DESCRIPTION OF THE COOS BAY QUADRANGLE.

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TOPOGRAPHY.

TOPOGRAPHY OF THE PACIFIC COAST.

Mountain ranges and great valleys of the Pacific coast.

The portion of the United States bordering the Pacific Ocean is mountainous, containing three ranges, the Coast, Cascade, and Sierra Nevada. In California the Coast and the inlying range are separated by the Great Valley; farther north, by the valleys of the Willamette and Puget Sound. Between the heads of these great valleys is a complex group of uplands, the Klamath Mountains, in which the three ranges appear to join, and it is only upon geological grounds that their limits can be determined.

The Cascade Range is composed almost wholly of volcanic material and is thus distinguished from the Sierra Nevada, which is composed largely of metamorphosed sediments and old eruptives. Mount Shasta is usually regarded as the southern end of the Cascade Range, but in reality the range extends about 75 miles farther southeast and ends a short distance beyond Lassen Peak, which fills a depression between the northern end of the Sierra Nevada and the Coast Range.

Klamath Mountains.

The Klamath Mountains, although composed largely of old rocks like those of the Sierra Nevada, belong to the Coast Range. They extend from the western base of Mount Shasta to the ocean, and from near the fortieth parallel in California to the forty-third in Oregon, embracing the Salmon, Trinity, Scott, Siskiyou, and Rogue River mountains, and many other ridges and peaks known by local names only. Although a unit geologically, the Klamath Mountain mass appears to have many distinct parts, owing to the cross drainage of the Klamath and Rogue rivers, as well as that of the Trinity and Sacramento. North of the Klamath Mountains the Coast Range of Oregon lies between the Great Valley and the coast.

TOPOGRAPHY OF THE COOS BAY QUADRANGLE.

Location and area.—For convenience, the four-sided tract of country represented by any of the maps of the Geologic Atlas of the United States, is called a quadrangle. The Coos Bay quadrangle lies at the northern edge of the Klamath Mountains, between parallels 43° and 43° 30′ north latitude and meridian 124° west longitude and the Pacific Ocean, among the foothills at the western base of the Coast Range of Oregon. It embraces about 640 square miles.

Flat-topped hills, terraced slopes, and broad valleys.

General features.—A general view of the country from one of its elevations shows it to be a dissected platform in which the flat-topped hills are the remnants of what were originally more extensive plains. The streams have cut into the plain so extensively that from the valleys the country seems hilly. The hilltops, although flat, are rarely broad, and the slopes toward the valleys are steep. In some cases they are well terraced. The valleys of the principal streamways are wide and characterized by comparatively broad flood plains. The flat-topped hills, terraced slopes, and broad alluvial plains are all features which will be readily understood as results of geologic processes now at work when we consider the later stages of the geological history of the region.

Drainage.—The northern half of the quadrangle is drained by the Coos River and the southern half by the Coquille. Both of these streams have cut deep canyons in the Coast Range and take the water from its eastern crest. Crooked courses constitute one of the most striking features of the principal and subordinate streams. There seems to be no agreement in the stream courses except in meandering. The North Fork of the Coquille, rising only a few miles from the South Fork of the Coos and scarcely more than 25 miles from the ocean, flows south for over 25 miles to near Myrtle Point, where it joins the South Fork of the Coquille and turns seaward, having yet over 30 miles to travel to its mouth.

Valley of Coos River.

The Coos River Valley is remarkable for its fertile plains, which rise in places 15 feet above low-tide level and are devoted largely to dairying, the traffic for which is wholly by small steamers on the river. The tide ascends the South Fork to a point about a mile beyond the eastern limit of the quadrangle and ascends the North Fork or Millicoma River nearly to the junction of the East and West forks. The continuous flood plains do not extend upstream beyond the tide limit, to which point the river is navigable. Above this point the stream is shallow and flows in a rocky or pebbly bed in a narrow valley, presenting a strong contrast with its lower course. In both cases, however, the sides of the valley are steep and occasionally terraced. The course of the river is in places deeply curved, and this is due not to the swinging of the river in its present flood plain but to some earlier condition, which may appear in considering the origin of the topographic features of the region. In the southwest part of T. 25 S., R. 12 W., the character of the drainage changes and the river enters Coos Bay, which differs from the river especially in the greater extent of its tidal flats and in having tidal branches or sloughs. The bay itself may be considered in two parts, one extending southeast from North Bend, the other extending southwest. Of these the southeastern has the greater expanse of tidal flats and several sloughs; the other arm has but a small margin of tidal flats and one slough. This difference is due chiefly to the mode of development, the one arm of the bay being very much older than the other.

