Platinum Deposits of Alaska

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Introduction

The placer deposits of the Goodnews Bay district in southwestern Alaska have yielded the only significant production of platinum metals in the United States, although small amounts of platinum metals have been produced from other deposits in Alaska and elsewhere in the United States. The Goodnews Bay deposits were described by Mertie in U.S. Geological Survey Bulletin 918 (1940). Many new data have been obtained since that time, and in order to make this information available in advance of publication, this report on Platinum deposits of Alaska has been placed on open-file.

Lodes

Salt Chuck mine

The Salt Chuck mine, formerly called the Goodro mine, is at the northwestern extremity of Kasaan Peninsula, about 36 miles N. 60° W. of Ketchikan. This property was described in considerable detail by Wright (1915, p. 99) at the time of his visit in 1908, when it was recognized as a small producing copper mine. The ore deposit differs from most others in that vicinity in that bornite is the principal copper-bearing mineral, though the ore also includes chalcopyrite, with small amounts of chalcocite, native copper, and gold. These ore minerals occur as small masses and disseminations in pyroxenite, gabbro, and gabbro pegmatite, all of which are differentiated products of the regional granitic rocks. The principal rock-forming mineral is augite, in addition to which are biotite, iron ores, plagioclase, apatite, and sphene. The pyroxene and plagioclase are locally much altered to epidote, and to chloritic and sericitic minerals.

The Salt Chuck ore, until 1917, had been rated as a small low-grade copper deposit, with a mean tenor of 1.4 percent copper, and a small byproduct of gold and silver. In 1917, however, the owners of this property discovered that their ore also contained platinum metals, which thenceforth became the principal product of mining. The property was visited in 1917 by the writer (Mertie, 1920 ~~1917~~, p. 17-20) shortly after this discovery was made, and he was able to describe the deposit in the light of this new information. The country rock is much fractured, but most of the copper ores occur as disseminated deposits in irregular ore shoots. Some of the chalcopyrite, however, occurs along planes of fracture. The ore body is ~~rated as~~ considered to be an epigenetic deposit.

The platinum metals occur both in the copper minerals and disseminated in the pyroxene and gabbro. The form in which these metals exist is not known, but probably they are not native alloys. This is generally true in deposits of this type, as seen in Sudbury, Canada. At the time of the writer's visit, the smelter had informed the owners of the property that platinum and palladium had a ratio of 1:50; and this was reported by the writer in his description of the property. Subsequent developments, however, contradict this statement. Thus Brooks (1922, p. 23) gives the production of platinum from Alaska in the years 1917-20, practically all of which came from the Salt Chuck mine; and the average value per troy ounce of this output was $115.63. Smith (1929, p. 39) quotes the Department of Commerce to the effect that 3,566 troy ounces were produced at this property in 1926, with an average value of $76.82. Obviously these outputs could not represent a product that was 98 percent palladium, as this metal has for years been the cheapest of the platinum metals. The designation of the Salt Chuck mine as a palladium-copper mine is therefore incorrect, as it should be called a platinum-copper mine. Owing mainly to litigation, this property was closed at the end of 1926, and has not subsequently been reopened.

Placers

Goodnews Bay district

Mining and production

Platinum was discovered in 1926 at the mouth of Fox Gulch, a headwater tributary of Platinum Creek, by an Eskimo named Walter Smith. The sample, after passing through the hands of two other men, was sent to the U. S. Bureau of Mines, at Fairbanks, Alaska, where it was analyzed and determined to be platinum. In 1928, platinum was discovered in the gravels of Clara Creek, and in the same year it was discovered on Squirrel Creek. Details regarding these discoveries have been published by Reed (1933, p. 103-126). Eventually the Goodnews Bay Mining Co., acquired title to most of the productive ground on Salmon River and its tributaries, and since 1940 has been the sole operating company.

A sketch map of the placer mining claims was published by the writer in U. S. Geological Survey Bulletin 918 (Mertie, 1940); but resurveys, the consolidation of some claims, and new locations have rendered this map obsolete. A new claim-map is therefore included in this report as figure 1. Unlike the original map, the names of the bench claims are not given, except for those to which reference is made in the text.

Figure 1. Sketch map showing locations of principal mining claims on Salmon River and its tributaries.

The Clara Creek Mining Co., using a dragline excavator, began mining on Clara Creek in 1936, but the paystreak in this valley was exhausted in the next 3 or 4 years. The Goodnews Bay Mining Co., likewise operating with a dragline excavator, began mining on Platinum Creek in 1934, and continued through 1941 until the placers of Platinum Creek, Fox Gulch, and Squirrel Creek were worked out. Thereafter this company, beginning on the Association claim opposite 9 above Discovery, worked the bench placers of Salmon River for 11 years, ending this operation on the Bobby bench, opposite claim 3 above Discovery. From this point downstream, all mining was done by dredging.

A dredge was built by the Goodnews Bay Mining Company in 1937 at the upper end of claim 1 below Discovery, Salmon River. This dredge worked upstream from its original site to claim 1 above Discovery, and turned working downstream to claim 7 below Discovery, where in 1942 it turned again and worked upstream to claim 5 above Discovery. Turning again in 1947, it worked downstream to claim 2 above Discovery, where in 1949 it moved eastward onto the bench paystreak. Starting on the Ethel bench claim, the dredge worked sinuously but generally southward across the Palladium, Osmium, Ruthenium, Rhodium, Platinum and Iridium bench claims to Discovery claim, of Snow Gulch; and thence, from 1955 to 1963, it worked southward to the Olson bench claim. At this point the alluvial cover became too thick for economical dredging, even though 40 feet of the overburden was being removed by a dragline excavator; and therefore the dredge moved westward onto the paystreak of the valley floor of Salmon River. Starting on claim 10 below Discovery, the dredge worked upstream to claim 8 below Discovery, where in 1964 it turned and has continued to work downstream. Eventually the dredge will turn at the lower end of claim 15 below Discovery, where the valley paystreak ends, and will again work upstream. The site where the dredge was built, and the course that it has followed since 1937, are shown on ~~plate VIII~~ Figure 1. Various parts of the valley remain to be dredged, and the stretch from claim 6 above Discovery to claim 11 above Discovery is entirely unworked ground.

The bench paystreak continues south-southwestward for about 2 miles from the Olson bench claim, then veers southeastward toward Chagvan Bay. Much of this ground has been prospected by drilling, but the limits and tenor of the paystreak have not yet been precisely determined. It is known, however, that the depth to bedrock continues to increase, approaching 250 feet near Chagvan Bay. New methods and equipment will be needed to mine this lower stretch of the bench paystreak. If the tenor will stand the cost, a belt conveyor may be used to dispose of a large part of the overburden.

The total production of platinum metals from Salmon River and its tributaries in the period 1934-1966, including the output from Clara Creek, is estimated to have been well over half a million troy ounces, with a maximum output in 1938 of 36,687 ounces.

Earlier and recent surveys

The general and economic geology of the Goodnews platinum district, a description of the placers, and a discussion of the character and composition of the platinum metals was published by the writer (1940) in U. S. Geological Survey Bulletin 918, based upon a survey made in 1937. At the same time, a topographic map on a scale of 1:62,500, with 50-foot contours, was prepared by Gerald Fitz Gerald. In 1950, however, a new topographic map of a part of this district was made by the U. S. Coast and Geodetic Survey, on a scale of 1:63,360. For the purpose of this report, it suffices to republish a part of the original geologic map (figure 1) on

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Figure 1. Geologic map of Platinum and vicinity, Alaska.

