CONTRIBUTIONS TO ECONOMIC GEOLOGY, 1928

PART I. METALS AND NONMETALS EXCEPT FUELS

PLATINUM AND BLACK SAND IN WASHINGTON

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INTRODUCTION

As a result of interest stimulated by the World War, an examination of reported occurrences of platinum in the State of Washington was made by the writer in 1917. The field work done at that time forms the basis of the present report. Because most of the platinum is found in the heavy natural or artificial concentrate known as black sand, a summary has been added of available information on the occurrence and character of black sand in the region described.

From the State of Washington a total production of about 7½ ounces of platinum has been reported. Most of this amount came from the ocean beach south of Cape Flattery; the remainder from a short course along the South Fork of Lewis River near Moulton. At both places the platinum was obtained as a by-product of placer mining of gold. The last reported production from Washington was an estimated total of 1.47 ounces in 1918.[1]

Gold had been mined intermittently on the ocean beach for 25 years or more before 1917, though it is said that no attempts were made to save the platinum except in the later part of that period. Estimates of the total gold production of the beach to the date mentioned range from 1,000 to 1,750 ounces, and as the proportion of platinum to gold, as shown by the more recent clean-ups in certain places, averages not less than 1 to 15, it is possible that as much as 100 ounces of platinum was overlooked. About 10 ounces of gold and 1½ ounces of platinum are reported to have been produced along the South Fork of Lewis River during the six or seven

[1] U. S. Geol. Survey Mineral Resources, 1918, pt. 1, p. 202.

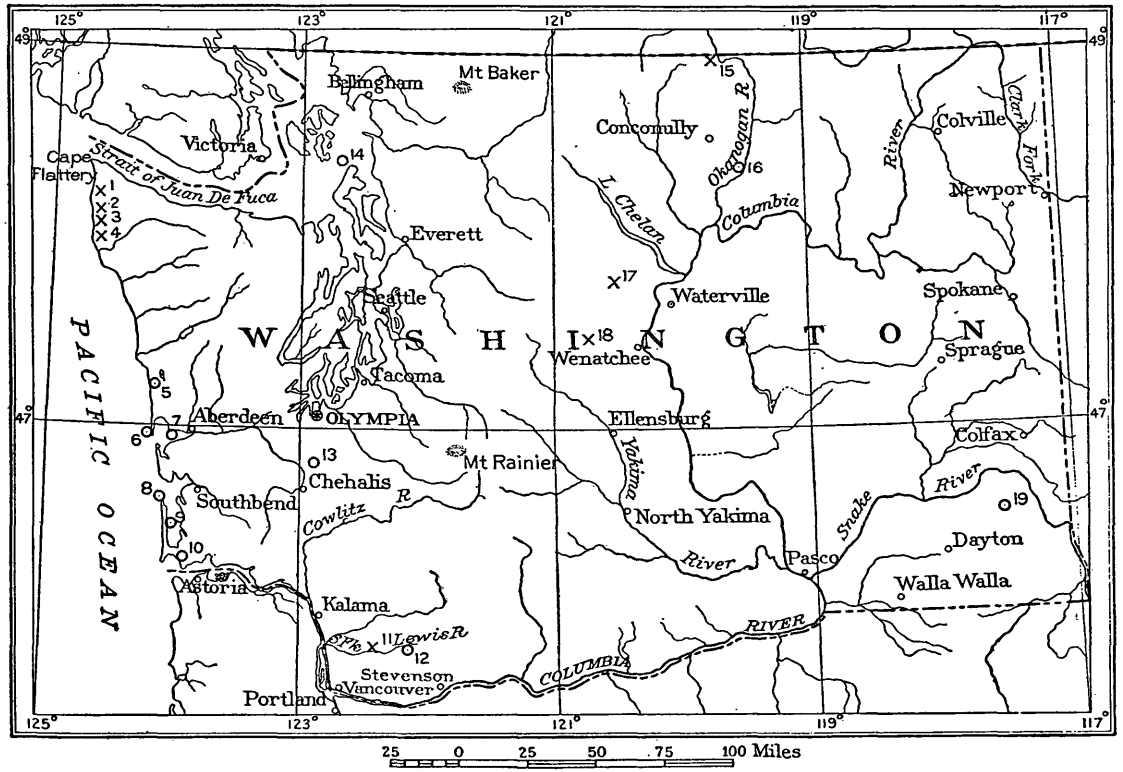

FIGURE 1.—Index map of Washington, showing location of deposits of platinum and black sand

1. Shi Shi Beach.
2. Ozette Beach.
3. Yellow Banks.
4. Sunset Creek.
5. Moclips.
6. Damon's Point (Point Brown).
7. Cow Point (Hoquiam).
8. Leadbetter Point.
9. Nahcotta.
10. Fort Canby.
11. South Fork of Lewis River.
12. Canyon Creek.
13. Bucoda.
14. Cypress Island.
15. Similkameen.
16. Riverside.
17. Mad Creek.
18. Negro Creek.
19. Pomeroy.

years before 1917, and in addition some gold is said to have been produced in an earlier period.

