UNITED STATES
DEPARTMENT OF THE INTERIOR
HAROLD L. ICKES, Secretary
GEOLOGICAL SURVEY
W. C. MENDENHALL, Director

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CIRCULAR 8

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BEACH PLACERS OF THE OREGON COAST

BY

J. T. PARDEE

WASHINGTON

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Abstract

Beach placers along the Oregon coast were richly productive for a time after their discovery in 1852 and have since yielded small amounts of gold and platinum annually. Renewed interest in them was caused by the industrial depression that followed 1929.

The generally mountainous Oregon coast is bordered in places by coastal plains that range from a quarter of a mile to 4 miles in width and are mostly less than 100 feet high. The plains are of two different geomorphic types. One consists of lowlands composed of bay-mouth bars or barrier beaches and the filled embayments behind them; the other is a group of slightly elevated marine terraces.

In addition to these terraces a remarkable series of marine benches, the results of a Pleistocene submergence described by Diller, appear at intervals between sea level and an altitude of 1,500 feet.

The original irregular outline of a submerged land surface has been straightened and simplified into the present shore by the action of the waves in cutting back headlands and building bars across embayed areas. Stretches that have retreated, however, show small-scale irregularities due to differences in the resistance of the rocks.

Around many of the capes and headlands the wave-cut bench is generally swept bare of debris by the waves, and stretches that are nearly always devoid of any noteworthy beach deposit aggregate about 50 miles in length. On the other hand, reentrants in the retreating shores are generally bordered by transitory beaches 50 to 200 feet or more wide, and such stretches aggregate about 100 miles in length. Along certain other stretches the retreat has ceased for the time being, and the shore has readvanced by wave-added beach material constituting a backshore deposit. Such retrograded and prograded shores aggregate 12 miles or more in length, and the maximum advance has been 1,000 feet.

Along the remainder of the Oregon coast the shore has advanced a quarter of a mile to 2 miles or more from its original position as the result of wave-built barrier beaches, bay-mouth bars, and spits. All of the prograded stretches are characterized by a simple shore line and a voluminous beach deposit.

The distribution and height of the islands, the character and profile of the submarine bench and other features shown by the charts of the Coast and Geodetic Survey indicate a shore recession ranging from a quarter of a mile to 4 miles and averaging at least a mile. The prograded shores have advanced as much as 3 or 4 miles in places, but the net result of the shore movements is apparently a loss of land area.

The different terraces are capped with Pleistocene marine sediments, the largest area of which is between Port Orford and Cape Arago and is related to an ancient shore line at an altitude of 170 feet. Beds formed offshore compose a terrace plain about South Slough that is somewhat lower, and there are remnants of beaches in some of the other terraces.

The placer deposits are wave-concentrated layers in the beaches and offshore beds and are generally called black sands for the reason that they are composed largely of magnetite, chromite, and other heavy minerals, most of which are dark-colored. Commonly these layers contain small particles of gold and platinum, and in places the metallic particles are abundant enough to be extracted profitably. In the beaches that are retreating under wave attack the deposits are variable and inconstant, but certain beaches are likely to be richer or more often workable than others. The backshore of the present beach and the ancient beach at an altitude of about 170 feet have been the most productive. The pay streak generally ranges from a few feet to 200 or 300 feet in width, is 3 or 4 feet thick in the middle, and tapers toward the edges. It consists largely of alternating layers of black and gray sand with more or less cobbles, boulders, and drift wood and in the ancient beach, is mostly covered with a barren sand "overburden" 20 to 60 feet thick.

The immediate sources of the beach minerals, including gold and platinum, are the shores that are being cut back by the waves. Most of the gold-bearing beaches are south of Coos Bay, along the coast opposite the Klamath Mountain region, described by Diller, which contains several areas of gold-bearing lodes. The lodes of the interior were the ultimate sources of the gold from which it has been carried seaward at intervals since middle Tertiary time. As a result of stream sorting only the finer particles reached the coast. No definite source of the platinum has been found, but its distribution and its association with chromite suggest the abundant serpentinous and other basic intrusives of the region. However, no relation of the platinum and chromite of the beaches to any particular rock mass could be made out.

Owing to the transitory character of the foreshores of the present beach no definite estimate of reserves can be made, but it is concluded that deposits suitable for small-scale operators will continue to form here and there along certain parts of the coast. Ordinarily these deposits may be expected, under the working conditions possible, to yield from a few cents to $2 a day per man (with gold reckoned at $20 an ounce). In places the backshore contains noteworthy amounts of gold and platinum, but in the decade immediately preceeding 1932 attempts to mine the deposits apparently met with no success, and no basis for an estimate of their value exists.

Parts of the ancient beach at 170 feet above sea level remaining between stream valleys aggregate 8 or 10 miles in length and contain pay streaks 50 to 300 feet wide and a few inches to several feet thick. These pay streaks are generally covered with 20 to 60 feet of barren sand, and in most places their richer parts have been mined. How much of the remainder can be profitably worked under given conditions remains to be determined by prospecting. Black sand layers occur also in ancient offshore beds and in places, at least, contain a little gold and platinum. The "black sand" beds may be regarded as a possible future reserve of chromite and other minerals in case of emergency.

Introduction

Along the Oregon coast gold and platinum bearing deposits were discovered on the present beaches in 1852 and on the ancient elevated beaches 18 or 20 years later. In places the deposits were rich, and for a time they were mined extensively. According to popular report a production of several million dollars, chiefly in gold but with a minor content of platinum, was obtained. After the more profitable stretdhes had been worked over mining activity decreased, but no season has passed without some production. In 1930 and 1931 renewed interest in the deposits was stimulated by the fact that the value of gold had become relatively enhanced as the result of disturbed economic conditions thrcughout the country. For this reason an examination was made in June and July 1931 of parts of the coastal belt, chiefly between Coos Bay and the California line. (See fig. 1.) Increases in the price of gold since the field work was done give the deposits an added interest.

Mining activity

In July 1931 a mine on the beach at Whisky Run, north of the Coquille River, was being operated by Hal. Stutsman and others, using a scraper, elevator, trommel, and riffle boxes. At the Lagoons, a little farther south and a short distance inland, machinery was being set up to rework a body of black-sand tailings washed down Cut Creek from the Pioneer and other mines on the ancient beach to the east. South of Cape Blanco J. C. Rowan, E. C. Britton, and others were mining the beach between high and low tide lines, using rockers or other movable equipment. Earlier in the season several persons were reported to have been working similar stretches at Gold Beach and a few other places.

On the ancient elevated beaches the Pioneer mine, north of Bullards, was being operated with sluices by C. W. Smith and R. Kemp Welch. Owing to the scarcity of water at that time of the year, barren sand overlying the placer deposit was being removed with a drag-line scraper. Work at the Eagle mine, near the Pioneer, had been recently suspended after the death of C. B. Zeek, one of the owners. At the Madden mine, south of Denmark, a concentrating plant was being installed under the direction of C. C. Hayes.

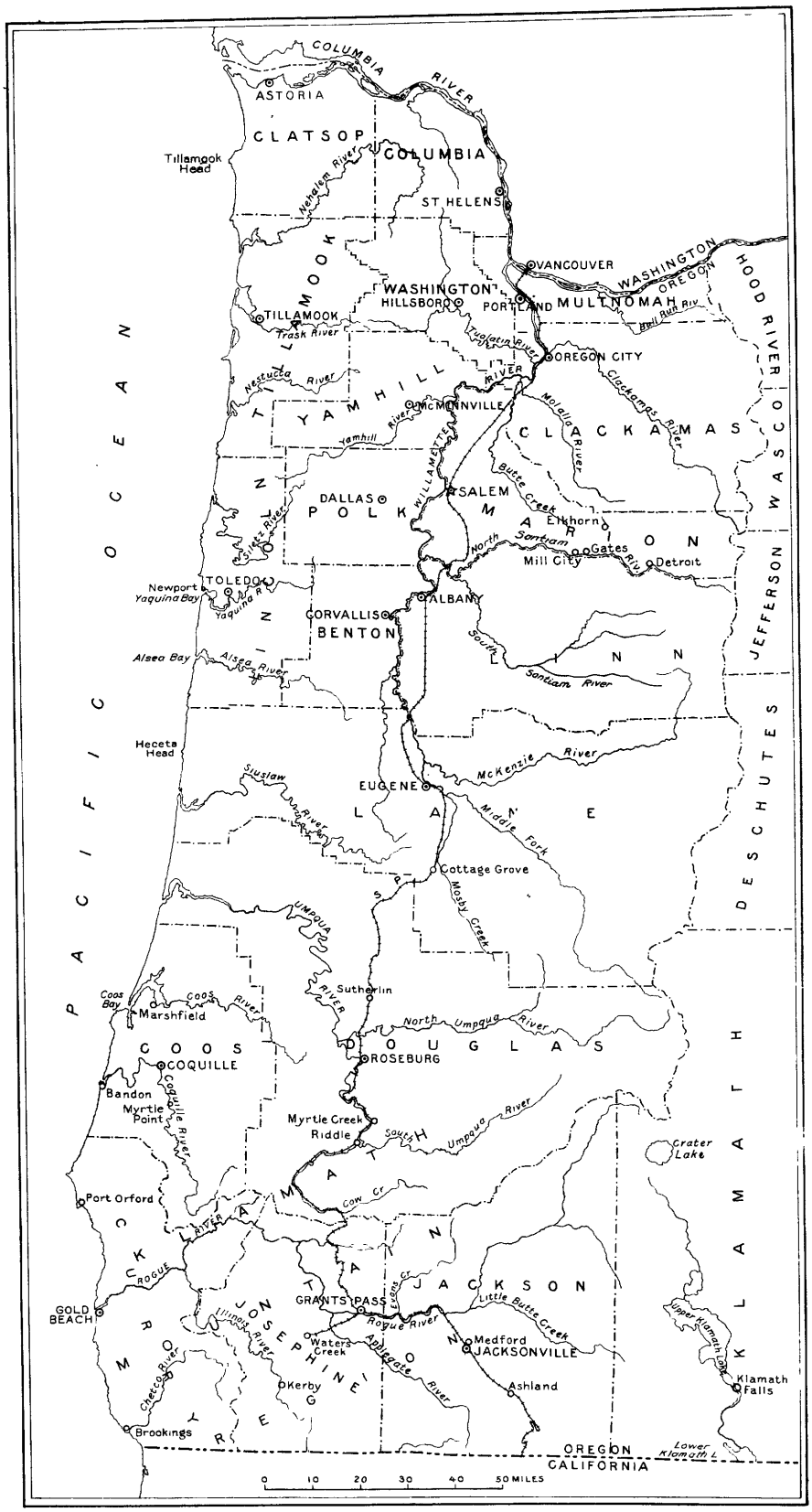


Figure 1.- Index Map of Oregon coast.

Previous reports

Brief descriptions of the beach placers have been given by Blake,[1] Washburne,[2] and Diller.[3] The mineralogy of the beaches is described by Day and Richards,[4] and different kinds of apparatus designed to work the deposits and the results obtained are described by Hornor.[5] In addition references to the deposits have appeared from time to time in the different mining journals.

Climate, vegetation, and accessibility

The climate of the Oregon coast is characterized by rainy winters, dry summers, and moderate to cool temperatures throughout most of the year. Storms sufficiently violent to prevent mining along the present beach are most likely to occur between October and April. During most of the remainder of the year the sea is comparatively calm. A feature of the summer season is a cool north breeze, accompanied by more or less fog, that may blow along the shore for days at a time. Back from the shore, placer mining of the elevated beaches or other deposits may be done at any time of the year that water is available.

In places drifting sand is able to hold back vegetation for a short distance, but generally the forest vegetation extends almost if not quite to the beach. Inland the undergrowth is thick, and travel is very difficult away from roads, trails or clearings. Most of the deposits on either the present or the ancient beaches, however, are not far from the Coast Highway or connecting roads.

