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Preliminary Report 38

PRELIMINARY REPORT ON THE GEOLOGY OF THE OKOKMILAGA AND JOHN RIVERS AREA, ALASKA

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By

W. W. Patton, Jr., M. D. Mangus, and W. P. Brosgé

November 1951

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PRELIMINARY REPORT ON THE GEOLOGY OF THE OKOKMILAGA AND JOHN RIVERS AREA, ALASKA

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INTRODUCTION

U. S. Geological Survey party 2 studied the geology along the Okokmilaga and John Rivers. Party 2 entered the field on June 4, 1951 and began geologic investigations on the upper Okokmilaga River. The party consisted of W. W. Patton, Jr., M. D. Mangus, W. P. Brosgé, geologists; G. Herreid, J. Warne, field assistants; R. Olson, cook; and M. Grady, Mechanic. Weasels were used to move the party through the Brooks Range to the divide and down the Hunt Fork to the John River. On July 1 the weasels were returned to Umiat by other members of the Geological Survey. From the Hunt Fork party 2 continued the geologic traverse by boat down the John River to Bettles.

For base maps party 2 used planimetric maps compiled from aerial photographs. Altitude was established on all stations barometrically. The formations were all studied and examined closely for macrofossils and other lithologic features.

STRATIGRAPHY

Sedimentary and metasedimentary rocks of Silurian-Devonian (?), Devonian-Carboniferous (?), Mississippian, Permian (?), Triassic, Jurassic (?), and Cretaceous ages and igneous greenstone were examined by party 2. In this report thicknesses given are approximate unless otherwise indicated.

Silurian-Devonian rocks

Skajit limestone

The Skajit limestone crops out on both sides of the lower John River between camp 11 and camp 15, and in a narrow belt east of the river between camp 9 and camp 10.

Except for thin zones of black phyllite and mica schist, the Skajit is composed almost entirely of limestone, dolomitic limestone, and their metamorphosed or altered equivalents. The limestone which makes up the bulk of the formation is dark gray or black and saccharoidal. Everywhere it is cut by a network of white calcite veinlets. The dolomitic facies is generally characterized by lighter shades of buff, gray, or pink. Locally the

limestone has been completely recrystallized to white marble and along zones of shearing has been altered to calcareous mica schist.

Sills and dikes of greenstone occur throughout the formation. Along the contacts of these intrusives the limestone is altered to green calcareous chlorite schist, and in many places the sills grade laterally into schistose limestone. Placer gold along with abundant magnetite sand derived from the greenstone occurs in the streams at the southern edge of the Skajit belt. Old claims have been worked on Fools Creek and Canyon Creek, and recently extensive sluicing has been done in Crevice Creek.

Because the Skajit is the oldest exposed formation in the Okokmilaga-John River area, the base was not seen. A maximum thickness of 2,600 feet was measured east of camp 12. No fossils were found.

Smith 1/ has assigned the Skajit limestone to the Silurian. However, some doubt of this age assignment exists in view of the probable Devonian age of fossils that occur in limestone above the gradational contact of the Skajit and the overlying metasediments.

Undifferentiated metasediments

Undifferentiated metasediments thought to be of Silurian or Devonian age crop out extensively along the lower John River and at several places along the Hunt Fork.

Many rock types occur within this group, most of which show a high degree of metamorphism. Most typical are black phyllite, gray mica schist, gray quartz-mica schist, and in the basal part, white, gray, and black limestone and marble in all stages of recrystallization. Locally there are lenses of pebble conglomerate whose matrix is largely a quartz-mica schist, and the pebbles are predominantly dark chert.

The most complete section was measured several miles southwest of camp 6. There the metasediments have been thrust northward onto sandstone of the Kanayut formation. Black brittle phyllite and dark, finely crystalline limestone make up the lower 1,700 feet of the section. The limestone lenses are restricted to the base of the section and grade upward into phyllite. This sequence is overlain by approximately 5,000 feet of mica schist and quartz-mica schist, with thin interbedded black phyllite and some conglomeratic schist lenses. The section is capped by a minimum of 1,200 feet of phyllite and phyllitic slate that appear to grade upward into the overlying Devonian slate and shale.

The metasediments are apparently gradational and conformable with the underlying Skajit limestone. For mapping purposes the contact has been arbitrarily placed at the lower limit of the massive phyllite sections.