The Coquille River is ascended by the tide nearly to Myrtle Point, a distance of about 34 miles from the mouth, although only 15 miles in a direct line from the ocean. In the Coos River the tide ascends about 30 miles by the river and reaches a point 17 miles in a direct line from the beach. This difference between the two rivers is due to the greater crookedness in the course of the Coquille. In all its meanderings the Coquille follows the general course of the valley, except, notably, between Norway and the mouth of Glen Aiken Creek, where the river wanders in its own flood plain. Another excepted stretch occurs on the South Fork 4 miles south of Myrtle Point.

Valley of Coquille River.

From Riverton to the mouth of the Coquille the river is bordered most of the way by arable flood plains from one-fourth to nearly one-half mile wide. They are rarely swampy and are generally cultivated. Between Riverton and Norway these flood plains expand to a mile or a mile and a half in width. They are largely marshy and are covered with a dense growth of small trees and vines. Some of these marshes have been cleared and cultivated. Most of the remainder could be made valuable in the same manner, so as greatly to increase the productive agricultural land of the region. The Coquille is navigable for small steamers to the head of tide water. A short distance above that point the river becomes shallow, full of pebbly rapids, and occasionally rocky. The flood plains extend 5 miles up the river beyond the present limit of high tide, and mark a point to which the tide once ascended.

Relief.—As the streams are irregular in their courses, so the hills, which are carved out by them, are irregular in outline. The rainfall is heavy and the rocks are generally so soft that erosion would proceed rapidly but for the protective influence of the dense vegetation, which breaks the dash of the rain.

The highest point in the quadrangle is between the forks of Coos River, where the elevation reaches 1700 feet. The next highest point is on Sugarloaf Ridge, directly east of Myrtle Point. The most prominent upland in the quadrangle, on account of its mass, and the only one commonly called a mountain in that region, is Blue Mountain, which for nearly 3 miles has an elevation of 1500 feet. Near the southern border of the quadrangle is Bill Peak, rising to over 1500 feet within 8 miles of the coast. The tops of the highest hills and the crests of the highest ridges are generally somewhat flat, although rather narrow, and the slopes are usually steep. The arrangement of the hills is digitate and they closely approximate a general altitude, but this feature is much more prominent at an elevation of from 500 to 700 feet in the region between Coos Bay and the Coquille, where there is a broad tableland incised by various sloughs.

Elevated sea beaches.

This is the region, too, of elevated terraces or elevated beaches. They are well displayed about the mouth of Coos Bay and the hill of Seven Devils, especially upon its seaward slope. 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 1500 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. Terraces may be seen also at points on the road from South Slough to Bandon.

Coastal plain.

A well-marked coastal plain, $2\frac{1}{2}$ to 4 miles in width, borders the coast south of Fivemile Creek. Generally it terminates along the sea in a cliff, whereas to the landward it rises by occasional terraces (old sea beaches) to an altitude of several hundred feet before abutting against the low hills. The black auriferous sand, which has attracted so much attention along the Oregon coast, is found locally not only along the present beach but also along the elevated beaches.

The Seven Devils.

An old trail to the Randolph mines at the mouth of Whiskey Run followed the coast south from the mouth of Coos Bay. Travel to Cape Arago was easy on the first broad terrace of the elevated beaches, but below that point for 2 miles the coast is cut by numerous deep ravines on a steep slope, and the sea dashes against the high cliffs. The name of this rugged feature, the Seven Devils, arose from the difficulties it imposed upon the early traveler.

Dunes and sand spits.

