THE SLANA DISTRICT, UPPER COPPER RIVER REGION

By Fred H. Moffit

INTRODUCTION

This paper is a brief preliminary statement about the geology and mineral resources of an area north of the Wrangell Mountains which includes a small part of the drainage basins of the Copper and Tanana Rivers. The area comprises the valleys of Indian Creek and the Slana River and parts of the Chistochina and Tok Valleys. Mentasta Pass, which lies between the Slana River and the Little Tok and is an Alaskan landmark, is in the eastern part of it. (See pl. 1.)

Topographic maps on which most of this area appears were based on surveys made by T. G. Gerdine and D. C. Witherspoon in 1902. Hasty geologic reconnaissances of the area were made by W. C. Mendenhall and F. C. Schrader at the same time. The economic results of these surveys were printed shortly afterwards,[1] but only a part of the geologic observations appear on published maps.

The writer spent the summer of 1929 in this district in order to extend the earlier geologic observations and examine such mineral deposits as are known. An area of about 800 square miles was covered, and the principal results of the work are presented here, although it is expected that the field work will be continued and a more comprehensive report will be made at a later time.

DRAINAGE AND RELIEF

The area considered includes a small part of the east end of the Alaska Range. It is crossed in an east-southeasterly direction by the axis of the range, which extends across the northern portion, marking the divide that separates waters flowing to the Pacific Ocean from those flowing to Bering Sea. The highest point of the divide is Mount Kimball (9,680 feet) on the west side of the area, where the mountains are rugged, snow covered, and seamed by numerous glaciers. Toward the east the altitudes are less and in the vicinity of the Little Tok River average not far from 6,000 feet. Moreover, the mountains of this part of the range are less jagged and have no glaciers. The south-central part of the area, between the main range and the Copper River, includes a separate group of mountains, which

[1] Mendenhall, W. C., and Schrader, F. C., The mineral resources of the Mount Wrangell district, Alaska: U. S. Geol. Survey Prof. Paper 15, 1903. Mendenhall, W. C., Geology of the central Copper River region, Alaska: U. S. Geol. Survey Prof. Paper 41, 1905.

are somewhat less rugged than the Alaska Range on the north and are markedly lower and of smoother contour on the south and west.

The area is drained by several small tributaries of the Copper River, the chief of which are the Slana River, Ahtell Creek, and the Chistochina River, and by the headwater tributaries of the Big Tok River,[2] which flows into the Tanana. The Slana River rises in a glacial source near Mount Kimball and flows southeastward through the center of the area but finally swings to the southwest and joins the Copper River at the northernmost point of the big bend of that stream, where it turns to the west in its sweep around the Wrangell Mountains. For much of the distance between the east end of Mankomen Valley and Burnt Creek the Slana flows through a narrow, canyonlike valley, but below Burnt Creek it is less confined and in some places meanders widely. This is especially true near the mouth, where the current is sluggish, the course winding, and the banks soft, so that fording with horses is not always easy. The valley of the Slana River separates the main part of the Alaska Range from the isolated group of mountains on the south. This group is drained for the most part by Ahtell and Indian Creeks and the East Fork of the Chistochina River.

The head of the Big Tok River receives most of its water from glaciers on the north side of the Alaska Range, opposite the head of the Slana. Like the Slana, it flows southeastward at first, but after joining with the Little Tok, which comes in from the south or southeast, it turns northeastward and flows into the Tanana. The largest western tributary of the Big Tok River is known to the few who visit it as the Dry Tok. Its headwaters are easily reached from the head of the Slana River by Gillett Pass, a low pass slightly above timber line and only a few hundred feet higher than the Slana. The Dry Tok flows nearly due east and joins the Big Tok about 12 miles from the mouth of the Little Tok River. Gillett Pass, the Dry Tok, and the upper valley of the Big Tok provide the easiest route from the Copper River side of the range to the head of the Robertson River, one of the tributaries of the Tanana River which has received some attention from prospectors. Another route between the Slana and Big Tok Rivers is afforded by Sikonsina Pass, in which Burnt Lake lies. It is used by the Indians and white trappers in winter but has never been used much in summer by the whites, as it is not the most direct route to the Robertson and has a good deal of soft ground.

