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GEOLOGICAL SURVEY OF CANADA

PAPER 58-9

KLUANE LAKE MAP-AREA  
YUKON TERRITORY

(115G and F E $\frac{1}{2}$ )

(Report and Map 19-1958)

By

J. E. Muller

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OTTAWA

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*Price, 50 cents*

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## KLUANE LAKE MAP-AREA YUKON TERRITORY

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The Alaska Highway traverses the entire area from southeast to northwest and is the main means of access from Whitehorse, 136 miles from Kluane Lake. Except for the rugged, glacier-covered, southwest corner, the whole map-area is readily accessible with pack-horses, though well-travelled trails are few. Kluane Lake and several smaller lakes northeast of the Highway can be used for float-planes; to the southwest only Tchawsahmon and Teepee Lakes are available.

The map-area is sharply divided by the Shakwak Valley lineament into two distinct geological regions. Northeast of this feature is a complex of metamorphic and intrusive, partly migmatic, rocks that form part of the Yukon Plateau; southwest of it is a structurally complex assemblage of Devonian to Tertiary sedimentary, volcanic, and intrusive rocks that form the St. Elias Mountains.

### Formations of the Yukon Plateau

Rocks of the Yukon Plateau (map-units 1 to 5) are unfossiliferous and cannot be correlated with those of the St. Elias Mountains (map-units 6 to 23).

Unit 1 contains the most highly metamorphosed rocks; they are largely dark brown quartz-biotite schist and quartzite, massive or with fine biotite laminations. The schist is locally garnet-bearing and may also contain zones of amphibolite. Andalusite- and staurolite-bearing schist also occur. There is a gradual transition through coarsely gneissic zones into bodies of granodiorite (4), thought to be, at least in part, granitized equivalents of the schist. Bedding-planes are nowhere found distinct from schistosity.

Unit 2, between Gladstone and Cultus Creeks, consists of a monotonous homocline of quartz-sericite-chlorite schist and minor quartzite. Boundaries with unit 1 are indistinct and the two units may represent different degrees of metamorphism of the same clastic sedimentary series.

Unit 3 is chiefly distinguished by the occurrence of bands of recrystallized limestone several hundred feet thick. Metamorphism is generally of lower grade than in unit 1, the rocks being mainly quartz-chlorite schist, epidote-actinolite greenstone, quartzite, and slate. Dunite (3b) occurs south of Dogpack Lake, and other ultrabasic rocks outcrop along strike farther west. Their age and relationships are unknown.

Rocks of units 1, 2 and 3 constitute the Yukon group, a complex of metamorphic rocks generally considered to be of Precambrian and possibly early Palaeozoic age.

Unit 4 consists mainly of biotite granodiorite in Ruby Range and of hornblende-biotite granodiorite in Nisling Range. Towards the borders the rocks are commonly gneissic or contain large orthoclase phenocrysts. Abundant inclusions, up to the size of roof-pendants, or more or less migmatized schist are also common. These granitic bodies may have been formed partly or entirely by the granitization of rocks of the Yukon group and may be nearly equivalent to them in age. They are, however, generally considered to be the northwestern extension of the Coast Intrusions and to be of Mesozoic age.

Unit 5 is an assemblage of volcanic, hypabyssal, and intrusive rocks mainly of acidic composition and probably related in origin.

Unit 5a includes dark green to black breccias and agglomerates, the latter partly coarse grained with fragments up to 2 feet in diameter and partly medium grained, with flow structure and fresh plagioclase phenocrysts. Lighter coloured, aphanitic or porphyritic rhyolite and latite also occur. Most of these rocks (5a) probably were emplaced in volcanic fissures and vents but tuff with graded- and cross-bedding outcrops on the ridge south of Rhyolite Creek. These rocks (5a) suggest the former presence of a volcanic centre between Rhyolite and Dwarfbirch Creeks, and another near Onion Creek. Their age is probably Mesozoic or Tertiary.

Unit 5b includes fine-grained to aphanitic, light-buff and orange, granophyric rhyolite, commonly occurring as a felsenmeer of loose slabs rather than outcrops. They are probably mainly dykes and sills but some vitreous rhyolite with flow texture may be extrusive.

