Unedited report to accompany Open File 381

PRE-CENOZOIC VOLCANIC ASSEMBLAGES OF THE KLUANE AND ALSEK RANGES, SOUTHWESTERN YUKON TERRITORY

P.B. Read and J.W.H. Monger

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ABSTRACT

Volcanic rocks which were mapped or correlated with the former "Mush Lake Group" contain a number of copper deposits. This field study provides a new geological framework within which to assess the mineral potential of these and adjacent rocks. Two major faults divide the map-area into three northwesterly trending blocks: (a) the western Alexander Terrane separated by the Duke River Fault from (b) the central Taku-Skolai Terrane which is juxtaposed by the Shakwak-Dalton Fault against the (c) eastern Gravina-Nutzotin Belt. A Cambro-Ordovician to Devonian eugeosynclinal assemblage and disconformably(?) overlying Devonian to (?) Carboniferous limestone-shale sequence comprise the polydeformed schist and phyllite sequence of the Alexander Terrane. Pennsylvanian (?) volcanics and Lower Permian sediments compose the Skolai Group which disconformably underlies Middle Triassic argillite, Nikolai Greenstone, Chitistone and Nizina Limestones, and McCarthy Formation of Late Triassic age, and grey phyllite which is possibly as young as the Lower Cretaceous Dezadeash Formation. Because rocks now known to be Cambro-Ordovician to Carboniferous (?) volcanics and limestone in the Alexander Terrane and Pennsylvanian (?) to Upper Triassic volcanics and sediments in the Taku-Skolai Terrane were erroneously assembled into and correlated with the "Mush Lake Group", the term is discarded. Marine flysch of the Dezadeash Formation dominates the Gravina-Nutzotin Belt. The Shakwak-Dalton Fault has a minimum right-lateral displacement of 300 km in Late Cretaceous. The Duke River Fault may be a strike-slip splay of the Dalton Fault.

Within the Alexander Terrane of the map-area, important mineral deposits are presently unknown. The Taku-Skolai Terrane hosts most of the lode deposits, such as: (a) Ni-Cu-Pt deposits at contacts of Permo-Triassic peridotite against Lower Permian sediments; (b) Cu deposits in Nikolai Greenstone; (c) Cu deposits in the Skolai Group; and (d) porphyry copper deposits. Of these (a) and (b) presently possess the greatest lode metal potential. To the west of the map-area in eastern Alaska, the Kennecott copper deposit and others lie in the Taku-Skolai Terrane, and within the map-area two deposits from (a) and (b) have produced. Since 1903 placer gold production has been and still is the economically viable mining activity of the map-area.

CONTENTS

Page

TABLES

MAPS

LIST OF ILLUSTRATIONS

FIGURES

PLATES

Page

Page

INTRODUCTION

The term "Mush Lake Group" has been applied to rocks exposed in the eastern ranges of the Saint Elias Mountains, between latitudes 60 and 62 degrees. Kindle (1953) introduced the term for an assemblage of volcanic and sedimentary rocks in southwestern Dezadeash map-area. The age of this assemblage was not known, but was inferred to be Triassic or Jurassic from its apparent position between possible Permo-Carboniferous rocks and known Lower Cretaceous rocks. Muller (1967) adopted this term for a succession of basic volcanics overlain by massive and thin-bedded carbonate and pelite of Late Triassic age in Kluane Lake map-area, north-northwest along strike from some of the rocks included in the group by Kindle. Muller (1967, p. 54) correlated his sequence with the Nikolai Greenstone and overlying Chitistone, Nizina and McCarthy Formations in the eastern Alaska Range, along strike to the northwest. Because rocks of the "Mush Lake Group" contain numerous copper showings, and the overlying Chitistone Limestone near McCarthy in eastern Alaska (Figure 1) contains the major Kennecott copper deposit, and evaluation of the mineral resource potential of these rocks was deemed essential before placement of boundaries for the proposed Kluane National Park.

In 1974 field work indicated that the Mush Lake Group included at least two sequences of very different ages (Read and Monger, 1975). Subsequent work in 1975 (Read, 1976) disclosed that it contained three or more volcanic assemblages of different ages, which are juxtaposed along major faults. Consequently there is no justification for retaining the term "Mush Lake Group" and rocks previously included in this group are subdivided into mappable sequences of known or inferred ages.

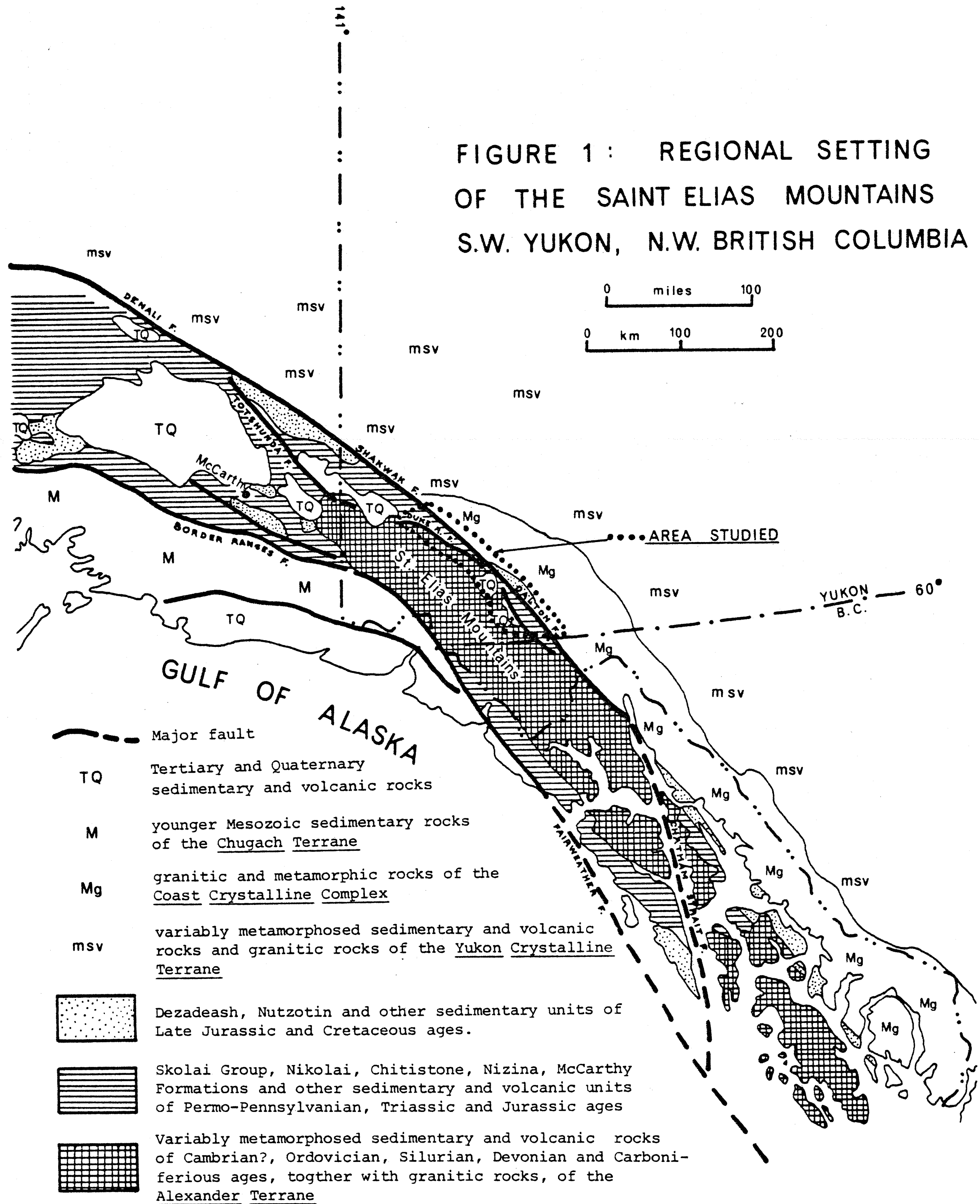


FIGURE 1: REGIONAL SETTING OF THE SAINT ELIAS MOUNTAINS S.W. YUKON, N.W. BRITISH COLUMBIA

REGIONAL SETTING

The regional setting of the Saint Elias Mountains and location of the area studied are shown on Figure 1. The outstanding feature of this region is the number of major, regional faults, most of which subparallel the regional trend and display evidence for dextral strike-slip movement. An example of such movement is apparent on Figure 1, where the geology on the west side of the Chatham Strait Fault is offset for about 100 km to the north relative to that on the east side. These faults separate the geology into a number of blocks. Within any one block the geology may be relatively uniform and rock units fairly continuous. By contrast, it is difficult or impossible to correlate lithological units between blocks. Even if rocks of the same age are present in adjacent blocks, they are stratigraphically dissimilar. The now discarded term "Mush Lake Group" spans a major fault - the Duke River Fault.

East of the Saint Elias Mountains lie the Yukon Crystalline Terrane (msv) and the north end of the Coast Crystalline Complex (Mg). The former consists of variably metamorphosed volcanic and sedimentary rocks of Proterozoic (?) to Late Paleozoic age cut by mainly Mesozoic granitic rocks (Tempelman-Kluit, 1976). The latter is mainly Mesozoic granitic rock but includes biotite-quartz schist that is a possible metamorphosed equivalent of the Dezadeash Group in the Saint Elias Mountains (Eisbacher, 1975).

The Saint Elias Mountains are bordered on the east by a single fault system called the Denali Fault in Alaska and Shakwak and Dalton Faults in Canada. These mountains consist of, easternmost, the narrow Taku-Skolai Terrane of mainly Permo-Pennsylvanian to Lower Cretaceous strata, the central, extensive Alexander Terrane of Cambrian (?) to Carboniferous rocks and the southwestern Chugach

Terrane of Cretaceous and Jurassic strata (Figure 1). Only rocks younger than Cretaceous are common to more than one of these terranes.

The Taku-Skolai Terrane (Berg et al, 1972), up to about 30 km in width, underlies the Kluane Ranges of the Saint Elias Mountains and extends south into Dezadeash map-area. It consists of probable Pennsylvanian and (?) Lower Permian volcanic rocks, Lower Permian sedimentary rocks, Middle Triassic pelite, Middle to Upper Triassic basalt, Upper Triassic carbonate and Upper Triassic, Upper Jurassic and Lower Cretaceous pelite and sandstone, locally cut by granitic rocks and metamorphosed (Table 1). Although no definite pre-Permian rock is known, a presently undated gabbro complex, which extends into Southeastern Alaska, underlies Lower Permian sediments. The Shakwak and Dalton Faults bound this terrane on the northeast and the Duke River truncates it on the southwest.

The Alexander Terrane (Berg et al, 1972) forms the extensive area underlying the Icefield Ranges of the Saint Elias Mountains. In Canada, it consists of Cambrian or Lower Ordovician volcanics, Silurian(?), Devonian and (?) Carboniferous carbonate, pelite and volcanics, metamorphosed to greenschist facies and cut by granitic rocks of Permian and younger ages. This constitutes the northern part of the Alexander Terrane that underlies much of the Alexander Archipelago of southeastern Alaska (Figure 1).

The Mush Lake Group of Kindle (1953) and Muller (1967) spans both of these terranes. Because Triassic rocks in the northern part of the Taku-Skolai Terrane called "Mush Lake Group" by Muller (1967) can be correlated unit for unit with formations in the eastern Alaska Range that have long been defined (Moffit and Capps, 1911), p. 11), the term "Mush Lake Group" has been dropped for these rocks

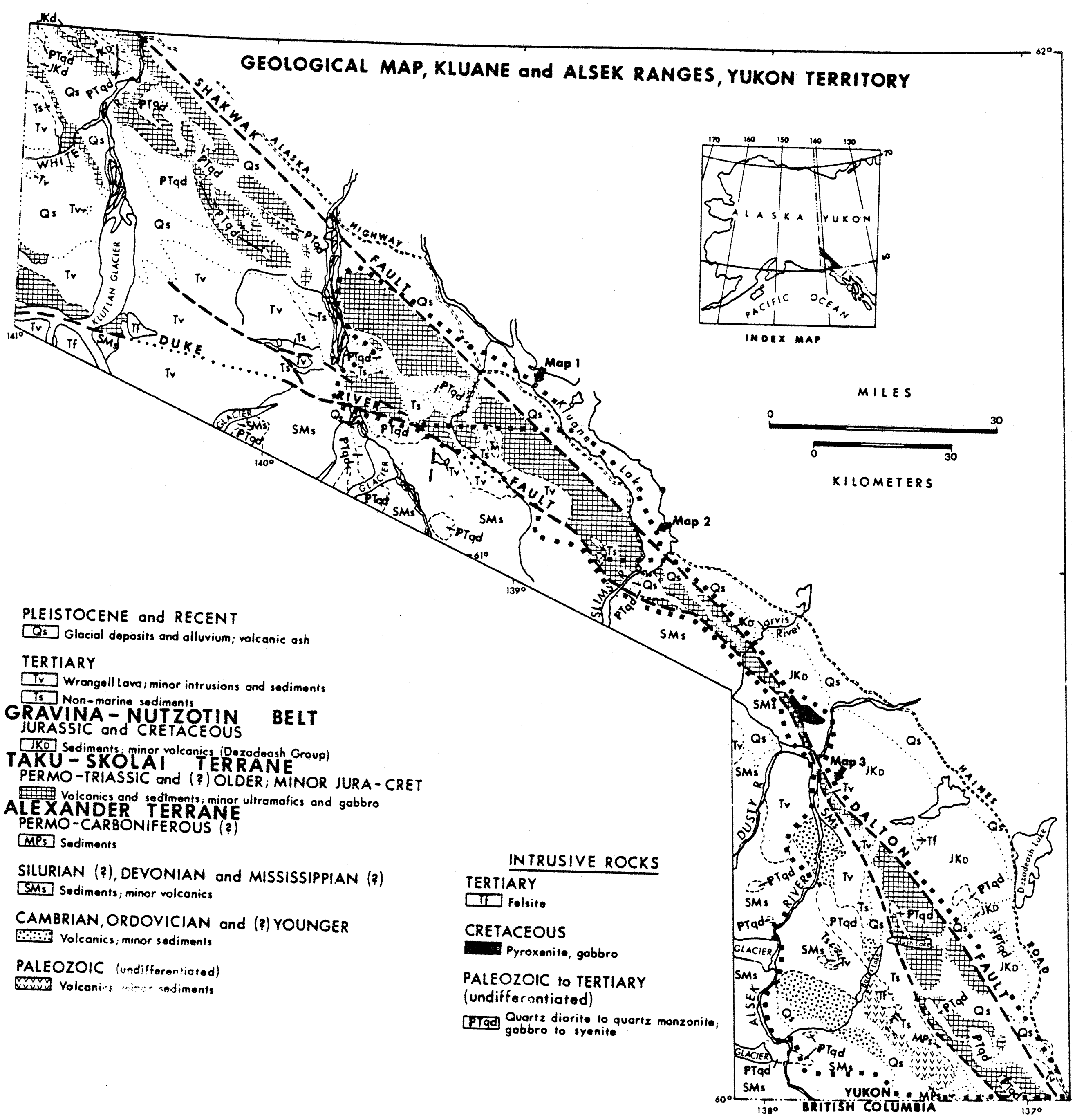

GEOLOGICAL MAP, KLUANE and ALSEK RANGES, YUKON TERRITORY
INDEX MAP
ALASKA
YUKON
PACIFIC OCEAN
MILES
KILOMETERS
SHAKWAK
ALASKA HIGHWAY
FAULT
DUKE RIVER FAULT
DALTON FAULT
HAINES ROAD
Map 1
Map 2
Map 3
Kluane Lake
YUKON
BRITISH COLUMBIA
PLEISTOCENE and RECENT
Qs Glacial deposits and alluvium; volcanic ash
TERTIARY
Tv Wrangell Lava; minor intrusions and sediments
Ts Non-marine sediments
GRAVINA-NUTZOTIN BELT
JURASSIC and CRETACEOUS
JKD Sediments; minor volcanics (Dezadeash Group)
TAKU-SKOLAI TERRANE
PERMO-TRIASSIC and (?) OLDER; MINOR JURA-CRET
Volcanics and sediments; minor ultramafics and gabbro
ALEXANDER TERRANE
PERMO-CARBONIFEROUS (?)
MPs Sediments
SILURIAN (?), DEVONIAN and MISSISSIPPIAN (?)
SMs Sediments; minor volcanics
CAMBRIAN, ORDOVICIAN and (?) YOUNGER
Volcanics; minor sediments
PALEOZOIC (undifferentiated)
Volcanics; minor sediments
INTRUSIVE ROCKS
TERTIARY
Tf Felsite
CRETACEOUS
Pyroxenite, gabbro
PALEOZOIC to TERTIARY (undifferentiated)
PTqd Quartz diorite to quartz monzonite; gabbro to syenite

FIGURE 2

and American formation names are used to reduce confusion produced by two sets of stratigraphic names for the same succession of rocks. These and probable Pennsylvanian rocks continue southwards into the Dezadeash map-area, where they constitute the eastern part of Kindle's Mush Lake Group (Figure 2). The western part as mapped by Kindle, lies west of the Duke River Fault (Read, 1976), and contains fossiliferous rocks of Late Cambrian (?) or Early Ordovician, Silurian (?), Devonian and Carboniferous(?) ages. Devonian carbonate in this sequence can be mapped into identical carbonate included in the Kuskawalsh Group by Kindle. West and northwest of Dezadeash map-area, the Kaskawalsh Group outcrops extensively west of the Duke River Fault and may constitute a major part of the Alexander Terrane. Because of this confusion the term "Mush Lake Group" is abandoned for the western part as well, and rocks previously forming the western part of the Mush Lake Group in Dezadeash map-area are referred to as "Paleozoic rocks of Alexander Terrane."

ALEXANDER TERRANE

The Alexander Terrane consists of a pre-Devonian eugeosynclinal assemblage underlying a carbonate, shale and sandstone of Devonian and (?) Carboniferous age. The sequence has been complexly deformed, metamorphosed to greenschist facies, intruded by Late Paleozoic to Tertiary plutons, and partly covered by Tertiary sedimentary and volcanic rocks. Stratigraphic relations are summarized in Table I.

Pre-Devonian Assemblage (ЄDv, ЄDs, ЄOv, ЄOc, ЄOwp):

This assemblage outcrops between Alsek River and Bates Lake-Wolverine Creek (Map 3A) but is best exposed along Alsek

River between Raft Creek and Bates River. It exceeds 4,000 m in thickness and the base is not exposed.

The lowest unit (ЄOwp) is an unfossiliferous sequence of greywacke and grey phyllite with sparse conglomerate layers. Its minimum thickness of 1,100 m is best displayed along Alsek River south of Raft Creek. Here it passes into overlying volcanics which have bedded tuffs intercalated with flows for the first hundred meters.

Along Alsek River 1,500 to 2,000 m of grey-green massive and commonly porphyritic (plagioclase) meta-andesite (ЄOv) outline a major anticline (Map 3A, Figure 3). Scattered sections of pillow lava (Plate 1) up to 30 m thick give facing directions. South of Field Creek correlative volcanics contain local breccia horizons and amygdaloidal and reddened flow tops, but lack pillow lava. Rare thin-bedded limestones (ЄOc) are either lenses or, less likely, infolds of Devonian limestone. At one locality flows are interbedded with fossiliferous limy tuffs up to 20 m thick which yield a brachiopod fauna of Late Cambrian or Early Ordovician age (F102).