Mentasta Pass is the best-known pass through the Alaska Range west of the Richardson Highway and the Delta River. The broad,

[2] The name "Tok" is an abbreviation of the Indian name, which is said to mean timber. It was given as "Tokai" by Lieut. (now Gen.) Henry T. Allen, who crossed the Little Tok in 1885. The stream is sometimes called "Tokio" by the prospectors.

low summit of the pass is below timber line and little over a mile east of Mentasta Lake, at the west end of the east-west valley that leads from the Slana River to the Little Tok. Mentasta station of the old military telegraph line and mail trail between Valdez, on Prince William Sound, and Eagle, on the Yukon, was on this summit, and the creek that comes down out of the mountains on the north and formerly flowed eastward through the valley to the Little Tok was named Station Creek for this reason. This creek, however, is no longer tributary to the Little Tok, for immense quantities of gravel brought down by the high waters of 1929 dammed the stream at the point where it emerges from its narrow mountain valley and diverted the waters to Mentasta Lake. What was before this diversion the lower part of Station Creek still meanders eastward in its former course through a chain of swamps and small lakes to the Little Tok. The winter of 1928–29 in this district was marked by exceptionally heavy snows and a late spring and was followed by a summer of unusual rain, including a fall of snow on July 29 that was more than a foot deep at the head of the Slana River. It is probable that the changes in the landscape due to landslides and the movement of gravel deposits by high water in 1929 were greater than in many years previously.

Numerous ponds and small lakes are scattered over the area. The largest are Mankomen Lake, at the head of the East Fork of the Chistochina River; Mentasta Lake, between the Slana River and Mentasta Pass; and the Cobb Lakes, near the westward bend of the Copper River. Most of these bodies of standing water are due to the action of glaciers in this region. They belong to a topography in which the drainage lines are not yet thoroughly established.

TIMBER

Practically all of the district is covered with timber up to an altitude of about 3,000 feet. In sheltered valleys and on sunny slopes trees may grow at somewhat higher altitudes, but in such places they are usually scattered and small. Spruce is the most common tree, both in the valley bottoms and on the hill slopes. Along many of the stream courses it is intergrown with cottonwood. Excellent timber suited for many purposes grows in some parts of the area, but unfortunately for those who may need it in the future much of it has already been destroyed by fire. The heavy, wet snow of July, 1929, came at a time when the deciduous trees were in full leaf, and the damage from breaking and overturning was far greater than takes place in winter. Even the conifers suffered much injury. Traveling in the valley bottoms, where the alders and small trees were bent down by the snow, was for this reason even more difficult than is usual in this district.

TRAILS

The area has few trails and in recent years has had few travelers. The trails most in use at present are the trail up the west side of the Chistochina River to the gold placers of Slate Creek and that part of the old military trail between the Chistochina and the mouth of the Slana. This section of the military trail is part of the present trail to the Nabesna and Chisana Rivers and is used more than the Chistochina trail, chiefly because mail for the placer miners in the Chisana district passes over it twice a month. The military trail and telegraph line between Valdez and Eagle, often called the Eagle Trail, was established by the United States Army in the early days of Alaskan exploration, but the part of it in the upper Copper River Valley above Gulkana was abandoned after the Richardson Highway was established. From Chistochina station, on the Copper River a mile west of the mouth of the Chistochina River, it traversed the swampy lowland north of the Copper to the Cobb Lakes, then swung north across Ahtell Creek and through a high valley to the crossing of the Slana River near Mentasta Lake. Passing along the foot of the steep mountain east of this lake, it turned east, traversed the valley of Station Creek to the Little Tok, which it followed northward to the Big Tok and eventually reached the Tanana River at Tanana Crossing. The part of the military trail north of Ahtell Creek is now almost unused except by a few Indians and trappers who travel it occasionally on foot in summer or by dog sled in winter. Many miles of the old telegraph wire remain, although most of the poles are down. The horses used by the writer in 1929 were the only horses that have been over Mentasta Pass in several years.

This description of trails would not be complete without some mention of the work of the Alaska Road Commission. A branch of the Richardson Highway which has been named the Abercrombie Trail is being extended up the Copper River as rapidly as money is available for the work. This road is designed for automobile use and in 1929 was open for travel between Gakona and a point on the Copper River 8 miles below Chistochina. By using the bars of the Copper River it was possible to drive a truck with a moderate load as far as the Chistochina River during the middle and later part of the summer. A camp for a crew of men and a portable sawmill were erected on the Chistochina River in the fall of 1929 to get out timbers for a pile bridge over the river. It is expected that the road will be opened for use as far as the Chistochina by the end of 1930 and that eventually it will connect with an international highway by which automobile travel between the United States and points in Alaska will be possible.