Areas where these rocks occur together with an equal or greater amount of schist or granodiorite have been shown as 1a or 4a, respectively.

Unit 5c consists of coarse- to medium-grained, light coloured, granophyric granite (alaskite) and quartz-monzonite. The rocks are commonly vuggy, weather into crumbly, rusty coloured outcrops, and contain microscopic quantities of fluorite.

A stock of such granite (5c) apparently forms the core of a complex of volcanic rocks (5a) between Rhyolite and Tyrrell Creeks, suggesting that both granite and associated rhyolite-dykes (5b) are connected with, and probably a later phase of, the volcan-

ism of 5a. Similar granophyric granites west of Fairbanks and in the Whitehorse area are late Cretaceous or younger and this is also assumed to be the age of the rocks in the map-area.

#### Formations of St. Elias Mountains

In St. Elias Mountains a series of sheared and recrystallized limestones and black slates (6) many thousands of feet thick is well exposed on Spring Creek and between Duke River and Bullion Creek. Poorly preserved corals in the limestone indicate a probable Middle Devonian age.

Unit 7 is a complex of greenstone, greenschist, phyllite, quartzite, slate, chloritic greywacke-schist, and sheared conglomerate with many limestone boulders. They are volcanic rocks and clastic sediments that underwent mainly dynamic metamorphism. A Devonian age is indicated for part of these rocks by fossils found by J. O. Wheeler to the west of Bullion Creek. In part they may also be correlative to similar rocks in the Alaskan Copper River area, believed to Mississippian.

Metamorphic rocks in the area south of Donjek Glacier, similar to and possibly equivalent with those of the Yukon group, are also included in this unit.

An assemblage (8) of chloritic, commonly albitized, volcanic flows, cherty tuffs with prominent banding due to size gradation, and volcanic breccia, with minor banded greywacke-argillite sequences and limestone is the major formation in Kluane Range. The rocks are commonly highly disturbed, broken, and changed into greenschist, especially near Shakwak fault. Their deposition probably preceded that of Lower Permian sediments (9), but some of the latter, as well as some Mesozoic rocks, may be included in the unit.

Clastic, fossiliferous Lower Permian sediments (9), consisting of calcareous argillite, greywacke, chert-pebble conglomerate, and limestone outcrop in Kluane Range, north of Duke River, but are much disturbed. A less distorted section is exposed north of Hoge Creek. At the base of the succession there is a gradual transition of volcanic breccia and conglomerate into finer chert-pebble conglomerate alternating with green and brown, calcareous, greywacke, sandstone, and black argillite. Many coquina layers with brachiopods occur. Higher up, the succession contains more black calcareous argillite, some limestone, and less conglomerate. The volcanic breccia and conglomerate (8) in this section are probably over 1,000 feet thick; the clastic sediments (9) may be as much as 2,000 feet thick. Overlying varicoloured chert with interbedded basic and ultrabasic sills has provisionally been correlated with unit 12 but may also be of Permian age.

A 500-foot section of relatively undisturbed, thick-bedded, fine-grained limestone (10) with Lower Permian fossils outcrops on the Alaska boundary at the head of Klefsan Creek. No clastic Permian sediments occur there, and the age-relation between 9 and 10 has not been established.

Sills of medium-grained gabbro and peridotite and a few larger, coarse-grained bodies occur in many places in the volcanic and sedimentary rocks of 8 and 9, and are most commonly associated with cherty rocks with gradational bedding, probably of tuffaceous origin, and are mapped with the rocks in which they occur. Some large areas in which gabbro and peridotite predominate are mapped as unit 11. The gabbro is mostly altered but nonetheless closely resembles the sills in unit 12 on Klefsan Creek, and like them may be Upper Triassic or younger.