Topography

Along the Oregon coast mountains are nowhere far from the sea. In some places they rise directly from the shore, and elsewhere they stand at the back of a narrow coastal plain. The slopes are generally steep, and summits a few miles back from the shore reach heights of 2,000 to 4,000 feet; the higher ones are toward the south.

1/ Blake, W.P., Gold and platinum of Cape Blanco: Am. Jour. Sci., 2d ser., vol. 18, p. 156, 1854.

2/ Washburne, C.W., Beach gold and its source: Oregon Univ. Bull., new ser., vol. 1, no. 4, pp. 18-19, 1904.

3/ Diller, J.S., U.S. Geol. Survey Geol. Atlas, Coos Bay folio (no. 73), 1901; Port Orford folio (no. 89), 1903; Mineral resources of southwestern Oregon: U.S. Geol. Survey Bull. 546, pp. 125-127, 1914.

4/ 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. 1175-1228, 1906.

5/ Hornor, R.R., Notes on black-sand deposits of southern Oregon and northern California: U.S. Bur. Mines Tech. Paper 196, pp. 13-27, 1928.

Coastal plains

As shown by the charts of the United States Coast and Geodetic Survey and the topographic maps of the United States Geological Survey, about half of the Oregon coast is bordered by plains that range from a quarter of a mile to 4 miles in width and are generally less than 100 feet high. These plains are of two different geomorphic types: one comprises lowlands composed of bay-mouth or offshore bars or barrier beaches and sediments accumulated back of them; the other is a group of elevated marine terraces.

North of Coos Bay the plains are low and consist almost exclusively of wave-formed, wind-formed, and marsh deposits, locally including stream alluvium, that partly or completely fill areas embayed as the result of a comparatively recent submergence. These areas are close to sea level, are largely occupied by sand dunes, marshes, and lagoons, and are characterized in particular by a smooth, even shore line that is generally somewhat concave toward the sea. A plain of this type that extends from Coos Bay north 50 miles nearly to Heceta Head is from a quarter of a mile to $2\frac{1}{4}$ miles wide. At the back are several lakes occupying ponded valleys. In the 100-mile stretch from Heceta Head to Tillamook Head small plains of the same type are developed in nine or ten embayments between the bold and rocky headlands which characterize that part of the coast. Some of them are little more than widened spits or bay-mouth bars. Others largely occupy the embayed areas, and in these the wave-formed and wind-formed deposits merge inland with alluvial flats. North of Tillamook Head a plain 2 miles wide that borders the remaining 20 miles of the coast to the Columbia River is composed chiefly of marine sands. It presents a remarkably smooth shore line, and its surface shows several lengthwise ridges, as if it had grown by successive additions of material from the sea.

South of Coos Bay the coastal plains consist chiefly of moderately elevated marine terrances but include some low areas of filled embayment and related alluvial deposits. The largest plain extends from Port Orford north to the vicinity of Cape Arago. It is 2 to 4 miles wide and 37 miles long, and on it are Bandon and several smaller settlements. This plain is a composite feature made up chiefly of elevated marine terraces but including considerable areas of the lowland types mentioned. The principal terrace was developed when the sea stood about 170 feet higher than now. It is partly the result of wave erosion and partly the result of wave deposition. From the foot of a slope that marks the former shore line it extends to the crest of the escarpment that forms the present sea cliff. Elsewhere it gives place 1 to 2 miles back to a low plain related to present sea level. The Coquille, Sixes, and Elk Rivers have cut wide flat-bottomed valleys across the terrace, and small streams have partly dissected the remaining parts. North and south of the Coquille River the surface descends gently seaward and ends at heights of 50 to 100 feet at the top of the sea cliff. South of Flora's Lake the surface arises slightly toward an axis that trends northwestward through Cape Blanco (fig. 3), where the bordering sea cliff is 225 feet high. Near Port Orford an unconsumed rock mass known as Silver Butte (fig. 2a) stands 200 feet above the plain of former marine demudation. In front of the terrace along a 5-mile stretch north of the Coquille River entrance and along a 13-mile stretch between Flora's Lake and Bandon (fig. 2b) plains of the filled embayment type from 1 to 3 miles wide are developed.

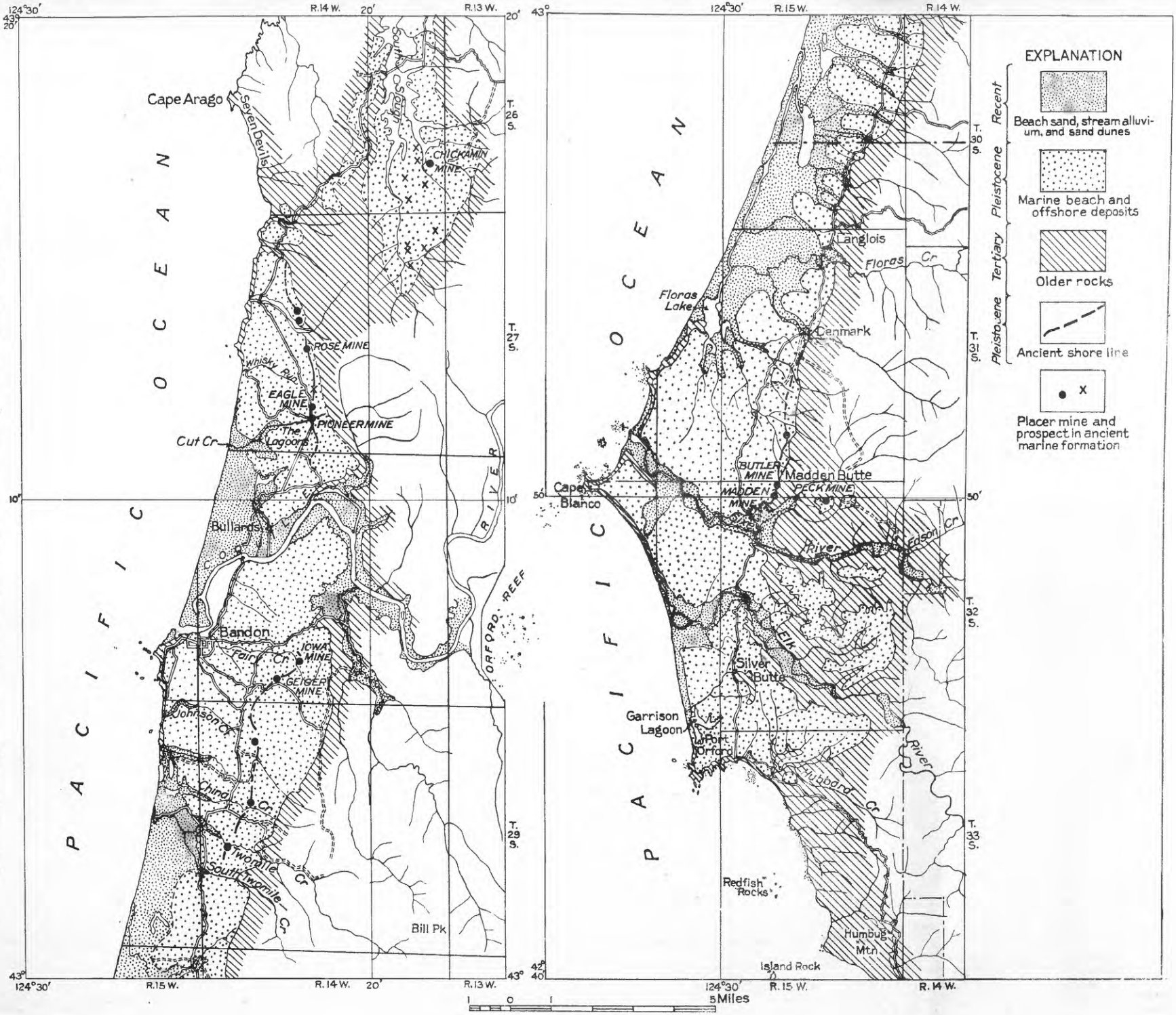
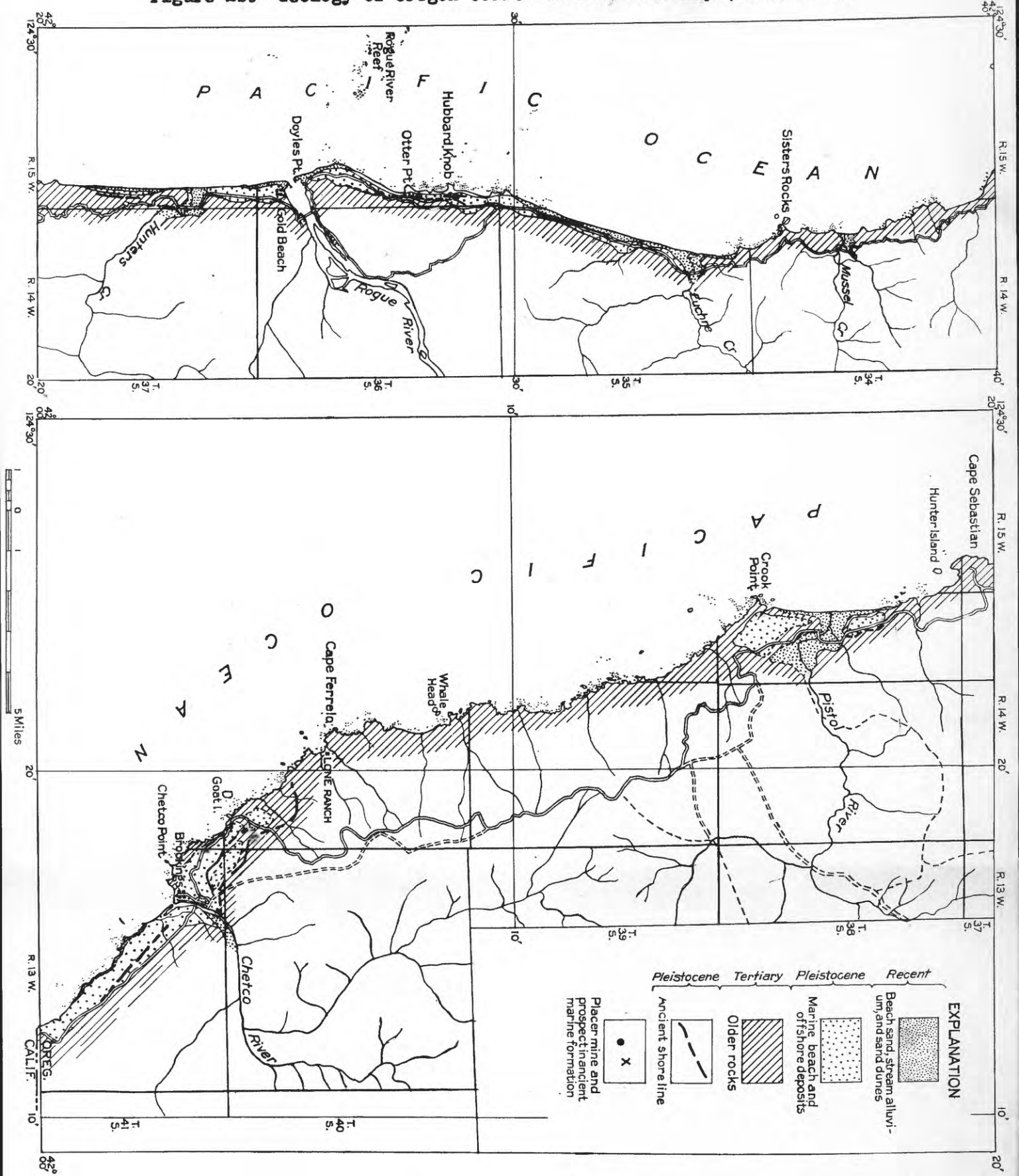


Figure 2a.- Geology of Oregon coast south of Coos Bay (north half).

Figure 2b.- Geology of Oregon coast south of Coos Bay (south half)



A plain 1 to 2 miles wide and 80 to 150 feet high that surrounds South Slough, an arm of Coos Bay, consists of the remnants of a dissected terrace composed entirely of marine sediments deposited in a bay that existed when the sea stood higher than now.

