PRELIMINARY REPORT ON THE SHEENJEK RIVER DISTRICT

By J. B. Mertie, Jr.

INTRODUCTION

Fort Yukon, at the confluence of Porcupine and Yukon Rivers, at north latitude 66° 34′ and west longitude 145° 18′, is the natural point of entry into a great unmapped area, with an extent of more than 60,000 square miles, in northeastern Alaska. (See fig. 2.) This area includes the territory southeast, east, and northeast of Fort Yukon to the international boundary, and north and northwest to the Arctic Ocean, with the exception of the Canning River district.[1] About one-third of this unmapped area is drained by Porcupine River and its tributaries, among the larger of which are Sheenjek (Salmon) and Coleen (Succor) Rivers, from the north, and Black and Little Black Rivers, from the east. Sheenjek River, with which this paper is concerned, heads in the Brooks Range and runs in a general southerly direction to the Porcupine, which it joins about 45 miles by river from the mouth of that stream. During the summer of 1926 a Geological Survey expedition, comprising four men with two canoes, worked up Sheenjek River almost to its forks, mapping the valley on both sides of the river as far as travel was practicable.

On account of injuries incurred by two members of the party this work was discontinued in mid-season, but an area of about 1,000 square miles was covered, as shown on Plate 2. The exact geodetic position of the mapped area is not well established, because the hurried return trip made it impossible to carry a traverse down through the Porcupine and Yukon Flats into Fort Yukon, whose geodetic position is established. Latitude and azimuth observations were made in the field, thus orienting the map and placing it correctly in regard to its north-south position. The longitude, however, is weak and will probably have to be corrected in later work. Altitude determinations also are approximate, the topographic map being based upon an assumed altitude of 1,844 feet at topographic station 1.

[1] Leffingwell, E. deK., The Canning River region, northern Alaska: U. S. Geol. Survey Prof. Paper 109, 1919.

GEOGRAPHY

DRAINAGE

Yukon River, in that part of its course between Circle and Fort Hamlin, spreads out into many channels, distributed over a great flood plain, which is known as the Yukon Flats. These flats, which

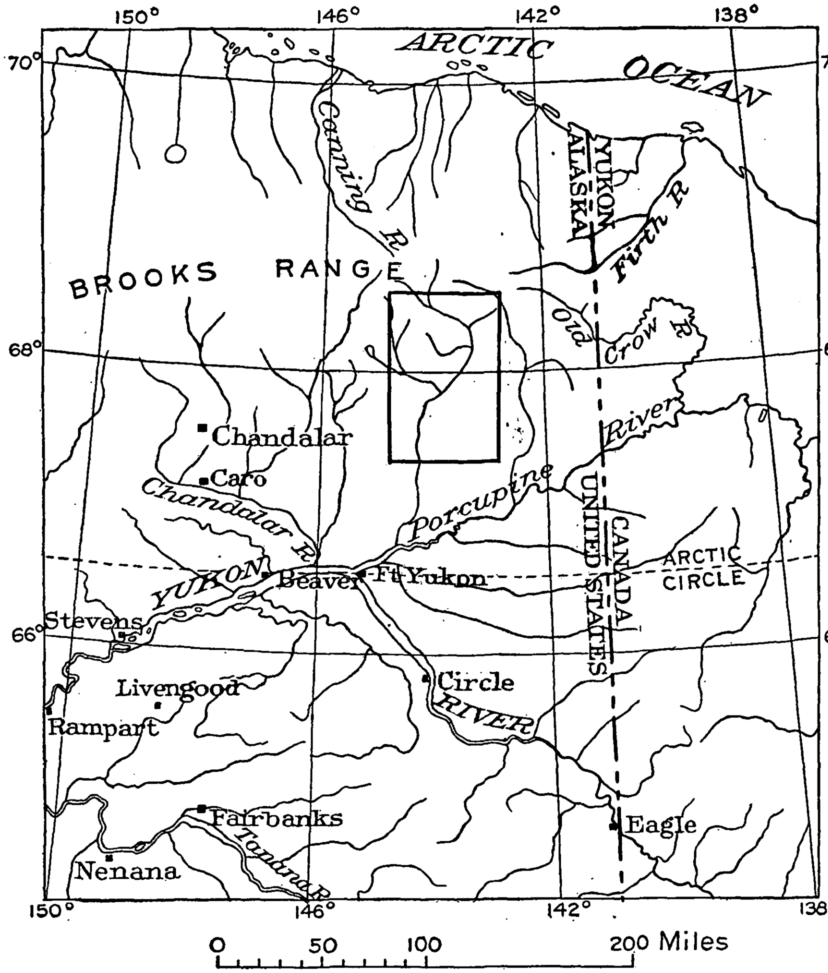

FIGURE 2.—Index map showing location of Sheenjek River district

have been observed, described, and discussed by many travelers in Alaska, are here mentioned merely to locate Fort Yukon, which lies in their midst and is separated from the hills by flats extending many miles in every direction. The Yukon, flowing northwestward from Circle for an air-line distance of 75 miles, turns abruptly southwestward at Fort Yukon and continues for 125 miles (air line) farther through these flats. All the streams tributary to the Yukon, within this stretch of 200 miles, also partake of the character of the flats in their lower courses.

Porcupine River, the largest tributary of the Yukon within the Yukon Flats, joins the main stream below Fort Yukon. The main body of Porcupine water enters the Yukon some miles below Fort Yukon, but a navigable slough of the Porcupine enters the Yukon a mile or two below the town and is the route usually taken by small craft entering the Porcupine. The lower Porcupine, from its mouth upstream for about 125 miles by river, though probably less than half that distance in an air line, meanders in curves of large amplitude through its flats, splitting, particularly in stages of high water, into numerous channels and sloughs. The banks consist of silt and peat, interspersed at places with bodies of ground ice, and are commonly undercut on the outer sides of the meanders, producing overhanging masses of peat and live vegetation, which form sweepers and snags. The insides of the meanders are usually bars of sand and gravel. The Porcupine Flats, like the Yukon Flats, are devoid of relief and approximate a plane in general character but are by no means "flat." On the contrary, the difference in altitude between the upper and lower ends of the Porcupine Flats is such as to give, even to this meandering stream, a current of 2 or 3 miles an hour at ordinary stages of water and a considerably swifter current in places at times of high water. The river current nearing the mouth depends upon the stage of water in the Yukon. If the Porcupine is in flood and the Yukon carrying its ordinary volume of water, there will be a swift flow-off current into the Yukon. If these conditions are reversed, the Porcupine tends to be sluggish in its lower course. The flats of the Porcupine are covered with willows, alders, and spruce; the willows and alders grow on low-lying ground subject to flooding back from the sand bars, and the spruce is found for the most part at some distance back from the main river, except along cut banks, where the river has migrated laterally into higher ground.

