MINING IN THE KOTSINA-CHITINA, CHISTOCHINA, AND VALDEZ CREEK REGIONS.

By Fred H. Moffit.

KOTSINA-CHITINA REGION.[a]

INTRODUCTION.

The notes here given do not present a full account of progress in the Kotsina-Chitina region in 1908, for some of the important copper prospects receive no mention. No property is omitted intentionally, however, and where claims or work are not mentioned it is because an opportunity for collecting the facts did not present itself.

This region has been recently described in some detail,[b] and these notes are intended to be merely a report of progress since the material for that description was collected.

Copper prospecting in the Chitina Valley was seriously hindered by the low price of copper and the financial depression of 1907–8. It was difficult to raise money for prospecting or for development, so that some claim owners made no attempt to do more than the assessment work necessary to hold their ground. This condition was noticeable in the early part of the year, for it was said in Valdez that the quantity of provisions and other freight carried in over the snow in the months from January to March was considerably less than usual. On the other hand, considerable effective development work has been carried on that seems likely to be of more value in showing the possibilities of the region and the nature of its ores than most of the work done in previous years. Such work has probably been stimulated in part by the fact that construction work on the Copper River Railroad is being pushed and that better transportation facilities are to be expected in the near future.

COPPER PROSPECTS.

BONANZA MINE.

A force of men was employed by the Kennicott Mines Company during the year 1908 in preparing the Bonanza mine for shipping ore. In the early part of the year provisions and equipment were started from

[a] Dan Creek, Chititu Creek, and the Bonanza mine were visited by members of the Geological Survey in the early part of September, 1908. The notes on other streams of the Kotsina-Chitina area were obtained from prospectors seen in Valdez later in the month.

[b] Moffit, F. H., and Maddren, A. G., The mineral resources of the Kotsina and Chitina valleys, Copper River region: Bull. U. S. Geol. Survey No. 345, 1907, pp. 127–175.

Valdez, but owing to the early opening of Chitina River a part of this freight did not reach its destination and was left near McCarthy's cabin, about 7 or 8 miles above the Chitina's mouth. This misfortune did not interfere with work, however, for most of the equipment left behind will not be needed till the work is further advanced. Construction of an aerial tramway from the camp on National Creek to the mine was begun and about half of the necessary towers were erected. A sawmill, a bunk house, and a blacksmith shop were built and a tunnel was started to cut the ore body about 40 or 45 feet below the bottom of the winze in the old tunnel, or about 75 feet below the old tunnel itself. This tunnel had been driven 137 feet in September, and it was expected that 90 feet more would be required in order to reach the winze. The wagon road leading to the mine was widened and graded, so that supplies can now be sledded almost to the mine. Furthermore, construction work on a short piece of railroad from the camp and ore bunkers to Chitina River was started. This road will extend from the mouth of National Creek to a point not far from the junction of Lakina and Chitina rivers, and will make it possible to ship ore and supplies before the Copper River Railroad is completed, as one or two steamboats in addition to the *Chitina* will be placed on Copper River by the spring of 1909 and will form a connection between the lower part of the railroad at Abercrombie Rapids and the upper part at Lakina River.

M'CARTHY CREEK.

The shear zone in which the copper ores of the Bonanza mine are deposited has been traced by prospectors northeastward across the ridge to its McCarthy Creek side, where it is intersected by other shear zones. The vicinity of these intersections is in places marked by the deposition of copper minerals, and the ground has been staked for copper. The occurrence of copper minerals differs here from that at the Bonanza mine in that deposition has taken place well up in the Chitistone limestone instead of near its base. Igneous intrusions are present in the limestone also and give another point of difference from the occurrence at the Bonanza mine.

The largest exposure of ore known on this "extension of the Bonanza lode," as it is called, was found on the Marvelous claim. It consists of two bodies of chalcocite about 6 feet apart, with surface exposures approximately 5 by 8 feet and 4 by 7 feet, joined by stringers. A tunnel was started 100 feet below the outcrop on the east side of the shear zone to cut the ore at depth. A second tunnel 100 feet below the first was also started, but the work was discontinued. On the Hero claim chalcocite in small amount is found near a porphyry dike, but whether there is a genetic relation between the two is not known.

The Houghton Alaska Exploration Company has, besides other property, twelve lode claims on or near the "Bonanza fault" and a 160-acre placer claim on McCarthy Creek. These claims have been surveyed for patent, and patent proceedings are pending. Two of the claims are on the Bonanza fault. Others lie on cross faults intersecting the main fault at a large angle. A tunnel was started on a claim known as Slide No. 3 on the east side of the Bonanza fault, and is being driven in a nearly westerly direction to intersect the fault. At the close of the season (1908) 113 feet of tunnel was completed. An incline raise on a gouge seam was started in the tunnel and continued for 12 feet. It is believed by the operators that this tunnel will have to be continued for about 1,000 feet before striking the Bonanza fault zone. Besides work on the claims, a trail was built from the camp on McCarthy Creek to the tunnel, and sufficient work was done on the placer claim to satisfy the $500 patent requirement. The claims on the "Bonanza fault extension" lie at elevations ranging from 3,000 to 3,500 feet above McCarthy Creek, and consequently could be mined to that depth by an adit tunnel if ore is found in sufficient quantity. Under present conditions the cost of mining is great, and it is not intended to undertake any considerable development work until the railroad has cheapened transportation rates.

There was also some prospecting on the lower part of McCarthy Creek, but it was not learned just what work was done or what success was met.

NUGGET CREEK.

Two tunnels were projected on the Valdez claim in the summer of 1908. One, a little more than a quarter of a mile northeast of the old Valdez tunnel, on a fault plane believed to be the same as that exposed in the old tunnel, showed a well-marked plane of movement but did not disclose any considerable amount of copper minerals. The second tunnel was southwest of the old tunnel and lower down on the hill slope. It had been advanced 100 feet northwestward to strike the Valdez fault, but was not completed. The tunnel was driven in amygdaloidal greenstone, and the rock in places was found to be mineralized. It was believed that the ore body of the Valdez tunnel would be encountered within a few feet.

ELLIOTT CREEK.

The most important work of development on Elliott Creek was that done on the Elizabeth claim. It consisted of an extension of the main adit and the driving of drifts, which now have a total length of about 475 feet. A winze also was started in one of the drifts. Two calcite veins, one carrying iron and copper sulphides, were cut in the adit tunnel and probably represent the Elizabeth vein exposed at the surface.

KOTSINA RIVER.

Work was carried on in the Kotsina River valley by a number of companies, but information concerning the development of all the properties is not at hand. The most extensive operations were those of the Great Northern Development Company, which continued the work begun in the previous year. The four tunnels on Kotsina River west of Ames Creek were extended, as were also those on Ames Creek itself. No considerable bodies of ore are reported to have been cut, however. Work was continued at Iron Mountain, west of Strelna Creek, where the company has two tunnels with a total length of not less than 635 feet, in the larger of which there is a raise of 159 feet. At Copper Mountain, on Clear Creek, the company has done a little work on a vein of chalcopyrite 2 feet wide in mineralized country rock.

PLACER MINING.

Placer mining in the Chitina Valley is still confined to Dan Creek and Chititu Creek. Prospecting on Young Creek has shown the presence of gold in the gravels, but not in sufficient quantity to be of commercial value, at least with the present cost of mining.

The Dan Creek Mining Company, which holds the creek claims below the canyon of Dan Creek, employed the summer in preparing ground for the installation of a hydraulic plant and in prospecting its claims. The improvements on the property include a bobsled road 16 feet wide and 5,800 feet long, from the site of the proposed sawmill to Nizina River, and a wagon road 8,500 feet long, from the sawmill to the canyon. All the rock and gravel cuts were made 12 feet wide, and a bridge 14 feet wide, with a span of 30 feet, was constructed over Dan Creek. A site was cleared away on Boulder Creek for a power plant which will use the water of that stream for generating electric current to run the sawmill and for other purposes.

Ground and timber were also prepared for a dam above the canyon of Dan Creek to furnish water for hydraulic mining. About 50,000 feet of logs were cut for mining purposes. Besides this 11 shafts, with a total depth of 188 feet, were sunk to determine the amount and gold tenor of the gravels on certain claims.