South of Raft Creek and opposite the mouth of Marble Creek, the Alsek River exposes up to a 1,500 m thickness of unfossiliferous clastic sedimentary rocks (ЄDs). They range in composition from massive tuffaceous greywacke and minor phyllite to massive, nonbedded siltstone. The base is placed at the top of the uppermost flow of unit ЄOv, and the top at the base of the overlying Devonian limestone (Dc).

Greenschist and greenstone of unit ЄDv outcrops only at the north end of the Alsek Ranges where limited study renders correlation of this volcanic unit to other volcanic units uncertain.

Devonian Limestone (Dc):

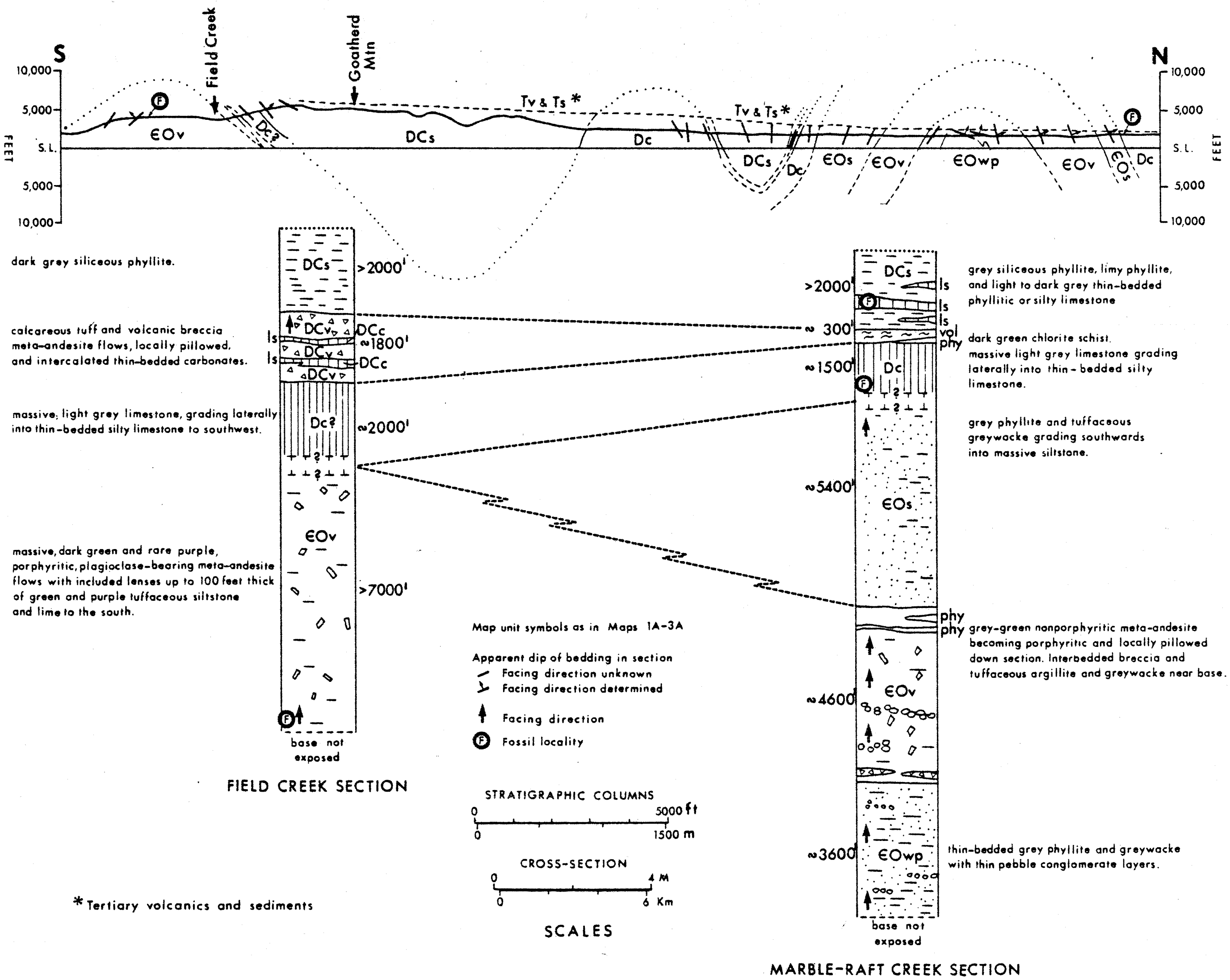
A massive white to light grey weathering limestone lies along the eastern side of the Alexander Terrane where it is well-exposed along the Alsek, Kaskawulsh, and Duke Rivers (Maps 2A and 3A) (Campbell and Dodds, 1975, p. 51). Medium to dark grey limestone is rare. Kindle (1953, p. 29) designated this carbonate together with minor zones of slate, quartzite and argillite as the Kaskawulsh Group. We have mapped the carbonate separately from the widespread, surrounding meta-sedimentary rocks. The limestone is sparsely fossiliferous and yields fauna of Devonian and (?) Silurian age. Wherever faunal assemblages are specific they give a Middle Devonian age.

Devonian and (?) Carboniferous Assemblage (DCp, DCv, DCc, DCs):

This assemblage of meta-pelite, limestone and minor metavolcanic rocks corresponds closely to Kindle's Dezadeash Group as mapped west of the Duke River Fault. It is well-exposed northwest of Bates Lake to and beyond the Alsek River (Map 3A) and probably greatly exceeds the 1,000 m thickness shown in Figure 3.

Unit DCv varies in thickness and lithology between Bates Lake and Marble Creek. At Bates Lake and Field Creek light to medium grey-green, layered tuff and breccia with calcite cement, calcite amygdule flows, and rare pillow lava comprise the unit (Plate 2). Thin-bedded, cream to grey limestones (DCc) are interbedded with the metavolcanic rocks. Northwestward near Marble Creek, dark green chlorite-actinolite schist and thin white marble lenses form unit DCv. Accompanying the lithologic change is a northwestward thinning from 600 m to 100 m.

North of Field Creek, dark grey phyllite (DCp) up to 500 m thick overlies volcanics (DCv) and carbonates (DCc). DCp thins



GEOLOGIC CROSS-SECTION of PALEOZOIC ROCKS EXPOSED ALONG ALSEK RIVER (115A)

Figure 3

northwest towards Alsek River and dies out northward probably through a facies change into medium to light grey phyllite, limy phyllite and thin-bedded phyllitic limestone which comprise unit DCs (Plate 3). Where thin-bedded, phyllitic limestone is sufficiently thick it is mapped separately as unit DCc.

Undifferentiated Paleozoic Units (Ppw, Pv, Pc, Pw):

These units, of which Ppw and Pv are extensive and thick, are unfossiliferous and of uncertain or unknown relation to the previously described units.

Northwest of Alsek and Dezadeash Rivers and southwest of Duke River Fault, massive Devonian carbonate (Dc) lies in grey phyllite, meta-sandstone and minor meta-grit of unit Ppw. (Map 1A, 2A, 3A). The complex deformation of these rocks renders uncertain their position above and/or below the Devonian carbonate. The lack of metavolcanic rocks in unit Ppw favours a position of part of it above unit Dc (Campbell and Dodds, 1975, p. 51) and its correlation to unit DCs.

Between Bates Lake and Tatshenshini River basic flows, pillow lava and breccia of unit Pv outcrop beneath an extensive Tertiary cover. The metavolcanics are dark grey-green, massive and moderately porphyritic (pyroxene). The Devonian carbonate appears to underlie them. The only Devono-Carboniferous volcanic unit (DCv) is lithologically dissimilar.

Massive greenschist, lacking textures of volcanic flows, may represent meta-greywacke and meta-tuff. Although of limited extent to the northwest of Kaskawulsh River (Map 3A) and Bullion Creek (Map 2A), these rocks form an important unit in the eastern part of the Alexander Terrane (Campbell, pers. comm., 1975).

Scattered unfossiliferous carbonates of uncertain correlation belong to unit Pc.

TAKU-SKOLAI TERRANE

The stratigraphy of the Taku-Skolai Terrane between the Shakwak-Dalton and Duke River Faults is summarized in Table I. These formations are described below from oldest to youngest.

Pre-Permian Gabbro Complex (Pb):

The apparently oldest rock unit exposed in the Taku-Skolai Terrane is a gabbro and diabase complex. This lies nonconformably below sandstone and conglomerate of the Hasen Creek Formation of Early Permian age (the upper part of the Skolai Group), on the mountain northwest of the confluence of Steele Creek and the valley of the Donjek River (Map 1A).

This complex ranges from very coarse-grained gabbro to diabase. The coarse-grained rocks are excellently exposed on the north bank of Steele Creek, just before it debouches into the Donjek valley (Plate 4). Many have a coarse-grained diabasic texture, and consist of 60-70% interlocking, greenish black, hornblende pseudomorphing clinopyroxene grains up to 3 cm across, with up to 30% ophitic plagioclase laths up to 2 cm long. Other rocks are mainly hornblendite with local veins and patches of plagioclase-rich material. In thin section scattered patches of serpentine suggest that olivine was originally present in subordinate amounts. Diabasic rocks outcrop subjacent to the Lower Permian nonconformity (right-hand peak in Plate 4) and are massive, fine-grained, greenish-grey rock. Equigranular, gabbro is present but subordinate to other rock types. All rocks are highly fractured, locally faulted, and cut by veins of calcite, epidote and chlorite.

This complex differs from the numerous younger gabbro intrusions in the following ways: (1) It is a single mass of considerable thickness, in excess of 1,200 m (Plate 4), and is overlain, not intrusive into Permian strata. The younger gabbro forms sills up to 600 m thick which clearly intrude surrounding strata. (2) Rocks of the gabbro complex are altered, commonly greenish, and irregularly fractured. The younger gabbro tends to be grey with columnar jointing that is normal to bedding in enclosing strata. (3) Texture and grain size of the gabbro complex is variable, whereas those of the younger gabbro tend to be of uniform and fine to medium grain.

Sharp (1943, p. 19) originally recognized that these rocks are overlain by Permian sedimentary rocks of the Hasen Creek Formation. The contact (Plates 4 and 5) is sharp and commonly overlain by conglomeratic, calcareous sandstone or locally by reddish carbonate. Sharp (1943, p. 19) believed that these rocks intruded Devonian rocks, now included in the Alexander Terrane, but the two are separated by the Duke River Fault.

The age of this complex is not known, but possibly it is the basement of the Skolai Group. Lithologically similar rocks exposed 25 km (15 miles) west of McCarthy, Alaska have preliminary age dates that suggest they are of Permo-Pennsylvanian age (MacKevett, pers. comm.). Possibly they are the basement of the Station Creek Formation, the lower part of the Skolai Group, that here was uplifted and eroded off, prior to deposition of the Hasen Creek Formation.

Skolai Group (Psp to Psv):

The Skolai Group was defined by Smith and MacKevett (1970) from a thick sequence of predominantly volcanic and volcaniclastic rocks exposed along the upper reaches of Skolai Creek, 40 km northeast of McCarthy, Alaska. It is divisible into two formations. The lower, Station Creek Formation, named from a creek located 46 km northeast of McCarthy, consists of a lower member of basic to intermediate porphyritic flows with plagioclase and pyroxene phenocrysts, and an upper member of volcanic rocks ranging from coarse breccia to fine tuff. The overlying Hasen Creek Formation, named after Hasen Creek located 35 km east northeast of McCarthy, consists of chert, black shale, sandstone, limestone and minor conglomerate and contains Lower Permian fossils. Lithology of these formations is summarized in Figure 4, taken from Smith and MacKevett (1970, p. Q4).

In Canada the Skolai Group displays two main facies, separated by Wade Mountain Fault, which is subparallel to the Shakwak and Duke River Faults (Map 1A). East of Wade Mountain Fault is a sequence very similar to that in Alaska with a lower volcanic formation and an upper sedimentary one. West of this fault the upper sedimentary formation either lies directly on the gabbro complex or it is truncated by the Duke River or Wade Mountain Faults (Maps 1A and 2A).

Station Creek Formation (Psv , Pssv):

This formation is best exposed along the eastern side of the area from the Donjek to the Slins River and from Jarvis River, through Mush Lake to and beyond the British Columbia-Yukon border. Pyroclastic rocks are widespread in the north (Map 1A) and flows are extensive in the south (Map 3A).

Pyroclastic rocks predominate in the north and flows are absent or rare. These rocks reach a maximum thickness of 1,000 m here (Map 1A) but the base is not exposed anywhere in the area studied. Where these rocks are undeformed they are medium grey-green, massive volcanic breccia with clasts up to 20 cm long of fine-grained basalt and augite- or plagioclase-porphyry (Plate 6). The breccia grades into lithic-vitric tuff with plagioclase crystals and

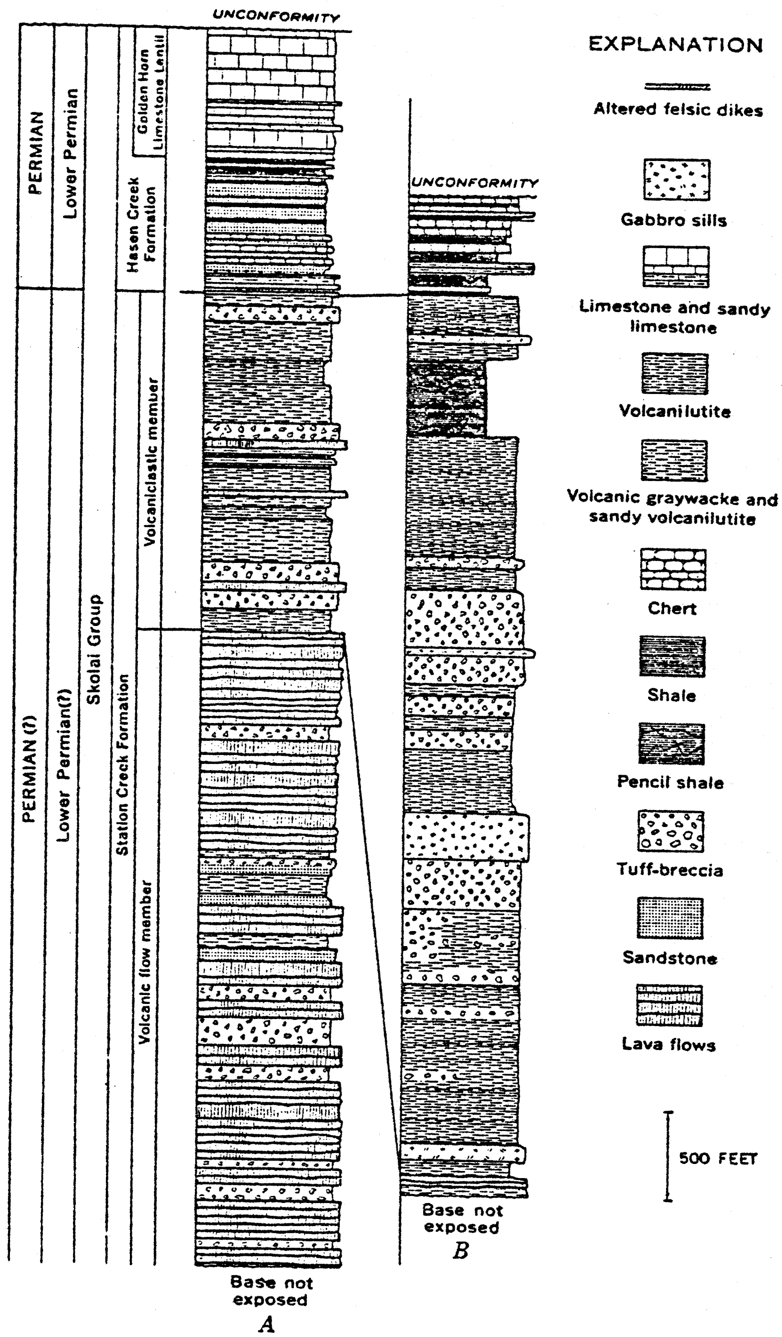


Figure 4: Generalized columnar sections of the Skolai Group in Alaska section A is from the type area (from Smith and MacKevett, 1970). Compare with Figure 5, which shows the Skolai Group in the Saint Elias Mountains.

amygdaloidal fragments before grading into well-layered, pale green to white siliceous tuff. Southwards between Duke and Slims Rivers, flows increase as pyroclastics diminish. The meta-andesite and meta-basalt flows, some of them pillow lava, contain augite phenocrysts and small chlorite amygdules. Volcanic breccia is still common but the thin-bedded tuff sequences, up to 100 m wide, thin and disappear south of Congdon Creek (Map 2A). Southwards in Dezadeash map-area (Map 3A), dark green massive flows with augite phenocrysts are widespread. Within the flows north of Mush Lake, a section of pillow lava and minor breccia comprise a sequence up to a few hundred meters thick and ten kilometers in length (Plate 7 and Map 3A).

Starting near the west end of Mush Lake, a sequence of volcanic breccia and layered tuff (Pssv) extends southeastwards to and beyond the British Columbia-Yukon border. These rocks are well-exposed on the shores of Mush Lake where they overlie the basic flows of unit (Psv). Unit Pssv might well pass upwards to the southwest into Hasen Creek Formation were it not truncated by the Duke River Fault. In the Dezadeash map-area (Map 3A) combined thicknesses of units Psv and Pssv yield a minimum of 3,000 m for Station Creek Formation in contrast to 1,000 m in the north.

Rocks of Station Creek Formation are phyllitic in the vicinity of faults such as Wade Mountain and Shakwak or where lithic tuff is widespread such as unit Pssv. In such areas, original phenocrysts become flattened chlorite blebs (Plate 8).

The contact of Station Creek Formation with the overlying sediments of Hasen Creek Formation is placed at the cessation of pyroclastic rocks. Where Nikolai Greenstone overlies Station Creek Formation, the boundary is placed at the first appearance of dark green amygdaloidal meta-basalt flows.