Sheenjek River flows in its lower course through flats that are of much the same character as the flats of Porcupine and Yukon Rivers. The Sheenjek, however, is a smaller stream and meanders in arcs of smaller amplitude, though no less tortuously, than the Porcupine. The cut banks also are lower, and gravel bars are less perfectly developed. Gravel bars are always visible along the lower Porcupine, no matter how high the stage of water, but in the spring trip up the Sheenjek no bars were seen for a distance of 60 miles by river from the mouth, although on the return trip, at low water, low sand bars were visible at nearly every turn of the river all the way to the Porcupine. A similar variation in the velocity of the current exists in

Sheenjek River between high and low stages of water. At low water the lower Sheenjek could certainly be called a distinctly sluggish stream, but in flood there is a strong current everywhere, and some of the swifter places require active paddling in conjunction with an outboard motor to drive a loaded canoe upstream against the current. In general, however, the lower part of the Sheenjek presents no difficulty to motor-boat navigation, except at high water, when muddy water concealing numerous snags, floating driftwood, and bad whirlpools necessitates a greater degree of care. One such whirlpool occurs about 5 miles from the mouth of the Sheenjek, where two channels of the river come together in a T-shaped chute, the two sloughs flowing directly toward one another and forming a single channel which flows away at right angles. At the junction of these sloughs, at high water, is a whirlpool that could almost surely overturn any small boat; but at low water this whirl is scarcely perceptible. One other bad place, at high water, is at the upper end of the flats of Sheenjek River, where the main channel flows swiftly through a group of upstanding snags through which it is necessary to steer carefully. This locality was called " Snag Flats " by the 1926 party.

In connection with high-water phenomena this party had an opportunity to determine the speed of a flood wave coming down the valley. A recent rain had given a sudden rise to the river, resulting in a flood crest which passed during the night, possibly six or eight hours before the party started downstream. With no motor propulsion, but with two men paddling at a moderate speed, this flood was overtaken and passed in four or five hours, and at the evening camp, after a nine hours' run of 70 miles, there was no indication of high water. This part of the run was in the upper Sheenjek, above the flats, where the river has a considerably swifter current than in its lower course. That night the river again rose and the flood crest passed downstream, and on the next day's run of 60 miles the experience of the previous day was repeated, except that the flood water was even more quickly overtaken. The third day showed the same phenomenon except that it is rather doubtful if the crest of high water had fully passed when the party embarked in the morning, and the flood water was quickly outdistanced. The general conclusion from these experiences is that the flood wave of the Sheenjek runs somewhat slower than the river current in the upper course and considerably slower in the lower course.

In its lower course few riffles occur in the Sheenjek, but riffles become progressively more numerous upstream. At ordinary stages of water the upper practicable limit of power-boat navigation is Carroll's cabin, about 75 miles by river from the mouth. At high water power boats can go up to Christian's cabin, about 20 miles farther upstream; but within this 20-mile stretch, with heavy loads and with small outboard motors for power, it is necessary to line or tow canoes through numerous swift places.

The first sight of any hills, in going upstream, is obtained about 72 miles by river from the mouth. Here, at the upper end of a short east-west course, the upstream traveler turns abruptly northward and catches glimpses of a low wooded ridge, which lies east of Christian's cabin, some 20 miles distant. From this point upstream, although still in the flats, the river changes rather abruptly to a swifter stream, with fewer cut banks and numerous gravel bars on each side. At Christian's cabin the river swings eastward and approaches closely the long low ridge above mentioned, which affords the first opportunity to climb out of the flats and look behind and ahead. At a point about 15 miles in an air line upstream from Christian's cabin or 115 miles by river from the mouth a low conical hill arises abruptly out of the flats on the east side of the river, about a mile away, and upon this hill was made the first topographic station of the trip. Here the bottom of the valley has narrowed to about 4 miles, and this is the northern limit of the flats in this longitude. From Christian's cabin upstream the Sheenjek is a swift braided, meandering stream for 25 miles in an air line or about 35 miles by river, to a point where the valley becomes much constricted, and it issues from the hills with a floor less than half a mile wide. Above this constriction the valley of Sheenjek River broadens again, its width ranging from 1 to 3 miles. The valley bottom in this upper stretch is a well-wooded flat characterized by oxbow and other lakes, swamps, and muskeg. The river itself continues to be up to the forks a swift braided stream, and although more confined than in the flats and straighter in its general course, it splits repeatedly into two or more main channels and has numerous high-water overflow sloughs.

The only large tributary of the Sheenjek is Koness River, called Ness River by some, which enters from the west side of the valley about 140 miles by river above the mouth of the Sheenjek and about 10 miles in an air line above the valley constriction just noted. Koness River, though not a large stream at normal stages of water, drains a large and diversified area lying to the west and heads apparently in high mountains. It is believed to head against Christian River, which is a smaller stream than was formerly supposed and which therefore probably does not reach northward to the Brooks Range. In its lower course Koness River is a meandering stream, bordered by numerous sand bars, and is pretty well confined to a single channel but flows in a swampy valley much like that of the Sheenjek. Farther upstream the valley appears to be particularly wide and open. Close to the Sheenjek, however, the valley of Koness River is almost canyon-like.

Several other smaller tributaries enter the Sheenjek from the west between Christian's cabin and the forks. No large tributaries enter the Sheenjek from the east, and even in the upper valley the east fork is small in comparison with the west or main fork. The valley is therefore markedly asymmetric, and the Coleen lies at no great distance to the east. In fact, about 20 miles in an air line above the mouth of Koness River a wide, low, swampy, lake-dotted pass exists between the Sheenjek and Coleen drainage basins.

An interesting physiographic feature of the west tributaries of the Sheenjek is their tendency to change in direction in their lower courses. Koness River, heading miles to the west, runs nearly due east until it gets close to the Sheenjek, and then turns abruptly southeastward to join the main stream. The other tributaries from the west show this feature to an even greater degree, running somewhat north of east in their upper courses and then turning southeastward like Koness River to join the Sheenjek. Monument Creek, which empties into the Sheenjek about 25 miles in an air line above the mouth of Koness River, runs northeastward in its upper course and therefore illustrates this feature to a degree almost sufficient to justify the term "back-hand drainage."

The main forks of Sheenjek River are about 185 miles by river from the mouth, and it is believed that the crest of the Brooks Range lies about 40 or 50 miles in an air line north of the forks. Some small glaciers are shown by Leffingwell at or near the crest of the Brooks Range, but such bodies of ice, if they also discharge southward, must be small and relatively inactive, for the Sheenjek at ordinary stages of water is a clear-water stream, showing no evidence of glacial origin. The east or smaller fork of the Sheenjek extends some 20 miles northeastward but is cut off from the Arctic divide by a west fork of Coleen River. A low divide exists between the east fork of the Sheenjek and Coleen River, and a very low pass divides the head of Coleen River from a headwater tributary of the west fork of Sheenjek River. The west or main fork of Sheenjek River swings northwestward to the Brooks Range and heads to the west against the headwater drainage of the East Fork of Chandalar River. The nearest stream of the Arctic drainage at this point is somewhat in doubt but is believed to be a fork of Canning River.

Coleen River, lying to the east of the Sheenjek and flowing roughly parallel with it, is likewise navigable for canoes and light power boats in much the same degree as the Sheenjek. It is a somewhat smaller stream, however, and is said to be more difficult of navigation. Its drainage relations to the Sheenjek have already been described. The eastern headwater tributaries of the Coleen head against Old Crow and Firth Rivers.