South of Port Orford small areas of filled embayment at the mouths of the Pistol River and a few other streams are related to existing sea level. Terrace plains generally less than half a mile wide and 50 to 200 feet high border the shore to an aggregate length of 10 or 12 miles north and south of the Rogue River (fig. 4), for 3 or 4 miles at the Pistol River, and for 10 miles south of Cape Ferrelo (fig. 5). At Brookings the last-mentioned plain includes two terraces related to ancient shore lines that are 120 and 200 feet high (fig. 13).

Terraces

The slightly elevated terraces described above as forming parts of the coastal plains are members of a remarkable series of marine benches appearing at intervals along the coasts of Oregon and California and ranging between sea level and a height of 1,500 feet. As described by Diller, 6/ a profile of the mountain front about 12 miles north of Port Orford shows "at 500 feet a distinct terrace of small extent, but at 1,000 feet is a much larger one, having a width of over a mile. This level is well marked on the next spur to the northward, 2 miles west of Hare, on the road from Langlois to Myrtle Point, and is cut on various hard rocks, such as serpentine, schists, and igneous rocks, as well as relatively soft sandstones. Some well-rounded pebbles are found at this place, marking the ancient sea beach. Marshy spots like those on the coastal plain also occur at this level.

"Rising over a steeper slope to nearly 1,500 feet, one arrives at a third terrace, several miles in width. Like the 1,000-foot terrace, it has suffered much from erosion, yet its character is unmistakable. Eastward it is limited by a sea cliff. There is an abrupt change from the flat terrace to a steep slope, and then a more gradual change to the gentle slope of White Mountain summit, where the peneplain is traceable at an altitude of about 2,200 feet.

"The sea beach at an elevation of 1,500 feet is the highest seen along the coast of the Klamath Mountains, and is very distinct at a number of points - for example, by the summit of Bill Peak in the south part of the Coos Bay quadrangle, as well as on the trail from Denmark to Eightmile Prairie and on the next divide beyond Crystal Creek. It occurs also on the divide between Edson Creek and Sixes River and at numerous other points farther south. The terrace connected with this beach is usually not wide but on the whole is one of the best preserved of the upper terraces along this portion of the coast.

6/ Diller, J. S., Topographic development of the Klamath Mountains: U. S. Geol. Survey Bull. 196, pp. 26-28, 1902.

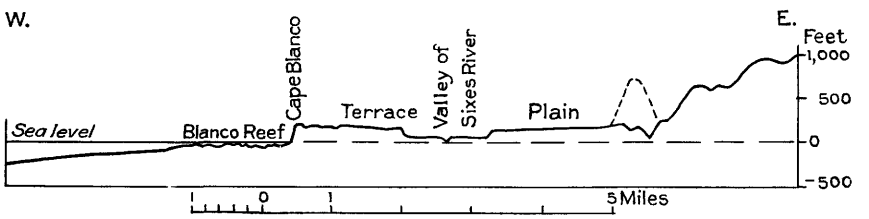


Figure 3.- Shore profile at Cape Blanco.

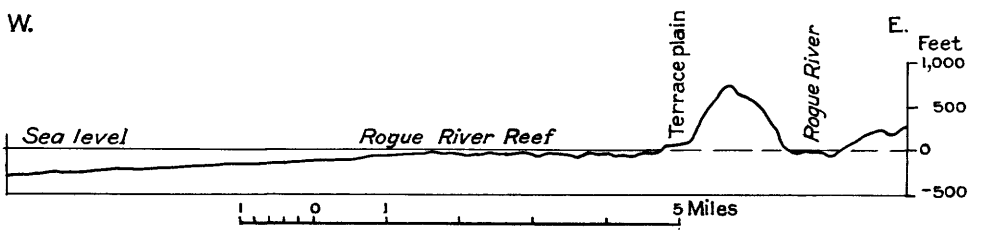


Figure 4.- Shore profile north of Rogue River.

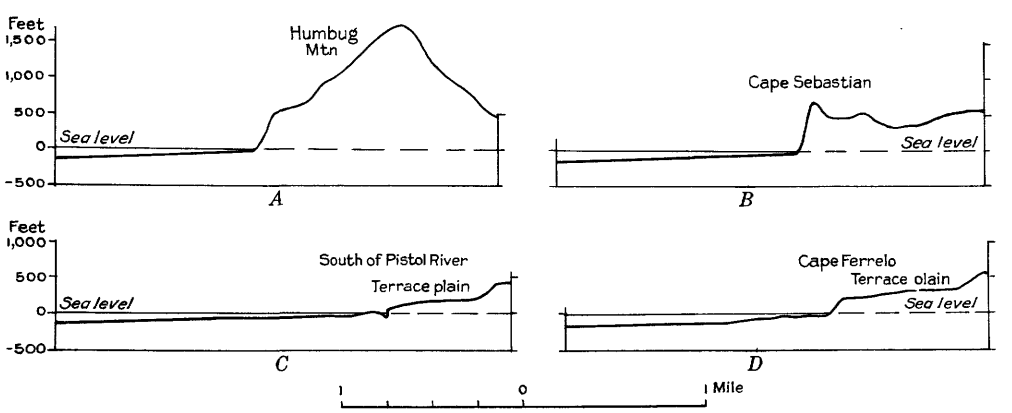


Figure 5.- Shore profiles south of Rogue River.

"The 500-foot terrace is most extensively developed north of the Coquille, where it is separated from the coastal plain by several sea cliffs and intervening plains. The 1,000-foot terrace is well developed near the northern end of the Port Orford quadrangle and is usually the most prominent of the elevated terraces on the coast.

"At Port Orford a prominent terrace at 300 feet spreads several miles to the northeast toward the Elk River divide. This divide rises by a number of terraces to the plains at the 1,000 and 1,500 foot levels. The latter is marked east of the stage road in the flat-topped hills about the head of Hubbard Creek. From the summit of Humbug Mountain the wide sweeps of the upper plain at about 1,500 feet is evident, and when that plain was at sea level Humbug Mountain and Colebrook Butte were small islands.

"Just north of Rogue River higher terraces may be seen, but they are not so conspicuous as the coastal plain. The highest is best displayed along the trail up the southern end of Brushy Bald Mountain and is at an elevation of 1,500 feet. The terrace with its sea cliff is of but small extend and the rounded slopes above are distinct.

"A section over the seaward slope was made from Scotts to the mouth of Lone Ranch Creek. The Klamath peneplain, fronting the coast, has an altitude of 1,800 feet. The first traces of terraces were seen at 1,500 feet, where the Lone Ranch road turns west to descend over the series of terraces to the coast. Although smaller terraces were seen at 1,140, 600, and 400 feet, the principal terrace, having a broad plain at least a mile wide, ranges from 850 to 925 feet and corresponds closely to the 1,000-foot terrace seen elsewhere. The next largest terrace occurs at 250 feet and is well developed near Lone Ranch. This terrace is the coastal plain and ranges in elevation from 250 feet at the northern end to almost sea level below Crescent City in California, a distance of 50 miles. There are small sea cliffs and minor terraces on this plain, but none of sufficient prominence to break the continuity of the plain."

Terraces in the vicinity of Coos Bay are described by Diller[7/] as follows:

"The first terrace, about 60 feet above the present sea level, is well displayed between Yokam Point and Cape Arago. The slope of the hill north of Cape Arago is like a giant staircase. The sea cliff, at the foot of which the present beach now lies, is at that point about 30 feet in height and is capped by a terrace at least 200 yards in width. At its eastern limit rises a steep slope, an ancient sea cliff, which is capped by a second terrace, and so upward a succession of steps and terraces of ancient beaches extend to the top of the hill. Above 800 feet elevation the beaches are less distinct, although they may be detected about the summits of the highest peaks near the sea. On the southwest side of Bill Peak, at an altitude of about 1,500 feet, a terrace is cut in the fissured sandstone of the peak. That this terrace is an ancient beach is shown by the presence of occasional pebbles and cobblestones upon its surface. Upon the eastern side of Seven Devils Hill terraces are well developed, but are somewhat broader."

7/ Diller, J. S., U. S. Geol. Survey Geol. Atlas, Coos Bay folio (no. 73), p. 1, 1901.

Topographic maps of the mountain front between Coos Bay and Alsea Bay[8] show profiles noticeably flattened at heights of about 250, 500, 800, and 1,000 feet, suggesting terraces similar to those described.

South of the Chetco River, according to Diller[9] "the coastal plain lies at the foot of the plateau escarpment, * * * rising to an altitude of 1,700 feet. This plateau escarpment has a slope of 17½°, and the absence of all clear traces of the terraces so well marked a few miles farther north suggests that it is a fault scarp. Only angular fragments were found along the east edge of the plain at the foot of this steep slope, where a beach would be expected if the plain developed after the faulting."

Beyond this stretch a comparable series of marine terraces reappears on the coastal slopes in California. Those as far south as the Eel River have been described by Diller[10] and those beyond that point by Lawson.[11]

Shore features

As summarized by Johnson[12] the principal zones of the shore belt are the coast, shore, shore face, and offshore (fig. 6). These zones

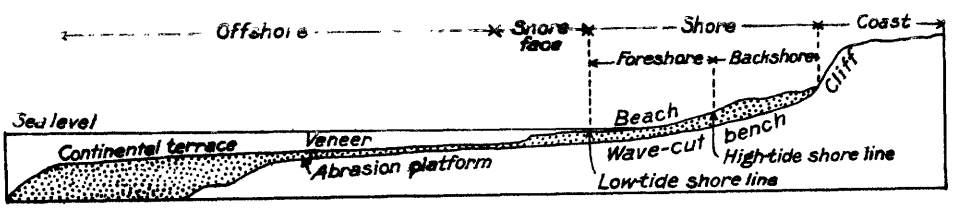


Figure 6.- Elements of shore zones in an advanced stage of development (After D. W. Johnson.)

8/ U. S. Geol. Survey, maps of Reedsport, Siltcoos Lake, Heceta Head, and Waldport quadrangles.

9/ Diller, J. S., op. cit. (Bull. 196), p. 28.

10/ Idem, pp. 28-30.

11/ Lawson, A. C., The geology of Carmelo Bay: California Univ. Dept. Geology Bull., vol. 1, no. 1, pp. 46-57, May 1893; The post-Pliocene diastrophism of the coast of southern California; Idem, vol. 1, no. 4, pp. 116-157, December 1893; The geomorphogeny of the coast of northern California: Idem, vol. 1, no. 8, pp. 241-272, 1894.

12/ Johnson, D. W., Shore processes and shore-line development, 1st ed., pp. 159-164, fig. 23, New York, John Wiley & Sons, 1919.

are subdivided into the following elements, some of which may be lacking according to the stage, young or old, of development. The coast includes the cliff and an adjacent strip of land of indefinite width. The foot of the cliff marks the coast line. The shore is divided into the backshore, which lies between the high-tide line and the cliff, and the foreshore, which lies between the high-tide and low-tide lines. The low-tide line is also the shore line. As variously understood the term beach includes both the wave-deposited materials and the zone above low-water line in which they are being more or less actively transported. For the sake of clearness Johnson proposes to restrict the term beach to the deposit. Therefore, the deposit that underlies the foreshore and backshore is the beach. It rests on a wave-cut surface called by Johnson the "bench" but by the placer miners "bedrock."

The shore-face and offshore zones are permanently under water and together form a belt extending out to the edge of the continental shelf. Deposits of these submerged zones are continuous with the beach and lie upon a surface called the abrasion platform that is continuous with the bench and, farther out, up on the uneven original floor of the sea.

Development of the coast line

The charts of the United States Coast and Geodetic Survey show that in general the present Oregon shore has reached the stage of development called late youth or submaturity.13/ Originally winding in and out of bays and around promontories formed by the valleys and ridges of a submerged land surface, the shore line has become straightened and simplified by the action of the waves in cutting back the headlands and building bars across the embayed areas. Along the stretches of terrace plain the shore has been cut back without change from an original generally simple outline, except that as in all other parts that are retreating under wave attack numerous small-scale irregularities have developed as a result of differences in the resistance of the rocks.

