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PLATINUM DEPOSITS OF THE GOODNEWS BAY DISTRICT, ALASKA

BY

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By J. B. Mertie, Jr.

ABSTRACT

Platinum metals have been found in earlier years at several localities in Alaska, but with the exception of a palladium-copper lode in southeastern Alaska none of these deposits has been of commercial importance. The platinum deposits described in this report are placers. They were discovered in 1926 and are now being worked on a large scale.

The area containing these deposits is located in southwestern Alaska, close to Kuskokwim Bay. The bedded rocks consist of sedimentary and volcanic rocks of late Paleozoic (?) age, which have been intruded by ultrabasic and granitic rocks, and overlying all of these is a variety of unconsolidated deposits of Quaternary age. The bedded rocks have an intricate structure and are more or less recrystallized. The ultrabasic intrusive rocks consist of several varieties of peridotite and perknite, but other specialized types of igneous rocks are closely associated with them. The Quaternary deposits reveal a long and intricate geomorphic history, which is likewise a history of the deposition of the platinum-bearing gravels.

INTRODUCTION

The Goodnews Bay district is an indefinite region that includes all the country contiguous to Goodnews Bay. The part of the district described in this report is a small area lying south of Goodnews Bay which, on the accompanying map, is designated Platinum and vicinity. This small area is the site of the platinum deposits that constitute the principal thesis of this report.

The map of Platinum and vicinity shows an area of about 210 square miles, between 161°28′ and 161°49′ west longitude and 58°48′ and 59°03′ north latitude. This area is bounded on the west by Kuskokwim Bay, on the north by Goodnews Bay, and on the east and south by the Kinegnak River and its tributaries. The accompanying index map (fig. 4) shows the position of this area in Alaska.

PLATINUM PLACERS

In recent years interest in the district has been revived by the discovery and commercial exploitation of platinum placers in a small area just south of Goodnews Bay. Accordingly in 1937 a topographic and a geologic party were sent by the Geological Survey into the area for the purpose of preparing maps and studying the economic geology of the platinum deposits. Gerald FitzGerald, topographic engineer, prepared a detailed topographic map of the small area called Platinum and vicinity for publication on a scale of 1:62,500 and a contour interval of 50 feet. This map has served as the base for figure 5. FitzGerald also did some less detailed topographic mapping to the east and south of the area. Geologic work was confined to the small area called Platinum and vicinity. In the

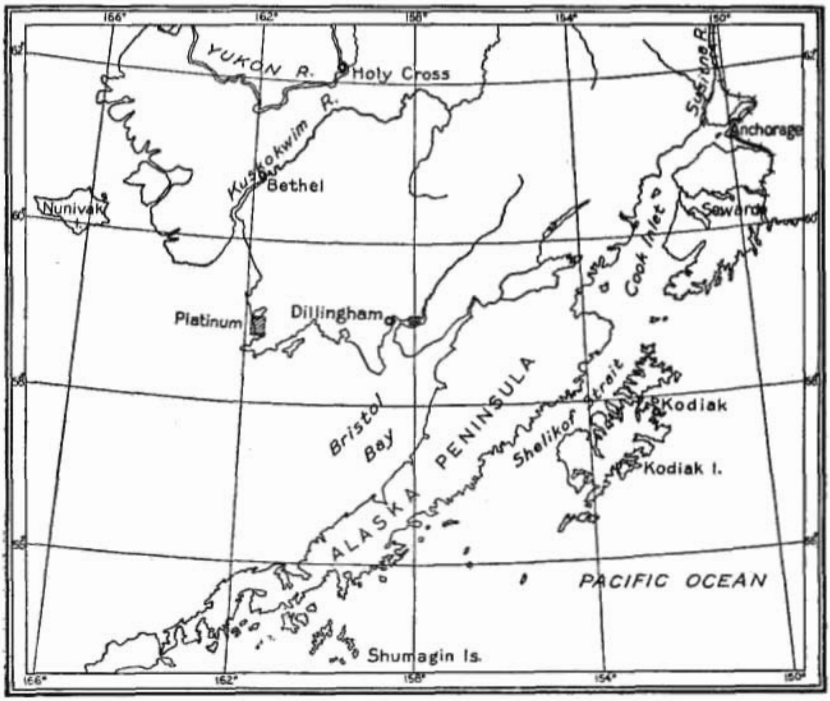

FIGURE 4.—Sketch map of part of southwestern Alaska showing location of Platinum.

course of 65 days, the writer studied the areal and economic geology and prepared a detailed geologic map of this area on a scale of 1:62,500.

The detailed topographic and geologic mapping was done from field camps. In the absence of pack horses or other means of transporting equipment from camp to camp, the Goodnews Bay Mining Co. and the Clara Creek Mining Co. furnished automotive caterpillar transport; and the writer, on behalf of Mr. FitzGerald and himself, wishes to thank these two companies for their generosity and helpful cooperation in this and other ways, as a result of which the work was materially aided and expedited. Grateful acknowledgment is also made to the miners, prospectors, and traders of Platinum and vicinity

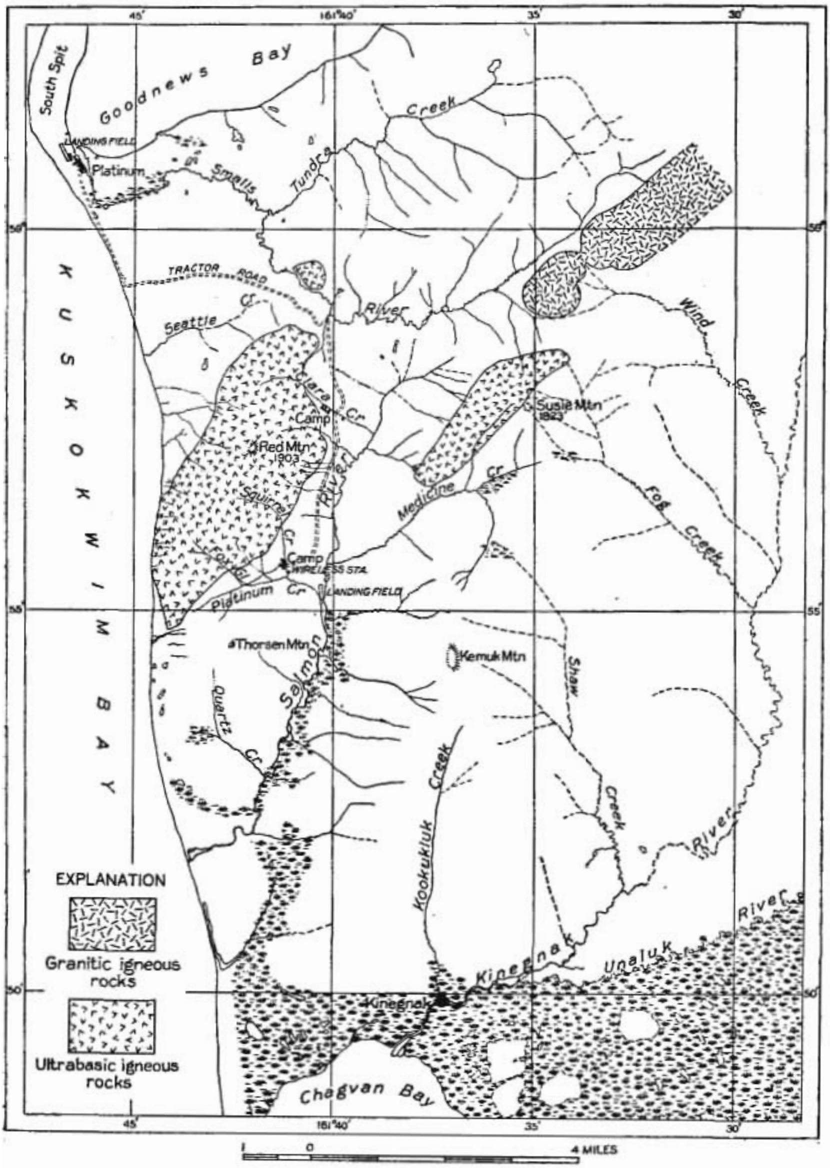

FIGURE 5.—Geologic sketch map of Platinum and vicinity.

for their hospitality, for information furnished, and for the sundry other ways in which they voluntarily helped the Survey parties.

