Principal Gold-Producing Districts of the United States

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A description of the geology, mining history, and production of the major gold-mining districts in 21 States

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ALASKA

Gold, the lure that drew settlers across the wide prairies and into the most remote mountain gullies in our Western States, proved also to be the dominant factor in the settlement of Alaska. This most important mineral commodity of the State was known in Alaska as early as 1848, long before the territory was acquired from Russia by the United States in 1867. P. P. Doroshin, a Russian mining engineer, made the discovery in the gravels of the Kenai River on the Kenai Peninsula, but there was no great excitement and apparently no gold was mined (Martin and others, 1915, p. 181–182). A second discovery of placer gold in 1865–66 on the Seward Peninsula by a party exploring for a telegraph route similarly failed to arouse much interest (Collier and others, 1908, p. 13–14).

Alaskan gold mining began in southeast Alaska. In 1869 miners who had been disappointed in the Cassiar gold district in British Columbia discovered gold placers at Windham Bay and Sumdum Bay southeast of Juneau. In 1870–71 the first gold produced in Alaska, reported to be worth $40,000, was extracted from these placers (Wright, 1906, p. 2). At about this time the first attempts to mine lode gold were made near Sitka (Knopf, 1912, p. 8 . In the early 1870's extensive copper deposits were found on Prince of Wales Island, but because of the remoteness of the area from transportation facilities, these were not developed for many years. The major lode gold deposits of Alaska were found in 1880 at Juneau, and by 1883 Juneau was the mining center of the territory (Wright, 1906, p. 3). Encouraged by the successes at Juneau, the prospectors spread through southern Alaska and made important gold discoveries at Berners Bay and Eagle River on the mainland near Juneau, at Klag Bay on Chichagof Island, at Willow Creek near Anchorage, and even on far-off Unga Island, 1,000 miles to the west.

Numerous gold districts, the most important of which are Nome, Council, and Fairhaven, are on the Seward Peninsula. This region was prospected first by gold seekers drawn north by the great Klondike (Yukon Territory, Canada) rush of 1897–98. By 1898 the discovery of the rich Nome placers triggered a stampede to the new area and led to the rapid development of the entire peninsula. Nome, the second largest gold-producing district in Alaska, was active until 1962.

The vast Yukon drainage basin has produced more gold than any other region in Alaska, even though it was the most recent of the gold-producing regions to be exploited. With transportation virtually limited to river travel, the great distances from gold deposits to supply and population centers inhibited any large-scale mining in the early days. The first gold discoveries were made in 1878 (Mertie, 1937, p. 4); however, tales of gold had been circulated years earlier by traders and trappers who set up posts at various points along the Yukon River. Smith (1933, table facing p. 96) listed the earliest production for this region in 1883 from the Fortymile district. The important placers at Fairbanks were discovered in 1902, and by 1910 lode mines were active in this district. The Fairbanks placers proved amenable to large-scale dredging

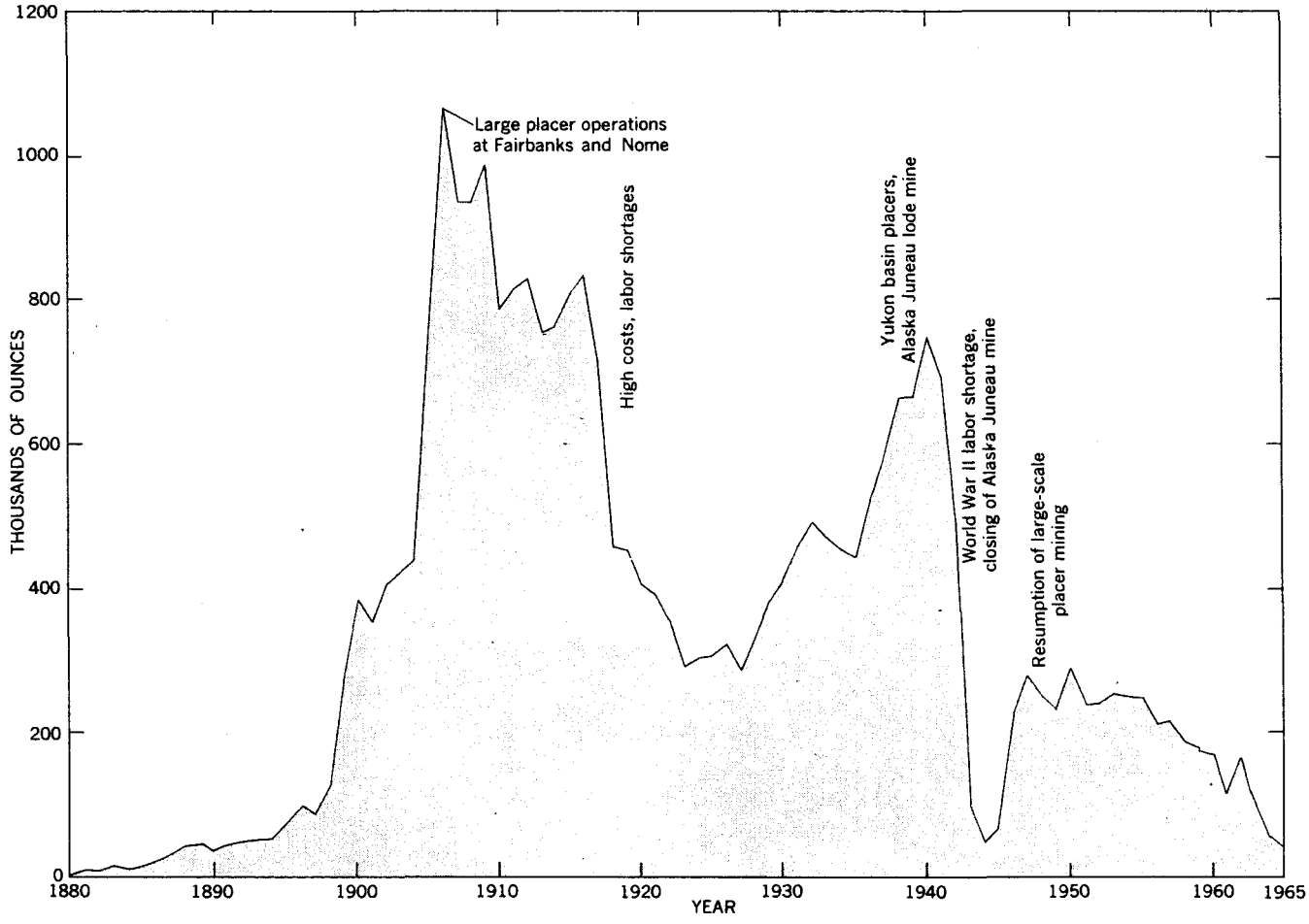

FIGURE 4.—Annual gold production of Alaska, 1880–1965. Sources of data: 1880–1900, U.S. Geological Survey (1883–1924); 1900–42, Smith (1944, p. 6); 1943–59, U.S. Bureau of Mines (1933–66). Production reported in dollar value was converted to ounces at prevailing price per ounce.

operations, which soon made this district the largest gold producer in Alaska.

As transportation facilities improved after 1900, new gold discoveries were made in the more remote areas, and previously known deposits were developed and mined. This activity extended into the 1930's, and several lode and placer districts in the Yukon basin were activated in this interval.

Gold mining in Alaska was seriously affected in 1943 by the imposition of War Production Board Order L–208 which closed nearly all of the gold mines during World War II (fig. 4). After the war the placer mines of the Fairbanks district resumed large-scale operations, and this single district accounted for more than half the total annual gold production for Alaska during 1950–65. The lode mines in Alaska were virtually inactive during 1942–65.

Of the total value of $722,122,186 of gold (28,859,718 ounces) produced in Alaska from 1880 to 1957, $504,076,577 came from placer mines (U.S. Bureau of Mines, 1957, p. 83, 85). During 1958–59 the gold production amounted to 365,353 ounces, most of which came from placers (U.S. Bureau of Mines, 1959, p. 84). Most of the lode gold has come from the Juneau district in southeast Alaska, and an unknown but probably small amount has been produced as a byproduct of copper ores in the Prince William Sound region. The gold production of Alaska before 1880 is unknown, but probably was not great.

Emmons (1937, p. 203) discussed the general relationships of gold deposits to geology. He pointed out that the chief lode deposits are associated with Mesozoic granite that have intruded rocks of Precambrian, Paleozoic, and Mesozoic ages. This belt of intrusives extends from the Seward Peninsula to the Yukon Territory. The lode deposit on Unga

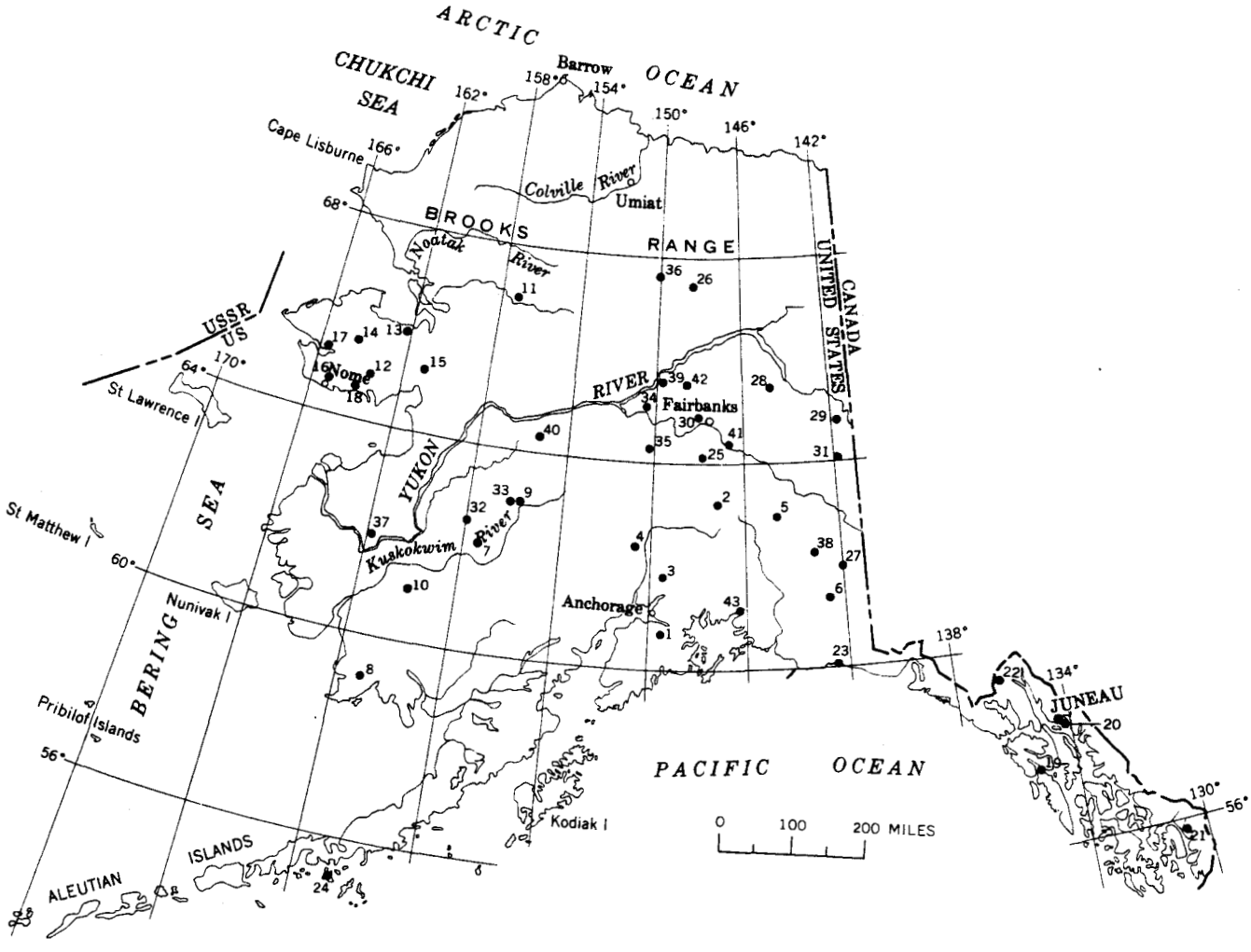

FIGURE 5.—Gold-mining districts of Alaska.

Cook Inlet-Susitna region:
1, Kenai Peninsula; 2, Valdez Creek; 3, Willow Creek; 4, Yentna-Cache Creek.
Copper River region:
5, Chistochina; 6, Nizina.
Kuskokwim region:
7, Georgetown; 8, Goodnews Bay; 9, McKinley; 10, Tuluksak-Aniak.
Northwestern Alaska region:
11, Shungnak.
Seward Peninsula region:
12, Council; 13, Fairhaven; 14, Kougarok; 15, Koyuk; 16, Nome; 17, Port Clarence; 18, Solomon-Bluff.
Southeastern Alaska region:
19, Chichagof; 20, Juneau; 21, Ketchikan-Hyder; 22, Porcupine; 23, Yakataga.
Southwestern Alaska region:
24, Unga.
Yukon region:
25, Bonnifield; 26, Chandalar; 27, Chisana; 28, Circle; 29, Eagle; 30, Fairbanks; 31, Fortymile; 32, Iditarod; 33, Innoko; 34, Hot Springs; 35, Kantishna; 36, Koyukuk; 37, Marshall; 38, Nabesna; 39, Rampart; 40, Ruby; 41, Richardson; 42, Tolovana.
Prince William Sound region:
43, Port Valdez.

