretation by Poole (1956) and Poole *et al.* (1960) that the stratified rocks in southwestern Wolf Lake map-area and northwestern Jennings River map-area occur in a regional, northwesterly trending synclinorium and that the oldest exposed rocks (Big Salmon Complex, in part) are probably correlative with the upper part of the Sylvester Group exposed east of Cassiar Batholith. Rocks probably mainly of Carboniferous age, outcrop west of Klinkit Lake and northeast of Parallel Creek and may comprise much or all of the Oblique Creek Formation. Strata of definite Permian age are confined to the area southwest of Jennings River and west of Tuya Lake.

Big Salmon Complex (Unit 9)

The Big Salmon Complex (Mulligan, 1963) comprises a thick sequence of metavolcanic and metasedimentary rocks continuous with a belt of regionally metamorphosed rocks known as the Yukon Group to the north and west of Teslin map-area in Yukon Territory. In Jennings River map-area the name is restricted mainly to those rocks that show a strong metamorphic development of micaceous minerals and hence are distinctly schistose or gneissic.

West of Smart River, where the Big Salmon Complex is best exposed, it includes several thousand feet of strongly recrystallized rocks displaying a wide range in texture and composition. Possibly the most abundant rocks are green-grey quartz-albite-muscovite gneiss, grey quartz-albite-epidote-mica gneiss, and dark green albite-epidote-actinolite-chlorite-mica schist. Some quartz-albite-epidote-biotite gneisses are strikingly banded and probably represent metamorphosed tuffs. In the coarser gneisses albite and biotite porphyroblasts attain a length of 2 mm.

Quartzites, in places strongly muscovitic, are common and range from light grey to a distinctive pink. Crystalline limestone, locally with calc-silicate skarn is present in several localities. Thinly banded meta-cherts with partings of muscovite are widespread.

Evidently, the Big Salmon Complex represents a sequence of volcanoclastic, sedimentary, and fairly massive volcanic rocks that have been regionally metamorphosed. The zone of highest grade metamorphism coincides approximately with the core of a major southeasterly plunging anticline. East of Smart River a transition from schists and gneisses to relatively little metamorphosed greywacke and greenstone, herein included in the Sylvester Group, is evident. Similarly, east of Teslin Lake in Atlin map-area and west of the north-south flowing reaches of Swift River, banded metagreywackes and associated rocks are apparently less metamorphosed than those farther east (Aitken, 1959).

The stratigraphic position of the Big Salmon Complex suggests that it is at least partly correlative with the upper part of the Sylvester Group and thus is probably in part of Mississippian age. Conceivably, older strata may be present.

Potassium-argon determinations of 222, 214, and 194 m. y. on muscovites from the Big Salmon Complex suggest that at least one significant period of metamorphism occurred during Middle or Early Triassic time and perhaps somewhat later.

Oblique Creek Formation (Units 10a, 10b, 10c)

Regionally metamorphosed sedimentary and volcanic rocks that outcrop east and southeast of Klinkit Lake are assigned to the Oblique Creek Formation (Watson and Mathews, 1944). Correlative rocks may be included in the terrain near and west of Klinkit Lake but the stratigraphy there is unique in several aspects and no general correlation is possible at present.

Northeast of Parallel Creek the Oblique Creek Formation comprises a complexly folded succession of grey and green-grey phyllitic meta-cherts, grey micaceous quartzites, creamy crystalline limestone, phyllitic argillite, chlorite schist, graphitic black chert and argillite, and metavolcanic rocks.

West of the headwaters of Cottonwood River fairly massive greenstone, in part vesicular, and meta-diorites are present locally. In general, however, volcanic rocks do not appear to be abundant.

Green-grey and grey, thin-bedded meta-cherts are common. The rocks typically consist of recrystallized chert beds a few inches to a fraction of an inch thick with phyllitic or schistose partings. Crumpling on a scale of inches is widespread but in places isoclinal folds on a scale of several feet were noted.

Blocky, grey, sugary, even-grained quartzites are also abundant. Some of the rocks are distinctly laminated whereas others are more homogeneous and massive. The quartzites are gradational through argillaceous quartzites to rocks which are dominantly argillaceous.

In places fairly pure argillaceous beds are represented by phyllitic, incipiently spotted slates. West of the fault on the ridge west of the headwaters of Toozaza Creek a southwesterly dipping sequence of dark grey, dominantly andalusite hornfels may be as much as 2,000 feet thick.

Rocks similar to those described above occur in the eastern and central parts of Tuya Range. The main difference appears to be absence of significant metavolcanic rocks and the presence of one or more thick crystalline limestone beds. Further metamorphism near granitic rocks has resulted in a local development of calc-silicate skarns.

More highly metamorphosed rocks of the Oblique Creek Formation outcrop in the western and southern parts of Tuya Range and along and near the lower reaches of Cottonwood River. Grey, foliated quartz-muscovite-biotite gneisses in Tuya Range are interleaved with numerous granitic sills ranging from a few feet to more than 50 feet thick. Rocks in the Cottonwood Valley comprise garnet-biotite-quartz schists and gneisses, biotite hornfels, and at least one bed of crystalline limestone about 150 feet thick. Near Cassiar Batholith these rocks are also interleaved with granitic sills. As noted by Watson and Mathews (1944), the more highly metamorphosed rocks of the Oblique Creek Formation are in areas that include widespread granitic sills.

No precise limits can yet be placed on the age of the Oblique Creek Formation. The unit as a whole has much in common with Carboniferous and possibly Permian strata elsewhere in the map-area. Dating the metamorphism of the formation by K/Ar methods is difficult because of widespread younger granitic intrusion. It may be assumed that a determination of 178 m. y. on biotite from rocks outcropping in northeasternmost Dease Lake map-area represents a minimum age.

Unit 11

Probably the best exposed succession of late Paleozoic rocks in the map-area outcrops in a southeasterly plunging anticline northwest of Klinkit Lake. A generalized sequence on the ridge east of the headwaters of Butsih Creek, described from the base upwards, is as follows:

1. Black to dark grey rusty weathering argillite and hornfels, in part massive; more than 1,000 feet thick.
2. Medium to dark grey, fine-grained, laminated, argillaceous and carbonaceous limestone interbedded with minor dark grey argillite; about 500 feet thick.

3. Granule, pebble, and cobble conglomerate; lower part has pebbles and granules of white, fine- to medium-grained quartzite, chert, grey phyllite, and quartz-mica schist in a coarse-grained, medium grey limestone matrix; predominant phyllite and schist fragments are flattened and elongated parallel with foliation; upper part has a siliceous matrix; on ridge to southeast conglomerate is much coarser and includes rounded quartzite and dolomite cobbles in a tough, green-grey, fine- to medium-grained quartzitic sandstone matrix; sandy orange dolomite clasts, as much as 2 feet in diameter display excellent crossbedding; about 400 feet thick.
4. Black, rusty weathering argillite, thin-bedded chert, minor epidotized banded tuff; more than 1,000 feet thick.
5. Dark grey to black, fine-grained, argillaceous limestone, fairly massive; about 50 feet thick.
6. Interbedded, banded, grey and green weathering, epidotized tuffs, commonly showing an incipient development of biotite or hornblende, and well-banded, pale mauve chert; tuffs locally display excellent graded bedding; some even-grained, fine-grained, massive green volcanic flows or sills; more than 1,500 feet thick.

Southeast of the mouth of Butsih Creek a sequence of thinly bedded hornfels and calc-silicate rocks includes a distinctive member of thinly bedded to laminated, grey-green, very tough, metamorphosed calcareous sandstone.

Several thousand feet of mainly massive but in part well-banded chert outcrops on a ridge 7 miles north-northwest of the west end of Klinkit Lake. The cherts are overlain by more than 500 feet of medium grey, finely crystalline, medium-bedded, fossiliferous limestone. Similar limestones outcrop on the ridge immediately north of Klinkit Lake where they are associated with chert and chert breccias.

Northwest of Klinkit Batholith meta-tuffs, banded on a scale of 1/2-inch to a few inches, are abundant. Typically the bands range in colour from pale yellow-green to dark green. In places the banding is emphasized by concentrations of biotite.

Spectacularly folded greenstones and cherts are exposed on a ridge east of the mouth of Kachook Creek. The greenstones, in part probably tuffaceous, are cut by fresh dark green aphanitic volcanic rocks. About two miles to the north-northeast another ridge is underlain by blocky, vitreous quartzite interbedded with black argillaceous chert and cherty argillite.

Although limestones near Klinkit Lake have yielded an abundant coral fauna the fossils have indicated only that the rocks are of Carboniferous or Permian age. The limestones are similar, however, to fossiliferous strata east of Screw Creek (unit 12 b) of Early Pennsylvanian, Morrowan age.