1/ Smith, P. S., and Mertie, J. B., Jr., Geology and mineral resources of northwestern Alaska: U. S. Geol. Survey Bull. 815, 1930.

Fossils were found in a crinoidal limestone lens near the base of the metasediments. They have been tentatively identified as upper Middle or Upper Devonian. P. S. Smith [2] regards these rocks as upper Silurian. Therefore until further fossil study is done, they are called Silurian-Devonian.

Smith [3] mapped a separate belt of rock that trends east across the John River roughly between Crevice Creek and camp17. He refers to them as metamorphic rocks of pre-Skajit age. Lithologically they strongly resemble the Silurian-Devonian metasediments exposed farther north. In addition, evidence suggests that they overlie the Skajit limestone. Meta-argillite of this belt is interbedded with limestone just above the contact with the Skajit. Thus it is included here with the metasediments.

Devonian-Carboniferous rocks

Shale and slate sequence

The probable Upper Devonian-Carboniferous sedimentary rocks examined in the area consist of a thick monotonous sequence of slate and shale with a small proportion of hard siltstone. These rocks were previously called the Fickett Series by Schrader [4], and reassigned to the Devonian by Smith [5].

The rocks crop out in two prominent belts, a northern belt just south of Chandler Lake and a southern belt along the course of the Hunt Fork.

The northern belt is 5 to 6 miles wide across the strike and forms a prominent system of west-trending valleys that extend from Chandler Lake to the Killik River. The southern belt, through which the Hunt Fork flows, is approximately 3 to 4 miles across.

Topographically these rocks form low sharp hogback ridges with talus slopes that shimmer in the sunlight. These ridges have a relief of approximately 1,000 to 1,200 feet. Where the slate ridges are capped by interbedded siltstone or by sandstone of the Kanayut formation, the ridges have ragged serrate crests and form some of the highest peaks in the Brooks Range.

On fresh surface the slate is gray brown to dark gray and weathers a mottled brown on the lower slopes; near the crests it weathers dark gray to black, owing to the slower rate of oxidation. The slate is quite soft and foliated, and with shiny cleavage faces. In most places the bedding has been obliterated by cleavage. Some dark bands which can be traced short distances could be bedding or traces of older cleavage.

2/ Smith, P. S., and Mertie, J. B., Jr., op. cit.
3/ Smith, P. S., and Mertie, J. B., Jr., op. cit.
4/ Schrader, F. C., A Reconnaissance in northern Alaska: U. S. Geol. Survey Prof. Paper 20, 1904.
5/ Smith, P. S., and Mertie, J. B., Jr., Op. cit.

Another striking feature of the slate is the presence of vein quartz. In many localities the slate is literally replaced by quartz veins and the ridge slopes in places are white with quartz regolith. Pyrite crystals are very common in the quartz; small amounts of chlorite, serpentine, olivine and galena are also associated with the quartz.

Toward the center of the northern belt, south of Chandler Lake, the rocks become a little softer and have some calcareous lenses.

The interbedded siltstone is dark gray, weathers gray brown, and breaks with a conchoidal fracture. These beds appear to be in the upper part of the slate sequence.

At one location, approximately 4,000 feet of slate, shale, and siltstone was measured. The top of the section was gradational with the Kanayut formation. The base of the slate and shale sequence was not exposed at this location, but as previously mentioned, it seems to be conformable with the Silurian-Devonian schist and phyllite. It is very possible that the formation is considerably thicker than 4,000 feet.

Near the Hunt Fork the Upper Devonian-Carboniferous (?) slate and shale appears to be gradational with the underlying Devonian-Silurian schist and phyllite.

The northern belt of slate and shale appears to lie in the axis of a large overturned anticline. The fact that the slate and shale are so sharply folded, crushed, and cleaved indicate that they presented little resistance to folding. The folds in the slate are much sharper than the broader, much gentler folds in the Kanayut formation and Skajit limestone.

Kanayut formation

The name Noatak formation as defined by P. S. Smith, 6/ is hereby restricted to the general type area in the western Noatak district 7/. The Kanayut and Kayak formations, which were originally mapped as part of the Noatak formation are now recognized as two distinctive mappable units, and have been mapped as such in north central Brooks Range areas.