The East Fork of Chandalar River, whose headwaters lie west of the headwaters of the Sheenjek, flows southwestward to the main Chandalar River, thus making room farther south for another stream, Christian River, which lies between the lower course of the Sheenjek and the East Fork of the Chandalar. Christian River is said to be a sluggish stream with numerous log jams and is regarded as unsuitable for canoe navigation. The East Fork of the Chandalar, however, is a large stream, swift but navigable for canoes, and is regarded as an excellent route into that part of the Brooks Range lying west of the headwaters of Sheenjek River.

RELIEF

The Sheenjek, Coleen, and Chandalar Valleys are naturally divisible into three well-marked physiographic provinces. The Yukon and Porcupine Flats, as above described, constitute the first of these three provinces which the traveler sees in working northward from Fort Yukon. They form a densely timbered alluvial plain, sloping gently southward and southwestward, devoid of relief, and traversed, especially at high water, by innumerable sloughs of Sheenjek, Christian, Chandalar, Porcupine, and Yukon Rivers.

North of the flats, beginning in the Sheenjek Valley a little north of Christian's cabin, is a piedmont country of rolling hills, which extends northward 50 miles or more to the high mountains of the Brooks Range. Within this stretch the average regional relief is less than 2,000 feet, the river bottom having an altitude (assumed) of 1,400 to 1,800 feet and the crest lines attaining 3,000 to 3,600 feet. The ridge east of Sheenjek River, which forms the divide between the Sheenjek and Coleen drainage basins, is relatively low, having an average altitude of 3,000 feet but rising in places to about 3,500 feet. The ridge along the west side is higher by 500 or 600 feet and includes a number of higher knobs that rise as high as 4,200 feet. Of these one of the most striking is Helmet Mountain, about 6 miles northwest of the constricted part of the Sheenjek Valley, which has an altitude of nearly 4,000 feet. The top of Helmet Mountain is a sharp protuberance of igneous rock, and the lower slopes down to the ridge level are rounded, giving to this mountain from a distance the appearance of a German helmet. Shoulder Mountain, about 6 miles north of the mouth of Koness River, is a high flat mesa-like mountain, whose highest point has an altitude of nearly 4,200 feet. A prominent landmark lying east of the Sheenjek and also east of Coleen River is a symmetrically conical mountain, about 5,000 feet high, which is known locally as Spike Mountain. This peak, which is perhaps 70 miles distant, is visible for many miles in all directions and is probably one of the highest mountains within the piedmont province. Its striking character and visibility should make it a valuable location to which to tie subsequent topographic surveys in this region.

In the upper valley of Sheenjek River, beginning perhaps 10 or 20 miles north of the forks, are high and rugged mountains, which extend northward to the Arctic divide and may be said to constitute the Brooks Range in this longitude. This province has not yet been visited by members of the Geological Survey, but as seen from a distance it presents a rugged appearance, suggestive of high peaks and abrupt declivities—in fact, typical alpine topography. It may conservatively be stated that the tops of some of the mountains of this part of the Brooks Range rise to altitudes of 9,000 feet or more. Unlike the crest of the range at the head of the North Fork of Chandalar River, the higher points of the Arctic divide appear to remain snow-covered all summer. A short distance to the west Leffingwell has mapped several small glaciers which discharge northward toward the Arctic, and similar glaciers probably occur at the head of Sheenjek River, but it is doubtful if there is much glacial activity on the south slope of the range. In the headwater tributaries of Sheenjek River, however, there are known to exist at several localities bodies of river ice ("aufeis") formed by the freezing of successive stream overflows in winter, which are known colloquially as "glaciers." These masses of river ice remain all or nearly all summer, their duration depending upon seasonal climatic conditions.

Two or three landmarks at the southern limit of the alpine province are visible from the lower valley. One of these, Table Mountain, on the east side of the west fork of Sheenjek River, is a flat-topped black-looking mountain with an altitude of about 5,650 feet, which was located by triangulation.

The benches of Sheenjek Valley constitute a physiographic feature worthy of separate mention. Along the west side of the valley, where it merges with the flats, is a bench about 300 feet high. At a point about halfway between Christian's cabin and topographic station 1 the river swings westward and impinges against this bench, truncating it and exposing a gravel bluff perhaps 50 feet high. It is probable, therefore, that this bench, which extends westward 3 or 4 miles to the hills, is composed essentially of alluvial material. This bench continues upstream with diminishing width to the constricted part of the valley above mentioned. Just above this constriction, on the east side of the valley, is another bench of about the same height, which is genetically related to the lower valley bench but appears to be essentially a rock-cut feature, although it may also have a veneer of alluvial material upon its surface. Finally, along the west side of the upper valley two high rock-cut terraces stand out prominently, one at about 2,600–2,800 feet and the other at about 3,400 feet. The higher one may be due to certain planating processes, peculiar to Arctic regions, whereby the summits of ridges and spurs are carved into forms resembling river terraces. The lower bench, however, appears to be an old stream terrace.

CLIMATE

The valley of Sheenjek River has the typical subarctic climate of northern Alaska. No temperature or precipitation records are available for the piedmont and alpine provinces, and for quantitative data it is necessary to extrapolate from the records for Fort Yukon. According to the Weather Bureau, Department of Agriculture, the annual precipitation at Fort Yukon is between 7 and 8 inches, of which perhaps 60 per cent falls in the form of snow. This precipitation is fairly well distributed throughout the year, although a somewhat greater proportion of it appears to take place in the late spring and early summer. September has a smaller mean precipitation than any other month. Fort Yukon, like the Yukon Valley in general, has a short, warm summer and a long, cold winter. The maximum daily temperature may be expected to exceed 70° for 40 to 60 days during June, July, and August, and some fairly warm days may occur, temperatures as high as 100° having been recorded. The minimum daily temperature may be expected to drop below the freezing point at any time within the nine months from September to May, inclusive, and freezing weather has occurred rarely within the three summer months. Minimum temperatures below zero may occur at any time within a period of seven months from October to April, inclusive, and the extreme temperature of 70° below zero has been recorded. The Yukon at Fort Yukon usually freezes over about the last of October, and the ice breaks and goes downstream about the middle of May.

In the piedmont and alpine provinces of Sheenjek Valley climatic conditions are believed to be much like those at Fort Yukon, though differing in some important respects. Although the lowest winter temperatures are probably not in any marked degree lower than those which prevail at Fort Yukon, the winter season is longer and the summer season shorter and cooler, and correlatively the streams freeze earlier in the fall. With regard to precipitation in the piedmont and alpine provinces, no quantitative data are available, but field observations indicate that both summer and winter precipitation are heavier than at Fort Yukon. Still farther north, however, on the Arctic slope, the precipitation probably decreases progressively to the Arctic Ocean. Certainly during the summer of 1926 more rain fell in the upper Sheenjek Valley than at Fort Yukon, and as the moisture-laden winds in the interior of Alaska come mainly from the south and southwest, this condition might well be expected. The Arctic Ocean appears to be too cold to furnish much moisture to the atmosphere.