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the new base, showing only drainage, though both topographic maps will later be assembled on a single sheet.

Much has been learned since 1937 regarding the distribution and character of these platinum metals by mining and exploratory drilling. To acquire the latest relevant information, the writer revisted this area in 1966; and the owners of the Goodnews Bay Mining Co. cooperated by making available all their mining records since 1934. A great deal of other information was obtained from the owners regarding the placers that bears directly upon the Pleistocene history of this district. Collateral data have also been obtained from the work of David Hopkins and other geologists of the U.S. Geological Survey, who have been studying submarine gold placers, offshore from Nome.

General geology

The bedrock formations of the area, exclusive of intrusive rocks, comprise highly folded sedimentary rocks with some tuffaceous beds, overlain by lavas and tuffs, all of which are believed to be of late Paleozoic age. In late Mesozoic or Tertiary time these rocks were invaded by ultrabasic intrusives, and at a somewhat later date by granitic rocks. The ultrabasic rocks are of two general types, of which one is composed largely of olivine, and the other of pyroxene with variable, but distinctly smaller, amounts of olivine. The olivine rock, or dunite, is the principal bedrock of Red Mountain; and about a quarter of it is altered to serpentinite. Olivine-bearing pyroxenite forms the ridge southwest of Susie Mountain. The granitic rocks occupy the long ridge southeast of the headwaters of Smalls River. The dunite and serpentinite are the bedrock sources of the platinum metals that are recovered from the placers of Salmon River and its tributaries. The granitic rocks are believed to be the sources of a small amount of gold that is also contained in the placers. The platinum metals have not been found in place, but much has been learned regarding their occurrence and character in bedrock, from the disposition and patterns of the areal drainage system, and from analyses of the platinum metals at many recorded sites in the valleys.

The Tertiary history of this region, from the time of its invasion by granitic rocks to the end of the Pliocene epoch, is obscure; but it seems probable that during most of this period the area was above sea level. Much more information, however, is available regarding the Quaternary period, though the regional geologic history during the Pleistocene epoch has proven to be a complex problem. In 1937, when the first geological survey of this area was made, all glaciation in western Alaska was referred to the Wisconsin stage of the Pleistocene epoch; and in the Goodnews Bay district, no consideration was given to the other glacial and interglacial stages that might have existed. This situation was changed in 1940, when a pre-Wisconsin glaciation was recognized by the writer in the tin country of northwestern Seward Peninsula, and later that year was corroborated at Nome. This information was published in a paper by MacNeil, Mertie, and Pilsbry (1943, p. 69-96). Seward Peninsula and the Goodnews Bay district differ from the region south of the Alaskan Range in that the Wisconsin ice of southern Alaska extended to and beyond the Pacific strand line; and regardless of whether an older glaciation had occurred, all traces of it have been obliterated, though its presence was recognized by Capps (1931, p. 1-8) north of the Alaskan Range. In western Alaska, however, the older glaciation was much more extensive than the Wisconsin ice, so that the evidence for its existence has been preserved.

Nebraskan, Illinoian and Wisconsin glaciation have now been recognized on Seward Peninsula, though evidence for a Kansan glaciation is still lacking. High mountains exist in the region east and northeast of Goodnews Bay, as in the central part of Seward Peninsula, and it seems probable that a similar Pleistocene history prevails in this district. In fact, at least three glacial stages seem necessary in order to explain the geochronology of the placer deposits. The Wisconsin ice, as at Nome, is believed not to have extended to the present strand line; but in any event, it appears to have had little or no effect upon the formation of the placers in the valley of the Salmon River. One of the earlier ice streams, however, possibly of Nebraskan age, was so extensive and thick that it overrode completely, or nearly so, the ridges on both sides of the Salmon River. But the course of that stream was athwart the flow of the ice, and this explains why the placers of that valley were not eroded and obliterated. The same, or more probably a later glacier of Illinoian(?) age, severed and destroyed a placer deposit in the lower valley of Salmon River, where it was not protected by bounding hills. Evidence for this overriding ice sheet consists of the presence of a small amount of free gold, not merely in the platinum placers of the Salmon River, but more particularly in the placers of Platinum Creek, and of Fox Gulch, its headwater tributary. This gold, not derived from the ultrabasic rocks of Red Mountain, is believed to have been concentrated from glacial deposits derived from the overriding ice, which possibly was of Nebraskan(?) age. Another significant occurrence is the presence of granitic erratics at the northern end of Red Mountain, at a maximum altitude of 825 feet above sea level. These were probably deposited by Illinoian(?) ice, and show that, although this ice did not flow down the valley of the Salmon River, it must have deposited morainal and glaciofluvial materials at the head of that stream, which later were moved downstream in that valley. Thus the deposits of glacial origin, hereafter described in one of the paystreaks of the Salmon Valley, may have had two sources, derived both from Nebraskan(?) and Illinoian(?) ice.

Two paystreaks exist in the valley of the Salmon River. One of the significant features of both these alluvial deposits is that the underlying bedrock, at their lower ends, is far below present sea level. If this condition is related solely to eustatic changes in sea level, it follows either that both these paystreaks were formed during glacial stages, when sea level was much lower than it is at the present time, or that one of them is of preglacial (Pliocene) age.

This partial history of glaciation during the Pleistocene epoch yields a geochronologic record that is patently incomplete; but the preceding statements of facts, with tentative interpretations, when coupled with the following descriptions of the two paystreaks in the valley of the Salmon River, will constitute an initial hypothesis which should lead eventually to a more complete understanding of the Quaternary history.

Platinum deposits

Practically all the platinum metals so far found in this district occur in placers within the valley of the Salmon River and its western tributaries that head in the dunite of Red Mountain. But Susie Creek, a small south-flowing tributary of Medicine Creek, that heads in the pyroxenitic rocks west of Susie Mountain, contains no workable paystreak. The tributaries of the Salmon River that head in the Paleozoic sedimentary rocks and the overlying volcanic rocks are quite devoid of platinum. These include Quartz Creek, on the west side of the Salmon Valley, and Medicine Creek, Snow Gulch, Anita Creek, and Happy Creek, on the east side.

This localization of the platinum metals in Red Mountain led naturally to a search for deposits of these metals along the west side of this mountain. No large streams are present, but a large volume of eluvial and alluvial deposits blanket its western slopes, extending to Kuskokwim Bay. A large amount of drilling and manual prospecting has been done along this foreland, notably during the summer of 1937, when several drills were working; but essentially no platinum has been found. Beach placers along the shore of Kuskokwim Bay are likewise absent, because the strand line at the time of Pleistocene glaciation was far west of the present strand line; and the platiniferous glacial debris has been moved far offshore. In later years, however, a little platinum was found and recovered from a small amphitheatrical opening in the southwest wall of Red Mountain, a short distance north of the low pass at the head of Platinum Creek.

Alluvial deposits of the platinum metals could also be present along the north side of Red Mountain, particularly because the dunite extends to and crops out along the north wall of Smalls River. But the valley of Smalls River has been deeply eroded by an Illinoian(?) glacier, which also scoured the northwest side of Red Mountain. However, a drill hole was sunk 192 feet to bedrock by the Goodnews Bay Mining Co. along the north side of the automobile road, about 1½ miles from Kuskokwim Bay, and reached platiniferous gravel. This platinum was apparently localized in a pot hole that was not eroded by the glacier, as no continuation of the deposit was found.