The Kanayut formation, which is probably Devonian-Carboniferous in age, consists of quartzite, quartzitic conglomerate, hard sandstone, and minor interbeds of shale and siltstone. It crops out in two prominent belts, each approximately 10 to 12 miles wide, along the Okokmilaga and upper John Rivers. The Kanayut formation forms strikingly high, rugged mountains which are the backbone of the Endicott Mountains; the general relief ranges from 4,000 to 5,000 feet.

6/ Smith, P. S. and Mertie, J. B., Jr., op. cit.
7/ Dutro, J. T., Jr., and Lachenbruch, M. C., Stratigraphy and structure of the western Noatak district: U. S. Geol. Survey Navy Oil Unit Rept. 39, 1951.

The massive beds of quartzite and quartzitic conglomerate are commonly 15 to 30 feet thick and form prominent steplike ledges up the mountain faces, whereas the interbeds of shale and siltstone are eroded.

In the northern belt the lower part of the Kanayut is comprised of about 1,500 feet of interbedded dark-green to black shale, siltstone, and platy sandstone which weather dark brown. They are cross-bedded and appear to be gradational with the Upper Devonian-Carboniferous slate and shale. The lower unit of the Kanayut formation grades upward into hard, light gray green sandstone and quartzite. Interbedded with the hard massive quartzite is massive, lenticular, quartzitic conglomerate. Throughout the quartzite and sandstone are small limonitic specks which probably are weathered pyrite crystals; they cause the rock to weather red brown. The pebbles in the conglomerate are predominantly varicolored chert but in many localities are predominantly milky quartz. Some pebbles are angular, but most are subround to round. In general the pebbles range from a quarter of an inch to one inch in diameter. Some beds of conglomerate are maroon and green and apparently are more lenticular than the more massive gray-green rocks. The color of the maroon and green beds is due to maroon and green chert in the matrix.

The minor interbeds of red and green siltstone and shale are generally 2 to 15 feet thick. The color of these sediments is probably the result of terrestial deposition, rather than secondary alteration.

The upper part of the formation is less conglomeratic and grades into a hard platy cross-bedded sandstone.

Toward the southern limit of the area the Kanayut formation becomes less conglomeratic and is almost entirely hard gray-green quartzite and sandstone. Field evidence suggests that the source area was probably to the north. In the southern belt the lower part of the Kanayut formation is a thin, platy, very cross bedded limonite-speckled sandstone. The middle part of the section is a monotonous, massive to medium bedded, light gray green quartzite and sandstone. The upper part of the section is platy and more shaly and grades into the Kayak formation. This section is very similar to the Kanayut formation in the Nigu River-Howard Pass area.

Good exposures of the formation were measured at several localities; the total thickness is more than 6,300 feet. The Kanayut appears to lie conformably on the Upper Devonian-Carboniferous shale and slate. These rocks were much more resistant to deformation than the underlying rocks, and thus form broader and gentler folds than the latter. The competent Kanayut formation crops out mostly in large low-angle thrust sheets which have moved northward over the Mississippian. The Silurian-Devonian metasediments and limestone are likewise thrust upon the Kanayut.

Mississippian rocks

Kayak formation

The Kayak formation (new name) is approximately 1,000 feet of black shale with minor amounts of sandstone and limestone; it lies between the Kanayut formation and the Lisburne limestone. This unit was called Noatak formation by Bowsher and Dutro 8/ in 1949. In 1950, Dutro 9/, after examining the type area of the Noatak formation on the Noatak River, found that the use of the term Noatak, in 1949, was incorrect. The black shale unit was therefore called Shale member of the Noatak formation in the 1950 reports of the Navy Oil Unit.

This black shale has been recognized as a distinct lithologic unit throughout the central part of the northern Brooks Range, but is not a mappable unit in the type area of the Noatak formation. The shale is therefore named Kayak formation for Kayak (Eskimo for "junction") Creek which joins Alapah Creek to form the Kanayut River. The type section of the Kayak formation is the 991 feet of shale, sandstone, and limestone that was described in detail as the Noatak formation by Bowsher and Dutro in 1949 10/. The type section was measured on the ridge crest about 2 miles east of the south end of Kanayut Lake. Detailed measurements of the limestones and collections of Kinderhookian fossils were made at exposures of the Kayak formation about 1 mile south of the lake. One and a half miles west of the junction of Kayak and Alapah Creeks the lower sandy part of the formation was measured in detail.