ANIMAL AND PLANT LIFE

The larger game animals of the country are moose, caribou, mountain sheep, and bear. Moose are fairly plentiful, particularly in the wide swampy, lake-dotted valleys. Caribou are seen as individuals and small herds and may be considered fairly plentiful, though no very large herds similar to those in the Yukon-Tanana region roam in this country. Mountain sheep appear to be scarce. Both the black and brown grizzly bear live in this region, and the brown grizzly sometimes attains great size. The smaller mammals, many of which are valuable for their fur, include wolf, wolverine, coyote, fox, lynx, mink, beaver, rabbit, muskrat, ground squirrel, and porcupine. The native game birds of the country are ptarmigan and grouse, but their numbers appear to vary greatly from year to year, and both were scarce during the season of 1926. Numerous varieties of migrating birds, however, visit this country in summer, when ducks and geese are plentiful on the lakes and sluggish sloughs. The streams are well stocked with fish, particularly grayling or Arctic trout, and lake trout, pickerel, and whitefish also inhabit these waters. Salmon run up the Porcupine and its tributaries in summer but not in the same degree as on the Yukon.

Spruce is the principal timber in the valley of the Sheenjek, ranging from trees 2 feet in diameter in the lower valley to the typical scrubby spruce of the upper wooded slopes. Poplar in several varieties is also common. Birch occurs usually in interior Alaska on well-drained lands, such as hill slopes, but the Sheenjek Valley is swampy in its bottom lands and not well drained on the slopes, so that birch is scarce. Willows and alders grow in profusion in the swampy bottom lands, usually as high underbrush. Buck brush, or dwarfed black birch, occurs in this region as a low underbrush, but not so plentifully as south of the Yukon. Timber line ranges from 2,000 to 2,500 feet, depending upon local conditions, but in the trunk valleys of the larger streams timber may follow up a main valley to an altitude of 3,000 feet.

Many varieties of flowering plants mature in this region during the summer. A small but fairly representative collection of the early-maturing plants was made by the writer from Sheenjek Valley in 1926 and submitted to the Smithsonian Institution for identification. The flora, as determined by Dr. Paul C. Standley, is given herewith:

Cyperaceae (sedge family):
- Eriophorum callitrix Chamisso. Cottongrass.

Liliaceae (lily family):
- Allium sibiricum Linné. Wild onion.
- Tofieldia palustris Hudson.
- Zygadenus elegans Pursh. Poison camas.

Orchidaceae (orchid family):
- Cypripedium guttatum Swartz. Lady's slipper.
- Habenaria obtusata (Pursh) Richardson.

Polygonaceae (buckwheat family):
- Polygonum bistorta Linné.

Silenaceae (pink family):
- Arenaria macrocarpa Pursh.
- Cerastium maximum Linné.
- Silene acaulis Linné. Carpet pink.
- Stellaria longipes Goldie. Chickweed.

Ranunculaceae (buttercup family):
- Aconitum delphinifolium De Candolle. Monkshood.
- Anemone multiceps (Greene) Wight.
- Caltha palustris var. arctica (R. Brown) Huth. Marsh marigold.

Brassicaceae (mustard family):
- Lesquerella arctica (Wormskiold) Watson. Bladder pod.
- Sisymbrium humile Ledebour.

Papaveraceae (poppy family):
- Papaver nudicaule Linné. Arctic poppy.

Parnassiaceae (Parnassia family):
- Parnassia kotzebuei Chamisso.

Saxifragaceae (saxifrage family):
- Saxifraga tricuspidata Rottboell. Saxifrage.

Rosaceae (rose family):
- Dryas drummondii Hooker. Yellow dryad.
- Dryas integrifolia Vahl. Dryad.
- Potentilla fruticosa Linné. Shrubby cinquefoil.
- Potentilla nivea Linné.
- Potentilla pennsylvanica Linné.
- Potentilla villosa Pallas.
- Rosa acicularis Linné. Wild rose.
- Rubus arcticus Linné.

Fabaceae (bean family):
- Astragalus alpinus Linné.
- Astragalus gormani Wight.
- Hedysarum mackenzii Richardson.
- Lupinus arcticus Watson. Lupine.
- Oxytropis campestris (Linné) DeCandolle.
- Oxytropis nigrescens (Pallas) Fischer.

Onagraceae (evening primrose family):
- Epilobium latifolium Linné. Fireweed.

Apiaceae (parsley family):
- Conioselinum gmelini (Chamisso and Schlechtendal) Coulter and Rose.

Cornaceae (dogwood family):
- Cornus stolonifera Michaux. Red-osier dogwood.

Pyrolaceae (Pyrola family):
- Pyrola grandiflora Rad.

Ericaceae (heath family):
- Arctostaphylos uva-ursi (Linné) Sprengel. Bearberry.
- Ledum decumbens (Aiton) Loddiges. Labrador tea.
- Rhododendron lapponicum Linné.

Vacciniaceae (blueberry family):
- Vaccinium vitis-idaea Linné.

Primulaceae (primrose family):
- Androsace chamaejasme Wulfen.

Polemoniaceae (Jacob's ladder family):
- Phlox hoodii Richardson.
- Phlox sibirica Linné.
- Polemonium humile Willdenow.

Boraginaceae (borage family):
- Eritrichum aretioides (Chamisso) DeCandolle.
- Mertensia alaskana Britton. Bluebells.

Scrophulariaceae (figwort family):
- Castilleja tristis Wight. Indian paintbrush.
- Castilleja tristis var. pubens Wight.
- Pedicularis sudetida Willdenow. Lousewort.
- Pentstemon gormani Greene. Beard tongue.

Caprifoliaceae (honeysuckle family):
- Linnaea borealis Linné. Twinflower.
- Viburnum pauciflorum Pylaie. Highbush cranberry.

Valerianaceae (valerian family):
- Valeriana capitata Pallas. Valerian.

Campanulaceae (harebell family):
- Campanula uniflora Linné.

Asteraceae (aster family):
- Arnica alpina (Linné) Olin.
- Arnica nutans Rydberg.
- Aster sibiricus Linné.
- Crepis nana Richardson.
- Erigeron caespitosus Nuttall.
- Erigeron hyperboreus Greene.
- Erigeron uniflorus Linné.
- Taraxacum ceratophorum (Ledebour) DeCandolle. Dandelion.

SETTLEMENTS

Fort Yukon, at the confluence of Porcupine and Yukon Rivers, and Beaver, about 60 miles farther down the Yukon, are the only white settlements in this region. Fort Yukon, the point of entry for Porcupine Valley, is the center of the fur industry of the upper Yukon, and its population is therefore to some extent nomadic, the trappers being alternately in and out of town. The stable white population consists perhaps of 40 or 50 people, augmented periodically by trappers and prospectors. A native village also is located at Fort Yukon, and one of the local points of interest is the Hudson

Stuck Memorial Hospital and Mission, where these natives are cared for in sickness and are taught the rudiments of sanitation and hygiene, as well as the fundamentals of Christianity. Two other native villages exist in this general region, of which one, known as Christian Village, is on Christian River about 75 miles by winter trail from Fort Yukon. The other, called Arctic Village, is on the East Fork of Chandalar River about 150 miles distant by trail. No permanent native settlements are located in the Sheenjek and Coleen Valleys, and this region east of Chandalar and Christian Rivers is therefore uninhabited except for a few hunters and trappers.