POPULATION

In the summer of 1929 the population of the area, not including the Slate Creek district, was three white men and a few natives. There is a white trader at Chistochina, another at the mouth of the Slana River, and a trapper at Mentasta Lake. There are also small settlements of natives at each of these places. The natives gain their living almost wholly by fishing, hunting, and trapping, but may get work from the Alaska Road Commission during the open season if they wish it. Their numbers appear to be slowly diminishing.

GEOLOGY

Only a brief, imperfect account of the geology of this area can be given, for it is not possible in reconnaissance work to discover more than the most outstanding geologic features of a mountainous area like this part of the Alaska Range.

The accompanying sketch map (pl. 1) shows both sedimentary and igneous rocks, together with large areas of stream and lake gravel and morainal deposits. In general the mountains south of the Mankomen Valley, between the Chistochina and Slana Rivers, are made up of igneous rocks, which include coarse-grained granitic rocks, dark fine-grained lava flows, intrusive rocks, and tuffs. They also include beds of limestone in a few places and possibly some other sediments. The mountains north of the Slana River are composed dominantly of sedimentary rocks but include considerable amounts of dark fine-grained igneous rock and some granitic rocks. Near the axis of the range most of these rocks have been altered to schist.

The age of most of the formations has not been established, and consequently they will be described by groups and localities rather than strictly in the order of age.

BEDROCK FORMATIONS

The mountains of the group between the Chistochina and Slana Rivers, south of the Mankomen Valley, have a characteristic topography, but within the group itself they are higher and much more rugged on the east than in the area between the Chistochina River and Indian Creek, where they appear as isolated smoothly rounded masses. So far as they have been examined they are a complex of igneous rocks which Mendenhall [3] described as Tetelna volcanics and Ahtell diorite. These rocks show wide variations in color and texture and possibly differ considerably in age. The dark fine-grained igneous rocks appear to include both lava flows and intrusive rocks. They are black or dark gray and show variations in texture that

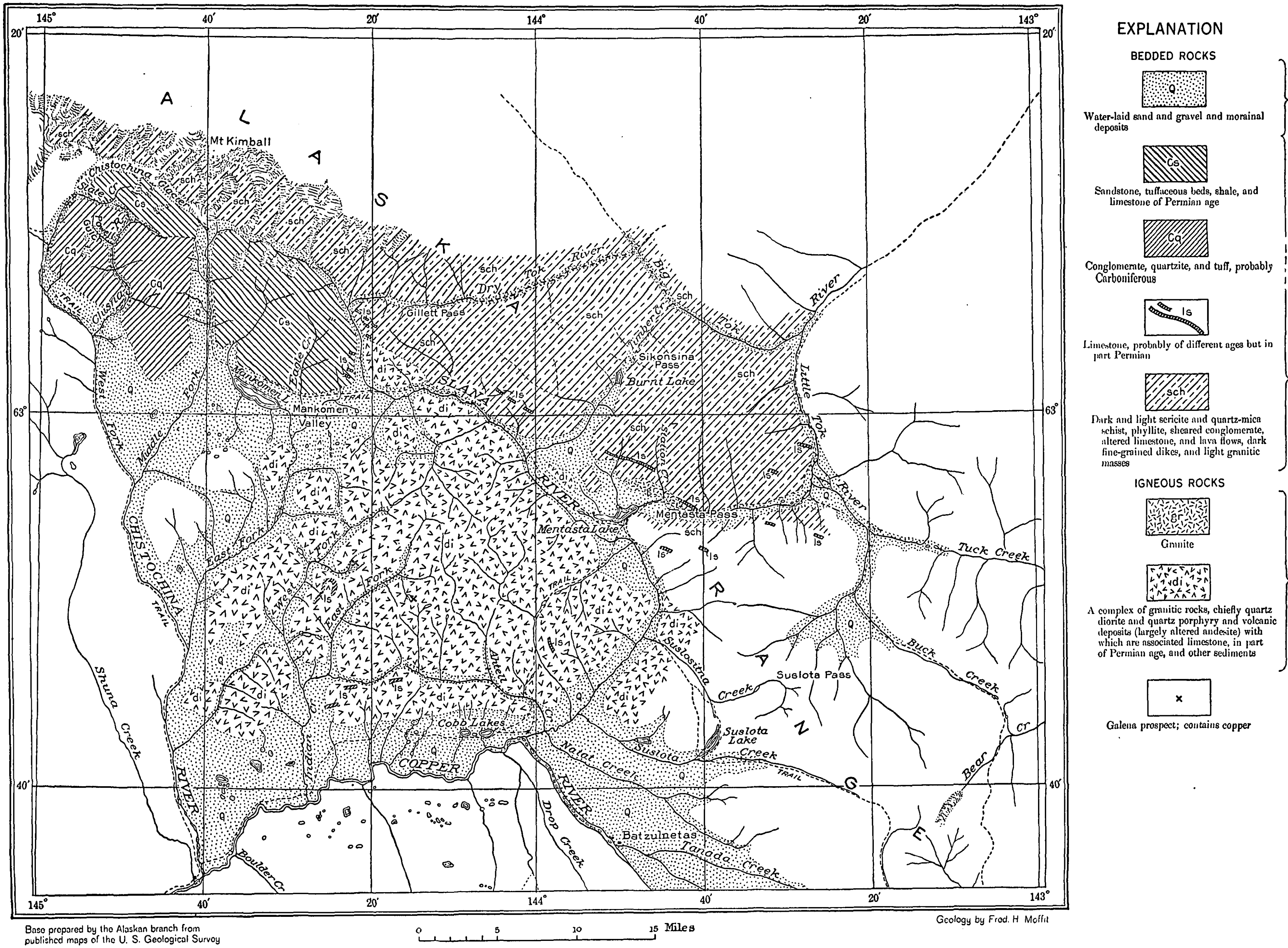
[3] Mendenhall, W. C., Geology of the central Copper River region, Alaska: U. S. Geol. Survey Prof. Paper 41, pp. 36, 38, 1905.