Retrograded shores

Along the retreating stretches of the shore the more resistant rocks, mostly unbroken igneous and metamorphic bodies, stand out as rugged capes and promontories. The less resistant rocks, mostly sandstone, shale, and fractured igneous masses, are worn back into bays or coves that are generally crescentic in outline, and these features are developed in different orders of magnitude, the smaller superimposed on the larger and so on. South of Coos Bay the larger of the projecting points are commonly spaced a quarter of a mile to 2 miles apart, and the depth of the intervening bays or coves, measured from a line joining the outer extremities, ranges

13/ Johnson, D. W., op. cit., p. 340.

from a few hundred feet to a quarter of a mile (fig. 3). The sea cliffs likewise vary in steepness according to the character of the rocks, their height being governed of course by the original topography of the land from which they have been carved. Along the terrace-plain shores the sea cliff is generally between 40 and 100 feet high but reaches a height of 225 feet at Cape Blanco (fig. 2). On several mountainous promontories the cliff is 500 to 800 feet high and reaches 1,000 feet or more on Tillamook Head.

Around many of the capes and headlands the wave-cut bench is relatively steep and generally swept bare of debris by the waves. The stretches that are nearly always devoid of any noteworthy beach deposit aggregate perhaps 50 miles in length. On the other hand, the crescentic indentations are bordered with a gently sloping bench on which a beach deposit is generally present. Owing to the fact that this deposit consists of material in transit, it varies in extent and composition from place to place and from time to time. At most times and places the part above low water is not more than a few feet thick, 50 to 200 feet wide, and made up of sand with pebbles, cobbles, or boulders, in varying proportions. Driftwood with huge logs is generally found stranded almost everywhere along high-tide line and in some of the coves has accumulated extensively. Beaches of the type described aggregate perhaps 100 miles in length, and most of them are south of Coos Bay. In places and at times they contain placer deposits, which are described beyond.

In places the retreat of the shore has halted and a readvance begun. Such stretches are characterized by a simple shore line. They extend for about 5 miles south and 3 miles north of the Rogue River, 4 miles south of Euchre Creek, half a mile or so north of the Elk River, and a short distance south of Whisky Run. South of the Rogue River the beach at the north end is about 1,200 feet wide, and its extremity is a short spit with two recurved points (fig. 2b). Southward it narrows gradually and tapers out near Cape Sebastian. At Gold Beach the foreshore part (fig. 7) is about 300 feet wide, and its landward limit is a ridge of sand and driftwood. Back of this ridge for about 700 feet is a backshore deposit, whose surface lies just above high tide and is slightly uneven, with half-buried logs, sand drifts, and ridges that mark the foreshore deposits at former stages. About two thirds of the way back the surface rises 3 or 4 feet and continues at that level to the back. This higher part has become forested. On the lower part little or no vegetation has obtained a foothold. Apparently the shore was first cut back to the position of the cliff, then advanced by the addition of material from the sea, was worn back again part way, was slightly elevated, and finally advanced to its present position.

North of the Rogue River (fig. 8) and south of Euchre Creek the beaches are similar to the one just described, except that they are narrower and without a noticeable division into higher and lower parts. These retrograded-prograded shores also contain beach placers, which are described beyond.

Prograded shores

Shores that have advanced seaward from their original position by the construction of barrier beaches and bay-mouth bars, including spits, occur along nearly half the coast line. They are characterized by a simple outline and a voluminous beach. North of Coos Bay for 50 miles a barrier beach was built in front of an extremely irregular shore of submergence. Material from the sea has been added to the barrier until the deposit is now a quarter of a mile or more wide, the landward margin being somewhat obscured by sand dunes. The embayed area at the back has been largely filled by drifting sand and marsh deposits, but parts of the former lagoons remain. In several valleys in the hilly country at the back are lakes held a little above sea level by sand drifts.

Between Tillamook Head and the Columbia River is a similar beach deposit 20 miles long and a mile or more wide. It is distinctly ridged as if widened by successive additions of wave-deposited material. Shorter beaches are formed by bars and related deposits and spits that block the mouths of eight or ten bays between Tillamook Head and Heceta Head. Other stretches of shore of the same type as those described extend from the Coquille River 5 miles north, from Twomile Creek near Bandon 12 miles south to Flora's Lake, and for short distances at Garrison Lagoon, near Port Orford, and at the mouths of Euchre Creek, the Pistol River, and a few other streams.

Extent of shore migration

In front of most of the shores that are retreating under wave attack the charts of the Coast and Geodetic Survey show a belt of islands and submerged rocks that ranges from a quarter of a mile to 4 miles in width and averages at least a mile. Opposite Bandon, Brookings, and several other places some of the islands have flat tops corresponding in altitude to the terrace plain on the adjacent mainland. The flat-topped islands are evidently remnants of the land area that have been cut away by the waves at present sea level, and the rocky belt as a whole is interpreted as a measure of the shore retreat. The greatest recessions thus indicated have occurred along stretches at Port Orford, at Cape Blanco, and north of the Rogue River. From Heceta Head north the different promontories are indicated in the same way to have been cut back a quarter of a mile to 1½ miles.

Along the prograded shores the land appears to have been extended as much as 3 or 4 miles in places, but the land area thus gained is apparently less than the area lost along the retreating shores. The most striking result of the shore migrations has been the straightening and shortening of the coast line.

Figure 7.- Profile and section at Gold Beach. a, Rusty consolidated marine sand (Pleistocene offshore beds); b, "bedrock" (pre-Pleistocene shale and sandstone); c, older backshore deposit; d, newer backshore deposit; e, foreshore deposit; f, mining trench.

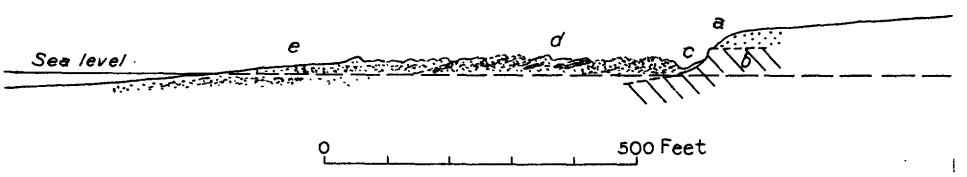


Figure 8.- Profile and section half a mile north of Doyles Point. a, Marine sand (Pleistocene); b, "bedrock" (greenstone); C, mining trench ; d, backshore deposit; e, foreshore deposit.

Shore-zone formations

The sand and other materials of the foreshore are subject to almost continuous wave action, which veries in intensity according to the tides and the weather. As a result of this process part or all of the deposit is at different times shifted from place to place, sorted according to weight and size, and redeposited more or less in order, with the heavier and coarser grains concentrated at the bottom. In addition to this vertical arrangement the waves tend to concentrate the heavier and coarser materials toward the landward edge of the deposit. It is a rule well illustrated along the Oregon coast that the boulders and most of the black sand are found toward the landward edge in both the ancient and the modern beaches.

The backshore part of the beach is an aggregate of layers, each of which was originally a foreshore deposit. Their accumulation at a particular place is due to an excess of sediment transported there by shore currents. As a result of changing conditions, a backshore developed at one time may be cut away at another.

In the submerged zones adjacent to the beach the processes of erosion, transportation, and deposition are more or less effective, according to the depth of the water, the width of the continental shelf, and other considerations. Wave motion diminishes gradually from the surface downward but may at times be sufficient at a depth of several hundred feet to shift loose sand or pebbles back and forth on the sea floor. Wave-generated and other currents are at times capable, down to the same or even greater depths, of transporting large quantities of material from one part of the coast to another. The action of the waves and currents tends to reduce the beach materials to a finer texture and to sort and re-sort them continually. During this process the finest particles are held in suspension and finally transported to deep and quiet water. As a result the beach and adjoining offshore deposits are characteristically free of clay or silt. In places strong undertow or other subsurface currents may sweep coarse material well out on the abrasion platform, but in general the landward movements of the water, particularly the surf, seem to be the stronger and to hold the coarser materials toward the upper edge of the beach until they are reduced in size.

Offshore beds

Soundings by the United States Coast and Geodetic Survey show that the Oregon coast is bordered by a gently sloping submerged shelf 15 to 60 miles wide. For distances of 3 to 15 miles out from the shore the submarine surface is either rocky or veneered with sand, pebbles, and shells. Farther out the soundings, as a rule, show finer material. The outer limit of the sandy zone is generally at a depth of 300 feet. The agitation of the water by the waves is apparently sufficient at shallower depths to prevent settling of silt or mud. The shallow sandy zone widens near the mouths of the Columbia and Rogue Rivers, the result apparently of sediments discharged by the streams. The huge amount of the sand and silt brought down by the Columbia River is indicated by a submarine bank 30 miles wide.

Sand dunes

The prograded shores described are generally bordered by sand dunes that in places extend inland a mile or more. The widest belts of drifted sand are north of the Coquille River entrance and between Coos Bay and the Siuslaw River. Some of the dunes are as much as 100 feet high, but generally they are 50 feet or less. At Whisky Run and south of the Pistol River the sand has crept above the sea cliffs and formed a narrow dune belt along the edge of the terrace plain. In most places the dunes have become fixed by forest vegetation within a short distance of the shore.

Sediments related to ancient shores

The terraces at different heights above sea level are stated by Diller[14] to be "capped more or less completely with Pleistocene marine sediments." The highest of these sedimentary bodies is on the 1,500-foot terrace on Bill Peak and neighboring summits, about 9 miles southeast of Bandon. It consists of sand and is as much as 100 feet thick.[15] A body on the spur north of the Sixes River at a height of 800 feet consists of 15 feet or less of black or gray sand with pebbles and is locally covered with an "overburden" 50 or 60 feet thick. A placer mine in this deposit is described by Hornor.[16] South of the Sixes River considerable areas of marine sediments are mapped by Diller[17] between altitudes of 500 and 1,000 feet.

The largest area of the Pleistocene marine sediments covers the terrace plain extending from Port Orford north nearly to Cape Arago. It includes material deposited when the sea stood at several different heights up to 300 or 400 feet, but the great bulk of it was formed when the sea level was about 170 feet higher than now. At that stage wave-cut cliffs were developed in the shores extending 3 or 4 miles north of the Sixes River and about 4 miles north of Cut Creek. The beach deposit along these stretches contains several placer mines, which are described beyond. As exposed by the mine workings the beach consists of stratified gray and black sand with cobbles and boulders and more or less driftwood. In places it is cemented with iron oxides. It is from a foot or two to 10 or 15 feet thick and is generally overlain by sand of probable wind-blown origin that in places is 50 feet or more thick.

The terrace plain extending seaward from this old beach is partly a plain of marine denudation and partly a constructional feature built of shore-face or offshore deposits. In the neighborhood of Port Orford and Cape Blanco exposures of the rock platform and the presence of Silver Butte, a rock mass not entirely cut away by wave erosion, standing above the plain, indicate that the general shore line was cut back 2 or 3 miles. Along a stretch extending from Denmark to a point north of the Coquille River no abrasion platform is exposed except at Bandon. Continu-

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14/ Diller, J.S., Topographic development of the Klamath Mountains: U. S. Geol. Survey Bull. 196, p. 14, 1902.

15/ Diller, J.S., U. S. Geol. Survey Geol. Atlas, Coos Bay folio (no. 73), p. 3, 1901.

16/ Hornor, R.R., Notes on black-sand deposits of southern Oregon and northern California; U. S. Bur. Mines Tech. Paper 196, pp. 27-29, 1928.

17/ Diller, J.S., U. S. Geol. Survey Geol. Atlas, Port Orford folio (no. 89), 1903

ous with the old beach, however, and extending in places out to the present sea cliff are offshore beds of stratified sand with pebbles (fig. 9). Incomplete exposures show these beds to be as much as 70 feet thick.