The succession exposed in the southeasterly plunging anticline northwest of Klinkit Lake is believed older than the fossiliferous limestones discussed above. Possibly the tuffs and greenstones are correlative with volcanic rocks of the Big Salmon Complex and Sylvester Group in the northwest part of the map-area. If this is so then the strata in the core of the anticline may be the oldest exposed rocks southwest of Cassiar Batholith in Jennings River map-area.

Unit 12

Strata of unit 12 comprise a thick sedimentary succession in the area north of Simpson Peak and Nome Lake batholiths. Most abundant are monotonous sequences of chert, argillite, slate and quartzite but several important units of limestone and dolomite and one unit of conglomerate are useful in subdividing the rocks.

In the area north of Swan Lake where stratigraphic relationships are reasonably clear the unit has been subdivided into three by Poole (1956). The lowest sequence comprises grey, in part laminated, fine-grained, even-grained quartzites and grey and black argillites and slates as individual members several tens of feet thick or, in the case of argillites and slates, as interbeds and partings within members of ribbon chert. The argillaceous rocks are generally massive, highly fractured and cleaved. Crumpled and chevron-folded ribbon cherts are widespread and being relatively resistant are much better exposed than the argillaceous strata.

Light grey crystalline limestone is not uncommon but the beds are generally discontinuous, perhaps in part a depositional feature and in part due to flowage and disruption during deformation. Probable repetition of a limestone bed in a fold overturned to the southwest occurs on a ridge 3 miles north of the west end of Swan Lake. Several prominent bands of limestone, cherty limestone, and dolomite, possibly also repeated by folding, outcrop east of the upper reaches of McNaughton Creek and south of Plate Creek Stock. The carbonate members range in thickness from a few tens of feet to a few hundred feet.

The middle member of unit 12 outcrops east of Screw Creek where it may be more than 1,000 feet thick. The member consists of light grey weathering, mainly thick-bedded but in part thin-bedded and laminated, crystalline, cryptograined to fine-grained, locally cherty limestone. Chert nodules, lenses, and beds ranging from light grey to dark grey and, in places, pink, occur in well-bedded rocks. Minor thick-bedded dolomite and brown argillite are also present. Crinoidal limestone and an abundant coral fauna occur in the uppermost few hundred feet of beds. Cherty, crinoidal limestone capping the ridge west of Plate Creek Stock may be correlative with the carbonates east of Screw Creek.

The uppermost subdivision of unit 12 includes two contrasting suites of sedimentary rocks. The lower part, disconformably or unconformably overlying the fossiliferous limestones described above, comprises as much as 1,000 feet of conglomerate, grit, quartzite, sandstone and argillite whereas the upper part comprises several thousand feet of ribbon chert, argillite, slate, and at least one prominent member of limestone.

Near Screw Creek the basal beds consist of angular to rounded white, pink, grey, red, buff, and green pebbles and granules of chert in a grey limestone or buff dolomite matrix. Higher in the sequence grey and dark grey, well-rounded chert pebbles and, locally, black slate fragments, occur in a siliceous matrix. Poole (1956) reports the occurrence, elsewhere, of coarse conglomerates including well-rounded cobbles and boulders of white or light grey orthoquartzite as much as 12 inches in diameter. Associated with the coarse clastic rocks are finer-grained grits, quartzites and greywackes.

Ribbon cherts, typically highly folded, are abundant in the upper suite of rocks where they are interbedded with argillites and slates. At least

one member of fossiliferous limestone, more than 500 feet thick, is exposed west of the lower reaches of Plate Creek. The limestone ranges from thin-bedded and laminated to thick-bedded, and, in places, contains abundant chert nodules, lenses, and beds. The total thickness of the upper subdivision of unit 12 appears to be several thousand feet.

North of Alaska Highway rocks of unit 12 occupy the southwest limb of a major syncline. The oldest strata overlie the volcanic-bearing Sylvester Group but the precise relationships of these units are not known. East of Alaska Highway and north of McNaughton Creek unit 12 is overlain unconformably by Lower Jurassic(?) greywacke and argillite.

Fusulinids collected by W. H. Poole from the middle, limestone, formation were identified by C. A. Ross as follows:

Eoschubertella sp.

Pseudostaffella sp.

Age: Pennsylvanian

Late Morrowan or early Derryan

Eostaffella sp.

Endothyra sp.

Age: Pennsylvanian

Probably late Morrowan, could be younger but is pre-Late Pennsylvanian.

Poorly preserved fusulinids were collected by W. H. Poole from the limestone member of the upper formation that is exposed in Jennings River map-area west of the lower reaches of McNaughton Creek. C. A. Ross comments that these fossils cannot be identified specifically but suggests a probable Morrowan (possibly younger) and most probably pre-Late Pennsylvanian age.

On the basis of the limited fossil control noted above rocks of unit 12 are considered to be mainly or entirely of Carboniferous age and the upper two subdivisions may be entirely of Pennsylvanian age.

Kedahda Formation (Unit 13)

A thick sequence of highly folded cherts, quartzites, and argillites, with minor limestone and volcanic rocks, named the Kedahda Formation by Watson and Mathews (1944) underlies extensive areas southwest of Jennings River and west of Tuya Lake. The most complete section is exposed north of the upper part of Shonektaw Creek. There, a monotonous succession of white, greenish grey, and black, thin-bedded ribbon chert; black, in part laminated argillite; and thick-bedded, even-grained quartzite, including at least one thin member of fine-grained greenstone, was estimated by Watson and Mathews to be in the order of 10,000 feet thick.

The largest area of volcanic rocks occurs along the southern boundary of Glundebery Batholith between Sheephorn and Glundebery creeks. The rocks are mainly massive and fine grained but near contacts with hornfelsic argillaceous rocks a crude layering, on a scale of 5 to 10 feet thick, is evident. In places several volcanic members are interbedded with argillaceous sedimentary rocks.

Massive greenstones were also noted in abundance along the southeast side of Nazcha Creek north-northwest of Badman Point where they are intercalated with chert and argillite. Smaller areas underlain by volcanic

rocks occur near Glundebery Creek about 6 miles from its head and about 4 miles west of the lower part of Josephine Creek.

Limestone members, possibly stratigraphically equivalent, outcrop near Kedahda Lake and along the southwest margin of Christmas Creek Batholith. The rocks range from light grey to dark grey and are locally fossiliferous. Near Christmas Creek Batholith the limestones are medium grey, well bedded, in part laminated, and coarsely crystalline. Lime silicates have been developed only locally.

Excellent outcrops of the Kedahda Formation occur in stream cuts west of Badman Point. In addition to the dominant lithologies of ribbon chert and argillite, the sequence includes a member, possibly a few hundred feet thick, of greywacke, chert breccia, and slate-chert-pebble conglomerate.

The base of the Kedahda Formation is not exposed and nowhere was the contact with the overlying Teslin Formation observed directly.

Watson and Mathews (1944) report the presence of probable Permian fossils in limestone near the southeast end of Kedahda Lake and suggest that the formation may be entirely of Permian age. The stratigraphic position of the limestone is unknown, however, and it is possible that the Kedahda Formation may include strata as old as Pennsylvanian.

PERMIAN

Teslin Formation (Unit 14)

The name Teslin Formation (Watson and Mathews, 1944) is restricted in this report to a thick unit of Permian limestone that overlies the Kedahda Formation in the southwestern part of Jennings River map-area. Volcanic rocks, also believed to be younger than the Kedahda Formation, are described separately. The formation is relatively resistant and underlies a number of northwesterly trending ridges in Teslin Valley. The most complete section, however, occurs in a canyon at the big bend in Kedahda River.

Limestones generally weather medium to light grey but are commonly grey to dark grey on a fresh surface. The rocks range from well-bedded to massive and from very fine grained to coarse-grained. Not uncommonly members of dark grey limestone are strongly fetid. In places bedding is emphasized by layers containing a prolific fusulinid fauna that can be described locally as fusulinid coquinas.

In places, lenses, pods, and thin beds of grey to dark grey chert occur in limestones but generally chert is a very minor constituent. Watson and Mathews (1944) report the local presence of black, argillaceous beds.

Where best exposed the Teslin Formation is more than 500 feet thick but the total thickness may be somewhat greater.

The Teslin Formation locally contains a prolific fusulinid fauna. Yabeina sp. and Neoschwagerina sp. indicating a Late Permian, probably late Guadalupian age are particularly abundant (personal communication, C. A. Ross to J. W. H. Monger, 1968).

Unit 15

Much of the ridge between Disella and Chismaina lakes in the southeasternmost part of the map-area is underlain by massive, green to brown

weathering, dark green, fine-grained, massive volcanic rocks. Some of the rocks are breccias and in rare cases platy layers about 1 foot thick can be observed. The stratigraphic relationship between these rocks and those of the Teslin and Kedahda formations is unknown.