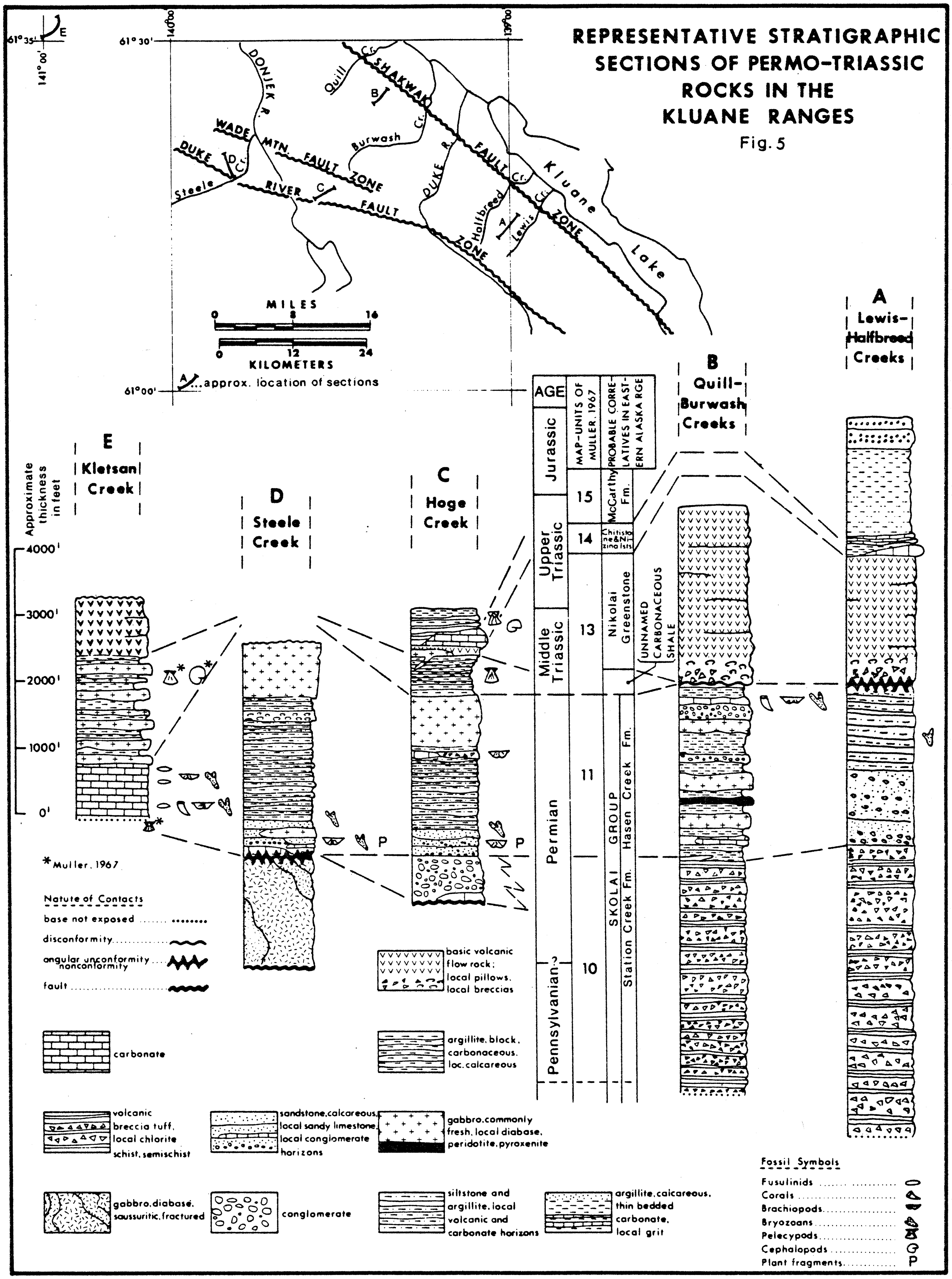
Within the map-area, Station Creek Formation is unfossiliferous. At least in part, it is probably Pennsylvanian and some of it may be Early Permian. In eastern Alaska Range, sparse fossil evidence in correlative rocks of the Tetelna Volcanics of the Mankomen Group (Richter and Dutro, 1975) suggests Station Creek Formation is probably Pennsylvanian.

Hasen Creek Formation (Psp to Pscg):

Hasen Creek Formation outcrops widely in the Kluane Ranges where it has a maximum thickness of approximately 800 m. Typical sections are summarized in Figure 5.

Southwest of Wade Mountain Fault (Map 1A and 2A), where the basement of gabbro complex is exposed, the sequence fines upwards from pebble and cobble conglomerate, locally with clasts derived from the underlying basement (Pscg) (Plate 9), sandstone (Pss), and fossiliferous arenaceous limestone (Psc) to buff-weathering siliceous argillite and siltstone (Psp) (Plate 10). Near the top of the worm-burrowed siltstone and siliceous argillite sequence are thin lenses of volcanic breccia and pillow basalt (Psv) or thin-bedded bioclastic limestone (Psc). Gabbro (b) and ultramafic (ub) sills up to 300 m thick intrude, bleach, and hornfels the adjacent siliceous argillite (Plate 10).

East of Wade Mountain Fault, the upward decrease in clast size from pebble conglomerate to olive green argillite continues as far eastward as upper Lewis Creek (Map 2A). North and east of here Hasen Creek Formation is entirely argillite and siltstone with rare limestone lenses (Map 1A and 2A). Southeastwards in the lower part of Nines Creek (Map 2A), Hasen Creek Formation is absent between Nikolai Greenstone and Station Creek Formation, but this is only local and sediments and volcaniclastic rocks of Hasen Creek Formation


REPRESENTATIVE STRATIGRAPHIC SECTIONS OF PERMO-TRIASSIC ROCKS IN THE KLUANE RANGES
Fig. 5
SHAKWAK FAULT ZONE
DUKE RIVER FAULT ZONE
WADE MTN. FAULT ZONE
Kluane Lake
DONJEK R.
DUKE R.
Quill Cr.
Burwash Cr.
Steele Cr.
Halfbreed
Lewis Cr.
MILES
KILOMETERS
approx. location of sections
E Kletsan Creek
D Steele Creek
C Hoge Creek
B Quill-Burwash Creeks
A Lewis-Halfbreed Creeks
Approximate thickness in feet
AGE
MAP-UNITS OF MULLER, 1967
PROBABLE CORRELATIVES IN EASTERN ALASKA RGE
Jurassic
Upper Triassic
Middle Triassic
Permian
Pennsylvanian-?
McCarthy Fm.
Chitistone&Nizina lsts
Nikolai Greenstone
UNNAMED CARBONACEOUS SHALE
SKOLAI GROUP
Hasen Creek Fm.
Station Creek Fm.
*Muller, 1967
Nature of Contacts
base not exposed
disconformity
angular unconformity nonconformity
fault
basic volcanic flow rock; local pillows, local breccias
argillite, block, carbonaceous, loc. calcareous
carbonate
volcanic breccia tuff, local chlorite schist, semischist
sandstone, calcareous, local sandy limestone, local conglomerate horizons
gabbro, commonly fresh, local diabase, peridotite, pyroxenite
gabbro, diabase, saussuritic, fractured
conglomerate
siltstone and argillite, local volcanic and carbonate horizons
argillite, calcareous, thin bedded carbonate, local grit
Fossil Symbols
Fusulinids
Corals
Brachiopods
Bryozoans
Pelecypods
Cephalopods
Plant fragments

reappear south in Dezadeash and Kaskawulsh map-areas (Map 3A).

The age of Hasen Creek Formation is Early Permian as first suggested by Muller (1967, p. 42). Wherever diagnostic faunas were collected in this study, this age was substantiated.

Middle Triassic Argillite (mTRp):

In the northwest corner of Kluane map-area, Muller reported possible Middle Triassic rocks (1967, p. 49) based on the presence of poorly preserved Daonella. This study substantiates the presence of Middle Triassic rocks as lenses up to a few hundred metres thick within several kilometers to the northeast of Duke River Fault. Dark grey phyllite, locally limy, and some thin grey limestones host Daonella-rich layers (F26). No obvious break separates buff-weathering, siliceous argillite of Hasen Creek Formation (Psp) from the grey-weathering Middle Triassic argillite (Plate 11). Where Nikolai Greenstone overlies Middle Triassic rocks, a breccia or conglomerate with angular volcanic clasts marks the base of the Nikolai.

Nikolai Greenstone (uTRNv):

Nikolai Greenstone outcrops extensively in the Kluane Ranges north of Jarvis River (Maps 1A, 2A, and 3A), but southeastwards in Dezadeash map-area, lithologically similar rocks are restricted to a fault slice adjacent to the Dalton Fault. The formation varies in thickness particularly in Hoge Creek Syncline where it is locally absent (Plate 11). Elsewhere it is up to a thousand metres thick. Grey-green volcanic breccia and pillow lava develop in the basal 100 m and underlie the rest of the formation of maroon and dark green amygdaloidal meta-basalt flows (Plate 12). Locally hematite-rich tuff and breccia or amygdule-rich zones separate flows ranging from 2 to 10 m thick. Apparently the basal part of the formation was deposited subaqueously but the bulk of the formation may have been deposited subaerially. Nikolai Greenstone is typically a sparsely porphyritic (augite and plagioclase) meta-basalt with large amygdules of chlorite, pumpellyite, prehnite, quartz, albite, epidote and quartz. Zeolites are absent and mineral assemblages of the prehnite-pumpellyite facies are widespread. Northeast of Tatamagouche Creek (Map 1A) a thin-bedded bioclastic limestone (uTRnc) and green and maroon shale are interbedded with Nikolai flows near the top of the formation. These sediments, less than 30 m thick, extend northwesterly for 10 km before truncation by faulting.

Although dating of units below and above the Nikolai Greenstone as Middle and Upper Triassic respectively, permit a Middle Triassic age for the Nikolai Greenstone, faunas (F9, F11) from the interbedded limestone (uTRnc) yield a Late Karnian or Early Norian age and suggest that the Nikolai is Upper Triassic.

Chitistone and Nizina Limestones (uTRcc and uTRce):

Massive light grey limestone outcrops throughout the Kluane Ranges to as far south as halfway between the Slims and Jarvis Rivers (Map 3A). Thickness is extremely variable from several hundred metres near the turn in Duke River (Map 2A; Plate 13) to discontinuous lenses (Plate 11), but regionally the formation thins northeastward. In the southwest within several kilometers of Duke River Fault, massive limestone and limestone breccia (Plate 14) up to 400 m thick conformably overlie Nikolai Greenstone and underlie the McCarthy Formation. Northeastwards the massive limestone thins to 30 m or less, forms lenses, and contains bioclastic layers.

Gypsum and anhydrite form a lens 7 km long and up to 1 km in width between the Duke River Fault and possibly overlying Chitistone Limestone (Plate 15). At McCarthy, Armstrong et al (1969) demonstrated a shallow-water environment for the deposition of the Chitistone and Nizina Limestones and postulated a sabhka environment for the lower part of the Chitistone Limestone which contains the Kennecott copper deposit. In the Kluane Lake section of the Taku-Skolai Terrane, the same depositional environment probably extended along the southwestern side of the Terrane with water deepening to the northeast. The thick gypsum truncated by the Duke River Fault would represent deposition in the sabhka environment postulated for the lower part of the Chitistone Limestone at McCarthy. Samller lenses, up to a few hundred metres long, outcrop in Maple and Wade Creeks and Bock's Brook in contact with Upper Triassic and Lower Permian rocks.

Chitistone and Nizina Limestones, nearly devoid of macrofauna except F34, locally contain abundant microfauna indicating a Latest Karnian to Early Norian age (F25, F47, F62, F63). Because of intense deformation in the mapped area, Chitistone and Nizina Limestones are not separated as they are in their type locality near McCarthy in the eastern Alaska Range (Moffit, 1938).

McCarthy Formation (u$\bar{R}$mc):

Within 6 km of the Duke River Fault and northwest of Slims River, thin-bedded limestone of the McCarthy Formation usually overlies Chitistone Limestone only where the Chitistone is thick. Light to dark grey argillaceous limestone interbedded with dark grey argillite produces a distinctively striped "pajama rock" ranging from tens to hundreds of metres in thickness (Plate 16). Within a hundred metres of the base of the McCarthy Formation, thin shell-beds containing Monotis subcircularis Gabb yield a Late Norian age for the lower limestone-rich section of the McCarthy Formation. The upper grey phyllite section of the McCarthy Formation grades imperciptibly into Jurassic (?) rocks and the Dezadeash Formation. Because these rocks are indivisible and rarely fossiliferous, they are mapped together as unit uTrKp. It cores synclines northwestward from Jarvis River. Nonbedded, dark grey phyllite dominates the unit and minor conglomerate and greywacke complete it. Pebble conglomerate with a minor proportion of granitic clasts (Plate 17) outcrops within a hundred metres of the base of the unit, and the minor greywacke is rarely bedded (Plate 18). The few fossil localities (F8, F56) yield a Late Jurassic or Early Cretaceous age.

GRAVINA-NUTZOTIN BELT

Rocks of the Gravina-Nutzotin Belt lie on the northeast side of the Shakwak-Dalton Fault. The marine flysch of the Dezadeash Formation dominates the exposures.

Dezadeash Formation (lKDwp):

The formation is well-exposed on the southwestern flanks of the Shakwak Trench southeast of Jarvis River. It is a well-layered sandstone-shale sequence with sedimentary structures inherited during deposition from turbidity currents. As pointed out by Eisbacher (1975), small areas of coal-bearing sediments, once considered near the base of the formation (Kindle, 1953), are Tertiary continental clastic sediments preserved on the south-western edge of the Dezadeash Formation as fault slices in the Dalton Fault. Northeast of the map-area, on the southwestern wall of the Shakwak Trench between Jarvis and Dezadeash Rivers, Kindle's map unit 5 of peridotite and serpentine contains mainly metavolcanic rocks and probably corresponds to the Nikolai Greenstone. In this area of the Gravina-Nutzotin Belt, the complete thickness of the

Dezadeash Formation rests on probable Upper Triassic rocks. According to Eisbacher (1975), the Dezadeash Formation is well-layered. Sparse faunas from both unit uTRKp and the Dezadeash Formation yield Late Jurassic (?) and Early Cretaceous ages, but the nonbedded character of unit uTRKp contrasts markedly to the well-layered nature of the Dezadeash Formation. For this reason part of unit uTRKp may correlate to pre-Upper Jurassic sediments and not to the Dezadeash Formation.

ROCK UNITS COMMON TO THE ALEXANDER AND TAKU-SKOLAI TERRANES AND GRAVINA-NUTZOTIN BELT

Only the Tertiary cover is common to the three fault blocks. These Tertiary rocks, not the emphasis of this study, (see Eisbacher, 1975; Souther and Stanciu, 1975) are briefly described.

Amphitheatre Formation (Ts):

Continental clastic sediments are extensively preserved under Tertiary volcanic rocks in the Duke Depression (Maps 1A, 2A, and 3A), and as slivers along the Shakwak-Dalton Fault. Southeast of Bates Lake, the Duke Depression exposes a maximum thickness of 1,100 m of sediments. Sandstone, conglomerate, and shale were transported westward and deposited in fluvatile floodplains (Eisbacher, 1975). This environment resulted in facies changes in lithology and laterally discontinuous coal seams. Rocks are probably Paleocene to Miocene.

Wrangell Lava (Tv):

Continental volcanic rocks of the Wrangell Lava are preserved in the Duke Depression (Maps 1A, 2A, and 3A), and as slivers along the Shakwak-Dalton Fault, but not in the Gravina-

Nutzotin Belt. Two areas of major volcanic cappings, each over 1,000 m thick, lie on a discontinuous Tertiary veneer of sedimentary rocks. The northern one, the Duke Province, straddles the Duke River (Map 2A) and the southern one, the Alsek Province (Souther and Stanciu, 1975) spans the Alsek River (Map 3A). At the head of Bock's Brook (Map 2A) in the Duke Province, steeply inward dipping attitudes of the base of the Wrangell Lava near the north end of the outcrop area define a volcanic centre intruded by a Late Tertiary diorite (Read, 1976). A few kilometers westward a felsite dome intrudes Wrangell Lava. Souther and Stanciu (1975) outlined a four-phase history involving andesite, basalt and minor trachyte and rhyolite of the Alsek Province, but the lithologically similar Duke Province has not been studied. The Miocene age of the volcanics is substantiated by a whole-rock potassium-argon date of 15.9 $\pm$ 1.4 m.y. on a felsite from the Duke Province (Map 2A).

INTRUSIONS

Sills, dykes and stocks sparsely intrude the three fault blocks within the map-area. They range in composition from ultrabasic to felsite and in age from pre-Permian to Miocene or younger. They are briefly described in order of decreasing age.

Pre-Permian Gabbro Complex (Pb):

The complex nonconformably underlies Lower Permian rocks of the Hasen Creek Formation (p.21). It may correspond in age to Late Pennsylvanian plutons (282 - 285 m.y.) reported by Richter, Lanphere and Matson (1975) from the eastern Alaska Range south of the Denali Fault.

Permo-Triassic Gabbro (b) and Ultramafite (ub):

Sills of gabbro and peridotite preferentially intrude

Hasen Creek Formation of the Taku-Skolai Terrane. Quill Creek crosses a sill over 7 km long and up to 1 km wide (Map 1A), and Duke River cuts a large but poorly exposed intrusion (Map 2A). Small sills, many less than 10 m thick, are not shown on the maps. Intrusions are usually gabbro or peridotite and only rarely are composite such as the one at the head of Halfbreed Creek (Map 2A). As a result of regional metamorphism, chlorite, clinozoisite and albite develop in the augite gabbro, and serpentine and actinolite pervade the biotite-bearing peridotite. Peridotite commonly has slickensided surfaces and many contacts with the country rock may be tectonic; however, where contacts are intrusive, the peridotite, like the gabbro (Plate 10), imposes a thin contact metamorphic aureole on the country rock. At the head of Halfbreed Creek, a wollastonite-grossularite-clinopyroxene-albite skarn of the pyroxene hornfels facies developed in marble (Psc) within one m of the peridotite.

Age of the gabbro and peridotite is only broadly defined. Their mutual cross-cutting relations suggest that they are coeval and comagmatic. In McCarthy Quadrangle (MacKevett, 1970a), gabbro clasts are a constituent of the basal conglomerate of the Nikolai Greenstone. East of Halfbreed Creek, north of locality F47 and immediately south of Wade Mountain Fault (Map 2A), the base of the Nikolai Greenstone is a breccia with angular blocks of siliceous argillite, limestone and slickensided peridotite. Although a tectonic breccia is possible, thin sections show the matrix consists of fine-grained clasts of detrital origin. This breccia and the preferential intrusion of gabbro and peridotite into Hasen Creek Formation of Early Permian age favours a pre-Middle Triassic age as proposed by MacKevett (1970) for similar gabbro without accompanying peridotite in the McCarthy Quadrangle. In the eastern Alaska Range (Richter and Jones, 1973) and in the Nebesna Quadrangle in particular (Richter, 1976), these workers believed the gabbro without comagmatic ultramafite found in the lower part of the Nikolai Greenstone represents the hypabyssal equivalent of overlying flows. On the northeast limb of Hoge Creek Syncline between Burwash Creek and Donjek River (Map 1A), a few gabbros within the Nikolai may represent such hypabyssal intrusions. Potassium-argon ages on phlogopitic biotite from peridotite at Wellgreen Mines and Canalask Property at White River, northwest of the map-area, yield ages of 421 ± 9 m.y. and 225 ± 7 m.y. respectively (Lanphere, pers. comm., 1976).

Early Cretaceous Gabbro (eKb) and Clinopyroxenite (eKpx):

North of the confluence of Dezadeash and Kaskawulsh Rivers (Map 3A), a small (6 sq. km), zoned clinopyroxenite-gabbro complex intrudes the Dezadeash Formation (Sturrock, 1975). Magnetite-bearing clinopyroxenite and wehrlite are rimmed by hornblende clinopyroxenite. A later, chemically unrelated gabbro intrudes the ultramafite, bounds the complex on the north, and has caused much of the hornblende alteration of the ultramafite.

Within 3 m of the clinopyroxenite, rocks of the Dezadeash Formation contain mineral assemblages of the pyroxene hornfels facies. This concentric or Alaska-type complex (Taylor, 1967) is truncated on the northwest by the Dalton Fault. Potassium-argon dates for hornblende and biotite give 118 m.y. and 107 m.y. respectively (Armstrong, pers. comm., 1976). Gabbro (Map 3A) and peridotite (Map 2A) intruding unit uTrKp are tentatively correlated with and eKb respectively eKpx.

Mesozoic Granitic Plutons:

Mesozoic granitic plutons outcrop in the Taku-Skolai Terrane to the northwest of Duke River (Map 1A), near Slims River (Map 3A) and southeast of Sockeye Lake (Map 3A). Details of the plutonic rocks are given by Muller (1967), Wheeler (1963) and Kindle (1953). On Burwash Creek (Map 1A), potassium-argon ages for hornblende of 115 ± 4 m.y. and 117 ± 4 m.y. correspond to an Early Cretaceous age (Christopher, White and Harakal, 1972), and near Slims River (Map 3A), where plutonic rocks intrude unit uTrKp, a Cretaceous and/or Tertiary age is possible. These ages for intrusions in the Taku-Skolai Terrane correspond to the 105 to 117 m.y. range for intrusions in the same terrane in the Eastern Alaska Range (Richter, Lanphere and Matson, 1975).