Between Denmark and South Twomile Creek is an area of marine sand 1 to 2 miles wide. It is built up to the 170-foot beach level, but apparently no cliff was ever developed, and the deposit is therefore interpreted as an offshore bar or barrier beach. Farther north, where the marine beds are crossed by the valleys of Twomile, China, and Johnson Creeks, old mine workings imperfectly show a beach deposit at about the 170-foot level. There the presence of some coarse gravel and boulders suggests a cliff, but if present it is low enough to be concealed by a wind-blown sand cover less than 10 feet thick. North of Johnson Creek the body of marine sediments widens until it reaches the sea at Bandon. From that point east and north it forms a plain that was probably made up of a bar and offshore beds with a spit that partly closed a bay extending up the Coquille Valley. Across the river is a similar body that still farther north is continuous with the 170-foot beach.

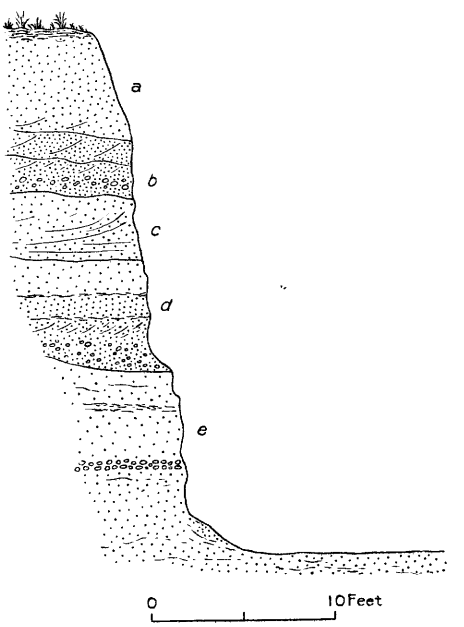

Figure 9.- Section at road cut east of Bandon. a, Light-buff to gray sand; b, rusty sand with pebbles; c, very fine buff sand; d, fine sand with pebbles; e, mostly loose pale-buff sand.

The terrace plain surrounding South Slough is underlain by marine sediments similar to those of the neighboring coastal plain, above described. Exposures at the Chickamin mine and at several mines described by Hornor[18] show from 2 to 10 feet of stratified gray and black sand. In places pebbly layers are present, and as a rule the beds are somewhat cemented by iron

18/ Hornor, R.R., op. cit., pp. 14-16.

oxides. Above and below the beds described is marine sand, the overlying part of which is generally 10 to 50 feet or more thick. Most of the exposures of the layers containing noticeable streaks of black sand range in altitude from 25 to 100 feet. When plotted on a vertical plane their projections indicate two main horizons of black-sand deposition (figs. 10, 11). The lower horizon rises southward within 2 miles from a height of 25 feet to 120 feet. The upper horizon is indicated at a height of 60 feet for a distance of less than a mile. No sea cliffs are shown. As the deposition of black sand and other materials occurred well out from the shore, all are regarded as offshore deposits. No source of the sediments appears other than longshore drift. Apparently such drift was carried by currents into the large bay which at the terrace-plain stage occupied the area.

Small areas of marine sediments occur on the terrace plains north and south of the Rogue River, at the Pistol River, and at Brookings. Sections north of the Rogue River made by old mine workings in the sea cliff show a beach deposit consisting of about 20 feet of stratified sand and pebbles resting on a surface eroded across shale and sandstone (fig. 12). Overlying the beach is wind-blown sand, the ancient sea cliff not being exposed. South of the Rogue River 20 to 40 feet of beach and offshore beds rest on a bench that is near present sea level (fig. 7). At Brookings a thin veneer of beach sand and pebbles rests on benches at two different levels, separated by a low escarpment representing a former sea cliff (fig. 13). South of the Chetco River a few feet of marine sand and pebbles resting on a bench at a height of 50 feet are exposed in the sea cliff. Above this deposit is alluvial gravel.

Placer deposits

The productive parts of the beach, generally called black sands, are layers in which magnetite, chromite, ilmenite, and other heavy minerals, most of which are dark-colored, have been concentrated by the waves. Commonly these layers contain very fine particles of gold and platinum alloys, and in places the metallic particles are abundant enough to be extracted profitably.

So far as known, gold and platinum alloys have been the only substances extracted from the beach at a profit, but more or less interest in the possibility that the black sands might, in addition to these metals, prove a valuable source of many other minerals has persisted since the mineralogy of the beach deposits was determined by Day and Richards in 1905.19/ Although it is true that most of the minerals composing the black sands have a market value, the difficulties of profitably recovering and marketing them apparently remain to be overcome. The deposits are therefore considered chiefly as a source of gold and platinum. They are classified according to age and position with respect to the present shore line and to ancient elevated shore lines.

19/ Day, D. T., and Richards, R.H., Black sands of the Pacific slope: U. S. Geol. Survey Mineral Resources, 1905, pp. 1175-1258, 1907.

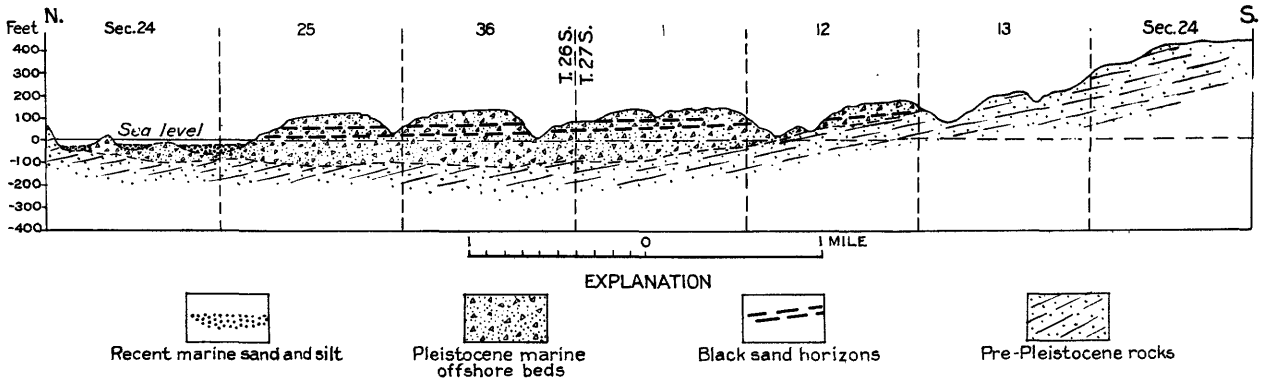

Figure 10. - North-south profile and section at South Slough.

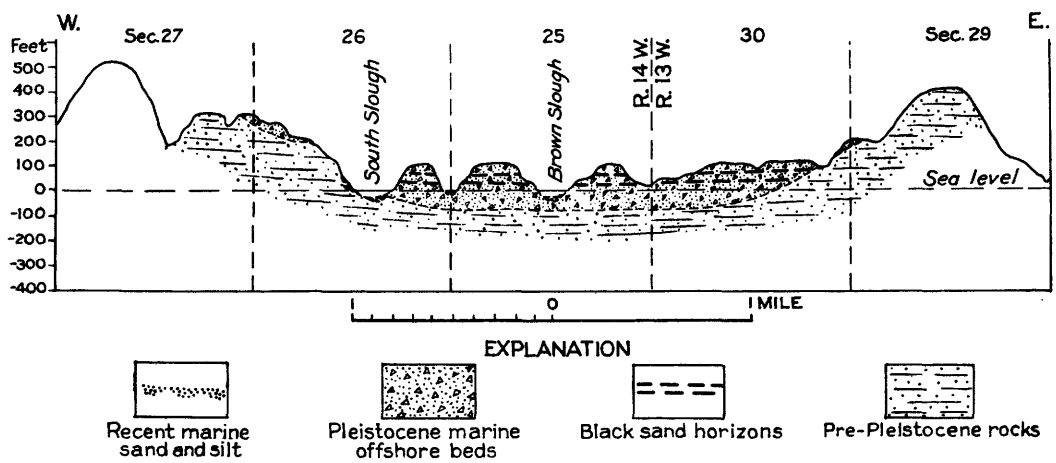

Figure 11. - East-west profile and section at South Slough.

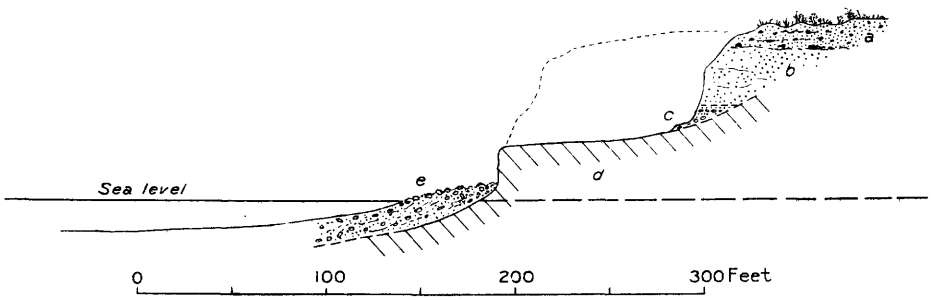

Figure 12. - Section at Old China mine, Hubbard Mound. a, Recent sandy soil containing shell heap; b, Pleistocene gray sand, probably wind-blown; c, Pleistocene marine sand and cobbles, with streaks of black sand, part of ancient beach; d, "bedrock" (pre-Pleistocene sandstone and shale); e, present beach.

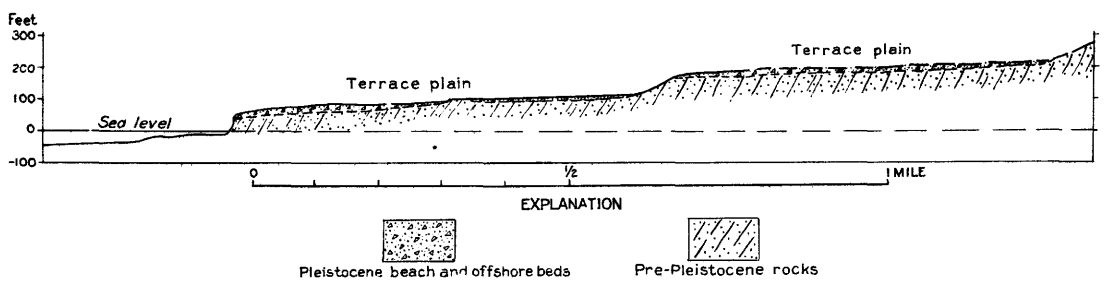

Figure 13. - Cross profile and section at Brookings.

Production

No records are available of the early production from the Oregon beaches but they are popularly reported to have yielded a large amount of gold. Since 1902, however, the records show a total of more than $60,000 worth of gold and platinum, distributed as follows:

Production of gold and platinum from Oregon beach placers, 1903-29
[Data from V. C. Heikes, U. S. Bur. Mines, San Francisco]

Locality	Gold		Platinum	Total value
	Ounces	Value		
Whisky Run-Bullards	804	$16,562	$1,707	$18,269
Port Orford-Cape Blanco	869	17,901	188	18,089
Ophir-Gold Beach	761	15,676	---	15,676
Newport	414	8,528	53	
	2,648	58,677	1,948	60,615

Occurrence and distribution

The gold and platinum alloys recovered from the beach deposits occur as particles most of which range in size from that of a small pinhead to microscopic specks. A sample of platinum from the Pioneer mine consists mostly of rounded flat grains from 0.8 to 0.05 millimeter (about 0.03 to 0.002 inch) in diameter and from 0.05 to 0.005 millimeter or less in thickness. These grains weigh from 0.55 to 0.01 milligram. At the rate of $20 an ounce, about 20 of the larger of 1,100 or the smaller particles would be required to be worth 1 cent. Still smaller specks, mostly rough and irregular, form a relatively inconsiderable part of the mass. In several deposits elsewhere in both the present and ancient beaches most of the gold observed consists of particles that range in size from miscroscopic specks to thin flakes about 1 millimeter (about 0.04 inch) in diameter. Those composing a sample from the beach south of Cape Blanco weighed from 0.035 to 0.215 milligram. At the rate of $20 an ounce, about 500 of the smaller or 75 of the larger particles would be worth 1 cent. Still smaller particles are present in all the samples obtained, but in none do they form the bulk of the mass.