South of Cape Flattery the platinum and gold are found in thin layers of heavy sand distributed here and there along the beach at the foot of the sea cliff. At this locality the sea is rapidly encroaching on the land, and the material that is being eroded and concentrated by the waves consists largely of Pleistocene gravel and drift deposited by a lobe of the Cordilleran glacier. This drift contains a small quantity of gold and presumably a little platinum also. The ultimate source of the platinum is thought to be the rocks, particularly the bodies of serpentine, eroded by the glacier in its course from the mountains of British Columbia and Washington to the sea.

Mining has been fairly profitable at places along the beach, and up to 1918 the deposits were not completely exhausted, though they were not extensive enough to warrant the expectation of more than a small additional amount of platinum.

The metalliferous sands of the South Fork of Lewis River are confined to the stream channel and, though fairly rich, were not found in commercially available quantities. The part of the channel that remains submerged at low water, which was not mined, presumably contains gold and platinum. To determine whether or not it could be profitably worked would require no great expenditure, but the most favorable interpretation of the field evidence does not warrant the expectation of more than comparatively small amounts of gold and platinum.

OCEAN BEACH

History of mining.—A few reports describing the coast region south of Cape Flattery have been published, among which those of Reagan [2] and Arnold [3] contain the most information about the platinum and gold deposits. According to the authors cited, during a brief gold excitement in 1894 the beaches were staked for 60 or 70 miles south of Cape Flattery. Afterwards, however, the productive localities were found to be confirmed within a strip 20 miles long, extending south from Portage Head, which is about 8 miles south of Cape Flattery, to Cape Johnson, a short distnace north of Quillayute River. The most productive locality was Shi Shi Beach, at the north end of the strip mentioned, where at least $15,000 in gold is estimated to have been recovered prior to 1904. Smaller quantities were washed out at Ozette Beach and Yellow Banks, farther south. Near the south end of the strip, at the mouth of Sunset Creek, about 6 miles north of Quillayute River, mining has

[2] Reagan, A. B., Some notes on the Olympic Peninsula, Wash.: Kansas Acad. Sci. Trans., vol. 22, pp. 131–238, 1908–9.

[3] Arnold, Ralph, Gold placers of the coast of Washington: U. S. Geol. Survey Bull. 260, pp. 154–157, 1905.

been done by J. M. Starbuck, who reports a production prior to September, 1917, of about $5,000 in gold and 5 ounces of crude platinum. In September, 1917, no work was being done except at Yellow Banks, where D. J. Wright was mining with a rocker modified so as to be capable of a jigging motion.

Geography.—The Olympic Peninsula, along the northwest coast of which the platinum-bearing sands are found, consists of a broad, high, rugged mountain mass bordered on the north and west by coastal plains 15 or 20 miles wide that lie a few hundred feet above the sea. The crest of the mountains extends from Hood Canal northwestward toward Cape Flattery, near which it sinks almost to the level of the plain. Owing to its heavy rainfall, this region contains many streams, some of which are of large volume and have made wide valleys across the plain from the mountains to the sea. There are several bodies of fresh water, one of which, Ozette Lake, a short distance east of the beach placer, covers about 15 square miles. Except a few small natural meadows or prairies, the coastal plain is covered with dense growths of timber and underbrush and is therefore extremely difficult to traverse in advance of the building of roads or trails. Many stretches of the beach can be easily traversed, but a continuous passage is barred here and there even at low tide by rocky headlands. The placer mines are most easily reached from Port Townsend or Clallam Bay by the Olympic Highway and automobile roads that branch from it.

Geology.—An area that extends 15 or 20 miles inland is underlain by Mesozoic and Tertiary rocks, which are largely covered by superficial deposits of Pleistocene age. The older rocks consist chiefly of sandstone and subordinately of quartzite, greenstone, and serpentine, the whole being severely deformed. In the vicinity of Clallam Peak, about 12 miles east of the beach, the older rocks are cut by quartz veins reported to contain a little gold and silver.