Platinum Creek, with a length of about 2 miles, has two tributaries from the north, called Fox Gulch and Squirrel Creek. These streams had paystreaks which extended from their headwaters to their mouths; and Platinum Creek was minable from the mouth of Fox Gulch to its confluence with Salmon River. The paystreak on Platinum Creek included stream placers, and others that would more properly be classed as bench placers, though the two types were not distinctly defined. At the mouth of Fox Gulch, the width of this paystreak was 200 feet, and at the confluence with Salmon River it had a width of at least 400 feet. The depth to bedrock, less the surficial cover of moss, ranged going downstream from 12 to 25 feet. The total length of the paystreaks of Platinum Creek, Fox Gulch, and Squirrel Creek, was about 3½ miles. The platinum metals occurred in the lower few feet of the gravels, and on the surface of bedrock, and for a few feet within the cracks and crevices of bedrock. These metals consist of fine grains, which, however, are larger than those recovered from the paystreaks of Salmon River. Nuggets are uncommon, though more common in Fox Gulch than elsewhere. The largest nugget so far recovered had a weight of 4 troy ounces.

The platinum deposits in the valley of Salmon River occur in two paystreaks, one in the present valley floor, and the other in what is hereafter called the bench channel, along the eastern side of the valley. The valley paystreak extends from claim 7 above Discovery downstream to the lower end of claim 15 below Discovery, a distance of about 6 miles. The bench channel, as defined by drilling, extends from the Association claim east of claim 9 above Discovery downstream to within three quarters of a mile from Chagvan Bay, a distance of about 10 miles, but the paystreak has been mined only as far downstream as the Olson claim, where mining was temporarily discontinued. These two paystreaks are generally distinct, and are separated from one another by a bedrock reef. At two places, however, namely on claim 2 above Discovery and on claim 2 below Discovery, the reef disappears, and the bedrock underlying both paystreaks is at the same altitude. This anomaly results from adjustments in the drainage pattern of the bench channel that occurred during the Pleistocene epoch.

The average bedrock gradient of the bench channel is about 50 feet to the mile, which is about 10 feet greater than the bedrock gradient in the valley floor, so that the overlying alluvium in the bench channel thickens more rapidly than in the present stream channel. Thus, at the northern limit of the bench paystreak, the depth to bedrock was found to be only 15 feet; east of Discovery claim, the depth had increased to 45 feet; and on the Olson claim, the depth had increased to 110 feet. One the Ptarmigan bench claim, next north of the Olson claim, the bedrock is 25 feet lower than the level of the Salmon River, and is 3½ feet below sea level; and at Happy Creek, the bedrock under the bench paystreak is actually 50 feet below sea level. The width of the paystreak on the Olson claim was 600 feet, but at some sites farther upstream it was as much as 1,000 feet. The bench channel in the lower valley of the Salmon River appears from drilling to veer away from the river, attaining at one site a depth of 200 feet; and at Chagvan Bay, the depth below sea level may be 250 feet or more. Owing to this increasing thickness of the overlying alluvium, a large dragline excavator was used ahead of the dredge for at least half of the distance mined. Finally, however, at the Olson claim, mining was temporarily ended, pending the development of new methods for excavating an increasing thickness of overburden.

Certain characteristics of the two paystreaks and other collateral evidence bear directly upon their origins and ages. The bench paystreak consists largely from top to bottom of beds of clay, with an average content of about 20 percent of gravel, generally present as inlaid seams and thin strata, from one to three feet thick. The cobbles and pebbles that constitute the gravels are not well rounded, and many of them are faceted. These alluvial materials, without doubt, were originally of glacial origin. The platinum metals occur mainly on the surface of bedrock, and in the uppermost 2 to 3 feet of bedrock, which is greatly shattered. But considerable platinum also occurs within the overlying 8 feet of clay and its included gravels. The bedrock, if susceptible to weathering, is greatly decomposed; in fact, it is generally so much softened by weathering that it is amenable to panning. Several samples of the semi-heavy minerals in this bedrock were thus obtained.

The platiniferous clay above bedrock is so cohesive that it does not disintegrate readily in the trommel screen of the dredge, and this has caused a serious loss of the platinum metals, which were not liberated for washing and recovery. To remedy this difficulty, the Goodnews Bay Mining Co. built in 1966 an experimental rig, which they called a "mud-hog", to macerate this clay and its included gravels, to be used in reworking the tailings of the bench paystreak left by the dredge. This equipment, in an improved form, has evidently been successful, as its output yielded a profit in 1967.

The surface of bedrock in the bench channel is nearly flat from side to side, with no incised channels, thus indicating continuous erosion at a nearly constant base level of erosion over a long period of time. This condition has made it possible for the ancient stream that occupied this channel to carve away the lower ends of the lateral spurs along its eastern side, thus expanding the valley floor to its stated width. It is also of interest that the bench paystreak has been locally enriched in platinum metals at the sites of tributary gulches from the east that drained a still older paystreak higher on the valley wall. The sites of these ancient gulches, however, do not correspond exactly with the position of the gulches shown on the topographic map. This ancient paystreak has been found to be narrow, intermittent (due to erosion), and too low grade to be mined.

The paystreak and channel in the present valley floor differs markedly from that of the bench channel. The paystreak is narrower, ranging from 300 to 450 feet, except at the mouth of Platinum Creek, where locally it was as wide as 600 feet. The overburden is shallower, ranging from 30 to 75 feet. The gravels are well rounded, and clay is absent. Also the mean size of the gravels is greater than those of the bench channel, though large boulders are not a problem. Finally, the bedrock, which is quite unweathered, is not level, but instead shows deep gutters with a depth as much as 20 feet. The platinum metals occur mainly on bedrock, in the overlying two feet of gravels, and in the uppermost 2 feet of shattered bedrock, though colors are found as high as 8 to 10 feet above bedrock. The sizes of the grains range from 0.2 inch to less than .0002 inch in diameter.

A highly significant feature of the paystreak in the valley floor is that it ends abruptly, or at least becomes of noncommercial grade, at the lower end of claim 15 below Discovery, though its channel continues downstream, attaining at the mouth of the Salmon River a depth of about 100 feet below sea level. Another significant feature is the occurrence, along the east bank of the Salmon River, just above the mouth of Happy Creek, of an ancient deposit of outwash gravels of glacial origin. Clearly the paystreak from claim 15 below Discovery downstream was severed and eroded by a glacier, perhaps of Illinoian(?) age, that emerged from the valley of Kinegnak River, reaching high on the north wall of that valley. But the bench channel, as earlier stated, continues without interruption to Chagvan Bay. Therefore the channel in the valley floor of the Salmon River is older than the bench channel.

Geochronology

The Pleistocene chronology, on the basis of the available facts and inferences, can at best be only tentative. In the early Pleistocene, a great ice sheet appears to have completely or nearly overridden the hills that bound both sides of the valley of the Salmon River. The glaciation of Nebraskan [redacted] age, from the data lately acquired at Nome, is believed to have produced the most extensive and thickest ice sheet that has existed in this region during the Pleistocene epoch. It is therefore inferred that the ice that overrode the Goodnews Bay district was probably of Nebraskan age. As a result of this glaciation, the valley of the Salmon River must have received a large volume of morainal and glaciofluvial debris, most of which was subsequently removed by stream erosion. This is indicated by the fact that no such materials now exist among the gravels that constitute the present valley floor.