The limestone (10) of Klefsan Creek is overlain by a Triassic succession (12). At the base of this sequence black calcareous, laminated greywacke and silty limestone occurs locally. A poorly preserved Daonella possibly indicates a Middle Triassic age for these beds. Above these strata or resting directly on Permian rocks are 600 to 800 feet of unaltered ophitic basalt and medium-grained gabbro, probably in part as lava and in part as sills, with minor interbedded argillite, limestone, and chert. Above these beds are some 120 feet of black and grey, shaly and silty limestone and black fissile argillite. They contain fairly abundant but poorly preserved ammonites, belemnites and pelecypods of the genus Halobia and are probably early Upper Triassic (Karnian) in age. They may thus be correlatives of the Alaskan Chitstone-Nizina limestone, the volcanic rocks being equivalent to "Nicolai Greenstone".

A narrow, tightly folded and overturned, discontinuous belt of Upper Triassic sediments (13, 14) can be traced from Cement Creek to Bullion Creek. Several hundred feet of reddish, commonly brecciated limestone (13), and in places enclosing anhydrite-gypsum deposits, is a topographically conspicuous formation. Its position under the shale of unit 14 suggests its correlation with Alaskan Chitstone-Nizina limestone with unit 12 at the Alaska boundary.

Unit 14 consists of thinly bedded, black to grey, shaly limestone and calcareous greywacke that commonly exhibit intricate folding. It contains Monotis sp. of mid-Upper Triassic (Norian) age, and is correlated with the Alaskan McCarthy formation.

A succession of andesitic lavas and associated breccias (15) with a characteristic purple and dark green colour and large white and green amygdules, overlies the Triassic sediments (12) near the Yukon-Alaska boundary. However, it apparently lies directly on the Permian (9) near former Canyon City and also north

of Tetamagouche Creek. The lavas contain a few interbeds of argillite and tuffaceous limestone. The age may be Upper Triassic or Jurassic and they may be extrusive equivalents of the basic rocks of (11) and (12), but the relationship to units 13 and 14 is uncertain.

On Tetamagouche Creek and farther southeast in Kluane Range limestone (16), in some places containing doubtful Triassic fossils, apparently intervenes between the andesite (15) and the greywacke-argillite series (17). The limestone is in places associated with gypsum.

Black and brown argillite and greywacke (17) outcrop in various places in Kluane Range. Interlayered with these are thin bands of sandy limestone and, in places, conglomerate mainly with pebbles of limestone and greenstone. They are mostly banded rocks with graded bedding and locally contain ironstone concretions. Slaty cleavage is commonly oblique to the original bedding which it obscures. Lithologically the argillite and greywacke (17) are very similar to the Permian clastic sediments (9). Diagnostic Aucellas or belemnites occur sparingly, but west of Tchawsahmon Lake two Aucella-faunas were found, one of lowermost Cretaceous (Valanginian) and one of perhaps Uppermost Jurassic age. The beds apparently form a tight syncline and overlie amygdaloidal andesite (10). The total succession is probably over 2,000 feet thick. A belt of sheared conglomerate with limestone, greenstone, and granitic pebbles, between Duke River and Bock's Brook, is provisionally assigned to this unit. A sequence of several thousand feet of banded greywacke and argillite between Tchawsahmon Lake and Miles Creek, largely metamorphosed to a banded hornfels, also belongs to this formation.

Hornblende-biotite granodiorite and quartz diorite (18) invade Permian to Cretaceous rocks of Kluane Range along a belt that runs intermittently from south of Slims River to beyond the Alaska boundary and is most prominent north of Teepee Lake, Light-coloured, commonly pinkish alaskite, leucogranite, and porphyritic rhyolite (19) are apparently shallow and contact-phases of the intrusion.

Adjacent rocks have been extensively metamorphosed into hornfels, commonly with feldspar porphyroblasts, quartz-mica schist, and medium-grained gabbroic rocks. Where they contain many apophyses and small stocks of alaskite, they have been included with unit 19. Also included in this unit is an intrusive complex with a northeasterly elongation surrounding Donjek Glacier. This consists mainly of a mixture of country rock and intrusion that occurs as alternating sheets or as an 'intrusive breccia' with angular fragments of wall-rock in intrusive matrix. White and pink, fine- to medium-grained alaskite is the main intrusive rock type.