Three occurrences of volcanic rocks are closely associated with limestones of the Teslin Formation. On a prominent ridge between the lower reaches of Kedahda River and Charlie Cole Creek, massive, blocky, fine-grained greenstone, in places weathering reddish brown, overlies Teslin limestone. The greenstone has a spheroidal weathering surface and some structures appear to be pillows. Watson and Mathews (1944) describe another occurrence of volcanic rocks on the north side of Charlie Cole Creek about 1 1/2 miles north of the locality described above. There the rocks are dark green and show a fine banding. They are interpreted as altered tuffs interbedded with the limestone. In a stream cut about 6 1/2 miles west-southwest of Badman Point basic volcanic rocks display well developed amygdaloidal pillows as much as 3 to 4 feet long. The pillows show a colour gradation outwards from grey in the core through buff and finally to a rind of buff-orange. In this locality the volcanics may lie stratigraphically between the Teslin and Kedahda formations.

UPPER TRIASSIC

Nazcha Formation (Unit 16)

The Nazcha Formation (Watson and Mathews, 1944) underlies Nazcha Hills at the southeast end of Atsutla Range. The formation comprises a very distinctive assemblage of fresh and blocky volcanic conglomerates, tuffs, arkoses, siltstones, and argillites.

Grits and pebble conglomerates are most abundant and are commonly composed of angular to subrounded clasts of porphyritic or maroon and green aphanitic rocks in an arkosic matrix. Clasts range generally to about 2 inches in diameter but some are more than 6 inches in diameter. Feldspar porphyry with creamy white weathering phenocrysts of plagioclase feldspar (mainly about An₅₀) averaging perhaps 1-2 mm in a fine-grained matrix of alkali feldspar and chlorite and/or actinolite is abundant as clasts in the conglomerates. Fairly coarse feldspathic tuff and rusty weathering, fine-grained banded tuff with distinct bands ranging from 1/8 inch to 2 inches are not uncommon. Some of the bedded rocks may be termed greywackes.

Rusty weathering siltstones in one locality contain poorly preserved fragments of wood. Elsewhere within the metamorphic aureole of Glundebery Batholith, argillaceous rocks have been converted to cherty hornfels.

The writer agrees with Watson and Mathews that much of the material in the Nazcha Formation was probably derived from subaerial disintegration of porphyries and tuffs and that deposition took place with a minimum of transport and sorting.

Rocks of the Nazcha Formation are much less sheared than those of the Kedahda Formation indicating a period of significant deformation in post-Permian and pre-Late Triassic time.

Shonektaw Formation (Unit 17)

Rocks assigned to the Shonektaw Formation outcrop in a discontinuous belt along the northeast flank of Atsutla Range. Tentatively included in the formation are rocks outcropping east of the lower part of Jennings River and southeast of Tuya Lake.

The Shonektaw Formation (Watson and Mathews, 1944) consists typically of massive greenstones and dark green augite porphyry in which flashing crystals of augite ranging up to 1/2 inch long are conspicuous. Less abundant are dark green tuffs, agglomerates and flow breccias. Watson and Mathews describe pillow lavas and bedded greywacke 2 1/2 miles south of Blackfly Lake and conglomerate containing well-rounded pebbles of highly altered medium-grained diorite 4 miles southeast of Aconitum Lake. In general the volcanic rocks of the Shonektaw Formation are considerably less altered than those of the Paleozoic formations.

Augite and possibly hornblende porphyry outcropping east of the lower part of Jennings River is tentatively assigned to the Shonektaw Formation although stratigraphic relations with nearby Paleozoic strata are obscure.

Foliated, in part gneissic, metamorphosed greenstones, outcrop southeast of Tuya Lake. The rocks are commonly banded on a scale of about 1/8 inch to 1/2 inch and are schistose. This sequence appears to be a direct continuation of a thick unit of massive greenstones, augite porphyry, and related volcanic rocks in northeastern Dease Lake map-area (Gabrielse and Souther, 1962). There the rocks overlie quartz-mica schists of the Oblique Creek Formation.

Nowhere in Jennings River map-area are the base and top of the Shonektaw Formation exposed. On the basis of an interpretation of structural relationships in northeastern Dease Lake map-area Watson and Mathews (1944) suggested that the Shonektaw Formation was younger than the Nazcha Formation. Regional stratigraphic relationships, however, suggest that the Nazcha Formation as exposed in Dease Lake map-area is probably younger than the Shonektaw Formation although it is possible that they are in part correlative.

The Shonektaw and Nazcha formations are believed to be Upper Triassic on the basis of their lithologies and general stratigraphic position. Ichthyosaur vertebrae collected by Watson and Mathews (1944, p. 19) from the Nazcha Formation in northeastern Dease Lake map-area were examined by C.M. Sternberg who commented that they suggest Delphinosaurus perrini, a fossil found in the Upper Triassic, Hosselkus Limestone in California.

LOWER JURASSIC(?)

Unit 18

As much as 1,000 feet of blocky, interbedded greywacke, feldspathic quartzite, grit, and argillite unconformably overlie late Paleozoic strata east of Alaska Highway and north of McNaughton Creek. Generally the rocks are well-bedded with beds ranging from 1/2 to 6 feet thick.

In hand specimen the greywackes are characterized by fairly abundant cream weathering feldspar grains commonly from 1 to 2 mm long and by

dark grey, opalescent quartz grains. Slate chips are present but are generally not abundant. Poole (1956) notes that the grains are poorly sorted and most are subangular or subrounded. The matrix is very fine grained micaceous and siliceous material. Microcline is fairly common but quartz is the dominant constituent.

Several thin members of laminated, grey chert and grey phyllitic argillite as much as 20 feet thick were observed within the greywacke succession.

No fossils were obtained from unit 18. The unconformable relationship with underlying late Paleozoic strata and the presence of fairly abundant potash feldspar in greywackes suggests a Mesozoic age for these rocks. Similar rocks are typical of the Lower Jurassic sequences in Dease Lake and Cry Lake map-areas.

GRANITIC ROCKS

In general, granitic rocks underlie most areas of rugged topography in Jennings River map-area. The granitic rocks comprise a large number of discrete plutons ranging from sills and dykes to batholiths and each pluton or, in some cases, group of plutons is characterized by fairly distinct composition, texture, and structure. To facilitate description of the granitic rocks three batholiths and one stock are named (Simpson Peak Batholith, Nome Lake Batholith, Klinkit Batholith, and Plate Creek Stock). These bodies, along with the previously named Cassiar, Christmas Creek, Glundebery, Tuya, and Parallel Creek batholiths and Charlie Cole Stock, include all the major plutons in the map-area.

It is apparent, from several lines of evidence, that regional metamorphism followed by periodic emplacement of granitic rocks took place over a time span encompassing much of the Mesozoic era. A study of the variation in compositions of granitic bodies, the relationships of composition to time of emplacement of granitic rocks, and the relationship of intrusive episodes with periods of regional deformation and uplift, is continuing and only a brief summary is given in this report. Ages of granitic plutons given in the Table of Formations and in the legend for the geological map must be considered as tentative only. Preliminary data from K-Ar age determinations indicate an Early Jurassic age for Simpson Peak and Nome Lake batholiths, a mid-Cretaceous age for Cassiar Batholith and a late Cretaceous age for Glundebery and Tuya batholiths.

Plate Creek Stock (Unit 19)

A roughly equidimensional, strongly discordant, homogeneous body of quartz diorite and diorite at the head of Plate Creek is herein named the Plate Creek Stock. The rocks are typically grey weathering and blocky, and range from fine-grained equigranular near the margins of the stock to medium-grained equigranular in the central part. The most conspicuous mineral is hornblende, possibly averaging more than 20 per cent of the mode, which forms euhedral to subhedral crystals in places as much as 1 cm long. In places, euhedral biotite occurs in subordinate amounts to hornblende. Plagioclase, commonly displaying strong, gradational, normal, and

oscillatory zoning generally comprises about 50 per cent of the rocks. Compositions of plagioclase range, for the most part, from medium oligoclase to calcic andesine but remnants of calcic labradorite are present and saussuritization has locally produced albite. Minor orthoclase forms poorly developed porphyroblasts barely detectable in hand specimens. Remnants of clinopyroxene are not uncommon in hornblende crystals. Interstitial quartz probably constitutes about 10 per cent of the Plate Creek rocks.

Several samples near the northern border of the stock are medium to coarse grained and in places megacrystic and contain biotite with minor hornblende. Locally the rocks are cut by aplitic dykes from 2 inches to 6 inches wide.