The glacial and fluvial history during the Aftonian, Kansan, and Yarmouth [redacted] times is particularly obscure. No record of Kansan time glaciation is available in this region, but eustatic effects on sea level must have been produced; and it is possible that during [redacted] Kansan [redacted] time the bedrock floor of the present stream channel was established, such that it is now about 100 feet below sea level at the mouth of the Salmon River. An alternative hypothesis is that the present stream channel was carved in Pliocene time, and that the gravels immediately above it are of preglacial age. But in any event, the basal gravels in the paystreak of the valley floor must have been deposited before the bench paystreak was formed, though its uppermost gravels were doubtless added in post-Illinoian time. Thus the paystreak in the present valley floor of Salmon River is both older and younger than the bench paystreak.

The Wisconsin glaciation that is so well known in this region, particularly in the area of the Tikchik lakes (Mertie, 1938), is believed now to have been rather localized, and it is improbable that the Wisconsin ice reached as far west as the present strand line. Therefore it is reasonably certain that the Wisconsin ice and its resulting morainal and glaciofluvial deposits have not been effective in developing the two paystreaks in the valley of the Salmon River. But it seems probable that an Illinoian glacier flowed down the valley of Goodnews River, and extended over into the valleys of Tundra Creek and Smalls River. The glacier that issued from the valley of Kinegnak River was probably also of the same age. The Illinoian glacier did not flow down the valley of the Salmon River, but instead was shunted seaward, scouring the northwest side of Red Mountain. During its retreat, however, it deposited morainal and glaciofluvial materials at the head of the valley of the Salmon River, and most of these were eventually transported down the valley of that stream. It is believed that they were deposited in the bench channel, which apparently was the only drainage channel in the valley of Salmon River at that time. This explains satisfactorily the presence of sediments of glacial origin in the bench channel, but a more difficult question is when the bench channel was first excavated, and made available for the reception of this glacial debris. This channel in bedrock had to be carved during some glacial stage, when the regional base level of erosion was at least 250 feet lower than it is at the present time. But it seems difficult to envision both the excavation and the filling of the bench channel during Illinoian time; moreover the Illinoian(?)

glacier that emerged from the valley of Kinegnak River would have constituted a barrier both to erosion and sedimentation. A possible alternative is that the bench channel was excavated during the Kansan [redacted] time, and that it was filled by sediments of glacial origin during late Illinoian and early Yarmouth time. Under this hypothesis, however, the channel in the present valley floor could not also have been carved in Kansan time, nor certainly in Nebraskan time, when the country was presumably submerged beneath an ice sheet. It follows that the basal sediments of the valley channel may possibly be of Pliocene age.

The deposition of glacial deposits in the valley of the Salmon River is believed eventually to have filled and overfilled the ancient bench channel, producing a superposition of the stream onto the west side of the valley. Thus a new stream channel was established, approximately above the original valley channel. As the glacial deposits were eroded and carried seaward, probably in Wisconsin time, new sediments of nonglacial origin began to be eroded and deposited in the new channel, thus covering the pre-existing older gravels close to bedrock. This process has continued during the post-Wisconsin or Recent epoch [redacted], but sufficient time has not elapsed since the new channel originated to build a new paystreak downstream from claim 15 below Discovery.

The foregoing chronology has been formulated without recourse to faulting that might have had an important effect upon the established or unrecognized changes in the base levels of erosion. Yet faulting, parallel to the coast, has been recognized in the search for submarine placers offshore from Nome. It follows that much more geologic work is needed in the Goodnews Bay district before all the known facts can be satisfactorily explained.

Platinum metals and gold

The platinum metals of the placers occur essentially in two distinct alloys intergrown in a pseudoeutectic fabric, which in nuggets is clearly visible under a low-powered lens. These alloys do not have constant compositions, nor do they have definite ratios to one another; and for this reason they are not individually or collectively homogeneous. Moreover, the metals recovered from the placers, because they have been intermingled by stream transportation and fortuitous deposition, represent mixtures from many sites in the original lodes. Chemical analyses, however, of the metals recovered from the headwaters of the streams that drain Red Mountain, where maximum mixing had not yet occurred, reveal certain general characteristics of the lodes. Moreover, these analyses, when charted by claims, reveal also significant data that have a bearing upon the regional physiographic history, and lead to an understanding of the sequential history of the two paystreaks in the valley of Salmon River.

The platinum metals at the south end of Red Mountain are distinctly higher in iridium and osmium than at the north end, as shown by numerous chemical analyses of these metals in the streams draining this mountain. Thus the mean tenors of iridium and osmium on Fox Gulch, and on Platinum Creek downstream to the mouth of Squirrel Creek, are respectively 27.85 and 5.24 percents; on Squirrel Creek, the corresponding values are 15.49 and 3.93 percents; on Dowry Creek, these values are 7.49 and 1.49 percents; and on Clara Creek, they are 6.17 and 0.93 percents. No analyses of the platinum metals from Boulder Creek are available, and it is therefore impossible to state whether the change in composition from Platinum Creek to Clara Creek is or is not linear in relation to distance. It should also be mentioned that the maximum values of iridium and osmium found on Fox Gulch were respectively 41.06 and 8.41 percents. Yet this product fails to qualify as osmiridium, on account of the high tenor in platinum, namely, 47.20 percent. In reality, this and all other platinum metals found in this district represent intergrowths in various proportions of the ordinary platinum alloy and osmiridium. The product from Fox Gulch merely has the highest ratio of osmiridium to the more common alloy.

The occurrence of the platinum metals in the dunite of Red Mountain has been proven indirectly, though no platinum lodes have been discovered, and no samples of platinum-bearing bedrock have been found. Moreover, a composite of this dunite, taken from the south to the north end of Red Mountain, revealed by analysis no trace of the platinum metals. It should be emphasized, however, that the content of platinum metals in such a sample was probably too low to be detected by ordinary chemical analysis. If the sample had been milled and panned, an analysis of the resulting concentrates might have shown the presence of platinum. In this connection, it should be recorded that the residual material at one site on top of Red Mountain was sampled and concentrated in 1965 by the Goodnews Bay Mining Co., and was found to contain a small amount of the platinum metals.

One mineralogical feature is the large amount of chromite recovered in the sluice-boxes during the placer mining now and earlier done. Nuggets have been found in which chromite is attached to or intergrown with the platinum metals; and these, together with the large volume of chromite recovered in the placer concentrates, lead to the belief that many of the platinum metals are associated in bedrock with chromite. A similar condition exists in the Ural Mountains of Russia. In the largest body of dunite in the Urals, in the Nishniy-Tagil district, about 600 lenses and irregular masses of chromite have been found, some of which contained notable amounts of platinum, as heretofore described. A part of the platinum metals in the Goodnews Bay district, however, may be sparsely and widely distributed in bedrock. The mean tenor of platinum metals in the dunite of Red Mountain may be computed by comparing what was probably the original volume of that mountain with the total platinum metals so far recovered and recoverable in the future, plus the metals lost in mining operations. Such a computation yields a mean value of about 0.13 grain per cubic yard, which might have a value of about 3 cents per cubic yard. Obviously, only local concentrations of platinum in chromite, such as that in the Krutoy Log property in the Urals, are likely to be of economic interest.