The Pleistocene deposits consist of stream gravel and glacial drift, the combined thickness of which is irregular but is commonly as much as 100 feet. In part at least, as indicated by the presence of marine fossils, the gravel and drift were deposited in the sea. Boulders of granite, a rock foreign to the Olympic Peninsula, found near Ozette Lake, indicate that the drift was deposited by an arm of the Cordilleran glacier that came out of Juan de Fuca Strait and overspread the coastal plain.

Platinum and gold.—Platinum and gold are found in a layer of heavy sand and gravel, concentrated by the waves on the beach at the foot of the sea cliff. At Shi Shi Beach the wave terrace, which forms the bedrock of the deposit, is cut in sandstone of the older series of rocks, the upper part of the cliff being composed of Pleistocene gravel and drift. The beach is covered with a layer of fine

gravel and sand from 1 to 3 feet thick and is strewn with cobbles at the base of the cliff. The metal-bearing part of this deposit is a thin layer of fine, heavy sand, composed chiefly of pink garnet and black grains of ilmenite and magnetite, that lies next to the bedrock. During storms the gravel and sand are shifted back and forth more or less, and some of the workable deposits may be buried or swept away and others may be uncovered as a result of the shifting. Part of the gold and platinum has worked down into joints and seams of the bedrock, the top layer of which, therefore, forms part of the pay streak. At Ozette Beach conditions are similar, but at Yellow Banks the surface of the older rocks does not rise to the sea level, and the wave terrace on which the metalliferous sand lies is cut in the Pleistocene drift. At Sunset Creek the wave terrace is cut in a layer of tough clay belonging to the drift. According to Mr. Starbuck, the pay streak at this locality is from 2 to 15 inches thick and 400 feet long, and the part of it exposed at low tide is 100 feet wide. It yields from 2 to 5 pennyweights of gold and platinum to a cubic yard, and the proportion of platinum to gold ranges between 1 to 5 and 1 to 15. Samples submitted by Mr. Starbuck show the gold particles to be small, flat, smooth, and rather light yellow and to average about one-tenth of a cent in value. The platinum particles are dull tin-white, smooth and flat, and not more than one-fourth as large as those of gold. About 10 per cent of the platinum is picked up by a small magnet, and most of the remainder is slightly attracted. The sand of the pay streak is rather fine and shows a decided pink tint due to a large proportion of transparent pink garnets. Its other chief constituents are black magnetic grains, chiefly ilmenite and magnetite. There is also some chromite and some very small clear crystals of zircon.

Owing to the small size of its particles the platinum is not very easily separated from the heavy sand by ordinary methods. It is thought, however, that after the sand has been properly sized by screening, practically all the platinum can be readily extracted by special forms of concentrating tables or jigs.

Along this coast the sea is rapidly encroaching upon the land, an advance of 300 yards in four years near the mouth of Quillayute River having been observed by Reagan.[4] A large part of the material eroded by the waves is supplied by the Pleistocene gravel and drift, which are known to contain a little gold and are therefore thought to be the source of the beach gold and also, because the two metals are closely associated, the source of the platinum. In general, therefore, the deposits are being added to continually, though the amount of new gold and platinum added in any one season is probably very

[4] Reagan, A. B., op. cit., p. 230.

small. At Sunset Creek a thin horizontal layer of pay gravel interbedded with the drift is said to be exposed in the cliff at the level slightly above high water. This layer is regarded as a beach or stream deposit concentrated at some former period. The fact that while the Pleistocene drift and gravel were being laid down the land moved up and down from time to time relative to the surface of the sea suggests that beach deposits like those now being mined may have been formed at different places that are now in the interior at different altitudes, but there is little to encourage the hope that such deposits will prove to be workable.

The original source of the gold and platinum is undoubtedly the rocks eroded by the glaciers. Serpentine, one of the rocks with which platinum is most commonly associated, occurs in places in the older rocks east of the beach and elsewhere in the path of the glacier that extended from the mountains of British Columbia to the sea. The occurrence of platinum with chromite in the serpentine of Cypress Island as described on page 9 is interesting as showing one of the possible sources of the platinum of the drift.

SOUTH FORK OF LEWIS RIVER

History of mining.—Placer mining is said to have been done 40 or 50 years ago by a miner known only by the nickname "Tex" along Texas Gulch, an affluent of the South Fork of Lewis River, near its head. No detailed information concerning this work is available, although the old excavations and other evidences of former mining remain along the gulch. Tex is said to have died at Corvallis, Oreg., a few years ago, leaving a good-sized sack of gold dust that he is supposed to have washed from Texas Gulch. In 1895 or 1896 there was a brief gold excitement on the South Fork of Lewis River. Claims were located for 6 or 7 miles along the upper and middle courses of the stream, but all except one owned by Harvey McMunn were afterwards abandoned. McMunn, having observed platinum in the heavy sand and residues from the gold clean-ups, patented his claim and continued to work it in a small way from time to time. In 1912, at a reported cost of $30,000, a company from Portland, Oreg., installed a hydraulic mining outfit, including a pumping plant run by water power, at a point 5 miles above Moulton, or 1 mile above McMunn's claim. After this company had mined a pit 75 by 100 feet in area and 30 feet deep in a gravel-covered terrace 150 feet high on the north side of the river, work ceased, and the plant was afterwards dismantled.