Contacts of the Plate Creek Stock with older rocks were observed only north of Plate Creek. There a leucocratic, fine- to coarse-grained border zone as much as 20 feet wide cuts highly foliated and sheared siliceous and micaceous metasedimentary rocks of unit 12. The latter appear to be significantly recrystallized only within about 30 feet of the stock.

A number of small, mesocratic, fine- to medium-grained, dioritic plutons, relatively rich in hornblende occur in a northwesterly trending belt near Swan Lake bounded by Smart River and Hook Creek to the southwest and Partridge Creek and McNaughton Creek to the northeast. Typically the bodies have fine-grained contact zones with a salt-and-pepper texture but in some cases contacts are marked by a development of dark weathering appinite containing as much as 60 per cent hornblende. Although hornblende is by far the dominant mineral, biotite occurs locally. Aplitic dykes are fairly abundant in the plutons between Smart and Logjam creeks. The upper Paleozoic strata cut by the dioritic rocks have been altered locally to tough, blocky hornfels and calc-silicate skarns.

Strongly jointed, fairly homogeneous biotite-hornblende diorite or quartz diorite underlies a ridge 4 miles north of the mouth of Kachook Creek. The rock is medium grained and contains about 20 per cent mafic minerals dominated by prismatic hornblende crystals. Except for a finer grain size the lithology is similar to that in parts of Christmas Creek Batholith. Similar rocks were also noted in along the southern margin of Simpson Peak Batholith near the headwaters of Butsih Creek.

Quartz diorite, diorite, and gabbro underlie a group of hills 4 to 8 miles northwest of Mount Charlie Cole. According to Watson and Mathews (1944) the rocks are mainly mesocratic, medium-grained quartz diorites containing slightly saussuritized calcic andesine, green hornblende partly altered to actinolite and chlorite, brown biotite, quartz, and accessory zircon and apatite. Similar rocks but somewhat coarser grained underlie several hills between Charlie Cole Stock and Christmas Creek Batholith.

An altered gabbroic body 3 miles southeast of Tuya Lake comprises dark grey to dark green rocks consisting of saussuritized labradorite, and secondary green hornblende, chlorite, actinolite, and magnetite (Watson and Mathews, 1944).

Charlie Cole Stock (Unit 20)

Distinctly foliated, blocky, grey weathering, quartz diorite underlies Mount Charlie Cole. The medium- to coarse-grained diorite locally contains fine-grained, mafic inclusions ranging from less than a foot to more than

10 feet in length. Thin sections reveal the presence of strained and crushed calcic oligoclase and quartz, shreds of brown biotite, and small amounts of epidote, chlorite, and sphene (Watson and Mathews, 1944). Gneissic structures dip steeply and generally strike north in the southern and northwestern parts of the mountain and northeasterly in the central and northeastern part.

Highly contorted schists and gneisses, metamorphosed equivalents of the Kedahda Formation in contact with quartz diorite in the side of Mount Charlie Cole, consist mainly of quartz, biotite, and muscovite (Watson and Mathews, 1944).

Christmas Creek Batholith (Unit 21)

Christmas Creek Batholith underlies the highest mountains in the core of Atsutla Range northwest of Kedahda Lake and extends southeasterly to include the highest part of the ridge southeast of Kedahda Lake. The typical lithology is a very distinctive medium- to coarse-grained, homogeneous, hornblende quartz diorite characterized by conspicuous, flashing, dark green to black stubby prisms of hornblende and fairly abundant vitreous quartz crystals. Locally, biotite is important but hornblende is almost invariably the predominant mafic mineral. Plagioclase, commonly about An₄₀, generally constitutes between 40 and 50 per cent of the rocks. Apatite, sphene, pyroxene, allanite, and zircon are accessory minerals. Gradations from diorites with a low quartz content through granodiorites to quartz monzonites containing more than 20 per cent orthoclase have been observed. In places fine-grained dioritic phases and, in rare cases, dioritic inclusions, as much as 1 foot in diameter, are present. Steeply dipping gneissic structure, essentially parallel with foliation in the intruded rocks, was noted at several places but is inconspicuous in contrast to the marked foliation in rocks of Charlie Cole Stock. A crude zonal arrangement, with diorite predominating near the margin of the batholith and quartz diorite in the core (Watson and Mathews, 1944), is evident in some areas but numerous exceptions were noted. In particular, diorites appear to be scarce or lacking along much of the northeastern and southeastern extremities of the batholith.

Christmas Creek Batholith is generally concordant with steeply dipping to vertical enclosing strata of the Kedahda Formation. Calc-silicate skarns, crystalline limestones, recrystallized cherts, hornfels, and mica-ceous quartzites have developed as the result of contact metamorphism in narrow zones adjacent to the batholith. East of Kedahda Lake Christmas Creek Batholith is cut by granitic rocks of Glundebery Batholith.

Simpson Peak and Nome Lake Batholiths (Unit 22)

Two regionally discordant, crudely equidimensional plutons that lie west of Cassiar Batholith in the northern part of the map-area are herein named the Simpson Peak and Nome Lake batholiths, the names derived respectively from Simpson Peak, the highest summit in Simpson Batholith, and Nome Lake which lies entirely within Nome Lake Batholith. Lithologies appear to range from biotite-hornblende quartz diorite, particularly in marginal phases, to hornblende-biotite-granodiorite and possibly in some areas

to quartz monzonite. The rocks are typically medium to coarse grained, the latter varieties displaying abundant megacrysts of perthitic, potash feldspar.

Plagioclase, commonly with well-developed oscillatory and gradational normal zoning, ranges in composition from about An₂₀ to An₅₀. Orthoclase is generally perthitic and in coarser-grained rocks is markedly porphyroblastic. The abundance of mafic minerals and the ratio of hornblende to biotite varies greatly but many samples contain about equal amounts of the two minerals that together comprise between 10 and 20 per cent of the rocks. Apatite, sphene, and zircon are common accessory minerals.

A discrete plug of leucocratic to mesocratic hornblende monzonite, characterized by a coarse development of black hornblende and well-twinned laths of pink potash feldspar, occurs in Nome Lake Batholith east of McNaughton Lakes. The rocks contain less than 5 per cent quartz. Strongly pleochroic (blue-green to tan) hornblende forms a subophitic intergrowth with porphyroblastic orthoclase that in some cases shows a well-developed preferred orientation. Hornblende constitutes about 30 to 35 per cent and orthoclase about 40 to 45 per cent of these rocks. Plagioclase, possibly averaging about An₂₅, is typically altered, especially in cores of crystals, to fine-grained sericite. Minor euhedral augite is present and the accessory minerals sphene, apatite, and magnetite are relatively abundant. The monzonite plug is separated from rocks of the main part of Nome Lake Batholith by a narrow zone of rusty weathering hornfels and micaceous quartzite.

Nome Lake and Simpson Peak batholiths are separated by a screen of metasedimentary rocks including hornfels, micaceous quartzite, crystalline limestone and skarn. Foliation in these rocks dips steeply to the northeast in the northwestern part of the screen but farther southeast dips are southwesterly.

The southern contact of Simpson Peak Batholith is well exposed west of the valley at the head of Hook Creek. There, foliation in the granitic rocks is parallel with foliation in adjacent banded hornfels and calc-silicate skarn, and dips steeply to the southeast. Tabular inclusions of metasedimentary rocks are abundant near the margin of the batholith and near the inclusions foliation in the granitic rocks is best developed. In the contact zone cross-cutting tabular quartz-feldspar pegmatite veins, locally containing clusters of black tourmaline crystals, and aplite dykes, a few inches to a few feet wide, cut mesocratic dioritic rocks. Southeast of the contact at least two sills of granitic rock, from 20 to 30 feet wide are characterized by a sugary texture.

Interleaved granitic sills and tough metasedimentary rocks were noted in a narrow contact zone at one locality east of the headwaters of Butsih Creek. There also the contact dips steeply south or is vertical.

Cassiar Batholith (Unit 23)

The eastern part of Jennings River map-area includes a segment of the markedly elongate Cassiar Batholith which extends southeasterly for more than 200 miles from near Wolf Lake in Yukon Territory to Lamarque Pass in Kechika map-area (94 L). The batholith underlies the most rugged terrain and the highest peaks in the map-area.

Large areas in Cassiar Batholith are underlain by massive, homogeneous, medium- to coarse-grained, grey biotite quartz monzonite. In

even-grained rocks calcic oligoclase generally predominates but in coarser-grained, megacrystic varieties microperthite may be dominant. Plagioclase and potash feldspar exhibit zoning and, in some samples potash feldspar shows unusually well-developed carlsbad and microcline twinning. Hornblende may be present locally but generally is minor or absent. Apatite and zircon are common accessory minerals. Commonly the rocks are fresh although plagioclase commonly shows a slight sericitic alteration and biotite in places is partly replaced by chlorite. Foliated rocks in which alternating sialic- and mafic-rich layers strike northwesterly and dip steeply are particularly widespread on the ridge west of Iverson Creek. Inclusions of quartz-biotite schist were observed in several localities south of Blue River and a large inclusion of metasedimentary rocks including crystalline limestone occurs just north of the headwaters of Blue River.