Operations on Chititu Creek were in continuation of those of the previous year. Two hydraulic plants were in operation, but neither one completed a full season's run, for trouble was experienced in procuring labor and work was suspended probably two weeks earlier than the weather required. In consequence the output of Chititu Creek was smaller than the amount which other conditions justified the operators in expecting. The two hydraulic plants are now in good condition, and there is every reason to believe that the summer of 1909 will see a marked increase in the production of the stream.

CHISTOCHINA RIVER REGION.

The Chistochina region is situated in the southern foothills of the Alaska Range. It includes the streams tributary to the head of Chistochina River and adjacent to the glacier of the same name, and lies 35 miles north of Copper River, or 225 miles by trail from Valdez. Its early history and the occurrence of the gold have been described by Mendenhall,[a] and little can be added to his description. The country rock is slate, and the gold occurs in gravels consisting principally of slate but containing also a small proportion of the porphyritic and diabasic intrusives that cut the slate, as well as granite cobbles from some foreign source. The streams that have been productive during the last summer (1908) are Slate Creek, Miller Gulch, Middle Fork, Eagle Creek, and Chisna River. It is estimated that about 100 men have been engaged in work during the season, and that the production of the streams enumerated above is $68,000. Development on Chisna River and Daisy Creek has consisted of prospecting and ditch construction, but the regular pick and shovel work was done on the other streams. It was found that some of the bench gravels of Daisy Creek are frozen and that steam points will be required in winning the gold from them. A thawer and an hydraulic plant for exploiting ground on both Daisy Creek and Chisna River will be installed in 1909.

VALDEZ CREEK.[b]

Valdez Creek is one of the small headwater tributaries of Susitna River. (See fig. 15.) It rises in the foothills of the Alaska Range and flows in a general southwesterly direction for about 12 miles. It is approximately 160 miles north-northwest of Valdez, or 120 miles directly south of Fairbanks. It lies in a region difficult of access and consequently not well known.

Although the creek is a tributary of SusitnaRiver, the trails most frequently used for reaching it approach the stream from the Copper River valley. Two trails are in use. One leaves Copper River at the mouth of Gulkana River and follows that stream to the head of its western fork. Crossing the divide to the Susitna drainage basin, it descends McLaren Creek to Susitna River and then turns northward, going up the river to the mouth of Valdez Creek. This trail traverses a broad, flat area, swampy and dotted with lakes so that traveling is difficult at many places. The second trail follows the southern foothills of the Alaska Range westward to Valdez Creek from Paxton's road house, between Gulkana and Summit lakes on the Valdez-Fair-

[a] Mendenhall, W. C., Geology of the central Copper River region, Alaska: Prof. Paper U. S. Geol. Survey No. 41, 1905, p. 107.

[b] The notes here given were obtained from prospectors who came out from Valdez Creek to the coast in September, 1908.

banks trail. This trail was used during last summer (1908), and is said to offer many advantages over the more southern one. Food and mining equipment for Valdez Creek have usually been taken in over the southern trail in winter, but in 1908 contracts were made for the delivery of freight by boat at the head of navigation on Susitna River, whence it was to be taken overland to Valdez Creek with horses. The trip from Valdez Creek to the mouth of Indian River was made in the fall of 1908 in eleven days with horses, the distance being

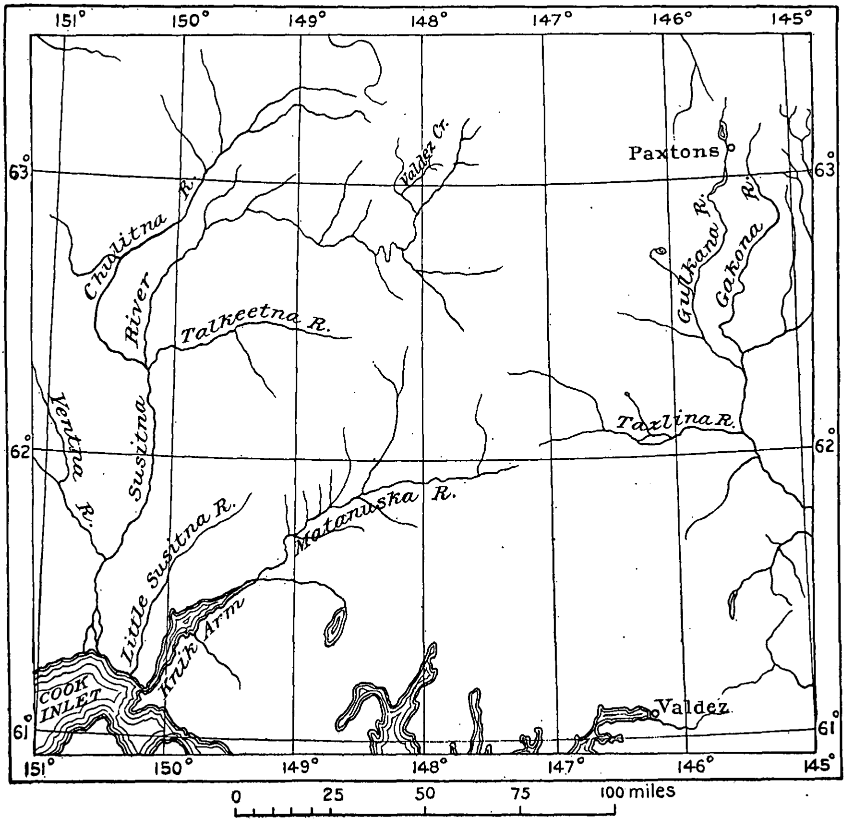


FIGURE 15.—Sketch map showing location of Valdez Creek.

approximately 90 miles. Eldridge has stated[a] that Susitna River is probably navigable for light-draft stern-wheel steamers for a distance of 130 miles above its mouth, which would be to a point near the mouth of Indian River. In July, 1898, the little steamer *Duchany*, drawing about 2 feet of water, ascended the Susitna to a point within 12 miles of Indian River. It is believed, however, that this would not be possible later in the summer. A light steamer drawing 2 feet of water could probably reach the Talkeetna, 87 miles from Cook

[a] Eldridge, G. H., A reconnaissance in the Sushitna Basin and adjacent territory, Alaska, in 1898: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 7, 1898, p. 10.

Inlet, at nearly all stages of open water, but it could traverse the remaining 35 miles to Indian River only on high water. When once established, this more direct route will doubtless result in a great saving of both money and time.

The excessive cost of freighting supplies into the region has hindered the development of mining and has prevented prospecting to a great degree. The average cost of supplies under present conditions is not far from 50 cents a pound, and the price paid for labor is $1 an hour without board.

The present importance of Valdez Creek lies in its gold placers, discovered in 1903. It is estimated that these placers have produced between $175,000 and $200,000. Mining is practically restricted to two localities on the creek—Lucky Gulch and the vicinity of Discovery claim at the mouth of Willow Creek. The productive area is a small

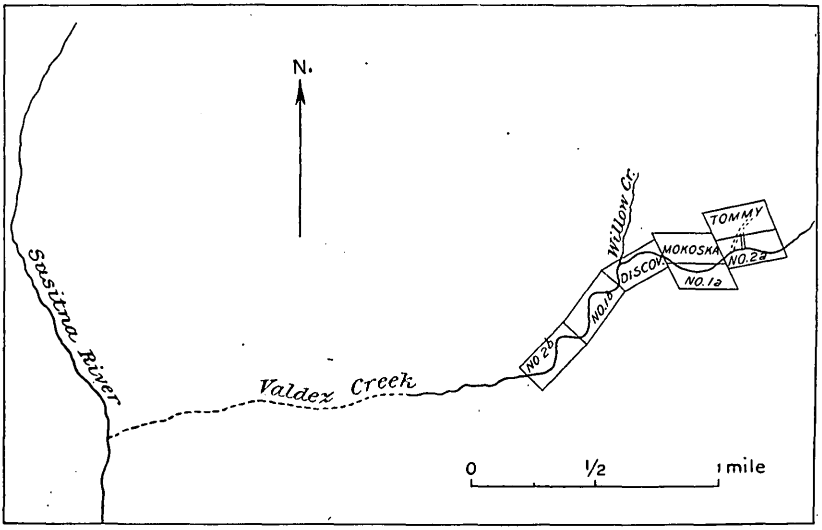


FIGURE 16.—Sketch map of Discovery and neighboring claims on Valdez Creek.

one, and though a large number of claims have been staked, only a few have contributed to the estimated output given above. Figure 16 shows the relation of the better-known claims.