A complete report on this investigation is in preparation, but as it will not be available for some time, it was considered advisable to issue advance statements regarding certain of the significant results that so far have come out of the study. In this brief account it is impracticable to treat of the general geography or geology of the region, but these subjects will be fully covered in the more complete report.

HISTORY AND GENERAL CONDITIONS OF MINING

Placer gold has been mined in a small way for many years in the part of the Goodnews Bay district north of Goodnews Bay; but in recent years platinum placers have been discovered and mined in the area south of Goodnews Bay. These deposits are particularly important, not only because they are the first placers found in Alaska which are workable primarily for their content of platinum metals but also because the present production is far in excess of any other area so far developed in the United States or its possessions. A small amount of gold is recovered with the platinum metals. Chemical examination of the rocks from which the platinum metals are derived shows also the presence of chromium, nickel, and copper, but none of these elements appear to occur as commercial ores. Platinum metals are therefore the only mineral products in the area called Platinum and vicinity that have any commercial value.

The general history of the discovery of platinum in this district, together with a sketch of earlier mining operations, has been given by Irving Reed.[1] According to this account, platinum was discovered in 1926 at the mouth of Fox Gulch, a tributary of Platinum Creek, by an Eskimo named Walter Smith. This native, who thought the platinum was "white gold," related his discovery to another native called Henry Whuya, who in turn communicated the information to Charles Thorsen, a local resident and miner, who had lived in this district for many years. Thorsen went to the site of the discovery, panned some of the metallic material, and sent it to the office of the Bureau of Mines, at Fairbanks, where it was analyzed and determined to be platinum. In 1928 Thorsen discovered platinum in the gravels of Clara Creek, and in the same year Edward St. Clair made the first discovery of platinum on Squirrel Creek.

The complete history of the earlier mining in this district is not known, but small-scale mining plants began operations on Platinum, Squirrel, Fox, Clara, and Dowry Creeks in 1927 and 1928 and mined intermittently until the large-scale plant of the Goodnews Bay Mining

[1] Reed, Irving, The Goodnews Bay district, Alaska: Mining and mine inspection in Alaska for 1931-32, pp. 103-126, Juneau, Territory of Alaska, 1933.

Co. began work in 1934. Thus Reed[2] has recorded the fact that Charles Thorsen worked on Discovery claim of Platinum Creek in 1927, that George Weickert operated on the same claim in 1929 and 1930, and that Charles Tonietzko and John Bennett worked bench ground on claim 2 below Discovery in 1930 and 1931 (pl. 2). On Squirrel Creek placer mining was done on claim 3 below Discovery in 1931 by W. B. Moeck and Fred Wolter, and in the same year on claims 1 and 2 below Discovery, respectively by Tupper Thompson and Edward St. Clair. As early as 1927 some small-scale mining was done by natives on Fox Gulch on claim 2 above Discovery; and on Discovery claim, of Fox Gulch, Neal Corrigal worked an open cut from 1929 to 1935. Some mining was also done on Dry Gulch in 1930 by Joe Chanie and Edward St. Clair.

On Clara Creek placer mining began in 1928, and in the period from 1928 until 1931 or later Charles Thorsen and Andrew Olson mined on Discovery claim. Mining operations were also in progress until 1931 or later on claims 1, 2, and 3 above Discovery. The work on claim 1 above Discovery was done by Martin Garthe; that on claim 2 above Discovery by O. J. Sampson and Martin Garthe; and that on claim 3 above Discovery by John Haroldsen and August Wicklund.

Most of this earlier mining was done in the valleys of Squirrel, Fox, and Clara Creeks, where the overburden was not too deep to be removed profitably by small-scale methods. Farther north in Alaska, where the ground is perpetually frozen to considerable depths, small-scale drift-mining methods could have been used. But in this part of Alaska there is no permanently frozen ground and no timber for timbering, and therefore underground mining is not practicable. Moreover, all the earlier mining was done in small valleys, where the supply of water is scarce, and hence most of the work had to be accomplished by hand methods, consisting of ground sluicing and shoveling into sluice boxes. To the several small operators it finally became evident that, although this was a promising field, mining would have to be done on a larger scale in order to be profitable. Consequently consolidation of the many mining claims began, and eventually many of the claims passed into the control of the Goodnews Bay Mining Co. and the Clara Creek Mining Co., which are now carrying on practically all the productive placer mining operations in this area.

The Goodnews Bay Mining Co., the larger of the two companies, holds or leases more than 150 claims in the valley of the Salmon River and its tributaries. This company began mining with a dragline excavator on Squirrel Creek on August 11, 1934, and in the 3 years of 1934–36, inclusive, mined the best of the placers in that stream.

[2] Reed, Irving, op. cit., pp. 117-122.

Mining by the same method was then begun on Platinum Creek in 1937, on claim 2 below Discovery, and the work was carried upstream to Fox Gulch, and for some distance up Fox Gulch during that year. This does not mean, however, that all of the pay streak on Platinum Creek within this stretch has been mined, as one or more parallel cuts will doubtless be worked later. In the summer of 1937 the Goodnews Bay Mining Co. also began the construction of a dredge, completed it that fall, and began operations on November 10, working until December 20. The length of the season in which mining can be carried on in this region with a dragline excavator is about 5½ months, but the working season of the dredge is expected to be about 8 months. Including the dredge crew, about 50 persons are employed by the Goodnews Bay Mining Co.

The Clara Creek Mining Co. holds or leases about 20 claims, located mainly in the valley of the Salmon River, north of the mouth of Platinum Creek, and in the valley of Clara Creek. This company began work in 1936 on the east end of claim 1 above Discovery on Clara Creek, and in the years 1936 and 1937 has worked up that stream to the west end of claim 3 above Discovery. About 23 persons are employed in this work. As on Platinum Creek, this does not mean that all of the pay streak on Clara Creek within this stretch has been worked, as one or more parallel cuts will also be mined here.

It is estimated that about 3,000 ounces of platinum metals was recovered from the placers of this area between 1927 and 1934. From 1934, when large-scale mining began, to the end of 1937 the production is believed to have been about 18,000 ounces. This includes the production of the new dredge, during its 6 weeks of operation, in 1937. It is believed that during the next few years, with the equipment now installed, if the tenor of the deposits remains as at present, the annual production for the area will not fall below 20,000 ounces.

PLATINUM CREEK AND FOX GULCH

Platinum Creek is a western tributary of the Salmon River, with an airline length of about 2 miles, though its length by the course of the stream is somewhat greater. Platinum Creek heads in a low divide only half a mile from Kuskokwim Bay, though it is 650 feet above sea level. On its south side and a little more than half a mile from its source a small valley known as Willow Gulch, enters the valley of Platinum Creek. This gulch is unimportant from both the geographic and the economic point of view and merits no further mention. No other tributaries enter Platinum Creek from the south. On its north side Platinum Creek has three tributaries, which named in order downstream are Fox Gulch, Dry Gulch, and Squirrel Creek. All three of these head in the ultrabasic intrusive mass to the north, and all three have deposits of platinum in their valleys. Fox Gulch, the most westerly of these tributaries, has a length of nearly a mile, but the downstream or southeastern end of its valley is inconspicuous, being merely a narrow incision in the north wall of Platinum Creek. Dry Gulch is shorter and even less conspicuous. Squirrel Creek, however, has a length of about 1½ miles and occupies a well-defined valley. The total area drained by Platinum Creek and its tributaries is only about 5 square miles.

The ultimate longitudinal and lateral limits of the platinum pay streaks on the various streams of this area cannot be definitely predicted, because the extent to which the platinum-bearing gravels may be worked in the future depends upon conditions that cannot at present be determined. One of these conditions is the future price of platinum metals; another is the relative proportion of the different platinum metals, which varies from place to place; other variable economic conditions constitute a third and very important factor; and finally, in the last stages of mining, when the original cost of mining equipment has been amortized, it might be desirable to work ground upon a salvage basis that would not be considered workable in the earlier stages of mining. At the present time, however, the pay streak on Platinum Creek is considered to begin at the west end of Discovery claim, at the mouth of Fox Gulch, and to continue to the east part of claim 2 below Discovery, a short distance upstream from the mouth of Squirrel Creek. From this point to the mouth of Squirrel Creek there is a short stretch, perhaps 1,000 feet in length, in which the gravels are not now considered workable. From the mouth of Squirrel Creek, the pay streak continues down Platinum Creek without interruption to its mouth. Above the mouth of Fox Gulch the gravels of Platinum Creek are not considered of workable grade, so that the pay streak of Fox Gulch may be said to constitute the headwater part of the pay streak of Platinum Creek. In view of the fact that the headwater branch of Platinum Creek does not drain an area occupied by ultrabasic intrusive rocks, this lack of workable placers is significant.