Coarsely megacrystic quartz monzonite underlies at least part of the ridge north of Maria Lake and a fairly large body of muscovite quartz monzonite of undetermined outline outcrops between the head of Toozaza Creek and Little Rancheria River. The latter is characterized by a strong development of microcline and by ubiquitous fluorite as an accessory mineral.

The western border of Cassiar Batholith north of Blue River is marked by a major shear zone in which the granitic rocks have been pervasively sheared and mylonitized over widths of as much as 2 miles. In a general way the degree of deformation decreases from an intensely sheared border zone to the interior of the batholith where weakly foliated rocks grade easterly into massive quartz monzonites. The gradation noted above is accompanied by a strong development of muscovite and albitized plagioclase in the most highly deformed rocks changing to a normal composition farther east.

South of Little Rancheria River metasedimentary rocks including hornfels and calc-silicate skarns occur as screens possibly forming one continuous unit within the sheared granitic rocks. Near Rancheria River the zone of sheared rocks appears to be offset to the southwest parallel with prominent lineations in the bedrock.

The most spectacular of the sheared rocks is a widespread, leucocratic augen-gneiss comprising creamy lenses of microperthite in a darker coloured quartz-feldspathic matrix. The intense and penetrative nature of the deformation is best revealed in thin sections which show rounded, rolled, and sheared oriented lenticular feldspar and quartz clasts ranging from 0.5 to 5 mm in length in a strongly foliated, fine-grained matrix of granulated felsic minerals and aligned micas. Evidently quartz has behaved in a plastic manner relative to the feldspar and commonly heals fractures in the latter mineral.

Less deformed rocks in the eastern parts of the shear zone are characterized by cataclastic and protoclastic textures, bent mica and plagioclase crystals, and strained quartz. Alteration of biotite to chlorite appears to be more prevalent in the deformed rocks than elsewhere.

About 3 1/2 miles southeast of Little Rancheria River feldspar-augen-gneiss is cut by very coarse grained muscovite-quartz-feldspar pegmatite dykes that post-date deformation of the granitic rocks.

Foliation in the shear zone commonly dips steeply and uniformly to the east or west for considerable distances. No consistent plunges of lineation on foliation planes were obtained although moderate to gentle plunges are

most common. In several places where detailed studies were made there are common structural elements in the sheared granitic rocks and adjacent meta-sedimentary strata.

This remarkable shear zone has been traced northwesterly to near Morris Lake in Wolf Lake map-area by Poole (1956) and, southeasterly as far as Blue River in Jennings River map-area, a total distance of more than 90 miles. What happens to the deformed zone beyond Blue River is not clear. It may simply end as a clearly recognizable structure or swing into the zone of mixed gneissic, schistose, and granitic rocks that borders Cassiar Batholith east of Cottonwood River.

In several areas Cassiar Batholith cuts sharply across regional trends in stratified rocks. Rusty hornfels and banded calc-silicate rocks delimit fairly distinct contact-metamorphic zones bordering the batholith.

Klinkit Batholith (Unit 24)

An elongate, foliated, pluton trending parallel with, and lying just north of Jennings River is named Klinkit Batholith. The typical lithology is a medium- to coarse-grained, locally megacrystic, leucocratic, biotite quartz monzonite containing roughly equal amounts of plagioclase (An₂₀-An₂₅), perthitic potash feldspar, and quartz. Biotite, commonly the only mafic mineral and comprising less than 10 per cent of most samples, is characterized in thin section by pronounced reddish brown pleochroism. Apatite and zircon are ubiquitous accessory minerals.

Quartz monzonites of Klinkit Batholith show well-developed steeply dipping foliation, in most areas parallel with the trend of the batholith. The foliation planes, best revealed in marginal phases of the pluton, represent zones of cataclasis that have imparted a conspicuous sugary texture to the rocks. This phenomenon is revealed under the microscope by xenomorphic texture, seriate grain size, and by cataclastic and protoclastic textures.

Several foliated, quartz monzonite sills north of the batholith and east of Klinkit Creek are presumed to be related to Klinkit Batholith. They also display the sugary texture characteristic of the main body.

Several screens of plagioclase-muscovite-biotite-quartz schist as much as 50 feet wide were noted in the batholith south of the headwaters of Butsih Creek. A much more prominent screen of rusty weathering, feldspathized, biotite-quartz schist outcrops 4 miles northwest of the mouth of Klinkit Creek. The metamorphic rocks are cut by biotite-muscovite-quartz-feldspar pegmatite dykes from 6 inches to 2 feet wide. Pegmatite is also abundant in the large screen of metasediments south of Klinkit Lake.

Granitic dykes occur in muscovite-quartz schists and rusty weathering hornfels near the northwest end of the batholith. In this area foliation in the metamorphic rocks is sharply truncated by the granitic rocks.

Tuya and Parallel Creek Batholiths (Unit 25)

Tuya and Parallel Creek batholiths, separated by a screen of meta-sedimentary rocks northwest and east of High Tuya Lake, have very similar compositions and weathering characteristics. Granite and biotite quartz monzonites, commonly even grained and medium grained, but in places

coarsely megacrystic, are the dominant lithologies. Generally potash feldspar and quartz are present in considerably greater amounts than plagioclase. Plagioclase compositions range from An₂₀ to An₃₀. Hornblende is present locally but is minor relative to biotite. Apatite, magnetite, and zircon are the common accessory minerals. Small crystals of red garnet are present in quartz monzonite 4 miles southeast of Edasp Lake. Three miles south of Edasp Lake Tuya Batholith includes quartz diorite consisting of andesine (An₄₀), quartz, biotite, and orthoclase (Watson and Mathews, 1944)

Typically, the granites and quartz monzonites weather a distinctive grey to buff-orange and, in places, disintegration by weathering results in an abundance of arkosic sand.

Near Edasp Lake, Tuya Batholith contains abundant inclusions of quartz-mica schist (unit 25 Ba) ranging from blocks 10 feet to more than 50 feet thick. According to Watson and Mathews (1944) the inclusions are generally unoriented but they state further that north of Edasp Creek "they occur in places as gently dipping sheets of tabular blocks in parallel orientation separated by sheets of inclusion-free granodiorite" (quartz-monzonite in this report). Bedding within the blocks dips at angles varying widely from those of the margins of the blocks.

Tuya and Parallel Creek batholiths intrude regionally metamorphosed rocks of the Oblique Creek Formation. In several places contacts dip steeply northeast or are nearly vertical. One notable exception can be observed north of Ash Mountain where the upper contact of Parallel Creek Batholith dips gently beneath a cover of moderately dipping metasedimentary rocks. The latter include calc-silicate skarns composed of garnet, idocrase, diopside, calcite, and quartz. The granitic rocks are overlain unconformably by volcanic rocks of the Tuya Formation.

Glundebery Batholith (Unit 26)

The roughly equidimensional Glundebery Batholith underlies a large part of southeastern Atsutla Range. Smaller masses of similar rocks outcrop southeast of Mount Charlie Cole and west of Snook Creek and near Aconitum Lake.

Much of the batholith comprises a very distinctive coarse-grained hornblende granite characterized by a waxy, pale green-buff weathering of perthitic potash feldspar, an abundance of watery quartz, common occurrence of microlitic cavities, and a peculiar 'aggregate' texture resulting from a predominance of subhedral feldspar crystals with a minimum of matrix. Commonly these rocks disintegrate readily by weathering and produce abundant buff, buff-brown, and reddish brown talus slopes and spheroidal, joint-bounded blocks. In addition to the widespread coarse-grained rocks described above, the batholith includes phases of porphyritic granite, noted particularly in areas of abundant dioritic inclusions and along the southwest contact, in which potash feldspar phenocrysts occur in a fine-grained matrix; abundant buff-brown weathering aplitic dykes in which euhedral equidimensional quartz crystals are conspicuous; and pegmatite with unusually abundant hornblende.

Under the microscope the typical granites of Glundebery Batholith reveal the preponderance of subhedral to anhedral perthite crystals, many of which have partly replaced plagioclase. Typically the perthite crystals are

turbid, possibly resulting from very fine grained, dark brown dusty hematite(?). Quartz forms roughly equant, anhedral crystals, in many cases displaying a crackled texture, and occurs in minor amounts as an interstitial mineral. Subhedral to euhedral hornblende shows strong pleochroism from dark olive-green to light brown. Plagioclase ranges in composition from oligoclase to fresh albite. Biotite is generally present in very minor amounts. Accessory minerals include apatite, sphene, zircon, epidote, allanite, and magnetite.