Pay streaks

Although a few specks of gold or platinum can be found almost anywhere along the present and ancient beaches, the workable deposits so far discovered form only a part of the whole and, as a rule are confined to the beaches bordering the shores that have receded under wave attack.

Present beach

Stretches of the shore that have been cut back at existing sea level border parts of the coast south of Coos Bay and north of Heceta Head. Along most of these stretches the waves are still eroding the land. In a few places after first cutting back they have built the shores forward. Around most of the rocky points and headlands the bench is nearly always swept bare. Elsewhere a beach from a few feet to 200 or 300 feet wide and at least a foot or two thick is generally present. Along the retrograded-prograded stretches there is a permanent beach from 200 to 1,000 feet wide. At one time or another gold has provably been mined along most parts of all these beaches, which together are more than 100 miles long.

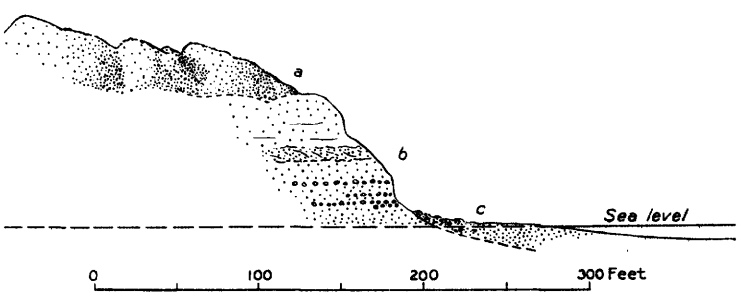

Figure 14.- Section at mouth of Whisky Run. a, Recent dune sand; b, Pleistocene marine sands (offshore beds); c, present beach.

In the shores that are now retreating the beach varies in extent and composition from time to time as the result of storms and tides. Thus a stretch that is barren on one day or in one season may be productive at other times. There are, however, certain stretches that have been richer and are more often workable than the rest. These are, in order from north to south, in the vicinity of Newport, Whisky Run, Cape Blanco, Port Orford, and the Rogue River.

Details concerning the beaches at Newport are not available except the production of late years reported above. At Whisky Run the beach in the later part of June 1931 was 3 or 4 feet thick near the upper edge at the foot of the cliff (fig. 14). It contained a large proportion of pebbles and cobbles, and the lower foot or two was heavy with black sand. Gold and platinum alloys were being recovered to an amount not learned by a group of miners using a scraper, elevator, revolving screen, and sluices.

Early in July 1931 the beach south of Cape Blanco for 2 miles or more was from a few inches to 2 or 3 feet thick in a zone 20 to 40 feet wide next to the cliff. It consisted of black and gray sand with many cobbles and boulders, but the landward edge of the belt was largely covered with driftwood, including huge logs. The black sand was mostly concentrated on bedrock in a layer a foot or less thick, which in places was exposed and in places was covered with gray sand. Several miners were at work using rockers or movable sluices, for which they obtained water from a small flume attached to the vertical face of the cliff above the waves at high tide. From information given by the operators it was estimated that the black sand layer yielded from $1 to $2 a ton in gold (reckoned at $20 an ounce) and platinum alloys, of which the platinum formed one-twentieth to one-tenth of the total value.

In the retrograded-prograded beaches extending north and south of the Rogue River and south of Euchre Creek a pay streak, said to have been very rich, was mined in the "early days." It lay along the inner edge of the beach next to the cliff and was at least 20 or 30 feet wide. At Gold Beach a second pay streak about 200 feet out from the cliff is indicated by several open cuts. This pay streak was formed during a pause in the forward growth of the shore.

The unworked parts of the backshore consist of sand, both wave-deposited and wind-blown, with a small amount of pebbles and more or less half-buried driftwood. At one place north of the Rogue River an open cut 6 feet deep exposed in 1931 a 3-foot layer at the bottom containing 50 percent of black sand. Panning tests yielded a few fine particles of gold.

The reports of operators given by Butler and Mitchell[20/] indicate that parts of the beach average $1 a ton in gold and platinum, found mostly in a 4-foot layer on bedrock.

No mining was being done on the foreshore in July 1931, and no concentrations of black sand were visible, but it is said that heavy seas occasionally "pan down" workable deposits.

Ancient beach and offshore beds

Pay streaks have been worked in the ancient elevated beaches or related offshore beds in the terrace plains north of Port Orford, north of the Rogue River, around South Slough, and in a terrace 800 feet above sea level at the Peck mine, on the spur north of the Sixes River. On the terrace plain north of Port Orford the deposits were formed when the sea stood about 170 feet higher than now. At that level the shore was cut back along two stretches one of about 4 miles between the Sixes River and Denmark, the other of about 4 miles extending north of Cut Creek. Pay streaks that were concentrated by the waves along parts of these stretches are exposed in the Madden and Butler mines, north of the Sixes River, and in the Pioneer, Eagle, Fletcher & Myers, and Rose mines, north of Cut Creek (fig. 3a). At these mines the pay streak ranges from a few feet to 200 or 300 feet in width, is 3 or 4 feet thick in the middle, and tapers toward the edges. It consists largely of black sand arranged in layers alternating with gray sand. More or less driftwood and pebbles,

20/ Butler, G.M., and Mitchell, G.J., Preliminary survey of the geology and mineral resources of Curry County, Oreg: Mineral Resources of Oregon, vol. 2, no. 2, pp. 49-52, 1916.

cobbles, or boulders are present. The deposit rests on bedrock at the foot of the ancient sea cliff and is generally somewhat cemented by iron oxides. Natural exposures were found in the valleys of streams that cross the terrace plain. Between the valleys the pay streak is covered with 20 to 50 feet of wind-blown sand on which is a soil supporting a generally thick forest.

Between Twomile and Fairy Creeks, east of Bandon, both ancient beach and foreshore beds contain black-sand layers. Old excavations covering less than an acre at China and Twomile Creeks imperfectly expose black sand and boulders. At the Geiger and Iowa mines, on Fairy Creek, 1 to 3 feet of black sand interbedded with gray sand occurs in offshore beds.

At several places sround South Slough mine workings expose in sections layers of black sand that at most places aggregate about 4 feet in thickness and extend at least 200 or 300 feet horizontally. The black sand is interbedded with gray and brown sand and generally is somewhat cemented. At most places from 5 to 50 feet of gray sand covers the pay streak. The formation is regarded as offshore beds.

North of the Rogue River a black-sand layer 1 foot thick lying on bedrock at a height of 30 feet is exposed by mine workings in the present sea cliff. It is overlain by 30 or 40 feet of gray sand, most of which appears to be wind-blown. The horizontal extent of the deposit is not shown.

At the Peck mine 21/ black sand interbedded with gray sand and pebbles is distributed through a layer as much as 14½ feet thick composing a beach or offshore bed related to a terrace at an altitude of about 800 feet. The deposit extends over more than 1⅓ acres and is covered by an overburden from 60 feet thick down to the vanishing point.

Origin

Some of the miners believe that the gold of the beaches comes up out of the sea, an idea suggested by the fact that after a storm a formerly barren stretch may be found to be gold-bearing. This notion is true so far as the immediate source of some of the gold is concerned. Materials composing the foreshore are carried out in the offshore zone at one time and returned to the beach at another. In the process a shift up or down the coast may occur. The huge amount of material composing the prograded beaches north of Coos Bay and between Tillamook Head and the Columbia River, for example, must have been cast up by the waves from the shore-face and offshore zones. The sea was therefore the immediate source of whatever gold and other minerals those beaches contain. Soundings of the Coast and Geodetic Survey show black sand to occur in the offshore zone at the present time. Gold and other minerals are doubtless present also. The occurrence of gold, platinum, and black sand in ancient offshore deposits at the Iowa mine and around South Slough is described beyond. For the beaches that border retreating shores, however, the most of the

21/ Hornor, R.R., op. cit., p. 28.

gold and other minerals come directly from the rocks that are being eroded by the waves. The relative distribution of the placers with reference to the different kinds of rock in the sea cliffs indicates that sandstone, conglomerate, or other sediments of Tertiary age and sand and gravel of Pleistocene age composing offshore beds and beaches related to ancient shore lines are the chief if not the only sources of the metals. These rocks contain no metalliferous lodes. Their gold and platinum are detrital and, as sketched in the following pages, were derived ultimately from metal-bearing formations in the interior and transported seaward by streams.

Source of the gold

A little placer gold may be found in almost any section of the beach, but the bulk of it is confined to certain stretches south of Coos Bay. That part of the coast is opposite an area in southwestern Oregon and the adjoining part of California described by Diller[22] as the "Klamath Mountains."

The Klamath Mountains contain several areas of gold-bearing lodes. One is at the head of the South Fork of the Sixes River,[23] about 15 miles east of the coast at Port Orford. Others farther south at Mule Creek and other localities scattered through Curry County[24] are from 10 to 30 miles inland. Farther back from the sea are many lodes in the Rogue and Klamath River basins. Opposite the comparatively lean part of the coast north of Coos Bay gold-bearing lodes are unknown.

In the Klamath Mountains the formations are chiefly folded and crumpled schists and slate, greenstone, serpentine, gabbro, diorite, and other intrusive and extrusive rocks, all of which are Cretaceous or older. On the north and northwest these rocks give place to successively later formations that are chiefly sandstone, shale, and conglomerate, with more or less basalt and related igneous rocks.

North of Coos Bay less information is available, but it is known that in general the prevailing formations are Tertiary sediments, chiefly sandstone, and dikes, sills, and flows of basaltic and andesitic composition.

22/ Diller, J.S., Topographic development of the Klamath Mountains: U. S. Geol. Survey Bull. 196, 1902.

23/ Diller, J.S., U. S. Geol. Survey Geol. Atlas, Port Orford folio (no. 89) pp. 5, 6, 1903.

24/ Butler, G.M., and Mitchell, G.J., op. cit., pp. 73-114.

The topographic development of the region began with the emergence in early Cretaceous time of an area that formed an extensive island.[25] Afterward this area was submerged and again elevated, this time as part of the continent. Succeeding events include several remarkable vertical oscillations that are recorded in flat erosion surfaces and marine terrances at different heights.[26] The oldest and highest of these surfaces, the Klamath peneplain (Eocene-Miocene), is represented by extensive flat and gently sloping areas that range in altitude from about 2,500 feet near the Columbia River to 4,000 feet at the California line and still higher farther south. Other flats 500 feet lower than the Klamath peneplain represent coastal plains and wide inland valleys ("Sherwood peneplain") that were developed after an uplift of the Klamath peneplain and during the second cycle of erosion. A further uplift, which raised the land 600 feet higher than at present, permitted the cutting of deep, marrow valleys during the third cycle of erosion. In Pleistocene time the land to a height of 1,500 feet above present sea level was submerged briefly. Its subsequent emergence was interrupted by pauses that permitted the waves to cut terraces at different levels. The upward movement continued until the land stood somewhat higher than now. After a pause the present sea level was established by a submergence that caused the tide to run several miles up the rivers north of Bandon but had much less effect south of that point.[27]

The old shore line at the edge of the terrace plain north of Port Orford, as shown at several mines in the old beach, now stands about 170 feet above sea level. In the narrow plain north of the Rogue River a shore line is shown at one place at an altitude of 30 feet; at Brookings there are two shore lines, 120 and 200 feet high. North of Coos Bay no counterparts of the terrace plains appear. The facts cited might be interpreted to mean that south of Coos Bay the sea developed plains here and there while standing at different levels, but that north of that place it failed for some unknown reason to either cut or build one. A more plausible explanation is that the elevation of the coast differed in amount in different places. In that event the terrace plains south of Port Orford may have been formed at one or two still-stands and were afterward elevated differentially. The absence of the terrace plain north of Coos Bay is most probably due to the fact that the latest subsidence carried it below present sea level.