GEOLOGY

OUTLINE

From geologic studies made by different workers to the east, south, and west of Sheenjek Valley, it is evident that a considerable sequence of Paleozoic rocks, ranging in age from Silurian and possibly pre-Silurian to late Carboniferous, may be exposed in the Sheenjek Valley from the Brooks Range southward to the Yukon Flats; and certain horizons of the Mesozoic, particularly the Upper Triassic, may also be represented in this geologic section. The northern part of this section—that is, the alpine belt—contains apparently formations at a diversity of geologic horizons which are well exposed, but this part of the Sheenjek Valley was seen only from a distance. Within the piedmont area, which was visited and mapped by the expedition of 1926, the country rock is uniformly of one age, probably lower Carboniferous, and consists essentially of chert and related rocks, diversified only by numerous included igneous rocks of basic affinities. The only geologic unit other than the chert formation, therefore, which is shown on Plate 2 is composed of unconsolidated alluvial deposits, which mantle a considerable portion of the piedmont area.

CARBONIFEROUS SYSTEM

CHERT

DISTRIBUTION AND LITHOLOGY

The first exposures of hard rock encountered in going up Sheenjek River are found on a low ridge about 3 miles east of Christian's cabin. This ridge, which at its highest point rises only 650 feet above the river level, trends somewhat east of north and is rounded and timber covered, with only scattered outcrops of bedrock along the crest. The country rock here is a massive light-gray chert, cut by numerous dikes of gabbro and diabase, many of which appear to trend about N. 75° E. The structure of the chert is indeterminate.

About 15 miles to the north and a mile east of Sheenjek River is the small conical butte previously described as the site of the first topographic station. The bedrock here also is a basic intrusive rock, but chert rubble seen farther down the slopes indicates that the greenstone is an intrusive rock invading a country rock of chert. The elongation of the intrusive body here is nearly east-west. Another isolated butte, about 8 miles farther up the valley on the same side, appears to be a similar occurrence of intrusive rock in chert.

Along the west side of the valley, 5½ miles northwest of the first topographic station, is a ridge that rises to an altitude of about 3,000 feet. The rocks along the summit consist of an intimate mixture of chert with gabbro, diabase, and basalt. Along the east side of this ridge, however, in the bluffs bordering the valley bottom, were seen beds of chert, from 1 to 3 inches thick, ranging from light gray to a black carbonaceous variety. Interbedded with these cherts are thin layers of a very fissile chocolate-colored shaly slate and a few more massive beds of the same lithologic character. These beds, as well as the chert beds, are much folded and crumpled but on the average appear to strike about N. 65° E. The dip is inconstant, but the available exposures suggest a prevailingly northwestward dip.

At 11 miles in an air line upstream from the first topographic station the valley of Sheenjek River becomes suddenly constricted to a width of less than half a mile. At the lower end of this constriction, on the west side, are two buttes close to the river, one on each side of a tributary from the west. The rock composing these buttes is a gabbro, with no indications of the presence of sedimentary rocks. The upper butte, however, is the end of a long spur that extends northwestward for 7 miles to Helmet Mountain, the most prominent landmark of the lower valley. The rocks exposed in this 7-mile stretch are a mixture of chert and basic intrusive rocks. The chert as seen along the summit of this spur is a light-gray to dark-gray variety, weathering white on the surface owing to the development of a thin veneer of opaloid material. The country rock forming Helmet Mountain is a fine-grained gabbro. Only angular chert débris and rubble are exposed along the summit of this spur, and no indications of the structure of the chert are visible.

About 14 miles upstream from the valley constriction above noted and 5 miles upstream from the mouth of Koness River is another spur by means of which it is possible to approach Shoulder Mountain, on the west side of the valley. The lower slopes of this spur consist mainly of chert, with some interbedded sandstone and argillite. One structure observation on one of the sandstone beds gave a strike of N. 55° E. with a steep southward dip. Here, as on Helmet Mountain, the high points are composed of basic intrusive rocks, practically all of Shoulder Mountain being of this character. On the next spur to the north, connecting Shoulder Mountain to the river bottom, a single exposure near the river shows light-gray chert in beds 3 feet thick. The beds, as usual, are much folded but appear to strike northeast as before, with indications, however, of a gentle northward dip.

At 10 miles above the mouth of Koness River another spur leading to the ridge is composed largely of chert, intruded, however, by some good-sized bodies of diabase and gabbro. Near the summit of the ridge are several thin bands of limestone and of partly calcified chert, interbedded with the chert. This material is worthy of particular mention. In some specimens from the beds where replacement has occurred the boundary line between the chert and limestone follows bedding planes, but in others the contact forms an intricate pattern in no way related to bedding. Some of the contacts between the two types of rock appear sharp and clean-cut, but others are rather indefinite. In thin sections of this material, however, even the sharp contacts are seen to be only relatively sharp, being bordered on one side by completely calcified material and on the other by a zone showing incipient calcification of the chert. Additional evidence of the presence of secondary processes at this locality is found in the form of numerous euhedral crystals of limonite, pseudomorphic after pyrite, scattered about on the surface. All the rocks at this locality have suffered intense and close folding, which has produced much duplication of beds.

At 13 miles in an air line upstream from the mouth of Koness River rubble of chert and diabase is found along the spur for 5 miles toward the southeast. At the crest of this spur, where it joins the main divide between Sheenjek and Coleen Rivers, a peculiar phase of the chert occurs. This rock, in the hand specimen, superficially resembles a gneissoid rock but is in reality a chert, recrystallized to a fine-grained granular quartzite, replaced to a considerable extent with calcite. It is best described as a calcareous quartzite. On the opposite side of the Sheenjek the spur leading northwestward is composed mainly of chert, interbedded with more or less siliceous slate and shale, the entire sequence being punctured at intervals by intrusive bodies of gabbroic and diabasic rocks.

In general, therefore, the country rock of the Sheenjek Valley, from Christian's cabin upstream to Monument Creek and probably as far north as the main forks, consists essentially of light to dark gray chert, with some black and red varieties, interbedded with a subordinate proportion of slate, shale, sandstone, and limestone. Thin sections of the chert show a marked tendency toward recrystallization, which at certain localities has resulted in the development of a true quartzitic type of rock. In addition to this recrystallization, replacement on a small scale by calcite has occurred particularly in the vicinity of interbedded limestone. Another noticeable secondary process is the surficial alteration of the chert to a white opaloid material, which usually coats the surface of weathered débris.

This chert formation, together with its associated rocks, is intimately intermingled with basic igneous rocks, which from their general appearance and habitat appear to be intrusive in character, although it is by no means certain that some of them may not be surface flows. This admixture of sedimentary and intrusive material is so intimate, however, that the two types of rocks can not be separately mapped and are therefore shown on Plate 2 as a single geologic unit. It is doubtful, in fact, if they could be properly separated even by detailed mapping, for within this piedmont area most of the country rock is concealed by vegetation and by eluvial as well as alluvial deposits.