From Coos Bay northward the coast is bordered by a waste of drifting sand, in places over 2 miles in width, which is thrown by the waves upon the beach and carried inland by the winds. The irregular hills, ridges, and dunes of sand usually have their largest diameters approximately parallel to the coast and frequently inclose lakes, like those west of North Slough, which appear to have no outlet to the sea save through the barrier of sand. A similar sand area, but one of much smaller size, extends north from the mouth of the Coquille for about 4 miles, with a maximum width of nearly a mile. The landward portion of this area, as well as some of that north of the Coos, is well covered with timber, showing that it assumed its present form long ago. Another sand stretch occurs along the coast near the mouth of Fourmile Creek, shutting in Davidson Lake.

Rock stacks.

Tupper Rock is an excellent example of a conspicuous rocky, stack-shaped ledge rising out of a level plain. It is composed of hard rocks and withstood the force of the erosive agents which carved away the softer surrounding rocks. Other rock stacks, somewhat less conspicuous, occur in the northern part of sec. 20, T. 28 S., R. 14 W., and on the western line of sec. 7, T. 29 S., R. 14 W. More pronounced examples occur farther south along the coast.

GEOLOGY.

The geological maps of this folio exhibit the distribution of eleven formations, of which nine are sedimentary and two igneous. In the legend the formations are arranged in the order of geological age, with the oldest at the base. The sedimentary rocks, beginning with the oldest, will be considered first, and then the igneous rocks.

SEDIMENTARY ROCKS.

CRETACEOUS PERIOD.

Chert.—The chert of this quadrangle, which is doubtfully assigned to the Cretaceous period, is compact, hard, and highly siliceous. It closely resembles some forms of flint and jasper, and has a wide range of color—from white and gray to yellow, green, and red. There are eleven outcrops of this rock which are shown on the map, some of them too small to be represented without exaggeration. They all lie in the southern portion of the quadrangle.

Radiolarian remains in the chert.

One of the most accessible areas is on Indian Creek, where the red and gray cherts are exposed. Although full of minute veins of quartz, the red chert contains a multitude of small round specks that clearly represent organisms, radiolaria, which lived in the water at the time the deposit was formed. Some of the ledges in this area are clearly but irregularly banded.

The small area in the NE. $\frac{1}{4}$ of sec. 3, T. 30 S., R. 12 W., contains dull-red chert in which the fossils are well preserved. To the naked eye the largest of these forms are scarcely visible, but with the aid of a small lens they appear as minute white spots, and when magnified in thin section their organic nature is evident. Similar areas of the rock occur in the neighborhood of Bill Peak, and in some of them the organic nature is evident, but in others the alteration is so great that the structure is obscured. A small area occurs at the China Creek bridge, and one also in the cliff west of Tupper Rock, too small to appear on the map. The material is reddish brown, veined with quartz and calcite, and contains numerous radiolaria.

Origin of the chert containing radiolaria.

The chert occurs only in small masses, showing that the conditions under which it formed must have been local and not general. The character of the contained fossils indicates that one of the peculiarities of the local conditions must have been the abundance of siliceous organisms. On Johnson Creek, in the Port Orford quadrangle, chert full of radiolarian remains is interstratified with fine sandstone composed almost wholly of volcanic material. The minute forms associated with volcanic deposits, both in lakes and in the sea, are most frequently highly siliceous. Among the lacustrine deposits of the great volcanic region of northern California and Oregon, diatomaceous earth composed almost wholly of silica is not uncommon. The marine equivalent of such deposits appears to be radiolarian chert.

Age of the chert.

Radiolaria are of little value in determining closely the geological age of the strata containing them. No other fossils are associated with them. As the sandstones and shales with which the chert appears to be interstratified are known in the Port Orford quadrangle to be of Cretaceous age, it is reasonable to regard a part of the chert as of the same age. In other cases, however, it is equally evident that the chert is of greater antiquity, for well-rounded pebbles of chert in which the radiolaria are distinct occur in the basal conglomerate of the Cretaceous.

Myrtle formation.—The Myrtle formation received its name from Myrtle Creek, Douglas County, in the Roseburg quadrangle, where it is well exposed and characterized by definite fossils. In the Coos Bay quadrangle the exposures, although much larger than those of the radiolarian chert, are not of great extent. The area south of Myrtle Point, which is the largest, occupies scarcely 6 square miles.