Quartz Latite Porphyry (Ofp):

A few biotite quartz latite porphyry dikes intrude the Taku-Skolai Terrane at Burwash Creek (Map 1A) and the Alexander Terrane west of Bullion Creek (Map 2A). Potassium-argon ages on biotite from these two localities give 26 m.y. and 28 m.y. respectively.

Wrangell Intrusions (Tfl, Tdi):

The youngest equigranular plutonic rock presently known in the Kluane Ranges is a medium-grained, hornblende-biotite diorite which intrudes a Tertiary vent in the Wrangell Lava (Read, 1976) (Plate 19). This stock of 2 sq. km area at the head of Bock's Brook (Map 2A) must be younger than 16 m.y. and is probably equivalent to similar intrusions in the Wrangell Lava of the McCarthy Quadrangle (MacKevett 1970b; 1972).

STRUCTURE

Within the map-area, two major faults, Duke River Fault and the Shakwak-Dalton Fault, divide rocks into three fault blocks: (a) the western Alexander Terrane; (b) the central Taku-Skolai Terrane; and (c) the eastern Gravina-Nutzotin Belt (Figure 2). Only Tertiary stratigraphic, plutonic and structural events are common among the fault blocks. Outside the map-area, the Shakwak-Dalton Fault continues northwesterly as the Denali Fault and may continue southeasterly after a 200 km right-lateral displacement along the Chatham Strait Fault as the Clarence Strait Fault (Read and Okulitch, in press). Southeast of the map-area, the Duke River Fault probably joins the Dalton Fault and together they form the southeastern boundary of the Taku-Skolai Terrane (Figure 1). In the McCarthy Quadrangle, northwest of the map-area, the Duke River Fault continues to separate the Taku-Skolai Terrane from the Alexander Terrane. Whether the fault turns northward again into the Totschunda Fault, or continues west-northwesterly (not shown in Figure 1) is unknown (Campbell and Dodds, 1975). Descriptions of structures within each fault block precedes an examination of faults between the blocks.

Structures of the Alexander Terrane:

Polyphase, noncoaxial deformation has affected the Alexander Terrane but within the map-area it was studied only in the vicinity of Alsek River (Map 3A). Designation of phases of folding as "first" and "second" indicates relative timing and applies only to the region studied.

First phase mesoscopic folds are common, but second phase folds are restricted to an area southwest of a line joining Marble Creek to the north end of Bates Lake. Mesocopic first phase folds are closed to isoclinal with a closely-spaced axial-plane foliation (Plate 3). Second phase folds are open to closed with a poor- to well-developed crenulation cleavage of northwest strike and subvertical dip (Plate 3). In areas affected only by first phase deformation, folds trend northwesterly or southeasterly and plunge less than fifteen degrees in either direction. In areas of second phase deformation, second phase folds plunge steeply northwesterly or southeasterly and first generation folds have moderate plunges. First phase structures are pre- to syn-crystallization, but second phase structures are post-crystallization.

Along Alsek River, a volcanic and sedimentary sequence outlines a series of northwest trending folds with highly variable plunges produced by polyphase deformation (Map 3A). Between Raft and Marble Creeks, the repetition of stratigraphy, changes of bedding attitudes, asymmetry of mesoscopic folds and facing directions define a first phase anticline which trends northwesterly. Although Tertiary sedimentary and volcanic rocks cover much of the northwesterly extension of the fold to and beyond Dusty River, absence of volcanic rocks and presence of limestone and phyllite in that direction infer a regional northwesterly plunge for the anticline. Its southeasterly extension under Tertiary cover probably terminates at the Duke River Fault north of Mush Lake. South of Marble Creek, a steeply plunging second phase anticline overprints a first phase syncline. Southeast of the Late Jurassic intrusion (lJg), unit Dc? repeats the form of the second phase anticline across Bates Lake (Map 3A). Southward a phase 2 syncline, cored by unit DCs, may continue southeasterly across Bates Lake and into an inferred syncline running through Onion Lake. In Field Creek, massive limestone (Dc) outlines the second phase Bates River Anticline. In the Alexander Terrane northwest of Alsek River, the absence of significant thicknesses of metavolcanic rocks implies that all of the structures exposed along the river in the map-area must plunge regionally to the northwest.

Much of the penetrative deformation and metamorphism of the Alexander Terrane is probably of Middle to Late Paleozoic age. The youngest deformed and metamorphosed rocks of unit DCs yield a Carboniferous or Permian age at locality F98 (Map 3A). The oldest, apparently post-kinematic plutons yield concordant potassium-argon dates from hornblende and biotite of 268 ± 11 m.y. and dates as old as 278 m.y. from hornblende (Campbell, pers. comm., 1976). This fragmentary evidence restricts the first, and possibly the second phases of deformation, to the Pennsylvanian. Preservation of these potassium-argon radiometric ages also implies that the eastern section of the Alexander Terrane was not involved in extreme vertical movement since Late Pennsylvanian time. This conclusion does not accord with MacKevett and Jones' model (1975, p. 69) of thrusting the Taku-Skolai Terrane over the Alexander Terrane along a major regional megathrust and its later complete removal by extreme Cenozoic uplift of the Alexander Terrane. Vestiges of such a history should remain in partly reset potassium-argon dates in the Alexander Terrane and eastward overturned folds instead of upright folds in the Taku-Skolai Terrane. Table II summarizes plutonic, structural and metamorphic events in the Alexander Terrane.

Structures in the Taku-Skolai Terrane:

The Taku-Skolai Terrane displays a single phase of folding and later subparallel faulting. Mesoscopic structures developed locally but are insufficient to allow determination of the orientation of macroscopic folds. The map pattern, which shows few fold hinges, results from extensive faulting and the subhorizontal regional plunge of upright folds.

Northeast of Duke River Fault, folds are upright and isoclinal, and faults numerous. Hoge Creek Syncline extends about 40 km southeasterly from Donjek River (Map 1A) to the headwaters of Lewis Creek (Map 2A). Wade Mountain Fault bounds it on the northeast and finally truncates it on the southeast. Northeast, east and southeast of Wade Mountain Fault, faults splay, transect folds, and sliver the stratigraphy. Bock's Brook Fault, here and there exposed as a crush zone, sets Station Creek Formation (Psv) against unit uTRKp north of Bock's Brook (Map 2A). Northeast of the fault lies the truncated northeast limb of the northwest plunging Lewis Creek Syncline. The ridge between Lewis and Halfbreed Creeks best exposes the grey phyllite (uTRKp) core of the syncline, slopes north of Nines Creek display the faulted hinge, and the contact of Nikolai Greenstone (uTRNv) against unit uTRKp outlines numerous parasitic folds on the northeast limb. Lewis Creek Syncline and a broad anticline-syncline pair to the northeast trend southeasterly into Shakwak Trench. These folds are upright or overturned to the northeast and modified by faulting.

Between Wade Mountain and Bock's Brook Faults, anastomosing faults preserve portions of upright, plunging folds. Southeastwards between Bock's Brook and Duke River Faults, Chitistone and Nizina Limestones (uTRcc) outline a pair of southeasterly plunging synclines near Slims River (Map 2A). Between Slims and Jarvis Rivers is a fold depression. Southeast of Jarvis River (Map 3A), a northwest plunging syncline cored by unit Psp is the first of a series of northwest plunging folds between Dalton Fault and Duke River or Beloud Creek Faults. The folds are asymmetric with N-shaped profiles looking northwesterly and must lie on the northeast limb of a large northwest plunging syncline (Read, 1976).

Deformation and accompanying low grade regional metamorphism of the Taku-Skolai Terrane are limited to being younger than unit uTRKp and older than post-kinematic intrusions which in Burwash Creek (Map 1A) are as old as 117 ± 4 m.y. Within the map-area, fossils at locality F56 (Map 2A) can be no younger than lowermost Cretaceous (Early Berriasian - 135 to 131 m.y.*), but if unit uTRKp correlates to the Gravina-Nutzotin sequence of the eastern Alaska Range, then the youngest marine rocks are Valanginian (131 to 126 m.y.) and the youngest nonmarine rocks are of Barremian age (121 to 115 m.y.) (Richter and Jones, 1973). Deformation and metamorphism must have occurred within the 117 to 131 m.y. interval and possibly within the 117 to 126 m.y. interval. Plutonic, structural and metamorphic events of the Taku-Skolai Terrane are summarized in Table II.

Gravina-Nutzotin Belt:

In the Gravina-Nutzotin Belt east of the Shakwak-Dalton Fault, the Dezadeash Formation exhibits two phases of macroscopic folds. An early phase of northerly trending folds overturned eastward are refolded by later northwesterly trending folds (Eisbacher, 1976). Gabbro (EKb) and clinopyroxenite (EKpx) as old as 117 ± 4 m.y. were intruded between the first and second periods of folding (Sturrock, 1975). This intrusion restricts timing of the first phase of folding to the same interval as deformation of the Taku-Skolai Terrane. The second folding is Late Cretaceous and precedes intrusion of granodiorite batholiths (Eisbacher, 1975) radiometrically dated as 106 ± 4 m.y. Table II summarizes the plutonic, structural and metamorphic history of the Gravina-Nutzotin Belt.

*Absolute times from van Hinte's (1976) Cretaceous time scale.

Late Cretaceous and Cenozoic Deformation:

In the map-area, faulting, broad warping, and uplift dominate Late Cretaceous and younger deformation. By Cenozoic time the three fault blocks were approximately in their present configuration and have shared a common structural history. Southeast of the turn in Duke River (Map 2A), the base of Wrangell Lava shows little offset across the Duke River Fault. Farther southeast at Sugden Creek (Map 3A), rocks of the Amphitheatre Formation and Wrangell Lava cover the Duke River Fault. Movement on the Shakwak-Dalton Fault outlasted that on the Duke River Fault. Rocks of the Amphitheatre Formation form steeply dipping slivers within the fault zone and the base of Wrangell Lava exposed southwest of the fault, is truncated by the fault (Map 3A), and does not reappear northeast of it (Fig. 2).

Duke River Fault, originally was described as a thrust or overthrust (Muller, 1967) with rocks of the Alexander Terrane (Kaskawulsh limestone) apparently overriding the Taku-Skolai Terrane and involving rocks as young as the Wrangell Lava. Remapping of areas previously interpreted as exposing gently dipping thrusts indicates the thrusts are either absent (Amphitheatre Mountain, Muller, 1967, Plate VIIIA) or are steep faults (west fork of Sheep Creek, Muller, 1967, Plate IXA). Fragmentary evidence (p.39) does not favour the interpretation of MacKevett and Jones (1975) that the Duke River Fault is a remnant of a megathrust which transported the Taku-Skolai Terrane eastward over the Alexander Terrane. In the map-area, none of the sedimentary rocks of the Taku-Skolai Terrane contains recognizable detritus derived from the Alexander Terrane. From Early Permian to Early Cretaceous, either sediments of the Taku-Skolai Terrane derived no detritus from the adjacent Alexander Terrane, or perhaps the Alexander

Terrane was not there. As significant dip-slip movement on the Duke River Fault seems unlikely, strike-slip movement may have occurred. In the map-area, strike-slip movement certainly occurred locally as seen on the exposed fault (Plate 20), but whether it juxtaposed the Alexander and Taku-Skolai Terranes, possibly during the Late Cretaceous, is less certain. This suggested strike-slip movement on the Duke River Fault treats it as a splay of the Shakwak-Dalton Fault.

The Dalton Fault (Plate 21) is a southeasterly extension of the Shakwak Fault starting from where the fault trace leaves the Shakwak Trench at approximately the south end of Kluane Lake to Chatham Strait (Campbell and Eisbacher, 1974). Eisbacher (1975; 1976) has documented a minimum displacement of 300 km of right lateral movement on the Shakwak-Dalton Fault. The movement, probably in Late Cretaceous, predates deposition of the Amphitheatre Formation. A minor component of vertical movement of some hundreds of metres or less postdates deposition of the Wrangell Lava. If the interpretation of Jones et al (1976) of preliminary paleomagnetic data from the Nikolai Greenstone in the Chulitna area is correct, then large-scale strike-slip movement may have occurred along the Denali-Shakwak-Dalton Fault system between Late Triassic and Late Cretaceous times.

Within the Taku-Skolai Terrane of the map-area, anastomosing faults dip steeply and locally show horizontal slickensides. Because the Amphitheatre Formation was deposited on a surface of high relief, post-Miocene fault movement requires a vertical component of only a few hundred metres or less on any fault. Some faults, such as Wade Mountain Fault, do not disturb overlying Tertiary sedimentary and volcanic rocks (Maps 1A and 2A). Lateral movement on these faults was likely synchronous with major Late Cretaceous movement on the Duke River and Shakwak-Dalton Faults.

MINERAL DEPOSITS

By the early 1900's placer and lode deposits had been discovered. Placer gold has been won from a number of creeks, especially Burwash Creek, since 1903, but lode mining did not start until 1959 with a small copper-ore shipment from Johobo Mine and later with the shipping of copper-nickel concentrates from the Wellgreen Mine. This study has modified the previously published geologic setting of some of the lode deposits in the Kluane and northern end of the Alsek Ranges. The subdivision of mineral deposits and their description incorporate these modifications which include:

(a) Recognition of the southeastward extension of the Duke River Fault in the Kaskawulsh and Dezadeash map-areas where it forms the southwestern limit of the distinctive copper and copper-nickel deposits of the Taku-Skolai Terrane.

(b) Division of pre-Cenozoic volcanic assemblages, which are host rocks of many of the lode deposits, into Cambro-Ordovician (ЄOv) Cambro-Devonian (ЄDv), and Devono-Carboniferous (DCv) volcanics, and their distinction from the Station Creek (PSv) and Nikolai (uTRNv) Formations which host many of the lode deposits.

Descriptions of mineral deposits have the following format:

No. PROPERTY NAME Commodities in decreasing order of economic importance.

References:

Location: N.T.S. sheet number; Universal Transverse Mercator (UTM) zone number; UTM co-ordinates: easting, northing;

location of the property as "in" or "out" of the Kluane National Park Reserve.

Type: of deposit. Status: of deposit as of December, 1974.

Description: of property partly based on earlier reports but modified by the new geological data.

PLACER DEPOSITS

Placer gold with minor silver and platinum has yielded, not only the major placer production, but is the major economic metal of the region. Recorded production is in excess of 40,000 crude ounces but probably a significant amount is not recorded. Native copper is common in creeks with Nikolai Greenstone in the watershed In 1903 and 1904 most of the creeks were staked, but Burwash Creek has been the most consistent producer and its production accounts for sixty per cent of the total.

1 ARCH CREEK Au

References: Bostock, 1941, p. 18; Bostock, 1957, p. 356, 360, 369-371; Cairnes, 1915, p. 10-33; Muller, 1967, p. 107; Sinclair and Gilbert, 1975, p. 143; Skinner, 1961, p. 18-19; Skinner, 1962, p. 17-18.

Location: 115G/5; UTM zone: 7V; UTM co-ordinates: EU0569400, EU6818500; out.

Type: Placer Status: Past producer/540+ crude ounces Au.

Description: Intermittent placer operations from 1904 to 1973 resulted in an incomplete production record of 540 crude ounces of gold taken mainly from gravels downstream from the lower canyon on Arch Creek.

47 BATES RIVER Au

References: Kindle, 1953, p. 53-54; Skinner, 1961, p. 19; Skinner, 1962, p. 22.

Location: 115A/4; UTM zone: 8V; UTM co-ordinates: LB0408800, LB6669100; in.

Type: Placer Status: Past producer/unrecorded.

Description: Bates River flows through a deeply incised canyon from one mile above its confluence with Iron Creek to two miles below. Immediately downstream from the canyon, B. Beloud and associates intermittently worked the gravels for placer gold starting in 1935. From 1958 to 1961, R.S. Richards and F. Young and son worked three placer claims here but production is unrecorded.

41 BELOUD CREEK Au, Cu

References: Kindle, 1953, p. 49, 50, Plate I.

Location: 115A/6; UTM zone: 8V; UTM co-ordinates: LB0424500, LB6699700; in.

Type: Placer Status: Past producer/unrecorded.

Description: Just above the lowest canyon of Beloud Creek before it joins Victoria Creek, gravel deposits are up to 140 feet thick. In 1938 and 1939 B. Beloud worked these deposits which yielded an unrecorded production of placer gold and copper.

31 BULLION CREEK Au, Pt, Cu

References: Bostock, 1935, p. 4; Bostock, 1936, p. 6; Bostock, 1937, p. 5; Bostock, 1938, p. 9; Bostock, 1941, p. 17-18; Cairnes, 1915, p. 19-20; Craig and Laporte, 1972, p. 152; Craig and Milner, 1975, p. 139; Findlay, 1967, p. 87; Findlay, 1969a, p. 113; Findlay, 1969b, p. 65-66; Green and Godwin, 1963,

p. 62-63; McConnell, 1905, p. 13A-15A; Muller, 1967, p. 105-106; Sinclair and Gilbert, 1975, p. 141-144; Skinner, 1961, p. 17-18; Skinner, 1962, p. 21.

Location: 115G/2; UTM zone: 7V; UTM co-ordinates: FT0624300, FT6765600; in.

Type: Placer Status: Producer/9486.8+ crude ounces.

Description: Except for a short canyon in the vicinity of Metalline Creek, Bullion Creek is floored by gravel. Placer gold was discovered in 1903 when 40 ounces of gold were obtained in a few hours. From 1904 to 1906, Bullion Hydraulic Company spent $300,000 and recovered $1,000 in gold. From 1906 to 1958 placer gold production was intermittent and minor. From 1959 to 1961, Action Mining Co. removed 6150 ounces of gold. H. Thorsen continued working Bullion Creek below the canyon until 1972.

11 BURWASH CREEK Au, Pt, Cu

References: Bostock, 1936, p. 6; Cairnes, 1915, p. 14-16, 22-23; Craig and Laporte, 1972, p. 152; Craig and Milner, 1975, p. 138; Findlay, 1967, p. 86-87; Findlay, 1969a, p. 112-113; Findlay, 1969b, p. 65; Green, 1965, p. 80; Green, 1966, p. 120-121; Green and Godwin, 1963, p. 63-64; Green and Godwin, 1964, p. 82-83; McConnell, 1905, p. 15A-17A; Muller, 1967, p. 105-107; Sinclair and Gilbert, 1975, p. 143; Sinclair, Maloney and Craig, 1975, p. 184; Skinner, 1961, p. 16-17; Skinner, 1962, p. 20-21.

Location: 115G/6; UTM zone: 7V; UTM co-ordinates: EU0591900, EU6805400; out.

Type: Placer Status: Producer/24,321.72+ crude ounces Au.

Description: Burwash Creek, considered the best placer gold creek of the Kluane Range, was first staked in May 1904. By 1914 the creek had been prospected from the mouth of the lower canyon to 1500 feet above its confluence with Tatamagouche Creek. Intermittent, unrecorded production continued to 1944. In 1945 H. Besner, owner of Burwash Mining Co. Ltd., initiated placer operations which he continued on Burwash Creek until 1972. His operations produced most of the recorded production of gold and platinum from Burwash Creek. From 1973 to present several small operations by W. Wyatt, S. Kinakin and Greenlands Exploration Ltd. have worked ground missed by Burwash Mining Co. Ltd. Total recorded production of gold is 24,321.72 crude ounces from 1904 to 1970. Probably a significant production of gold and platinum is unrecorded.