ASSOCIATED IGNEOUS ROCKS

The igneous rocks associated with the chert are all of basic character but may in general be classified into four types—gabbro, quartz gabbro, diabase, and basalt. The gabbro, diabase, and basalt are normal rock types and require no particular description. They consist essentially of plagioclase, with an average composition about that of labradorite, augite, and iron oxides, with more or less accessory apatite. In some of these rocks the pyroxene or plagioclase, or both, are altered to a degree sufficient to justify the appellation greenstone. In others the component minerals are little altered. The three types mentioned differ from one another mainly in their granularity and texture.

An intrusive of more specialized type, designated quartz gabbro, is distributed along with the others at several localities in the valley but occurs particularly at Shoulder Mountain. This is typically a granular rock but is in places rather exceptionally coarse-grained. It consists essentially of plagioclase, quartz, augite, and iron oxides, with accessory apatite, together with secondary minerals such as sericite, chlorite, biotite, basaltic hornblende, and iron hydroxides. The feldspar is zonally grown, with centers of labradorite and rims of oligoclase. Another peculiar feature is the presence of latticed intergrowths of magnetite and biotite. The general conclusion reached from a microscopic examination of these quartz gabbros is that they have been extensively altered by hydrothermal processes at a late stage of their formation, to which may be attributed the formation of the sericite, biotite, and hornblende and possibly a certain degree of the albitization.

STRUCTURE

In proportion to the area covered by this series of rocks, within the piedmont province, relatively few observations of strike and dip can be made; moreover, these rocks seem to be rather incompetent and are therefore much deformed into small folds, so that the observations of this kind that were made can have relatively little value in interpreting the larger structural features. So far as the strike or trend of the rocks is concerned, the direction of the drainage channels and ridge tops probably gives more real information than the structural observations. From the accompanying map it will be seen that many of the tributaries of the Sheenjek and a number of crest lines trend about N. 70° E., and the few available observations on structure and directions of elongation of intrusive rocks do not, as a whole, depart greatly from this same direction. It is inferred, therefore, that the regional strike of the chert series in this piedmont province is about N. 70° E. This feature, at the same time, affords an explanation of the tendency toward " backhand " drainage that appears to be characteristic of the west tributaries of the Sheenjek.

The direction of the prevailing dip of this series of rocks can be inferred even less surely than the strike. Indeed, it may be said that such scattered observations as were made are practically worthless for this purpose, and a structural interpretation must be based upon the relation to adjoining formations. Nothing whatever is known regarding the hard rocks that may border this chert series on the south. On the north, farther up the valley, however, occur bodies of limestone which are inferred to be older than the chert. The presence of schist (Neruokpuk schist) at the crest of the range, at the head of Canning River,[2] also favors the belief that in general older rocks crop out progressively northward to the crest of the range in this longitude.

If the rocks of this chert series lie conformably upon older rocks to the north and are not part of an overturned fold, a fair presumption might be made that the chert, although closely folded, has a southerly dip where it comes into contact with the older rocks; but as nothing is yet known of the character or age of the bordering rocks on the south, no similar inference could be made as to the structure of the intraformational and southerly beds. On the other hand, the possibility exists that the chert rests unconformably upon older rocks bordering it on the north. Presumptive confirmation of this idea may be found in the Chandalar district, about 100 miles to the west,[3] where a somewhat similar group of rocks occupy the

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[2] Leffingwell, E. deK., The Canning River region, northern Alaska: U. S. Geol. Survey Prof. Paper 109, pp. 103–105, 1919.

[3] Mertie, J. B., jr., Geology and gold placers of the Chandalar district, Alaska: U. S. Geol. Survey Bull. 773, pp. 235–238, 1925.

same geographic position with reference to the south front of the Brooks Range and are believed to lie unconformably upon the older rocks to the north. If the same conditions prevail in the valley of Sheenjek River, the contact relations, as exposed in the shape and direction of the northern contact line, are correspondingly more involved.

These rocks crop out for at least 60 miles up and down the Sheenjek Valley, and if the strike is, as inferred, about N. 70° E., they are exposed across the strike for a distance of about 35 miles. This geographic distribution in folded rocks can be interpreted only as the result of duplication of beds along the surface, due to folding. Furthermore, the net effect of this folding must be such that a low regional dip is produced, even if these rocks are regarded as a basin of sediments lying unconformably upon older rocks. Otherwise, younger rocks would show as infolded strata, or older rocks would be exposed by erosion, unless an inordinately great thickness is assumed for this group of rocks. Deformational stresses may still have produced complex folding as a result of the inherent weakness of the thin beds of chert and the other related rocks of this group. The few observed exposures of structure confirm this idea and suggest a multiplicity of intricate folds of small amplitude, which duplicate the beds at certain horizons many times.

It is interesting to observe that the trend of these rocks parallels roughly the course of Porcupine River and the eastward continuation of the Arctic coast and is entirely unrelated to the northwesterly trend of the Paleozoic rocks farther south in the Yukon Basin proper. The Brooks Range, in this longitude, also has the same general trend, veering off apparently toward the lower Mackenzie Basin. Here is additional evidence favoring the idea, first advanced by A. H. Brooks, that the Arctic Mountains are a structural feature related to the Arctic Ocean and are structurally independent of the Rocky Mountain system, which appears farther south in Alaska.

AGE AND CORRELATION

No fossils have yet been found in this group of rocks, and their age is therefore not definitely known. Comparative studies of similar rocks in adjacent areas, however, serve as a basis for the correlation of these rocks and the determination of their probable age.

Within the Yukon Basin a group of rocks composed of a great thickness of chert, interbedded with a minor proportion of shale and limestone, has been observed at numerous localities; and at most such localities these rocks are invaded by many intrusive bodies of basic igneous rocks, just as the similar rocks are in the valley of Sheenjek River. Only at one or two localities within the Yukon Basin have fossils been found in these cherty rocks, but at several localities the structural and geographic relations leave little doubt of their age, at least between narrow stratigraphic limits.

This group of rocks was first recognized in the Livengood district and described as a geologic unit by the writer [4] in 1916. No group or formational name was given, only the appellation "chert" being used in the geologic legend. It was recognized at that time that the "chert" was definitely younger than Middle Devonian and older than Pennsylvanian. A small collection of imperfect fossils was made from the same district two years later by Overbeck,[5] on the basis of which it was inferred that these rocks were probably of Mississippian age. This chert formation was subsequently (in 1921) traced by the writer for 75 miles along the strike east and west from the Livengood district.

A chert formation on the West Fork of Chandalar River, which may possibly be correlated with the chert of the Sheenjek Valley, was described by the writer [6] in 1923. Here also the evidence was too meager for a definite age determination but was sufficient to justify the assignment of the formation to the Mississippian or Upper Devonian.

During the season of 1925 similar cherty rocks were seen by the writer underlying conformably the known upper Mississippian rocks of Calico Bluff, on the upper Yukon. In this district these rocks appear to be definitely of Mississippian age, and to distinguish them from the Calico Bluff formation, of upper Mississippian age, they were referred to the lower Mississippian. In general, therefore, it appears highly probable that the cherty rocks of the Sheenjek Valley lie at or near the base of the Carboniferous sequence of interior Alaska.