range from that of basalt so fine grained that individual minerals can not be determined to that of porphyritic rock with feldspar crystals an eighth of an inch across inclosed in a dense groundmass. Some of the porphyritic rocks were determined by Mendenhall as andesite. Coarse tuffs, which are calcareous in places and contain crinoid stems, are associated with some of the dark rocks. The dark rocks extend eastward across the lower Slana and appear also in a small area north of the upper Slana near the Mankomen Valley. In places they are pyritiferous and the weathered surfaces are brilliantly colored.

The coarse-grained light-colored granitic rocks have their greatest development in the northeastern part of the area south of the Slana but are present in all parts of it. They are prevailingly gray of varying shades but in places have a pinkish cast. They also vary in coarseness of texture. Some very coarse varieties are made up largely of pink feldspars. For the most part the granitic rocks are related to the diorites rather than to the granites and were described by Mendenhall as "chiefly quartz diorite or quartz diorite porphyry."

The relations of the light-colored granitic rocks and the dark fine-grained rocks are not everywhere clear. In some places dark rocks and light appear to grade into each other. Here and there dark rocks seem to intrude light rocks; elsewhere the reverse may be true. If the dark rocks are in part lava flows, as the writer believes, the relations are still more involved. It appears probable that the area has had a complicated history of igneous activity and that in addition to the extrusion of lavas and tuffs intrusion has occurred, perhaps in different geologic periods or epochs.

No sedimentary rocks were seen in the northern part of this mountain group, but the long low ridge north of the trail from Indian Creek to the mouth of the Slana is made up of igneous rocks, with which are associated beds of coarse white crystalline limestone and possibly some other sedimentary deposits, as observed by Mendenhall on Ahtell Creek. The limestone occurs in detached exposures but probably is several hundred feet thick. The recrystallization is thought to be due to the heat given off by hot intruded masses of melted rock rather than to dynamic metamorphism. The limestone appears to continue into the mountains west of Indian Creek but was not examined close at hand. Sedimentary rocks are known at two other localities within the area of igneous rocks. One locality is on the ridge between the forks of Indian Creek about 6 miles north of the junction. At this place a limy tuffaceous grit is overlain by about 100 feet of nearly horizontal light bluish-gray limestone weathering brown, which locally contains numerous fossils. The rocks that lie above the limestone and form the top of the hill are light-colored porphyritic granitic rocks of varying degrees of coarseness,



GEOLOGIC MAP OF SLANA DISTRICT, ALASKA

containing feldspar, hornblende, and a little quartz. The second locality is about 4 miles from Ahtell Creek on the east side of the Eagle Trail. The exposures here were not examined, but the débris from the cliffs indicates the presence of rocks similar to those on Indian Creek.