The compositions of the two alloys that contain the platinum metals have not been specifically determined, first because they are variable and second because, for reasons heretofore stated, it is impossible to obtain a pure sample of either alloy. Approximately, however, the minor alloy (osmiridium) may be separated electromagnetically, if grains of very small size are utilized in the separation. A sample weighing 365.53 grams, that represented platinum recovered from Discovery claim, Salmon River, was used for this investigation. This sample was separated by sieving into 14 fractions; but unfortunately insufficient material of -200 mesh was available for an electromagnetic separation and a chemical analysis of that part of the sample with the smallest paramagnetism. One of the 14 fractions of larger size was therefore selected, weighing 90.95 grams, and this was separated electromagnetically into 7 subfractions. One of these subfractions, weighing 8.13 grams, with the least paramagnetism, was analyzed chemically, with separate analyses of the parts soluble and insoluble in aqua regia. Thus three analyses were obtained and are shown in Table 1.

Table 1. Compositions of placer platinum, and of its soluble and insoluble fractions, Goodnews Bay district

	A	B	C
	(percent)	(percent)	(percent)
Platinum	14.48	93.50	11.52
Iridium	71.22	5.78	73.67
Osmium	11.00	0.00	11.42
Ruthenium	1.15	0.00	1.19
Rhodium	2.15	0.72	2.20
	100.00	100.00	100.00

A. Composition of entire sample of 8.13 grams, wherein the ratio of the soluble to the insoluble fraction $\frac{B}{C} = 0.37$.

B. Composition of that part of A soluble in aqua regia.

C. Composition of that part of A insoluble in aqua regia.

This subfraction, as might be expected, contains no palladium. Analysis C represents approximately the composition of the alloyed osmiridium, but is believed to contain too much platinum; and the iridium, too, may be too high. The selectivity of the method is indicated by the fact that for the original fraction of 90.95 grams, from which Sample A was taken, the ratio $\frac{B}{C} = 5.87$.

The physical properties of the two alloys doubtless differ materially, but these cannot be determined, because pure samples of these alloys cannot be obtained. The magnetic properties, however, are quite evident in bulk samples from the placers. Thus 4 percent of a sample from Salmon River was found to be ferromagnetic, whereas 25 percent of a sample from Clara Creek was found to be ferromagnetic. This difference is doubtless related to the change in composition of the platinum metals, from the south to the north end of Red Mountain. That is, the ratio of the major to the minor alloy probably increases in this interval. All these platinum metals, however, are paramagnetic, though in varying degrees.

A small amount of gold is recovered with the platinum metals from the placers. The exact source of this is unknown, but it is thought to have originated in quartz veins associated with the granitic rocks at the head of Smalls River. The proximate sources of most of the gold are twofold. An early Pleistocene glacier, possibly of Nebraskan age, overrode the valley of Salmon River, and deposited large amounts of glacial debris. Later, the Illinoian(?) ice moved down the valley of Goodnews River and spread out into the valleys of Tundra Creek and Smalls River; and thus morainal and glaciofluvial materials were dumped at the head of Salmon River, whence they later were moved down that valley by running water. The free gold in the valley of Salmon River has a proximate source in both these generations of glacial debris.

The dross of platinum metals is rarely determined, as it is generally included with the residual black sand under the heading of "impurities". Actually such impurities include the alloyed dross of the platinum metals, a minor amount of silver and dross in the gold, extraneous metallic impurities such as solder and lead shot that have not been removed, minerals adhering to or included in the platinum metals, and black sand that was impracticable to remove from the final product. The dross of native gold, which generally is copper and iron, constitutes about one percent of the gold-silver alloy. The dross of the major platinum alloy is believed generally to consist of 8 to 10 percent of iron, copper, and nickel, rarely cobalt. Chromium, if it shows in an analysis, is probably not an alloyed metal, but comes from included chromite. Under the microscope, a few minute included crystals of chalcopyrite have been identified in the Goodnews product, so that even the copper and iron of the analysis of a picked sample may not be entirely alloyed metals, though they dominantly are such. The dross of the osmiridium in the Goodnews Bay placers has not been determined, but like that from the Urals and Colombia, probably consists also mainly of iron and copper, though in much smaller amounts than in the major alloy.

Some data on the character and amount of the true dross of these platinum metals were earlier published by the writer (1940, p. 80-81). These are republished below as analyses A and B. In addition, Charles J. Johnston, of the Goodnews Bay Mining Co., later authorized Johnson, Matthey & Co./ to make two complete analyses of platinum metals entirely free of black sand, from the Goodnews Bay district. These comprise analyses C and D. These four analyses, recomputed free of all constituents other than the platinum metals and dross, are shown in the table 2.

Table 2. Analyses of platinum metals showing dross, Goodnews Bay district

(percent)

	A	B	C	D	Mean
Platinum	57.84	82.25	77.07	77.09	73.56
Iridium	26.15	5.37	10.56	10.54	13.16
Osmium	5.71	.54	1.95	2.03	2.56
Ruthenium	.39	.28	.16	.16	.25
Rhodium	1.52	1.45	.94	.94	1.21
Palladium	.21	.14	.33	.35	.26
Iron	7.51	9.48	8.54	8.48	8.50
Copper	.40	.37	.43	.41	.40
Nickel	.27	.09	Tr	Tr	.09
Cobalt	----	.03	----	----	.01
Total	100.00	100.00	100.00	100.00	100.00

A. Fox Gulch, Discovery claim.

B. Clara Creek.

C and D. Exact localities unknown, but believed to be from Salmon River.

The dross shown in these analyses is the dross of mixed platinum and osmiridium, which is somewhat less than that of the major alloy, but much greater than that of the osmiridium alone.

A large volume of heavy minerals is recovered with the platinum metals. For example, a clean-up at one locality in the upper valley of Platinum Creek yielded 250 ounces of platinum metals together with 2 tons of concentrates, which were mainly magnetite, ilmenite, and chromite. The concentrates are classified, and the platinum metals are separated on a Wilfley concentrating table. The finest of this material still contains platinum, and is ground and further concentrated. The platinum metals are finally cleaned by an ingenious vibrating blower. The final product that is sent to the refiner contains about 11 percent of impurities, of which perhaps 8 to 10 percent is alloyed dross, showing that the removal of black sand by the Goodnews Bay Mining Co. is nearly complete.

Chemical analyses

Every cleanup of the dragline excavators and dredge of the Goodnews Bay Mining Company, since 1934, has been graded by sieving into 8 fractions, ranging in size from +8 to -48 mesh; thereafter the output from each cleanup was sent to the refiner (Johnson, Matthey and Co., Inc.) at Malvern, Pennsylvania, though duplicate chemical analyses have also been made by the Griffith, Ledoux, and Baker companies. The sieving analyses since 1943, and all the chemical analyses since 1934, have been made available to the writer by the Goodnews Bay Mining Company. A few analyses of the product from Clara Creek, made by the Wildberg Smelting and Refining Co., were obtained from the Clara Creek Mining Co. The data obtained from the Goodnews Bay Mining Co. comprise 643 sieving analyses and 977 chemical analyses.

A second source of information needs to be mentioned. From the 25th cleanup of 1945, the writer obtained from Charles J. Johnston, Treasurer of the Goodnews Bay Mining Co., a sample of 365.53 grams, that included 321.84 grams of platinum metals, a little gold, and about ~~10 3/4~~ 10.75 percent dross. This sample was taken to Malvern, Pennsylvania, where it was opened and sieved in the presence of John Cochrane, then Chief Chemist, but now a Vice President of the American branch of Johnson, Matthey and Co., Inc. The sample was divided by sieving into 14 fractions, and the largest of these was subsequently subdivided into 7 other fractions, which were separated from one another electromagnetically. Under the supervision of Mr. Cochrane, these 20 fractions were separated into dual subfractions, soluble and insoluble in aqua regia, and 40 complete analyses were made by E. R. Johnson, a chemist in the employ of Johnson, Matthey and Co., Inc. The expense of this work was born jointly by the Goodnews Bay Mining Co. and by Johnson, Matthey and Co., to both of whom the writer is greatly indebted. The three analyses shown in table 1 are based upon a part of these results.