The width of the workable pay streak on Platinum Creek is even more difficult to state. Above the mouth of Squirrel Creek, the Goodnews Bay Mining Co. so far has worked the platinum gravels for a width of 100 to 120 feet. At the mouths of Dry and Fox Gulches the pay streak widens appreciably. It is probable, however, that this part of the pay streak will ultimately be worked for a width of at least 200 feet. Downstream from the mouth of Squirrel Creek, the pay streak on Platinum Creek widens rapidly, and near the mouth of Platinum Creek, where the dredge operated in 1937, the pay streak is at least 400 feet wide. It must be stressed, however, that this figure is based on the presumption that the ground is to be mined by dredging.

high, with ¾-inch slots in them. In the lower one and one-half lengths of the sluice boxes undercurrents are used, underlain by matting. The holes in the undercurrents are tapered, with the small diameter, about ⅜ inch, on the upper side. In order to distribute the tailings more evenly at the end of the sluice line, the last sluice box is equipped with a three-way outlet gate, so that the tailings may be discharged in three different directions. Near the lower end of the last sluice box there is a transverse slot, about 3 inches in width, in the matting and through the bottom of the sluice box, through which fines escape below to a matting-covered table, 5 feet in width and 10 feet in length. This table, having twice the width of the sluice boxes, slows up the sluice water and causes the finest of the platinum grains to settle.

As the dump box and sluice boxes are elevated, water has to be pumped to the dump box both for washing the gravel and for sluice water. For this purpose a small dam is built in the bed of the creek a short distance downstream from the washing plant, in the cut where mining has already been completed. At this site is also mounted a 6-cylinder, 75-horsepower Caterpillar Diesel engine which operates a direct-connected Allis-Chalmers centrifugal pump, with a 12-inch intake and a 10-inch outlet. This pumping plant supplies 3,500 gallons a minute under an 80-foot head, but on account of loss of pressure in the pipe line this is reduced to a 40-foot head at the dump box. To compensate for a part of this loss of pressure, a small 20-horsepower Diesel engine and pump are mounted directly under the sluice line and are utilized as a booster unit. A giant, with a 3-inch nozzle, is used in washing the gravel in the dump box.

In the process of cleaning up, a large part of the platinum metals is found in the dump box, but the exact ratio between the recovery in the dump box and in the sluice boxes is not known. About 13 percent of the platinum metals is recovered in the undercurrents, and about 1 percent in the concentrating table below the sluice boxes. After the rough clean-up, the platinum product is subjected to additional treatment, in order to reduce the black sand to a volume of less than 20 percent, as above that amount a penalty is charged by the purchaser. The concentrates, consisting of both pebbles and grains of black sand, is twice classified, first through a ¼-inch sieve and later through a twelve-mesh screen. The fines are run over a small Wilfley table two or three times, in the course of which treatment most of the black sand is eliminated. After treatment on the Wilfley table, the platinum product then recovered is further processed by an ingenious vibrating blower, which separates the material into five fractions, of which one is almost pure platinum metals. The second is easily cleaned by blowing with the breath; and the others are returned to the Wilfley table for further treatment. There is a certain residual product that cannot be satisfactorily cleaned with present facilities. The finest of this material contains about 2 ounces, the coarsest about 4 ounces, of platinum metals to the ton of black sand. This material is being saved for future treatment with a ball mill and classifier. Of the total clean-up about 15 to 20 percent is recovered from the black sand that goes over the Wilfley table.

In addition to the mining equipment above mentioned, the Goodnews Bay Mining Co. also has a second dragline excavator of the erector type, which is convertible into a derrick hoist. This was used in some measure during the season of 1937, in conjunction with the other unit mainly for the purpose of removing that part of the overburden that is not put into the dump box and through the sluices. It was also used for a variety of other purposes, but chiefly as a derrick hoist, in the construction of the dredge. This unit is a type 34–B Bucyrus-Erie excavator, equipped with a 100-horsepower Caterpillar Diesel engine and having a 55-foot boom, which swings a bucket with a capacity of 1¼ cubic yards. The company also owns and operates a considerable variety of electrical equipment, of which the more important are a 6½-kilowatt Fairbanks-Morse direct-current generator, a 1½-kilowatt direct-current Kohler plant, a ½- and 1½-kilowatt converter for changing direct current to alternating current, direct-current Kohler plants on the two dragline units, a small windmill generator for radio receiving and for lighting in winter, and a variety of electrical machines in the radio station, which the company owns and operates. There are also a high voltage, 3-phase alternating-current generator and a direct-current Kohler plant on the dredge.

SQUIRREL CREEK

Squirrel Creek is the most easterly and largest tributary of Platinum Creek, entering from the north. Squirrel Creek has a length of about 1½ miles and occupies a well-defined valley, which in its lower reaches is broad and open. The headwater part of the valley is a narrow gulch, cutting well back into the central portion of the ultrabasic intrusive massif that forms Red Mountain.

The placers of Squirrel Creek were worked by the Goodnews Bay Mining Co. by means of a dragline excavator during the seasons of 1934, 1935, and 1936 and are now nearly exhausted. The ground that was worked extended from the south end of Discovery claim downstream for 2,600 feet nearly to the south end of claim 3 below Discovery. In this stretch, the width of the pay streak ranged from 150 to 550 feet, being narrowest in the medial part of claim 3 below Discovery and widest in the vicinity of Tupper Gulch, a small tributary from the west. This ground was worked in from one to four parallel cuts, but in the vicinity of Tupper Gulch, the fourth or most westerly cut was of almost too low grade to be profitable. Some of the placers of Squirrel Creek were of rather high grade, approaching 0.1 ounce to the cubic yard, but the average tenor for the whole pay streak is reported to have been about 0.03 ounce to the cubic yard.

The gravel of the southern end of the pay streak of Squirrel Creek is similar in size and shape to that of Platinum Creek, upstream from the mouth of Squirrel Creek, but at the upper or northern end of the pay streak it was coarse and angular and more nearly similar to that of Fox Gulch. As on Platinum Creek, the petrographic character of the gravel is the same as that of the rocks within the drainage basin. The average thickness of the alluvium in Squirrel Creek is about 13 feet, but in the most westerly cut, in the vicinity of Tupper Gulch, the thickness increases to about 20 feet. The bedrock of most of the valley of Squirrel Creek is essentially the same as that on Platinum Creek, but in the northern part of the pay streak, near the line between Discovery claim and claim 1 below Discovery, the contact between the country rock and the ultrabasic intrusive mass of Red Mountain was uncovered; and from this point upstream the ultrabasic rocks form the bedrock. On account of tailings and sediment in the cut this contact is not now actually visible, but its position is closely marked by the bedrock material that was excavated during the mining operations and is now dumped on one side of the cut. From the character of this material it is evident that the contact at this place was the site of a peripheral intrusion of gabbro-pegmatitic material, the crystallization of which probably postdated that of the ultrabasic rocks of Red Mountain. Some of the coarser samples of this material are greenish-black and consist almost entirely of large crystals of hornblende. Other samples of the coarser material consist mainly of albite, intergrown with considerable white sericite.

The platinum metals recovered from Squirrel Creek occurred generally in coarser grains than these same metals found on Platinum Creek, and nuggets were somewhat more common. The largest nugget found on Squirrel Creek weighed 1½ ounces. A comparison of the commercial analyses of the platinum metals found on these two creeks shows that the product of Squirrel Creek contains on the average 8½ percent more of platinum and 9 percent less of iridium than that of Platinum Creek. It is an interesting fact, however, that the sum of the platinum and iridium, as shown by all the commercial analyses from this district, tends to approach a constant value, approximating 82 percent of the product as given by the commercial analyses. The proportions of the other metals of the platinum group, and also of gold as found on Squirrel Creek, are not significantly different from those found on Platinum Creek.