The production of $150 in gold and 1½ ounces of platinum is reported by McMunn, who estimated that in addition $200 in gold was produced by others whose work came under his observation.

The clean-up at the hydraulic plant is said to have been a ton of black sand, which upon being smelted yielded about 1 ounce of gold.

Geography.—The South Fork of Lewis River drains a small part of the western slope of the Cascade Mountains north of the Columbia River, in Clarke and Skamania Counties, Wash. Its upper course is through a deep and narrow valley that opens out upon the lowland north of Vancouver. In places the stream channel is in a narrow vertical-walled trench or box canyon sunk from 10 to 50 feet below the valley floor. Elsewhere adjoining the stream are low flood plains or gravel bars that range from a few feet to 50 feet or more in width.

In addition the valley contains several broad rock-cut terraces, veneered with gravel, that lie from 40 to 300 feet or more above the stream. Along the upper course of the river there are several waterfalls and cascades, and the average grade is rather steep. The volume of water discharged during the dry season, from May to October, is roughly estimated to range from 80 to 100 cubic feet of water a second. In winter, as shown by driftwood and water marks, it is many times this amount. A dense forest similar to that on the western slope of the Cascade Range covers most of the basin of the South Fork of Lewis River, except along the lower slopes, where much of the timber has been cut. A considerable part of the valley also has been devastated by forest fires. The district is reached by the Yacolt branch of the Oregon-Washington Railroad & Navigation Co.

Geology.—No reports describing the geology and mineral deposits of the basin of Lewis River have been published so far as the writer is aware. The neighboring regions, however, are known to be underlain almost exclusively by Tertiary or later lavas, and similar rocks apparently extend over the Lewis River Basin generally. Except superficial deposits of gravel, the only formation observed along the river below the hydraulic mine is a dense to vesicular dark-gray basalt. This rock occurs as thick flows that lie nearly horizontal in the vicinity of McMunn's claim but rise farther east and acquire a slight westward dip. They show little or no evidence of faults or other dislocations. At the hydraulic mine a purplish-brown andesite showing numerous small white feldspars is interbedded with the basalt, and the occurrence of other kinds of rock farther upstream is shown by the composition of the river gravel. About 50 per cent of the cobbles are a light-gray granular rock, somewhat decomposed but still fresh enough to be determined as diorite or a closely related species. There are in addition several varieties of andesite porphyry and a basaltic tuff. One boulder of a light-gray sandstone that contains secondary tourmaline crystals was observed. On the Canyon Creek that is tributary to the North Fork of Lewis River, at a point about 8 miles north of McMunn's claim, a 50-foot dike that contains

gold and copper is said to crop out. Specimens submitted by S. S. Campbell, of Yacolt, show this rock to be sheared and decomposed serpentine, locally containing bronzelike scales of iron oxide and good-sized flakes of native copper in seams. Serpentine is said to occur also on the South Fork of Lewis River above the hydraulic mine, and some gold and copper bearing rocks are reported along the Canyon Creek that is tributary to the South Fork about 6 miles east of McMunn's claim.

Unconsolidated gravel deposits that apparently are of Pleistocene and recent age cover the terraces generally and occupy small areas along the stream. As shown by prospect shafts and the workings at the hydraulic mine, the gravel is from 5 or 6 feet to 30 feet or more in thickness and contains many smoothly rounded cobbles and boulders, the largest of which are 2 feet in diameter. The higher terrace gravel evidently occupies ancient flood plains and channels abandoned by the river from time to time, as it widened and deepened its valley.

Platinum and gold.—Platinum-bearing sand and gravel are found in cracks and rough places on the bedrock of the stream channel from a point below the railroad tunnel near Moulton upstream as far at least as the hydraulic mine, a distance of 6 or 7 miles. Commonly a pan of this material yields a few ounces of heavy black sand and several small particles of platinum and gold. Most of the black sand is fine and strongly magnetic and is evidently magnetite. The remainder is chiefly small round grains of hematite and limonite. Platinum is said to have been found also at one or two places on the Canyon Creek that is tributary to the South Fork of Lewis River east of McMunn's claim. A little gold is found in the terrace gravel also, but no platinum so far as known.