17 DUKE RIVER Au

References: Green, 1965, p. 81; Sinclair and Gilbert, 1975, p. 141-144.

Location: 115G/6; UTM zone: 7V; UTM co-ordinates: EU0597700, EU6801100; out.

Type: Placer Status: Showing

Description: This river has received little attention. In 1964, L.I. Procter applied for a 10-mile dredging lease extending upstream from one-quarter mile above the Alaska Highway bridge. The application was dropped after drilling 12 holes to bedrock at about 22 feet deep. In 1973, S. and G. McCallum and J. and B. LeMoignan tested ground between the lower and upper canyons on Duke River.

22 HOGE CREEK Au

References: Sinclair and Gilbert, 1975, p. 141, 142, 144.

Location: 115G/5; UTM zone: 7V; UTM co-ordinates: ET0579800;

ET6795200; out.

Type: Placer Status: Showing

Description: Moraine Gold Mines Ltd. held placer claims in 1973 at about the 5000 foot level in Hoge Creek.

48 IRON CREEK Au

References: Bostock, 1936, p. 6; Bostock, 1937, p. 5; Kindle, 1953, p. 53.

Location: 115A/4; UTM zone: 8V; UTM co-ordinates: LB0411700, LB6667400; in.

Type: Placer Status: Prospect.

Description: Iron Creek flows through a 400 foot deep gorge incised in till. Placer gold is reported to be concentrated on bedrock or glacial clays. Two miners worked the creek in 1933 and 1934 and F. McDougall tested and worked gravels about one mile downstream from the glacier terminus in 1945 and 1946.

37A KIMBERLEY CREEK Au

References: Kindle, 1953, p. 55; McConnell, 1905, p. 13A.

Location: 115B/16; UTM zone: 8V; UTM co-ordinates: FT0392500, FT6746300; in.

Type: Placer Status: Prospect

Description: In 1904 placer gold was being won from two claims at the head of the large gravel fan in the lower course of Kimberley Creek.

30 SHEEP CREEK Au

References: Cairnes, 1915, p. 21-22; McConnell, 1905, p. 15A; Muller, 1967, p. 106; Skinner, 1961, p. 18.

Location: 115G/2; UTM zone: 7V; UTM co-ordinates: FT0628000, FT6769600; in.

Type: Placer Status: Past producer/675.55+ ounces.

Description: Placer claims were staked on Sheep Creek before 1904. By 1914 about $10,000 of placer gold had been obtained from the stream; $7,000 of the production was obtained in 40 days by the Fisher brothers from an old stream channel cut by Fisher Pup just above its junction with Sheep Creek. R. Chaykowsky worked Sheep Creek between Fisher and Fortyeight Pups in 1960 and produced 120 ounces of gold.

52 SILVER CREEK Au

References: Kindle, 1953, p. 50.

Location: 115A/3; UTM zone: 8V; UTM co-ordinates: LB0437300, LB6657200; in.

Type: Placer Status: Prospect.

Description: Silver Creek has cut a 600 foot deep canyon in glacial debris. O.F. and D. Jurgeleit unsuccessfully tried to work this stream in 1949.

53 SQUAW (DOLLIS) CREEK Au

References: Bostock, 1933, p. 6AII; Bostock, 1934, p. 4A; Bostock, 1936, p. 6; Bostock, 1937, p. 5; Bostock, 1939, p. 10; Bostock, 1941, p. 18; Cockfield, 1928, p. 7A; Cockfield, 1930, p. 2A; Kindle, 1953, p. 48, 50-53; Mandy, 1933, p. 74-79; Mandy, 1934, p. 90-93; Skinner, 1961, p. 19; Watson, 1948, p. 36-39.

Location: 115A/3; UTM zone: 8V; UTM co-ordinates: LB0442100, LB6667400; out.

Type: Placer Status: Past producer/5077+ crude ounces which includes production from British Columbia section of the creek.

Description: Squaw (Dollis) Creek is eight miles long, heads in British Columbia and flows northwestward to join the Tatshenshini River three miles north of the British Columbia-Yukon boundary. Coarse placer gold was discovered by Paddy Duncan in 1927. The stream has been worked each year by ten or more prospectors until 1950, but post-1950 only a few prospectors have worked the creek. The upper section of the creek in British Columbia has been more productive than the lower Yukon section.

39 SUGDEN CREEK Au, Pt

References: Kindle, 1953, p. 54-55.

Location: 115A/12; UTM zone: 8V; UTM co-ordinates: LC0400800, LC6730300; in.

Type: Placer Status: Past producer/15.3 oz. Au; 7.7 oz. Pt.

Description: In about 1914 gold was first discovered by Mr. Sugden in gravels at the head of the fan below the canyon on Sugden Creek. Of the several small operations, only that of Pete Peterson is recorded as 23 ounces of platinum-rich gold dust assaying about one-third platinum.

8 TATAMAGOUCHE CREEK Au, Pt, Cu

References: Cairnes, 1915, p. 15, 22-24; Findlay, 1969a, p. 112-113; Green 1966, p. 120; Sinclair and Gilbert, 1975, p. 143; Sinclair, Maloney and Craig, 1975, p. 184.

Location: 115G/6; UTM zone: 7V; UTM co-ordinates: EU0589600, EU6806900; out.

Type: Placer Status: Producer/100+ ounces Au.

Description: Gravels above and below the canyon on Tatamagouche Creek have received minor, intermittent exploitation from 1904 to present. By 1914 total production was estimated at $2,000. Since 1968 Burwash Mining Co. Ltd. (H. Besner) and W. Rothbauer have worked below and above the canyon respectively.

52A TATSHENSHINI RIVER Au

References: Kindle, 1953, p. 52-53; Mandy, 1934, p. 91-92.

Location: 115A/3; UTM zone: 8V; UTM co-ordinates: LB0440200, LB6657200; out.

Type: Placer Status: Showing

Description: In 1933, B.C. Prospectors Ltd. drilled a few holes in the gravel bench at Dalton Post and the gravel fan at the mouth of Squaw (Dollis) Creek.

33 H. THORSEN Au

References: Craig and Laporte, 1972, p. 152; Craig and Milner, 1975, p. 139; Findlay, 1967, p. 87; Findlay, 1969a, p. 113; Findlay, 1969b, p. 65, 66; Muller, 1967, p. 106; Skinner, 1961, p. 17.

Location: 115B/15; UTM zone: 8V; UTM co-ordinates: FT0626600, FT6763400; in.

Type: Placer Status: Past Producer/843+ crude ounces.

Description: See description for Bullion Creek.

LODE DEPOSITS

Regional mapping (Muller, 1967; Wheeler, 1963; Kindle, 1953) indicates that the Taku-Skolai Terrane hosts most of the lode deposits. Some of these were staked as early as 1908, but the remoteness of the area stiffled interest in and development of lode deposits. Only Wellgreen and Johobo Mines with productions of 189,211 and 3,647 tons respectively were initially staked as recently as 1952 and 1958. Characteristics of host rock and mineralogy allow the following subdivision of lode deposits:

(a) Nickel-copper-platinum deposits

(b) Copper deposits in the Nikolai Greenstone

(c) Copper deposits in the Skolai Group

(d) Porphyry copper deposits

(e) Silver-lead veins

(a) Nickel-Copper-Platinum Deposits:

Basic and ultrabasic rocks of Permo-Triassic age and adjacent Skolai Group host these deposits. Siliceous argillite, the most common host, may contain pods of sulphides up to a few hundred feet away from the intrusions. Variations in pentlandite, chalcopyrite and pyrrhotite cause a decrease in Ni:Cu ratio from a high of 3:2 at the Wellgreen Mine.

2 ARCH CREEK GROUP Cu, Ni

References: Hilker, 1967, pp. 14.

Location: 115G/5; UTM zone: 7V; UTM co-ordinates: EU0574700, EU6817200; out.

Type: Massive and disseminated sulphides. Status: Showing

Description: A group of 46 claims accessible by road and lying twelve miles west of Mile 1111 on the Alaska Highway. Cu-Ni mineralization is localized on the northeastern contact of a Permo-Triassic peridotite sill which intrudes sedimentary and volcanic rocks of Station Creek Formation. The main showing is a zone 200 feet long and 50 feet wide consisting of narrow widths of massive chalcopyrite and nickeliferous pyrrhotite in altered peridotite and argillite.

28 DC GROUP Ni, Cu

References: Muller, 1967, p. 111; Sevensma, 1968, pp. 14.

Location: 115G/2; UTM zone: 7V; UTM co-ordinates: FT0613200, FT6777800; in.

Type: Massive and disseminated sulphides Status: Showing

Description: Twenty-two claims located across the lower course of Dickson Creek between the 4600- and 5200-foot levels. Here Permo-Triassic peridotite and gabbro dykes intrude siliceous argillite and minor limestone of the Hasen Creek Formation of Early Permian age. Pyrrhotite-pyrite-chalcopyrite mineralization occurs either sparsely disseminated in peridotite or as small massive bodies in the adjacent siliceous argillite. The best nickel values come from peridotite (0.10 to 0.20% Ni; 0.05 to 0.10% Cu) and the best copper values from mineralized siliceous argillite. To assess the potential of the property, detailed geological and ground magnetometer surveys have been conducted over the group.

34 FREDA GROUP Ni, Cu

References: Walker, 1956; Wheeler, 1963.

Location: 115B/16; UTM zone: 8V; UTM co-ordinates: FT0364200, FT6760400; in.

Type: Disseminated sulphides Status: Showing

Description: A lapsed group of 22 claims located just south of the lower course of Vulcan Creek and east of Slims River. The area is underlain by Permo-Triassic siliceous argillite, limestone and shale intruded by peridotite and gabbro. Some peridotite is sparsely mineralized but geophysical surveys failed to discover the source of mineralized float assaying 0.4 to 0.8% Ni and lower values of copper.

14 GLEN GROUP Cu, Ni

References: Findlay, 1969a, p. 73; Morrison, 1967, pp. 8.

Location: 115G/6; UTM zone: 7V; UTM co-ordinates: EU0589900, EU6804800; out.

Type: Massive sulphides Status: Prospect

Description: This group of 60 claims straddles Tatamagouche and Burwash creeks. On Burwash Creek, about one-half mile above the junction of the two creeks, a copper-nickel showing consists of small, scattered pods of chalcopyrite and nickeliferous pyrrhotite over a zone 20 feet long and 5 feet wide. Siliceous argillite of the Hasen Creek Formation and Permo-Triassic peridotite host the mineralization. An electromagnetic survey outlined three anomalies of which two probably reflect contacts between peridotite and argillite.

9 MARY GROUP Cu, Ni

References: Siega, 1973; Sinclair and Gilbert, 1975, p. 65-66.

Location: 115G/6; UTM zone: 7V; UTM co-ordinates: EU0590200, EU6806300; out.

Type: Massive sulphides Status: Prospect

Description: A group of 24 claims, originally part of the Glen Group, straddles Tatamagouche Creek about one-half mile upstream from its junction with Burwash Creek. A geochemical survey on 1973 outlined copper-nickel anomalies in an area 900 feet by 1000 feet which is underlain by siliceous argillite of the Hasen Creek Formation intruded by Permo-Triassic peridotite and gabbro. Mineralization consists of scattered stringers of pyrrhotite, chalcopyrite and pentlandite.

27 SPY GROUP Cu, Ni, Zn, Pb

References: McLoughlin and Vincent, 1973, pp. 18; Sinclair and Gilbert, 1975, p. 66-67.

Location: 115G/2; UTM zone: 7V; UTM co-ordinates: FT0620800, FT6780800; out.

Type: Vein, and massive and disseminated sulphide Status: Showing

Description: This group of twelve claims is on the west valley wall of the south branch of Nines Creek about four miles west of Mile 1077 on the Alaska Highway. Phyllite, sandstone and limestone of the Lower Permian Hasen Creek Formation are intruded by Permo-Triassic peridotite and gabbro dykes. Quartz-carbonate veins up to one foot thick lie in minor shears in the gabbro-peridotite with an attitude of 150°/80°NE. Accompanying sphalerite and galena yield assay values of 0.25% Pb and 1.2% Zn. In limestone, fractures at 130°/70°NE contain massive pyrrhotite or magnetite. The basal twenty feet of gabbro and the adjacent sedimentary rocks have disseminations and blebs of copper- and nickel-bearing sulphides.

3 WELLGREEN PROPERTY Ni, Cu, Pt, Pd, Au, Co

References: Campbell, 1960, p. 953-959; Craig and Laporte, 1972, p. 2, 100-101; Craig and Milner, 1975, p. 7, 41-42; Findlay, 1967, p. 52-53; Findlay, 1969b, p. 7, 43; Muller, 1967, p. 110-111; Sinclair and Gilbert, 1975, p. 6, 64-65; Skinner, 1961, p. 36.

Location: 115G/5; UTM zone: 7V; UTM co-ordinates: EU0578800, EU6815500; out.

Type: Massive sulphides Status: Past producer/189,211 tons; 8,433,139 lbs. (Ni); 5,262,217 lbs. (Cu); 12,298.7 oz (Pt); 276,248 lbs. (Co).

Description: Discovered in 1952 by W.B. Green and C.A. Aird.

From 1953 to 1956 the property was developed by 14,000 feet of underground workings and 65,000 feet of drilling which outlined 738,000 tons of reserves of 2.04% nickel, 1.42% copper and minor amounts of platinum, gold, palladium and cobalt. From 1956 to 1968 the property was inactive. Ground geophysics outlined several anomalous areas in 1968 and 2500 feet of diamond drilling in 1969 preceded production which began in May 1972 and ended in August, 1973. Permo-Triassic peridotite and gabbro intrude argillite and basic metavolcanic rocks of the Skolai Group. The thin and irregular ore shoots roughly parallel the peridotite-gabbro contact. Mineralization is massive to disseminated pyrrhotite, chalcopyrite, pentlandite and violarite which forms lenses along the contact and in the bordering hornfels zone.

(b) Copper Deposits in Nikolai Greenstone:

Copper deposits in the Nikolai Greenstone are characterized by a high Cu:S reflected in a mineralogy dominated by chalcocite, bornite and native copper. Chalcopyrite and pyrite are rare or absent. The gangue mineralogy of quartz, calcite, prehnite, pumpellyite, chlorite and epidote is the same as that of the low grade regional metamorphism of the Nikolai Greenstone. Copper mineralization fills irregular fractures and amygdules, and forms pods in shear zones. Similarity between the mineralogy developed during regional metamorphism of the Nikolai Greenstone and that of the gangue, and absence of wall rock alteration adjacent to mineralization indicate that metamorphism probably concentrated copper mineralization in permeable zones. Within the map-area, Kennecott-type deposits have not been discovered in the overlying Chitistone Limestone.

42 HUSKY GROUP Cu

References: Sawyer, 1968.

Location: 115A/6; UTM zone: 8V; UTM co-ordinates: LB0426900, LB6695800; in.

Type: Disseminated sulphides Status: Prospect.

Description: The group consists of 72 claims in the Virgin Creek area. On the west side of Virgin Creek, meta-andesite of the Station Creek Formation contains some disseminated chalcopyrite. On the east side of the valley and across a fault, Nikolai Greenstone of Late Triassic age hosts chalcopyrite, bornite, chalcocite, cuprite and native copper in irregular aggregates, fracture-fillings and amygdules.

40 JOHOBO Cu, Ag

References: Craig and Laporte, 1972, p. 10; Findlay, 1967, p. 55; Green, 1965, p. 35-36; Green and Godwin, 1963, p. 24-25; Green and Godwin, 1964, p. 29; Kindle, 1953, p. 57-58; Skinner, 1961, p. 28-30, 37; Skinner, 1962, p. 27-29.

Location: 115A/5; UTM zone: 8V; UTM co-ordinates: LC0419200; LC6708100; in.

Type: Vein Status: Past producer/3647 tons; 1,617,511 lbs. (Cu); 6232 oz (Ag).

Description: This property of 58 claims straddles Bornite Creek on the western flank of the Kluane Ranges southeast of Sockeye Lake. The original showings were discovered by Kindle in 1950, but they remained unexplored until H. Honing and associates staked them in May 1958. Between 1958 and 1962, the property has been geologically mapped (1960, 1961), drilled (1959, 1960, 1961), worked on surface (1958 to 1962) and underground (1961) and mined (1958 to 1962). The property is in Nikolai Greenstone on the northeast limb of a faulted and gently northwest plunging anticline. Bornite and less chalcopyrite and pyrite form massive pods and disseminations in sheared and brecciated zones. These lie in green and purple amygdaloidal meta-basalt of the Upper Triassic Nikolai Greenstone close to its contact with limestone of the Lower Permian Hasen Creek Formation. Attitudes of the several "veins" which form the deposit range from 065° to 090° with steep dips. Lenses six to twelve feet wide and 50 feet or more in length have produced 3647 tons which assay 22.18% Cu and 1.71 oz/T silver (Plate 21).

43 KEL GROUP Cu

References: Cathro, 1968; Dollery-Pardy, 1968; Lees, 1968.

Location: 115A/6; UTM zone: 8V; UTM co-ordinates: LB0430600, LB6690700; in.

Type: Vein Status: Prospect.

Description: A group of 72 claims which lies west of Dalton Creek and north of Mush Lake. Chalcocite and bornite are present in pods up to six inches in longest dimension in a few shear zones in meta-basalt of the Nikolai Greenstone.

6 MARY AND TEDDY GROUPS Cu

References: Craig and Laporte, 1972, p. 10, 103; Cairnes, 1915, p. 30-31; Muller, 1967, p. 109.

Location: 115G/6; UTM zone: 7V; UTM co-ordinates: EU0589700, EU6809000; out.

Type: Vein Status: Showing

Description: About 1908 a one to two foot wide vein of bornite, malachite, epidote, calcite, and quartz was discovered on the crest of Kluane Range north of the mouth of Tatamagouche Creek and presently 1000 feet north of Trig 6342'. The shear zone in amygdaloidal meta-basalt of the Nikolai Greenstone strikes 070 and dips 40°NW. About one-half mile north is a second shear zone with similar mineralization which strikes north a dips moderately to the west.

4 RAM GROUP Cu

References: Findlay, 1967, p. 53-54; Findlay, 1969a, p. 70-72; Tremblay, 1968.

Location: 115G/6; UTM zone: 7V; UTM co-ordinates: EU0583700, EU6812100; out.

Type: Vein and disseminated sulphides Status: Prospect.

Description: Ram and Jay Groups comprise 153 claims on the southeast side of Quill Creek between 4500 and 6000 feet and eight miles up Quill Creek from the Alaska Highway. Chalcocite, native copper, minor bornite and rare chalcopyrite are dispersed in amydgaloidal meta-basalt of the Nikolai Greenstone as specks or amygdule- and fracture-fillings accompanied by quartz, calcite, prehnite and pumpellyite. The Ram showing is an erratically mineralized zone of variable width but at least 1000 feet long. The Linda and Fossil showings lie at 5700 and 5900 foot levels and are 3200 and 4800 feet respectively northeast of the Ram showing. Mineralization is similar but dimensions are unknown.

(c) Copper Deposits in the Skolai Group:

Copper deposits in the Skolai Group are characterized by a low Cu:S reflected in the dominance of chalcopyrite and pyrite. Calcite and quartz are the gangue minerals which fill fractures, shear zones and breccia zones and alter the wall rock. Granodiorite, diorite or quartz diorite are nearby.