Island in the Aleutian Islands is in Tertiary andesite. The placer deposits are widespread, occurring along nearly all the major rivers and their tributaries, and even in beach sands in the Nome area, on Kodiak Island, Yakataga, Lituya Bay, and Cook Inlet.

As in earlier reports of the Geological Survey (for instance, Smith, 1939), the State is subdivided into nine geographical regions: Cook Inlet-Susitna, Copper River, Kuskokwim, Northwestern, Seward Peninsula, Southeastern, Southwestern, Yukon, and Prince William Sound. The regions and the individual districts (fig. 5) within the regions are discussed in this report.

COOK INLET-SUSITNA REGION

Bounded roughly by the Aleutian or Alaska Peninsula on the southwest, the Alaska Range on the west and north, and by the Talkeetna Mountains on the east, the Cook Inlet-Susitna region includes the Kenai Peninsula, Valdez Creek, Willow Creek, and Yentna-Cache Creek mining districts.

Gold was first discovered in Alaska in 1848 in the gravels of the Kenai River. Apparently this gold was not present in minable quantities, and it was not until the 1890's that minable placers were found in the Turnagain Arm area (Martin and others, 1915, p. 181–183). The first lode deposits in the Cook Inlet-Susitna region were found in 1896 also in the Turnagain Arm area, more precisely, the Moose Pass-Hope area; however, the deposits, although rich, were of small tonnage, and there was very little lode production before 1911 (Martin and others, 1915, p. 129–131).

Placers in the Valdez Creek district, in the southern foothills of the Alaska Range, were worked from 1904 to 1924 (Ross, 1933b, p. 427–428) and desultory operations were carried on as recently as 1947 (E. H. Cobb, written commun., 1962).

In the western part of the Cook Inlet-Susitna region, placers were discovered in the Yentna-Cache Creek district in 1905 (Capps, 1913, p. 10). These deposits were moderately productive through 1957. The most productive district in the entire region is the Willow Creek district, about 20 miles north of the towns of Palmer and Wasilla, where placers were discovered in 1897. The first lode claims were located in 1906 (Capps, 1913, p. 50) and were worked fairly steadily until the early 1950's.

From 1880 through 1959, a recorded total of 919,532 ounces of gold was produced from the Cook Inlet-Susitna region. Of this, 588,361 ounces was from lode mines, 324,370 ounces from placers, and 6,801 ounces from undifferentiated sources. After the end of World War II production from both lode mines and placers declined markedly.

KENAI PENINSULA DISTRICT

The Kenai Peninsula is near the center of the southern coastline of Alaska, immediately northeast of the Alaska Peninsula.

The districts of Moose Pass-Hope, Girdwood, and Turnagain Arm—all in the central and northern part of the peninsula—have been combined in this discussion because most of their production data have been combined under "Kenai Peninsula."

Numerous small placers were discovered in the Turnagain Arm area in the early 1890's, but no significant production occurred until news of the auriferous gravels on Mills and Canyon Creeks brought several thousand prospectors to the area in 1896 (Martin and others, 1915, p. 182–183). Two years later another influx occurred. In a short time the small richer deposits were exhausted and the hand-operated rockers and sluices were supplanted by hydraulic plants that successfully mined the large reserves of low-grade gravels.

Lode mining, overshadowed by the placer operations, has been conducted chiefly in the Moose Pass-Hope camp and to a lesser degree in the Girdwood camp. The first indications of economic lode deposits were noted in 1896, but interest was diverted for a number of years to the more accessible placers. The lode deposit at the Hirshey mine, discovered in 1911, became the most consistently productive in the district (Tuck, 1933, p. 489–494). Lode mining continued sporadically until the end of World War II, when it dwindled to almost nothing.

Total recorded gold production from the Kenai Peninsula from 1895 through 1959 was 23,700 ounces from lodes, 96,500 ounces from placers, and 175 ounces from undifferentiated sources. Data from 1931 through 1945 are incomplete, so that the figures given here are minima.

The geology of the Kenai Peninsula was described by Martin and others (1915), Tuck (1933), and Park (1933). The oldest rocks on the peninsula are schists and crystalline limestones of uncertain age; however, the most widely distributed rocks are slates and graywackes that range in age from Paleozoic or Early Triassic to possible Late Cretaceous (Martin and others, 1915, p. 33–35). Granitic intrusive masses are abundant in the slaty rocks along the southern and eastern coasts. The Kenai Formation, of Eocene or younger Tertiary age, is exposed in the low country in the southwest part of the peninsula, north of Kachemak Bay, and consists of coal-bearing sand and clay. This formation is 15,000–20,000 feet thick and contains economically important oil and gas accumulations (Lian and Simonson, 1962, p. 271). Quaternary gravels—mostly till, outwash, and terrace sands and gravels—cover vast areas of lowlands in the west and northwest parts of the peninsula. The pre-Tertiary rocks that comprise most of the mountainous part of the peninsula are intricately folded whereas the Tertiary rocks, which occupy the low areas of the peninsula, are either horizontal or only gently warped into folds in which dips are generally less than 10° (Barnes and Cobb, 1959, p. 227).

The lode deposits of the Moose Pass-Hope camp consist of fissure veins. Mineralized acidic dikes are

also in the district, but the gold production has been from the fissure veins that cut across the slaty cleavage of the slate and graywacke country rocks. The veins strike in all directions and have an average dip of 45° north or west (Tuck, 1933, p. 490). The ore minerals are arsenopyrite and small amounts of galena, sphalerite, pyrite, and chalcopyrite in a gangue of quartz, calcite, and ankerite (Tuck, 1933, p. 491). Free gold occurs in the quartz, commonly near accumulations of galena and sphalerite.

The placer deposits of the Kenai Peninsula, described by Martin, Johnson, and Grant (1915, p. 181–208), are most productive in the northern part of the peninsula along the various streams—Crow, Resurrection, Palmer, Bear, and Sixmile Creeks—that debouch into Turnagain Arm. Farther south, the gravels of Canyon, Mills, Falls, and Cooper Creeks, and of the Kenai River have yielded some placer gold. The deposits were formed in Quaternary time by postglacial streams reworking and resorting the debris that choked the valleys after the retreat of the glaciers. Present streams that have incised their courses in the unconsolidated material have left terraces and have further reworked the gravels. The productive glaciers are along these streams and in channel deposits in the terraces.

VALDEZ CREEK DISTRICT

The Valdez Creek district is on the southern flank of the Alaska Range at approximately lat 63°12′ N. and long 147°20′ W. The drainage area of Clearwater Creek in addition to that of Valdez Creek is usually included in the district.

Gold was first discovered in this district in 1903, in the gravels of Valdez Creek, but no production was recorded until 1908. The "Tammany Channel," a buried channel representing the course of an ancestral Valdez Creek, yielded most of the placer gold from the district. This channel, discovered in 1904, has been worked by hydraulic and underground methods (Tuck, 1938, p. 113). The chief production has been from placers. Several gold lodes were located, but none were productive to 1936 (Tuck, 1938, p. 121), and no record of any later lode production was found in 1959.

Total estimated gold production through 1936 was about 34,900 ounces, worth about $720,000 (Tuck, 1938, p. 113). The district was virtually dormant during 1937–59.

The geology of the district was described in detail by Ross (1933b, p. 428–444). Triassic(?) metasedimentary rocks—argillite, slate, and sericite and chlorite schist with limestone lenses—were intruded by a small batholith of quartz diorite in the northern part of the district and by small stocks and plugs of diorite elsewhere in the district. Structurally, the district is on the northwest flank of a large northeast-trending anticlinal fold; large normal faults trending N. 65° E. cut the metasedimentary rocks.

There are several types of veins in the district, and those showing the most promise, according to Ross (1933b, p. 456), are quartz veins associated with sheared and metamorphosed wallrocks. In their unoxidized state these veins contain pyrite, arsenopyrite, pyrrhotite, and a little chalcopyrite. Native gold occurs in the quartz. Some quartz veins contain abundant calcite (Ross, 1933b, p. 457). Ross (1933b, p. 458) believed the veins were related to hydrothermal activity that followed the intrusion of the dioritic bodies.

The placers are buried channels in which gold was concentrated next to the bedrock floor. The old gorges, eroded into bedrock, are V-shaped and probably were cut into a mature erosion surface (Ross, 1933b, p. 444–445).

WILLOW CREEK DISTRICT

The Willow Creek district, an area of about 50 square miles, is 23 miles by road northeast of Wasilla and 21 miles northwest of Palmer.

Gold-bearing veins were discovered in this district in 1906, but lack of transportation facilities hindered their development and no production was recorded until 1909 (Ray, 1954, p. 35–36). After 1909 the district developed steadily and maintained substantial annual production until 1951, after which there was only sporadic small-scale activity. Total gold production through 1959 was 652,080 ounces; nearly all production was from lode mines.

The geology and ore deposits of this district were described by Ray (1954, p. 10–54). The oldest rock is muscovite-quartz-plagioclase schist. Intruded into this is a mass of quartz diorite, the Talkeetna batholith, which underlies the major part of the district. Dikes of lamprophyre, diabase, aplite, and pegmatite cut the intrusive. The batholith is believed to be of late Mesozoic age. Sedimentary rocks, including conglomerate, arkose, shale, and sandstone of Tertiary(?) age, dip to the south, away from the quartz diorite body. Numerous faults cut the quartz diorite. Those with the larger displacements are postore in age, trend northwest, and dip northeast.

Two types of veins are in the quartz diorite: (1) an older nonproductive group, containing assemblages of chalcopyrite-molybdenite, pyrite-stibnite, or low-grade gold-quartz, and (2) minable

gold-bearing quartz bodies in shear zones that occur along the southern margin of the quartz diorite. Vein minerals, in addition to quartz and gold, are pyrite, arsenopyrite, sphalerite, chalcopyrite, tetrahedrite, nagyagite, altaite, coloradoite (?), galena, stibnite(?), and sparse scheelite. Gold commonly occurs as irregular grains in and around nagyagite and as fracture fillings in pyrite, and locally occurs as blebs and stringers in quartz.

YENTNA-CACHE CREEK DISTRICT

The Yentna-Cache Creek district includes about 2,000 square miles on the southeast slope of the Alaska Range and is located roughly between lat 61°55′ and 62°45′ N. and long 150°25′ and 151°5′ W. It includes the upper drainage of the Yentna River and its tributaries, the best known of which, from the standpoint of gold mining, are Cache, Mills, Peters, and Long Creeks.

Gold was discovered in this district in 1905 in gravels in the basins of Peters and Cache Creeks. During the first few years most of the production was from these placers. In 1911 additional placers were discovered on Dollar Creek and a few years later on Thunder Creek and Upper Willow Creek (Capps, 1925, p. 54–55). The district, although not a tremendous producer, had a steady output, entirely from placers, and was active through 1957. From 1905 through 1959, about 115,200 ounces was recorded; data for 1931–46 are not available.

The geology and placer deposits were described by Capps (1913; 1925, p. 53–61). Intensely folded slates and graywackes of Mesozoic age compose most of the bedrock. Masses of granitic and dioritic rocks were intruded into the metasedimentary rocks, and Capps believed that the numerous gold-bearing quartz veins in the slates and graywackes were derived from solutions emanating from the cooling intrusives. Poorly consolidated lignitic sand and clay of Oligocene age (MacNeil and others, 1961, p. 1904) unconformably overlie the folded older rocks. The sand and clay are overlain by younger Tertiary gravels.

The placers were derived by weathering and erosion of the auriferous veins in the metasedimentary rocks, first by Tertiary streams which deposited the gold in channels in the Tertiary gravels, then by postglacial streams which reworked the glacial debris and Tertiary deposits and concentrated gold from these earlier deposits into placers in the present stream channels. Minable placers occur in the Tertiary deposits as well as in the Recent gravels.

COPPER RIVER REGION

The elliptical-shaped Copper River region, which includes a large part of the drainage basin of the Copper River, is in southern Alaska, bounded by the Alaska Range on the north, the Chugach Mountains on the southwest, and the Wrangell Mountains on the northeast. The region lies roughly between lat 61°00′ and 63°10′ N. and long 142°00′ and 146°00′ W., and it includes the major gold districts of Chistochina and Nizina.

Gold mining began in this region in 1900 in the Chistochina district, but prospectors were active in the Copper River country as early as 1898 (Schrader, 1900, p. 421). The first locations were in auriferous gravels along the Chisna, one of the main tributaries of the Chistochina River. Productive placers were discovered along the upper part of the Nizina River and its tributaries in 1902 (Mendenhall, 1905, p. 118). Minor discoveries were made elsewhere in the Copper River region about this time, and in 1914 the Nelchina placers were discovered (Chapin, 1918, p. 59)—but the bulk of the gold production came from the placers of Chistochina and Nizina. In the Copper River region, especially the Chitina district, copper deposits were worked extensively by the Kennecott Co. during 1900–38 (Moffit, 1946, p. 93), but they yielded little gold.

From 1900 to 1959 the Copper River region produced 2,400 ounces of lode gold, 295,000 ounces of placer gold, and 5,600 ounces of gold undifferentiated as to source—a total of 303,000 ounces. From World War II through 1959 only a few hundred ounces per year were produced.

The geology of the region is summarized here from a more detailed account by Moffit (1938, p. 19–107).

Throughout most of the region the low-lying areas are blanketed by glacial sands and gravels of Quaternary age. In the higher areas, a thick succession of bedded rocks range in age from early Carboniferous to Recent. The oldest rocks consist of schist and slate associated locally with altered limestone, tuff, and basalt flows, and they include the Mississippian Strelna Formation and Dadina Schist and the Carboniferous or older Klutina Series. Overlying these rocks are layers of lava flows, tuff, volcanic breccia, shale, limestone, sandstone, and conglomerate of Permian age; these are overlain by the Nikolai Greenstone, a thick sequence of basaltic lava flows of Permian and Triassic(?) age.