Miarolitic cavities are common in rocks of Glundebery Batholith. Generally they are less than 2 cm in diameter and are lined with euhedral crystals of quartz, feldspar, and in some places, fluorite. One area of pink, fine- to medium-grained, miarolitic and graphic granite outcrops near the lake on the northeast fork of Nazcha Creek. Watson and Mathews (1944) state that typical specimens consist of micrographic intergrowths of quartz and microcline-albite perthite with accessory muscovite, green biotite, monazite, magnetite, fluorite, and hematite.

Ridges 1 mile southeast and 2 miles south of the lake at the head of Kahan Creek include large areas of medium- to coarse-grained syenite and hornblende syenite. In places these rocks contain very little mafic material and are almost wholly composed of perthite crystals displaying excellent carlsbad twins. Thin sections of perthites show a microscopic intergrowth of microcline and plagioclase (An₁₀), the latter occurring as patchy remnants.

Watson and Mathews (1944) noted the presence of hornblende gabbro at the contact of the batholith 7 1/2 miles northeast of Metah Mountain. The gabbro is described as "a grey medium- to coarse-grained rock composed of bytownite and green hornblende and small amounts of biotite, carbonate, epidote, chlorite, apatite, and magnetite". They also observed occurrences of quartz diorite between Chokatah and Kahan creeks along the side of Jennings Valley and between Kahan and Tahoots creeks near the contact with the Shonektaw Formation. The quartz diorite east of Kahan Creek is described as "a light grey, medium-grained, foliated variety consisting mainly of quartz, andesine (An₃₈), slightly sericitized orthoclase, green hornblende, and brown biotite. Small amounts of micropegmatite occur interstitially and sphene, apatite, and pyrite are present as accessories".

Dioritic inclusions ranging from a few inches to more than 100 feet in length are abundant between the headwaters of Tahoots and Sheephorn creeks and near Blackfly Lake. Similar bodies are present 6 miles northeast of Metah Mountain and near the contact with Shonektaw Formation on the east side of Kahan Creek valley. Watson and Mathews (1944) note that "Generally, the diorite blocks are about equidimensional, but on the northern wall of Sheephorn Creek valley they are tabular and have a parallel orientation".

Between the headwaters of Tahoots and Sheephorn creeks mesocratic and melanocratic inclusions are bounded by stockworks of leucocratic granitic dykes. The dykes range from fine-grained, pink weathering granite to coarse-grained, megacrystic granite, and, in places the central parts of dykes are coarse pegmatites. Possibly the dominant lithology in the inclusions is a melanocratic, medium- to fine-grained, equigranular hornblende biotite diorite. Locally, fine-grained varieties contain feldspar metacrysts with mafic rims and hornblende metacrysts with feldspar rims. Some inclusions are very fine grained and resemble andesite. Watson and Mathews (1944) noted that in places near Blackfly Lake diorite contains cavities generally lined with crystals of hornblende and feldspar. Thin sections of dioritic

inclusions show an intergrowth of plagioclase (unzoned andesine or in zoned crystals ranging from cores of sodic labradorite to rims of andesine or from cores of andesine to rims of oligoclase), green hornblende, brown biotite, clinopyroxene, apatite, and magnetite (Watson and Mathews, 1944).

Greenish grey, fine-grained spherulitic, flow-banded rhyolite dykes consisting mainly of quartz, potash feldspar, and riebeckite were observed in Glundebery Batholith near the head of the northeast fork of Nazcha Creek and about 2 miles south of Blackfly Lake (Watson and Mathews, 1944). Buff-coloured rhyolite dykes with glassy margins also cut strata of the Kedahda Formation near the batholith about 1 1/2 miles west of Glundebery Creek.

Glundebery Batholith has intruded rocks of the Kedahda, Shonektaw and Nazcha formations and dioritic rocks of Christmas Creek Batholith. Five miles west of Blackfly Lake the pluton is overlain by extrusive volcanic rocks of the Tuya Formation. Contacts are invariably steep and contact metamorphism is relatively minor. Argillaceous strata of the Nazcha Formation are locally represented by fine-grained, cherty hornfels. Rusty weathering hornfelsic rocks are also present where the Kedahda Formation is cut by the batholith and in a few places micaceous quartzites, possibly in part recrystallized cherts, have been developed. Volcanic rocks of the Shonektaw Formation show little if any metamorphic effects.

TERTIARY(?) TO RECENT

Tuya Formation (Unit 27)

From late Tertiary to the Recent, perhaps mainly during the Pleistocene, lavas, tuffs, and agglomerates were extruded from numerous, widespread volcanic centres in the map-area. Although the relative abundance of these undeformed volcanic rocks is not great they form many of the most conspicuous landmarks in the region.

The lavas occur partly in two sharply contrasting topographic environments - in valley bottoms such as Swift River, Little Rancheria, and Jennings River valleys, and as cappings of prominent flat-topped volcanic cones such as Tuya Butte. They are perhaps most widespread on Kawdy Plateau but the sequence generally appears to be thin. Typically the flat-lying, dark weathering flows range in thickness from a few feet to more than 20 feet. Well-developed columnar structure is common. Vesicles may occur throughout individual flows but they are most abundant near the upper surface which in many places is characterized by irregularly crackled basaltic glass. On a fresh surface the lavas are generally dark grey but in places where deeply weathered they produce dark brown talus and sand.

In hand specimens the basalt flows are either completely aphanitic or, more commonly, they contain yellow-green phenocrysts of olivine or, rarely, amber crystals of plagioclase in an aphanitic or fine-grained matrix. In thin section the texture is holocrystalline, felty or intergranular. Constituent minerals are very fresh and include equidimensional olivine and tabular labradorite (about An₆₀) phenocrysts in a matrix of labradorite, clinopyroxene, olivine, and probably magnetite. Watson and Mathews (1944) noted the presence of augite and pigeonite.

Watson and Mathews (1944, p. 29) described samples of trachyte collected from the two hills north and south of the head of Josephine Creek as

rocks that weather lighter grey than the basalt and form flows that in places, display red-stained highly vesicular tops. They describe the rocks further as follows: "The groundmass of the trachyte consists of a fine-grained holocrystalline aggregate of potash feldspar, clinopyroxene and black, opaque grains. Usually, tabular crystals of glossy alkali feldspar up to 3/4 inch long occur in the trachyte. Less commonly, the trachyte contains nodules, 1/4 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 3/4 inch in diameter, were observed in the trachyte."

More spectacular occurrences of lava flows are those that form the flat tops of volcanic cones. These include Tuya Butte, Isspah Butte, and unnamed mountains 5 miles north-northwest of Mount McGavin, north and south of the headwaters of Blue River, at the headwaters of Toozaza Creek, east of Klinkit Creek, south of Klinkit Lake, north of Little Rancheria River, and on a ridge south of Little Rancheria River just east of the eastern margin of Cassiar Batholith. These flows, from a few feet to more than 50 feet thick, comprise sequences as much as 300 to 400 feet thick commonly overlying thicker sequences of well-bedded, buff-brown and orange-brown weathering tuff and agglomerate displaying primary dips of from 15 to 25 degrees. In all cases the contact between fragmental material and overlying flows is remarkably sharp and essentially horizontal. The fragmental rocks are heterogeneous in texture and consist of buff and yellow fine-grained matrix with angular fragments of black, scoriaceous, vesicular basalt generally from a fraction of an inch to several inches long. East of Iverson Creek a columnar basalt flow about 20 feet thick overlies tuff that contains boulders of vesicular basalt as much as 10 feet in diameter. The flat-topped volcanoes have been named 'tuyas' by Mathews (1947) and are assumed to result from eruption of volcanics into glacial lakes formed by thawing of an ice cover by volcanic heat. Thus the extent of the tuyas when formed may not have been much greater than they are today.

In several places it is clear that the layering in fragmental rocks is primary and was formed prior to emplacement of the overlying flows (Mathews, 1947). These fragmental rocks therefore do not represent re-eroded scree material along the sides and slopes of mountains as described for some table mountains in Iceland by Van Bemmelen and Rutten (1955).

A number of conspicuous, dark weathering, partly dissected, roughly conical mountains in the map-area consist largely of layers of tuff and agglomerate that dip outwards at angles from about 20 to 30 degrees. These include the cone 4 miles west of Blackfly Lake, Metah Mountain, Badman Point, the mountain 3 miles southwest of Ash Mountain and the mountain 5 1/2 miles north of the head of Tuya Lake. The cone west of Blackfly Lake rises about 1,500 feet above its base of granitic rock. In cross-section the volcano appears to comprise two outwardly dipping wedges of layered fragmental rocks separated by a core of blocky, highly vesicular, porphyritic, olivine basalt. The fragmental rocks in places form beds about 1 foot thick and comprise rusty to dun-brown weathering palagonite(?) with angular, black, aphanitic to glossy, vesicular olivine basalt fragments as much as 6 inches across but generally between 1/2 inch and 1 inch across. A few large, pitted, partly resorbed biotite crystals are present as well as rare boulders of granite.