The rocks of units 18 and 19 in Kluane Range intrude Jurassic-Cretaceous sediments (17) in the Tchawsahmon Lake area and are perhaps internal and marginal phases of a single major Cretaceous batholithic intrusion. The intrusions in the Donjek area may be related to them, but may also be older.

Continental deposits (20) of sandstone and conglomerate with well-worn, flattened cobbles of granite, gneiss, and volcanic and sedimentary rocks, in places poorly consolidated, and minor shale and coal, overlie Mesozoic rocks disconformably and contain fossil leaves of Paleocene age. A section of about 2,500 feet was measured in a gully down the Wolverine excarpment.

This section also exhibits younger Tertiary volcanic and sedimentary rocks (21, 22). The lower part, about 1,600 feet thick, contains brown and red basalt and andesite, massive or columnar, partly vesicular and commonly with feldspar phenocrysts. The lavas are interbedded at the base with sand, shale, and coal, and in the upper half with many layers of tuff and ash. These beds grade into a 350-foot sequence of coarse volcanic conglomerate with boulders up to 3 feet in diameter, coarse tuff, and some shale. At the top of the section basalt once more occurs.

A sequence of boulder gravel with minor sand and shale, mainly derived from volcanic rock (21), has been shown separately (22). It is distinguished from the quaternary gravels by the degree to which it has been folded and tilted. Some lava, mapped as (21), may overlie these sediments.

North of White River structureless coarse agglomerate (21) riddled with latite-dykes lies beneath a capping of basalt flows interlayered with a little tuff and conglomerate. Their great mass and complete lack of bedding suggest accumulation in a volcanic vent.

The Tertiary rocks (20 to 22) have been intruded by plugs and domes of porphyritic, light-coloured, latite and trachyte, of which bodies large enough to be mapped are shown as unit 23.

#### Glaciation and Recent Ash-deposit

The area was glaciated during the Pleistocene. The ice stood above the 7,000-foot elevation in the upper Donjek area. The Shakwak Valley was a large basin of accumulation in which the level of the ice was between 6,000 feet at Slims River and 4,000 feet at White River. The foremost ice-tongues descended to an elevation of 3,500 feet at the edge of Nisling Range; beyond this the land was unglaciated. Boulder till and fluvio-glacial gravels occur in all major valleys.

A layer of white ash and pumice occurs over most of the map-area. It overlies glacial deposits and is overlain by post-glacial peat and sand. The thickness of the ash is only an inch in the eastern part of the area, and the material is fine grained. Both the thickness of the accumulation and the size of the fragments increase towards the area between White and Generc Rivers, where deposits several feet thick with fragments 4 inches in size occur. The centre of eruption was probably in the vicinity of Mount Natazhat in Alaska.

### Structural Geology

The main structural feature of the map-area is the Shakwak lineament, a tectonic hingeline separating the geanticlinal basement complex of Yukon Plateau from the more recently folded, Palaeozoic-Mesozoic St. Elias geosyncline.

In Yukon Plateau, Ruby Range is marked by high-grade metamorphism and large, probably migmatic, granodiorite bodies, whereas Nisling Range is characterized by the abundance of rhyolitic dyke-swarms, related stocks, and volcanic rocks. The two ranges may be separated by a fault or flexure following valleys from Talbot Creek northwestward to the mouth of Kluane River. The preferred due-north strike of many dykes and the direction of many major valleys suggest rifting of the basement complex in post-Palaeozoic time.

Folding and thrusting of the St. Elias geosyncline occurred in late Cretaceous and Tertiary time. Pre-Permian and pre-Cretaceous orogenies are indicated by conglomerates and the higher degrees of folding and metamorphism of the older rocks. The Shakwak lineament, originally probably a normal fault or flexure, became later a thrust zone along which Permian and younger rocks were thrust against the Yukon Plateau shield. Highly sheared and schistose rocks occur everywhere along the Kluane Range mountain front. Recent movements have in several places produced fault scarps in the valley-deposits.

Another major thrust fault zone, the Duke River fault, runs from Bullion Creek to Steele (Wolf) Creek and perhaps continues into Alaska passing south of Mount Constantine and Mount Natazhat. Along it older Palaeozoic rocks have been thrust north-eastward over Mesozoic and Tertiary rocks. The main fault, along which the St. Elias Ranges were raised, is perhaps a prominent topographic step 2 miles or less northeast of the ice-divide.