The post-Triassic Mesozoic rocks in the Copper River region are not fully understood because of the correlation problems imposed by variable lithology, exposures in disconnected areas, and lack of diagnostic fossils. Tuffaceous beds of Middle Jurassic

age occupy a small area near the mouth of the Chitina River. Upper Jurassic rocks occur in a few places in the central part of the Copper River basin along the north tributaries of the Chitina River. Along the north side of Chitina River valley a thick series of bedded sedimentary rocks of varied lithology is Jurassic or Cretaceous in age. Black shale and sandstone, conglomerate, and sandy shale considered to be of Early Cretaceous age overlie Triassic rocks in the Nizina district. The Chugach Mountains, in the southern part of the region, are underlain by dark slate and graywacke considered to be Cretaceous or older(?). These are equivalent to the Valdez and Orca Groups of earlier reports.

The Tertiary rocks are dominantly of volcanic origin and include several thousand feet of lavas and tuffs interbedded with fresh-water conglomerate, clay, sandstone, and shale. These rocks compose the higher parts of the Wrangell Mountains.

CHISTOCHINA DISTRICT

The Chistochina district is in the northwest part of the Copper River basin near the intersection of lat 63°00′ N. and long 145°00′ W. The drainage area of the Chistochina River, including the southern foothills of the Alaska Range, roughly determines the boundaries of this district.

The initial gold discoveries of the Copper River region were made in this district along the Chisna River in 1898 by Hazelet and Meals (Moffit, 1944, p. 27). Slate Creek and Miller Gulch later became the leading gold-producing areas. Production from this district began in 1900 and continued, though at a diminishing rate in the later years, to 1942. From 1942 to 1959 the district was almost dormant, with only sporadic small-scale activity. Total production from 1900 through 1959 was about 141,000 ounces, all from placers. Production data from 1931 through 1945 are not complete.

Bedrock in the district consists of Carboniferous and Permian clastic and sedimentary rocks—predominantly shale, limestone, conglomerate and some sandstone—and subordinate volcanic tuffs and lava flows. All the foregoing rocks are cut by dikes (Moffit, 1944, p. 28). The gold placers were formed by reworking of glacial debris and occur in bench gravels as well as present stream gravels.

NIZINA DISTRICT

The Nizina district is in the eastern part of the Copper River drainage basin between lat 61°12′ and 61°37′ N. and long 142°22′ and 143°00′ W. This is a placer district along the Nizina River, a tributary of the Chitina River.

In 1898–99 prospectors were active in the Chitina River valley and some went up as far as the Nizina area. Although copper deposits were soon found and quickly developed, it was not until 1902 that placers rich enough to precipitate a rush were found on Chititu Creek (Moffit and Capps, 1911, p. 76). The rich deposits were quickly exhausted and the operators who remained developed previously known lower grade gravels on Chititu and Dan Creeks. In 1959 these gravels were still being mined, although on a smaller scale. Total production through 1959 from the Nizina district was 143,500 ounces of gold; all but about 60 ounces was from the placers.

The geology of the Nizina district was described by Moffit and Capps (1911, p. 20–75). Bedrock in the mountain areas consists for the most part of moderately folded Permian and Triassic(?) marine sediments and greenstone intruded by laccoliths, dikes, and sills of quartz diorite porphyry (E. H. Cobb, written commun., 1962). Deposits of morraine and alluvium blanket the lower slopes of the mountains and fill the river basins. The source of the gold in the placers is probably the small quartz veinlets in the black shales that may be related to porphyritic intrusives in the shales. High bench gravels, remnants of a deep alluvial valley fill, contain workable deposits, but the richest placers are in present stream gravels where the gold has been concentrated by reworking of older deposits (Moffit and Capps, 1911, p. 98–100).

KUSKOKWIM REGION

The Kuskokwim region, which includes the country drained by the Kuskokwim River, is roughly 400 miles long and 75 to 100 miles wide extending from the mouth of the Kuskokwim River, in southwest Alaska, to the northwest slopes of the Alaska Range, in south-central Alaska. Important gold-producing districts are Georgetown, Goodnews Bay, McKinley, and Tuluksak-Aniak.

The area southwest of the town of Aniak is underlain predominantly by Quaternary sands and gravels, but the more mountainous regions east and northeast of Aniak are underlain by bedded rocks that range in age from Ordovician(?) to Tertiary (Cady and others, 1955, pl. 1). Only parts of the region have been geologically studied in any detail; much of it remains to be mapped.

The Kuskokwim River, particularly its lower reaches, was penetrated first by Russians who in 1829 began exploring the area and later established trading posts along the river (Cady and others, 1955, p. 3–4). The first report of gold in this re-

gion was by Spurr (1900, p. 259–261) who, in 1898, noted that gold was present both in veins and in stream gravels at various points along the Kuskokwim. These reports were of mere occurrences rather than of bonanza deposits; thus prospectors were reluctant to enter this relatively unknown region. It was not until 1908 that the first gold was produced (Smith, 1933, table facing p. 96). Placers have been the principal producers from this region, yielding substantially even in the 1950's. Production from 1908 through 1959 totaled 640,084 ounces, of which only 41,598 ounces was from lode mines.

GEORGETOWN DISTRICT

The Georgetown district, between lat 62°00′ and 62°15′ N. and long 157°15′ and 158°15′ W., includes the upper reaches of the George River and Crooked Creek, tributaries of the Kuskokwim River.

Production data are incomplete but they indicate that the district has produced somewhat less than $300,000 in gold (about 14,500 ounces), chiefly from placers along Donlin and Julian Creeks which, respectively, are branches of Crooked Creek and the George River (Cady and others, 1955, p. 117–119). The placers were known as early as 1909, and mining began about a year later (Cady and others, 1955, p. 118). This early production either was unrecorded or was combined with some other district, as 1917 is listed as the first year of production. No gold production was reported from this district from the end of World War II through 1959. The low gold content of the deposits required that large volumes of gravel be handled—this was successfully accomplished by hydraulic methods.

The bedrock consists of interbedded graywacke and shale of the Kuskokwim Group of Cretaceous age into which sheets, dikes, and sills of albite rhyolite are intruded. Quartz veins containing small amounts of gold are at or near the contacts of the intrusives with the enclosing sedimentary rocks. These veins no doubt were the source of the gold in the placers (Cady and others, 1955, p. 116–117). Bench gravels, buried channels, and the deposits of existing streams contain concentrations of placer gold (Cady and others, 1955, p. 116).

GOODNEWS BAY DISTRICT

The Goodnews Bay district, along the southwest coast of Alaska between lat 59°00′ and 59°40′ N. and long 160°40′ and 162°00′ W., includes the area drained by the Goodnews and Arolic Rivers.

Placer gold was discovered about 1900 by prospectors from Nome (Harrington, 1921, p. 220), and for a few years thereafter placers along the Arolic River were mined on a small scale, though it is not known how much gold was produced. Several sporadic influxes of prospectors in the early 1900's were short lived because no profitable deposits were found (Harrington, 1921, p. 221). By 1911, however, production was reported annually from this district, and until 1947 the placers continued to yield small amounts of gold. From 1947 through 1959 the district was dormant. Total recorded production from 1911 through 1959 is about 29,700 ounces, all from placers. Data for 1931–46 are incomplete, so that the total given here is a minimum, though the magnitude is probably of the right order.

The placers of this district are of two types (Harrington, 1921, p. 222–225). One type occupies wide gravel-filled valleys and represents a reworking of earlier glaciofluviatile materials. The other type is found in narrow valleys and is derived from stream erosion of bedrock since glacial times. Narrow quartz veinlets in sedimentary rocks that were invaded by granitic rocks are believed to be the source of the gold in the placers. None of the auriferous veins have been of economic value (Harrington, 1921, p. 223–224).

McKINLEY DISTRICT

The McKinley district, in the eastern part of the Kuskokwim River valley, includes the placer caps of McGrath, Takotna, and Medfra and the lode deposits of the Nixon Fork country.

Placers along the Kuskokwim and its tributaries have been productive since 1908, although in recent years activity has diminished considerably. In the winter of 1919–20 production began from lode mines in the Nixon Fork area (Martin, 1922, p. 149). Production for the district from 1908 through 1959 was 40,600 ounces of lode gold and 13,900 ounces from placers, but data are incomplete for 1931–46.

In the Nixon Fork area, the oldest rocks are low-grade metamorphic rocks of pre-Ordovician age overlain by a 5,000- to 7,000-foot-thick limestone of Ordovician age and by a small patch of Permian sandstone, slate, and limestone (Brown, 1926, p. 101–127). Upper Cretaceous and Eocene(?) shale, sandstone, and graywacke cover large parts of the area and are overlain locally in the north by Tertiary andesite, basalt, and rhyolite lavas. Several small intrusive masses of diabase, quartz monzonite and granite, and porphyritic dikes and sills of variable composition cut the layered rocks.

The gold lodes in the Nixon Fork area are contact metamorphic deposits in limestone along its contact with a quartz monzonite intrusive. Native gold occurs in association with copper carbonates

and sulfides in irregular masses and shoots (Brown, 1926, p. 128–134).

TULUKSAK-ANIAK DISTRICT

The Tuluksak-Aniak district comprises the drainage basins of the Tuluksak and Aniak Rivers between lat 60°30′ and 61°30′ N. and long 159°00′ to 161°00′ W.

After 1900, prospectors from Nome roamed throughout the lower Kuskokwim River valley and made placer discoveries along the Innoko and Holitna Rivers and finally, in 1907 or 1908, in the Bear Creek area of the Tuluksak watershed (Maddren, 1915, p. 299–300). About 2 years later gold was found in the gravels of the Aniak River. From 1909 through 1959 the district produced 230,555 ounces of gold; however, the data for 1931–46 are incomplete. The district was active in 1959.

Flood-plain and bench gravels have been productive. The gold probably has been derived from small quartz stringers in the country rock composed of sandstone, shale, agglomerate, and fine-grained tuffaceous rocks. A granitic stock cuts the sedimentary rocks and probably was responsible for the mineralization (Maddren, 1915, p. 327).

NORTHWESTERN ALASKA REGION

The vast, sparsely populated Northwestern Alaska region lies north of the Yukon drainage basin and the Seward Peninsula. The gold-producing districts, which are in the southern part, lie in the Kobuk and Noatak River basins.

In the late 1890's part of the horde of prospectors attracted to Alaska from the crowded Klondike fields discovered gold placers in the Kobuk River valley, and the rush that ensued culminated with about 800 men populating the valley (Smith and Mertie, 1930, p. 321). Activity declined in a few years, and these placers were never as productive as those in the neighboring Yukon basin.

The Shungnak district in the Kobuk River basin is the largest producer in the region. Small amounts of placer gold were produced from the Squirrel Creek area and the Noatak River valley. Auriferous veins are known in the Shungnak and Noatak areas, but these are little more than prospects (Smith and Mertie, 1930, p. 336–339).

Recorded gold production from the Northwestern Alaska region began in 1905. Total production through 1959 was about 23,000 ounces; presumably all production was from placers.

SHUNGNAK DISTRICT

The Shungnak district is in the Kobuk River valley between lat 66°50′ and 67°10′ N. and long 156°50′ and 157°25′ W. This was the major gold-producing district of Northwestern Alaska, having had a total production valued at approximately $200,000 (about 9,700 ounces) to 1930 (Smith and Mertie, 1930, p. 321). From 1930 through 1959 a few hundred more ounces were mined. The total production through 1959 probably was between 10,000 and 15,000 ounces.

The district was activated by the rush to the Kobuk River valley in 1898, but by 1910 it was almost deserted (Smith and Eakin, 1911, p. 271). Small amounts of gold were produced through the succeeding years to 1955.

Much of the district is underlain by metasedimentary rocks consisting of quartzose schist, crystalline limestone, and sheared conglomerate. Locally these rocks are mineralized and the gold placers are thought to be derived from such deposits (Smith and Eakin, 1911, p. 282–284).

SEWARD PENINSULA REGION

The gold placers of the Seward Peninsula, in western Alaska, rank second in production among Alaska's placer regions. The following description of its mining history has been abstracted from an excellent and detailed account by Collier, Hess, Smith, and Brooks (1908, p. 13–39).

Placer gold was discovered on Seward Peninsula in 1855–56 by Baron Otto von Bendeleben, an engineer leading a party exploring a possible route for a telegraph line. Nothing, apparently, came of this discovery, for as late as 1897 the Seward Peninsula was regarded as a wasteland. But about this time the rushes to the Klondike and the upper Yukon brought in many gold seekers who eventually prospected the lowly regarded gravels along the streams of Seward Peninsula. Discoveries were made at Council in 1897, and in 1898 the Nome district was organized. News spread slowly because of the isolation of this new district, but by 1899 the rush had begun and, swelled by new discoveries of beach placers and auriferous bench gravels, it continued through 1900.

In 1900, mining of placers began in the Fairhaven district in the northeastern part of the peninsula, and small production was made from discoveries in the Kougarok, Port Clarence, and Council districts. The Solomon-Bluff district, along the southern coast just east of Nome, also began producing placer gold in 1900, and from 1903 to 1907 lode gold was mined from the Big Hurrah mine in this district. During 1908–59 only very minor amounts of lode gold were produced from scattered localities on the peninsula.

The Koyuk district was not productive until 1918

even though for some years gold had been known in the gravels of the Koyuk River and Alameda Creek, one of its tributaries.