Another interpretation of the age of the chert in the Sheenjek Valley should be mentioned, however, not because it is believed by the writer, but because it is so suggestive that it should not be ignored. A chert formation was observed and described farther down the Yukon, in the Ruby district, by Eakin [7] in 1913 and by Eakin [8] and the writer [9] in 1915. These cherty rocks, however, are somewhat different lithologically and are interbedded with rhyolitic lava flows.

[4] Mertie, J. B., jr., The gold placers of the Tolovana district, Alaska: U. S. Geol. Survey Bull. 662, pp. 239–244, 1918.

[5] Overbeck, R. M., unpublished manuscript.

[6] Mertie, J. B., jr., Geology and gold placers of the Chandalar district, Alaska: U. S. Geol. Survey Bull. 773, pp. 235–238, 1925.

[7] Eakin, H. M., The Iditarod-Ruby region, Alaska: U. S. Geol. Survey Bull. 578, p. 22, 1914.

[8] Eakin, H. M., The Cosna-Nowitna region, Alaska: U. S. Geol. Survey Bull. 667, pp. 30–33, 1918.

[9] Mertie, J. B., jr., and Harrington, G. L., The Ruby-Kuskokwim region, Alaska: U. S. Geol. Survey Bull. 754, pp. 22–24, 1924.

One fossil collection was made, which if really from these rocks indicates that they may be of Mesozoic age. In general, the age of these cherts is highly doubtful, but the present weight of evidence favors their assignment to the Triassic.

An Upper Triassic chert, called the Kamishak chert, was described by Martin [10] from observations in the Cook Inlet country of southern Alaska in 1909, and recently Upper Triassic chert has been found in northern Alaska by W. R. Smith and P. S. Smith.[11] The possibility therefore exists that the chert of the Sheenjek Valley may not be correlative with the chert of the Livengood district but may be of Triassic age. Sheenjek River, however, is hundreds of miles from southern Alaska, and the Triassic chert of northern Alaska lies for the most part north of the Brooks Range. Moreover, the Triassic rocks of the Yukon are nonsiliceous, as are also the Triassic rocks nearest to the Sheenjek—namely, the Upper Triassic shale and limestone along the northern part of the international boundary, described by Maddren,[12] who correlates the cherty rocks of that area with the Carboniferous. The writer therefore correlates the chert and related intrusive rocks in the Sheenjek Valley with the chert as exposed at Livengood and along Yukon River and with the chert on the West Fork of Chandalar River, assigning all these rocks to the lower part of the Mississippian sequence.

QUATERNARY SYSTEM

PLEISTOCENE DEPOSITS

The piedmont province, with which this report is primarily concerned, does not appear to have been affected by glacial action. Farther north, however, in the Brooks Range or alpine province, extensive glaciation took place during Pleistocene time, and a few small glaciers are known still to persist along the Arctic divide. The bodies of "aufeis," known locally as "valley glaciers," which originate by the freezing of winter overflows of the river and often remain during most of the summer, show that this mountain province is even now not far removed from the condition of alpine glaciation.

Unsorted alluvial materials, or morainal deposits, are therefore confined to the alpine province and are not believed to exist as such south of the main forks of the Sheenjek. Glacial deposits, however, have probably acted as a partial source of material for the postglacial and recent streams, and the alluvial material that now constitutes the

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[10] Martin, G. C., A geologic reconnaissance of the Iliamna region, Alaska: U. S. Geol. Survey Bull. 485, pp. 47–50, 1912.

[11] Smith, P. S., and Mertie, J. B., jr., Geography and geology of northwestern Alaska: U. S. Geol. Survey Bull. — [in preparation].

[12] Maddren, A. G., Geologic investigations along the Canada-Alaska boundary: U. S. Geol. Survey Bull. 520, pp. 18–19, 1912.

gravel bench along the river where it enters the Yukon Flats may be in part derived from such a source. The lower gravel of this bench, however, at the one locality where it is well exposed, about 8½ miles in an air line above Christian's cabin, is well rounded and well stratified in beds ranging from sand and small pebbles up to good-sized cobbles, not unlike the material that constitutes the present valley alluvium. Only about 50 feet of gravel is exposed in this cut, but the gravel bench itself must be nearly 300 feet from top to bottom.

Above and below the mouth of Koness River, along the east side of the Sheenjek Valley, is a well-developed bench from half a mile to a mile wide, which slopes very gently from the main valley wall toward the center of the valley and drops off by a steep declivity to the valley floor. Hard rock was seen on top of this bench as well as in the declivity at its south end, and this feature is therefore believed to be essentially a rock-cut terrace, with possibly a thin alluvial veneer. This terrace doubtless marks the old valley floor, where the river flowed at the time the bench gravel was being deposited; and it also represents a base-level that was about 300 feet higher than the present local base-level and that remained essentially unchanged for a considerable time. It can not at present be shown just what relation exists between this old erosion level and the retreat of the ice, but by making due allowance for the active erosion that must have characterized the upper Sheenjek River after the new base-level was established, it seems possible that this terrace may well have been a preglacial physiographic feature.

A higher terrace, as previously noted, exists at an altitude of 2,600 feet in the lower valley, increasing to 2,800 feet or higher in the upper valley. This terrace, which is about 1,200 feet above the present valley floor, is believed to represent the remnants of an old valley floor, probably of preglacial age. It brings to mind the high gravel-covered terrace along the south side of Seventymile River, in the Yukon-Tanana region, which, however, rises only 500 feet above the valley floor.

RECENT DEPOSITS

The Recent deposits of the Sheenjek Valley may conveniently be classified into three major types, which differ not only in lithologic character but also in physiographic history. These are (1) the sand, silt, and carbonaceous deposits that constitute the detrital material in the Yukon Flats, (2) the gravel and sand deposits that form the alluvial filling of the present valley floor, within the piedmont province, and (3) the hillside rubble, or eluvial deposits, due to soil flow, frost heaving, and related processes, also preeminently developed in the piedmont province.

The physiographic history of the Yukon Flats has not yet been worked out, and it is doubtful if a thoroughly satisfactory explanation of this great alluvium-filled depression of the Yukon can be formulated until a reliable topographic map of the flats and the bordering hills shall have been drawn. Yet whatever the final explanation may be, it is evident that the encircling hills at Fort Hamlin, at the lower end of the flats, were a bulwark that controlled for a long period the base-level of the upper Yukon. In the absence of any reliable data indicating glacial action or major reversals of drainage, it is commonly inferred that the Fort Hamlin hills and the Yukon Valley above Fort Hamlin have been involved in differential uplift or depression, whereby the natural downward grade of the bedrock floor of the Yukon has been changed, so that at Fort Hamlin and for an undetermined distance above it the bedrock grade of the Yukon is upstream. This condition has produced a great dumping of river deposits above Fort Hamlin, and the long-continued operation of this process has extended such alluvial deposits up into all the streams tributary to the Yukon, to a point where their naturally high headwater gradients have sufficed to raise the valley floor above this great alluvial plain.