Valdez Creek has cut its present channel through deep gravels and has intrenched itself in the underlying schist bed rock. On claim "No. 2 above" the bench bordering the creek has a height of 170 feet. The lower 60 feet is rock, leaving a thickness of 110 feet of gravel.

Gold is found in the creek gravels and in the bench gravels. A considerable portion of that in the creek is probably derived from the benches and is therefore a product of secondary concentration. Gold is not distributed in paying quantity throughout the bench gravels, nor uniformly over the bed rock, but occurs in a well-defined pay streak—an old channel occupied by the stream before its present rock-walled channel was cut. The two channels intersect each other on claim "No. 2 above," the old channel being 60 feet above the present one. The portion of the pay streak or old channel on claim "No. 2 above" is mined directly from the face of the bench, but the values of the Tommy claim are recovered through a tunnel starting from the bench face and crossing low-grade or barren ground of "No. 2 above." The entrances to these workings are of course 60 feet above the creek. Gold is found in paying quantities in the lower 5 feet of gravel and in the upper 2 feet of the schist bench on which the gravel rests. The average width of the pay streak is 40 feet, and it has been exploited for a distance of about 400 feet from the face of the bench.

A hydraulic plant was installed on Valdez Creek below Willow Creek in 1908, but until that time most of the work of washing the gravels had been done by hand methods. This plant includes a pipe line with two giants and an elevator. For the most part Valdez Creek affords good dumping ground for tailings, but unfortunately an elevator is required at the locality where this plant is in operation.

The gravels of Lucky Gulch are shallow, averaging about 4½ feet in depth. There is much coarse gold in the product of this gulch, nuggets ranging from $5 to $50 being frequently obtained. The largest yet discovered had a value of $970. Lucky Gulch is reported to yield about $40 a day to the man.

The total number of men engaged in mining on Valdez Creek during the summer of 1908 is estimated to be about 120, of whom 20 expected to remain on the creek during the winter. With better facilities for carrying in supplies, the number of men employed by the operators will doubtless be increased.

MINERAL RESOURCES OF THE NABESNA-WHITE RIVER DISTRICT.[a]

By Fred H. Moffit and Adolph Knopf.

INTRODUCTION.

The district of which this paper treats lies on the northeast side of the Wrangell Mountains and includes the headwaters of Copper, Tanana, and White rivers. Nearly all of the area is within the rectangle formed by parallels 61° 40′ and 62° 40′ north latitude and meridians 141° and 143° 20′ west longitude. Like the district south of the Wrangell Mountains, it has attracted the attention of prospectors and miners through reports of wonderful copper deposits. These reports have originated partly in stories told by Indians and partly in accounts of ornaments and implements found in their possession by the early explorers.

The region is difficult to reach, and supplies are not easily obtained, yet the search for valuable minerals has been carried on by a few men since shortly after the discovery of gold in the Klondike, and it was to aid in the development of the mineral resources that the surveys of 1908 and of previous years were undertaken.

The work on which this paper is based was a continuation and extension of the work begun by F. C. Schrader and D. C. Witherspoon, of the United States Geological Survey, in 1902, and Mr. Schrader's field notes and maps have been used freely in the field and office studies. During the course of the summer all the better-known prospects on the northeast side of the Wrangell Mountains and in the Alaskan portion of the White River valley were visited, and the geologic and topographic mapping begun by Schrader and Witherspoon was extended down White River to the international boundary. In this work the writers were assisted by S. R. Capps, whose time was given chiefly to topographic mapping, but who also helped in geologic work during the earlier part of the season.

The party consisted of seven men and was equipped with a pack train of eleven horses and the usual camp outfit. Supplies for the

[a] This paper is a preliminary statement of the results of a geologic and topographic reconnaissance survey made in 1908, concerning which a more comprehensive report is in preparation.

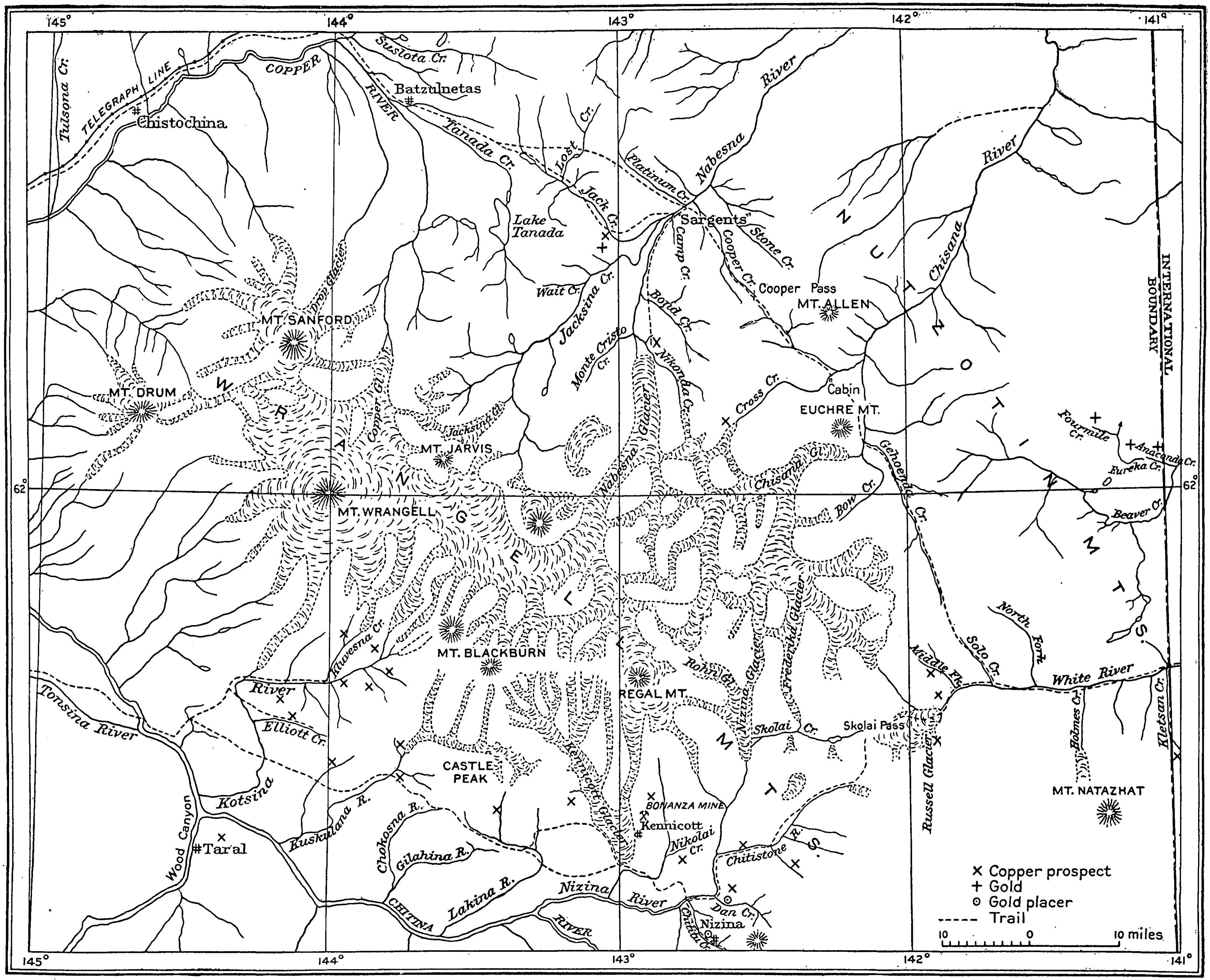
summer's needs had been taken in over the snow and stored at "Sargent's cabin," on Nabesna River, late in February, 1908, so that when the party left in June it was necessary to carry only provisions sufficient for the trip into the interior. Field work began on Nabesna River, July 8, and was ended on White River, August 25, when Skolai Pass was crossed and the return trip to Valdez was begun. Thus only forty-seven days were available for field study on the northeast side of the Wrangell Mountains, but ten days additional were spent on Nizina River before the season's work ended.