The most prominent rock in this formation is gray sandstone, moderately hard and in general so greatly fissured as to break into small pieces. It has evidently been much affected by pressure, for it is so crushed as to obliterate the bedding. It is frequently schistose, and within the quadrangle the attitude of bedding can rarely be determined. Fine conglomerates and shales also occur. The sandstone is well exposed in a ledge near the forks of the river in the southern part of sec. 22, T. 29 S., R. 12 W., and also at a few places by the river road around the hill of diabase in sec. 26. It is well exposed also near the southeast corner of sec. 28 in the same township, where it contains some fine conglomerate. Farther south thin beds of shale and sandstone are interstratified.

There is another small area, embracing about 3 square miles, southeast of Bill Peak. The peak itself is composed of much-fissured sandstone.

As to the age of this formation no conclusive evidence has been found. That it is older than the relatively soft, yellowish, unaltered fossiliferous sandstone appears to be evident, although the contact has not been found within the quadrangle. In the Port Orford quadrangle, which lies next southward, rocks which appear to belong to the same formation as those under consideration contain *Aucella piochii*, which is a characteristic Cretaceous fossil.

Age of the Myrtle formation.

Amphibole-schist.—Under this head are included certain crystalline rocks which are closely related in structure, mode of occurrence, and origin, although they differ widely in composition and general appearance. Their outcrops are usually prominent, standing out in conspicuous ledges, of which Tupper Rock, near Bandon, is one of the best examples.

Like the radiolarian chert, the schists have small outcrops and are confined to the southern third of the quadrangle. The largest area is scarcely 50 acres in extent, and the smallest contains less than that number of square feet. Toward the southeast corner of the quadrangle there are at least fourteen outcrops, and in the southwest corner an equal number, some of which are well exposed along the beach.

Distribution of amphibole-schist.

The most important varieties of these crystalline rocks found in the Coos Bay quadrangle are amphibolite, amphibole-schist, mica-schist, and chlorite-schist.

Amphibolite and amphibole-schist are characterized by an abundance of amphibole, which may be either blue or green. When the schistose structure is evident the rock is amphibole-schist; otherwise it is amphibolite. Amphibole-schist is more abundant, although amphibolite usually forms the larger exposures. There is no sharp distinction between them and they frequently occur in the same outcrop, as, for example, Tupper Rock. In portions of the mass the rock splits readily in one direction and is amphibole-schist, but in other parts it is amphibolite. The blue amphibole of Tupper Rock and the other similar crystalline rocks of the region is probably not all the same, but most of it appears to be of the variety known as glaucophane, so that the schist may be appropriately called *glaucophane-schist*.

Glaucophane-schist.

Besides glaucophane, the blue schists frequently contain other minerals, among which epidote, garnet, muscovite, zoisite, and albite are most common and important. Epidote that is usually of a faint yellowish color may be scattered rather regularly through the whole mass or arranged in bands alternating with the blue amphibole, producing epidote-glaucophane-schist. A finely crumpled epidote-glaucophane-schist occurs on Johnson Creek 3 miles southeast of Bandon, where it contains small quantities of other minerals also.

Garnets are rarely conspicuous. In some outcrops there are well-defined crystals, but more frequently the garnet appears as round, reddish to purplish grains. The so-called black sand, which in some places contains considerable gold is composed largely of garnets derived from these rocks. One of the best garnet localities in the Coos Bay quadrangle is in the small area one mile northeast of Bandon, but even there they are not abundant.