A third source of information has been annual statements since 1934 by Charles J. Johnston, treasurer of the Goodnews Bay Mining Co., of the yearly production of the six platinum metals and gold, together with the weights of dross and other impurities as determined by chemical analyses. From 31 of these statements, omitting those of 1934 and 1935 of doubtful accuracy, it has been possible to construct two tables, nos. 3 and 4, wherein are given respectively the annual percentages of the platinum metals as well as gold and impurities, and of the platinum metals free of gold and impurities.

Table 3. Percentages of platinum metals, gold, and impurities, Goodnews Bay [redacted] district

Year	Pt	Ir	Os	Ru	Rh	Pd	Au	Impurities
1936	68.39	12.72	3.24	0.24	1.46	0.23	0.45	13.27
1937	64.95	17.28	3.29	.29	1.85	.25	1.08	11.01
1938	72.19	11.24	2.24	.17	.99	.29	1.69	11.19
1939	71.54	12.26	2.57	.20	1.16	.31	1.63	10.33
1940	71.77	12.34	2.56	.19	1.16	.32	1.80	9.86
1941	72.44	11.05	2.22	.20	1.14	.31	2.01	10.63
1942	72.50	10.37	2.14	.16	1.31	.36	2.73	10.43
1943	74.68	9.39	1.75	.13	1.21	.36	2.19	10.29
1944	74.67	9.65	1.82	.14	1.21	.37	2.13	10.01
1945	73.09	10.30	2.07	.16	1.31	.34	2.16	10.57
1946	76.24	7.61	1.42	.10	1.12	.39	2.91	10.21
1947	77.25	5.83	.94	.07	1.01	.38	3.73	10.79
1948	77.47	6.20	1.01	.08	1.04	.39	2.83	10.98
1949	76.86	7.07	1.22	.10	1.14	.38	2.54	10.69
1950	75.46	9.13	1.59	.14	1.23	.35	1.64	10.46
1951	75.26	9.33	1.76	.14	1.28	.35	1.43	10.45
1952	73.23	11.10	2.15	.18	1.30	.33	1.32	10.39
1953	71.57	12.19	2.45	.19	1.21	.31	1.46	10.62
1954	73.31	10.91	2.02	.17	1.19	.34	1.37	10.69
1955	74.39	9.83	1.76	.16	1.31	.38	1.69	10.48
1956	76.19	8.27	1.10	.10	1.16	.37	1.57	11.24
1957	75.39	8.26	1.42	.11	1.12	.38	1.70	11.62
1958	75.03	7.96	1.25	.11	.98	.33	1.70	12.64

Table 3. (continued)

Year	Pt	Ir	Os	Ru	Rh	Pd	Au	Impurities
1959	75.22	7.88	1.40	.11	.95	.32	1.98	12.14
1960	75.64	7.85	1.34	.11	.89	.36	1.54	12.27
1961	76.19	7.42	1.28	.10	.96	.37	1.68	12.00
1962	76.16	7.22	1.25	.10	.96	.37	1.82	12.12
1963	71.83	10.18	1.93	.15	.98	.33	2.52	12.08
1964	69.42	11.92	2.38	.19	1.00	.29	3.11	11.69
1965	68.90	12.26	2.41	.19	1.01	.29	3.34	11.60
1966	67.62	12.75	2.56	.19	1.04	.28	3.85	11.71
Weighted means	73.71	9.90	1.88	.15	1.15	.34	2.03	10.84

Table 4. Percentages of platinum metals,
Goodnews Bay [redacted] district

Year	Pt	Ir	Os	Ru	Rh	Pd
1936	79.26	14.74	3.76	0.28	1.69	0.27
1937	73.88	19.66	3.74	.33	2.11	.28
1938	82.86	12.91	2.57	.19	1.13	.34
1939	81.25	13.93	2.92	.23	1.31	.36
1940	81.25	13.97	2.89	.22	1.31	.36
1941	82.92	12.65	2.54	.22	1.31	.36
1942	83.48	11.94	2.46	.19	1.51	.42
1943	85.33	10.73	2.00	.15	1.38	.41
1944	84.99	10.98	2.07	.16	1.38	.42
1945	83.75	11.80	2.37	.19	1.50	.39
1946	87.76	8.76	1.63	.12	1.28	.45
1947	90.38	6.82	1.09	.08	1.18	.45
1948	89.89	7.19	1.17	.09	1.20	.46
1949	88.58	8.14	1.40	.12	1.32	.44
1950	85.85	10.39	1.80	.16	1.40	.40
1951	85.40	10.59	2.00	.16	1.46	.39
1952	82.94	12.57	2.43	.21	1.47	.38
1953	81.40	13.87	2.78	.21	1.38	.36
1954	83.36	12.40	2.30	.20	1.35	.39
1955	84.70	11.19	2.00	.18	1.50	.43
1956	87.39	9.48	1.26	.11	1.34	.42
1957	86.97	9.53	1.64	.13	1.29	.44
1958	87.59	9.29	1.46	.12	1.15	.39

Table 4 (continued)

Year	Pt	Ir	Os	Ru	Rh	Pd
1959	87.59	9.17	1.63	.12	1.11	.38
1960	87.77	9.11	1.55	.12	1.03	.42
1961	88.27	8.59	1.48	.12	1.11	.43
1962	88.49	8.39	1.45	.12	1.12	.43
1963	84.11	11.92	2.26	.17	1.15	.39
1964	81.47	13.99	2.79	.22	1.18	.35
1965	81.00	14.41	2.83	.23	1.19	.34
1966	80.07	15.10	3.03	.23	1.24	.33
Weighted means	84.59	11.37	2.16	.17	1.32	.39

Table 3 shows the percentages of the platinum metals, gold, and all impurities. Silver that was reported in a few of these analyses is alloyed with gold, and in table 3 is included as a part of the dross. Table 4 shows the platinum metals alone, recomputed to total 100 percent. The means at the foot of each column in both tables have been computed, not from the annual percentages, (which would be improper), but from the actual weights of the metals produced, and are therefore equivalent to weighted mean values. From no other platinum field in the world is it possible to state with precision the actual composition of the metals that characterize that particular field.

The analytical data cited on pages 42-45 of this report yield a number of conclusions regarding the composition and distribution of the platinum metals and alloys in bedrock, and also interpretations of the genesis and chronology of the two paystreaks in the valley of the Salmon River. These data will not be analyzed exhaustively in this report, but one generalization bearing upon the composition of the platinum metals in these two paystreaks should be mentioned. The crux of all these problems is the variable ratio of iridium to platinum in the platinum alloys of the ultrabasic massif that constitutes Red Mountain. As earlier stated, iridium is most prevalent at the southern end of this mountain, and least so at its northern end. Consequently, if the analyses of the platinum metals are charted claim by claim in the valley of the Salmon River, it is found that iridium increases and platinum decreases in both paystreaks, from their upper ends downstream to the mouth of Platinum Creek. Downstream from Platinum Creek, the amount of iridium in the paystreak of the valley floor continues to increase, rising to 15½ percent of the total platinum metals on claim 11 below Discovery. Parenthetically, this value approaches the mean value of 18 percent that characterizes the placers of Platinum Creek, between the mouth of Squirrel Creek and the Salmon River. In the bench paystreak, however, after a marked increment at the mouth of Platinum Creek, the amount of iridium decreases downstream, diminishing finally to 8½ percent on the Olson bench claim. Inversely, the percentages of platinum in the two paystreaks change respectively to 79¼ and 88 percent. In general, the percentages of osmium and ruthenium correlate closely with those of iridium.