Through the 1950's placer mining continued to flourish on the Seward Peninsula, although at a somewhat lower rate than before World War II. The Nome district has been by far the largest producer; Council, Fairhaven, Solomon-Bluff, Kougarok, Koyuk, and Port Clarence have produced progressively lesser amounts. Total gold production of the Seward Peninsula from 1897 through 1959 was 6,060,000 ounces; all but about 10,000 ounces was from placers.

The geology of the Seward Peninsula was described by Collier (in Collier and others, 1908, p. 60–110). The peninsula is underlain chiefly by metasedimentary rocks comprising the Kigluaik and Nome Groups of early Paleozoic or older age and by unnamed slates, phyllites, and limestones some of which may be as young as Mississippian. Collectively these rocks can be considered a sequence of limestone, biotite gneiss, slate, quartzite, dark phyllite, and schist, cut locally by small bodies of greenstone and granite. Basalt of Pleistocene age covers a sizable area in the northeast part of the peninsula. Quaternary gravels blanket the low-lying coastal areas and occur in all the major stream valleys.

COUNCIL DISTRICT

The Council district, in the southern part of the Seward Peninsula, includes all the drainage area of Golovnin Bay extending eastward almost to the Tubutulik River.

Although gold had been reported in the Council area as early as 1865, there was very little excitement and no mining until after the discoveries of the rich Ophir Creek gravels in 1896–97 (Smith and Eakin, 1910, p. 343). Production began in 1900, and the district was still active in 1959. Total production through 1959 was about 588,000 ounces, all from placers. Data for 1931–46 are incomplete.

Nearly all production came from creek gravels and bench deposits in the drainage basin of the Niukluk River—including Ophir, Melsing, Goldbottom, Mystery, and Elkhorn Creeks (Collier and others, 1908, p. 238). The following summary of the geology is from Collier, Hess, Smith, and Brooks (1908, p. 234–235).

The district is underlain by rocks of the Kigluaik Group and the Nome Group, except in the southeast where part of a large granite mass forms the bedrock. Schists of the Nome Group contain numerous small veins and stringers of quartz and calcite, many of which contain gold along with sulfides. The gold of the placers is believed to have come from these veins.

FAIRHAVEN DISTRICT

The Fairhaven district, about 40 miles long and 20 miles wide immediately south of Kotzebue Sound in the northeast part of Seward Peninsula, is bounded roughly by lat 65°40′ and 66°10′ N. and long 161°40′ and 163°20′ W.

Gold was discovered in this district in 1900 on Old Glory and Hannum Creeks, and although there was no production that year, the news of the discovery spread through crowded Nome that winter and prompted a rush to the new district in the spring of 1901 (Moffit, 1905, p. 49). Rich placers, the most productive in the district, were found along Candle Creek in 1901 (Moffit, 1905, p. 49). The district produced steadily and was still active in 1957. Total recorded production through 1959 (data are incomplete for 1931–46) was 379,200 ounces, all from placers.

The predominant bedrock in the district is a series of micaceous, chloritic, and graphitic schists with intercalated thin limestones believed by Collier (in Collier and others, 1908, p. 65) to be Devonian or Silurian in age. Unaltered conglomerate, sandstone, and shale unconformably overlie the schists in a few areas. Locally coal beds are present. Small bodies of granite and quartz diorite intrude the schists, but their age relations with the unaltered sedimentary rocks are not clear (Collier and others, 1908, p. 83, 108). Large areas of the district are covered by sheets of basaltic lava, remnants of a more extensive cover. The youngest of these flows is Pleistocene; the age of the older lavas has not been satisfactorily determined (Moffit, 1905, p. 34). Low-lying coastal areas and river valleys are blanketed by unconsolidated gravels. The gold of the placers was concentrated from small amounts disseminated in quartz veinlets and stringers in the schistose country rock. These low-grade lodes have never been productive.

KOUGAROK DISTRICT

The Kougarok district is in the central part of the Seward Peninsula between lat 65°10′ and 65° 45′ N. and long 164°20′ and 165°20′ W.

The district began producing gold in 1900, after the initial discoveries the previous year sparked a rush from Nome (Brooks, in Collier and others, 1908, p. 306–307). Because of its remoteness and its paucity of bonanza-type deposits, the district developed slowly. Water shortage necessitated the construction of ditches. By 1906 several ditches were completed and sufficient water for larger scale

operations was assured. Afterward, the Kougarok placers were moderately productive and were active in 1957. A total of about 150,400 ounces of gold has been produced from the district, all from placers. This is a minimum total as data for 1931–46 are incomplete.

The geology of the district was discussed by Brooks (in Collier and others, 1908, p. 297–298) and is summarized as follows. The bedrock consists of the Kigluaik and Nome Groups—the former is predominantly schist and granite; the latter is made up of a sequence of phyllite, schist, greenstone, and a consistent unit, the Port Clarence Limestone. The schistose rocks of the Nome Group contain small auriferous quartz veinlets and stringers which appear to be the source of the placer gold that has been concentrated into minable quantities in present stream gravels, bench gravels, and floodplain gravels. The lodes themselves are not of economic value.

KOYUK DISTRICT

The Koyuk district, in the southeast corner of the Seward Peninsula between lat 64°55′ and 65°40′ N. and long 160°20′ and 162°00′ W., includes the drainage area of the Koyuk River.

Although gold placers were known along Alameda and Knowles Creeks in 1900 (Smith and Eakin, 1910, p. 336–340), the area remained inactive until 1918. From 1918 to 1959, a recorded total of about 52,000 ounces of placer gold was produced, but the years 1931 through 1946 are not represented in this total because production data for these years cannot be found. The district was active in 1959.

NOME DISTRICT

The Nome district is in the south-central part of the Seward Peninsula between lat 64°25′ and 64° 57′ N. and long 165°00′ and 165°30′ W. More than half the gold mined on the peninsula has come from Nome placers. The brief summary that follows was abstracted from Brooks' (in Collier and others, 1908, p. 13–39) detailed history of mining on the Seward Peninsula.

Soon after the discoveries of placer gold at Council in 1897, placer gold was discovered on the Snake River near Nome and a short while later on Anvil Creek, Snow Gulch, Glacier Creek, and other streams. Miners streamed into the area from Golovnin Bay, and the Nome district was formed in October 1898. A great rush to the new district took place in 1899 and a still greater one in 1900. The new town was bursting, and the known placer grounds could not accommodate all those who sought gold. The unrest thus created led to claim jumping and general lawlessness which taxed the small military garrison to the utmost. With the discovery of rich beach placers in the district, this unhealthy situation was relieved somewhat in that a large new area was available for prospecting and the miners were diverted to gold mining instead of preying upon one another. After 1900, the population stabilized somewhat and with additional discoveries of deep gravels and buried beach placers, the district settled down to a long period of economic stability and orderly growth.

Production of the district from 1897 through 1959 was about 3,606,000 ounces of gold, almost all production was from placers. Data are lacking for 1931–46, so that the total given is a minimum. Cobb (1962) reported small but undisclosed production from scattered lode claims in the district. The Nome district, one of the major producers of Alaska, was active in 1959.

The Nome placers are of several varieties—residual, stream, bench, and beach. Moffit (1913, p. 74–123) discussed these in detail, and his work is the source of information in the summary presented here.

Residual placers, produced by the solution and erosion of less durable components of bedrock, have been mined profitably at a few localities, particularly at Nekula Gulch.

Stream placers are gravels that contain gold that was removed either directly from bedrock or from older gravels that contained gold. Important among the stream placers are those on Anvil Creek, Dexter Creek, and other tributaries of the Nome and Snake Rivers.

The high bench placers are remnants of deposits of an older drainage system. Present streams have eroded away most of these deposits, so that only benches remain. Such placers occur at the head of Dexter Creek and have been profitably mined.

Rich placers occur in sands of the present beaches and in older beaches that were elevated above present sea level and then buried in coastal plain deposits. Five or six ancient beaches are known and have been given local names. The second and third beaches (the present beach is the first) have been the most productive.

Structures of two ages are identifiable in the metamorphic bedrock (Hummel, 1960). The older and major set consists of large north-trending folds of Mesozoic age transected by younger east-trending folds of Tertiary age. The younger system is also characterized by three sets of faults. Some of the minor faults and joints of the younger defor-

mation are mineralized, and these lodes are probably the source of the gold in the Nome placers.

PORT CLARENCE DISTRICT

The Port Clarence district, an area of about 2,000 square miles on the west end of the Seward Peninsula, has produced small amounts of placer gold from the Bluestone and Agiapuk River basins and from a few streams that drain into Grantley Harbor. The district was prospected as early as 1898, and by 1903 an estimated $200,000 in gold had been produced (Collier and others, 1908, p. 269). Total recorded production through 1959 is about 28,000 ounces, all from placers, but 1931–46 production is not recorded. Since World War II there has been only small-scale activity.

The district is underlain by schist, limestone, and small intrusive bodies comprising the Kigluaik and Nome Groups of early Paleozoic or older age, and by Devonian(?) slate and Carboniferous(?) limestone. Stocks and dikes of granite and greenstone intrude the metasedimentary rocks. Quaternary gravels contain gold placers which are restricted in general to areas underlain by rocks of the Nome Group. These rocks seem to contain more auriferous veinlets and stringers than the other bedrock types. The foregoing account is from Collier, Hess, Smith, and Brooks (1908, p. 268–281).

SOLOMON-BLUFF DISTRICT

The camps of Bluff and Solomon, an area enclosed by lat 64°30′ to 65°00′ N. and long 163°30′ to 164°30′ W., are combined here.

Gold was first discovered in this district in 1898 in gravels along the Casadepaga River, a tributary of the Solomon River. The following year other placers were found along the Solomon and on the beach of the mouth of Daniels Creek in the Bluff camp (Brooks, in Collier and others, 1908, p. 288). The beach placers were exhausted in about a year, but more extensive placers were found along Daniels Creek and along Hurrah and Shovel Creeks in the Solomon camp. These were worked by dredges and hydraulic methods (Smith, 1910, p. 139). The only important gold-quartz mine on the Seward Peninsula was the Big Hurrah in the Solomon camp, which was active from 1900 to 1937.

A total of 251,000 ounces of placer gold has come from the Solomon-Bluff district not including production from 1931 to 1946 for which records have not been found. Lode production was 9,375 ounces; all was presumably from the Big Hurrah mine. Total production recorded for the district is 260,375 ounces. No production was recorded from 1937 through 1959.

The district is underlain by rocks belonging to the lower part of the Nome Group of early Paleozoic or older age. These are a series of schist, slate, and limestone. The metasedimentary rocks were intruded by basic igneous rocks, were later altered to schist and greenstone, and were finally intruded by basalt (Smith, 1910, p. 49–137). Unconsolidated deposits consist of coastal plain deposits, stream gravels, and high-level gravels.

The lode deposit at the Big Hurrah mine consists of several quartz veins in a dense, hard, quartzitic, graphitic schist. There is a noticeable absence of sulfides; the minerals consist almost exclusively of native gold in quartz (Smith, 1910, p. 144).

The gold in the placers, which consist of stream and beach gravels in the Bluff area and stream and bench gravels in the Solomon area, was derived from disseminations and veinlets in rocks of the Nome Group, particularly in the schist and in the vicinity of schist-limestone contacts (Smith, 1910, p. 214–216).

SOUTHEASTERN ALASKA REGION

Southeastern Alaska, the panhandle of Alaska, is the narrow coastal strip that extends southeastward from the main peninsula and is bordered on the north, east, and southeast by Canada. Important gold-producing districts in this region are Juneau, Chichagof, Ketchikan-Hyder, and Porcupine. For the purpose of this report, the Yakataga district, which lies just to the northeast of what is usually considered to be the Southeastern Alaska region, is included in this section.

Gold was known in this region in the days of Russian ownership of Alaska, but no mining was done until 1870–71 when about $40,000 was produced from placers at Windham Bay and on nearby Powers Creek at Sumdum Bay in the Juneau district (Buddington and Chapin, 1929, p. 8). The important discoveries in the Juneau district were not made until the period 1880–85. During the 1890's and early 1900's lode gold mines began significant production in the Ketchikan and Chichagof districts, and beach placers were mined in the Yakataga district.

The Alaska Juneau mine in the Juneau district yielded the bulk of the gold produced in the Southeastern Alaska region. When this mine closed in 1944, the production of the entire region dropped accordingly to only a few hundred ounces annually.

Total gold production through 1959 for Southeastern Alaska was 7,788,514 ounces, of which

7,614,791 ounces was from lode deposits, 138,503 ounces was from placers, and 35,220 ounces was a byproduct from copper ores from the Ketchikan-Hyder district.

This is an extremely mountainous region with complex geologic structures and varied bedrock types. Dominant among the geologic features are the intrusive rocks of Late Jurassic or Early Cretaceous age that occupy much of the mainland area of this region. These rocks range in composition from gabbro to granite and are believed to be related to the great composite Coast Range batholith (Buddington and Chapin, 1929, p. 173–253). Adjacent to the intrusive rocks on the west is a belt of low-rank metasedimentary rocks comprising the Wales Group of early Paleozoic age. Other sedimentary rocks in this region represent every period from Ordovician to Cretaceous and have an aggregate thickness of about 50,000 feet. Tertiary clastic rocks and lavas accumulated in a trough between the major mountain ranges. A few sills and dikes of basalt and andesite cut the Tertiary rocks (Buddington and Chapin, 1929, p. 260–275). Quaternary deposits are of minor areal extent and consist mostly of marine gravels, delta deposits, basalt, and tuffs (Buddington and Chapin, 1929, p. 275–281).

CHICHAGOF DISTRICT

The Chichagof district comprises an area of about 4,500 square miles and includes Baranof, Chichagof, Kruzof, and Sitka Islands.