The fossils collected on Indian Creek show that the limestone is of late Carboniferous (Permian) age and is to be correlated with the Mankomen formation of Mendenhall and with the Permian limestones at the heads of the White and Nizina Rivers. This is the only direct evidence of the age of any of the rocks so far described which has been obtained. On the other hand, Mendenhall pointed out the lithologic similarity of many of these rocks to the lava flows, tuffs, and interstratified sediments which he saw between the Middle and West Forks of the Chistochina River and regarded as older than the Mankomen formation.

Exclusive of the unconsolidated deposits, the rest of the area represented on the geologic map is occupied by rocks which are dominantly of a bedded character, in contrast to the complex of igneous rocks just described. They include slate, quartzite, and limestone, interstratified in places with large amounts of tuffaceous material and lava flows. All are folded and faulted, and part of them are altered to schist. In places they are intruded by igneous rocks of various kinds.

The mountains about the headwater tributaries of the Chistochina River, west of the Slana River, were not examined by the writer in 1929, but for a better understanding of the remaining part of the map a brief account of their geology is abstracted from Mendenhall's description.[4]

The block of mountains between the Middle and West Forks of the Chistochina River, south of the transverse valley in which Slate Creek lies, is made up of conglomerate, pyritiferous tuff, lava flows, quartzite, and arkosic beds cut by numerous diabasic and dioritic intrusive rocks. The bedded rocks have a nearly east-west strike corresponding with the direction of the Alaska Range in this vicinity and show various dips. Some of the calcareous members of this succession contain fragments of crinoid stems and other organic remains so imperfectly preserved that they have not yet yielded conclusive evidence for the age of the beds. Mendenhall named these rocks the Chisna formation and assigned them provisionally to the lower Carboniferous or Devonian.

The mountain mass between the Middle Fork of the Chistochina River and Slana River is described by Mendenhall[5] as

[4] Mendenhall, W. C., Geology of the central Copper River region, Alaska: U. S. Geol. Survey Prof. Paper 41, pp. 33–36, 1905.

[5] Idem, pp. 40, 41.

made up of a sedimentary series of sandstones, shales, and limestones with intrusive sheets whose total thickness, as determined from rough barometric measurements, is between 6,000 and 7,000 feet. * * *

This section falls naturally into two divisions, an upper prevailingly calcareous division, which includes somewhat more than half the total thickness, and a lower prevailingly arenaceous and tuffaceous division over 2,000 feet thick.

The sediments of the lower part, which are exposed near the Mankomen Valley, "are for the most part variegated feldspathic sandstones, often exhibiting decidedly tuffaceous phases." Near the head of Eagle Creek, in the upper part of the section, Mendenhall found a great bed of northward-dipping white limestone 500 feet thick overlying several hundred feet of beds which include dark thin-bedded limestone, sandy limestone, quartzite, sandstone, and thin beds of black shale. The big limestone is overlain by several hundred feet of black shale, which in turn is overlain by about 600 feet of very fossiliferous thin-bedded limestone lying beneath black shale of undetermined thickness. Mendenhall named this succession of beds the Mankomen formation and assigned to it a Carboniferous (Permian) age on the evidence of fossils. He recognized the fact that the Mankomen beds west of the Slana River are not structurally continuous with the rocks on the east side and attributed this to faulting. A narrow belt of the Mankomen formation extends from the Middle Fork of the Chistochina River to the West Fork. This belt is separated from the Chisna formation by a fault and from the schist north of it by another great fault, as is also the larger area of Mankomen rocks between the Middle Fork and the Slana River.