51 JACK POT COPPER MINES LTD. Cu

References: Craig and Laporte, 1972, p. 108; Findlay, 1969b, p. 7, 43-44; Parker, 1967; Sinclair and Gilbert, 1975, p. 72.

Location: 115A/3. UTM zone: 8V; UTM co-ordinates: LB0442100, LB6658800; out.

Type: Vein Status: Prospect

Description: Jack Pot Copper Mines Ltd. holds 206 claims covering a copper prospect located about one mile east of Tatshenshini River and six miles southwest of Dalton Post. The property was first staked in 1965 on a shear zone containing quartz breccia-filling with disseminated chalcopyrite. The shear zone trends slightly west of north, dips steeply eastward, and lies along the contact between diorite-quartz diorite and basic meta-volcanics of Station Creek Formation. Geophysical surveys (1967, 1973), geochemical survey (1967), bulldozer trenching (1968, 1969), and diamond drilling (1970, 1973) outlined a mineralized zone two to seven feet wide and more than 600 feet long.

46 MIKE GROUP Cu

References: Findlay, 1969a, p. 73-74; McGinn, 1967.

Location: 115A/3; UTM zone: 8V; UTM co-ordinates: LB0431700, LB6670400; in.

Type: Vein Status: Prospect

Description: A group of 32 claims located on a tributary of Fraser Creek along which Geophoto Services Ltd. discovered anomalously high copper values in silts in 1966. Geological, electromagnetic and geochemical surveys delineated a major north-trending and steeply dipping shear zone up to 800 feet wide with calcite-quartz veins which host chalcopyrite. In the shear zone, volcanics of the Station Creek Formation are thoroughly bleached and silicified. Five diamond drill holes totalling 128 feet in length penetrated mineralization in the shear zone. Chalcopyrite, pyrite, some pyrrhotite and minor erythrite are present in calcite-quartz veinlets and replacements in the shear zone. Within the zone a two foot wide vein trends east and consists of calcite and chalcopyrite. The largest vein is a six foot wide calcite vein with chalcopyrite, pyrite and erythrite that strikes northwest and dips northeast.

21 PAT GROUP Cu

References: McGinn, 1969.

Location: 115G/6; UTM zone: 7V; UTM co-ordinates: ET0581600, ET6797500; out.

Type: Unknown Status: Prospect.

Description: A group of eight claims on the west side of Burwash Creek about one mile below the terminus of the glacier at the head of the creek. Malachite is found in basic volcanics associated with peridotite. A 33 foot diamond drill hole failed to intersect mineralization. Electromagnetic and soil geochemistry surveys did not yield anomalies.

43A SANDY CLAIMS Cu

References: Sawyer, 1968.

Location: 115A/6; UTM zone: 8V; UTM co-ordinates: LB0427400, LB6685700; in.

Type: Unknown Status: Showing

Description: Claims staked on chalcopyrite disseminated in meta-andesite of Station Creek Formation on the south shore of Mush Lake at its east end.

45 SNO GROUP Cu

References: Kindle, 1953, p. 56-57; Skinner, 1961, p. 37-38.

Location: 115A/3; UTM zone: 8V; UTM co-ordinates: LB0428100, LB6667300; in.

Type: Vein Status: Prospect

Description: On the south side of Mush Creek-Fraser Creek pass between 3250 and 3900 foot levels, copper mineralization is associated with a northerly trending fault zone. Chalcopyrite, quartz and minor pyrite fill divergent faults and form veinlets. The host rocks are silicified and carbonatized pillow lava and breccia of Station Creek Formation. Although the fault zone is supposed to traverse the granodiorite south of the prospect, the intrusive contact is not offset.

(d) Porphyry Copper Deposits:

A few quartz latite porphyry stocks, sills and dykes outcrop in Burwash and Bullion Creeks. Potassium-argon radiometric dating has delineated three Oligocene intrusions of which only one is mineralized.

10 CORK GROUP Cu, Mo

References: Bell and Hallof, 1967; Christopher, White and Harakal, 1972, p. 918-921; Craig and Laporte, 1972, p. 101-102; Findlay, 1969a, p. 73; McGinn, 1967.

Location: 115G/6; UTM zone: 7V; UTM co-ordinates: EU0589300, EU6805400; out.

Type: Porphyry copper Status: Prospect

Description: Sixty claims cover a weakly mineralized, quartz latite porphyry stock (26 $\pm$ 0.3 m.y.) and adjoining hornfelsed and weakly mineralized argillite of Hasen Creek Formation of

Early Permian age which are situated 11 miles up Burwash Creek from mile 1104 on the Alaska Highway. The porphyry has numerous quartz-filled fractures and is weakly altered with kaolinized feldspar phenocrysts and secondary biotite and sericite developed in the matrix. Pyrite, chalcopyrite and molybdenite with minor magnetite and hematite fill fractures and are disseminated in the porphyry and adjoining hornfels.

(e) Silver-Lead Veins:

At the southern end of the map-area (Map 3B), two silver-lead showings may be the northern extremity of silver-lead showings in the Rainy Hollow area (Watson, 1948).

49 IRON CREEK Pb, Ag

References: Kindle, 1953, p. 56.

Location: 115A/4; UTM zone: 8V; UTM co-ordinates: LB0412600, LB6667300; in.

Type: Vein Status: Showing

Description: A quartz vein with minor pyrite and galena outcrops between 3,600 and 3,800 foot levels on the west side of Iron Creek about one mile below the glacier terminus in 1950. The vein strikes 030° and dips 80° southeasterly. A four-foot channel sample across the vein assayed: gold, a trace; silver, 1.03 ounces per ton; lead 3.10%.

50 MOHAWK AND SKY GROUPS Ag, Pb, Zn, Cu

References: Sevensma, 1974; Sinclair, Maloney and Craig, 1975, p. 140-141.

Location: 115A/3; UTM zone: 8V; UTM co-ordinates: LB0442200, LB6666200; out.

Type: Vein Status: Past producer/10-15 tons.

Description: Two groups of 24 claims are located three miles west of Dalton Post at the 3,500 foot level on the south-facing slopes which drop into the Tatshenshini River. J. Johns and associates discovered the showing in the early sixties and 10 to 15 tons of ore were shipped in 1969. Detailed geological, geochemical, and geophysical surveys and trenching in 1974 exposed a galena-sphalerite-stibnite-jamesonite-quartz vein up to 18 inches wide which strikes 315° and dips 69° southwest. The vein is beside or within a hornblende-plagioclase andesite dyke which shows argillic alteration adjacent to the vein. The dyke intrudes diorite and quartz diorite close to their contact with volcanics of the Station Creek Formation. Assay values of up to 281 oz/T of silver over one foot come from this high grade silver vein of undetermined length.

(f) Miscellaneous Deposits:

7 AMP GROUP Cu

References: Craig and Milner, 1975, p. 42-43; Sadlier-Brown and Chisholm, 1970.

Location: 115G/6; UTM zone: 7V; UTM co-ordinates: EU0579900, EU6808000; out.

Type: Anomaly Status: Showing

Description: A group of 79 claims located at the heads of Wade and Maple creeks. In 1970 a geochemical survey outlined nine areas of anomalously high copper content in soils. Nikolai Greenstone, Hasen Creek Formation and granitic rocks underlie the group. Many of the copper anomalies are from soils either directly overlying or adjacent to Nikolai Greenstone.

44 BATES LAKE Asbestos

References: Kindle, 1953, p. 38.

Location: 115A/5; UTM zone: 8V; UTM co-ordinates: LB0417000, LB6684600; in.

Type: Vein Status: Prospect

Description: The central island of a group of three islands near the north end of Bates Lake is composed of peridotite. Fine veinlets up to one inch in width of picrolite asbestos traverse the peridotite.

35 CUB PROPERTY Cu, Zn

References: Coates, 1970; Watson, 1961; Wheeler, 1963; Woodcock, 1967.

Location: 115B/16; UTM zone: 8V; UTM co-ordinates: FT0380600, FT6755200; in.

Type: Unknown Status: Prospect

Description: This claim group straddles Cub Creek, a tributary of Telluride Creek. Access to the property is by a CN microwave road which leaves Alaska Highway at Mile 1050, continues along the pipeline right-of-way for 3 miles to reach a 6 mile long bulldozer road to the property. Since the discovery of laminated pyrite-sphalerite-chalcopyrite boulders by Gaymont Prospecting Syndicate in 1955, a resistivity survey (1956), electromagnetic surveys (1958, 1961 and 1966), geochemical surveys (1967 and 1970) and drilling (1956, 1961 and 1970) have failed to discover the source of the mineralized float. In 1970 diamond drill holes by Atlas Explorations Ltd. intersected the geophysical anomaly and proved it was caused by water-saturated, marcasite-bearing coal seams of the Amphitheatre Formation. Sparse outcrops on the property expose Nikolai Greenstone and overlying grey phyllite (u Kp).

19 PTARMIGAN (WINDGAP) CREEK Asbestos

References: Walker, 1955, pp. 5.

Location: 115G/6; UTM zone: 7V; UTM co-ordinates: ET0596900, ET6798800; out.

Type: Vein Status: Showing

Description: See Teck Group, p

18 TECK GROUP Au, Ag

References: Walker, 1955, pp. 5.

Location: 115G/6: UTM zone: 7V; UTM co-ordinates: EU0597400, EU6800500; out.

Type: Unknown Status: Showing

Description: This group of 48 claims spans Duke River between Squirrel and Ptarmigan (Windgap) creeks. Geological mapping and a magnetometer survey revealed a carbonate zone with pyrite containing trace amounts of gold and silver exposed on Duke River about 1,800 feet upstream from the mouth of Squirrel Creek. In Ptarmigan (Windgap) Creek about 800 feet upstream from Duke River a few thin (1 cm) asbestos veinlets in peridotite are exposed. Permian sediments and Pennsylvanian volcanics of the Skolai Group and Permo-Triassic peridotite host the mineralization.

SEDIMENTARY DEPOSITS

(a) Coal:

Coal, in seams up to ten feet thick, occurs in the Amphitheatre Formation of Eocene age. The coal is sub-bituminous C or lower class and is presently uneconomic.

20 AMPHITHEATRE MOUNTAIN Coal

References: Cairnes, 1915, p. 32-33; Cameron and Birmingham, 1970, p. 20, 21, 34; Craig and Laporte, 1972, p. 9; Speelman, 1971, pp. 6.

Location: 115G/6; UTM zone: 7V; UTM co-ordinates: ET0587400, ET6798000; out.

Type: Stratiform Status: Showing

Description: As early as 1914 coal had been discovered on Amphitheatre Mountain where seams 4 feet 5 inches and 3 feet thick of lignite were exposed. These together with others over one foot thick were said to give a total thickness of 30 to 50 feet in 1200 to 1500 feet of Amphitheatre Formation. Because much of the coal is shaly, Muller believed this aggregate thickness to be too high.

16 CEMENT CREEK Coal

References: Craig and Laporte, 1972, p. 9; Muller, 1967, p. 113.

Location: 115G/5; UTM zone: 7V; UTM co-ordinates: EU0564500, EU6804300; out.

Type: Stratiform Status: Showing

Description: Muller reported a coal seam several feet thick in the Amphitheatre Formation south of Cement Creek.

23 GRANITE CREEK Coal

References: Cameron and Birmingham, 1970, p. 20, 21, 34; Muller, 1967, p. 113-115; Speelman, 1971, pp. 6.

Location: 115G/6; UTM zone: 7V; UTM co-ordinates: ET0586800, ET6794800; out.

Type: Stratiform Status: Showing

Description: At the head of the south tributary of Granite

Creek, seams three, four, and five feet thick are intercalated with shale in the Amphitheatre Formation. Analyses show this coal is of sub-bituminous C class. In 1950 a group of Whitehorse businessmen took a coal mining lease but later dropped it.

37 KIMBERLEY CREEK Coal

References: Cairnes, 1915, p. 32; Cameron and Birmingham, 1970, p. 20, 21, 34; Kindle, 1953, p. 58; McConnell, 1905, Map 894.

Location: 115B/16; UTM zone: 8V; UTM co-ordinates: FT0392500, FT6746300; in.

Type: Stratiform Status: Showing

Description: As early as 1904 coal was known in Kimberley Creek. McConnell (1905) mapped Tertiary lignite beds in Kimberley Creek but Kindle (1953) erroneously placed these at the base of the Dezadeash Formation of Early Cretaceous age. The coal-bearing strata in Kimberley Creek belong to the Eocene Amphitheatre Formation and they are preserved as a fault sliver in the Dalton Fault zone.

24 NIAMODLAOC MOUNTAIN COAL PROSPECT Coal

References: Cameron and Birmingham, 1970, p. 20, 21, 34; Craig and Laporte, 1972, p. 153-154; Muller, 1967, Map 1177A; Speelman, 1970, pp. 17.

Location: 115G/6; UTM zone: 7V; UTM co-ordinates: ET0601000, ET6793200; out.

Type: Stratiform. Status: Showing

Description: The Amphitheatre Formation is at least 1,500 feet thick and may exceed 2,500 feet below Niamodlaoc Mountain. Three foot and six foot thick coal seams were exposed and sampled. About one-quarter mile south (UTM co-ordinates:

ET0600900, ET6792700) four coal seams ranging from one to six feet thick are poorly exposed in a gully. At the 4,000 foot level in a gully 1.1 miles northwest of the locality shown on Map 1B (UTM co-ordinates: ET0599300, ET6793200) slumped coaly material floors a gully.

25 NIAMODLAOC MOUNTAIN COAL PROSPECT Coal

References: Cameron and Birmingham, 1970, p. 20, 21, 34; Craig and Laporte, 1972, p. 153-154; Nandi, Speelman and Montgomery, 1971; Speelman, 1970, pp. 17.

Location: 115G/3: UTM zone: 7V; UTM co-ordinates: FT0600900, FT6789300; out.

Type: Stratiform Status: Showing

Description: Two localities in the Amphitheatre Formation expose coal seams in a sandstone-shale sequence. At the locality shown on the map with the above co-ordinates, an 11 to 14 foot thick coal seam is intruded by a 3 to 6 foot thick sill which is a feeder to the overlying Wrangell Lava. The sill has baked the coal at its contacts. At a second locality, 780 feet higher in the section (UTM co-ordinates: FT0601600, FT6789400), one 6 foot and two 3 foot thick coal seams are exposed just beneath the Wrangell Lava.

29 SHEEP CREEK Coal

References: Cairnes, 1915, p. 21, 32; McConnell, 1905, p. 15A, 18A; Muller, 1967, p. 113, 114.

Location: 115G/2; UTM zone: 7V; UTM co-ordinates: FT0624600, FT6770400; in.

Type: Stratiform Status: Showing

Description: As early as 1904 coal was known in Sheep Creek.

A six-foot thick seam in sandstone and shale of the Amphitheatre Formation has been sampled and analyzed.

38 SUGDEN CREEK Coal

References: Cameron and Birmingham, 1970, p. 20, 21, 34; Kindle, 1953, p. 58.

Location: 115A/12; UTM zone: 8V; UTM co-ordinates: LC0404000; LC6733000; in.

Type: Stratiform Status: Showing

Description: Conglomerate, sandstone, and shale of the Amphitheatre Formation contain several coal seams up to 6 inches thick.

36 TELLURIDE CREEK Coal

References: Cairnes, 1915, p. 32; Coates, 1970; McConnell, 1905, Map 894.

Location: 115B/16; UTM zone: 8V; UTM co-ordinates: FT0387600, FT6751900; in.

Type: Stratiform Status: Showing

Description: As early as 1914 coal was known in Telluride Creek. In 1970 diamond drilling of a geophysical anomaly on the Cub Property intersected thin coal seams in the Amphitheatre Formation.

(b) Gypsum and Anhydrite:

Sedimentary deposits of gypsum and anhydrite contact Upper Triassic, Lower Permian and Devonian rocks. The largest deposit in lower Bullion Creek lies above the Chitistone Limestone of Late Triassic age and may represent deposition within or adjacent to the sabkha environment postulated during deposition of the lower part of the Chitistone Limestone near Kennecott in the Eastern Alaska Range (Armstrong and MacKevett, 1975, p. 68).

26 BOCK'S BROOK GYPSUM Gypsum

References: Muller, 1967, p. 115.

Location: 115G/2; UTM zone: 7V; UTM co-ordinates: FT0615800, FT6786400; out.

Type: Stratiform Status: Showing

Description: Minor gypsum lenses are present in the Chitistone Limestone of Late Triassic age.

32 BULLION CREEK GYPSUM Gypsum

References: Muller, 1967, p. 115.

Location: 115B/15; UTM zone: 8V; UTM co-ordinates:FT0627700, FT6763900; in.

Type: Stratiform Status: Showing

Description: On the northeast side of Bullion Creek and Sugden Pup valleys is a lens of gypsum-anhydrite over 4 miles long and up to 1 mile wide. It probably overlies massive Chitistone Limestone on the east and the Duke River Fault bounds it on the west.

5 MAPLE AND WADE CREEKS GYPSUM Gypsum

References: Muller, 1967, p. 115.

Location: 115G/5; UTM zone: 7V; UTM co-ordinates: EU0576000, EU6810000; out.

Type: Stratiform Status: Showing

Description: Small lens of gypsum or anhydrite located on the boundary of Lower Permian sediments of Hasen Creek Formation and Upper Triassic Nikolai Greenstone. Although Muller suggested a Late Triassic age for the gypsum or anhydrite, an Early Permian age is possible.

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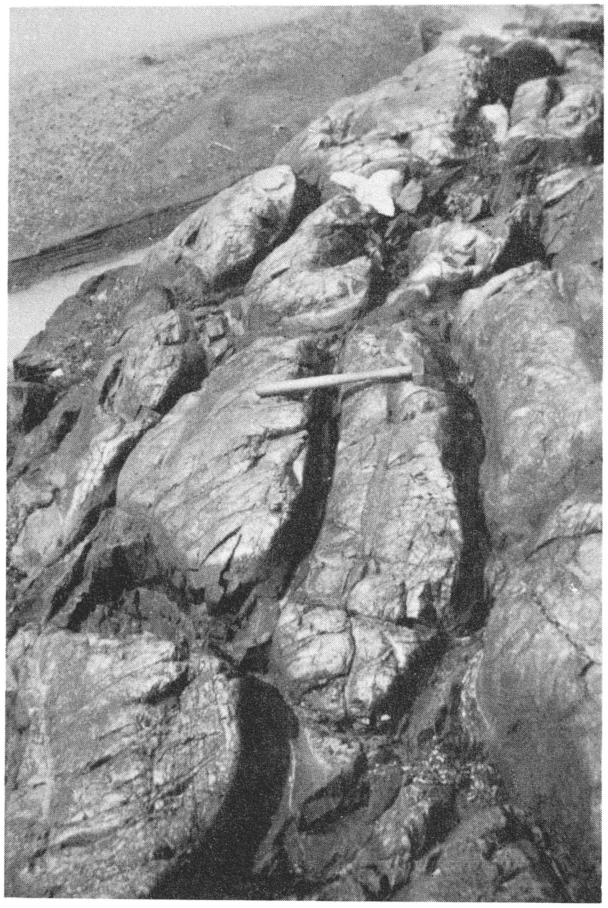
Plate 1: Pillow lava of unit ЄOv exposed along Alsek River on the northeast limb of the anticline south of Raft Creek (Map 3A).

Plate 2: Limy tuff and breccia, locally with graded bedding, of unit DCv at the head of Field Creek (Map 3A).