SALMON RIVER

Little mining had been done by the fall of 1937 in the valley of the Salmon River, but the general extent of the platinum placers had been determined by the drilling operations of the Goodnews Bay Mining Co. From the mouth of Medicine Creek the pay streak extends downstream on the Salmon River for at least 2½ miles, with a width ranging from 300 to 1,000 feet. Upstream from the mouth of Medicine Creek insufficient drilling has yet been done to delimit the workable ground, but it appears reasonable to expect a downstream continuation of the pay streak of Clara Creek. The configuration of the valley of the Salmon River upstream from the mouth of Medicine Creek is such as to suggest that such a pay streak may lie along the east side of the valley.

The upstream limit of the V-shaped incision in the bedrock floor of the Salmon River and its tributaries has not been traced on the Salmon River, but judging from the fact that the incision extends 2 miles up the valley of Medicine Creek and half a mile up the valley of Platinum Creek, it might be expected to persist up the valley of the Salmon River at least as far as Clara Creek. So far as known now this incision lies for the most part west of the present bed of the stream. The platinum metals in the pay streak of the Salmon River are found both on the bedrock of this deep incision and on the higher bedrock on its sides. It is also significant that the platinum placers are neither appreciably richer nor leaner in this notch than on the higher bedrock. Drilling has also shown that the thickness of the alluvium in the Salmon River at the site of the pay streak is 25 to 50 feet.

Some further local details regarding the pay streak on the Salmon River are known from the operations of a dredge, which was installed by the Goodnews Bay Mining Co. in 1937 near the mouth of Platinum Creek. This dredge was built in the valley of the Salmon River, on claim 1 below Discovery, west of the river and about 50 yards southwest of the mouth of Platinum Creek. In the fall of 1937 the dredge worked northwestward and about parallel to Platinum Creek for a distance of 750 feet, taking a cut 200 to 250 feet wide. The average depth of the gravel within this stretch is about 35 feet.

The proportions of the precious metals recovered by the dredge are significantly different from those found either on Platinum or Squirrel Creeks. The proportion of platinum, for example, is about 13½ percent higher than that of Platinum Creek and 5 percent higher than that of Squirrel Creek. Conversely, the proportion of iridium is 13 percent lower than that of Platinum Creek and 4 percent lower than that of Squirrel Creek. Another significant fact is that the proportion of gold recovered with the platinum metals by the dredge is considerably greater than that recovered on Squirrel and Platinum Creeks.

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The dredge had not been built at the time of the writer's visit to Goodnews Bay, but its construction was afterwards described by Sawin,[3] from whose paper a part of the following data were taken. The dredge is of the Yuba type, built by the Yuba Manufacturing Co., of San Francisco. The hull is assembled from 33 steel pontoons, electrically welded together, and measures 130 feet long, 60 feet wide, and 9½ feet deep. The total weight of the hull, machinery, and superstructure is about 1,400 tons. With the digging ladder set at an angle of 45° the dredge can dig 50 feet below water level, and with the ladder held at 25° the hull has about 3 feet of freeboard. The digging ladder is 112 feet long and is equipped with buckets having a capacity of 8 cubic feet. The dredge operates from two spuds, two bow lines, and two stern lines and has two winches on the starboard side, one of which has 8 drums. The other is an independent ladder hoist winch. The stacker is 140 feet long and like the digging ladder is covered and heated to permit operation in subzero weather. The 36-inch stacker belt is made of canvas and rubber. The trommel-screen is 7½ feet in diameter and has a perforated section 26 feet long. The power plant, which is on the boat, is a McIntosh-Seymour Westinghouse diesel-electric generator, rated at 625 kilovolt-amperes. It delivers high voltage three-phase current, for electric operation throughout.

The dredge began mining operations on November 10, 1937, and worked for 41 days before closing down for the season. In 1938 it began work on April 27, so that it would appear that the working season in this district will be about 8 months. It was planned that the dredge should work up the valley of Platinum Creek only to claim 5 below Discovery, where it would turn and come back down the valley of Platinum Creek, into the valley of the Salmon River, where its principal work will be done. The Goodnews Bay Mining Co. plans to work claim 4 and part of claim 5 below Discovery, on Platinum Creek, by means of a dragline excavator.

CLARA CREEK

Clara Creek is a western tributary of the Salmon River, entering the Salmon about 2¾ miles by airline upstream from the mouth of Platinum Creek. Clara Creek heads in the north end of the ultrabasic massif that forms Red Mountain and flows about S. 50° E. from its source to its mouth, a distance of about 1½ miles. The valley of Clara Creek is not well marked, even in its headwaters, and in reality is little more than a straight shallow gulch without tributaries, which is incised in the west wall of the valley of the Salmon River. The total area drained by Clara Creek is estimated to be less than 1½ square miles.

[3] Sawin, H. A., Bucket dredge installed at Goodnews Bay, Alaska: Eng. and Min. Jour., vol. 139, no. 5, pp. 40-41, 1938.

The longitudinal and lateral limits of the platinum pay streak on Clara Creek are not well known, as little drilling has yet been done in this valley, and large-scale mining operations have been carried on only since 1936, from the eastern end of claim 1 above Discovery upstream. According to Reed[4] earlier mining on a small scale was done on Discovery claim, and on claims 1, 2, and 3 above Discovery, but this work was confined to a narrow channel in the bed of the creek and did not serve to test the width of the pay streak. It is probable that the pay streak is continuous from the contact of the ultrabasic rocks in the headwaters of Clara Creek downstream to its mouth, with the possible exception of that part of the valley contiguous to the Salmon River, where the platinum-bearing placers may have been disturbed by changes in the course of the Salmon River that occurred at the end of the glacial period. The tenor of the platinum placers of Clara Creek cannot at present be definitely stated. Reports of the earlier small-scale mining indicate that some of the placers contained as much as 0.08 ounce of platinum metals to the cubic yard of gravel, but as in the valley of Squirrel Creek, the amount of such ground was small. It is likely that the large-scale operations now in progress will disclose an average tenor, including the platinum mined in earlier years, of about 0.02 ounce to the cubic yard of gravel.

In the placer-mining operations of the Clara Creek Mining Co., a cut ranging from 100 to 150 feet in width has been mined from the eastern end of claim 1 above Discovery upstream to the western end of claim 3 above Discovery, where mining terminated at the end of the season of 1937. Throughout most of this distance the operators have mined what they consider the south side of the pay streak, with the idea that there is at least as much additional ground to the north that can ultimately be worked. At the west end of their operations, however, on claim 3 above Discovery, the dragline plant crossed to the north side of the pay streak, leaving a block of ground on the south side to be worked later.

The alluvial material on Clara Creek has a thickness of 10 to 12 feet, of which the upper 2 to 3 feet consists of turf, peat, and dark-colored vegetal material mixed with sand. Throughout most of the valley of Clara Creek the gravel though subangular is of small size, the cobbles averaging perhaps not more than 3 or 4 inches in diameter. Unlike the conditions found in the valley of Platinum Creek and its tributaries, the gravel of Clara Creek, though consisting in part of materials derived from the local bedrock, includes also a considerable quantity of rocks of foreign origin, which undoubtedly is glaciofluviatile gravel derived from a glacier that formerly reached the

[4] Reed, Irving, The Goodnews Bay district, Alaska: Mining and mine inspection in Alaska for 1931–1932, pp. 113–116, Juneau, Territory of Alaska, 1933.

GENERAL CHARACTERISTICS OF THE PLATINUM GROUP OF METALS

Before discussing certain of the results obtained through the chemical analysis of the product of the Goodnews Bay placers, it may be of service to those not familiar with the properties of the platinum group of metals to state briefly some of their more significant characteristics.

The physical and chemical properties of the various platinum metals have been studied by many investigators, but much remains to be done, particularly in the study of natural platinum alloys. It is a well known fact that certain metals, when they occur as atomic mixtures, give rise to alloys that do not necessarily have the physical or chemical properties of their components. Individual grains of placer platinum undoubtedly contain not only these submicroscopic atomic mixtures but also particles of the individual metallic components, which are large enough to be resolved under the microscope. The placer grains of platinum metals differ also in composition, and doubtless some could be found which are higher in platinum, osmium, iridium, or palladium than others. But it is improbable that any one grain could be selected which on chemical analysis would prove to be entirely free of any one of the six platinum metals. Therefore the placer platinum may be regarded as atomic and mechanical mixtures, representative of stable phases that existed successively during the period of their formation. In this paper the term alloy is used to mean all such metallic mixtures, whether atomic or mechanical.