In 1951, party 2 measured two sections of the Kayak formation, one at the northern edge of the Kanayut formation outcrops on the Okokmilaga River, the other in a narrow infolded belt of post-Kanayut rocks about 10 miles south of Chandler Lake.

The northern section (Fire Creek section, pl. 2) is about 1,140 feet thick. The thickness of the basal 200 feet was estimated. In ascending order, this formation consists of 200± feet of limonitic silt shale, 180 ± feet of sandstone and green to black shale, 420 ± feet of limonitic shale with ironstone concretions, 150 feet of poorly exposed shale with two ledges of limestone, and 180 ± feet of shale, mostly covered. The sandstone of the lower part of the section is white, very fine to medium-grained, thin- to medium-bedded, and composed of very clean quartz. One bed is dense. The two limestone ledges exposed in the upper part of the section are interbedded dark limy siltstone, cherty limestone, and thin-bedded, red-weathering, medium-grained limestone with abundant crinoids and brachiopods.

The sequence of lithology of the middle part of the Kayak formation at Fire Creek (i.e., sandstone unit, shale-ironstone unit, limestone unit, and upper shale unit) is like that of the type section at Kanayut Lake

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8/ Bowsher, A. L., and Dutro, J. T., Preliminary report on the Mississippian rocks of the Kanayut, Namushuk, and Itkillik Lakes areas, Alaska: U. S. Geol. Survey Navy Oil Unit Prelim. Rept. No. 24, 1949.

9/ Dutro, J. T., and Lachenbruch, M. C., op. cit.

10/ Bowsher, A. L., and Dutro, J. T., op. cit.

and the section on the Anaktuvuk River. However, the Fire Creek section differs from these sections in several respects. At Fire Creek the sandstone is clean quartz sand and is separated from the sandstone and conglomerate of the Kanayut formation by 200± feet of silt shale. At the type section these sandstones are ferruginous, cross-bedded, and fucoidal and lie directly upon the Kanayut formation. The topmost beds of the typical Kayak formation are red weathering, generally coarse-grained, medium-bedded, and highly fossiliferous limestone (the "red limestone" of Bowsher). These were not observed in place in the Fire Creek section. Float of red, fossiliferous, thin-bedded to shaly limestone was found in the covered shale interval at the top of the section and may represent the equivalent of the typical "red limestone". The limestone unit below the covered shale interval at Fire Creek seems correlative in position and lithology with the argillaceous limestone member of the type section, but differs from it in that chert nodules occur with the shaly limestone.

At the front of the Range the Kayak formation is commonly the locus of thrust faults which have moved slices of Lisburne limestone or of the overturned Kanayut formation. Much of the shale is contorted, and blocks of the easily recognized red fossiliferous limestone are scattered, but are a good clue to the identity of the formation.

The Kayak formation exposed in the syncline south of Chandler Lake (Agak Lake section, pl. 2) is about 850 feet thick. The lower 100± feet consists of clay and silt shale interbedded with 3- to 6-inch beds of dark-gray, fine-grained, quartzitic, somewhat cross bedded sandstone like the sandstone of the Kanayut formation immediately below. The rest of the formation is black to green silt and clay shale with one massive 30-foot unit of dark-gray, red-weathering, medium-bedded sandstone about 250 feet below the top. The argillaceous limestone member in the upper part of the northern sections is missing here, and its approximate position in the section is occupied by the massive sandstone. As the Kayak-Lisburne contact has been drawn in the columnar section (pl. 2), the topmost red limestone is also missing, but it is possible that part of the red-weathering limestone assigned to the basal Lisburne limestone may belong in the Kayak formation. Careful study of fossils from these lowest beds is necessary in order to place this Kayak-Lisburne contact with certainty.

Lisburne limestone

Like the Kayak formation the Lisburne limestone crops out in two belts, one along the north front of the Brooks Range, the other in the syncline 10 miles south of Chandler Lake. The limestone sequences of these belts are quite dissimilar. The Lisburne limestone mapped on Fire Creek and northward along the Okokmilaga River is much like that exposed in the same belt of outcrop at the north end of Chandler Lake. This belt trends slightly south of east from Chandler Lake and lies near the divide of the Range at the longitude of Kanayut Lake. The Lisburne limestone in the syncline south of Chandler Lake is therefore the southernmost belt yet seen in the central Brooks Range. This limestone is much thinner than that at the front of the range, largely because of the absence of all of the middle units of the Lisburne limestone.