GENERAL DESCRIPTION OF THE DISTRICT.

GEOGRAPHIC FEATURES.

The Nabesna-White River district lies in a region of rugged topography, as it includes not only the northeast slopes of the Wrangell Mountains and the north slope of that part of the St. Elias Range which lies between Skolai Pass and Mount Natazhat, but the Nutzotin Mountains also. (See Pl. VII.) The principal peaks within the area range from 6,000 to 12,000 feet in elevation, but on the whole those of the Nutzotin Mountains are lower than those to the west and south. Furthermore, they do not possess such great snow fields and their valley glaciers are much less prominent, both in number and extent. Between the head of Copper River on the northwest and the international boundary line on the southeast three principal streams with sources in the Wrangell and Skolai mountains cross the Nutzotin chain in a northeasterly direction to the lowlands beyond, and there join the Tanana or the Yukon. They are the Nabesna and Chisana,[a] which unite to form Tanana River, and the White, which empties into the Yukon about 75 miles above Dawson. The valleys of the Nabesna and Chisana are narrow and canyon-like. That of the White is broader and less shut in by the mountains, for though it is limited by the lofty snow-covered St. Elias chain on the south, the Nutzotin Mountains immediately north of the river are made up of low rounded and flat-topped hills with summits for the most part less than 3,000 feet above the valleys. The valley floors are broad gravel flats ranging in width from a quarter of a mile or less to 8 or 9 miles, as on White River, near the boundary line. These streams have their sources in the broad snow fields of the Wrangell-St. Elias chain, and like all glacial streams are exceedingly changeable in the amount of water they carry, rising and falling with a daily variation, as well as that depending on season and the irregularities of precipitation. They are heavily burdened with débris brought

[a] The name of the river called Chisana on Witherspoon's map of 1902 is usually pronounced by the prospectors as if it were spelled Shushana. Its exact pronunciation as given by the natives is difficult to determine.



MAP OF THE REGION OF THE WRANGELL AND NUTZOTIN MOUNTAINS.

down by the glaciers, and the deposition of their overload has built up the wide gravel flats of the valley floors.

In the late fall of 1908 the surveyors sent out by the United States and Canadian governments located the position of the international boundary line on White River. It proved to be a short distance east of the mouth of Kletsan Creek, or about 3 miles farther west than it was formerly supposed to be. During the summer of 1909 the line will be permanently marked with the usual monuments, and the custom of recording claims in both Alaska and Yukon Territory when their location is doubtful will no longer be necessary.

TRAILS.

There are three routes by which the Nabesna-White River region may be reached. Prospectors usually approach Nabesna River from the northwest by a trail that leaves the military trail from Valdez to Eagle near the mouth of Slana River. It ascends Copper River to Batzulnetas, whence it continues southeastward to the heads of Jack Creek and Platinum Creek, either of which leads directly to the Nabesna, although Platinum Creek offers the better route for summer travel. After leaving Batzulnetas the trail bears to the east and follows the ridge northeast of Tanada Creek. This portion of the trail is a little hard to pick up at Batzulnetas because of the presence of numerous Indian trails, but when once found it can be followed with little difficulty except that much of it is exceedingly swampy, although possibly no worse than some stretches of the government trail between Tonsina and Copper Center, or between Gakona River and Chistochina. The distance from Slana River to "Sargent's," on Nabesna River at the mouth of Camp Creek, is approximately 40 miles by way of Platinum Creek, and a few miles farther by way of Jack Creek.

The customary route of travel followed by prospectors in entering the White River region is either from the east through Canadian territory or, less commonly, from the Chitina Valley on the southwest by way of Skolai Pass. There is a choice of two Canadian routes, dependent on the means of transportation which it is desirable to use. White River may be ascended from the Yukon in small boats, or the overland trail may be followed from White Horse by way of Kluane Lake. This last-named trail is probably the easiest and best way of reaching either White or Nabesna River with stock in summer, and the best way of reaching White River with stock at any season. A wagon road leads from White Horse to Kluane Lake, a distance of 142 miles, and thence a good trail approximately 120 miles long leads to "Canyon City," on the north side of White River a few miles below the boundary line. Prospectors often bring their supplies up White River from Dawson in poling boats or by tracking, and most of them leave the country by boat in the fall, as it gives them an easy and quick method of reaching the Yukon.

The route from Chitina River by way of Skolai Pass is not regularly traveled, but is used by a few prospectors who have claims in both the Chitina and the White valleys and cross over from the south to do their assessment work. During the earlier days of its use the trail extended over the lower end of Nizina Glacier from a point on the west side about 4 miles above the head of Nizina River to the mouth of Skolai Creek, whose north bank it followed to the pass. At present this trail along Skolai Creek is not used, as Nizina Glacier is so traversed with crevasses as to be practically impassable, and though horses have been taken high on the mountain around the east side of the small lake formed by the damming of Skolai Creek by Nizina Glacier the climb is so great and so difficult that it has been attempted but a few times. Travelers now ascend Chitistone River to its head and cross a broad, high pass with abrupt northern slope to the foot of Russell Glacier, which occupies Skolai Pass, and thence reach the head of White River. This trail will be described in a little more detail, in the hope that such a description may possibly benefit some one who has occasion to use it. It must be borne in mind, however, that the condition of a glacier changes from year to year and that a route followed this year may be impassable next year. In crossing with horses from White River to Skolai Creek, the north side of the glacier should be followed as closely as possible. The top of the "moraine," the débris-covered east end of the glacier, is gained by ascending one of two or three narrow gulches that drain the surface. These gulches are located somewhat north of the central front of the moraine and lead with an easy grade to the summit. When once fairly on top, the traveler will not find it difficult to follow the ill-defined trail or to pick a way across the moraine to the bare ice, a distance of 2 or possibly 3 miles. Little direction can be given for crossing the bare ice further than to follow as closely as possible its north side and not to get out on the middle. The lobe of the glacier at the head of Skolai Creek is greatly crevassed and terminates in an abrupt face or wall not less than 25 feet high at the lowest point. With a little difficulty horses can be taken off the glacier at a point a short distance east of the source of Skolai Creek, but they could not be taken on there without a great deal of work. A better way is to leave the glacier at some point farther east, along the side of Castle Mountain, but it is difficult to describe the proper place where this may be done. From six to eight hours' time are required in crossing the glacier. After leaving it the traveler should immediately cross to the south side of the Skolai Creek valley, being careful to avoid quicksand. If it is needed, a camping place with feed for horses and willows for firewood is available on the low bench above the river flat, at the foot of the steep 1,400-foot climb to the pass between Skolai Creek and Chitistone River. For the first mile or two after crossing the summit traveling is easy, except that care must be taken to avoid soft ground. The greatest difficulty to be overcome on Chitistone River is encountered several miles below the summit, where a high climb over loose talus slopes is necessary to avoid the deep canyons of the river's northern tributaries. This portion of the trail, as well as the glacier in Skolai Pass, should not be attempted after the first winter snows have fallen. Only light packs should be carried, and two days should be allowed for completing the trip, unless the traveler is perfectly familiar with the trail.

The trail from Nabesna River to White River traverses the depression between the Wrangell and Nutzotin mountains. It ascends Cooper Creek, following its eastern fork to the head of Trail or Notch Creek, down which it leads to the Indian village on the south side of Copper or Cross Creek, and thence southeastward across the low timbered point to Chisana River and the mouth of Gehoenda Creek. From Chisana River the trail follows Gehoenda Creek to its head and, keeping close along the lower slope of the mountains on the west, crosses a broad, open divide to the head of Solo Creek, and thus to White River.

Supplies intended for use in this region should be taken in during the winter unless it is intended to bring them up White River in boats. The cost of freighting either from Valdez to Nabesna River or from White Horse to Canyon City is probably not less than 35 cents a pound when conditions are favorable, and may be considerably more.

WORKING SEASON.

The climatic conditions here are those of interior Alaska. Separated from the Pacific by a broad belt of lofty mountains, the region is outside of the immediate influence of the ocean, with its tendency to increase precipitation and minimize the temperature variations. The rainfall is moderate in summer and the winter snows are not excessive. Feed for horses is good in May or early June. On some of the river bars there is an abundance of grass, particularly on upper Nabesna and White rivers. For several years horses have even wintered on the White River bars. Prospectors using stock leave Nabesna River for Valdez at the end of a summer's work about August 25, or not later than September 1, but those on White River remain till October without danger of lack of feed on the trail to White Horse. Thus the working season on White River is considerably longer than on the Nabesna or anywhere in the Copper River basin.