Muscovite-mica is a common constituent of the glaucophane-schists and sometimes becomes so abundant that the rock passes into regular mica-schist. Zoisite, although somewhat widely distributed, is rarely abundant, but feldspar, which is generally if not always albite, becomes important in places and forms many small veins. With quartz it occasionally forms light-colored bands alternating with those of glaucophane. The best observed examples of albite veins occur with greenish amphibole-schist near Crooked Creek, about 3¼ miles directly south of Bandon, while the alternating bands of albite and glaucophane occur near Mr. Peter Axes's, on Big Creek, just east of the quadrangle. Many of the amphibolites and amphibole-schists are characterized by green amphibole, which is almost as abundant as the blue. The blue and green amphiboles are generally not intermingled in the same rock. They appear to be in a measure mutually exclusive, and yet they occur abundantly in adjacent masses and are closely related in origin. One of the best examples of green amphibole-schist occurs about 3½ miles south of Myrtle Point, where the fibrous green amphibole is prominent and forms practically the whole mass. Another occurs 1 mile southeast of Bill Peak, where the green rock is an amphibolite rather than a schist.

Green amphibole-schist.

With the green amphibole is commonly found considerable chlorite, and it may become so abundant as to form the principal portion of the rock. As it contains alumina, one would expect it to be associated with glaucophone, but its most common association is with green amphibole, which is not aluminous. A fine example of chlorite-amphibole-schist occurs near the road up Big Creek three-fourths of a mile above Bridge. Chlorite occurs also in the greenish schist one mile northeast of Gravelford and on the spur above Weaklys, near the mouth of Elk Creek.

A green schist in which chlorite is so abundant as to become one of the most important constituents, occurs 4 miles southeast of Myrtle Point. Chlorite in small green scales is most conspicuous. The mass is penetrated by many bluish-green blade-like crystals of amphibole, and in thin section numerous small crystals of sphene may be seen. A short distance west of Tupper Rock, on the beach, is a chlorite-schist containing much muscovite and considerable quartz.

An exceptional form of rock which may be considered in this place occurs at Bandon, on the mud flat near the mouth of Fairy Creek. It is composed chiefly of moderately fine granular quartz, penetrated by a multitude of acicular and hair-like crystals of a blue and green pleochroic mineral that appears to be amphibole, so that the rock may be considered quartzite containing amphibole, or, more likely, a form of chert.

Quartzite containing amphibole.

The sporadic distribution of the amphibole and associated schists shows that their origin is not due to regional metamorphism, but is to be ascribed rather to some form of local metamorphism. Their intimate association with igneous rocks on the one hand and with sedimentary rocks on the other points emphatically to some form of contact metamorphism as their source. Further than this the evidence is less specific. The parent rock from which they were derived and the peculiar conditions under which the changes were effected are not clearly understood, although in a few cases there are suggestions as to the course of events. The associated sedimentary rocks of the Myrtle formation are not infrequently much affected by pressure, and shearing has rendered them fissile, but in such cases they clearly retain their fragmentary character, and among the new minerals formed no trace of blue amphibole was observed within the quadrangle. This is surprising when we remember that in the neighborhood of San Francisco blue amphibole occurs not only in slightly altered sandstones but also in rocks exhibiting intermediate stages of metamorphism and, finally, in those showing complete alteration to amphibole-schist. The apparent absence of a transition phase in the Coos Bay quadrangle is due possibly to lack of contact exposures. The only sedimentary rock of that region containing a suggestion of its alteration to amphibole-schist by the intruded rock is the chert, and in this case the evidence furnished by the small ledge on the flat near the mouth of Fairy Creek at Bandon is very meager.

Origin of the schists.

On the other hand, the contemporaneous or subsequent changes which occurred within the intruded masses are more clearly in the direction of producing the peculiar amphibole-schists. It is evident that the wide range in mineral composition of the metamorphic rocks must indicate either their derivation from rocks differing widely in chemical composition or else a mode of alteration that permits the transfer of much chemical matter.

Interval between Myrtle and Pulaski formations.—There was a long interval between the completion of the Myrtle formation and the beginning of Eocene deposition in the Pulaski formation. This interval is represented in other parts of Oregon and California by 5000 feet or more of marine sediments, known to geologists as the Chico formation. The absence of the Chico from the Coos Bay region indicates that some time after the Myrtle formation was laid down the Coos Bay region was raised above the sea and exposed to extensive erosion, but it again subsided beneath the ocean to receive the deposits of the Arago formation.

Late Cretaceous erosion.