On both sides of Gillett Pass, between the head of the Slana and the Dry Tok, is southward-dipping black slate or phyllite filled with white quartz and cut by basaltic dikes. The black slate of this locality is evidently many hundred feet thick. It overlies silvery-gray schist on the north, and, although this condition may represent an original structural relation, faulting between the two formations has doubtless taken place. The mountain side east of the Slana River and south of Gillett Pass shows numerous exposures of silicified limestone representing a bed or succession of beds that crop out for a distance of more than a mile across the strike and appear to be several hundred feet thick. A few fragments of organic material were found in the limestone, but nothing from which the age could be determined. The black slate extends eastward from Gillett Pass, forming the lower slopes of the mountains north of the upper course of the Dry Tok and making up all the north slopes of the mountains south of it. Although the black slate beds were not followed through to Sikonsina Pass on the southeast, they are probably to be correlated with the black slate that is exposed there. The rocks north of the black slate on the upper Dry Tok comprise silvery siliceous schist, black siliceous schist, sheared quartzite, and subordinate amounts of recrystallized limestone. They form the mountains on both sides of the lower part of the north end of the valley occupied by Burnt Creek and Timber Creek and extend eastward at least as far as the Little Tok. These rocks seem to be made up chiefly of altered sedimentary beds. South of Burnt Lake the schist beds are succeeded on the south by possibly 500 feet of black slate or phyllite overlain by several hundred feet of basalt flows. This section is repeated on upper Station Creek, and the volcanic member, which here includes a minor bed of black slate, is followed on the south by sheared conglomerate in which pebbles are sparingly scattered through a subschistose groundmass. In places the larger fragments consist wholly of limestone. This conglomeratic schist contains a bed of limestone which is conspicuous in the mountains north of Mentasta Lake, northeast of Mentasta Pass, and in the mountains south of Station Creek near the Little Tok. The rocks along the west side of the Little Tok are the eastward extension of those seen on upper Station Creek and Timber Creek. These rocks have been intruded by coarse granitic rocks whose outcrops may be seen in several places along the Eagle Trail. An example of such intrusive rocks is the light-gray granite north of the old telegraph station in Mentasta Pass. This granite is much altered chemically but is not schistose like the rocks which it intrudes. The difference, however, may indicate simply greater ability to withstand pressure rather than intrusion after the schistose structure was formed.

The geologic map immediately suggests that the limestone exposures south of Gillett Pass, north of the Slana River, and west of Burnt Creek, north of Mentasta Pass, and south of Station Creek between Mentasta Pass and the Little Tok belong to the same series of beds. Although this is probably true, the beds are much folded and faulted, and proof of their equivalence is lacking.

The two low hills about 2 miles northwest of Mentasta Lake are composed of dark basaltic rocks and tuffaceous conglomerate in which limestone pebbles are numerous. The mountain east of Mentasta Lake and south of Mentasta Pass shows a large thickness of hard conglomerate with many pebbles of limestone and limy argillite associated with beds of gray arkosic sandstone. Both the conglomerate and the arkosic sandstone appear in the hand specimen to be somewhat tuffaceous. These rocks contain one or more limestone beds, whose outcrops may be seen on the mountain slopes facing the Slana River several miles southeast of Mentasta Lake. The rocks between Mentasta Pass and the Slana River are distinctly less metamorphosed than those north of the pass. The significance of this difference was not learned. It may be that formations of different ages are present, or possibly the forces which produced the schistose structure were less effective at this distance from the axis of the range.

UNCONSOLIDATED DEPOSITS

Deposits of unconsolidated material conceal much of the bedrock in this district. Aside from the thin mantle of vegetation and unsorted waste from rock disintegration that is now in progress, the unconsolidated deposits may be classified as stream gravel, lake gravel, and morainal deposits, the assignment depending on whether the effects of moving water or of glacial ice are most in evidence in their present condition, for these different deposits can not everywhere be distinguished from one another. The deposits of water-borne gravel and glacial deposits are not separated on Plate 1.

Practically all of the area under consideration, with the possible exception of some of the higher peaks, was once covered by glacial ice, which left a veneer of débris when it disappeared. This débris was most abundant at the lower levels, for the thickest accumulation of ice was there and remained there longer. As the glaciers melted the load of rock waste on and within them was gradually freed. Much of it was immediately subjected to sorting and transportation by running water, and the characteristic features of glacial deposits were modified or obliterated. In this way coarse and fine materials were sorted, and the sharp edges and angular forms of rock fragments typical of glacial deposits were largely destroyed.

Stream gravel is present along all the streams of the district and in their flood plains and terraces. Elevated bench gravel was not seen but is doubtless present in protected places. No preglacial deposits were recognized, and it is doubtful if they exist, for the ice moving down the narrow valleys swept away the loose material.

A feature that is not yet fully explained is the presence of well-rounded waterworn pebbles and cobbles of quartz, diorite, basalt, and other rocks on the hilltops up to an altitude of more than 4,000 feet, or 3,000 feet above the neighboring streams. The scattered pebbles are plainly rock fragments that have been rounded by running water and were probably brought to their present resting places by the glacier ice or by streams upon its surface, for many of them are foreign to the localities where they are found.