These conditions show that it is practically impossible to determine the character of any individual grain or nugget of platiniferous composition by any simple chemical or physical tests. Field tests that may serve to distinguish the pure metals are meaningless when applied to alloys. The magnetic property shown by some platinum metals may or may not be due to the presence of alloyed iron, and in any event the intensity of the magnetic susceptibility is no indication of the quantitative content of iron. Some stainless nickel steels, for example, are nearly as magnetic as soft iron, but others are essentially nonmagnetic. In a similar way, the specific gravity of a sample of platinum metals cannot be theoretically computed from the specific gravities of the various components together with a chemical analysis because of molecular readjustments between the components. Practically, therefore, it is futile to give chemical and physical tests for the determination of platinum alloys. Again the chemical and physical properties of the pure metals are of much interest, but the chemistry of platinum metals is too vast a field to be summarized in a geologic report.

Some of the more well-known physical properties, however, are shown in the following table for those interested in platinum mining.

Physical properties of the precious metals

	Atomic weight	Specific gravity	Melting point (° C.)	Boiling point (° C.)	Hardness (Moh's scale)	Electrical resistivity (ohms per cm.^{3}, at 20°)	Magnetic suscepti-bility (mass unit, 18°)	Thermal coefficient of linear expansion (20°)	Crystallographic system	Workability
Paramagnetic										
Platinum	195.2	21.45	1,755	4,300	4.5	10.5×10^{-6}	1.10×10^{-6}	8.9×10^{-6}	Cubic	Malleable and ductile.
Iridium	193.1	22.4	2,350	4,800	6.5	6.0×10^{-6}	$.14\times10^{-6}$	6.5×10^{-6}	Cubic	Brittle.
Osmium	190.8	22.5	2,700	5,300	7.0	9.0×10^{-6}	$.05\times10^{-6}$	6.1×10^{-6}	Hexagonal	Brittle.
Ruthenium	101.7	12.2	2,450	2,800	6.5	10.0×10^{-6}	$.50\times10^{-6}$	9.1×10^{-6}	Hexagonal	Brittle when cold, malleable at red heat.
Rhodium	102.9	12.5	1,955	2,500	4.0	5.1×10^{-6}	1.11×10^{-6}	8.4×10^{-6}	Cubic	Brittle when cold, malleable at red heat.
Palladium	106.7	11.9	1,555	2,200	4.8	10.8×10^{-6}	5.4×10^{-6}	11.8×10^{-6}	Cubic	Malleable and ductile but less so than platinum.
Diamagnetic										
Gold	197.2	19.3	1,063	2,600	2.5	2.4×10^{-6}	-0.15×10^{-6}	14.2×10^{-6}	Cubic	Very malleable and ductile.
Silver	107.9	10.5	960	1,950	3.0	1.6×10^{-6}	$-.20\times10^{-6}$	18.9×10^{-6}	Cubic	Very malleable and ductile but less so than gold.

This table shows numerous significant relations. Lode or placer gold never occurs pure in nature but is always alloyed with more or less silver; and although the usual composition of such alloys is 75 to 80 percent of gold, 24 to 19 percent of silver, and about 1 percent of dross, yet many variations are known. These relatively simple alloys are composed essentially of two elements, of which one is much heavier than the other. Actually the specific gravities of gold and silver have the ratio of 1.84:1, and their atomic weight the ratio of 1.83:1.

Analogously, the platinum metals consist of alloys of six metals, of which three are heavy metals and three are lighter. If the average specific gravity of platinum, iridium, and osmium is compared with the average specific gravity of ruthenium, rhodium, and palladium, it will be found that the ratio of these two means is 1.81 : 1; and a similar mean summation of the atomic weights is found to result in the ratio 1.86 : 1. There seems, therefore, to be a physical analogy between gold and platinum alloys; but on the other hand it should be noted that although the atomic weight of gold is greater than the mean atomic weights of platinum, iridium, and osmium, the specific gravity of the three heaviest of the platinum metals is greater than the specific gravity of gold. The same generalizations hold true for silver as compared with ruthenium, rhodium, and palladium as a group.

The melting points of the platinum metals do not correlate with this subdivision of heavier and lighter elements, as platinum, one of the heavier group of platinum metals, has a much lower melting point than two of the lighter group. But there does seem to be a correlation between these two groups and the boiling points, as all the elements of the heavier group have higher boiling points. The other physical properties above tabulated appear to bear no unique relationship to the specific gravities of the platinum metals. Gold is the softest and osmium is the hardest of the precious metals. Silver has the highest electrical conductivity and palladium the least. All the platinum metals are paramagnetic, but gold and silver are diamagnetic; and of the platinum metals palladium has the highest and osmium the lowest magnetic susceptibility. Osmium and ruthenium are crystallographically hexagonal, but all the other precious metals belong in the cubic system. And finally, gold has the greatest degree of ductility and malleability, but among the platinum metals, platinum stands first and osmium or iridium last in this respect, the last two being actually brittle.

CHEMICAL ANALYSES OF GOODNEWS BAY PLATINUM

The platinum metals recovered in the placer-mining operations in this area are platinum, iridium, osmium, ruthenium, rhodium, and palladium. A small amount of gold is also recovered. Careful analysis in the chemical laboratory of the Geological Survey has shown that the platinum metals contain no alloyed gold and that the gold contains little or no alloyed platinum metals. Therefore all the gold found in the placers is free gold.

In marketing the platinum metals, the two mining companies of the Goodnews Bay district have utilized different methods. The Goodnews Bay Mining Co. in 1937 sent its product to Ledoux & Co., of New York City, where it was analyzed and held to await the selling order of the company. In this transaction Ledoux & Co. acted only as chemists, assuring both the seller and the purchaser of the purity and grade of the product. But in 1938 the Goodnews Bay Mining Co. had its product analyzed by two independent concerns—D. C. Griffith & Co. and Johnson, Matthey & Co.—and contracted with Johnson, Matthey & Co. to take its entire output. The Clara Creek Mining Co. on the other hand sells its product to the Wildberg Bros. Smelting & Refining Co. of San Francisco, who are both analysts and purchasers of the product.

As the placer product is inconstant, every shipment of platinum metals must be analyzed in order to learn its intrinsic value. In the sale of these precious metals, all the platinum metals and gold are paid for in the ratios of their presence in the product. But unlike the practice in gold placer mining, the silver in the gold is regarded as an impurity and does not enter into the composite sales price. As a result of this practice the commercial assays show only the amount of pure gold and no silver. The common elements of the dross—iron, copper, and nickel—are likewise neglected. Hence the commercial assays, though accurate as to the content of precious metals, do not give the complete composition of the platinum and gold alloys but instead contain an item called impurities, which represents all the elements of the dross, together with any extraneous metallic impurities, such as lead shot, solder, and other such materials. Nevertheless such analyses yield a great deal of information regarding the placer product, and the writer is greatly indebted to the Goodnews Bay Mining Co. and to the Clara Creek Mining Co. for their courtesy in making these analyses available for publication in this report. All these analyses, arranged by creeks and in numerical order downstream are given below:

Commercial analyses of platinum metals

Platinum Creek

[Ledoux & Co., analysts]

	1	2	3	4	5	6	7	8
Platinum	56.25	61.71	61.62	61.38	60.88	59.73	59.42	57.81
Iridium	25.43	20.52	19.43	21.21	21.65	23.04	23.24	23.52
Osmium	5.55	4.34	4.74	3.76	4.09	4.42	4.74	3.57
Ruthenium	.38	.31	.37	.44	.48	.33	.37	.40
Rhodium	1.48	1.98	2.01	1.66	1.58	1.53	1.52	1.93
Palladium	.21	.13	.24	.22	.23	.21	.28	.10
Gold	Trace	Trace	Trace	.02	.02	.15	.24	.37
Impurities	10.70	11.01	11.59	11.31	11.07	10.59	10.19	12.30

Commercial analyses of platinum metals—Continued

Platinum Creek—Continued

	9	10	11	12	13	14	Mean
Platinum	57.97	57.75	56.65	57.96	65.23	66.95	60.09
Iridium	24.21	25.83	24.31	23.39	16.30	16.54	22.04
Osmium	3.58	4.34	3.42	3.50	1.85	2.88	3.91
Ruthenium	.49	.46	.30	.27	.19	.29	.36
Rhodium	2.28	1.67	3.13	1.68	1.79	1.38	1.83
Palladium	.28	.14	.16	.26	.27	.24	.21
Gold	.28	.29	.78	.54	.91	.35	.28
Impurities	10.91	9.52	11.25	12.40	13.46	11.37	11.26

1-14. Arranged in order from southeastern end of Fox Gulch downstream on Platinum Creek to the eastern part of claim 2 below Discovery.