The first attempts at lode mining in Alaska, under American rule, were made near Sitka in 1871 (Knopf, 1912, p. 8). These ventures and others in the succeeding few years failed, and mining in the Sitka area lapsed into a period of dormancy until the lode discoveries were made at Klag Bay on Chichagof Island in 1905. The Chichagof mine soon became the big producer here, with a production from 1906 through 1938 of $13,784,710 in gold (Reed and Coats, 1941, p. 89). The Hirst-Chichagof mine, which went into production in 1922, produced $1,702,624 in gold through 1938 (Reed and Coats, 1941, p. 104). In succeeding years production from these mines dwindled, and the Chichagof district was operating on a very small scale in 1959. The total recorded production for the district through 1959 was 770,000 ounces, all from lode mines.

The general geology of Chichagof and Baranof Islands has been described by Knopf (1912, p. 11–21), and according to him the oldest rocks are chert and quartzite which are overlain by cherty limestone of Silurian age. Devonian limestone and tuff, Mississippian limestone, Permian or Triassic gypsiferous limestone, Mesozoic graywacke, and postglacial lavas and tuffs complete the stratified rock sequence. The central parts of the islands are composed of masses of granitoid rocks, dominantly quartz diorite of late Mesozoic age. In the Klag Bay area of Chichagof Island masses of greenstone and greenstone schist of possible Triassic age (Reed and Coats, 1941, p. 14–22) occur between the diorite and graywacke. The stratified sedimentary rocks lie on the west bank of an anticlinorium, the axial part of which in this district is occupied by the diorite. Many northwest-trending high-angle faults cut the bedded rocks (Reed and Coats, 1941, p. 64).

The ore deposits are in plunging quartz bodies along the faults. Quartz is the main constituent of these lodes, but calcite may be present. Sulfides, in conspicuously minor amounts, consist of pyrite, arsenopyrite, galena, sphalerite, and chalcopyrite. Gold is present as specks in the quartz and in the sulfides (Reed and Coats, 1941, p. 78–80).

JUNEAU DISTRICT

The Juneau district includes Douglas and Admiralty Islands, lat 57°00′ to 59°00′ N. and long 133°00′ to 135°00′ W.

Placer discoveries were made in 1869 at Windham Bay and at Sumdum Bay, about 50 miles south of Juneau, and lode gold, which has been the mainstay of the district, was discovered in 1880 by Joe Juneau and Richard Harris whose locations included the site of the Alaska Juneau mine, the largest lode gold mine in Alaska (Wright, 1906, p. 2). The discovery resulted in a rush to the area and the founding of the town of Juneau, which, by 1883, became the locus of gold mining in Alaska. Numerous lode properties were located near Juneau and on neighboring Douglas Island where the Treadwell group—including the Treadwell, Mexican, Ready Bullion, and 700 Foot mines—was quickly developed into a major producer, yielding $26,556,470 in gold through 1905. Caving, which began in the Treadwell and 700 Foot mines as early as 1913, culminated with the complete flooding of the Treadwell, 700 Foot, and Mexican mines in 1917 (Eakin, 1918a, p. 78–79). These mines were never reopened, but the Ready Bullion remained productive until 1922 (Brooks and Capps, 1924, p. 24). Other important mines in the early days of this camp were the Sumdum and Ebner. Production records for the Alaska Juneau mine began in 1893 and are complete to April 9, 1944, when the mine was closed due to manpower shortages and excessive costs (C. W. Henderson and R. V. Cushman, in U.S. Bureau of

Mines, 1945, p. 232). This mine yielded a total of 2,874,361 ounces of gold, almost as much silver, and large quantities of lead. The closing of the Alaska Juneau mine signaled the end of gold mining in Southeastern Alaska. Only a few hundred ounces of gold were produced annually from the entire region from 1944 through 1959.

Total gold production of the Juneau district from 1882 through 1959 was 6,883,556 ounces—66,279 ounces from placers, the remainder from lodes.

The eastern part of the district is underlain by the dioritic and granitic intrusives composing the Coast Range batholith of Late Jurassic or Early Cretaceous age (Buddington and Chapin, 1929, p. 173–175). This is flanked on the west by several north-trending bands of schist, slate, and greenstone (Spencer, 1906, p. 16–19) which according to Buddington and Chapin (1929, p. 73–74) may include rocks ranging in age from Ordovician to Cretaceous. Still farther west is a band of interbedded slate and graywacke with some greenstone which Buddington and Chapin (1929, p. 157) consider Jurassic or Cretaceous. The rocks have been folded into a northwest-trending synclinorium, bounded on the east by the Coast Range batholith and on the west by an anticlinorium (Buddington and Chapin, 1929, p. 289–290).

The gold deposits of the Juneau district, according to Spencer (1906, p. 22–24), are of three types: veins, impregnated deposits, and combinations of these two types, or mixed deposits. Though other rock types may be mineralized, most of the deposits are found in the slate and greenstone. The veins vary considerably in thickness, trend, and continuity. Quartz is the main constituent; however, calcite is common, and albite is abundant in some veins. Pyrite, galena, sphalerite, and arsenopyrite are the common sulfides. Gold is either associated with pyrite or arsenopyrite or is found as small flakes in the quartz (Spencer, 1906, p. 33–36). In the impregnated deposits, the country rock has been replaced by large masses of the sulfides listed above, but these deposits are relatively unimportant as a source of gold. The mixed deposits were the most important of the three types at the famous Treadwell mines (Spencer, 1906, p. 24).

KETCHIKAN-HYDER DISTRICT

The Ketchikan-Hyder district includes the southern end of the Alaska panhandle, roughly the area between lat 54°20′ and 57°00′ N. and long 130°00′ and 134°00′ W.

Most of the early mining interest in Alaska was centered in Sitka and Juneau, and Ketchikan was neglected for many years. But in the late 1890's discoveries of gold and copper were made at Ketchikan, and this together with the news of the Klondike successes encouraged many people to prospect the new area (Brooks, 1902, p. 39). By 1900 there was feverish activity in the district with several mines open and many claims located. Gold was produced from auriferous veins and from copper ores.

At Hyder, near the Canadian border, lode deposits of gold were discovered in about 1901 but were neglected until 1909, when a short-lived boom occurred (Buddington, 1929, p. 2–3). In the 1920's there were several small discoveries near Hyder that caused some mild excitement.

Production of gold from the Ketchikan-Hyder district amounts to about 62,000 ounces, of which 35,000 ounces is byproduct gold from copper ores and 27,000 ounces is from lode mines. Data for 1938–46 are incomplete. The district was still active in 1959, though only small quantities of byproduct gold were produced.

The oldest rocks in the district are limestone and phyllite of Silurian or pre-Silurian age. These are overlain by limestone, slate, and schist of probable Middle Devonian age. In the central part of the district the Devonian rocks are overlain by argillite, limestone, and sandstone of the Ketchikan Series, partly of Paleozoic and Mesozoic age. Locally, Mesozoic conglomerates overlie the Devonian rocks. A broad belt of granite (or diorite), part of the Coast Range batholith, underlies the eastern part of the district (Brooks, 1902, p. 40–41), but the most widely distributed igneous rock is the Kasaan Greenstone, which is the oldest of the intrusive rocks. Warner, Goddard, and others (1961, p. 13) imply that the greenstone is of Mesozoic age, but older than Cretaceous. In general the metasedimentary rocks throughout the district occur in northwest-trending bands (Brooks, 1902, p. 51).

The geology of the Hyder area is summarized as follows from Buddington (1929, p. 13–42). The Hazelton Group, of probable Jurassic age, is composed of greenstone, tuff, breccia, graywacke, slate, argillite, quartzite, and some limestone, and it occurs as large disconnected patches in the east and west parts of the area. The beds are tightly folded and strike predominantly to the east. A granodiorite batholith, called the Texas Creek batholith, intruded the Hazelton Group, and the Hyder Quartz Monzonite and the Boundary Granodiorite intruded both the Hazelton Group and Texas Creek batholith. The intrusive rocks are of Jurassic or Cretaceous age and are genetically related to the Coast Range batholith.

The ore deposits are somewhat varied in this district; commercial amounts of silver, copper, iron, lead, and zinc are present in addition to gold. The ore deposits are of four general types—vein deposits, breccia veins, mineralized shear zones, and contact metasomatic deposits. The veins occur in the oldest rocks of the district. They range in width from a few inches to 10 feet or more and are made up of quartz, calcite, pyrite, chalcopyrite, galena, sphalerite, and gold (Wright and Wright, 1908, p. 80–81). Breccia veins, most abundant in the limestone and schist, consist for the most part of quartz-cemented country rock. Auriferous sulfides may be in limestone fragments or in the quartz (Wright and Wright, 1908, p. 81–82). The shear zone deposits range in width from 5 to 50 feet and follow the structure of the enclosing rock—most commonly slate or greenstone. The dominant minerals are quartz and calcite in veinlets and chalcopyrite and pyrite disseminated throughout the rock. Gold occurs in the quartz-calcite veinlets (Wright and Wright, 1908, p. 82–83). The contact metamorphic deposits are in limestones near their contacts with intrusives. These deposits consist of masses of chalcopyrite, pyrrhotite, pyrite, and magnetite in a gangue of garnet, epidote, calcite, quartz, amphibole, and wollastonite. Both copper and gold are produced from these deposits (Wright and Wright, 1908, p. 83–84). On the Kasaan Peninsula, contact metasomatic deposits of magnetite, pyrite, and chalcopyrite are found in association with tactite bodies in layers and lenses of metamorphosed sedimentary rocks in the Kasaan Greenstone (Warner and others, 1961, p. 30–52).

Worthy of special mention is the Salt Chuck mine on the Kasaan Peninsula. Originally located as a copper prospect in 1905, this deposit was later found to contain platinum minerals and gold and silver in recoverable amounts (Holt and others, 1948, p. 3). The ore bodies are masses of bornite and chalcopyrite that have replaced and filled fractures in a pyroxenite country rock (Mertie, 1921, p. 124–125). According to Holt, Shepard, Thorne, Tolonen, and Fosse (1948, p. 4), a total of 326,000 tons of ore with an average gold content of 0.036 ounces per ton was produced from the beginning of mining to the spring of 1941. This amounts to 11,736 ounces of gold.

PORCUPINE DISTRICT

The Porcupine district is just north of lat 59°15′ N. at long 136°20′ W. along Porcupine Creek, a tributary of the Klehini River.

Productive gravels were discovered in 1898 along Porcupine Creek and its tributaries (Wright, 1904, p. 12). The era of greatest activity was from 1900 to 1906 when about $100,000 in gold per year was produced. Between 1915 and 1917, hydraulic equipment was installed which accounted for a brief rejuvenation of the district (Eakin, 1918b, p. 99), but from 1917 through 1959 there was only occasional small-scale production by individuals. Total production for the district through 1959 is 53,250 ounces, all from placers.

Eakin's report (1919, p. 9–21) on the Porcupine district is the source of the data on geology and placer deposits given here.

The northeast part of the district is underlain by dioritic rocks of the Coast Range batholith. Bordering this on the south is a northwest-trending belt of phyllite, slate, and limestone of Late Pennsylvanian or Early Permian age. An elongate mass of diorite cuts the metasedimentary rocks in the west and southwest part of the district. The metasedimentary rocks are also cut by numerous stringers of quartz and calcite carrying variable amounts of sulfides, and locally the rocks are impregnated with lenticular masses of sulfides.

Placers consist of creek gravels, side benches, and high benches. The gold probably was derived locally by erosion of the auriferous sulfides in the country rock.

YAKATAGA DISTRICT

The Yakataga district, an area of about 1,000 square miles, is between lat 60°00′ and 60°30′ N. and long 141°20′ and 144°40′ W., just west of the northern end of the panhandle that forms southeast Alaska.

The date of discovery of ore in the Yakataga district is unknown. According to Maddren (1913b, p. 133), gold was first found in the beach sands at Yakataga about 1897 or 1898, but Smith (1933, p. 96) listed the first production for the area in 1891. During the first years the beach sands were worked with simple rockers. Later, several attempts at larger scale mining, by using sluice boxes, were made (Maddren, 1913b, p. 133–134). Bench gravels along the White River were found to be gold bearing and these have been worked intermittently by hydraulic methods. Total recorded production for the district from 1891 through 1959 was only 15,709 ounces, all from placers. In 1959 the district was virtually inactive; less than 75 ounces was reported from 1950 through 1959.

In the northern part of the district the high St. Elias Range, which dominates the landscape, is composed of intensely contorted metamorphic and intrusive rocks. The Robinson Mountains, in the

central part of the district, are composed of Tertiary and Pleistocene sedimentary rocks in northwest-trending folds. In the south, the district is covered with outwash gravel and fluvial deposits (Maddren, 1913b, p. 126–132). The gold in the beach placers was concentrated by wave action from the glaciofluvial deposits of the White River. The ultimate source of the gold was the crystalline rocks of the St. Elias Range from which the gold was removed either by glaciers or by Pleistocene streams and was redeposited at lower levels. The present stream system of the White River reworked the auriferous outwash gravel and Pleistocene fluvial deposits and concentrated the gold in channel sands which now form low benches that are being eroded (Maddren, 1913b, p. 142–143).

SOUTHWESTERN ALASKA REGION

In the Alaska Peninsula, which forms the Southwestern Alaska region, only the Unga district contains commercial gold deposits of any magnitude. There has been scattered production from the Kodiak area, where lodes and beach placers were mined on a small scale, but more than 90 percent of the total production has come from Unga. Total recorded production for Southwestern Alaska through 1959 is 112,570 ounces, of which 108,000 ounces is of lode origin and 4,570 ounces is from placers.