The Lisburne of the northern belt (Fire Creek section, pl. 2) is about 2,400 feet thick. The upper 900 ± feet is commonly cut out by thrust faults, and where present is poorly exposed, so only the gross interval of that part of the section has been measured. The basal 400 feet was not measured in continuous sequence with the rest of the section and correlation of this part of the section may be in error by 50 ± feet. The lowest 100 feet of this basal interval is covered, but probably includes some limestone.

The section above the covered interval consists, in ascending order, of 120 feet of interbedded clay shale and light-gray, coarse-grained, fossiliferous limestone; 120 feet of dark, fine-grained cherty limestone and calcareous shale, mostly covered; 640 feet of dark-gray, fine-grained cherty limestone, massive at the base and partly shaly near the top; and 400 feet of white to gray dolomite, silicified limestone and limestone. Above this is the 800 ± foot covered interval which includes interbedded dark cherty limestone and light-colored coarse-grained limestone in the lower part, and about 100 feet of black shaly limestone at the top just below the Siksikpuk group.

Fossils are rare in this belt; fossils distinctive of the members as mapped elsewhere were found only in the basal unit. However a fair correlation with the section at Chandler Lake can be made on the basis of lithology alone. The interbedded shale and coarse-grained fossiliferous limestone at the base of the Lisburne is like that of zones 1 and 2 of the Wachsmuth member in fauna as well as lithology. The dolomite and silicified limestone are like those of zone 3 of the Alapah member in lithology and position in the sequence. The intervening cherty and shaly limestones correspond to similar limestones of zones 3 and 4 of the Wachsmuth member and zones 1 and 2 of the Alapah member at Chandler Lake, but the Wachsmuth-Alapah contact within these beds cannot be drawn with certainty. Neither the heavy chert and abundant chert replacements of big gastropods, nor the index fossils distinctive of the lowest zone of the Alapah were found on the Okokmilaga River. The Wachsmuth-Alapah contact has been placed tentatively at the base of a 60-foot unit of black nodular cherty limestone that overlies 2 feet of coarse-grained limestone with abundant phosphatic fish plates and horn corals. This horizon is about 200 feet lower in the section than is the Wachsmuth-Alapah contact at Chandler Lake.

The black shaly limestone at the top of the Lisburne limestone and underlying the Siksikpuk group is like that of the Kiruktagiak member. The typical Kiruktagiak member phosphatic and chert zones were not seen.

The Lisburne limestone of the southern belt (Agak Lake section, pl. 2) is only 345 feet thick. It may be divided into two units; the lower is 170 feet of red-weathering, coarse-grained fossiliferous limestone interbedded with black clay shale, and shaly limestone, and the upper is 175 feet of black massive chert, clay shale, limy shale, and phosphatic limestone. The chert contains small residual lenses of black saccharoidal medium-grained limestone.

The lower unit is similar in lithology to zones 1 and 2 of the Wachsmuth member at Chandler Lake, except that the coarse fossiliferous limestone is more argillaceous and weathers yellow red like the topmost limestone of the Kayak formation, rather than buff like the massive beds of the basal Lisburne. Fossils tentatively identified as lower Wachsmuth types have been collected from the uppermost of the red-weathering limestone beds, but faunas collected from the lowest of these limestones may be of the Kayak formation. The Lisburne-Kayak contact has been tentatively placed at the base of the limestone beds.

No fossils were found in the upper chert and shaly limestone unit. The phosphatic limestone at the top of the unit is separated from the overlying Triassic shale and siltstone by a yellow oxidized zone. This combination of phosphate deposits and oxidation is taken to indicate a pre-Triassic weathered surface. Part of the chert and limestone unit may be correlative with the Siksikpuk group, but because there is limestone throughout the unit, even in the chert, the unit is placed in the Lisburne limestone. The lithology of the unit is typical of the Kiruktagiak member, but lack of fossils makes it impossible to correlate the unit with any particular zone. It may be restricted to zone 5 of the Alapah member, as is the Kiruktagiak facies at Chandler Lake, or may represent a greater zonal range, as does the Kiruktagiak facies farther west.

Pennsylvanian (?)-Permian rocks

Siksikpuk group

Several small outcrops of Siksikpuk were seen on the Okokmilaga in complex fault zones. Possibly some of the exposures assigned to the Lisburne limestone or Shublik formation 6 miles east of Agak Lake are the Siksikpuk group.