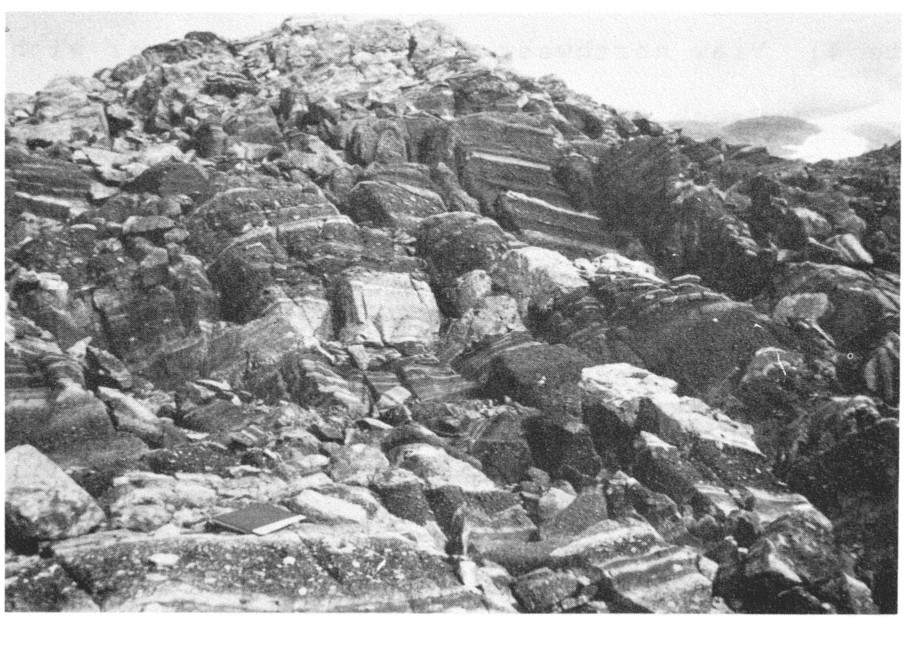
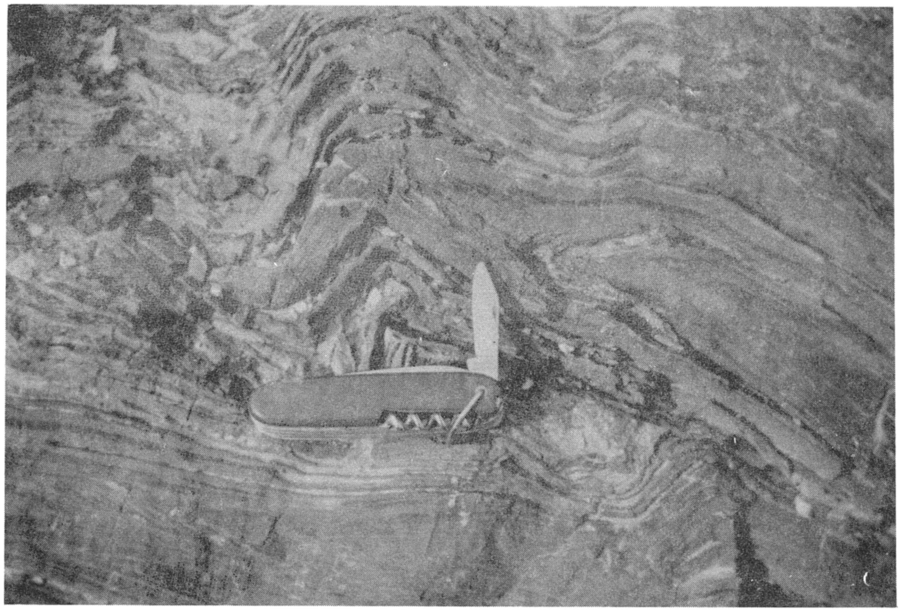


Plate 3: On the bank of Alsek River south of Marble Creek, limy phyllite of unit DCs showing an isoclinal fold folded around an open fold to the left of the knife blade (Map 3A).

Plate 4: View northwest across Donjek River with Steele Creek at the far side of the valley. Dark coloured slopes expose pre-Permian gabbro complex (Pb) nonconformably overlain by sandstone and conglomerate of the Hasen Creek Formation (Pss) (Map 1A).



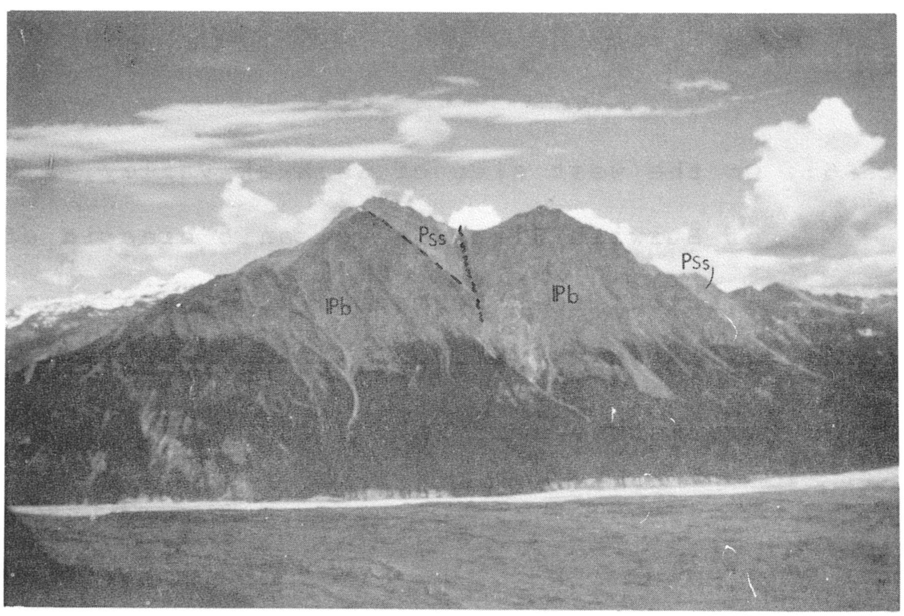

Pss
IPb
IPb
Pss

Plate 5: Nonconformity between pre-Permian gabbro complex (lPb) and bedded Lower Permian sandstone (Pss) of Hasen Creek Formation above confluence of Steele Creek and Donjek River (Map 1A).

Plate 6: On the west side of Shakwak Valley, 5 km west of Burwash Flats, a volcanic breccia of Station Creek Formation (Psv) contains clasts up to 20 cm of augite porphyry or fine-grained greenstone (Map 2A).


PS.s

Plate 7: On the ridge between Beloud and Virgin Creeks, pillow lava of Station Creek Formation (Psv) (Map 3A).

Plate 8: On the summit of Wade Mountain (Map 1A) where altered augite phenocrysts become flattened chlorite blebs in foliated lapilli tuff (Psv) next to Wade Mountain Fault.

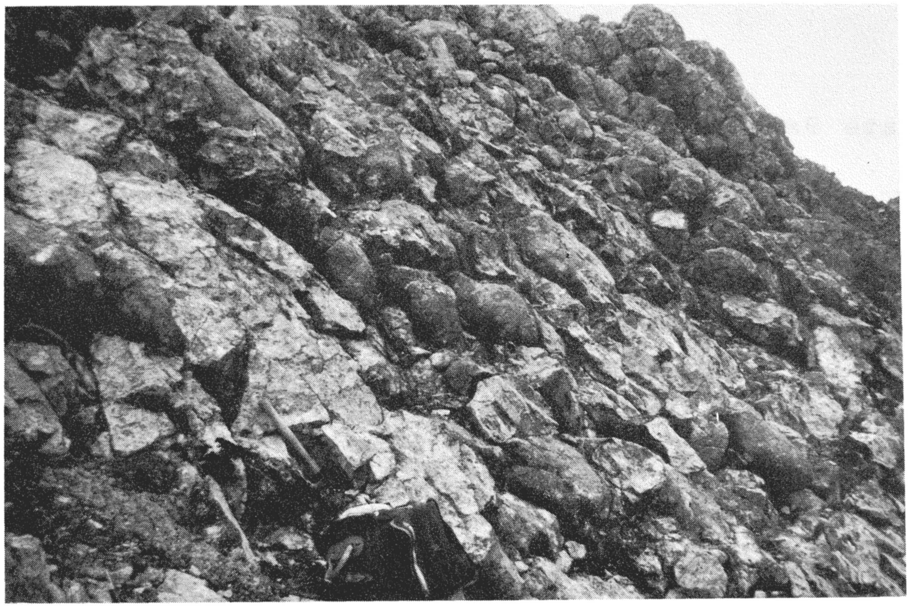
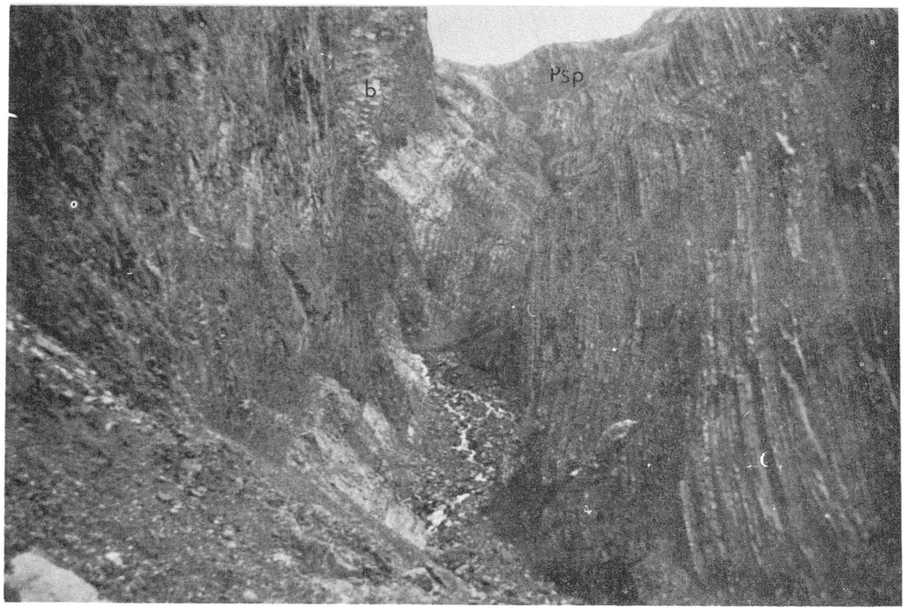


Plate 9a: At Hoge Creek (Map 1A), conglomerate at the base of Hasen Creek Formation (Pscg) contains coarse-grained gabbro clasts such as ones on either side of hammer head.

Plate 9b: On the northeast flank of Duke River valley opposite the mouth of Grizzly Creek (Map 2A), pebble conglomerate of Lower Permian Hasen Creek Formation with a granitic clast.

Plate 10: Contact between gabbro (b) and thin-bedded siliceous siltstone (Psp) of Hasen Creek Formation with "bleached" hornfels zone in sediments (Map 1A).

Plate 11: West limb of Hoge Creek Syncline above Donjek River (Map 1A), thin-bedded limestone and argillite of the McCarthy Formation (uTrmc) overlying lenses of massive Chitistone Limestone (uTrcc) above possible Middle Triassic argillite (mTrp) intruded by gabbro sills.


b
Psp

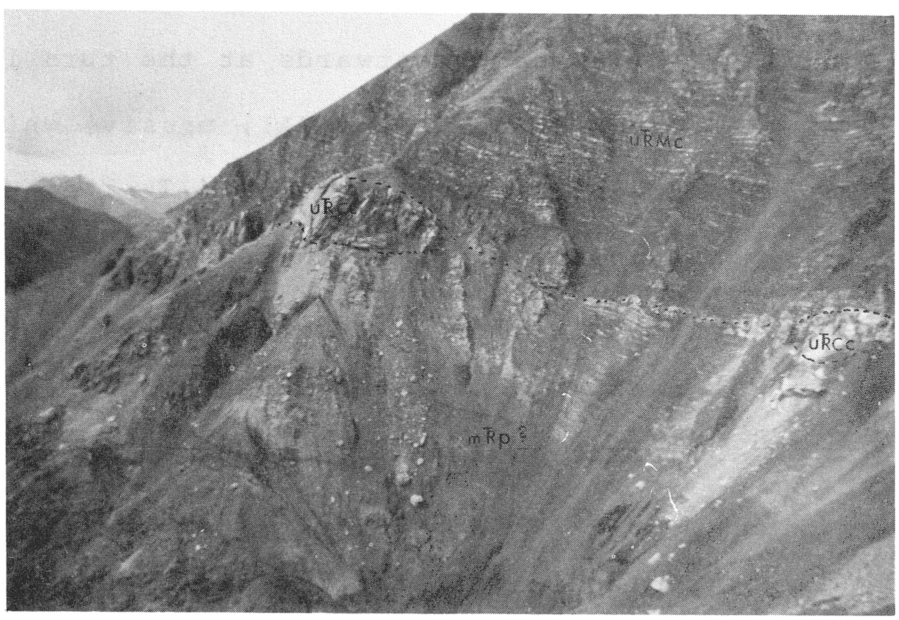

uRMc
uRc
uRcc
mRp

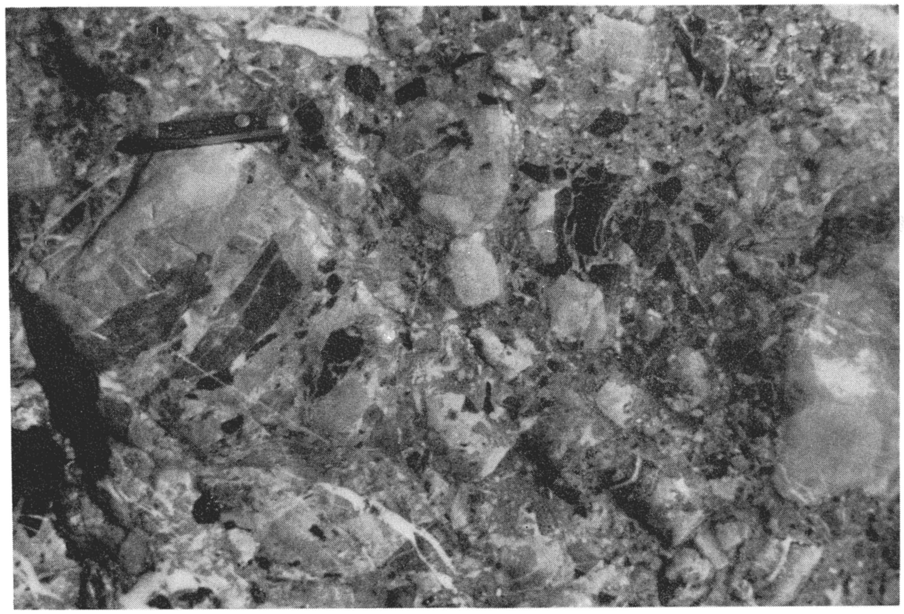
Plate 12: At the head of Williscroft Creek near F62 (Map 2A). Nikolai Greenstone with typical amygdaloidal zones defining flow top parallel to knife.

Plate 13: A view southeastwards at the turn in Duke River (Maps 1A and 2A), massive white cliffs of Chitistone Limestone (uTRcc) of Hoge Creek Syncline which is cored by thin bedded limestone of the McCarthy Formation (uTRmc) and overlying shale of McCarthy to Dezadeash Formation (uTRKp). At the left, Wade Mountain Fault juxtaposes Chitistone Limestone against volcanics of Station Creek Formation (Psv).


Psv
uTRKp
uTRcc
uTRmc
uTRmcl
uTRcc

Plate 14: Near the turn in Duke River (Map 2A), a typical exposure of limestone breccia of the Chitistone Formation.

Plate 15: Near the head of Sugden Pup (Map 2A), the Duke River Fault truncates and juxtaposes white gypsum (uTRce) against downslope exposures of grey phyllite (IPpw) of the Alexander Terrane.



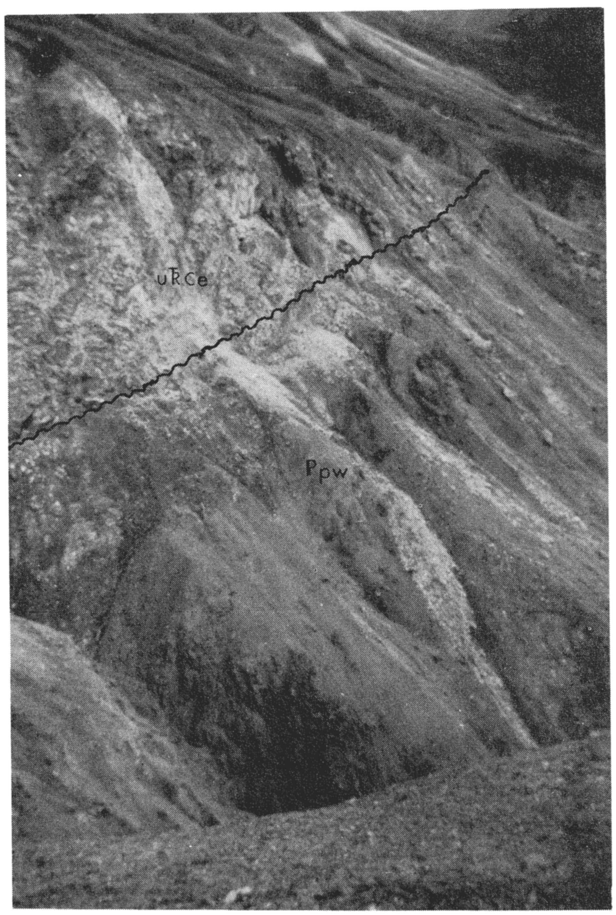

uT̄Rce
Ppw

Plate 16: At the head of Burwash Creek (Map 1A), chevron-folded, thin-bedded limestone and argillite of the McCarthy Formation in the core of Hoge Creek Syncline.

Plate 17: In the lower part of Bock's Brook (Map 2A), a granitic clast, lower centre, in conglomerate of unit uTRKp.