UNGA DISTRICT

Unga is an island, one of the Shumagin Group, between lat 55°10′ and 55°23′ N. and long 160°30′ and 160°50′ W.

Almost the entire production of this district is attributed to the Apollo Consolidated mine which began production in 1891 and by 1904 yielded between $2 and $3 million (Martin, 1905, p. 100). Production decreased markedly after 1905 and ceased after 1922. Total production through 1959 was 107,900 ounces, all of lode origin.

The country rock is andesite and dacite believed by Becker (1898, p. 83) to be Miocene or younger and by Martin (1905) to be somewhat older than Miocene. Sedimentary rocks that range in age from Oligocene to Pliocene (MacNeil and others, 1961, p. 1802) are also present on Unga Island, but their relations with the igneous rocks cannot be determined from the published literature. Becker (1898, p. 84) described the deposit as a reticulated vein—a zone of fractures that was mineralized. The wallrocks are much altered and have been replaced by chlorite and pyrite. Gangue minerals are sugary quartz with some calcite, and the ore minerals are free gold, pyrite, galena, sphalerite, chalcopyrite, and native copper (Becker, 1898, p. 83).

YUKON REGION

The vast Yukon region encompasses the entire drainage basin of the Yukon River in Alaska. It has the shape of a truncated wedge extending across central Alaska. The region is narrower (80 to 100 miles wide) along the west coast of Alaska at the mouth of the river and wider (200 to 300 miles) along Alaska's eastern border, where it includes the basins of the Yukon and one of its main tributaries, the Tanana. This has been by far the most productive of all the gold-producing regions, with a recorded total through 1959 of 12,282,250 ounces, most of it from placers.

Goodrich's detailed account (in Spurr and Goodrich, 1898, p. 103–131) of the early explorations, the discovery of gold, and the development of the first mining districts is the source of much of the material presented here.

The Yukon region had been traversed rather thoroughly after the 1840's by explorers and traders intent on establishing new posts and opening new country for the fur trade. A lively competition which developed among the Russians, the Hudson Bay Co., and the Americans was terminated by the purchase of Alaska by the United States.

In the 1860's small quantities of gold had been found at several localities in the Yukon basin, but credit for the discovery that led to intensive prospecting goes to George Holt, who made several trips to the Yukon in the 1870's and returned with glowing, if not entirely veracious, tales of gold in the interior. In 1881 a few prospectors panned some gold along the Big Salmon River, one of the tributaries of the Yukon River in the Yukon Territory, Canada. A year later, prospectors working up the Yukon from its mouth found gold in considerable quantities near what is now Rampart, in central Alaska. Discoveries in the 1880's along the boundary between Alaska and Canada in the Fortymile River area were developed rapidly, and by 1893 more than 300 men were working the gravels. Birch Creek in the Circle district next attracted attention and it soon rivaled the Fortymile district. Between 1890 and 1895 gold-bearing gravels were found along the Koyukuk River and additional discoveries were made in the Rampart area and in the adjacent Hot Springs district.

In 1902 gold was discovered in the Fairbanks district (Prindle, 1904, p. 64) which in the succeeding years developed into the leading producer

in Alaska. The Fairbanks discoveries stimulated prospecting to the south in the foothills of the Alaska Range, and placers were found in the Bonnifield country in 1903 and the Kantishna district in 1906 (Prindle, 1907, p. 205).

At about the same time, commercial quantities of gold were found several hundred miles to the west in the gravels of the upper valley of the Innoko River and this led to discoveries on the adjacent Iditarod River. In about 1910 placers were found along Long Creek in the Ruby district, about 70 miles east of Koyukuk (Mertie and Harrington, 1924, p. 88, 89, 101). One of the most recently discovered placer districts in the Yukon region is the Tolavana district situated along the Tolovana River, a tributary which joins the Tanana River about 100 miles west of Fairbanks. Mining of these placers began in 1915 (Brooks, 1916, p. 201).

Most of the placer districts of the Yukon basin remained active after World War II, through 1959, though production decreased because of the constantly rising mining costs especially since 1950.

Only two districts—Fairbanks and Nabesna—have had any significant lode production, but this is dwarfed by the placer output. The Yukon basin has yielded a total of 12,282,250 ounces of gold, of which 10,776,460 ounces is from placers, 305,560 ounces is from lode deposits, and 1,200,230 ounces is undifferentiated but presumably from placers. It may seem strange that from such a large region so few commercial vein deposits have been exploited; however, several factors must be considered in an analysis of this imbalance. First, the placers are amenable to large-scale dredging methods which means that low-grade material can be mined even at present high costs. Secondly, the remoteness of the areas containing the lode deposits demands large tonnages of high-grade ores for profitable mining.

It is difficult to summarize the geology of a region as large as the Yukon drainage basin, especially in view of the fact that the region has not been completely mapped and the areas that are mapped were done at different scales at different times and by numerous individuals. The upper part of the basin, the Yukon-Tanana area, was mapped first by Spurr (in Spurr and Goodrich, 1898) and then by Mertie (1937), but that part of the basin from the junction of the Yukon and Tanana to the mouth of the Yukon has been mapped in small parcels by individuals investigating only certain districts.

In the upper part of the basin, stratified rocks ranging in age from Precambrian to Recent are exposed. Representatives of every period except Jurassic are present (Mertie, 1937, p. 44–46). Mesozoic and Tertiary granitic intrusive rocks are the most important members of the igneous family in this area, and it is believed that the metalliferous ore deposits are related to them (Mertie, 1937, p. 46).

Farther downstream, in the Ruby area, greenstones and undifferentiated metamorphic rocks of Paleozoic age and older are the predominant country rocks (Mertie and Harrington, 1924, p. 12).

In the Innoko and Iditarod districts, which may be considered the lower reaches of the Yukon, Mesozoic sedimentary rocks, chiefly Cretaceous in age, compose most of the country rock. These are interlayered locally with basic igneous rocks. Granitic intrusions make up the mountain areas, and rhyolite dikes are scattered throughout the area (Eakin, 1913, p. 295).

Throughout the Yukon basin, large areas are covered with fluvial deposits that form flats tens of miles wide. The entire region has a complex geomorphic and structural history, much of which is fairly recent in age, but not enough work has been done in the region to interpret the many anomalous features of the present drainage (Mertie, 1937, p. 237).

BONNIFIELD DISTRICT

The Bonnifield district is between lat 63°30′ and 64°50′ N. and long 145°40′ and 149°20′ W. It extends from the Tanana flats on the north to the north slope of the Alaska Range on the south, and it is bounded on the west and east by the Nenana and Delta Rivers, respectively.

The first gold was mined from the gravels of Gold King Creek in 1903. During the early years there were high hopes that the Bonnifield would become a major district, but only small amounts of gold were produced annually, and after 1949 the district was idle. Total production through 1959 was about 36,600 ounces, all from placers.

The geology, as outlined by Capps (1912, p. 17–19), is as follows. The oldest rocks in the district are metasedimentary rocks of Precambrian or early Paleozoic age—the Birch Creek Schist, consisting of quartz and mica schist, phyllite, and quartzite. Mertie (1937, p. 46) considered the Birch Creek to be Precambrian in age. The Birch Creek Schist is overlain by quartz-feldspar schists forming the Totatlanika Schist of Silurian or Devonian age. A sequence of Tertiary sediments beginning with Eocene fresh-water deposits unconformably overlies the schists. The fresh-water deposits are followed by the Nenana Gravel of middle Miocene to early Pliocene age (MacNeil and others, 1961, p.

1806) and Pleistocene and Recent glaciofluvial deposits. The schists are highly contorted, and as the Alaska Range rose in Tertiary time the Tertiary beds were subjected to considerable folding and faulting immediately after their deposition. Intrusive rocks of granitic to dioritic composition cut the schists at various localities. These bodies are older than Eocene and younger than Silurian or Devonian (Capps, 1912, p. 41–42).

The placer deposits are in the foothills between the Tanana Flats to the north and the high slopes of the Alaska Range to the south. Present streams have cut through valleys previously filled with alluvium and have reconcentrated and redeposited the detrital gold of the older alluvium.

CHANDALAR DISTRICT

The Chandalar district, between lat 67°00′ and 68°10′ N. and long 147°00′ and 150°00′ W., includes the upper drainage of the Chandalar River.

The Chandalar district, which began producing placer gold in 1906, is one of the small producers of the Yukon basin. Total placer production through 1959 was 30,708 ounces. Cobb (1962) indicated small but undisclosed lode production from the district.

Lode deposits, which have been known in the district for many years, have recently received renewed attention. In 1961 the Little Squaw Mining Co. reported blocking out an ore body worth $1,013,000 in gold (Mining World, 1961).

The geology given here is generalized from a more detailed account by Mertie (1925, p. 223–252). Schists, resembling the Birch Creek Schist, of Precambrian or early Paleozoic age are the oldest rocks in the district and are found in the southern part. Other schists and phyllites of early Paleozoic age compose the bedrock in the central part of the district, north of the area underlain by Birch Creek(?) Schist. Silurian limestone and dolomite and Devonian slate occur still farther north. In the southwest corner, Devonian or Mississippian rocks unconformably overlie the schists, and a small patch of Upper Cretaceous sandstone caps the sequence. Igneous rocks in the district consist of granite, granodiorite, and basic lavas, that range in age from Late Silurian or Early Devonian to Tertiary.

The schists contain numerous small auriferous quartz veins and stringers that no doubt were the source of the gold in the placers. Both preglacial and postglacial gravels have been productive.

CHISANA DISTRICT

The Chisana district is between lat 61°55′ and 62°20′ N. and long 141°40′ and 142°35′ W., in the drainage area of the Chisana River, a tributary of the Tanana River.

Gold lodes were known in this area before 1910, but were never developed; then in 1913 placer discoveries along Bonanza Creek started a stampede to the district (Capps, 1916, p. 89–92). The placers, however, were relatively small, and efforts to find and develop lode deposits were unsuccessful. Small amounts of placer gold were produced up to World War II, but since then the output has been insignificant. Total production from 1913 through 1959 was 44,760 ounces, all from placers.

The rocks of the district range in age from Devonian to Recent (Capps, 1916, p. 29–31). The oldest rocks are black shale, basic lava, and pyroclastic of Devonian age which are overlain by a great thickness of Carboniferous lava, tuff, breccia, agglomerate, and some limestone and shale. Shale and graywacke of Mesozoic age are faulted against the older rocks along an east-west line. Several small patches of Tertiary sediments unconformably overlie the Paleozoic rocks, and in the stream valleys considerable areas are covered with glacial debris and stream deposits interbedded with lava flows. Granitic intrusions cut the Devonian and Carboniferous rocks but the exact age of the igneous rocks is not known (Capps, 1916, p. 84–85).

Most of the placers occur in the area of Carboniferous pyroclastic rocks and the granitic intrusions. Capps (1916, p. 96–98) believed that the gold of the placers was eroded from veins in these Paleozoic rocks near their contact with the intrusives and that the present placers are a product of several previous reworkings of Tertiary auriferous gravels, first by streams, then by glaciers, then by the present streams reworking the glacial deposits.

CIRCLE DISTRICT

The Circle district is between lat 65°15′ and 66°00′ N. and long 144°00′ and 146°00′ W.

This is one of the older districts of the region, gold having been discovered along Birch Creek in 1893 (Prindle, 1906, p. 20). Production began the following year and was continuous through 1957. Hydraulic methods were used on nearly all productive streams, particularly along Mastodon Creek. Total production through 1959 was 705,660 ounces, all from placers.

The rocks, as summarized from Mertie (1932, p. 158–161), consist of schist, clastic sedimentary rock, limestone, and granitic rocks ranging in age from Precambrian to Mesozoic. Pleistocene and Recent unconsolidated deposits complete the sequence.

The Birch Creek Schist, the oldest rock, is of Precambrian or early Paleozoic age. Next youngest are lower Paleozoic metamorphic rocks—quartzite, phyllite, and slate—together with graywacke, arkose, limestone, and chert. The Crazy Mountains in the central part of the district are underlain in succession by Silurian or Devonian limestones, basic flows and sedimentary rocks of the Rampart Group of Early Mississippian age, and by a later Mississippian chert formation. Several small bodies of granite are intrusive into all the foregoing rocks, and the placer deposits are in the vicinity of the intrusive bodies. Alluvial deposits in the Circle district represent several erosional periods during Pleistocene and Recent time.

EAGLE DISTRICT

The Eagle district is between lat 64°35′ and 65° 15′ N. and long 141°00′ and 142°40′ W., along Seventymile, American, and Fourth of July Creeks, all tributaries that enter the Yukon River near Alaska's eastern boundary.

Placer gold was first found in 1895 along American Creek, and production began the following year (Mertie, 1938, p. 190). Although it attracted few miners, the Eagle district maintained a small annual production even through the difficult post-World War II years. Production data before 1906 cannot be found and was probably reported under some other district. Total recorded production for the Eagle district from 1906 through 1959 is 40,220 ounces, all from placers.

The district is underlain in the southwest by a large mass of granite of Late Jurassic age that has intruded and thrust upward a series of Precambrian and Paleozoic sedimentary rocks that are now exposed in northwestward-trending bands in the central and northern parts of the district. Lower Cretaceous marine rocks are exposed in the northern part of the district and these are succeeded by a thick series of fresh-water deposits of Late Cretaceous and Eocene age (Mertie, 1930, pl. 12). Post-Eocene uplift caused much of this covering to be removed. Unconsolidated deposits of sand and gravel of Pleistocene and Recent age are in the stream valleys. These sediments reflect a complex geomorphic cycle involving local glaciation, climatic changes, and changes in base level (Mertie, 1930, p. 147–148).