Watson and Mathews (1944) reported the occurrence of abundant faceted and striated cobbles and boulders of basalt and a few of granite in gently dipping grey agglomerate exposed at the southeastern base of the large cone 5 1/2 miles north of the head of Tuya Lake. Ash Mountain, Mount Josephine, and the volcanic mountain 5 1/2 miles south of Edasp Lake include abundant disintegrated basaltic scoriae. Ash Mountain reveals the best exposures of well-stratified, in places weakly welded, porous, and friable lapilli tuff. Locally the tuffs are intercalated with basalt flows. Basalts near the summit of Ash Mountain and in a sharp canyon 1 1/5 miles south-southeast of the peak display well-developed classic pillow structure. The latter reveals a flat-lying section several hundred feet thick.

Watson and Mathews (1944) noted pillow lavas at the eastern base of Metah Mountain and along the southwestern base of the mountain 5 1/2 miles south of Edasp Lake.

The age of the oldest rocks in the Tuya Formation is unknown. It is clear, however, that some volcanic activity preceded a time of glaciation as evidenced by the presence of glacial striae, volcanic boulders in drift, glacial erratics on volcanic rocks, and cirques cut into volcanoes. On the other hand the presence of striated boulders in agglomerate, and of unweathered fresh, smooth surfaces of granite beneath volcanic rocks indicates some glaciation prior to volcanism.

A remarkably fresh, clearly postglacial volcanic vent is exposed near the floor of a valley 4 miles southwest of the lake at the head of Iverson Creek. Volcanic ejecta composed of maroon weathering, porous, ropy agglomerate forms a cone a few hundred feet in diameter with a central crater about 100 feet deep. Bedrock of Oblique Creek Formation is exposed in the north wall of the crater.

PLEISTOCENE AND RECENT

Unit 28

A thick mantle of drift is present in the main valleys and seriously restricts the outcropping of bedrock in these areas. Bedrock in many of the high-level valleys is commonly obscured by kettle and kame topography, outwash fans, lake-terraces and moraines. Although relatively thin, the soil cover on the gently rolling or flat-lying upland areas also obscures bedrock over extensive areas.

STRUCTURE

The regional structural trend in Jennings River map-area is north-westerly but local deflections from this, particularly near granitic plutons, are common.

The structure of the McDame synclinorium (Gabrielse, 1963) north-east of Cassiar Batholith is relatively simple. The generally broad synclinal structure is locally complicated, however, by a number of steeply dipping faults and by tight folding near Cassiar Batholith southeast of Tootsee Lake.

Near-vertical northerly trending faults cutting Silurian and Devonian strata east of the upper reaches of Tootsee River are marked by topographic

depressions and the presence of greenstone dykes. In some places the dykes are highly schistose. The easternmost fault of this set passes through the Silvertip Mineral Group and brings the lower part of the Sylvester Group to the east against the McDame Group to the west.

The repetition of Ordovician to Devonian strata north and south of the upper reaches of Tootsee River suggests the presence in the valley of an important northeast-trending fault downthrown to the northwest.

The contact between the McDame and Sylvester Groups is almost invariably faulted, perhaps because of the difference in competency between the units. On the other hand this phenomenon has been observed to the north in Wolf Lake map-area (Poole, 1956) and in many places to the southeast in McDame map-area (Gabrielse, 1963) and possibly the faulting is of considerably greater tectonic significance than has been realized.

Strata southeast of Tootsee Lake have been deformed into tight folds in places overturned to the northeast and are cut by northwest trending faults, some of which are marked by abundant, highly fractured white quartz. North of Tootsee River bedding dips uniformly away from Cassiar Batholith but elsewhere near the contact bedding commonly dips into the batholith. Lineations in the upper Tootsee River area plunge consistently to the southeast and south.

The strong shear zone along the west side of Cassiar Batholith has been described in a previous section. From observations in several areas where lineations in sheared granitic rocks are concordant with gently plunging fold-axes in bordering metasedimentary rocks, it is assumed that movements along shear planes were dominantly in the direction of dip. Thus it seems probable, as suggested by Poole (1956), that the Cassiar Batholith at some time following its initial emplacement and consolidation moved upward relative to adjacent strata along its western margin. The direction of movement is not clear, however, and a conspicuous fault bounding sheared granitic and metamorphic rocks west of the headwaters of Toozaza Creek appears to be a steeply dipping, northeasterly directed thrust. In any event it is evident that deformation took place in an environment of strong compression and not one of tension that characterized Cenozoic tectonics.

West of Cassiar Batholith in the northern part of the area the structure is dominated by a regional northwest-trending synclinorium with an axis near Partridge Creek and a regional anticlinorium with an axis trending southeasterly from the northwest corner of the map-area. Within the broad framework of these structures, however, the strata are intensely folded on a small scale.

Asymmetrical or southwesterly overturned folds with amplitudes of a few feet to several tens of feet are particularly well exposed in thin-bedded cherty rocks between Logjam and Screw creeks and between Hook and Redfish creeks. Axial planes dip northeast at angles ranging from 20 to 45 degrees. Limestone of unit 12 north of the British Columbia-Yukon boundary and rocks northeast of Partridge Creek commonly show northeasterly overturned chevron folds (Poole, 1956). Northeast of McNaughton Creek fold axes in upper Paleozoic and Lower Jurassic(?) strata plunge consistently to the southeast at angles up to 30 degrees. A similar consistency of southeast plunges is evident in the anticlinorium in the northwest part of the map-area.

Strata northwest of Klinkit Lake occur in an apparently broad southeasterly plunging anticline best revealed on the ridge east of the headwaters of Butsih Creek. On the adjacent ridge to the southeast, however, well-bedded

strata near the axis of the anticline are intensely folded and the structure is probably much more complicated than shown on the geological map. In one locality tight overturned folds with amplitudes of about 15 feet have axial planes dipping 25 degrees southwest. A pervasive flat-lying cleavage is well developed in interbeds of fine-grained rocks.

A small outcrop area of thin-bedded meta-tuff(?) and chert east-northeast of the confluence of Kachook Creek and Jennings River shows a spectacular development of tight folds, with amplitudes from a few inches to several feet, plunging steeply southeast. Axial planes dip 55 degrees northeast.

No generalizations can be made about major structures within the Oblique Creek Formation other than that the strata generally trend north-westerly and dips are commonly steep. On a small scale rocks are highly deformed and in some places refolded tight folds have been observed. Local east-west attitudes may reflect the presence of steeply plunging folds. Strong foliation in schists and gneisses along and near Cottonwood River dip steeply and, with few exceptions dip to the east.

Massive to thick-bedded rocks of the Nazcha Formation appear to be tightly folded about one or more northwesterly trending axes. No small scale deformation was observed but this may be the result of the competency of these rocks.

The detailed structure of the Kedahda Formation is complex. The beds commonly dip steeply and tight folds are abundant. In stream cuts west of Badman Point a steeply dipping, northwest-trending cleavage is offset in places by a steeply dipping east-northeast trending strain-slip cleavage. This relationship seems to be consistent over a considerable area.

Although tight folding and repetition of strata almost certainly occur throughout the Kedahda Formation, a regional dip to the southwest is indicated by the distribution of the Kedahda and overlying Teslin formations.

As noted by Watson and Mathews (1944) the contact between the Kedahda and Shonektaw formations is a fault. Farther southeast several northwest-trending rusty weathering shear zones were observed in Glundebery Batholith. One of these zones, east of the lakes at the head of Tahoots Creek, is about 200 feet wide and is marked locally by cherty mylonitic rocks that display horizontal slickensides trending parallel with the shear zone.

In summary, the structural style northeast of Cassiar Batholith is characterized by relatively simple major and minor structures with the exception locally of rocks near the batholith. In contrast, the structural style west of the batholith is characterized by intense folding commonly evident on a scale of individual outcrops.

TECTONIC DEVELOPMENT

Several aspects of the geology of Jennings River map-area are of considerable significance with respect to the tectonic development of the northern Canadian Cordillera. These may be discussed under the categories of sedimentation, intrusive and metamorphic activity, and structure.

SEDIMENTATION

The character of Middle Devonian and older strata northeast of Cassiar Batholith reflects quiescent conditions of deposition on a slowly subsiding relatively stable shelf or platform (Cassiar Platform; Gabrielse, 1967). Temporary increased subsidence of the platform is indicated by the presence of Ordovician and Early Silurian graptolitic shale and siltstones. During the Late Devonian(?) the former platform subsided rapidly and received a thick sequence of mainly noncalcareous, clastic rocks and bedded cherts. The sequence is commonly fine grained in the lower part but includes much grit and chert-pebble conglomerate in the upper part. The enormous volume of these clastic sediments in the northern Cordillera demands corresponding great uplift and erosion of extensive source areas, probably lying to the west.