The bench paystreak has obviously received more of the platinum metals that originated in that part of Red Mountain north of Squirrel and Platinum Creeks; and conversely, a major part of the platinum metals in the paystreak of the valley floor came from the southern end of Red Mountain, via Platinum Creek and its left limit tributaries. It is not entirely clear, however, whether this condition is a result of peculiar physiographic ~~phases~~ processes, or whether it is a function primarily of time. If, as heretofore stated, the paystreak of the valley floor is of composite origin, it is more probable that the high-iridium product in this paystreak may be dominantly a function of time, though other contributing causes will also require examination and evaluation. The volume of platinum metals in each paystreak, and other information deducible from the cited data, may yield more definite conclusions.

Other Alaskan deposits

Alluvial platinum metals have been found to be widely distributed in Alaska, and prior to the discovery of the placers of Goodnews Bay district, had been identified in alluvial deposits at about 20 localities. All these occurrences consisted of small amounts of the platinum metals found in gold placers, and none of these deposits became significant producers of platinum. These occurrences have been described by Theodore Chapin (1919, p. 137-141), G. L. Harrington (1919, p. 339-351, p. 369-400), A. G. Maddren (1919, p. 299-319), and J. B. Mertie, Jr. (1919, p. 233-264; 1933, p. 134-135). The recognized localities are as follows:

Central Alaska

Granite Creek, Ruby district

Boob Creek, Tolstoi district

Southern Alaska

Kahiltna River, tributary Yentna River

Cache Creek, tributary Kahiltna River

Willow Creek, Cache Creek district

Poorman Creek, Cache Creek district

Long Creek, Cache Creek district

Slate Creek, Chistochina district

Miller Gulch, Chistochina district

Metal Creek, Kenai Peninsula

Lituya Bay, beach deposit

Kodiak Island, beach deposit

Southwestern Alaska

Arolic River, lower Kuskokwim area

Snow Gulch, tributary Arolic River, Lower Kuskokwin area

Bear Creek, tributary Tuluksak River, lower Kuskokwim area

Butte Creek, tributary Faro Creek, tributary Arolic River, lower Kuskokwim area

Marshall district, several localities, lower Yukon area

Seward Peninsula

Dime Creek, Koyuk district

Bear Creek, Fairhaven district

Sweepstakes Creek, Fairhaven district

Cache Creek is an eastern tributary of the Kahiltna River, which flows to the Yentna River, of southern Alaska. Traces of gold and platinum were panned on the bars of Kahiltna River, but the valley of this stream had no placers. On Cache Creek, however, and on a number of its tributaries, workable placers were found. A dredge which operated on Cache Creek in 1917 and in subsequent years, commonly recovered about a level teaspoonful of platinum with each cleanup, and this probably represents the maximum production from any one site. The writers estimated that the platinum metals constituted about 0.3 percent of the gold by weight. Small amounts of platinum metals were also found in the upper tributaries of the Tokichitna River which head against Cache Creek. All these streams are in an intensely glaciated part of Alaska so that the bedrock sources of the gold and platinum are unknown.

Dime Creek, on Seward Peninsula, was one of the better known localities where the platinum metals were found in gold placers. The tenor was estimated by Harrington at one ounce per $5,000 in placer gold, which, when the price of gold was $20.67 per fine ounce, amounted to about that found on Cache Creek. During the season of 1917, 35 ounces platinum metals were produced on Dime Creek. Another small producer was Boob Creek, in the Tolstoi district, where 30 ounces were reported to have been sold, but not necessarily produced, in 1917. The valley of Dime Creek, and the other tributaries of the Koyuk River were not overridden by Wisconsin ice, but the bedrock sources of the platinum metals have not been definitely recognized. The same is true for Boob Creek, and the placers of the Ruby district, though bedrock has been recognized of a type that could have supplied platinum metals.

The production of placer platinum overlaps in time the lode production from the Salt Chuck mine, in southeastern Alaska; and as the two kinds of production were combined in the statements of the Geological Survey after 1917, no satisfactory estimate of annual or total placer production can be given, though the recorded annual production began with 8 1/3 ounces in 1916, and was reported by Brooks (1922, p. 23) to have been 53.4 ounces in 1917. The gold placers of Snow Gulch, Bear Creek, and Butte Creek were prospected and worked by the Goodnews Bay Mining Co., but the platinum that was recovered was added to that produced in the early years of mining in the Goodnews platinum placers.

Chemical analyses

Four analyses of the platinum metals of Alaska were made in the laboratory of the U.S. Geological Survey by R. C. Wells, and published by Harrington (1919a,b), Maddren (1919), and Mertie (1919, [redacted]). In addition, three superior analyses were made by Johnson, Matthey and Co., at the request of the Goodnews Bay Mining Co., of the platinum metals from Snow Gulch, Bear Creek, and Butte Creek. Ruthenium was not determined in the U.S. Geological Survey analyses, and a considerable part of the iridium was not separated from the osmium. These analyses, recomputed free of impurities to total 100 percent, are shown in table 5.

Table 5.--Analyses of Alaskan placer platinum metals

(percent)

	A	B	C	D	E	F	G
Platinum	98.1	88.8	51.4	64.8	76.32	72.82	59.07
Iridium	.5	4.7	12.3	10.0	8.34	15.58	15.38
Iridium plus osmium	.7	4.3	34.8	24.2	----	----	----
Osmium	----	----	----	----	8.34	8.17	14.82
Ruthenium	N.D.	N.D.	N.D.	N.D.	5.05	2.29	9.31
Rhodium	.4	1.1	1.5	.9	1.26	.78	.96
Palladium	.3	1.1	Tr	.1	.69	.36	.46
Total	100.0	100.0	100.0	100.0	100.00	100.00	100.00

A. Boob Creek, Tolstoi district, central Alaska. Analyst, R. C. Wells.

B. Dime Creek, Seward Peninsula. Analyst, R. C. Wells.

C. Poorman Creek, tributary Peters Creek, Cache Creek district, southern Alaska. Analyst, R. C. Wells.

D. Canvas Point, west coast of Kodiak Island. Analyst, R. C. Wells.

E. Snow Gulch. Analysis, Johnson, Matthey & Co.

F. Bear Creek. Analysis, Johnson, Matthey & Co.

G. Butte Creek. Analysis, Johnson, Matthey & Co.

These analyses are highly variable in their contents of the six platinum metals. The combined contents of iridium and osmium in samples C, D, E, F, and G range from 17 to 47 percent, but samples E, F, and G are much higher in ruthenium than any samples from the Goodnews Bay district. The analysis of sample C bears some resemblance to the analyses of the samples from Fox Gulch, in the Goodnews Bay district. Analysis A appears to represent a single platinum alloy, wherein the other elements are scantly represented. Analysis B may represent a major platinum alloy mixed or intergrown with a small amount of osmiridium, but the percentages are too indefinite to draw any certain conclusions. Analyses C to G, inclusive, definitely represent mixtures or intergrowths of two alloys, one mainly platinum and the other osmiridium. For samples E to G, inclusive, this conclusion is fortified by the relatively high percentages of ruthenium.