Glacial deposits are widespread and in places are so typical in form as to be recognized without difficulty. Such deposits are conspicuous in the Mankomen Valley, which is floored with sheets of morainal material crossed by numerous winding ridges of ice-borne débris and dotted with depressions, many of which are occupied by small lakes and ponds. Similar but less extensive deposits are present in the Mentasta Valley, where they are partly hidden by timber and are not so readily seen as in the Mankomen Valley. The south side of Mentasta Pass is covered with such deposits. Moreover, parts of the Mentasta Valley appear to be underlain by ice or by frozen silt, which thaws and allows the surface to sink, thus forming depressions that may be dry or may contain water and that are surrounded by nearly vertical banks with overhanging fringes of moss and vegetation. In some of these depressions the slumping of the banks has caused the trees to fall inward and has given the trunks a striking radial arrangement.

Although all the narrow mountain valleys were once occupied by ice, glacial moraines are not common in them, for the streams, confined to the narrow valley floors, eventually remove all traces of original morainal structure in the débris and redistribute the material in the stream gravel.

STRUCTURE

This area does not extend far enough north to furnish a complete section across the Alaska Range. Furthermore, not enough work has been done in it yet to give more than an imperfect idea of the structure of the part that was examined. In a general way the bedded rocks north of the Slana, which include volcanic as well as sedimentary material, dip southward away from the axis of the range wherever they were observed. Although steep dips are common, closely compressed folds are less so, especially in the less metamorphosed beds. In addition to being folded and in part altered to schist these rocks are much faulted, as is shown by discontinuous and offset beds of limestone and the disturbed condition of all the beds in many places. Faults of at least two kinds are present—those that trend with the strike of the beds and those that are transverse to it. Among the strike faults is the great southward-dipping fault between the black slate and silvery schist near Gillett Pass. This fault is believed to extend many miles to the west, but its eastward extension is not known. West of the head of the Slana River it separates relatively unaltered Permian deposits from schist. A parallel fault separates the Mankomen and Chisna formations on Slate Creek and the head of the Chisna. Doubtless much faulting of this kind has escaped notice.

Transverse faulting is suggested by Mendenhall as the explanation of the lack of structural continuity of the beds between the Middle Fork of the Chistochina and the Slana with the beds west of the Middle Fork and those east of the Slana. This mass of Permian beds appears to be a tilted fault block. Transverse faulting is also believed to account for offsetting of beds on Burnt and Station Creeks and in other localities.

A close relation probably exists between faulting and the intrusion of igneous masses like the granite at Mentasta Pass and the numerous dikes that cut the black slate at Gillett Pass and many other places.

MINERAL RESOURCES

The upper part of the Copper River Basin received considerable attention from prospectors in 1898 and the next few years. During this time the gold placers of Slate Creek, Miller Gulch, and neighboring streams were discovered and evidences of mineralization were found at several other localities, including Indian Creek and the vicinity of Mentasta Pass. Since that time and especially since the military telegraph line was abandoned comparatively little prospecting has been done.

The gold placers of Slate Creek and Miller Gulch are much the most valuable of the mineral deposits so far discovered and are the only deposits on which profitable mining operations have been conducted. This district was described first by Mendenhall [6] and later by Moffit.[7] Still later a short account of it was written by Chapin,[8] whose attention was given chiefly to the platinum that occurs with the gold. The Slate Creek placers have been in continuous production since their discovery. They were not visited by the writer in 1929 and will not be described here.

The brilliant coloring that results from the weathering of pyrite or other iron sulphides is particularly conspicuous in the mountains north of the Slana, and an examination of many specimens collected there shows that the content of pyrite is large. At one locality near the northward turn of the Eagle Trail into the Little Tok Valley large blocks of limestone mineralized with a variety of iron sulphides were seen in the débris from limestone cliffs high on the mountain. The outcrop of the sulphides was not sought out, but evidently the limestone contains one or more veins of such minerals.

Veins of galena were found by the early prospectors, and a little placer gold was discovered near Mentasta Lake, as well as in the Slate Creek district. A vein carrying tungsten is reported on the upper part of the Big Tok River, outside the area visited by the writer, not far from the pass to the Robertson River, a tributary of the Tanana, on which a little prospecting has been carried on for many years.

The only prospect known to the writer on which development work is being done at present is a vein of galena on Indian Creek held by Carl Whitham, who has prospected in the Copper and Tanana headwaters for many years. The claims are on a small tributary of Indian Creek 15 miles from its mouth. This tribu-

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[6] Mendenhall, W. C., Geology of the central Copper River region, Alaska: U. S. Geol. Survey Prof. Paper 41, pp. 107–117, 1905.

[7] Moffit, F. H., Headwater regions of Gulkana and Susitna Rivers, Alaska: U. S. Geol. Survey Bull. 498, pp. 70–80, 1912.