25/ Condon, Thomas, The Two Islands and what came of them, 1902; revised and enlarged by E. C. McCormack in 1910 as "Oregon geology."

26/ Diller, J.S., op. cit. (Bull. 196), pp. 45-49.

27/ Idem, pp. 59, 60.

Bodies of gold-bearing conglomerate formed from the erosion of the Cretaceous island mentioned lie on or near the surface of the Klamath peneplain.[28] Most of these bodies are rather far from the sea, but one of them extends to the shore near the mouth of the Klamath River and is the immediate source of the beach gold.[29] Other bodies of gold-bearing gravel, ranging in age from Tertiary to Recent, are found here and there from the interior almost to the present shore along the Rogue, Klamath, and Sixes Rivers. During Cretaceous and Teriary time the products of erosion were carried northward, as well as in other directions and deposited as beds of sandstone, shale, and conglomerate. Fine particles of gold may have been carried out with these sediments. In fact, Diller has expressed the opinion that certain of these beds (Eocene shale and sandstone) in the neighborhood of Coos Bay have yielded gold directly to the beach.[30] There is also a suggestive relation between a bed of Miocene conglomerate that is exposed to the waves south of Cape Blanco[31] (fig. 15) and the fact that the beach at that place is one of the more productive.

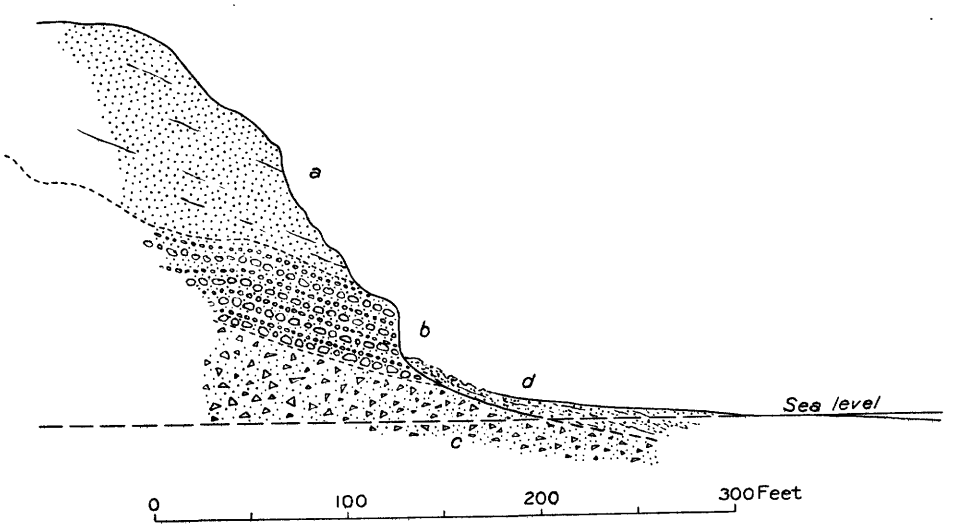

Figure 15.- Section south of Cape Blanco. a, Pleistocene marine sand and gravel (offshore beds); b, conglomerate (Empire formation, Tertiary); c, sandstone and tuff (Empire formation); d, present beach.

28/ Diller, J.S., Mineral resources of southwestern Oregon; U. S. Geol. Survey Bull. 546, p. 89, fig. 9, 1914. Haley, C.S., Gold placers of California: California State Mining Bur. Bull. 92, p. 84, 1923. Dunn, R. L. Auriferous conglomerate in California: California State Mineralogist 12th Rept., pp. 459-471, 1894. Turner, H.W., The Cretaceous auriferous conglomerate of the Cottonwood mining district, Siskiyou County, Calif.: Eng. and Min. Jour., vol. 76, pp. 653, 654, 1903.

29/ Chase, A.W., The auriferferous gravel deposit of Gold Bluffs [Calif.]: Am. Jour. Sci., 3d ser., vol. 7, pp. 379-384, 1874. Haley, S.C., op. cit., p. 84.

30/ Diller, J.S., U. S. Geol. Survey Geol. Atlas, Coos Bay folio (no. 73), p. 6, 1901.

31/ Diller, J.S., U.S.Geol. Survey Geol. Atlas, Port Orford folio (no. 89) p. 3, 1903.

From the foregoing statements it appears that detrital gold from lodes in the interior has been transported seward by successive steps at intervals during a long time. The placers at Gold Beach and in the elevated beach east of Port Orford probably owe their comparative richness mostly to gold that was carried out by ancestors of the present Rogue and Sixes Rivers during the later stages in the topographic development of the region. The deposits at Whisky Run and in the elevated beaches east of it, however, have no relation to any existing gold-bearing stream. Their gold may have come from the interior during the earlier stages of development, when the drainage was more northerly than now.

In view of the fact that little shore erosion appears to have occurred around South Slough, the rather lean deposits of that area are thought to have been carried to place by shore or offshore currents. The information at hand is too scanty to explain the relative concentration of gold in the vicinity of Newport. Elsewhere north of Coos Bay the small amounts of beach gold reported may be ascribed to shore erosion alone or to longshore drift.

In the past, as at present, the streams sorted the gold during its transportation, leaving the larger grains near the source and distributing progressively smaller and smaller particles downstream. This selective process, together with attrition, probably accounts for the fine subdivision of the gold throughout the beaches.

Source of the platinum

In this region, as in many others, a general association of platinum and platinum alloys with serpentinous rocks is indicated, but no definite source of the metal is known. In both the beach and stream placers platinum is about as widely distributed as gold, but the proportions of the two vary from place to place. There is a well-marked association of platinum and chromite, as shown, for example, at Whisky Run and at mines on the old beach to the east. There the reported production shows a ratio of gold to platinum, measured in dollars, of somewhat less than 10 to 1. At the same places chromite, as shown by samples collected by Day and Richards[32] and by the writer, is by far the most abundant of the black-sand minerals. At Port Orford and Cape Blanco the ratio of gold to platinum is about 100 to 1; at Newport it is 160 to 1. No platinum is reported from Ophir and Gold Beach. At all these places chromite is relatively low. Serpentinous rocks containing chromite are widely distributed in the Klamath Mountain region, and the association in the beaches of chromite with platinum suggests that serpentine was the original source of both. Except for the chromite no relation between any particular black-sand mineral and the metals is apparent. It appears, however, that most of the platinum and chromite, as well as the gold, must have come from the interior, for they bear no relation to particular areas of serpentine - as along the lower Rogue River, for example - that are exposed near the coast.

32/ Day, D.T., and Richards, R.H., op. cit., pp. 1208-1214.

Tenor and extent of remaining deposits

Samples and assays.- The reports of Hornor and of Day and Richards already cited give the results of several assays of the black sands or other parts of the beach for gold and platinum. In view of the fact that little other definite information as to the tenor of the deposits is to be had, it is worth while to examine the results somewhat critically. There is no reason to doubt that Honor's samples correctly represent certain thicknesses of deposit at certain places. Altogether he reports about 27 samples from beaches or offshore beds in place that range from 2 feet to a little more than 9 feet in thickness and average a little more than 4½ feet. The samples were taken at widely separated points from South Slough to an old beach high on the mountain front east of Port Orford but are not claimed to be numerous enough to form a basis for any definite estimate.

The gold and platinum content of Hornor's samples as determined by assay ranges from 0 to 0.06 ounce to the ton, but the accuracy of these results may be questioned. The usual procedure in assaying (which in the absence of evidence to the contrary is assumed to have been applied to these samples) is to quarter down the sample and finally select a small part from which the metals are extracted by melting. A monents consideration will show that it is difficult if not impossible to mix a sample so as to obtain an even distribution of the metals it contains in the form of free particles of different sizes. If, for example, the part finally selected for melting is 1 assay ton (29,166 milligrams) and this part should happen to contain one of the smaller particles of gold weighing 0.01 milligram, the result would be taken to indicate 0.01 ounce (about 20 cents) of gold to a ton. The ton which the sample purports to represent should contain 29,166 such particles, and the particles should be evenly distributed. As the gold and platinum particles in the black sands range from less than 0.01 to more than 0.3 milligram in weight and are almost certainly not distributed evenly, the result is manifestly doubtful. It follows that the larger the part selected for melting the more nearly correct the result, and that relatively large samples are required to be in any measure representative of such deposits. If, as indicated by the description,[33] Hornor's samples were assayed as outlined above, the results are suggestive only. Another cutting from a sample that had yielded no gold on the assay of the first cutting might show it to be richer than any others, and vice versa. The practical conclusion is that to obtain a dependable result the total gold in a relatively large sample should be determined.

33/ Hornor, R.R., op. cit., p. 15.

The report of Day and Richards 34/ lists a large number of samples from the beaches of the Oregon coast, most of them from places north of Tillamook Head. As described many of the samples consisted of crude sand, and some of these were as large as 1 carload. Other samples consisted of concentrate, for some of which the degree of concentration is known but not for others. The assay scheme used for these samples included the selection usually of 1,000 grams (a little more than 2 pounds) from which the metals were extracted by concentration and amalgamation. From the results obtained on this portion the value of the whole was estimated in great refinement (to cents per ton). Thus very precise-appearing results were obtained, but owing to the fact that neither the conditions under which the samples were collected nor the extent of any deposits they may represent are known these results mean nothing more than the fact that in places gold and platinum are present.

Present beach.- Owing to the transitory character of the foreshore of the present beach, definite estimates of either the quantity or the value of the metals it may contain are not warranted. On this deposit the limitations imposed by tides and other natural conditions rule out anything like continuous or large-scale operations. On the other hand, deposits that will pay to work intermittently in a small way by single individuals or small groups will continue to be found here and there and now and then. New concentrations are, of course, most likely to be found after the winter storms have remade the beach. The stretches of foreshore in which workable deposits may be found are practically limited to retreating shores. These aggregate perhaps 100 miles in length, but only a small part of this distance contains such deposits at any one time. The beaches that are most often found to be remunerative are in the vicinity of Newport, Whisky Run, Cape Blanco, Port Orford, and Gold Beach.

The tenor of the foreshore deposits is most usefully stated in terms of recovery under the working conditions that are possible. With equipment ranging from a pan to a light sluice, one man can recover from a few cents to about $2 a day at times and in places, gold being reckoned at $20 an ounce. Exceptionally as much as $100 a day has been taken out near Whisky Run. 35/ Some comparably rich concentrations may, of course, form again, but in general only the low-grade deposits may be expected.

The backshore of the present beach is a formation of considerable extent, not subject to shifting by the waves. On shores that have first retreated and then advanced pay streaks in the backshore have been mined, but evidence as to the value of the remainder is somewhat contradictory. On one hand abandoned plants indicate that attempts to mine the material have been unprofitable. On the other hand it evidently contains, at least in places, noteworthy amounts of gold and platinum. So far as could be learned no systematic sampling of the backshore has been done. Parts of it may prove to be workable, due allowance being made for natural handicaps. Roughly the backshore beds occupy areas aggregating 12 miles in length and ranging from 700 feet or more to the vanishing point in width. Most of these areas are north and south of the Rogue River. Short stretches of beach south of Whisky Run, north of the Elk River, and perhaps at a few other places belong in the same category.

34/ Day, D.T., and Richards, R. H., op. cit., pp. 1206-1214.

35/ Diller, J.S., U.S. Geol. Survey Geol. Atlas, Coos Bay folio (no. 73), p. 5, 1901.

Ancient beaches and offshore beds.- Much of the old beach at about 170 feet above sea level which contains the Madden, Pioneer, and other mines has been cut away by streams. The remaining parts, which aggregate perhaps 8 or 10 miles in length, are found mostly between the Sixes River and Denmark, between Twomile and Johnson Creeks, and from a point somewhat south of Cut Creek north to Fivemile Creek. Pay streaks ranging from 50 to 200 or 300 feet in width and from a few inches to several feet in thickness extend through most if not all of the distance mentioned. They are generally covered with 20 to 60 feet of sandy overburden, and in most places the richer parts have been mined.