GAME.

Game is plentiful throughout this area. Sheep can be found at the heads of almost any of the streams. In the early spring they feed in the main valleys, but as the summer season advances they work farther and farther back into the higher mountains and seem to choose especially the vicinity of the glaciers. Caribou, although not present in such great numbers as in the Tanana-Yukon country, are frequently seen on the low hills north of White River, and can often be got with little difficulty. Moose in considerable numbers range the flats bordering White River. Black and grizzly bears are numerous, and the natives take a quantity of furs each year—fox, lynx, marten, and mink. A few ptarmigan are found in the higher untimbered valleys.

NATIVES.

The total native population of the area extending from the head of Copper River to White River is probably not far from 45 or 50. The natives are divided between three villages, if such they may be called—one at Batzulnetas on Copper River, one at the mouth of Cooper Creek on Nabesna River, and a third on Cross Creek opposite the mouth of Notch Creek, in the Chisana Valley. The Batzulnetas and Nabesna natives seem to rely on the white men for a considerable portion of their food, but the Chisana natives are more independent. Their more isolated position has brought them less into contact with white men, and they have retained their own manner of living to a greater extent. They depend almost entirely on game for food, and lay up a good supply each fall for the winter's use. All these natives wear clothing obtained from white men, except their moccasins, which they make themselves. Tea and tobacco also are in great demand and can always be used in trade.

GENERAL GEOLOGY.

Both igneous and sedimentary rocks are present in the Nabesna-White River region. In a broad way it may be said that the rocks of the Wrangell and Skolai mountains are prevailingly igneous, although they are associated with important water-laid rocks, and that those of the Nutzotin mountains are prevailingly sedimentary, although igneous rocks are locally prominent. Thus the depression between these two mountain chains separates an area on the southwest characterized chiefly by the results of volcanic activity from one on the northeast characterized chiefly by the accumulations due to sedimentation. The following table gives the important features of the stratigraphic column so far as they are known:

Generalized geologic section of Nabesna-White River district.

Quaternary	Gravels, till, and other unconsolidated deposits.
Tertiary	Volcanic rocks.
	Lignitiferous formation including shales, sandstones, lignite beds, etc.
Jurassic	Shales of Jacksina River.
	Shales, slates, and graywackes of the Nutzotin Mountains.
Triassic	Thin-bedded limestones of Cooper Creek.
Carboniferous or later	Lavas and pyroclastic rocks, tuffs, etc.
	Shales.
Carboniferous	Massive limestone.
	Shales.
	Basic lavas and pyroclastic rocks.

These rocks are not known to be present in a continuous section at any one locality, and the table as given is made up from data collected at various places. All the consolidated rocks are cut by dikes and sills of basic igneous rock, mostly of a basaltic or diabasic nature. The Carboniferous sediments have been further intruded by large masses of quartz diorite and by diorite porphyries and andesites. Whether these more acidic intrusions extend into the Triassic and Jurassic sediments was not determined. In other words, the quartz diorites and diorite porphyries are known to have been intruded after the deposition of the Carboniferous shales and limestones, but it is uncertain whether they were intruded before or after the Triassic beds were laid down.

As is shown by the table, the oldest known rocks of the region are of Carboniferous age. The most conspicuous member of the Carboniferous succession is a massive limestone, highly fossiliferous, ranging in thickness from not less than 200 to 500 or more feet. It is exposed on the mountain sides south of White River and is seen at various places along the northeastern slope of the Wrangell Mountains from Skolai Pass to the head of Jack Creek. It should be stated, however, that the correlation of some of the limestone areas of the Wrangell Mountains is based on field relations rather than on fossil evidence. The massive limestone is underlain by fossiliferous shales or slates of Carboniferous age and by lava flows. Immediately above it, as seen at Skolai Pass, are about 300 feet of shales with intruded diabase sills. These shales, from which no fossils were collected, appear to lie on the limestone conformably and are overlain in turn by a great thickness of tuffs and lava flows. About 4 or 5 miles north of Skolai Pass this succession of volcanic rocks includes water-laid tuffs and conglomerates, as well as diabasic and andesitic flows, and is intruded by light-colored diorites. The evidence for the age of the shales overlying the limestone is not conclusive, but they are nevertheless included provisionally with the Carboniferous sediments because of their seeming conformity with them.

The Carboniferous beds are folded and locally are highly metamorphosed. This difference in the amount of metamorphism at different localities is noteworthy, for in some places, as at a few of the exposures on White River, the limestone seems scarcely to have suffered change, whereas in others, as on Notch Creek, it is completely altered to a fine white marble. This extreme alteration can readily be explained, however, as an effect of the diorite intrusion with which it is associated. The effect of this intrusion is further seen in the region of Orange Hill and at the Fjeld gold property on Jacksina River, where mineralization of contact-metamorphic order is one of its immediate results.

The known Triassic sediments consist of thin-bedded limestones occupying a single small area in the ridge between the two forks of Cooper Creek. They have been greatly disturbed both by folding and by faulting, and their relation to the near-by Carboniferous limestones and the Jurassic shales was not determined.

The Jurassic sediments comprise banded slates and shales, together with smaller amounts of arkose or graywacke, conglomerate, and thin limestone beds. In places they are intruded by basic igneous rocks, principally diabase, in the form of dikes and sills. A small area of fossiliferous Jurassic shales was found near the mouth of Jacksina River, but Jurassic sediments are developed mainly in the Nutzotin Mountains, where, so far as known, they make up the greater part of the chain. In most places the bedding of the Jurassic rocks is easily distinguishable. The beds are folded and are locally metamorphosed, with the production of a slaty cleavage. Small veins of calcite and quartz are numerous, and some of them are known to carry gold. The succession of banded slates and arkoses exhibited in the Nutzotin Mountains, even when allowance is made for possible reduplication of beds due to folding, must have a great thickness, for it is exposed in a belt whose average width is not less than 15 miles. The sediments are only slightly fossiliferous, and the fossil localities found are few, so that the presence in this range of rocks other than those of Jurassic age is entirely possible.

The Tertiary sedimentary deposits, so far as they are known, are confined to a small area near the international boundary, a few miles north of White River. They comprise sandstone, shale, and conglomerate with thin lignite beds, all lying in a nearly horizontal position and cut by basaltic dikes. Furthermore, they appear to be covered locally by lava flows. No fossils were collected from them and their age was not definitely determined.

To the Tertiary period is also assigned a vast quantity of the younger volcanic rocks, chiefly dark vesicular lavas that are best seen in the northern part of the area. These flows are most abundant on the slopes of Mount Wrangell and Mount Sanford, but are less well developed to the southeast and seem to be present only in the highest parts of the mountains. They differ from the older lavas in being entirely fresh and unaltered. Their extrusion is thought to have begun some time in the Tertiary period and to have continued to very recent time,[a] for in places they rest upon unconsolidated gravel deposits.

The Quaternary deposits include the unconsolidated materials occurring throughout the region, and also a part of the lava flows mentioned in the preceding paragraph. The unconsolidated deposits consist principally of stream gravels, till, and other rock material deposited by the glaciers, volcanic "ash," and unassorted débris resulting from rock weathering. In this region much of the material composing the broad gravel flats built up by the streams was originally laid down by glaciers, but has since been transported and redeposited by water, so that indirectly a very large part of the unconsolidated deposits may be considered as of glacial origin. Glacier and stream deposits together constitute the major part of the Quaternary. A conspicuous member of the unconsolidated materials is made up of white volcanic ash and is best developed in the White River region, where it forms immense drifts on the lower slopes north of Mount Natazhat and is present in a bed 30 inches thick overlain by 8 feet of peat on the gravel benches bordering the river. It is found in an easily distinguished bed from 6 to 10 inches thick as far north as Chisana River, but was not noticed on the Nabesna. It consists chiefly of fine white pumice, inclosing a large number of tiny hornblende crystals and biotite. Occasionally pieces of pumice several inches in diameter are found on the river bars, but in the undisturbed beds pieces half an inch in diameter are exceptional. The source of this material is not known, but it is thought to have come from a volcano somewhere to the south of White River.