The rocks were mostly interbedded red, black, green, and orange silicified siltstone, hard shale, and chert. The siliceous beds were 2 to 6 inches thick.

Triassic rocks

Shublik formation

Two small patches of Shublik formation were mapped in the block of closely folded younger rocks beneath the thrust sheet of Lisburne limestone at the front of the range. In each of these the exposed Shublik was sooty black, and white unfossiliferous chert.

The Shublik formation crops out extensively in the syncline south of Chandler Lake. Thrust faults and tight overturned folds have cut out the top of the section. Only an estimated 160 feet of the formation is present.

The base of the section is drawn at a zone of oxidized yellow clay that overlies phosphatic limestone assigned to the Lisburne. The clay is succeeded by about 80 feet of silt and clay shale, light gray and silicified at the base, dark gray at the top. The shale grades up into 80 feet of interbedded chert and limestone. The limestone is dark gray, yellow-red weathering, fine-grained, thin- to medium-bedded, and alternates with bedded chert at 4-inch intervals, giving the rock a banded look. Monotis sp. was found in the upper limestones.

Jurassic-Cretaceous rocks

Kingak-Okpikruak formations

The Kingak-Okpikruak formations on the Okokmilaga River west of camp 1 were not mapped separately. They crop out in a small complex zone with the underlying Triassic chert and Siksikpuk group. The Kingak-Okpikruak formations consist of medium- to coarse-grained dark olive green graywacke sandstone and interbedded light buff cherts. The sandstone weathers red brown.

Cretaceous rocks

Koyukuk-Bergman series undifferentiated

Cretaceous rocks are exposed along the lower John River and Koyukuk River between camp 17 and Bettles. Outcrops are limited to a few scattered cut banks.

On the north, Cretaceous rocks unconformably overlie the Silurian-Devonian metasediments. The basal beds are massive, reddish-brown, poorly consolidated graywacke conglomerate. Subangular fragments of mica schist along with rounded pebbles of milky quartz and greenstone are imbedded in a calcareous silty matrix. Carbonized plant material and narrow seams of coal are abundant. The section grades upward into better consolidated, interbedded greenish graywacke sandstone and conglomeratic sandstone; the visible constituents are chiefly quartz, chert, greenstone, and diabase. The fragments of nonresistant rocks such as schist and phyllite, become less common in the upper part of the section.

Between camp 18 and Bettles the Cretaceous rocks appear to be better indurated and more highly folded than those to the north. They are principally interbedded green muddy sandstone and conglomerate and dark silt shale, with nodules and lenses of limy siltstone. Locally the Cretaceous rocks are laced by thin quartz veinlets. A few poorly preserved pelecypods found at one locality have not yet been identified.

Indications are that the Cretaceous beds exposed between camp 18 and Bettles may be older than the Koyukuk-Bergman series exposed farther north; however, more work is necessary before this can definitely be established.

Schrader [11] recognizes the Lower Cretaceous Koyukuk series and Upper Cretaceous Bergman series along the Koyukuk valley. For the purpose of this report the Cretaceous rocks exposed along the lower John River and the Koyukuk River as far as Bettles is called the Koyukuk-Bergman series undifferentiated.

IGNEOUS ROCKS

Mafic intrusives now largely altered to chlorite schist crop out as small sill- and dikelike bodies in the Silurian-Devonian metasediments and in the Skajit limestone along the lower John River.

These intrusives generally range in thickness from a few feet to not over 50 feet. They most commonly parallel the bedding of the enclosing rocks but in some places were found to cut across the bedding in narrow dike-like stringers. They occur most abundantly along and near zones of closely spaced faults and shears.

In hand specimens the rock is green, has a distinct schistose structure, and locally is studded with cubes of pyrite and octahedra of magnetite. Where the intrusive has invaded noncalcareous sediments there is little contact alteration. However, calcareous strata along the contact are generally recrystallized and chloritized, and in some garnet and biotite have been developed. The association of these intrusives with shears and faults suggests that they are probably of Mesozoic age.