The platinum grains are dull tin-white and rather smooth except that some of them show small pits filled with iron oxide. Some are rather flat but not flaky, and others are as round as shot. They range in size from fine specks to small pin heads. On an assumption of $80 as the value of an ounce of the crude platinum, the value of the particles from the different places examined by the writer ranges from half a cent to 3 cents each. Most of the platinum is strongly attracted by an ordinary horseshoe magnet, and nearly all the particles are slightly magnetic. This property is doubtless due to iron, which is commonly alloyed with crude platinum. Its rather strong magnetism indicates that the Lewis River platinum probably contains as much as 10 per cent of iron. The platinum from Lewis River is coarser than that from the ocean beach and is rather easily separated from the heavy sand by panning.

The gold is deep yellow, and its grains average two to three times as large as those of the platinum. Panning tests made at several places

indicate the pay gravel to contain 0.126 gram of platinum and 1.14 grams of gold to the cubic yard. In 1917 Mr. McMunn washed 1 cubic yard of the gravel in a rocker and obtained 0.187 gram of platinum and 1.21 grams of gold. On the assumption that crude platinum and gold are worth $80 and $20 an ounce, respectively, the clean-up amounts to about 49 cents in platinum and 75 cents in gold. These tests also show that the ratio of gold to platinum ranges between 1 to 7 and 1 to 10 by weight.

No material bearing evidence of glacial transportation was seen in the basin of the South Fork of Lewis River, and there is nothing to suggest that the platinum is of other than local origin. The serpentine reported to occur farther upstream is thought to be the most probable source. It is rather curious that, so far as known, the platinum is confined to the present channel of the South Fork, although gold is found not only in that situation but also more sparingly in the gravel of the terraces. This condition suggests that the platinum-bearing rocks, which are presumably older than the lavas, were not uncovered until the river had cut down nearly to its present level. The terraces do not appear to have been exhaustively prospected, however, and it is possible that some platinum may have been overlooked in them. Except at the hydraulic plant, mining has so far been confined to that part of the river channel between high and low water. Although the material deposited in the stream channel is fairly rich, it is so thinly and irregularly distributed and so difficult to dig out of the cracks and crevices that the cost of mining is generally more than the value of the metal recovered. That part of the channel occupied by the stream at low water presumably contains platinum and gold also and may, because it is lower, be richer than the other part. In places during low water the stream could be turned aside for short distances by rather inexpensive dams, and the value of the channel could then be easily determined. At a moderate expense a flume large enough to carry the stream at low water could be laid along any stretch of the channel found rich enough to be workable.

CYPRESS ISLAND AND OUTLYING LOCALITIES

Cypress Island, which is a part of the hilly archipelago that separates Juan de Fuca Strait from Queen Charlotte Sound, is underlain almost exclusively by serpentine in which chromite occurs here and there as irregular masses and disseminated grains. Analyses reported by operators of some of the chromite deposits show the presence of 0.006 to 0.245 ounce of platinum to the ton in some of the chromite concentrate produced from the serpentine. Cypress Island

has been severely eroded by a great glacier that, coming from the north, passed on into the Puget Sound Valley and sent a branch westward out Juan de Fuca Strait and across the district in which are located the beach placers south of Cape Flattery. As previously described, the platinum-bearing beach sands were formed by the ocean waves from the drift deposited by this branch of the glacier. Except in front of southward-facing cliffs or steep slopes on Cypress Island or adjacent lands, little or no drift was deposited, but farther south in the Puget Sound Valley, as well as on the plain that borders the Juan de Fuca Strait, the drift is deep and extensive. Doubtless the drift generally contains a little gold and platinum, although, so far as known, no valuable deposits have been concentrated from it except by the waves of the ocean. A few specks of gold together with considerable chromite sand can be obtained from a pan of gravel here and there along the beaches of Fidalgo Island, but apparently there are no valuable deposits. As a rule the waves of Puget Sound and neighboring waters appear to have reworked but little material since the drift was deposited, and the streams that cross the drift-covered areas apparently excavated their valleys rapidly, a condition generally unfavorable to the concentration of placer stream gravel.

Two very small particles of platinum were found in a sample of black sand, said to have come from the clean-up of placer mining, that was submitted by M. T. Hurst of Leavenworth, and an assay of about one-fourth of an ounce of platinum, iridium, and osmium together to a ton is reported by C. W. Smith, of Oroville, from a small chromite-bearing serpentine dike near Okanogan.