The Nabesna-White River region is one of profound glaciation, whose existing glaciers are but small remnants of those that have gone before. Till and other glacial deposits high above the valley floors give abundant evidence of a former ice extension which was far greater than that of the present and during which most or all of the valleys were filled by the ice and many hills of considerable height were buried beneath it.

MINERAL RESOURCES.

INTRODUCTION.

The mineral resources of the upper White-Nabesna region that have attracted the attention of the prospector are copper and gold, and, in an incidental way, zinc, lead, and lignite. The probable

[a] Mendenhall, W. C., Geology of the central Copper River region, Alaska: Prof. Paper U. S. Geol. Survey No. 41, 1905, p. 57.

occurrence of native copper has long been surmised from the reports of the Indians. As early as 1891, the year in which the upper White River country was first penetrated by white men—an exploring party of three, one of whom was C. W. Hayes, of the United States Geological Survey—astonishing Indian stories concerning the enormous quantities of native copper found in that region were told to the members of the expedition while at Fort Selkirk, on the head of the Yukon.[a] During the trip up White River and over Skolai Pass, which was made by back packing and which consequently allowed but a casual examination of the line of travel, nothing, however, was seen to support the exaggerated statements of the Indians; but it was definitely ascertained that some placer copper was present on Kletsan Creek near the international boundary. From 1898 onward, in response to Indian reports which had in popular esteem invested the upper White River country with mineral wealth of a vastness in proportion to its remoteness and inaccessibility, prospectors kept coming into the region in search of native copper and gold.

The first published description of copper as a prospective resource was given by Brooks,[b] who hastily traversed this belt in 1899 as geologist accompanying the Peters exploring expedition and who came to the conclusion from the abundance of copper indications "that this upper region is one that is worthy of careful investigation by the prospector and the capitalist."

In 1902 a placer-gold stampede brought an influx of prospectors into the upper White River country, but as no paying quantity of precious metal was discovered the majority soon left for more promising fields. The few that stayed turned their attention to the copper resources of the region, many of them being incited to this search by the prevalent Indian reports of large deposits of native metal.

In 1905 reports of fabulously rich deposits of metallic copper in the headwater region of Nabesna River were widely circulated in the public press. Examination in the field shows that these statements rest on but a very slender basis.

COPPER.

GENERAL CONDITIONS OF OCCURRENCE.

The reported presence of native copper in vast quantities was, as already pointed out, the original incentive that drew the pioneer to the White-Nabesna region. Prospecting in search of these deposits has shown that copper in its bed-rock sources is widely distributed in

[a] Hayes, C. W., An expedition through the Yukon district: Nat. Geog. Mag., 1892, pp. 117-162.

[b] Brooks, A. H., A reconnaissance from Pyramid Harbor to Eagle City, Alaska, including a description of the copper deposits of the upper White and Tanana rivers: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 2, 1900, p. 382.

the form of sulphides (chalcocite, bornite, and chalcopyrite), and on the basis of the facts revealed by the little development work that has been done it may be stated that most of the native copper found in the region is an oxidation product of those sulphides. In mode of occurrence the copper ore shows two different habits, geologically distinct. In one, so far the better known, it occurs associated with the Carboniferous basaltic amygdaloids, and in the other it is found in limestone at or near the contact with the dioritic intrusives.

Native copper occurs as nuggets in the gravels of many of the streams, and green-coated lumps of metal up to 5 pounds or more in weight are occasionally found in the wash of creeks draining areas of amygdaloid bed rock. This stream copper was the source from which the Indians obtained their supply when it was an object of barter among them. From the accounts of Hayes and Brooks, Kletsan Creek appears to have been the placer locality best known to the natives.

Metallic copper occurs also in the surface croppings of sulphide deposits in the amygdaloids, where it is undoubtedly an oxidation product of the sulphides that appear in depth. In such places it is directly associated with the dark-red oxide (cuprite) and more or less green carbonate. At the prospect known as "Discovery," which is located in Canadian territory on White River a few miles below the international boundary, a large slab of native copper averaging 8 by 4 feet by 4 inches thick and weighing probably close to 6,000 pounds has been uncovered in the slide rock. A number of other sheets of copper up to several hundred pounds in weight have been found in the near vicinity. On account of the stimulus that this find has exerted on the prospecting of the adjacent American territory, the occurrence merits some description in this report. The stripping of the bed rock near the great nugget exposes a face of green basaltic amygdaloid 20 feet high and 15 feet wide. The rock is traversed by numerous seams of native copper along fractures and slickensides, but toward the bottom of the open cut stringers of chalcocite begin to appear. About 150 feet from this prospect an opening on an independent occurrence shows stringers of cuprite with admixed copper, stringers of glance and calcite, and chalcopyrite disseminated through the amygdaloid country rock. From these features it is clear that the metallic copper of this deposit is a superficial oxidation product of sulphides, that its downward extension is small, and that the prevailing sulphide at greater depth will probably turn out to be chalcopyrite.

At a few localities native copper is associated with certain highly amygdaloidal portions of the Carboniferous basalts and intergrown with the white minerals that fill the former steam cavities in the ancient lava flows. Slaggy-looking portions produced by the weathering and removal of the amygdules from the lava and amygdaloid that is cut by small irregular veinlets filled with the same minerals as those forming the amygdules appear to be the most favorable places for metallic copper. The copper in the vesicles and stringers is associated with calcite and delicately spherulitic prehnite, but in some of the veinlets calcite, prehnite, quartz, a black lacquer-like mineral, partly combustible, and chalcocite, instead of metallic copper, are associated together.

At a number of places throughout the region narrow stringers of chalcocite cutting the ancient basalts are encountered, but so far as known none have any great persistence. Near the head of Cross Creek, locally known as Copper Creek, a thin quartz-chalcopyrite vein cutting the bedded volcanic rocks has been discovered. At other localities some irregularly disseminated sulphides, in some places chalcocite, in others bornite, occur in the basalts, but these do not appear to be connected with definite vein or lode systems and are consequently of an unencouraging character. Oxidation of these sulphides and disintegration of the containing rock give rise to the nuggets of cuprite and native copper that are found in the talus slopes at several places in the region.

In contrast to these occurrences, which, as shown by the foregoing discussion, are limited to the ancient basalt flows, copper is found as bornite and as chalcopyrite intergrown with contact-metamorphic rock in limestone adjoining diorite intrusives. In deposits of this type the ore mineral is associated with garnet, coarsely crystalline calcite, epidote, specular hematite, and scattered flakes of molybdenite. The garnet is commonly crystallized in dodecahedra and is intimately intergrown with the bornite and chalcopyrite. On account of its weight and especially its appearance, which is not unlike that of cassiterite, it was mistaken for tin ore by some of the early prospectors. Only two deposits of this character were seen in place, but evidences of energetic contact metamorphism were detected at a number of other localities. An extensive contact zone has been produced along the junction of the diorite and the massive limestone exposed on the ridge west of Copper Pass. Various contact-metamorphic rocks, pyritiferous as a rule, are present in this zone, and these rocks on oxidizing give rise to large iron-stained outcrops, which contrast strongly with the surrounding white limestone. In connection with the discussion of the contact-metamorphic deposits it may be stated that the writers were shown some specimens of copper ore containing abundant large octahedra of magnetite and blebs of chalcopyrite in a gangue of coarse calc spar. This ore was undoubtedly obtained from the vicinity of an intrusive diorite-limestone contact, but whether commercially valuable ore bodies of this character exist in this region, which is so remote from transportation facilities, is yet to be demonstrated, in view of the fact that copper deposits of contact-metamorphic origin are characteristically bunchy and low grade.

NABESNA RIVER.

Near the head of Nabesna River and below Nikonda Creek some work has been done on a prospect (the Shamrock claim) situated 2,000 feet above the floor of the valley. The stripping of the talus from the base of the massive Carboniferous limestone has disclosed a large, irregular body of massive garnet rock containing some disseminated bornite and chalcopyrite. Here and there a little molybdenite can be detected. Veinlets of garnet traverse the surrounding coarsely crystalline white limestone. At the time of examination the best exposure of visible ore was a body of solid bornite 4 or 5 inches thick and perhaps a foot long.