STRUCTURE

The area mapped is divided into 5 structural districts. From north to south they are Okokmilaga anticlinal area; the Hunt Fork synclinal area; the John River synclinal area; the John River anticlinal area; and the Cretaceous synclinal area which lies south of the Brooks Range. Each of the first four areas is structurally higher than the next area to the north, and is separated from it by a major overthrust from the south. The Cretaceous synclinal area is bounded on the north by the unconformable contact of Cretaceous rocks on Silurian-Devonian metasediments.

Okokmilaga anticlinal area

The Okokmilaga anticlinal area extends from the north front of the Brooks Range to the fault at the base of the metasediments just south of the divide. The general structure, as shown schematically in figure 1, is a broad anticline, or nappe, of Devonian-Carboniferous rocks overturned to the north and thrust forward over younger Paleozoic rocks. Remnants of the upper, right-side-up limb are preserved in the high mountains of Kanayut sandstone around Pasture Creek and Fire Creek and in the root zone at the divide.

11/ Schrader, F. C., op. cit.

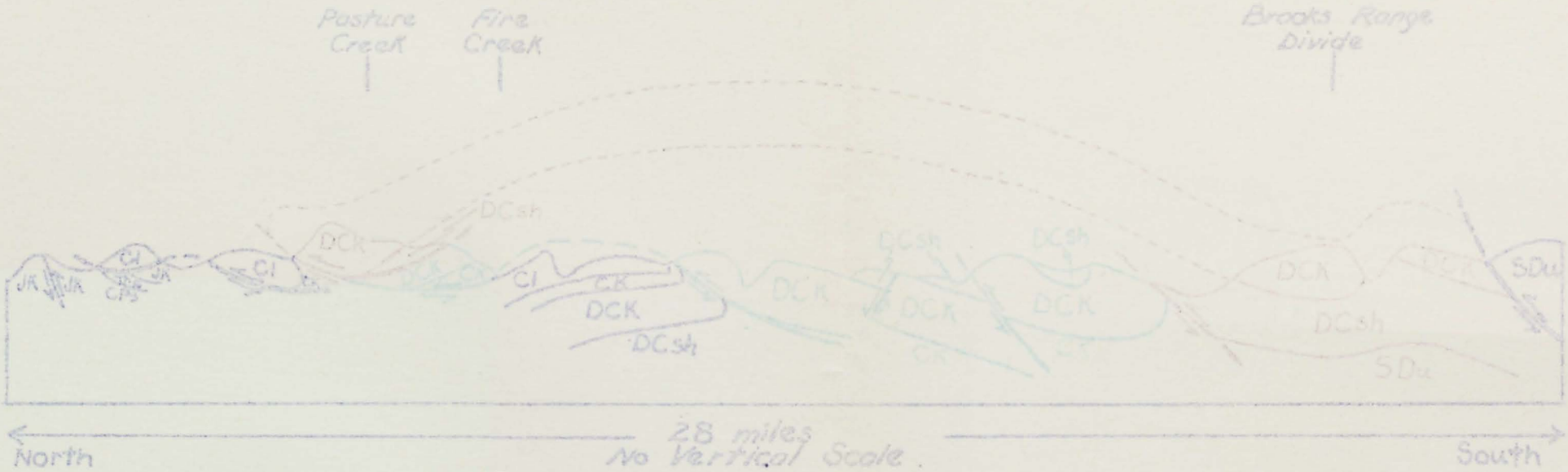

Figure 1. Schematic cross-section along the west side of the Okokmilaga River showing the interpretation of the overturned anticline.

Rocks shown in green are of the upside-down under limb of the overturned anticline.
Rocks shown in red are of the right-side-up upper limb of the overturned anticline.
Rocks shown in blue are of the block overridden by the overturned anticline.

EXPLANATION

Jk = Kingak-Okpikruak formations.
Trs = Shublik formation
CPs = Siksikpuk formation.
Cl = Lisburne limestone.
Ck = Kayak formation.
DCk = Kanayut formation.
DCsh = shales and slates.
DSu = undifferentiated metasediments.

This map is preliminary and has not been edited or reviewed for conformity with U. S. Geological Survey standards and nomenclature.

The mountains between are formed largely of the rocks of the under-limb which are shown to be upside down by the superposition of older slate and shale on the Kanayut formation, by superposition of the Kanayut formation on the Kayak formation and by the cross bedding in the Kanayut sandstone. The under limb is broken by a large thrust fault and by several high-angle faults that bring the Kanayut formation to the surface in the slate and shale belt. Just north of the leading edge of the nappe Lisburne limestone of the overridden block has been thrust northward over complexly folded Mesozoic rocks. This Lisburne thrust sheet has been folded into a broad anticline, whose southern limb is broken by minor thrust faults on the east side of the Okokailaga River.