Squirrel Creek

[Ledoux & Co., analysts]

	15	16	17	18	19	20	21	Mean
Platinum	65.92	68.50	68.35	68.84	68.88	72.33	66.53	68.48
Iridium	13.77	12.73	14.44	12.32	15.63	9.41	13.54	13.12
Osmium	3.75	3.34	3.09	3.19	3.48	2.05	3.98	3.27
Ruthenium	.46	.14	.22	.14	.44	.19	.27	.26
Rhodium	1.30	1.52	1.90	1.45	1.04	1.34	1.25	1.40
Palladium	.34	.29	.16	.17	.48	.23	.19	.26
Gold	.16	.15	.25	.16	.37	1.21	.54	.41
Impurities	14.30	13.33	11.59	13.73	9.68	13.24	13.70	12.80

15. Discovery claim and claim 1 below Discovery.
16. Claim 1 below Discovery.
17. Claims 1 and 2 below Discovery.
18. Tupper Gulch, adjoining claims 1 and 2 below Discovery; and on claims 1 and 2 below Discovery.
19-20. Claim 2 below Discovery.
21. Claim 2 below Discovery and Sinclair fraction.

Salmon River

[Ledoux & Co., analysts]

	22	23	24	25	26	Mean
Platinum	74.58	75.03	72.13	72.94	72.31	73.40
Iridium	9.30	9.04	8.54	8.64	9.14	8.93
Osmium	2.07	1.77	2.13	2.16	2.14	2.05
Ruthenium	.14	.13	.16	.21	.12	.15
Rhodium	1.89	2.02	1.80	1.84	1.83	1.88
Palladium	.32	.33	.27	.28	.29	.30
Gold	1.62	1.77	2.72	2.44	2.54	2.22
Impurities	10.08	9.91	12.25	11.49	11.63	11.07

22-26. Claim 1 below Discovery, and right limit bench opposite claim 1 below Discovery, arranged in order downstream.

Clara Creek

[Wildberg Bros. Smelting & Refining Co., analysts]

	27		27
Platinum	73.29	Rhodium	0.42
Iridium	5.90	Palladium	.56
Osmium	.69	Gold	1.01
Ruthenium	.13	Impurities	18.00

Certain relations are at once apparent from these sets of analyses, but they are still more apparent in the four mean recomputed analyses below, which omit gold and impurities.

Recomputed analyses of platinum metals

	Platinum Creek	Squirrel Creek	Salmon River	Clara Creek
Platinum	67.93	78.90	84.65	90.49
Iridium	24.93	15.12	10.30	7.29
Osmium	4.42	3.77	2.36	.85
Ruthenium	.41	.30	.17	.16
Rhodium	2.07	1.61	2.17	.52
Palladium	.24	.30	.35	.69
	100.00	100.00	100.00	100.00

From this tabulation it is apparent that both iridium and osmium decrease—though at different rates—as platinum increases. In the diagram, figure 6, the four mean percentages of platinum are plotted as ordinates, against abscissas arbitrarily chosen, so that the four resulting points will lie upon a straight line. If now the percentages of iridium and osmium are also plotted as ordinates, against the same respective abscissas, it will be observed that two straight lines will almost pass through the corresponding points. This indicates that some kind of an inverse relation exists between platinum on the one hand and iridium and osmium on the other hand.

This diagram also brings out a significant geographic relation. Much of the material containing platinum metals in Platinum Creek, above the mouth of Squirrel Creek, came out of the valley of Fox Gulch. Hence if the first, second, and fourth abscissas are considered to represent respectively Fox Gulch, Squirrel Creek, and Clara Creek, it will be seen that there is a regular change in the character of the platinum metals in going northeast from Fox Gulch along the flank of the ultrabasic intrusive mass. Even more significant is the fact that the third abscissa, which represents the Salmon River, falls in about halfway between Squirrel Creek and Clara Creek, as if the Salmon River product were about an equal mixture of platinum metals from Squirrell and Clara Creeks. As the Salmon River analyses represent the product of the Salmon River at the mouth of Platinum Creek this relation is exactly what would be theoretically expected.

Two other less significant relations are also apparent. Ruthenium decreases and palladium increases as platinum increases, but the rates of change are nonlinear. These conditions suggest that palladium is closely related to platinum and that ruthenium may be more closely related to osmium and iridium. The rate of change of rhodium is anomalous.

All the relations above mentioned, when considered together, suggest that two dominant alloys form the principal components of the platinum metals mined in this district. One of these alloys is platinum combined with considerable iridium and small quantities of the

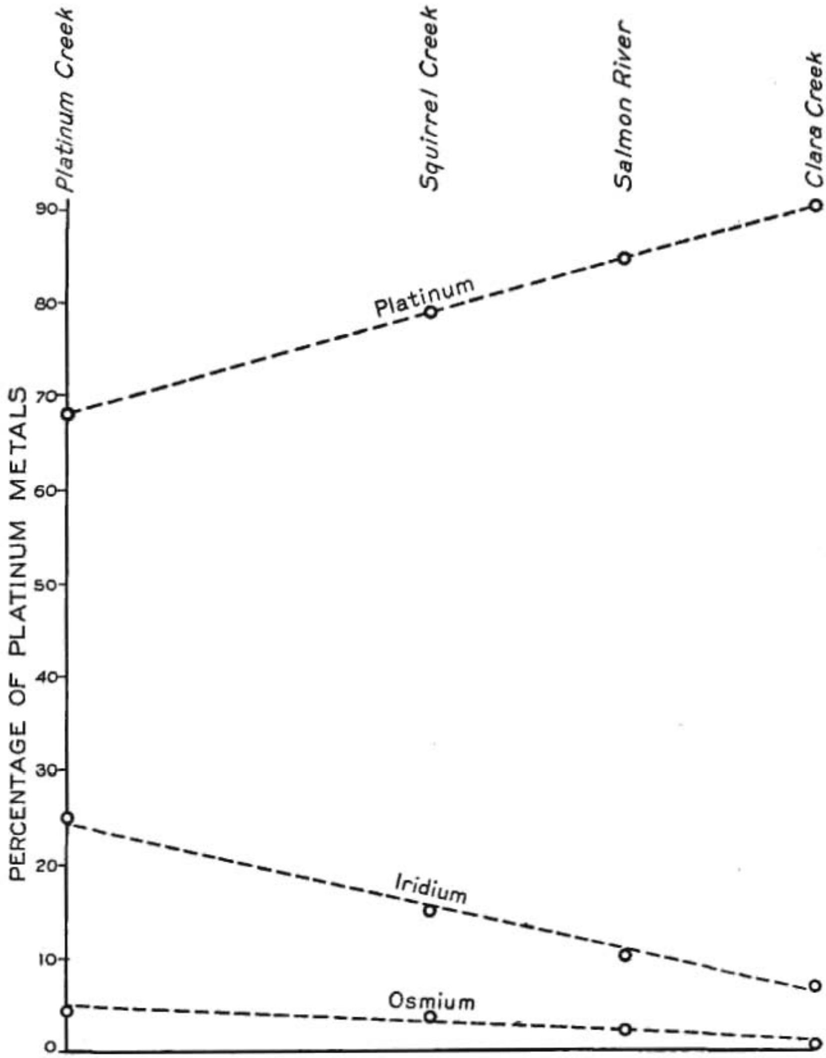

FIGURE 6.—Percentage of platinum, iridium, and osmium in total platinum metals.

other four elements. The other alloy is osmium and iridium combined probably with small quantities of platinum, ruthenium, and rhodium and traces of palladium. It is probable that these two dominant alloys are themselves of variable composition. All that can be inferred on this subject, therefore, is that two dominant but variable alloys probably exist in these placers, and that there are definite ranges of the composition of each of these alloys, so that they do not grade continuously into one another.