The Shakwak and Duke River fault zones are well separated in the White River area and the mountains between them are subdivided by two other subparallel faults, the Miles Creek fault and the Canyon City fault, into geologically distinct belts. The former fault is marked most of the way by valleys and probably meets Shakwak fault at

Duke River; the latter fault is marked by an escarpment from west of Tchawsahmon Lake to south of Wolverine Creek. South of this fault Tertiary volcanic rocks are flat-lying or in open folds and Permian and Mesozoic rocks are less intensely compressed.

East of Donjek River the convergence of the Shakwak and Duke River faults may have caused greater compression of the intervening formations. There the angular discordance between the Paleocene and older beds indicates Mesozoic folding, but major thrusting occurred in middle or late Tertiary time, when Paleocene coal-bearing beds were covered by Permo-Triassic rocks in the Sheep Creek area, and by late Mesozoic (?) intrusive rocks on Granite Creek. Several of the Tertiary faults are low-angle north-east-dipping thrusts, in contrast to the generally steeper, south-west-dipping major faults. Evidence of in-faulting of Tertiary rocks was observed in many other places.

#### Economic Minerals

The area has been a minor placer gold producer since 1903 and in the last decade some 15,000 ounces were recovered, mainly from Burwash and Gladstone Creeks. Gold-bearing gravels have been found in the canyons of several streams cutting through Kluane Ranges. As in adjacent Alaskan camps, the gold may have been derived from previous concentrations in Tertiary gravels, commonly occurring in the headwaters of these streams. On Gladstone Creek, in Yukon Plateau, the gold apparently occurs in boulder till.

The occurrence of native copper in the White River area was long known to Indians and first reported on in 1891. Occurrences in the map-area are on Kletsan Creek at the International Boundary, in the upper White River canyon, and in the ridge north-east of Tetamagouche Creek. The copper occurs in tabular masses in a few instances weighing several thousand pounds, in cracks in amygdaloidal lavas (15) overlying Upper Triassic sediments, and as nuggets in adjacent streams. Economic quantities have nowhere been found.

In 1952 and subsequent years the area received much attention when nickeliferous sulphide deposits were found in Kluane Range. Hudson Bay Mining and Smelting Company did extensive underground work on its Wellgreen property on Quill Creek and reported a total of 737,600 tons of ore, averaging 2.04% Ni and 1.42% Cu, and small amounts of Co, Pt, Pd and Au. Work at the property has now been discontinued. Canalask Mines, on White River reported 550,000 tons of ore, averaging 1.68% Ni and 0.04% Cu, based on underground drifting and drilling, but in 1958 suspended development work. The deposits occur as irregular massive

lenses of pyrrhotite, with minor pentlandite, or as disseminated sulphides, in siliceous tuffs and argillites at the contact of basic intrusions (12). Diabase gabbro may contain appreciable quantities of sulphides but peridotite has generally been found to contain negligible amounts.

Fluorite occurs microscopically in alaskite and quartz monzonite (5c) of Yukon Plateau and small quantities of the mineral were seen on Rockslide Creek. Wolframite was found by a prospector in the same locality.

Coal of subbituminous C grade occurs where greater thicknesses of Tertiary sediments are exposed. A section of 18 feet of shale and coal, with about 10 feet of clean coal, was measured on a south tributary of Granite Creek, and similar sections occur on Sheep Creek, east of Ptarmigan, and between Cement and Steele Creeks. No good seams were observed in the White River area.

A large tonnage of gypsum mixed with anhydrite is present in the ridge east of Bullion Creek. Smaller deposits occur on the headwaters of Bock's Brook, at Burwash Creek, a small creek to the north of it, and at the junction of Wade and Maple Creeks. The deposits are much faulted and the gypsum may have pierced the overlying strata possibly diapiric. The gypsum may be related to the limestone of unit 13.

Barite was found as a vein in amygdaloidal volcanic rock (not mapped) near the limestone west of Burwash Creek.