This critical point, in the Sheenjek Valley, is just above Carroll's cabin, although the hills really begin some 20 miles upstream at Christian's cabin. From Carroll's cabin downstream, however, the Sheenjek changes from a braided mountain stream to a meandering river and flows across a plain of lower slope than that of the upper valley. The current, at the same time, becomes markedly less, not only on account of the lower slope of the valley floor but also because the stream meanders tortuously and thus further reduces its grade per stream mile. Consequently little gravel is seen on the river bars below Carroll's cabin, the alluvial filling being largely the finer material that a sluggish stream can handle. Actually, to judge from the appearance of the water, little or no sediment of any kind is handled by the river in its lower stretches, except at stages of high water, when it becomes a fairly rapid, mud-laden stream that inundates much of its lower valley. The presence of high alluvial banks that appear to be above the highest stage to which the streams now reach indicates, however, that the downward movement of sediments, even in the lower valley, exceeds the yearly alluviation by overflow, and that the flats as a whole are in process of destruction rather than construction.

The presence of sand and silt in the lower valley is therefore to be expected. The black carbonaceous sediments seen in many of the river banks in the lower river are also explicable in terms of present conditions. The numerous log jams and snag flats of the present stream show how carbonaceous material can accumulate in the river muds; and the heavy layers of moss in the forest and brush, back from the river, afford a major source for the peaty deposits seen in the silt.

From Carroll's cabin upstream to the forks the present stream deposits consist of gravel, sand, and silt. Along the river bars in the lower part of this 90-mile stretch large boulders are relatively few, but they become increasingly evident upstream. Above the forks beds of large boulders are said to be present in places. Few of the tributary streams in this piedmont area have precipitous grades, and the main river stays fairly well in the middle of its wide valley, so that small alluvial-fan deposits of coarse detritus from such streams are not a characteristic feature. All the stream deposits appear to be well sorted.

Eluvial deposits are present everywhere on the gentle lower hill slopes in the piedmont province and constitute a considerable part of the surficial detritus. In most places, however, they are covered by heavy layers of vegetal material. Much of the ground back from the main waterways is perpetually frozen, so that solifluxion, nivation, and similar processes play an important part in the genesis and later movement of such material.

ECONOMIC FEATURES

No workable mineral deposits have yet been found in the Sheenjek Valley or in the adjoining country to the east and west. Granitic rocks, however, are found north of the Brooks Range in the Canning River region, and it is possible, therefore, that metalliferous deposits may be present in this general region. Glaciation, however, is an unfavorable condition for the possible presence of placer deposits, for glacial action does not itself produce concentration of heavy metals and tends to scour out and dissipate any older placers that may have existed prior to glaciation. Moreover, it is a fact that most of the important placers of interior and northern Alaska have been found in areas of relatively low altitude and relief, where the present gradients of the streams are slight. The headwater region of the Sheenjek, therefore, does not seem a favorable site for workable placers. Lode deposits, in this remote region, would have to be of a bonanza type to justify development at the present time. But if granitic rocks and consequent mineral deposits are found in the piedmont province, the chances for gold placers should be considered favorable.

One of the interesting mineral occurrences in this region is a deposit of oil shale. A sample from Christian River, about 75 miles north of Fort Yukon, submitted to the Geological Survey in 1926, was found to contain a remarkably high percentage of shale oil. This sample was distilled and examined by E. T. Erickson, of the Geological Survey, and his report is given herewith:

A distillation test using the Bureau of Mines oil shale distillation method[13] gave 122 gallons of crude oil to the ton. Rate of distillation maintained during the period of active distillation, 0.5 cubic centimeter of distillate per minute. Spirit grade of the crude distillate, 0.864 at $\frac{15° \text{ C.}}{15° \text{ C.}}$. Setting point of the crude oil, 11° C.

When first distilled the crude oil had a strong green color, unlike the amber or dark-brownish colors usually exhibited by crude shale oils. The color, however, darkened considerably upon prolonged contact with air, and this change was accompanied by the separation of a dark-colored substance. The green color, together with the unusually high yield of the crude oil, suggested that the sample might be related to some form of residual petroleum, as the heavier lubricating fractions of certain petroleums are characterized by a similar color. Extraction tests made with chloroform and benzene directly on the sample and with the same solvents on the sample previously treated with hydrofluoric acid gave no evidence of such a supposition, yielding but slight quantities of soluble material. Hydrocarbon material directly related to petroleum would probably exhibit solubility in these solvents. The slight solubility noted, together with ash determination of 33.15 per cent, may be considered to classify the sample as oil shale.

The setting point is the temperature at which solidification of the oil occurs, probably owing to the separation of wax and other hydrocarbon substances. The setting point noted is considerably lower than that of typical Colorado and Scottish shale oils.

The green color may have some significance as to the commercial value of the crude oil for lubricants and may also be of scientific interest in regard to the geologic origin of the colored hydrocarbons of petroleum, as their occurrence in the crude shale oil involves a distillation process.

As this deposit has not yet been visited by members of the Geological Survey, its age and extent are undetermined. It is possible that this oil shale comes from Upper Triassic rocks of the type of those that have been found by the writer to contain oil shale along Yukon River, just above Nation River. A sample of the latter shale, however, yielded only 28 gallons of oil to the ton, whereas the sample from Christian River, as shown above, yielded 122 gallons to the ton. The examination and evaluation of this deposit remain for the future.

Another possibility for this region is the presence of free-flowing oil. At Fort Norman, Yukon Territory, some 500 miles to the southeast, an oil-bearing zone has been discovered, apparently in rocks of Devonian age. During the summer of 1926 a seepage was reported

[13] Karrick, L. C., A convenient and reliable retort for assaying oil shales for oil yield: Bur. Mines Repts., No. 2229, March, 1921; revised April, 1922.

to the writer along Porcupine River, south of Salmontrout River, from rocks of Middle Devonian age. This report has not yet been corroborated, but the mere fact that the seepage is said to come from Middle Devonian rocks lends a certain degree of plausibility to it.

Another interesting mineral occurrence, though apparently of no economic significance, is the presence of potash salts in some of the small lakes north of Fort Yukon and probably elsewhere in the Yukon Flats. Frank Jackson, of Fort Yukon, noticed during the winter of 1922–23 that some of these small lakes do not freeze thoroughly in winter, and subsequently, at the suggestion of the writer, he obtained samples of the water from three lakes, as follows: No. 1, north of Fort Yukon, on the Alexander (Indian) trail; No. 2, 8 miles northeast of No. 1; No. 3, 10 miles east of No. 1. These waters were analyzed by R. K. Bailey, of the United States Geological Survey, with the following results:

Analyses of lake waters from Yukon Flats

	Per cent of soluble salts	Per cent of K_2O in soluble salts
1	0.068	10.65
2	.58	4.82
3	.28	3.91

These analyses show percentages of K_2O too small to be of economic value but are nevertheless worthy of mention.

In general, all this northeastern part of Alaska is as yet undeveloped economically, but the outlook for mineral deposits is by no means discouraging. It is hoped that the next decade will see a revival of prospecting in this region.