The topmost portion of the Myrtle formation was removed during this epoch of erosion, and possibly also strata equivalent to a part of the Chico formation of California, for the beds now exposed in the Coos Bay quadrangle are those which should immediately underlie the Chico. Study of the structure of the region demonstrates that much has been washed away.

Within the interval between the Myrtle and the Arago epochs, probably in connection with the uplifting of the region, the molten igneous masses of older basalt and perhaps also of saxonite were intruded from below into and through the Myrtle formation. Along portions of their contacts with the sedimentary rocks the peculiar metamorphic rocks already described were in some way developed.

EOCENE PERIOD.

The rocks of the Eocene period in this region have been called the Arago formation, but in this quadrangle they are grouped into two formations: the Pulaski and the Coaledo. These formations occupy almost the whole of the Coos Bay region. They are composed generally of sandstones and shales, which are especially well exposed near the mouth of Coos Bay and at Cape Arago, where they contain *Cardita planicosta* and numerous other characteristic Eocene fossils. Heavy-bedded sandstones prevail in the eastern part of the area, toward the Coast Range, where the Eocene rocks have a wide distribution, and shales become abundantly interstratified with the sandstones in the western part near the coast. In the eastern part of the quadrangle the sandstones are penetrated and separated by dark, heavy intrusions of igneous rock, basalt, and the overlying sandstone nearby generally contains much sediment derived from it.

The strata among which the coal beds are found contain at a number of places the fossils which characterize the Arago formation, and it is therefore evident that the coal-bearing strata are of the same age as that formation and form part of it. For convenience and clearness, however, in describing the coal field it is necessary to consider the coal-bearing strata apart from the other portion of the Arago formation. For this purpose the coal-bearing strata will be designated the Coaledo formation because they are well exposed in the vicinity of Coaledo. The other portion of the Arago formation, which is older and lies beneath the Coaledo formation, will be designated the Pulaski, because it forms the hills about the head of Pulaski Creek and makes the Pulaski arch, which separates the Beaver Slough and the Coquille coal basins. The distribution of both the Pulaski and Coaledo formations is shown upon the Historical Geology sheet. Their combined area is that of the Arago formation.

Pulaski formation.—The Pulaski formation embraces all the Eocene strata of the Coos Bay quadrangle not included in the coal field. In the northern portion of the quadrangle, along the forks of the Coos River near the junction, are massive sandstones which have been quarried for building jetties. Toward the south the sandstones are less massive and locally shales become extensive, but the prevailing rock nearly everywhere within the area occupied by the Pulaski formation is rather soft, yellowish sandstone, contrasting strongly with the sandstone of the Myrtle formation in its color and freedom from the multitude of cracks which traverse the latter. Along the coast the beds of Pulaski sandstone are thinner and more frequently interstratified with thin beds of shale.

Traces of limestone have been found at a number of places within the Coos Bay quadrangle, but the masses are too small to be indicated upon the map. They are of scarcely any economic importance. On the East Fork of Kentuck Slough, in sec. 3, T. 25 S., R. 12 W., several bowlders of limestone were observed. The rock is composed almost wholly of microscopic fossils of many varieties. On Denton Creek in sec. 13, T. 25 S., R. 12 W., and also in sec. 27, T. 25 S., R. 12 W., one-fourth mile southwest of the forks of Coos River, there are similar rocks full of minute fossils, which, according to Dr. G. H. Girty, are calcareous algæ and foraminifera of marine origin. On Daniels Creek, near its mouth, concretions of limestone occur in Pulaski shales. No traces of fossils have been found at that point. The nodules are so abundant that some years ago they were burned to furnish the lime used in constructing a neighboring building. All of the outcrops of limestone are close to the diabase and in some cases contain lapilli, suggesting that the eruption of the igneous material was submarine.

Limestone composed of microscopic fossils indicating marine conditions.

At the close of the long interval of erosion following the deposition of the Myrtle formation the Pulaski epoch was initiated by a subsidence which brought in the sea from the northwest over the land, and the Coos Bay quadrangle and the adjacent region was completely submerged beneath the ocean. The shore from which the sediments were then derived lay only a short distance away to the south. The tilted strata of the Myrtle formation then formed the sea bottom in the Coos Bay region, and the Pulaski beds were laid down unconformably upon their upturned edges.