Hunt Fork synclinal area

Just south of the Hunt Fork the rocks reflect a broad, open, southwest plunging syncline. The northern edge of the syncline has been thrust northward upon the Kanayut formation, exposing the Silurian-Devonian undifferentiated metasediments. Overlying the undifferentiated metasediments are the conformable Devonian-Carboniferous slate and shale. The shale is sharply folded and reflects the fact that it presented little resistance to orogenic forces. The flat-lying Kanayut formation appears to be along the axis of the syncline.

Several small high-angle reverse faults are present along the northern edge of the Silurian-Devonian metasediments and probably were formed during or immediately after thrusting. This conclusion is based on the fact that the high-angle faults are located near or along the edge of the thrust sheet.

John River synclinal area

In the vicinity of camp 9 the rocks have been folded into a broad open west-plunging syncline. Erosion has exposed the Skajit limestone along the nose of the syncline east of camp 9. This formation appears to have been thrust over metasediments and subsequently folded and displaced by high-angle east-west faults. The Kanayut formation apparently lies along the axis west of Crag Creek.

In the low area south of camp 10 the phyllite of the metasediments are presumed to be in a syncline. It is not known whether the thrust fault beneath the Skajit goes under or over this phyllite. A big anticline trends east from Lake Creek and exposes Skajit limestone along the axis east of the mapped area.

John River anticlinal area

Between camps 11 and 12 the Skajit limestone has been thrust over the phyllite to the north and folded into a large east-trending anticline. South of camp 12 is a small syncline with metasediments exposed along the axis. This structure trends northwest. At the south end of the Skajit belt, from 3 miles south of camp 12 and continuing to camp 15, the trends are essentially north-south. This change in strike may be explained as a regional bend in the fold axes, or as wrapping of the formations around the nose of an exceptionally large, east-plunging anticline.

West of the John River at the south edge of the Skajit belt, the metasediments lie normally upon the Skajit. East of the river the Skajit limestone has been thrust onto the metasediments. Just north of the Allen River the thrust fault dips north. South of the Allen the fault dips east and strikes north. This may be a case of thrusting and subsequent folding that resulted in a north trend of the faulted contact.

South of camp 15 the structure trends essentially east. For the most part the beds dip south and the section is apparently duplicated by numerous south-dipping thrusts.

Cretaceous synclinal area

The Cretaceous rocks between camps 17 and 18 lie unconformably on the metasediments and have been warped into broad open folds. Between camp 18 and Bettles the folds are more complex and the dips are steep to vertical, but suggest a broad syncline with an axis about 6 miles north of Bettles.

SUMMARY

1. Rocks of Silurian through Cretaceous age are exposed in the area studied by party 2.

2. The following formations were measured: Skajit limestone (Silurian-Devonian), 2,600 + feet; metasediments (Silurian-Devonian), 7,400 feet; Devonian-Carboniferous slate and shale, 4,400 + feet; Kanayut formation (Devonian-Carboniferous), 6,300 + feet of quartzite and conglomerate which become finer-grained and less conglomeratic to the south; Kayak formation (Mississippian), 1,100 feet of black shale, limestone, and sandstone in northern belt, 850 feet in southern belt; Lisburne limestone (Mississippian), 2,400 feet in the northern belt, of which 700 feet was Wachsmith and 1,700 feet Alapah, and 350 feet in the southern belt; Sikaikpuk group, Pennsylvanian (?)-Permian, unable to measure; Triassic, partial section beneath the lower Monotis zone, 150 feet; rocks of Jurassic (?) and Cretaceous age crop out only sparsely along the river banks.

3. The area is divided into 5 structural belts: (1) Okokmilaga anticlinal belt, (2) Hunt Fork synclinal belt, (3) John River synclinal belt, (4) John River anticlinal belt, and (5) Cretaceous synclinal belt south of the Brooks Range.

4. Structural forces came from the south.

5. Possible reservoir rocks exist, but extensive thrust faults and low-grade metamorphism make oil accumulation unlikely.

6. Placer gold occurs along the southern contact of the Skajit limestone.