In order to learn the entire composition of the platinum metals, two analyses were made in the chemical laboratory of the Geological Survey. One of these analyses of material corresponding closely to sample 1 of the commercial analyses was made to determine only the metals of the dross. This analysis was then combined with Ledoux's analysis of sample 1, to serve essentially as a complete analysis. The second analysis was a complete one of the platinum metals from Clara Creek. These results are given below:

Chemical analysis of dross of platinum metals from Clara Creek

[R. C. Wells, analyst]

	Material corresponding to sample 1	Recomputed free of SiO_2 and MgO
SiO_2	0.23	
MgO	Trace	
Iron	7.30	7.32
Copper	.39	.39
Nickel	.26	.26

NOTE.—No gold, silver, cobalt, or manganese was found in the sample. Specific gravity, 18.33 (determined by George Steiger).

Below are given commercial analysis No. 1 and No. 1 combined with this dross analysis.

Analyses of platinum metals from Fox Gulch

	Commercial analysis No. 1	Complete analysis
Platinum	56.25	57.96
Iridium	25.43	26.21
Osmium	5.55	5.72
Ruthenium	.38	.39
Rhodium	1.48	1.53
Palladium	.21	.22
Iron		7.32
Copper		.39
Nickel		.26
Impurities	10.70	
	100.00	100.00

The complete analysis of the sample from Clara Creek and its recomputation free of MgO and Al_2O_3 are given below:

Complete analysis of the platinum metals from Clara Creek

[J. K. Murata, analyst]

	Part soluble in aqua regia	Part insoluble in aqua regia	Total	Recomputed free of MgO and Al_2O_3
Platinum	80.80	0.59	81.39	82.25
Iridium	2.20	3.11	5.31	5.37
Osmium	[1] .53		.53	.54
Ruthenium	[1] .28		.28	.28
Rhodium	1.38	.06	1.44	1.45
Palladium	.14		.14	.14
Iron	9.38		9.38	9.48
Copper	.37		.37	.37
Nickel	.09		.09	.09
Cobalt	.03		.03	.03
MgO	.10		.10	
Al_2O_3	.35		.35	
Total	95.65	3.76	99.41	100.00

[1] Osmium and ruthenium of soluble and insoluble portions were combined.

NOTE.—No gold, silver, thallium, lead, tin, mercury, chromium, manganese, arsenic, or antimony were found. Specific gravity of sample, 17.20, determined by George Steiger.

In the analysis of the platinum metals from Clara Creek, a preliminary treatment was given by immersion in a 1:1 solution of hydrochloric acid to remove surficial material that was not a proper part of the platinum alloy. With regard to the analytical methods of this analysis, Mr. Murata appends the following note:

The scheme for the determination of the platinum metals published recently by Gilchrist and Wichers [5] was used in the chemical analysis. A preliminary separation from the base metals was effected through a method developed by Gilchrist.[6] Dr. Gilchrist's courtesy in making the details of the method available prior to publication is greatly appreciated. The sample was attacked with aqua regia and the insoluble residue alternately fused with the sodium hydroxide-sodium peroxide flux and with sodium chloride in an atmosphere of chlorine.

Between a fourth and a third of the grains of platinum metals in the sample from Clara Creek are magnetic, though in varying degrees. All the grains, however, are held by a strong electromagnet. Mr. Murata found that the magnetic grains are generally darker in color than the nonmagnetic grains; they also give off an appreciable amount of iron (about 0.4 percent) during the preliminary treatment with hydrochloric acid. Although they tend to be less magnetic after this acid treatment, no correlation was found between the total content of iron in the alloy and the magnetic property.

The platinum metals of Clara Creek were also tested spectrographically by George Steiger, of the Geological Survey, who says:

[5] Gilchrist, Raleigh, and Wichers, E., Procedure for the separation of the six platinum metals from one another and for their gravimetric determination: Am. Chem. Soc. Jour., vol. 55, pp. 2565–2573, 1935.

[6] Gilchrist, Raleigh, New procedure for the analysis of dental gold alloys: Bur. Standards Research Jour., vol. 20, pp. 745–771, 1938.

Three grains of the alloy were tested separately in the spectrograph, by placing each directly in the electrode without any chemical separation. Two of the grains were "non" or very weakly magnetic, the other was easily attracted by a weak magnet. No difference between the grains was detected by the spectrograph. Each grain gave distinct tests for copper and iron, a weak test for arsenic, and a possible test for silver.

Several lead lines were noted in one of the specimens. The specimens were also tested for boron, beryllium, bismuth, cadmium, germanium, antimony, tin, and zinc. Negative results were given for all these metals. From magnetic properties already observed, the iron content evidently varies greatly. The copper content may also vary, but no indication of this was observed. These two metals can be easily and accurately quantitatively determined by simple chemical methods, using no larger quantities of material than is found in individual grains.

The two complete analyses of the platinum metals of Fox Gulch and Clara Creek represent so far as now known the two extremes in composition in the platinum alloys of this area. The alloy from Clara Creek contains about 24 percent more platinum than the one from Fox Gulch; but the product from Fox Gulch contains about 5 times as much iridium and 10 times as much osmium as the alloy from Clara Creek. As the absolute amounts of osmium are small in both alloys, the osmium relation has no economic significance. But as the market price of iridium is usually 3 or 4 times that of platinum, the high content of iridium in the alloy of Fox Gulch is an important economic factor, as the price of the product is thereby considerably enhanced.

The gold found with the platinum metals also leads to some significant inferences. From the beginning of the field work it was believed that some of the gold recovered with the platinum metals, particularly on Clara Creek and on the Salmon River, was erratic gold, which was transported to the head of the valley of the Salmon River and there deposited in the glacial outwash deposits. These deposits were subsequently reworked by fluviatile action, and the gold was thus added to the preexisting placers. Some of the gold, however—for example in Fox Gulch, Squirrel Creek, and Platinum Creek above the mouth of Squirrel Creek— was not introduced by glacial action, as no glacial ice from the north penetrated into these valleys. The gold found in these valleys is therefore of local origin and may be connected genetically with certain dikes of sodic granite and syenite that cut the ultrabasic rocks. As the sodic granites and syenites are believed to be differentiates of the basic magma, it was thought that the dross of this gold alloy might show a relationship with the dross of the platinum metals. Accordingly an analysis was made in the laboratory of the Geological Survey of a hand-picked sample of the gold from Spuirrel Creek. The results of this analysis are given on the following page.

Complete analysis of placer gold from Squirrel Creek

[E. T. Erickson, analyst]

	Analysis	Recomputed free of SiO_2, Al_2O_3, Cr_2O_3, and insoluble material
Gold	83.90	87.99
Silver	10.42	10.93
Copper, very little, not over	.002	.002
Iron	.96	1.07
Nickel	.007	.008
Cr_2O_3	.002	
SiO_2 and Al_2O_3	.43	
Insoluble in aqua regia	[1] 1.73	
	97.451	100.000

[1] Includes 0.06 iron and no chromium. Specific gravity of sample, 13.32, determined by George Steiger.

NOTE.—No lead or bismuth was found in the sample.

Ordinarily copper and iron constitute the dross of placer gold, but the relative proportions of these two metals vary greatly. In this analysis iron is the dominant mineral of the dross, and copper occurs only in a minute amount. Nickel also forms a small proportion of the dross but is nevertheless nearly 4 times as plentiful as copper.

The analyst has interpreted the chromium not as an alloyed metal but as Cr_2O_3, intergrown or included with some of the grains of gold in the form of chromite ($FeO.Cr_2O_3$). This is justified by the fact that no alloyed chromium was found in the complete analysis of the platinum metals. The presence of Cr_2O_3 shows that some of the gold must have occurred in bedrock either intergrown with chromite or in contact with it. These facts are considered adequate to relate this gold genetically with the chromite and therefore indirectly with the platinum. In this connection, it is also worth mentioning that this placer gold is held weakly by a strong electromagnet, though pure gold is known to be diamagnetic.