During the earlier portion of the Pulaski epoch there were but slight changes in the relative elevation of the land and sea, and they had but little effect upon the character of the material deposited, but near the end of that epoch there occurred in the eastern portion of the quadrangle eruptions of large masses of basalt. The eruptions were in some measure explosive, for fragmental volcanic material was thrown out and formed tuff beds near the border of the igneous rocks. The amount of this fragmental material is insignificant when compared with that of the sandstones of the Pulaski formation.

Volcanic tuff interbedded with the sediments.

During the Pulaski epoch there were doubtless many slight oscillations of the land and the sea floor, but the sea appears to have almost entirely covered the quadrangle throughout the whole of the epoch, for the fossils found are everywhere purely marine except at a place a few miles south of Myrtle Point, where some brackish and fresh-water shells have been discovered. After the volcanic eruptions, however, changes of sea level became frequent and led to the development of the Coaledo beds.

Coaledo formation.—The Coaledo formation, besides bearing coal, is found to have characteristics by which it may be distinguished from the Pulaski formation. One of its especially interesting features is the occurrence of fresh- or brackish-water fossils in immediate connection with the coal, while between the coals, and sometimes close to them, purely marine fossils are occasionally found. The fresh- or brackish-water fossils most frequently occur in the roofs of coal beds, as at Newport, Beaver Hill, and Riverton, but may be found at some distance from the coal in the associated strata. They evidently indicate variations in

Fresh- and brackish-water fossils associated with coal beds.

saltness of the estuary, variations probably due to irregular subsidence accompanied by sedimentation, which now inclosed lagoons of brackish water, and now admitted the sea. When the lagoons were long maintained they became fresh-water marshes in which the peaty vegetation accumulated to form beds of coal.

The Coaledo formation is characterized not only by the presence of coal, but also by the relatively large proportion of beds containing brackish-water fossils, which have been found in rocks outside of the coal field at only a few places, although they are common within it. In the Pulaski formation of the Coos Bay quadrangle mere traces of coal occur, and strata containing brackish-water fossils are rare.

Upon the Historical Geology sheet is shown the area of the coal field, i. e., the region over which the Coaledo formation is exposed. Besides coal the rocks of the Coaledo formation are varied sandstones and shales. In the lower portion sandstones predominate; then comes the portion where the workable coal beds occur, and the associated rocks consist of about equal thicknesses of sandstones and rather dark-colored shales. In the upper portion light-colored shales are most abundant and characteristic, none like them occurring outside of the coal field in the Coos Bay quadrangle. This fine, white shale of the Coaledo formation is well exposed by the roadside at a number of points between Coquille and Marshfield. When examined under a microscope it is found to contain numerous minute flakes of biotite-mica, with much clear, glassy material which looks like volcanic dust. A somewhat similar white shale occurs in the Empire formation on South Slough near the ferry, but under the microscope this is readily distinguished from the white shale of the Coaledo formation by means of the multitude of peculiar minute fossils which the Empire shale contains.

Development and structure of the coal field.—In its early stages of development the surface of the coal field was flat and the strata deposited were nearly level. The swamp in which the vegetation accumulated to form beds of coal extended more or less continuously over the whole field. It bordered upon the sea and was but little above the sea level. When the associated sandstones and shales containing fresh- or brackish-water shells were laid down the field was covered by fresh water or a brackish-water estuary, but when the sediments containing purely marine shells were deposited it was invaded by the open sea.

During the deposition of the Arago formation the whole area receiving such deposits was subsiding irregularly. Slight subsidences alternated with episodes of constant level, and accumulations of sand or shale succeeded those of peaty vegetation. In the coal field the movements were repeated many times, resulting in the alternate deposition of many beds of coal, sandstone, and shale over the same area. They were so slight that the strata were laid upon one another in parallel positions. Later, after the Arago epoch came to a close and when the Coast Range was formed, there came a change. The rocks, originally horizontal, were then compressed laterally and thrown into folds, i. e., into upward and downward flexures. On opposite sides of an upward flexure the strata incline away from each other, forming an anticline or arch, while on opposite sides of a downward flexure the strata incline toward each other, forming a syncline or basin. When such compression continues far enough folds may be pressed close, and the strata may be driven into a vertical position, or beyond the vertical into an overturned attitude. During such folding the rocks are generally broken and may be displaced or faulted along lines of fracture. The Arago formation has been both folded and faulted, but was most affected by the folding. The faulting, so far as known, is of minor importance, and the displacement is small.