The gold placers are in present stream gravels. The gold in these deposits came originally from small veins related to the granitic mass in the southwest part of the area, but much gold also came from ancient placers in the Upper Cretaceous and Eocene clastics (Mertie, 1930, p. 161–162).

FAIRBANKS DISTRICT

The Fairbanks district, about 300 square miles between lat 64°40′ and 65°20′ N. and long 147°00′ and 148°10′ W., has produced more gold than any other district in Alaska. It is predominantly a placer district, although it also ranks high among the lode districts.

Fairbanks was slow to develop. Placer gold was known in the area as early as 1878 (Mertie, 1937, p. 4), but the active districts of Fortymile, Rampart, and Circle kept all but the most restless away from the Fairbanks area. In 1901 the town of Fairbanks was founded as a trading post, not as a consequence of gold mining (Prindle and Katz, 1913, p. 86). The following year some workable placers were found along Pedro Creek. This discovery brought a rush of miners and prospectors to the district, most of whom became discouraged and left after learning that the rich, easily accessible placers were few and that the large, lower grade deposits were buried and required processing large volumes of material with special machinery. Large investments were needed to purchase and construct hoisting machinery, large dredges, and machinery for thawing the frozen overburden. But gradually, as the obstacles were overcome, it was found that the buried gravels could be mined profitably, and the district prospered as the dredges chewed through huge reserves of auriferous gravels on Dome, Ester, Vault, Cleary, and Chatanika Creeks. Production continued at a high level even after World War II, but in 1959, activity began to diminish. The Fairbanks Daily News-Miner reported (Sept. 15, 1959) that gold dredging was gradually ceasing in this area. Two dredges were closed in 1959 and a third was transferred to the Fortymile district.

Interest in lode mining began after the placers were developed. Small-scale operations were under way in 1910 in Skoogy Gulch and upper Cleary and Fairbanks Creeks (Hill, 1933, p. 51). The peak of lode mining was reached just before World War II. The Pedro Dome and Ester Dome areas contain the most productive lode deposits.

The total gold production of the Fairbanks district through 1959 was 7,464,167 ounces—7,239,696 ounces from placers, 224,471 ounces from lodes.

The Birch Creek Schist, of Precambrian or early Paleozoic age, underlies most of the district (Hill, 1933, p. 41). This includes a variety of rock types, among which quartz schist and quartzite are domi-

nant. Masses of crystalline limestone are present locally. Small bodies of biotite granite and quartz diorite believed to be of Mesozoic age (Hill, 1933, p. 43) intrude the Birch Creek. In the northeast corner of the district is a small patch of Tertiary sandstone and conglomerate, and in the same general area are a few small isolated areas of Tertiary basalt (Hill, 1933, p. 42–43).

The lode deposits of the Fairbanks district are fissure veins in the Birch Creek Schist in the vicinity of bodies of intrusive rock. The trends of both the veins and intrusives seem to be controlled structurally, but the trends are not consistent throughout the district (Hill, 1933, p. 63–64). All the major intrusives trend eastward; the veins in the Pedro Dome area also trend eastward, but the veins in the Ester Dome area trend more northward. The veins consist of quartz with small amounts of the sulfides arsenopyrite, pyrite, sphalerite, jamesonite, and stibnite, and free gold which is associated either with quartz or with the sulfides. Cervantite is widespread as an oxidation product of stibnite, and its yellow-green stain is a guide to high-grade gold ore in this district (Hill, 1933, p. 64–73).

The gold placers occur along stream valleys in unconsolidated gravels. The most productive layer is normally a few inches to 8 feet above the bedrock; the bedrock from 1 foot to several feet below the gravel is usually gold bearing. A thick mantle of barren material consisting of sands, clays, and muck covers the deposits (Prindle and Katz, 1913, p. 92–98).

FORTYMILE DISTRICT

The Fortymile district, between lat 64°00′ and 64°30′ N. and long 141°00′ and 142°20′ W., along the international boundary, includes the upper drainage of Fortymile River, one of the Yukon tributaries that joins the main stream in Canada. It is one of the oldest placer areas in the Yukon region and had uninterrupted output through 1959.

According to Mertie (1938, p. 157), gold was discovered in the district in 1886, but Smith (1933, p. 96) listed small production beginning in 1883. Discoveries of rich stream placers in 1893 in the Sixtymile River area, across the international boundary, drew many prospectors to the Fortymile district as well, and in a relatively short interval all the major gold-producing grounds in the Fortymile district were found. The placers of Dome, Wade, and Chicken Creeks were all discovered during the 1890's (Mertie, 1938, p. 157). Large-scale mining methods—dredge and hydraulic—have been used with success, which is probably why the district was still active in 1959.

Total recorded gold production of the Fortymile district through 1959 was about 400,000 ounces, all from placers.

The most abundant country rock of the district, according to Mertie (1938, p. 148), is the Birch Creek Schist, but locally other rocks are present. In the Chicken Creek and Franklin Creek areas granite is exposed (Mertie, 1938, p. 171, 182). Small patches of Tertiary conglomerate, shale, and sandstone are known in the Chicken Creek and Napoleon Creek areas, and some lower Paleozoic greenstone and limestone is exposed along Napoleon Creek (Mertie, 1938, p. 184). Basalt, gabbro, and diabase, younger than the granite, are found in the central part of the Chicken Creek basin.

The productive deposits are in gravels of Pleistocene to Recent age. There are also ancient placers in the Tertiary deposits, but none of these contain gold in commercial quantities. On the other hand, these Tertiary deposits, where eroded, contributed their gold to the younger deposits. Quartz veins related to the granite intrusives are the ultimate source of the gold, according to Mertie (1938, p. 154).

HOT SPRINGS DISTRICT

The Hot Springs district is between lat 65°00′ and 65°20′ N. and long 149°40′ and 151°20′ W. The drainages of Baker, Sullivan, and American Creeks are its major placer areas.

Gold-bearing gravels were discovered in 1898 on Baker and Eureka Creeks by a group of New Englanders known throughout the area as the "Boston Boys" (Mertie, 1934, p. 165–166). When the party returned in 1899 to the new settlement of Rampart, news of their discoveries leaked out and caused a rush to the Hot Springs area. The first production reported was in 1904 (Smith, 1933, table facing p. 96); a town was built a few years later (Mertie, 1934, p. 166).

The district maintained a steady output since mining began and was still active in 1959. Opencut, drifting, and hydraulic methods have been used in the mining. Total production through 1959 was 447,850 ounces, all from placers.

As the Hot Springs and Rampart districts are separated by only a narrow drainage divide, their geology can be summarized together.

Consolidated sedimentary rocks that range in age from pre-Ordovician to Tertiary and include sandstone, shale, conglomerate, chert, limestone, and coal-bearing rocks compose the bulk of the bedrock in these two districts (Mertie, 1934, p. 172–173). These are intruded locally by granite of Tertiary age.

Eakin (1915, p. 239) noted that the placers of the Hot Springs district were of several types—bench deposits, reworked bench deposits, irregular discontinuous bodies of auriferous gravel called "spots," and normal stream gravels containing pay streaks.

The gold of the placers was deposited during early and late Tertiary from lodes in and adjacent to granitic intrusives (Mertie, 1934, p. 223).

IDITAROD DISTRICT

The Iditarod district, between lat 62°10′ and 63°00′ N. and long 157°30′ and 158°30′ W., along the upper drainage of the Iditarod River and its tributaries, ranks second among the gold-producing districts in the Yukon basin.

Gold was discovered in 1908 along Otter Creek, a tributary of the Iditarod River (Maddren, 1911, p. 238). Despite its remoteness, the district developed, and in 1910 production was reported at $500,000 (Smith, 1933, table facing p. 96). Productive gravels also were found on Flat and Willow Creeks. The placers have been mined by dredges, mechanical scrapers, and hydraulic equipment (Mertie and Harrington, 1924, p. 110). Total gold production through 1959 was 1,297,500 ounces; nearly all production was from placers.

The underlying bedrock of the district, as described by Mertie and Harrington (1924, p. 12–82), consists dominantly of sandstone, shale, and conglomerate of late Cretaceous and Eocene age. In the western part of the district, west of the Iditarod River, undifferentiated metamorphic rocks of Paleozoic and Precambrian age are exposed; in the central part there are a few small stocks of quartz monzonite and basic intrusives. Unconsolidated deposits of sand, gravel, and silt of Pleistocene and Recent age are in the stream valleys.

Placers are of two types—residual and stream (Mertie and Harrington, 1924, p. 111–115). The stocks of monzonite, which are sheared and mineralized, are the source of the gold for each type.

INNOKO DISTRICT

The Innoko district, in the upper drainage area of the Innoko River between lat 62°50′ and 63°15′ N. and long 156°10′ and 156°50′ W., lies immediately northeast of the Iditarod River. The Beaver Mountains form the drainage divide between the Innoko and Iditarod Rivers.

Gold was discovered in the gravels of Ganes Creek in 1906, and despite its remoteness the new camp attracted permanent settlers (Maddren, 1911, p. 236) who began gold production in 1907 that continued uninterrupted through 1957. Most of the mining was in the Ophir, Spruce, Little, Ganes, and Yankee Creek areas (Maddren, 1911, p. 246). The Innoko is a placer district and through 1959 produced a total of 518,565 ounces of gold. Most of the placers are in the gravels of the present streams or in bench deposits.

Argillaceous beds of Late Cretaceous and Eocene age underlie most of the Innoko district, except for a small area in the northeastern part where several small bodies of quartz monzonite and basic intrusives cut the sedimentary rocks (Mertie and Harrington, 1924, p. 30, 62, 69, pl. 4).

KANTISHNA DISTRICT

The Kantishna district is an area of about 4,500 square miles, between lat 63°25′ and 65°00′ N. and long 149°00′ and 151°10′ W., that includes part of the Alaska Range foothills on the south and part of the Tanana lowlands on the north. It is bounded on the east by the Nenana River and on the west by the western tributaries of the Kantishna River.

The Tanana River valley became well populated by miners and prospectors during the early part of the Fairbanks rush, and soon the rich gravels in the Kantishna district were found. In 1904 gold was found along Toklat River and the following year a flood of hopeful gold seekers left Fairbanks for the new district (Capps, 1919, p. 75). Soon several thousand people swarmed into the area, nearly all streams were staked, and several towns were built. It soon became apparent that the deposits, though rich, were shallow and of small area, so that a dismal exodus began and the population of the district quickly dwindled to about 50 (Capps, 1919, p. 76). Those who remained were able to maintain small production from the placers, and the district was still active on that scale in 1957. In 1904–5 lode deposits of lead-silver and antimony were found, and in 1921 gold, copper, and mercury lode deposits were discovered. The antimony deposits were worked sporadically during 1936–55, but the other lode deposits never achieved any significance (Reed, 1961, p. 27–28). Total gold production from the district from 1905 through 1957 was 45,925 ounces, all from placers. No activity was reported in 1958–59.

The oldest rock in the district is the Birch Creek Schist of Precambrian age (Wells, 1933a, p. 343). This schist is succeeded by younger schists, phyllites, and gneisses, composing the Totatlanika Schist of pre-Devonian age and the Tonzona Group of Devonian or Silurian age. Pre-Tertiary greenstone, Mesozoic limestone, a sequence of Tertiary fresh-

water sediments, tuffs, and flows, and Quaternary glacial, glaciofluvial, and fluvial deposits complete the sedimentary column in the district (Capps, 1919, p. 22–23). The pre-Tertiary and lower Tertiary rocks have been deformed into east-trending folds parallel to the axis of the Alaska Range to the south of the district (Capps, 1919, p. 22).

The productive placers of the district are along the streams that radiate outward from the higher parts of the Kantishna Hills. The gold was believed by Capps (1919, p. 79) to be derived from erosion of small quartz veins that cut the Birch Creek Schist.

KOYUKUK DISTRICT

The Koyukuk district, between lat 67°00′ and 68°00′ N. and long 149°00′ and 150°50′ W., drained by the north, middle, and south forks of Koyukuk River, is often considered to be one of the most northerly in the world.

Some time between 1885 and 1890 placer gold was first found in this district on the sand bars along the Koyukuk River. Maddren (1913a, p. 76) reported that by 1898 at least $4,000 in gold had been mined from them; however, Smith (1933, p. 96) did not report production from the Koyukuk district until 1900. Nearly all the upper reaches of the Koyukuk tributaries have been prospected, and the results have been rewarding. The district was still active in 1959, though only on a small scale. Total production from the district through 1959 was about 278,000 ounces, all from placers. Promising lode deposits of gold have not been found in this district.

The most abundant bedrock in the district is the ubiquitous Birch Creek Schist of Precambrian or early Paleozoic age. The schist is exposed in two belts—one in the southern part of the Endicott Mountains and the other in the Hodzana highland area, between the Yukon River and the Koyukuk valley. Numerous dikes and small intrusives of granitic composition, probably Mesozoic in age, cut the schist (Maddren, 1913a, p. 34–36). Exposed in the central and northern parts of the district are two sequences of Paleozoic rocks: one is of Devonian(?) age and consists of greenstone, slate, chert, and limestone; the other is a section of crystalline limestone and mica schist of Carboniferous(?) age. Underlying the western part of the district are Mesozoic sedimentary rocks represented by Cretaceous limestone and calcareous sandstone interbedded with basic flows and pyroclastics (Maddren, 1913a, p. 50–55).

Pleistocene gravel covers large areas in the district, including all the major stream valleys. Recent deposits include gravels along present stream courses.