[8] Chapin, Theodore, Platinum-bearing gravels of Chistochina River: U. S. Geol. Survey Bull. 692, pp. 137–141, 1919.

tary is little more than a mile long and flows northwestward, joining the east branch of Indian Creek a short distance above the point where Indian Creek forks. The vein is at the head of the tributary, near the top of the ridge dividing this tributary from the next small tributary on the east. The country rock is quartz diorite, which shows wide variations in texture but at the place where the vein was found is coarsely granular and contains large phenocrysts of feldspar. At this place the diorite is cut by a number of vertical fracture planes extending east and west and distributed over a distance of 100 or 200 feet from north to south. About 75 feet below the top of the ridge, which is 1,800 feet above Indian Creek, a quartz vein stands more than 6 feet above the ground and is at least 10 feet wide, although its boundaries are not exposed. Broken-down ledges and float show that this vein extends down the hill several hundred feet, but it does not hold the same width and where it crosses the ridge is reduced to about 18 inches. The quartz is cavernous and iron stained and evidently contained iron sulphides, which have been leached out, leaving the more resistant galena.

Between 100 and 200 feet south of this vein are two open cuts on similar quartz veins, but they were caved, so that the veins could not be seen. Almost directly west of these open cuts and 300 feet lower on the mountain slope are two other open cuts on the east side of a small gulch. The southern one is about 15 feet higher than the other. The diorite between them is crossed by numerous parallel fracture planes, which are vertical, trend east, and contain mineralized quartz in veins from a fraction of an inch to several feet thick. The largest of the quartz veins exposed in the gulch is about 7 feet thick but was not wholly in view, for the gulch was still partly filled with snow at the time of visit. Moreover, the character of the vein varies within a short distance, for a few feet above in the gulch half of the thickness of solid quartz is replaced by smaller parallel veins. The quartz is mineralized with galena, chalcopyrite, and probably pyrite. It is cavernous and iron stained from the weathering of iron sulphide and in places is stained with copper. A small vein about an inch thick in the lower open cut shows a large proportion of galena distributed with considerable regularity throughout a gangue of quartz, but the larger vein of the cut to the south contains galena and a little chalcopyrite somewhat more unevenly distributed. Between the outcrop and the open cuts near the top of the ridge several exposures of quartz vein matter were seen, but because of loose material on the surface it was not possible to tell whether they are part of a continuous vein or fracture zone. The development work on the claims consists of open cuts, mostly on the west side of the ridge, and a trail which climbs the mountain side from the rock slide at the head of the valley to the upper open cuts, a vertical distance of 400 feet. There is also an open cut on the east side of the ridge which was not examined because of a snow comber on that side.

At 3 miles below the forks of Indian Creek is a pass leading to the west branch of that stream. About 2 miles northeast of the summit of this pass, near the head of the stream that flows westward from the pass, is a vein of galena-bearing quartz in diorite showing great similarity to the occurrence just described. Several open cuts have been made to uncover the vein, but they were so badly caved at the time they were visited that none of the vein material could be seen in place. The hill slope below the open cuts is strewn with loose blocks of float, but the writer was unable to tell whether they came from a vein uncovered by the pits or are float from a more distant source. The valley is a cirque valley and contains many erratic boulders.

At present no productive mining is being done within the district about the Slana River, but the evidences of mineralization appear in widely separated localities and are the basis of a hope for the development of profitable mining in the future. The district has features which commend it to the attention of prospectors, yet its distance from a source of supplies and the lack of inexpensive transportation have so far prevented thorough prospecting. Among the geologic features that may be looked on as favorable are the presence of sedimentary rocks, including limestone, and interstratified volcanic beds cut by numerous intrusive masses of diorite, granite, and other igneous rocks. These rocks show different degrees of metamorphism, ranging from slight alteration to well-developed schistose structure, and in numerous places they contain iron sulphides widely distributed, as is shown vividly by the brilliant color of the weathered surfaces. Although the presence of such granitic rocks is not an assurance of the presence of valuable minerals, the close genetic relationship of a great number of well-known mineral deposits with such rocks is a firmly established fact.

The physical features of the district are no more unfavorable than those of much of the rest of Alaska. The summer season is short and the winter is cold, but the snowfall is usually not great. Feed for stock is not everywhere plentiful but in places is abundant for a few weeks in summer. Much of the district is favorably situated with reference to a supply of timber, which is always in demand in mining operations. Lastly, the completion of a highway suitable for automobile transportation will assist greatly in reducing the cost of supplies and should stimulate prospecting.