Samples of placer concentrates received by the United States Geological Survey from a deposit near Riverside, Okanogan County, contained a considerable proportion of platinum.[5]

In addition to the localities already mentioned a small production of platinum is reported from Negro Creek near Mount Stuart,[6] from Mad Creek, a branch of Entiat River, in Chelan County north of Leavenworth, and from Similkameen River, Okanogan County. In the Castle Creek district, in the northern part of Ferry County, a plant costing $50,000 was built to recover platinum from black shale. After the plant was completed the shale was found to be barren.

The evidence above set forth indicates that the natural platinum deposits are of little or no promise, and this conclusion is supported by the results of investigations of the black-sand deposits of the Pacific slope given in the following pages.

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[5] Hill, J. M., Platinum and allied metals: U. S. Geol. Survey Mineral Resources, 1916, pt. 1, p. 11, 1919.

[6] Patty, E. N., and Glover, S. L., The mineral resources of Washington: Washington Geol. Survey Bull. 21, pp. 84–85, 1921.

The occurrence of platinum in the terraces or "bars" along Columbia River above the mouth of the Nespelem is mentioned in a paper by Collier,[7] from which the following paragraphs are quoted:

The gold is associated with black sand containing a large amount of magnetite and somewhat smaller amounts of ilmenite, zircon, garnet, and other heavy minerals. Platinum probably also occurs in small quantities, though its presence was not detected in the field.

An average sample of sand was run over the Wetherill separator at the concentrating pavilion, and its mineral constituents were determined as follows:

Mineralogical composition of average sand from Columbia River terraces

Magnetite	0.3
Ilmenite	.1
Garnet	.1
Zircon	.1
Quartz	39.4
Others	60
	100

One large color of gold and 16 to 20 small colors of platinum.

The amount of black sand in the pay streaks is much greater than in this sample, in some places reaching 3 or 4 per cent.

BLACK SAND

Heavy "black" sands are commonly found in Washington along beaches and streams, where waves and currents have concentrated them, and in placer mines, where they become artificially concentrated in the process of recovering gold. Mention has already been made of these heavy sands at Shi Shi Beach and other localities along the coast, and on the South Fork of Lewis River, where a ton of sand was recovered that upon being smelted yielded 1 ounce of gold.

Much information as to the occurrence and character of black sand in Washington is found in a report on the black sands of the Pacific slope by Day and Richards.[8] This report gives the results of a rather exhaustive investigation which was carried out chiefly at Portland, Oreg., during the Lewis and Clark Exposition in 1905. Below in abstract form are the parts relating to Washington.

The expression "black sands" as used in the report includes the heavy sands that settle in the sluice boxes in placer mining and the similar sands produced by the natural concentrating action of waves and streams. As the name implies, the sands are composed predominantly of dark-colored minerals, though they commonly contain light-colored species also. The mineral composition of nearly 2,000 samples was determined. Though most of these, as the title of the report

[7] Collier, A. J., Gold-bearing river sands of northeastern Washington: U. S. Geol. Survey Bull. 315, p. 61, 1907.

[8] Day, D. T., and Richards, R. H., Useful minerals in the black sands of the Pacific slope: U. S. Geol. Survey Mineral Resources, 1905, pp. 1175–1258, 1906.

implies, came from States west of the Rocky Mountains, several were from States farther east and a few from foreign countries. Omitting quartz as normally present, the minerals found were as follows, in order of frequency:

Minerals other than quartz in black sands of Pacific slope

Mineral	Specific gravity	Mineral	Specific gravity
Magnetite	5.16– 5.18	Pyroxene	3.2 – 3.6
Gold (native)	15.16–19.3	Apatite	3.17– 3.23
Ilmenite	4.5 – 5	Titanite	3.4 – 3.65
Garnet	3.15– 4.3	Manganese ores	3 – 4.82
Zircon	4.7	Copper	8.8 – 8.9
Hematite	4.9 – 5.3	Cinnabar	8 – 8.2
Chromite	4.3 – 4.6	Cassiterite	6.8 – 7.1
Platinum (including arsenides)	14 –19	Tremolite	2.9 – 3.1
Mercury	13.6	Tourmaline	2.98– 3.2
Amalgam	13.75–14.1	Lead (shot, etc.)	11.37
Feldspar	2.5 – 2.9	Wolframite	7.2 – 7.5
Epidote	3.2 – 3.5	Siderite	3.83– 3.88
Olivine	3.2 – 3.6	Corundum	3.95– 4.10
Pyrite (chalcopyrite, arsenopyrite, pyrrhotite)	4.9 – 6.2	Josephinite (awaruite)	8.1
Monazite	4.9 – 5.3	Topaz	3.4 – 3.65
Limonite	3.6 – 4	Scheelite	5.9 – 6.1
Iridosmium	19.3 –21.12	Molybdenite	4.7 – 4.8
Rutile	4.18– 4.25	Fluorite	3 – 3.25
		Columbite and tantalite	5.3 – 7.3

The statement is made that platinum was found "in place in chromite" near Anacortes, but the quantity was not given.