The placer deposits are in present stream gravels and bench gravels; some of them are buried. Maddren (1913a, p. 83) considered that the gold in the placers was derived from the Birch Creek Schist. Auriferous pyrite occurs in carbonaceous phyllite facies and free gold is found in quartz veinlets and stringers that cut the micaceous quartz schist facies. The gold was transported by streams and glaciers and later concentrated by further stream action into the placer deposits.

MARSHALL DISTRICT

The Marshall district is between lat 61°40′ and 62°00′ N. and long 161°30′ and 162°10′ W., along the lower Yukon River.

During the early days, just after the discoveries at Nome, the port of St. Michael was the terminus and supply center for prospectors embarking on trips up the Yukon River or along the coastline of the Seward Peninsula. A portage to the upper Anvik River, one of the Yukon tributaries, greatly shortened the trip to the goldfields at Dawson and elsewhere on the upper Yukon by eliminating travel along several hundred miles of meanders on the lower Yukon River. Thus, except for a few itinerant prospectors and traders, the Marshall district was rather thinly settled and sparsely prospected.

In 1913, however, gold was discovered on Wilson Creek in the Marshall district (Harrington, 1918, p. 56). The usual rush followed. Additional placers were found on Willow Creek, and the first production was in 1914. Lode deposits were found in 1914, and a small shipment was made that same year (Harrington, 1918, p. 57). The quartz veins did not warrant extensive development; at any rate, lode production for the district is unrecorded.

After the first few years of near-bonanza placer production, activity slackened, was rejuvenated briefly in the late 1930's, then declined after World War II. In 1957 there was only small-scale activity in the Marshall district. Total recorded gold production through 1957 was 113,200 ounces, all from placers. The district was idle in 1958 and 1959.

Much of the bedrock in the Marshall district is greenstone and intercalated sedimentary rocks of Carboniferous age (Harrington, 1918, p. 22–26). These rocks are cut by several stocks and dikes of granite, quartz diorite, and dacite of possible Jurassic or Tertiary age (Harrington, 1918, p. 45–46). Cretaceous sandstone and argillite, somewhat metamorphosed, occur adjacent to the greenstone throughout much of the district. The most abun-

dant rock type exposed in the district is the unconsolidated material deposited during Quaternary time by the debris-laden streams issuing from the huge glaciers of the interior of the Yukon River basin (Harrington, 1918, p. 36–44).

NABESNA DISTRICT

The Nabesna district is between lat 62°10′ and 62°30′ N. and long 142°40′ and 143°10′ W.

Gold had been known in this district since 1899, but there was no significant production until 1931 when the first shipments were made from the Nabesna mine, the lone producer of the district. Credit for the discovery is given to a bear who exposed the moss-covered outcrop of the principal vein while digging out a gopher. The property was developed by C. F. Whithan, who formed the Nabesna Mining Co. in 1929 and began shipping ore in 1931 (Wayland, 1943, p. 176–177). By 1939, much of the vein was worked out and in 1940 production halted. Additional exploration and development work in the district apparently was unsuccessful for there has been no further production reported. In its brief history the Nabesna district produced about 63,300 ounces of gold, all from lodes.

The rocks in the vicinity of the mine consist of the Nabesna Limestone of Late Triassic age and basaltic lavas and shale of possible Permian age (Wayland, 1943, p. 177). A few small bodies of quartz diorite cut the limestone. The thick Wrangell Lava of Tertiary and Quaternary ages unconformably overlies these rocks. Moraine and fluvial sediments of Quaternary age are found in all the stream valleys.

The ore bodies are in contact-metamorphosed limestone near the largest of the quartz diorite intrusives (Wayland, 1943, p. 183–191). Ore deposits are of three types: bodies of magnetite with pyrite, calcite, and some gold; veins and bodies of pyrrhotite with minor pyrite and gold; and gold-bearing pyrite veins in tactite or along intrusive contacts. The third type is the most important and has accounted for most of the production of the Nabesna mine.

RAMPART DISTRICT

The Rampart district, between lat 65°15′ and 65°40′ N. and long 149°40′ and 150°40′ W., joins the Hot Springs district on the north.

Gold was discovered in the gravels of Minook Creek and Hess River and their tributaries in 1882, but for the succeeding 10 years nothing was done to develop the placers. In the early 1890's more discoveries were made and finally in 1896 the first mining was done on Little Minook Creek (Hess, in Prindle and Hess, 1906, p. 26). Smith (1933, table facing p. 96), however, does not report any production until 1904. The district reached its peak of activity before 1910; after that time, production decreased, and in the 1950's only a few hundred ounces per year were mined. Total gold production through 1959 was 86,800 ounces from placers. There are no workable lode deposits in the district.

The geology of the district, as summarized by Mertie (1934, p. 172–173), is chiefly the same as that of the Hot Springs district. Consolidated sedimentary rocks—which range in age from pre-Ordovician to Tertiary and include sandstone, shale, conglomerate, chert, limestone, and coal-bearing rocks—compose the bulk of the bedrock. These are intruded locally by granite of Tertiary age. The major placers are along Minook Creek and its tributaries and along Quail Creek, one of the tributaries of Troublesome Creek.

Several prominent stream terraces containing low-grade gold deposits occur along the Minook Creek valley, but most production has come from gravels at present stream levels along Little Minook Creek (Mertie, 1934, p. 181).

RUBY DISTRICT

The Ruby district is between lat 63°40′ and 64°45′ N. and long 154°40′ and 156°20′ W.

The first discoveries of gold in this district were made in 1907 along Ruby Creek (Mertie, 1936, p. 144). These placers were soon exhausted, but other discoveries in 1910 along Long Creek and in 1912 along Poorman Creek kept the district flourishing (Mertie, 1936, p. 145, 159). Underground drifting, sluicing, and hydraulic methods have been used to mine the gravels. Although production decreased somewhat in recent years, the district was still producing substantially through 1959. Total gold production through 1959 was 389,100 ounces, all from placers.

Undifferentiated metamorphic rocks, including schist, phyllite, slate, quartzite, chert, and limestone, are mainly of Paleozoic age and are the predominant bedrock types in the Ruby district (Mertie and Harrington, 1924, p. 12). A complex of greenstone derived from basic igneous rocks, believed to be Mississippian in age (Mertie and Harrington, 1924, p. 59), is exposed throughout the district. A few granite stocks of Mesozoic(?) age intrude both the Paleozoic rock units. The generalized structure is an anticline trending northeast and plunging to the southwest.

Numerous quartz veins are in the country rocks;

some undoubtedly contain gold and could be regarded as the source of the gold in the placers. The distribution of the placers, however, does not directly coincide with areas of abundant veins, so that no clear relationship is apparent (Mertie and Harrington, 1924, p. 121). Nearly all the placer deposits are buried discontinuous bodies that occur mostly in fairly wide valleys. They were formed by streams older than those now occupying the valleys (Mertie, 1936, p. 144).

RICHARDSON DISTRICT

The Richardson (or Tenderfoot) district is between lat 64°15′ and 64°25′ N. and long 146°00′ and 146°40′ W., about 60 miles southeast of Fairbanks, along the Tanana River.

This is a little-known district, about which only a few brief accounts have been written. According to Prindle (in Prindle and Katz, 1913, p. 141) gold was discovered in the gravels of Tenderfoot Creek in 1905 and for the following 4 years the gold production was probably "$300,000 or $400,000 annually." Smith (1933, table facing p. 96), however, reported a much more conservative figure. Productive deposits also were found along Buckeye and Democrat Creeks. Activity declined after the initial boom period and in recent years the production, which is low, has been combined with that of the Fairbanks district. Total recorded production for the district through 1959 was 64,300 ounces, all from placers.

Prindle (in Prindle and Katz, 1913, p. 140–141) noted that the bedrock in the district is Birch Creek Schist of Precambrian age (Mertie, 1937, p. 46). Numerous small quartz veins, some of which carry gold and sulfides, occur in the schist. Just west of the district are some large granitic masses (Prindle, in Prindle and Katz, 1913, p. 140–141). The placers are along present streams in the area.

TOLOVANA DISTRICT

The Tolovana district is between lat 65°20′ and 65°45′ N. and long 147°50′ and 149°00′ W. in the upper drainage of the Tolovana River, a tributary of the Tanana.

Brooks (1916, p. 201) reported that placer gold had been found in this area as early as 1892 but that no interest was aroused until 1914, when placers along Livengood Creek were discovered. Mining began in 1915 and was substantially increased the following year with the development of the deposits on Livengood Creek and others on Gertrude, Ruth, Lillian, and Olive Creeks (Mertie, 1918, p. 256). The district continued to prosper and it was still productive on a small scale in 1959. Total gold production through 1959 was 375,000 ounces, all from placers.

The bedrock in the Tolovana district is distributed in several bands or belts that cross the area in a northeasterly direction. The oldest rocks in the district crop out in the southeast; the rocks become successively younger in a northwesterly direction. Briefly, the bedrock units consist of the Tatalina Group, of Cambrian or Precambrian age, Devonian and Silurian(?) sedimentary and igneous rocks, a chert unit of Devonian or Carboniferous age, and Carboniferous arenaceous and argillaceous units (Mertie, 1918, p. 230–256).

Igneous rocks, chiefly basic, occupy a considerable area in the northwestern part of the district. Small bodies of granitic intrusives are scattered throughout most of the district. In the stream valleys, unconsolidated deposits of sand and gravel were deposited during several stages in the Quaternary geomorphic cycle. The earlier of these are only remnants and are seen as benches along the valley walls (Mertie, 1918, p. 230–231).

Gold placers in the district are in bench and stream deposits (Mertie, 1918, p. 259). The bench deposits have been the more productive. The gold in the placers of Tolovana was derived from low-grade lode deposits at the heads of many of the tributary streams (Mertie, 1918, p. 274–275).

PRINCE WILLIAM SOUND REGION

The Prince William Sound region is along the southern coast of Alaska, immediately east of the Kenai Peninsula. It is a constricted area between the rugged Chugach Mountains on the north and that part of the Gulf of Alaska known as Prince William Sound. In this region copper and gold are the chief mineral commodities, and the notable mining districts are Port Wells, Port Valdez, and Ellamar. Only Port Valdez is shown on the index map (fig. 5) because it is the only district that has produced any significant quantities of gold.

The earliest record of gold production in the Prince William Sound region was in 1894, when some placers were worked on a small scale near Port Valdez (Brooks, A. H., in Grant and Higgins, 1910, p. 72). A few years later other small placers were found in the Port Wells district. Auriferous veins were found here in 1907, and in the following 6 years numerous properties were developed and small shipments were made (Johnson, 1914, p. 214–215). The Cliff mine, staked in 1906 in the Port Valdez district, became the largest gold producer

in the district in the early years (Moffit, 1954, p. 228, 304).

The copper ores at Ellamar and La Touche Island carry variable amounts of gold (Grant and Higgins, 1910, p. 71), but the amount produced from this source could not be determined.

Gold production from this region reached its zenith before 1920. Thereafter, except for a slight revival in the late 1930's, output has dwindled. No production was reported for 1957–59. Total recorded gold production was 137,600 ounces, all from lode mines or as a byproduct from copper mines. Production data for individual districts have not been found. It is fairly certain that the Port Valdez district has produced most of the lode gold from this region; however, it is not known how much of the total gold production was a byproduct from copper ores of Ellamar, La Touche, or elsewhere.

Numerous fiords along the irregular coastline and glaciated islands that dot Prince William Sound give evidence of a once extensive ice covering in this region (Grant and Higgins, 1910, p. 18–19). In the northern part of the region, especially in the Port Wells district, several ice tongues still travel far enough down the valleys to meet the sea.

The rocks of this region consist of two loosely defined groups of low-rank metasedimentary rocks of Mesozoic age, distinguished from one another by minor differences in gross lithologic characteristics and by differences in metamorphism (Moffit, 1954, p. 234–250). These rocks have been complexly folded, faulted, and intruded by basaltic and granitic igneous rocks.

The Valdez Group is composed predominantly of graywacke, slate, and argillite, with subordinate siliceous and carbonaceous slate, feldspathic quartzite, and a few beds of conglomerate and impure limestone. The rocks are metamorphosed locally to schist and phyllite. The Orca Group consists dominantly of slate and graywacke, and in places greenstone and conglomerate are major components. Though the rocks of the Orca Group are intensely folded and faulted, their metamorphism seems to be related to igneous intrusions rather than regional tectonism. The distinction and separation of the Valdez and Orca Groups cannot be consistently made everywhere in the region (Moffit, 1954, p. 234–273). The ages and stratigraphic relations of these two groups have not been clearly established; however, the meager paleontological evidence suggests a Late Cretaceous age for both groups (Moffit, 1954, p. 273–275).

The gold-bearing quartz veins of the Port Valdez district are found in slates and graywackes of both the Valdez and Orca Groups. At Port Wells, gold occurs in quartz veins and stringers that occupy fissures in slate, graywacke, and conglomerate. Mineralization probably is late Mesozoic or Tertiary in age, closely associated with granitic intrusions (Moffit, 1954, p. 295). Vein minerals are pyrite, galena, sphalerite, pyrrhotite, arsenopyrite, stibnite, chalcopyrite, gold, and silver in a gangue of quartz.

The copper deposits of Prince William Sound, which have yielded moderate amounts of gold, occur as impregnations or replacement bodies usually along zones of shearing in the country rock. Chalcopyrite and pyrrhotite are ubiquitous, pyrite is common, and galena, sphalerite, bornite, chalcocite, native copper, cuprite, and malachite are present in small amounts. The nonmetallic minerals in these deposits are quartz, calcite, epidote, and chlorite (Grant and Higgins, 1910, p. 53–54).