The oldest strata exposed southwest of Cassiar Batholith in Jennings River map-area are probably those in the core of a major anticline west-northwest of Klinkit Lake. The stratigraphic sequence there appears to be unique and its age is of critical importance because one of the units, a pebble- and cobble-conglomerate, as much as 500 feet thick, contains well rounded clasts of distinctive, crossbedded, orange weathering dolomitic sandstone and sandy dolomite, quartzite, grey phyllite, and quartz-mica schist. The stratigraphic position and composition of the conglomerate indicate uplift during the Mississippian(?) of a terrain, possibly of pre-Mississippian age, that included metamorphic rocks. No volcanic material was observed in the conglomerates.

Mississippian(?) volcanism northeast of Cassiar Batholith was characterized by the submarine extrusion of massive flows and, in places, thick accumulations of agglomerate. Near Smart River and west-northwest of Klinkit Lake, however, great thicknesses of graded-bedded tuff were deposited. Ultramafic rocks in the Sylvester Group show a close spatial relationship with volcanic rocks, and commonly occur a short distance stratigraphically above the base of the oldest volcanics.

Volcanism appears to have been generally of little importance during post-Sylvester and pre-Permian time when great thicknesses of fine-grained clastic rocks, ribbon cherts, and some important limestone members were deposited. Environments of deposition may have ranged from relatively deep water for the cherts to shallow water for the limestones. Local emergence is attested by conglomerates, in places containing well-rounded cobbles, overlying limestone east of Screw Creek.

The Kedahda and Teslin formations with associated volcanic rocks are the uppermost units in the map-area that were deposited in the deeply subsiding Carboniferous and Permian eugeosyncline. The subsequent depositional record is fragmentary and the relationships between Paleozoic and Mesozoic strata are poorly shown.

Volcanic conglomerates and massive augite porphyry of the Nazcha and Shonectaw formations probably lie near the northeastern limit of Late Triassic volcanic activity in this part of the Cordillera.

The non-volcanic Lower Jurassic(?) strata, unconformably overlying late Paleozoic rocks north of McNaughton Creek, mark the first important influx of potash feldspar into the sedimentary sequence.

INTRUSIVE AND METAMORPHIC ACTIVITY

The belt of regionally metamorphosed rocks trending diagonally across the map-area from northwest to southeast was established at least by Late Triassic time. Preliminary data on the major granitic plutons suggests an age range from possibly Early Jurassic to latest Cretaceous or Early Tertiary and a change in composition reflected mainly by a marked increase in potash content with decreasing age. Numerous centres of predominantly basaltic volcanism were established during the Late(?) Tertiary presumably the result of post-tectonic extension.

STRUCTURE

Many structures were clearly established prior to the emplacement of granitic plutons as old as Early Jurassic. Significant deformation of Permian strata probably took place in pre-Late Triassic time. Tight folding of Upper Triassic and Lower Jurassic(?) rocks indicates a period of deformation between Early Jurassic and mid-Cretaceous time. Lower Jurassic(?) rocks north of McNaughton Creek appear to be less tightly folded than underlying late Paleozoic strata. Some deformation accompanied granitic intrusion but resultant structures appear to be local.

ECONOMIC GEOLOGY

Silver-Lead-Zinc. Several silver-lead-zinc showings occur northeast of Cassiar Batholith near Tootsee River. On the Silvertip Group about 4 miles northeast of Tootsee Lake exploration work, including surface trenching and diamond drilling, and underground diamond drilling from an adit, has revealed an extensive gossan zone at or near the contact between carbonates of the Middle Devonian McDame Group and overlying fine-grained clastic rocks of the Upper Devonian(?) lower Sylvester Group. Ore minerals include galena, sphalerite and possibly tetrahedrite. Relatively high silver assays have been obtained and considerable tin is present in samples analyzed spectrographically (R. Mulligan, personal communication, 1968).

A fault marks the contact between the McDame and Sylvester groups and, in addition, the strata are cut by a major northerly trending, steeply dipping fault along which the east side has been relatively downthrown. Therefore, the general stratigraphic interval that is mineralized west of the fault must lie at some depth east of the fault.

Exploration work on the Amy Claims 2 miles northwest of the north end of Tootsee Lake has included trenching, diamond drilling, and underground work. Galena, sphalerite, pyrrhotite, ankerite or siderite and silver-bearing tetrahedrite, occur in a strong shear zone trending west-northwest, parallel with the contact of Cassiar Batholith, and dipping about 60 degrees southwest (Holland, 1966). The host rocks, possibly of Cambrian age, comprise phyllite, argillite, quartzite, and limestone locally altered to hornfels, micaceous quartzite, schist, and crystalline limestone. Much of the mineralization occurs as a replacement of limestone along or near a contact with argillite. At least three fine-grained, greenstone sills, ranging from 3 feet to 25 feet wide and locally containing pyrite and pyrrhotite occur in the

contact-metamorphosed rocks. An aplite dyke, 4 feet wide, and a dyke of fine-grained biotite granodiorite about 10 feet wide also occur within the metamorphic aureole of the batholith.

Trenching has been carried out on a silver-lead showing about 5 miles north-northeast of the north end of Tootsee Lake. There, a gossan in Middle Devonian carbonates of the McDame Group contains galena.

Two quartz-galena veins cut rusty weathering sheared quartz monzonite of the Cassiar Batholith just south of the British Columbia-Yukon Territory boundary at the headwaters of the west fork of Freer Creek (Hemsworth, 1950). The galena contains appreciable silver. The upper vein, near the crest of the mountain at an elevation of about 6,000 feet, strikes north 35 degrees east and dips vertically and is exposed over a width of 6 feet and a length of 10 feet. The lower vein, at an elevation of about 5,000 feet, strikes north 65 degrees east and dips 80 degrees south. It has been exposed by trenching over a width of 4 feet and a length of 150 feet.

Watson and Mathews (1944) reported the presence of sparse galena and sphalerite in a garnet-idocrase (vesuvianite)-diopside-calcite skarn at the head of a cirque 4 1/2 miles north of Ash Mountain.

Copper. Chalcopyrite occurs in rocks of the Big Salmon Complex on a ridge about 5 1/2 miles east of Swift Lake. Samples seen by the writer include garnet-diopside and garnet-diopside-magnetite skarn with disseminated chalcopyrite. Exploration work was carried out on the property during the 1967 field season. Watson and Mathews (1944) report the local occurrence of chalcopyrite and bornite along the southeastern side of Christmas Creek valley within the batholith.

Molybdenum. Molybdenite occurs in quartz monzonite along the eastern contact of Cassiar Batholith northwest of Tootsee River and just east of Jennings River map-area southeast of Toozaza Creek (Wolfe, 1965). A small rounded boulder of fine-grained, rusty granitic rock found on the beach at the west end of Swan Lake contains abundant disseminated molybdenite. If the boulder was naturally transported the most probable source was probably to the south or southwest.

Tungsten. Exploratory work, including trenching and diamond drilling, has been carried out on the Blue Light mineral claims in the shear zone along the west side of Cassiar Batholith 2 miles southeast of Little Rancheria River. There, scheelite is found in a skarn, intimately associated with feldspar augen-gneiss that has been cut by coarse muscovite-feldspar-quartz pegmatites. Scheelite is reported to occur in pyrrhotite-bearing, interbedded hornfels, quartzite and crystalline limestone along the southwest contact of Nome Lake Batholith about 8 miles north-northwest of the west end of Klinkit Lake. Skarn, and white quartz veinlets cutting skarn contain small amounts of scheelite 1 mile north of Ash Mountain (Watson and Mathews, 1944). They also reported traces of scheelite in skarn along the west contact of Parallel Creek Batholith about 2 miles southeast of Ash Mountain.

Beryllium. Minor crystals of beryl are present in pegmatites on the Blue Light property described above. Green amazonite occurs in pegmatite north of Ash Mountain and has been mistaken for beryl (R. Mulligan, personal communication, 1967). Beryllium does occur, however, as a trace element in vesuvianite in the same locality.

Tin. Spectrographic analyses reveal the presence of tin in skarns north of Ash Mountain (Mulligan and Jambor, 1968). The tin is believed to occur mainly in garnet and epidote.

Fluorite. Colourless fluorite forms colloform masses and lines vugs in breccia at the head of the stream that flows through the Blue Light property. East of the property muscovite quartz monzonite forming a body of unknown extent in Cassiar Batholith contains appreciable amounts of accessory fluorite.

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