About 50 of the samples examined came from Washington. Their composition is shown in the table on pages 14 and 15.

Altogether platinum was found in samples from 120 localities, most of which are in a field comprising parts of southwestern Oregon and northern California.

In addition, small samples of concentrates from several localities were assayed for gold and platinum, no separation of other minerals being made. Only samples that contained more than 1 ounce of gold to the ton or that contained platinum are listed. The following results were obtained on samples from Washington, none of which contained any platinum:

Assays of samples from Washington

Serial No.	Locality	Gold (dollars per ton)
	Okanogan County:	
R 3457	Wesheville	21.08
R 3734	Chesaw, Myers Creek district	73.38
P 76	Skamania County: Texas Gulch	150.68
R 3983, No. 1	Snohomish County: Sultan River	87.43

Tests with shaking tables and other machines on a number of samples resulted in concentrating many of them to a relatively small

bulk, which contained most of the very small amounts of gold and platinum present. A lot of 2,746 pounds from Damons Point, Grays Harbor County, Wash., showed a concentration to 360 pounds, or about 8 to 1, and the actual value of gold and platinum in the concentrate was 7 cents, this amount being 87.5 per cent of the total amount of gold present in the lot of crude sand. Another lot of 1,375.5 pounds from Cow Point, in the same State and county, showed a concentration of about 70 to 1. In this lot all the gold was recovered, and it amounted to only 1 cent.

Assaying of the samples for gold and platinum was done chiefly by agitation with sodium amalgam. A charge consisting of 1,000 grams of sand, sufficient water, and 50 grams of mercury to which a little metallic sodium had been added was placed in a 2-gallon bottle, which was revolved endwise for one hour at the rate of fifty times a minute. This test gave accurate results on free gold that was clean or partly rusty and failed only on gold that was completely coated with iron oxides. The platinum metals combined perfectly with the sodium amalgam but separated from the mass as soon as the sodium became spent (oxidized). The results obtained by the amalgamation assays were checked by the ordinary fusion method (fire assay), large charges being used.

The occurrence of black sand in the terraces along Columbia River above the mouth of the Nespelem is mentioned on page 11.

Deposits of black sand in southern Oregon and northern California were investigated during the World War by R. R. Hornor,[9] who concludes that—

> In general the black-sand deposits are disappointing in both value and quantity; they rarely contain enough gold and platinum or occur in adequate quantity to be exploited at a profit.
>
> There are, it is true, a few favored places where small areas of the black sand show some precious-metal content, and these may become the site of small operations. The deposits in many places contain appreciable amounts of magnetite, chromite, and ilmenite, but these minerals are generally too scattered and too poor to constitute an important source of iron ore, especially in competition with the known deposits of magnetite on the Pacific coast.
>
> The chief difficulties in the profitable exploitation of these deposits are: First, lack of uniformity in occurrence and metallic content; and, second, the high cost of mining and treating the materials.

Similar considerations apply to the deposits of black sand in Washington.

[9] U. S. Bur. Mines Tech. Paper 196, p. 35, 1918.

Composition of black sands from Washington

[Figures indicate pounds per ton except for gold and platinum]