Platiniferous placer gold

A terrestrial formation of Tertiary age crops out south of the Yukon River in Alaska, and extends from the international boundary N. 60° W. for about 90 miles. East of the international boundary, these rocks extend into Canada for an undetermined distance. This belt ranges from a width of 2 miles or less at the boundary to as much as 13 miles in the valley of Seventymile River, south of Eagle. At its western limit, the belt thins considerably, and west of Thanksgiving Creek is overlapped by unconsolidated alluvial deposits of Pliocene and Pleistocene age.

A batholith of granitic rocks crops south of the terrestrial belt at distances ranging from 4 to 15 miles; and from quartz veins and other sources related to the granitic rocks much native gold has been liberated by weathering and erosion. The granitic rocks and their lodes are believed to be of Mesozoic age, but were bared to erosion in early Tertiary time; and the gold from the related lodes was transported northward by streams and deposited in beds which later were indurated to form parts of the terrestrial formation. This Tertiary formation thus became a proximate source of native gold, and many of the valleys of streams that flow northward from these rocks contains gold placers which exist both as terrace deposits and as younger deposits in the present valley floors. The principal streams whose valleys have gold placers derived from such sources are, named from east to west, American Creek, Wolf Creek, Mission and Excelsior Creeks, several south-flowing tributaries of the Seventymile River, a small stream called Fourth of July Creek that flows northward to the Yukon River, Washington Creek, certain tributaries of the Charley River, Sam Creek, Coal Creek, Woodchopper Creek, Webber Creek, and Thanksgiving Creek. The regional and economic geology of the granitic rocks, the terrestrial formation, and the placers derived therefrom have been described by the writer (1937, p. 251-261, and 1942, p. 213-264) in two earlier publications.

None of the gold placers that originated in the manner above described contains the smallest trace of free platinum metals. Nevertheless, three samples of the placer gold were selected by the writer for complete analyses, with special reference to any content of alloyed platinum metals. This work was done in the laboratory of the U. S. Geological Survey by R. E. Stevens. The resulting analyses recomputed to total 100 percent, together with their localities, are shown in table 6.

Table 6.--Analyses of placer gold, Yukon Valley, Alaska

(percent)

	38 A Mt 27	38 A Mt 57	38 A Mt 90a	Mean
Gold	81.13	88.23	93.17	87.51
Silver	18.33	11.21	6.19	11.91
Platinum	.20	.28	.42	.30
Iridium	.02	.05	Trace	.02
Rhodium	None	None	None	None
Palladium	None	Trace	None	Trace
Lead	.06	.07	.08	.07
Mercury	.10	.05	.02	.06
Iron	.08	.07	.07	.07
Copper	.03	.01	.04	.03
Zinc	.04	.03	.01	.03
Cobalt	None	None	None	None
Nickel	None	None	None	None
Bismuth	None	None	None	None
Tin	Trace	Trace	Trace	Trace
Total	100.00	100.00	100.00	100.00

38 A Mt 27 Seventymile River, at mouth of Broken Neck Creek. Analyst, R.E. Stevens
38 A Mt 57 Fourth of July Creek, 7 miles airline from mouth. Analyst, R.E. Stevens
38 A Mt 90a Woodchopper Creek, 4 miles airline from mouth. Analyst, R.E. Stevens

These analyses represent three grades of native gold, having finenesses respectively of 811, 882, and 932. Sample 38 A Mt90a, with gold of the highest grade, contained the largest amount of platinum metals. This high grade gold was being mined in large volume in 1938 by a dredge, and the operators, when informed by the writer of the content of platinum metals in their product, tried to recover payment for the same. Payment, however, was refused, because the United States mint claimed the platinum metals as seignorage. Thereupon the operators took steps to recover the value of the platinum metals by having them separated from the gold before the latter was sold. This yielded an increment in gross profit of about 1.3 percent, from which, however, the cost of the pretreatment of the gold had to be deducted.

This occurrence of platinum metals in native gold is not unique, as similar gold has been mentioned by others, but it probably is one of the best authenticated quantitatively. It is also known that significant amounts of the platinum metals are recovered in the refining of gold and copper. From these considerations, it follows that native gold containing small amounts of alloyed platinum metals may be more commonplace than is generally recognized.

Exploration in Alaska

The platinum metals have been shown to exist at many widely separated sites in Alaska; and one workable lode and one important placer deposit have been developed. These occurrences should offer encouragement for a careful search throughout the state for new deposits. It is true that a great deal of prospecting has been done in Alaska, but this work has had for its principal objective the discovery of gold placers. Native platinum could readily be overlooked in panning streams for gold, as the ordinary prospector might not have been impressed by the presence of steely looking grains in his gold pan. This apparently was true in the Goodnews Bay district, as this area was well known and accessible to prospectors for at least 25 years before the initial discovery of platinum was made. Therefore such earlier prospecting by men searching primarily for gold must be greatly discounted.

The search for platinum lodes, however, is a project that requires understanding of the difficulties involved, and may be beyond the capabilities and resources of ordinary prospectors. Platinum-bearing lodes, such as those of Canada, South Africa, and Siberia, are generally deposits of sulfides of copper and nickel. Those sulfides, if not destroyed by weathering, could be recovered in concentrated form by panning alluvial deposits; and if they are thought to be platinum-bearing, may be submitted for analysis. On the other hand, if the sulfides have been destroyed by weathering, the liberated platinum minerals, because they are so fine-grained, are likely to have been floated by water, and to have been widely distributed far downstream. And if the platinum metals are chemically combined with the sulfides, the scattering is still more diffuse. Hence the gold pan has a limited adaptability in prospecting for platinum lodes.

Small samples of bedrock will not be useful for analysis, because the platinum metals are so sparsely and widely disseminated, both as native platinum and platinum minerals, that such analyses will be undependable. Large samples of bedrock will be needed, and in a country like Alaska, these will have to be transported long distances to get them to a laboratory where they can be crushed, milled, and concentrated prior to analysis. Bearing in mind these obstacles and safeguards, and the lack of cheap transportation throughout most of Alaska, it is not surprising that the search for platinum lodes in this state has so far been unsuccessful. Finally, analyses for the platinum metals, should not be attempted by an ordinary assayer or chemist; in fact, assayers of excellent reputation have failed in such work. Instead, the samples should be submitted to processors of the platinum metals, or to others who are familiar with the chemical methods required. Superior analyses for the platinum metals are very expensive, and for this reason, the prospecting for platinum lodes will have to be done by mining companies with adequate financial backing.

Geologic maps on reconnaissance or exploratory scales are now available for most of Alaska; and more detailed maps are locally available. Ultrabasic and gabbroic rocks, the hostrocks of most of the platinum metals, will appear on these maps; and such rocks will serve as a first guide to concerns that are financially able to undertake prospecting for platinum metals. One example of an area that should be prospected is in the Yukon-Tanana region, of interior Alaska, where ultrabasic and basic rocks crop out intermittently for a distance of about 90 miles from the headwaters of Salcha River west-southwestward to the Tanana River, about 25 miles southeast of Fairbanks. Similar examples may be found in other parts of Alaska. Most of these projects will require the use of helicopters.

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