The fact that an ancient beach at the Peck mine, at an altitude of 800 feet on a ridge north of the Sixes River, contains a placer deposit encourages the belief that other placers are to be found in the higher beaches. A considerable area of marine sands on the ridge south of the Sixes River probably includes several beaches at different levels between the terrace plain and an altitude of 1,000 feet. This area or parts of it for which water can be obtained appears to be worth prospecting. The terrace plain north of the Rogue River contains a beach at an altitude of 30 feet that has yielded gold and may contain some unworked deposit.

The black-sand layers in the offshore beds exposed around South Slough and at the Iowa mine, east of Bandon, appear in the aggregate to be of conciderable extent. Whatever production has been made from them was not learned. Hornor's samples show that in places, at least, they contain gold and platinum.

Amounts of black-sand minerals.- The great bulk of the beaches as a whole consists of sand grains of quartz and other minerals and undecomposed rock having a specific gravity less than 3. The remainder includes a variety of heavier minerals, the most abundant of which are magnetite, chromite, ilmenite, garnet, and olivine. As a rule these heavy minerals have been mostly concentrated by the waves into layers that range from mere seams to beds 5 to 10 feet in greatest thickness and 200 to 300 feet in horizontal dimensions. The exposures indicate that beds averaging 3 or 4 feet thick and 200 feet wide and long are present along at least half of a 4-mile stretch extending from the vicinity of Cut Creek northward. Around South Slough bodies of about the same size are distributed through an area of 3 or 4 square miles. Probably they underlie at least a quarter of that area. Black-sand layers can be seen at many places elsewhere in the ancient beaches, but information as to their extent is scanty. In a few places layers of black sand 1 to 4 feet thick were observed in the backshore of the present beach north of the Rogue River. At other places exposures were lacking. It is likely, however, that this beach contains about as much black sand per unit as the ancient beach.

The wide distribution of black sand along the coast and the relative predominance of certain minerals at certain localities is shown by the investigations by Day and Richards.[36] The concentration of the black sands evidently varies from place to place. Beds specifically mentioned above probably contain 50 percent or more of the heavy minerals.

Although no estimates can be made as to the size of the bodies that the samples of Day and Richards may have represented, the analyses reported indicate in a general way the relative predominance of certain of the black-sand minerals at certain places, as follows:

Magnetite: several places in the beaches of Clatsop County, Rogue River beach, and near the Pistol River.
Chromite: Alsea, Lane (Pioneer) mine, and Coos Bay.
Ilmenite: Yaquina Bay.
Garnet: Yaquina Bay.
Olivine: Beaches of Clatsop County, Port Orford beach, and Rogue River beach.

Some of the samples from Coos Bay and Yaquina Bay contained noteworthy amounts of zircon, and in several samples, mostly from Clatsop County, a little monazite was found. Samples collected during the present investigation show predominant magnetite in those from the beach north of the Rogue River and predominant chromite in those from the old beach at the back of the terrace plain north of Port Orford and from the offshore beds around South Slough.

Mining Conditions

The conditions under which the beach deposits must be mined differ in some respects from those governing the operation of stream placers. The foreshore deposit can be worked only between tides and with movable equipment. The backshore is out of the reach of the waves of at least ordinary storms and tides, but workings are likely to be filled and machinery buried by wind-blown sand. Salt spray causes rapid corrosion of metallic parts. Low position and a high water level make hoisting machinery of some sort necessary. Excavation with drag-line scrapers or similar machinery is hindered by buried drift wood, including huge logs. The deposit is ordinarily too shallow for dredging. These difficulties, so far as the backshore is concerned, could doubtless be partly or wholly overcome, but only at added expense. They are mentioned in order that a true comparison may be made between the beaches and other types of placers. Bodies of stream alluvium containing as little as 3 or 4 cents a cubic yard have been profitably worked where favorably situated for hydraulic mining, and deposits are worked with dredges at a cost of less than 10 cents a yard where conditions are favorable. Under the handicaps attached to the beach deposits the cost would probably be several times as great. Parts of the elevated beaches are suitably situated for hydraulic mining, and in general conditions surrounding them are more favorable than those on the present beach. In deposits of both types the metallic particles, owing to their fine subdivision and the abundance of heavy sand, are more difficult to recover than in placer deposits generally.

36/ Day, D. T., and Richards, R. H., op. cit., pp. 1206-1214.

In the ancient beaches some of the gold is coated with iron rust or other material that makes amalgamation difficult. The generally thick overburden of barren sand must be considered in making estimates of yardage value. The report of an engineer, J.D. Mereen, referred to below, estimates that from the pay streak at the Eagle mine 2 tons of crude sand would yield 1 ton of black-sand minerals but that removing the overburden would make it necessary to handle 17 tons of sand to obtain the ton of concentrate. For the present beach (backshore south of Whisky Run, including drifted sand) he estimates 1 ton of concentrate from 85 tons of crude sand.

Difficulties caused by the fact that the black sand is dispersed as relatively thin layers with no great quantity at any one place are referred to by Hornor 37/ in considering the deposits as a possible source of iron ore. The same objections apply to the chromite or other low-price minerals in the deposits.

On the other hand, with suitable equipment it is possible to separate cleanly several of the black-sand minerals from the others, and therefore the deposits should be regarded as a reserve possibly available should an emergency make a special demand for chromite, ilmenite, zircon, etc.

Descriptions of mines

Pioneer

The Pioneer (Lane) mine, about 2 miles north of Bullards, is in an ancient beach at an altitude of 170 feet. At the time of examination the mine was being operated with sluice boxes suitable for the small head of water then available, and a drag-line scraper was being used to remove 15 or 20 feet of overburden consisting of gray sand.

The pay streak is a layer of black sand 3 feet or more thick, the richer part of which was mined through drifts said to have been made more than 60 years ago. Some of the mining timbers as well as an occasional huge log of drift wood are exposed by the present workings. Samples of the black sand remaining averaged about 3 percent of magnetite and 55 percent of chromite and ilmenite together. Gold and platinum alloy were being recovered by sluicing. A sample of the platinum alloy as determined by a spectrographic examination by George Steiger in the laboratory of the United States Geological Survey is composed of a relatively very large amount of platinum and smaller amounts of iridium and ruthenium. It contains in addition a possible trace of rhodium but no osmium or palladium.

Most of the black-sand tailings resulting from former operations at the Pioneer mine were washed down Cut Creek until they reached a ponded area near the sea known as the Lagoons, where they have formed a deposit several acres in extent. A sample from a hole 3 feet deep at one place contained 4 percent of magnetite and 60 percent of chromite and ilmenite. It is said that the tailings in the Lagoons contain unrecovered gold and platinum, and in July 1931 a machine designed to test the deposit for these metals was being installed. The result was not learned.

37/ Hornor, R.R., op. Cit., p. 12

Eagle

The Eagle mine, on Cut Creek north of the Pioneer mine, was idle at the time of visit. As described by Hornor 38/ it contains a bed of black sand 200 to 250 feet wide and several hundred feet long that is lenticular in cross section and 6 to 8 feet thick in the middle. This bed is composed of chromite, magnetite, ilmenite, and other heavy minerals, with a little gold and platinum. Except along Cut Creek, there is an overburden of 50 to 60 feet of fine-grained gray sand. Part of the deposit that has been worked, mainly by drifting, is said to have made a relatively large production, of which 5 to 10 percent of the value was in platinum and the remainder in gold.

According to a report made in 1927 by J.D. Mereen for the owners of the property a layer averaging 5 1/4 feet thick yields 50 percent of concentrate composed as follows:

	Percent
Chromite, containing 50 percent of Cr_2O_3	44.20
Magnetite	18.90
Ilmenite, containing 50 percent of TiO_2	15.00
Zirconium [Zircon?] containing 95 percent of $ZrSiO_4$	13.70
	91.80

In addition, the material is said to yield $3.50 in gold and $1 in platinum (reckoned at $100 an ounce) to the ton.

Owing to the depth of the overburden it is estimated that 17 tons of crude sand would have to be handled to obtain 1 ton of concentrate.

Chickamin

An open cut of the Chickamin mine, at an altitude of 60 feet on the east side of Brown Slough, exposes chiefly gray sand, with streaks of black sand and at the bottom a pebbly layer (fig. 16). The black-sand streaks range from 1 to 8 inches in thickness and aggregate perhaps 3 or 4 feet. The whole mass is rather compact and partly cemented by iron oxides and is regarded as offshore sediments. At the open cut a plant, which was idle at the time of visit, includes a steam shovel, sluices, shaking tables, and other equipment. The results of its operation were not learned.

A sample of the black sand contains about 85 percent of heavy minerals, of which 20 percent is magnetite and 65 percent chiefly chromite, with ilmenite and garnet. The remainder is quartz, undecomposed rock grains, and rusty-brown limonitic cement. This deposit is probably the same as one sampled by Hornor in July 1917 39/ and described as on the land of M.J. Mathews. Assays of Hornor's samples indicate from $1 to $1.55 a ton in

38/ Hornor, R.R., op. cit., pp. 18-21.
39/ Idem, p. 15.

gold and platinum. Samples are also reported by Hornor representing 12 other exposures around South Slough, of black-sand beds which range from 3 to 8 feet in thickness. The assays indicated that 8 of the samples were barren and that 4 contained gold and platinum worth 20 to 60 cents a ton. The samples, however, do not represent definite quantities of the deposits, and the results, as explained above, are merely qualitative.

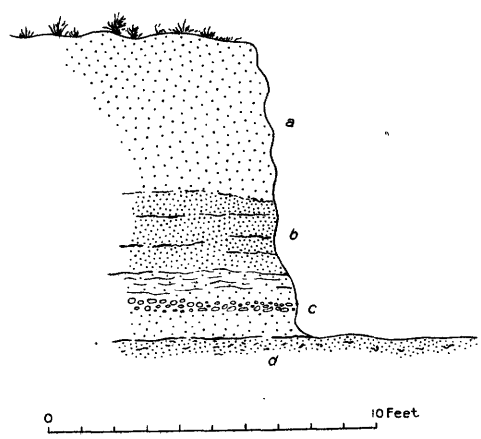

Figure 16.- Section of Pleistocene offshore beds at Chickamin mine, a, Light-gray marine sand; b, rusty gray marine sand with thin streaks of black sand; c, marine sand with pebbles, mottled with black and rusty spots; d, gray marine sand.

Iowa

Black-sand layers in offshore beds related to the Pioneer (170-foot) beach are explored by workings on the north branch of Fairy Creek, 2 miles east of Bandon and 1 1/4 miles south of the main highway. The stratigraphic section at this point includes a layer about 50 feet thick of sand and pebbles, above which is 50 feet more of gray to buff sand, which in turn is overlain by 30 or 40 feet of loose-textured wind-blown sand. Two streaks of very fine grained black sand 6 and 12 inches thick occur in the lower part of the gray marine sand at an altitude of about 120 feet. According to W. M. Briner, who was prospecting on the property, very fine particles of gold and platinum alloys occur in the black-sand layers, and the platinum alloy is commonly the more abundant of the two. A sample of the black sand collected by Mr. Briner contained about 23 percent of magnetite and 64 percent of ilmenite and chromite together.

Old mines north of Rogue River

At Otter Point and Hubbard Knob, respectively 3 and 4 miles north of the Rogue River, mine workings said to have been made several years ago by Chinese consist of two pits, each about 50 by 100 feet in area. The production is not known. At both places the deposit rests on a wave-eroded surface of shale and sandstone. Each pit exposes a layer of black sand and cobbles, about 1 foot thick, at an altitude of 30 feet, overlain by 30 or 40 feet of gray sand streaked with iron rust. Most of the gray sand appears to be wind-blown. The deposit is evidently the remnant of an ancient beach that has been largely cut away by the waves at existing sea level.