No.	Locality	Magnetite	Chromite	Ilmenite	Garnet	Hematite	Olivine	Monazite	Limonite	Zircon	Quartz	Unclassified	Gold (dollars per ton)	Platinum [a] (ounces per ton)	Gold and platinum (dollars per ton)	Remarks
	Asotin County:															
P 626 A	Snake River	34		18	8	Tr.				2			1.64			Natural sand.
P 626 B	Do	20	Tr.	12	6					Tr.			.19			Do.
P 626 C	Do	30	Tr.	16	4					2			.12			Do.
R 3386, No. 1	Do	256									760	992	3.72			22 pounds per ton of gravel.
R 3386, No. 2	Do	936		512				Tr.		16		536	13.23			18 pounds per ton of gravel.
R 3860	Do	900		150	600			Tr.		50		300	.39			Concentration, 100 to 1.
P 169 B	Clarkston	572		530	274					30	370	224	24.99			Concentrated by panning.
	Chehalis County:															
P 135	Oyhut	8	4	53			118	Tr.			1,330	487	.72			Natural sea-beach sand.
P 179	Damons Point, Grays Harbor.	474		689	154		412			43	89	134			0.05	Do.
P 134 B	Joe Creek, Grays Harbor.	100		162	498		418			15	788	16			Tr.	Do.
P 133	Moclips, Grays Harbor.	72	24	82			1,597	71.5		10	12	122			.17	Do.
P 132	Cow Point, Hoquiam	12	12		4		6				434	1,530			.02	Do.
Do	Do	8	2		4		22			.4	438	1,528			.02	Do.
	Clallam County:															
R 3865	Shi Shi Beach	40		1,120	424			Tr.		96		120	558.09	[b]20.45		
P 209	Camas	90		1,282	20	2				2	384	218	1.34			Concentration not known.
R 3329	Brush Prairie	1,176		328	320			Tr.		Tr.		176	57.05			
R 3419	Canyon Creek	1,726				200					74		Tr.			
P 639	Douglas County: Columbia River.	1,414	150	188				6		24	84	132	30.59			13 pounds per cubic yard of gravel.
P 692	Garfield County: Pomeroy.	426		298	36	Tr.				72					17.36	Concentration not known.
	King County:															
P 434	Auburn	Tr.		Tr.					6						(c)	Trace of siderite; natural sand.
P 524	Fort Canby	296		36							60	1,608			(c)	Natural sand.
P 525	Near Fort Canby	172		12	2	Tr.			30		996	786			(c)	Do.
P 83	Kittitas County	1,643	188		118						5.5	45	315			25 pounds per ton of gravel.
R 3700	Liberty	112			120						1,500	268	2.69			2 pounds per cubic yard of gravel.
R 3431	Do	900			500	100					1,400	100	896.66			Concentration not known.

R 3589	Cle-Elum district	1,568	272									160	530.81			4 pounds per cubic yard of gravel.
R 3169	Lincoln County: Davenport.	664			24						1,200	112	59.12			25 pounds per cubic yard of gravel.
R 3463	Okanogan County: Similkameen Falls.	1,664		152		160				8		16	31.42			110 pounds per cubic yard of gravel.
	Pacific County:															
P 529	Nahcotta	2		2	Tr.								Tr.		Tr.	Natural sand.
P 530	Oysterville	2		8	6					Tr.					No tr.	Do.
P 531	Leadbetter Point	74	8	76	36					6					Tr.	Do.
P 532	Ocean Park	22		4						Tr.					.87	Do.
P 533	Sand Island	160		68	10	Tr.				2					1.51	Do.
P 534	Beards Hollows	436		524	4	2				4				.0193		Do.
P 535	Fort Canby	822		240	20			Tr.		Tr.	396	520			.81	Do.
	Skagit County:															
P 338 through ½	Anacortes	1	1,137									859			.14	Do.
Do	Do		715									1,282			.41	Do.
R 3983	Snohomish County: Near Silverton.	952	280			320						448	11.58			Ore.
	Stevens County:															
P 220	Newport	2									1,608	366			No tr.	24 pounds of mica; natural gravel.
R 3635	Marcus	1,096		56	432			Tr.			344	72	12.61			5 pounds per cubic yard of gravel panned.
R 3201	Wilmot Bar, Columbia River.	1,308		150	272			30		60	50	30	1.65			
	Thurston County:															
P 660 A	Bucoda	4		4						Tr.					.21	Natural sand.
P 660 B	Do	8		2	2					Tr.					.62	Do.
R 3915	Lime Water	728								Tr.	1,000	270			None.	
P 250	Wahkiakum County: Sand Island, Columbia River.	54	16		32		130				1,108	658	.06			Do.
	Whatcom County:															
P 697	Excelsior	2	Tr.		Tr.	Tr.				Tr.			.62			Trace of pyrrhotite; tailings.
P 78	Bellingham	[d]1,978			2						18.3		Tr.			Ore.
P 79	Do								1,427			573	Tr.			Pyrite and iron phosphate; ore.
P 113	Do	7			1		1			.1	1,502	487	Tr.			
R 3598	Mount Baker district	1,568		176	Tr.							256	50.43			
P 148	Yakima County: Mabton	50		2							882	1,066	.23			
P 141	San Juan Island: Guemes	17	1,735							1.5	10.5	235			(c)	

[a] In the original table platinum was given in dollars per ton, the author having reckoned its value at $30 per ounce. Owing to its fluctuations in price the amounts of this metal given have been reconverted to ounces per ton.
[b] Presumably represents material that has been highly concentrated.
[c] No assay.
[d] Includes hematite.