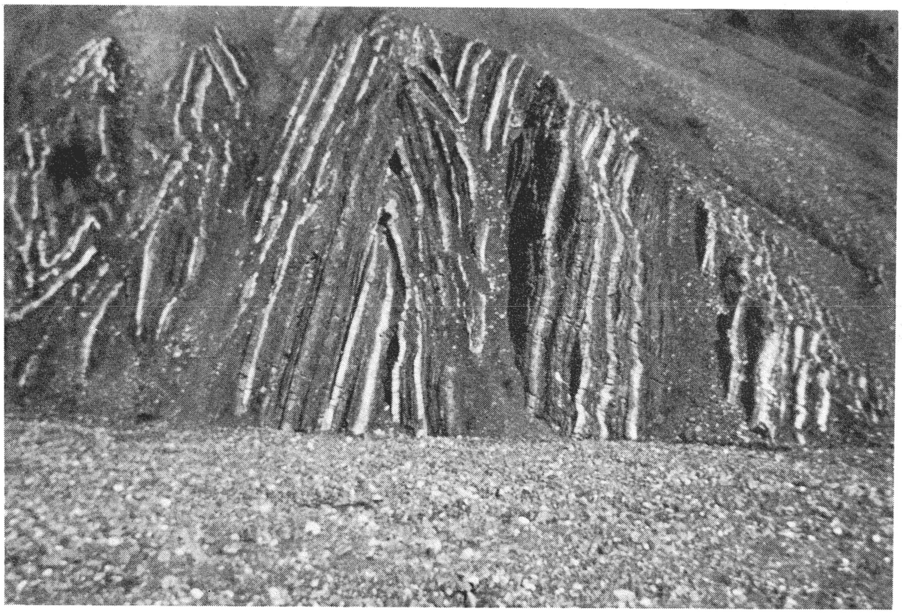
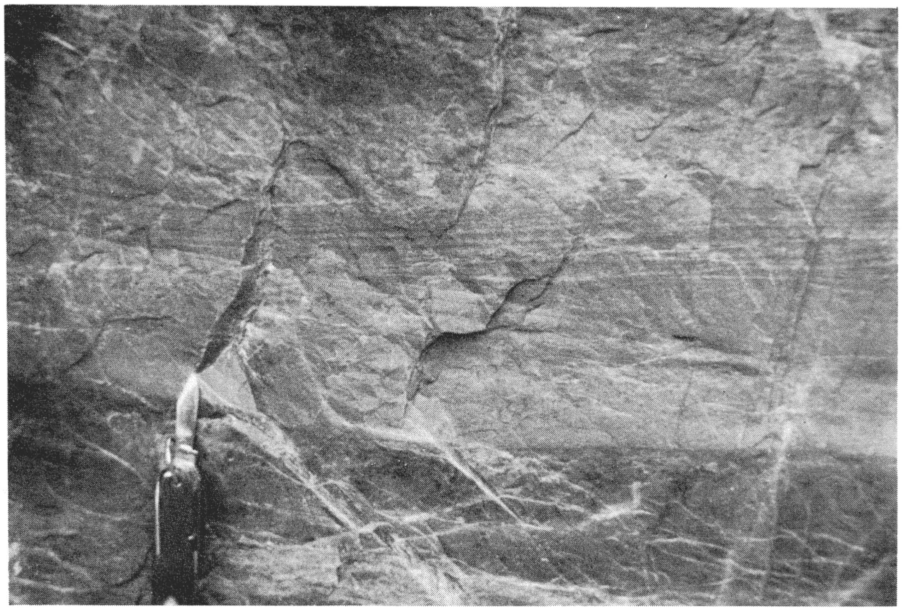


Plate 18: In the lower part of Bock's Brook (Map 2A), cross-bedded greywacke of unit uTRKp.

Plate 19: At the head of Bock's Brook (Map 2A), a stock and dykes of Tertiary diorite (light) intrude Wrangell Lava (dark).



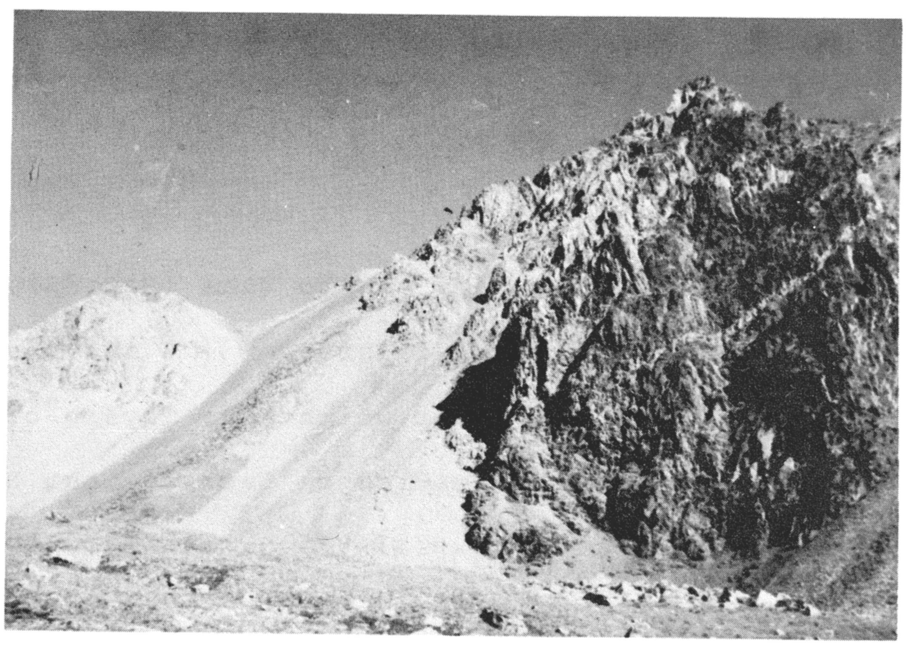
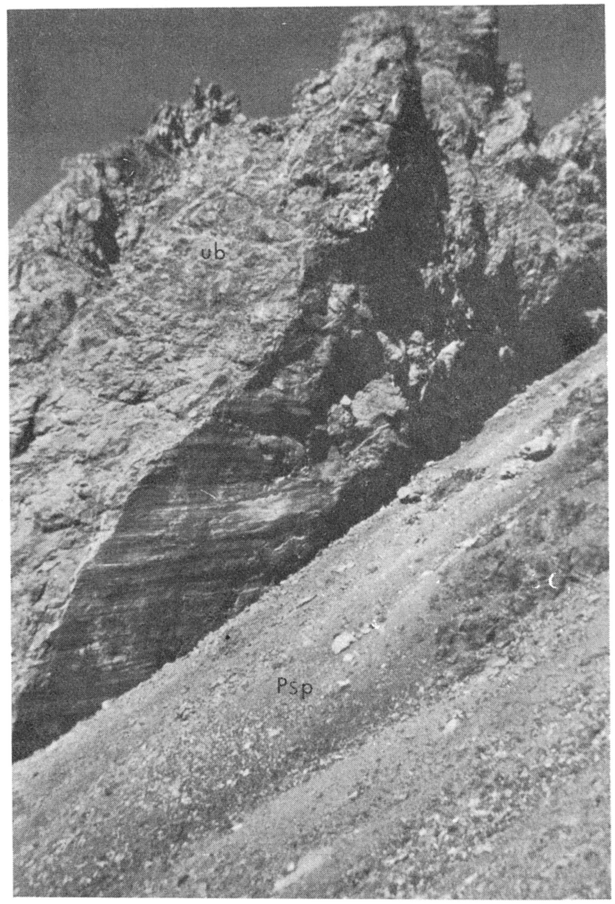


Plate 20: At the head of the west tributary of Congdon Creek, 0.5 km west of locality F60 (Map 2A), horizontal slickensides exposed on contact between blocky peridotite (ub) and siliceous phyllite of Hasen Creek Formation (Psp) at Duke River Fault.

Plate 21: A view south to Johobo Mine (Map 3A), showing light coloured felsites (Tfl) intruded along the Dalton Fault which sets flysch of Dezadeash Formation on left against Nikolai Greenstone (?) (uTRNv?) on right.


ub
Psp


TFl
IPDwp
RNv ?

REFERENCES

Armstrong, A.K. and MacKevett, E.M.

1975: Genesis of Kennecott-type copper deposits; in Geological Survey Research 1975; U.S. Geol. Surv., Prof. Pap. 975, p. 68-69.

Armstrong, A.K., MacKevett, E.M. and Silberling, N.J.

1969: The Chitistone and Nizina Limestones of part of the southern Wrangell Mountains, Alaska - a preliminary report stressing carbonate petrography and depositional environments; U.S. Geol. Surv., Prof. Pap. 650-D, p. D49-D62.

Bell, R.A. and Hallof, P.G.

1967: Report on induced polarization survey of the Cork Group, Whitehorse M.D. Yukon; unpub. rept., 7 p.

Berg, H.C., Jones, D.L. and Richter, D.H.

1972: Gravina-Nutzotin Belt - tectonic significance of an Upper Mesozoic sedimentary and volcanic sequence in southern and southeastern Alaska; U.S. Geol. Surv., Prof. Pap. 800-D, p. D1-D24.

Bostock, H.S.

1933: The mining industry of Yukon, 1932; Can., Geol. Surv., Summ. Rept. 1932, pt. A II, p. 1A-14A.

1934: The mining industry of Yukon, 1933, and notes on the geology of Carmacks map-area; Can., Geol. Surv., Summ. Rept. 1933, pt. A, p. 1A-8A.

1935: The mining industry of Yukon, 1934; Can., Geol. Surv., Mem. 178, 10 p.

Campbell, R.B. and Eisbacher, G.H.

1974: Operation Saint Elias; in Report of Activities, Can., Geol. Surv., Pap. 74-1, pt. A, pt. 11-12.

Cathro, R.J.

1968: Engineering evaluation report Re: Mush Lake, Y.T. Property; unpub. rept., 3 p.

Christopher, P.A., White, W.H. and Harakal, J.E.

1972: K-Ar dating of the 'Cork' (Burwash Creek) Cu-Mo prospect, Burwash Landing Area, Yukon Territory; Can. J. Earth Sci., v. 9, p. 918-921.

Coates, M.E.

1970: Report on diamond drilling Cub Property; unpub. rept. 18 p.

Cockfield, W.E.

1928: Dezadeash Lake area, Yukon; Can., Geol. Surv., Summ. Rept. 1927, pt. A, p. 1A-7A.

1930: The Mining Industry of Yukon, 1929; Can., Geol. Surv., Summ. Rept. 1929, pt. A, p. 1A-15A.

Craig, D.B. and Laporte, P.

1972: Mineral industry report 1969 and 1970. volume 1. Yukon Territory and southwestern sector District of Mackenzie; Can., Dep. Indian Northern Affairs, 188 p.

Craig, D.B. and Milner, M.W.

1975: Mineral industry report 1971 and 1972. volume 1 of 3. Yukon Territory; Can., Dep. Indian Northern Affairs, 169 p.

Dollery-Pardy, W.

1968: Geochemical, geophysical and geological report on Kel Claims 1-48 Mush Lake Yukon; unpub. rept., 28 p.

Eisbacher, G.H.

1975: Operation Saint Elias, Yukon Territory: Dezadeash Group and Amphitheatre Formation; in Report of Activities; Can., Geol. Surv., Pap. 75-1, pt. A, p. 61-62.

1976: Possible dextral displacement of 300 km along the Denali Fault: Yukon Territory and Alaska; in Geol. Assoc. Can., Mineral. Assoc. Can., 1976 Annual Meetings; Prog. Abs. v. 1, p. 69.

Findlay, D.C.

1967: The mineral industry of Yukon Territory and southwestern District of Mackenzie, 1966; Can., Geol. Surv., Pap. 67-40, 104 p.

1969a: The mineral industry of Yukon Territory and southwestern District of Mackenzie 1967; Can., Geol. Surv., Pap. 68-68, 131 p.

1969b: The mineral industry of Yukon Territory and southwestern District of Mackenzie, 1968; Can., Geol. Surv., Pap. 69-55, 71 p.

Green, L.H.

1965: The mineral industry of Yukon Territory and southwestern District of Mackenzie 1964; Can., Geol. Surv., Pap. 65-19, 94 p.

1966: The mineral industry of Yukon Territory and southwestern District of Mackenzie 1965; Can., Geol. Surv., Pap. 66-31, 137 p.

Green, L.H. and Godwin, C.I.

1963: Mineral industry of Yukon Territory and southwestern District of Mackenzie, 1962; Can., Geol. Surv., Pap. 63-38, 71 p.

1964: The mineral industry of Yukon Territory and southwestern District of Mackenzie, Northwest Territories, 1963; Can., Geol. Surv., Pap. 64-36, 94 p.

Hilker, R.G.

1967: Geological mapping, magnetometer and electro-magnetic survey Arch Creek area, Kluane Mountains; unpub. rept. 14 p.

van Hinte, J.R.

1976: A Cretaceous time scale; Am. Assoc. Pet. Geol., Bull. v. 60, p. 498-516.

Jones, D.L., Pessagno, E.A., and Csejtey, B.

1976: Significance of the Upper Chulitna ophiolite for the Late Mesozoic evolution of southern Alaska; Geol. Soc. Am., Abstr., v. 8, no. 3, p. 385-386.

Kindle, E.D.

1953: Dezadeash map-area, Yukon Territory; Can., Geol. Surv., Mem. 268, 68 p.

Lees, E.J.

1968: Engineering report, Mush Lake Property, Yukon; unpub. rept., 10 p.

MacKevett, E.M. Jr.

1970a: Geologic map of the McCarthy C-4 Quadrangle Alaska; U.S. Geol. Surv., Geol. Quad. Maps U.S., Map GQ-844.

1970b: Geologic map of the McCarthy C-5 Quadrangle Alaska; U.S. Geol. Surv., Geol. Quad. Maps U.S., Map GQ-899.

1972: Geologic map of the McCarthy C-6 Quadrangle Alaska; U.S. Geol. Surv., Geol. Quad Maps U.S., Map GQ-979.

MacKevett, E.M. Jr., and Jones, D.L.

1975: Relations between Alexander and Taku-Skolai terranes in the McCarthy quadrangle; in Geological Survey Research 1975; U.S. Geol. Surv., Prof. Pap. 975, p. 69.

Mandy, J.T.

1933: Tatshenshini River section; B.C. Dep. Mines Ann. Rept. 1932, p. A74-A79.

1934: Tatshenshini River section; B.C. Dep. Mines Ann. Rept. 1933, p. A90-A93.

McConnell, R.G.

1905: The Kluane mining district; Can., Geol. Surv., Summ. Rept. 1904, Rept. A, p. 1A-18A.

McGinn, G.J.

1967: Geological report, Mike Group; unpub. rept., 8 p.

1969: Pat Group, Burwash Creek, Yukon Territory; unpub. rept., 5 p.

McLoughlin, R.F. and Vincent, J.S.

1973: Geological report Spy Claims 1-12 (incl.); unpub. rept. 18 p.

Moffit, F.H.

1938: Geology of the Chitina Valley and adjacent area Alaska; U.S. Geol. Surv., Bull. 894, 137 p.

Moffit, F.H. and Capps, S.R.

1911: Geology and mineral resources of the Nizina district, Alaska; U.S. Geol. Surv., Bull. 448, 111 p.

Morrison, L.G.

1967: Report on the Glen mineral claim group of Alice Lake Mines Ltd. N.P.L. Burwash Creek, Y.T.; unpub. rept., 8 p.

Muller, J.E.

1967: Kluane Lake map-area, Yukon Territory; Can., Geol. Surv., Mem. 340, 137 p.

Nandi, B.N., Speelman, E.L., and Montgomery, D.S.

1971: Study of two naturally carbonized coals; in Seventh International Congress of Carboniferous Stratigraphy and Geology.

Parker, A.R.

1967: Preliminary geochemical and geophysical survey of the Alder Hill - Ste claim group, Whitehorse mining district, Yukon Territory; unpub. rept., 10 p.

Read, P.B.

1976: Operation Saint Elias, Yukon Territory: pre-Cenozoic volcanic assemblages in the Kluane Ranges; in Report of Activities, Can., Geol. Surv., Pap. 76-1, pt. A, p. 187 - 193.

Read, P.B. and Monger, J.W.H.

1975: Operation Saint Elias, Yukon Territory: the Mush Lake Group and Permo-Triassic rocks in the Kluane Ranges; in Report of Activities, Can., Geol. Surv., Pap. 75-1, pt. A, p. 55-59.

Read, P.B. and Okulitch, A.V.

in press: The Triassic unconformity of south-central British Columbia; Can. J. Earth Sci.

Richter, D.H.

1976: Geologic map of the Nabesna Quadrangle, Alaska; U.S. Geol. Surv., Misc. Geol. Invest. Map I-932.

Richter, D.H. and Dutro, J.T., Jr.

1975: Revision of the type Mankomen Formation (Pennsylvanian and Permian) Eagle Creek Area, eastern Alaska Range, Alaska; U.S. Geol. Surv., Bull. 1396-B, B25 p.

Richter, D.H. and Jones, D.L.

1973: Structure and stratigraphy of eastern Alaska Range, Alaska; Am. Assoc. Pet. Geol., Mem. 19, p. 408-420.

Richter, D.H., Lanphere, M.A., and Matson, N.A., Jr.

1975: Granitic plutonism and metamorphism in the eastern Alaska Range; in Geological Survey Research 1975; U.S. Geol. Surv., Prof. Pap. 975, p. 68.

Sadlier-Brown, T.L. and Chisholm, E.O.

1970: A geochemical report: the AMP claims Burwash Creek, Whitehorse Mining Division, Y.T.; unpub. rept., 10 p.

Sawyer, J.B.P.

1968: Husky Syndicate: report on 1967 field work in the Dezadeash area, Yukon Territory; unpub. rept., 15 p.

Sevensma, P.H.

1968: Report on the D.C. Group of claims, map sheet 115G/2, Whitehorse M.D., Y.T.; unpub. rept., 14 p.

1974: Skyline Explorations Ltd. Mohawk Group; unpub. rept., 19 p.

Sharp, R.P.

1943: Geology of the Wolf Creek area, St. Elias Range, Yukon Territory, Canada; Geol. Soc. Am., Bull. v. 54, p. 625-650.

Siega, L.A.

1973: Geological report on Mary mineral claims, northwest of Whitehorse, Yukon Territory; unpub. rept., 5 p.

Sinclair, W.D. and Gilbert, G.W.

1975: Mineral industry report 1973. Yukon Territory; Can., Dep. Indian Northern Affairs, 177 p.

Sinclair, W.D., Maloney, J.M., and Craig, D.B.

1975: Mineral industry report 1974. Yukon Territory; Can., Dep. Indian Northern Affairs, 216 p.

Skinner, R.

1961: Mineral industry of Yukon Territory and southwestern District of Mackenzie 1960; Can., Geol. Surv., Pap. 61-23, 52 p.

1962: Mineral industry of Yukon Territory and southwestern District of Mackenzie, 1961; Can., Geol. Surv., Pap. [illegible]

Smith, J.G. and MacKevett, E.M., Jr.

1970: The Skolai Group in the McCarthy B-4, C-4 and C-5 quadrangles, Wrangell Mountains, Alaska; U.S. Geol. Surv., Bull. 1274-Q, Q26 p.

Souther, J.G. and Stanciu, C.

1975: Operation Saint Elias, Yukon Territory: Tertiary volcanic rocks; in Report of Activities, Can., Geol. Surv., Pap. 75-1, pt. A, p. 63-70.

Speelman, E.L.

1970: Report on Niamodlaoc Mountain coal prospect 1970 field season; unpub. rept., 17 p.

1971: Report on reconnaissance of Burwash Creek for coal float and northern access to Amphitheatre Mountain area; unpub. rept., 6 p.

Sturrock, D.L.

1975: The Pyroxenite Creek ultramafic complex: an Alaska-type ultramafic intrusion in southwestern Yukon; Univ. Br. Col., unpub. B. Sc. thesis, 90 p.

Taylor, H.P.

1967: The zoned ultramafic complexes of southeastern Alaska; in Ultramafic and Related Rocks, ed. P.J. Wyllie; John Wiley & Sons Inc., New York, p. 97-121.

Tempelman-Kluit, D.J.

in press: The Yukon Crystalline Terrane - enigma in the Canadian Cordillera; Geol. Soc. Am., Bull.

Tremblay, J.H.

1968: Ram group; unpub. rept.

Walker, A.J.

1955: Report of work on Teck claims, Duke River, Kluane Lake by Teck Exploration Co. Ltd. during 1954; unpub. rept., 5 p.

1956: Teck Exploration Co. Ltd. report of work on Freda, Wendy, Vulcan, Eagle, and Hawk claim groups, Vulcan Creek, Yukon Territory; unpub. rept., 4 p.

Watson K. DeP.

1948: The Squaw Creek-Rainy Hollow area, northern British Columbia; B.C. Dep. Mines, Bull. 25, 74 p.

Watson, R.K.

1961: Report on Turam electromagnetic survey in the Cub Creek area, Yukon Territory, unpub. rept., 8 p.

Wheeler, J.O.

1963: Kaskawulsh, Yukon Territory; Can., Geol. Surv., Geol. Map 1134A.

Woodcock, J.R.

1967: Geochemistry of Cub Creek prospect, Yukon Territory; unpub. rept., 9 p.