SUMMARY OF CONCLUSIONS REGARDING GOODNEWS BAY PLATINUM DEPOSITS

Red and Susie Mountains are composed of ultrabasic rocks, and Red Mountain, except for a peripheral zone, is made up largely of a variety of peridotite, known as dunite. The platinum placers are localized mainly in the valley of Platinum Creek and its tributaries, in the valley of Clara Creek, and in the valley of the Salmon River, downstream from the mouths of these, and other gulches that drain the eastern side of Red Mountain. In other parts of the world the platinum metals are known to be associated generally, though not exclusively, with ultrabasic rocks. Therefore, as the platinum placers are localized in valleys that drain the flanks of Red Mountain, there can be little doubt that the dunite and related rocks of Red Mountain are the bedrock source of the platinum metals.

The platinum metals, however, have not been found in place in Red Mountain, nor does a chemical analysis of the dunite show any traces of them, though a small quantity of platinum could not be detected in the amount of rock that is ordinarily used in making a chemical analysis. On the other hand some of the larger nuggets of platinum metals found in the placers are intergrown with chromite, and chromite is known to constitute about 0.4 percent of the dunite of Red Mountain. Moreover, an analysis of the pebbles of chromite that constitute a part of the placer concentrates shows that this chromite contains about 0.05 ounce of platinum metals to the ton. It is therefore believed that most of the platinum metals found in the placers are genetically associated with the chromite that occurs in the dunite.

It is believed that the dunite originated by the separation and sinking of crystals of olivine from a cooling magma. Most of the iron and chrome ores, having a limited miscibility in the magma, also separated at this or an earlier stage in the process of cooling. It is also inferred that the intrusive bodies of ultrabasic rock in this area, though generally lenticular in shape, approximated a vertical position from the time when they originated. It therefore follows that the dunite, chromite, and associated platinum metals were probably localized in the lower parts of the lenticular but upright intrusive masses, so that as these lenses were subsequently bared to erosion, the platinum metals began to be freed from their bedrock source. In intrusive masses, which have not been deeply eroded, the ultrabasic rocks may not therefore contain much platinum; and this is a possible explanation for the scarcity of platinum metals in the stream gravels in the vicinity of Susie Mountain.

From the localization of the placers on the east side of Red Mountain it might be inferred that the bedrock source of the platinum metals likewise was localized on this side of the mountain. This may or may not be true, but it is known that the northwest side of Red Mountain was once the site of one lobe of Goodnews Glacier. Therefore, even if platinum metals had occurred on the west side of Red Mountain, it is improbable that extensive placer deposits would be present on that side, as glacial action tends to dissipate rather than to concentrate metallic elements in gravel. Moreover, not only are the streams on that side of the mountain small, but it would also appear that insufficient time has elapsed since the retreat of the glacier for the formation of extensive Recent platinum-bearing deposits.

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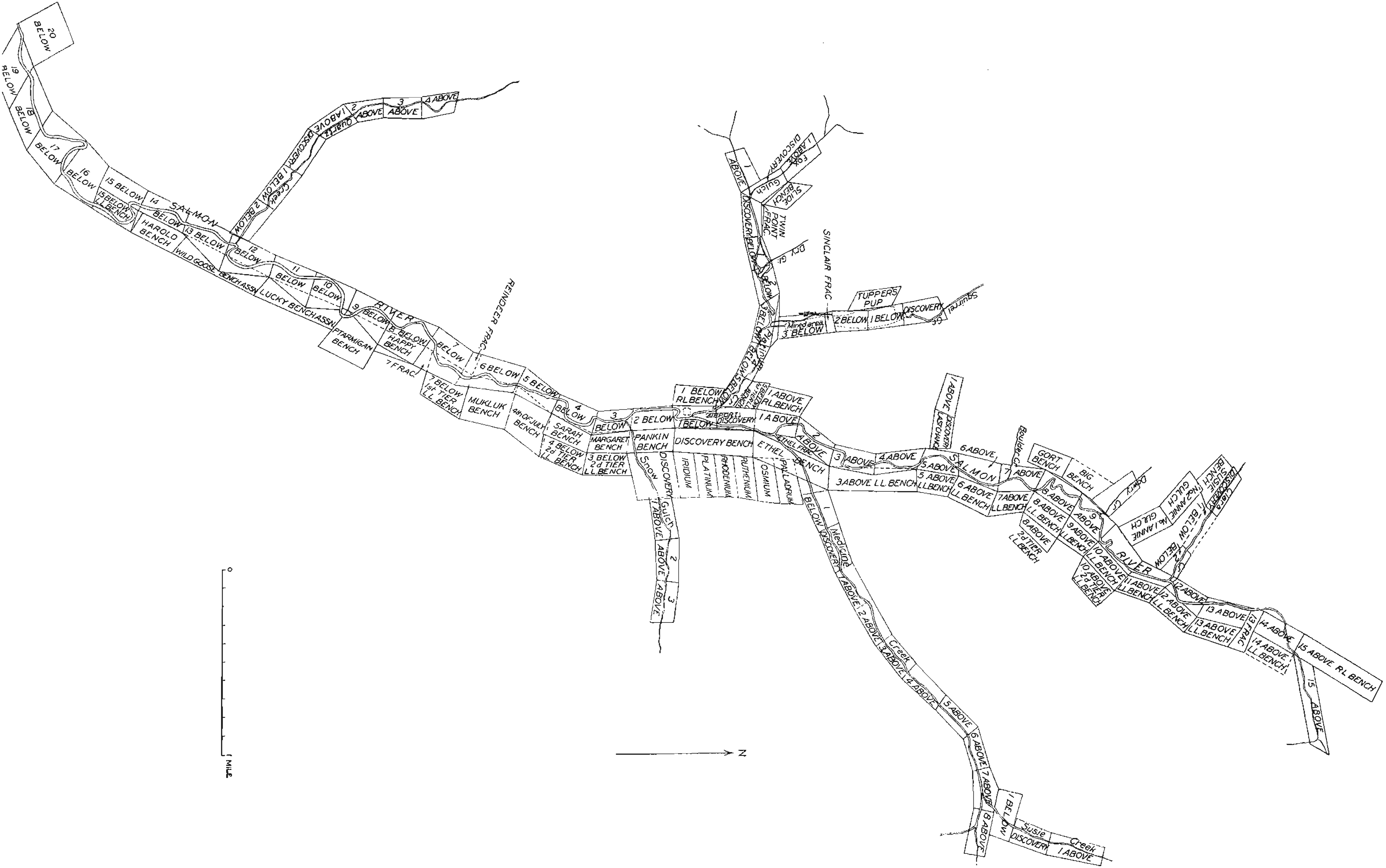
SALMON RIVER
20 BELOW
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HAROLD BENCH
12 BELOW
WILD GOOSE BENCH ASSN
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PTARMIGAN BENCH
8 BELOW HAPPY BENCH
7 FRAC
7 BELOW
REINDEER FRAC
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7 BELOW 1st TIER L.L.BENCH
MUKLUK BENCH
4th OF JULY BENCH
SARAH BENCH
4 BELOW 2d TIER L.L.BENCH
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MARGARET BENCH
3 BELOW 2d TIER L.L.BENCH
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DISCOVERY BENCH
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15 ABOVE RL BENCH
15 ABOVE
GORT BENCH
BIG BENCH
Boulder Cr.
Dairy Cr.
1 ABOVE DISCOVERY LAST CHANCE
No. 1 ANNIE GULCH
1 BELOW
SUSIE BENCH
DISCOVERY
Quartz Creek
DISCOVERY
1 BELOW
2 BELOW
1 ABOVE
2 ABOVE
3 ABOVE
4 ABOVE
Fox Gulch
DISCOVERY
1 ABOVE
SLIDE BENCH
TWIN POINT FRAC
Dry Gl.
SINCLAIR FRAC
TUPPERS PUP
Mined area
3 BELOW
2 BELOW
1 BELOW
Squirrel Cr.
Snow Gulch
1 ABOVE
2 ABOVE
3 ABOVE
Medicine Creek
1 BELOW
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Susie Creek
DISCOVERY
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