On Jacksina Creek the same limestone is intruded by diorite and cut by a large number of diorite dikes. Considerable contact metamorphism has resulted and large garnet masses, locally rich in chalcopyrite, were produced. The metamorphic action was of selective character, certain limestone beds being converted into garnet, whereas others were changed to tabular masses of white silicates. These relations are exposed with diagrammatic clearness in the limestone cliffs. The copper-bearing rock, in typical specimens, consists of garnet, much of it finely crystallized in dodecahedral form, calcite, chalcopyrite, and some specular hematite. The present indications show that the ore occurs rather in a number of scattered bunches than in a single large workable deposit.

CHISANA RIVER.

At the head of Cross Creek, several miles above the lower end of the glacier, a thin quartz-chalcopyrite vein cutting the andesitic lavas and breccias has been discovered, but most of the information concerning it is derived from fragments of ore found in a talus slope 600 feet high. A little galena is associated with the copper mineral. In the same vicinity some outcrops of zinc ore, a resinous sphalerite with scattered galena, have been found, but the exposures are poor on account of the covering of slide rock.

Native copper can be found in some of the streams in the amygdaloid area between Cross Creek and the Chisana. There are also indefinite Indian reports that rich deposits of native metal occur in the mountains bordering Chisana Glacier, but the exact locality has not yet been discovered.

WHITE RIVER.

At the head of the middle fork of White River, a large tributary entering from the northwest 5 miles below the head of the main stream, some claims have been staked on outcrops of rock carrying native copper. Two small open cuts 1,450 feet above the stream were seen on the Copper King claim. The country rock at this locality consists of stratiform basalts of Carboniferous age intercalated with beds of breccia and brick-red tuffs, striking N. 85° E. (magnetic) and dipping 18° S. into the mountain. Native copper is apparently limited in its occurrence to a certain definite volcanic sheet—a reddish lava that is locally amygdaloidal to a high degree. For 200 feet along the outcrop of this sheet metallic copper intergrown with prehnite, calcite, and zeolites can be found here and there in encouraging amounts. The thickness of the cupriferous portion of the amygdaloid appears to be about 6 feet, but as almost no development work has been done on the property figures of this kind have little value. The copper occurs as irregular reticulating masses of metal several inches long and as small lumps and minute particles embedded in the minerals that fill or line the former vesicles in the lava flow. In places these minerals ramify in the shape of small veinlets through the body of the rock surrounding the amygdules, or form irregular masses, and such places are eminently favorable for metallic copper.

This occurrence is the only one seen during the summer in which the native copper appears to be of undoubted primary origin. If the ore shown on the surface has any downward extension, a fact which can be established only by actual exploration, it can be predicted with a high degree of confidence that metallic copper also will persist downward. To this extent the surface indications are distinctly favorable. Some doubt as to the probable amount of ore may well be entertained in view of the character of the deposits. It is well known that native copper associated with zeolites filling amygdules in basaltic lavas is found throughout the world in widely separated localities—the Faroe Islands, the trans-Baikal region, Brazil, Queensland, and Lake Superior—yet only those from the Lake Superior region have yielded ore bodies of commercial value.

On Moraine Creek, a small stream in a glacier-filled valley on the east side of Russell Glacier, a number of claims were staked during 1907 and 1908. The bed rock here also consists of green and reddish amygdaloids, with associated breccias striking N. 85° W. (magnetic), but dipping 55° S. at an angle considerably steeper than on Middle Fork. In some places it can be seen that the upper portion of a lava sheet is more highly amygdaloidal than the rest of the flow. Malachite-stained fragments of rock can readily be found in the talus slopes. Copper occurs in place in small seams cutting the amygdaloid, the veinlets consisting of spherulitic prehnite and calcite, flecked with red metal and chalcocite. There are also small stringers composed of quartz, prehnite, a black combustible mineral (a solid hydrocarbon?), and chalcocite. It seems probable that the native copper and chalcocite are of contemporaneous origin. At another point on Moraine Creek the lava, in addition to containing white amygdules of zeolite, carries irregular blebs of chalcocite, which give the rock somewhat the appearance of a glance-bearing amygdaloid. Such development work as has been done on Moraine Creek indicates that the amygdaloidal phases of the basalts here, too, are the most favorable, and are likely to be found along the contacts of successive lava flows. As the superimposed sheets of lava commonly differ in color and texture the contacts can easily be located.

Near the head of White River similar Carboniferous volcanic rocks form the west wall of the valley. They consist of basaltic tuffs, breccias, amygdaloids, and porphyritic sheets, dipping 10° N. The colors of the lavas are dark red-browns and greens. A number of prospects have been located on chalcocite croppings a few miles below the edge of the moraine of Russell Glacier. In the main, these outcrops consist of small bodies of shattered amygdaloid permeated with seams of chalcocite. At one prospect a thin glance stringer an inch or so in thickness cuts vertically across the nearly horizontal volcanic rocks. It is adjoined by sheared amygdaloid walls, and veinlets of white earthy material ramify through the adjacent rock to great distances. A few hundred feet below this locality, on what is thought to be the same vein, is another open cut on a glance stringer about 3 inches wide, largely solid sulphide, which is intergrown to some extent with a zeolite mineral, probably laumontite. The cliff above the cutting shows that the stringer pinches out vertically within 6 feet.

On Rabbit Creek, at a point near the international boundary and about 7 miles north of White River, an adit 20 feet long has been driven on a shattered zone in basalts, presumably of Carboniferous age like those prevailing throughout the region. At the mouth of the adit the zone, which is about 40 feet wide, is iron-stained and variegated with blue and green carbonates of copper. The unoxidized rock carries sparsely disseminated chalcopyrite.

The copper deposits on Kletsan Creek were not visited on account of lack of time at the end of the field season. The placer copper, according to Brooks,[a] "as far as observed, is confined to a distance of about half a mile above the point where the creek leaves its rocky

[a] Brooks, A. H., A reconnaissance from Pyramid Harbor to Eagle City, Alaska, including a description of the copper deposits of the upper White and Tanana rivers: Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 2, 1900, p. 381.

canyon." It is traceable up to the glacier from which the creek is discharged. In 1902, a number of years after this examination, which was necessarily of a hasty character, some attempt was made by interested capitalists to test the placer copper possibilities of the locality. On account of the glacial ice and snow in the high ranges at the head of the creek and a number of other adverse conditions, unfavorable conclusions were reached. Some bed-rock occurrences of native copper were described by Brooks[a] as consisting of an irregular system of veins traversing joints in the greenstones. The filling of the veinlets consists of calcite, and careful search showed that some of them carried native copper. The deposits on which prospecting is being done at present consist, however, of chalcocite, as seen from specimens purporting to have come from Kletsan Creek. It is stated that a good trail has been built from Generk River[b] to the deposits and that considerable work has been done on them.

GOLD.

At the present time prospecting for gold in this region is confined to lode deposits, as placer gold has proved to be present in the streams in unremunerative amounts. The stampede from Dawson in 1902 was directed toward Beaver Creek and its tributaries in the vicinity of the international boundary, and the surrounding territory was soon staked far and wide by the stampeders. A few holes put down in the gravel bench of Beaver Creek are now the only tangible signs of their former activities. It is reported by participants in the stampede that some coarse colors of gold were found in the creek gravels. The wash of the streams is rather coarse, consisting mainly of well-rounded cobbles and bowlders of diorite, and the bench gravels also are coarse, as, for example, in the 50-foot bench of Beaver Creek, where bowlders of diorite up to 6 feet in diameter are not uncommon.

NABESNA RIVER.

At the Royal Development Company's property on Jacksina Creek a number of cuts have been opened on a gossan derived partly from the oxidation of a pyritized sheared diorite and partly from the oxidation of the adjoining pyritized contact-metamorphosed limestone. The trend of the deposit is N. 45° E. (magnetic), and it ranges in width from 4 to 15 feet. The surface ore consists in part of cellular quartz, iron stained and carrying free gold. A 3-stamp mill was erected in 1906 and about 60 tons of surface ore was crushed, yielding, it is reported, $12 a ton in gold. During the summer of 1908 the mill was not in operation, inasmuch as the work of the season was directed

[a] Op. cit., pp. 380–381.

[b] This name conforms to official Canadian usage; on older maps the stream was called "Klutlan."

toward crosscutting the deposit about 200 feet below the outcrop. At the time of visit (middle of July) the crosscut was expected to strike ore within 25 feet. Three men were employed on the property.

WHITE RIVER.

Near the base of the gravel bench on Beaver Creek, about 1 mile upstream from the mouth of Ptarmigan Creek, an outcrop of sulphide ore 2½ feet by 5 feet in surface exposure protrudes through the gravel. It consists of solid pyrrhotite, admixed with a little chalcopyrite and minor amounts of quartz, and is reported to carry $18 to $40 a ton in gold. An adit 30 feet long has been driven 10 feet to the east of the outcrop, but encounters no ore, showing only shattered diorite country rock traversed by narrow quartz seams. As the gravel bench is grown over with moss, the single cropping furnishes the little that is known concerning the lode. About 200 feet downstream the bluffs show that the diorite is intrusive into hard massive shales.

At the head of Eureka Creek, near the international boundary, a number of strong quartz ledges have been discovered. Eureka Creek is situated about 30 miles north of the mouth of the upper canyon of White River, where a small settlement ("Canyon City") has grown up on the north side of the stream. The bed rock at the head of Eureka Creek consists of shales interstratified with limestones and dark-violet andesitic breccias. Locally the limestones are highly tuffaceous and crowded with fossils. The rocks are practically standing on edge and trend N. 87° E. (magnetic). A lenticular bed of limestone 200 feet in maximum thickness and several thousand feet long forms bold crags projecting above the more easily weathering shales that inclose it. The sedimentary rocks are pierced by a large number of porphyritic dikes and intrusions, of which at least four varieties were seen during the very hasty reconnaissance of the region. These include green dioritic and andesitic porphyries and, in the vicinity of the Violet claim, a more siliceous porphyry containing small feldspars and quartzes embedded in a flinty-looking matrix. From the prevalence of diorite bowlders in the gravel of Eureka Creek it can safely be inferred that irruptive masses of diorite, such as were found in neighboring areas, are present in the vicinity. The quartz lodes form prominent outcrops ranging in thickness from 4 to 12 feet, and many of them can be traced for considerable distances. As a rule, the quartz is nearly barren to the eye, showing only a small amount of chalcopyrite and surface stains of azurite. The values are believed to lie in gold, but information on this point is scanty as yet.

The most development work, however, has been done on the Eureka claim, where an argentiferous galena-sphalerite ore has been discovered. Values close to $30 a ton are claimed. The mineralization follows a zone of crushing 6 to 8 feet wide apparently in a porphyry dike crosscutting the shale country rock. The trend of the deposit is N. 25° W. and the dip 74° E. An adit 60 feet long has been driven on the lode.

On the other side of the divide at the head of Eureka Creek a small stream named Anaconda Creek flows eastward to Beaver Creek. Near its head a quartz lode on what is known as the Beaver claim has been staked. It ranges in thickness from 6 to 12 feet of solid quartz and strikes north and south, crosscutting the strata of the country rock. A number of large outcrops expose the ledge for several hundred feet, and it probably extends for several thousand feet. Chalcopyrite and azurite are the only visible ore minerals. Assays are reported to have yielded \$1.50 a ton in gold and 1½ per cent in copper. It is possible that the apex of an ore shoot carrying profitable amounts of gold may yet be found in a vein of this size and persistence, and further prospecting with this possibility in view is certainly to be recommended.

Near the head of Fourmile Creek, a large western tributary of Eureka Creek, a considerable number of quartz outcrops have been discovered, and some of these, it is stated, give encouraging returns in gold from panning of the crushed ore. Along the crest of the ridge 2,500 feet above the stream a great number of quartz veins from 8 to 30 feet thick are exposed. The Jumbo quartz vein, approximately 30 feet thick, forms towering pinnacles emerging through the slopes of loose talus. It represents a zone of brecciation and silicification and includes large angular fragments of country rock several feet in diameter. The quartz shows to the naked eye nothing but small sporadic amounts of chalcopyrite. The wall rock of this great quartz mass is a siliceous feldspar porphyry which forms a large intrusion in the surrounding shales and argillites. The porphyry itself is cut by green dikes which are noteworthy on account of the numerous large crystals of hornblende, 2 to 3 inches in size, scattered through them.

The Husky lode is situated in a more accessible place than the Jumbo. The cropping forms a 15-foot stream bluff on the north side of Fourmile Creek and shows that the lode is a zone of silicification, approximately 30 feet wide, in a crushed feldspar porphyry. The top of the bluff reveals the fact that considerable unsilicified porphyry occurs within the lode. Only one wall of the lode is exposed, and this is not sharply defined, but is a zone of imperceptible transition from quartz to unsilicified porphyry country rock. The lode carries a small tenor of chalcopyrite and an undetermined amount of gold.

Along the middle course of Fourmile Creek some desultory prospecting has been done in the tributaries entering from the south side. The geologic features are essentially similar to those on Eureka Creek.

Intrusive masses of a gray medium-grained hornblende-biotite diorite appear here, and large areas of this rock are shattered and reticulated with veinlets of gypsum, a very unusual mode of occurrence for that mineral. The gypsum is fine grained and crystalline and many of the stringers carry considerable pyrite, but are of no economic importance.

LIGNITE.

A formation consisting of sandstones, shales, and conglomerate lying nearly horizontal is developed in the region of Coal Creek near the international boundary, but its areal distribution is not known. Fragments of lignite can be found in the slide rock of stream cuttings on Coal Creek, but at the point examined by the writers they did not appear to come from thick or continuous beds. In addition to these unfavorable features the strata are pierced by large vertical dikes of basalt. Toward the head of Coal Creek the lignite-bearing formation appears to be covered under a heavy series of volcanic flows. Petrified wood is common as float in the gulches cutting the formation. The lignite has a woody, fibrous texture, but on cross fracture shows a brilliant black glossy surface. The subjoined analysis, furnished by the courtesy of Mr. John Sinclair, shows that it is well within the lignite class of coals.

Analysis of lignite from Coal Creek.

[By Athelstan Day.]

Moisture	14.85
Volatile matter	47.20
Fixed carbon	29.15
Ash	8.80
	100.00

CONCLUSIONS.

The White-Nabesna region can be more easily prospected in some respects than many other parts of Alaska, on account of the relative abundance of bed-rock exposures. Most of the showings of ore found thus far are situated well up on the mountain sides, generally beneath walls of rock cliffs and above the encumbering talus slopes. This is, of course, to be expected in a region that is incompletely prospected, but it entails the disadvantage that the prospects are located far from timber. The greater number of the copper prospects are found in the Carboniferous basaltic amygdaloids, a relation which is also essentially true for those of the Chitina country. The geologic investigation of the region has established the fact that these volcanic rocks have a considerable distribution and underlie the greater part of the Wrangell Mountains. Much of this territory, however, is unfortunately not accessible on account of its numerous glaciers and extensive ice fields.

The main interest of the White-Nabesna region has centered in the occurrences of native copper. No phenomenal ore bodies have yet been discovered, but it has been shown that primary native copper occurs in the amygdules of zeolitic amygdaloids, a mode of occurrence unknown on the Chitina side of the Wrangell Mountains. This discovery is sufficiently encouraging to warrant further development, and it is to be hoped that the nature and extent of the deposit will soon be demonstrated.

From the descriptions given in the preceding pages it will be apparent that a lode-quartz region of some promise has been discovered in the Nutzotin Mountains, near the international boundary, and that as yet it has been but imperfectly explored by the prospector. It was shown that the intrusion of quartz diorite produced a number of contact-metamorphic bodies of copper sulphides, and the occurrence on Jacksina Creek suggests that the magma was also capable of effecting an auriferous mineralization. From the meager data at hand it is perhaps unsafe to venture on generalizations, yet it is probable that the quartz veins are genetically related to the intrusion of the post-Carboniferous quartz diorites and that, therefore, the intruded areas are those most likely to be mineral bearing. Such areas are known to occur throughout the Nutzotin Mountains at a number of localities, especially along the northeastern flanks. Brooks has mapped a large area of granular intrusive on the lower Nabesna. It is probable that in the vicinity of such masses the search for lode quartz may be prosecuted with the most hope of success.