Folding of the coal-bearing rocks.

Considering the folds of the coal-bearing rocks—the Coaledo formation—the coal field may be divided into six portions, four basins and two arches, all of which are marked upon the Structure Section sheet. The basins contain the coal; the arches bring to the surface the underlying strata of the Pulaski formation, which are generally without coal beds. The basins are the Newport, the Beaver Slough, the Coquille, and the South Slough. These are separated by the Westport and Pulaski arches. Upon the Structure Section sheet the attitude of the strata upon the surface is indicated by the strike and dip symbol, and beneath the surface by a series of structure sections. The dark color used to represent the lower portion of the Coaledo formation, where coal occurs, makes the coal basins conspicuous, in contrast with the anticlines between them. It is possible, however, that the Westport arch is made up of coal-bearing strata. Upon the west the South Slough Basin appears in sections B–B, C–C, and D–D. The Newport Basin appears in B–B only, and the Coquille in D–D only, while the Beaver Slough Basin appears in all the sections.

Four basins and two arches in the Coaledo beds.

The folding of the strata was doubtless accompanied by the raising of a large tract of sea bottom to make dry land of part if not the whole of the Coast Range of Oregon, and before the beginning of the next epoch (the Empire) the country was subjected to much erosion.

Along the coast for 2 miles east of Coos Bay light-house the Coaledo beds dip eastward at an angle of about 70°, and afford an excellent opportunity to measure their thickness. At a few points heavy sandstones occur, but generally the strata are comparatively thin beds of sandstone and shale. The total thickness of strata measured at this place is over 7000 feet, and there are probably several thousand feet of underlying strata exposed along the coast from the light-house to Cape Arago. Eastward from the light-house there is also a considerable thickness of strata which could not be accurately measured, so that the total thickness of the Arago beds must be at least 10,000 feet. The measured section includes foraminiferal and other shales (2200 feet) and the sandstones of Tunnel Point (850 feet), which are paleontologically distinguished from the Arago formation by Dr. Dall (Eighteenth Ann. Rept., Pt. II, 1898, pp. 340-343). The Tunnel Point sandstones and the foraminiferal shales are conformable with each other and are apparently conformable with the underlying Arago beds, with which they are herein combined on lithologic grounds. As far as known, these upper beds have a very limited distribution and occur only in the middle portion of the South Slough syncline.

Thickness of the Arago formation.

NEOCENE PERIOD.

Empire formation.—The Empire epoch was initiated by the general erosion which followed the uplift at the close of the Arago epoch. A narrow tract about South Slough and along the coast south from Seven Devils, however, was still submerged, and received deposits of sand and silt which contained numerous marine fossils characteristic of the Miocene. Coos Head is composed of massive sandstones belonging to this formation, and northeast of the mouth of South Slough, as far as Pigeon Point, there is a mass of darker, somewhat shaly, and highly fossiliferous sandstone containing concretions.

The Miocene strata upon the opposite sides of South Slough at its mouth incline gently toward each other, as if forming a syncline. In fact, these strata lie in the South Slough Basin, and it is probable that the South Slough syncline continued as an axis of down-folding after the close of the Arago epoch and its terminating upheaval. A white shale lies in the middle of the syncline and rests upon the sandstones and darker shales which form the lower portion of the Empire formation. This whitish shale appears to be closely related in its general appearance and composition to that which occurs at Mist, on the Nehalem River, in Oregon, and to the Monterey shale of California. Upon the bank of South Slough near the ferry the whitish shale contains a multitude of microscopic fossils. Shale of the same sort occurs by the road upon the grade above the west end of South Slough bridge, and the syncline in which these beds are contained evidently rises southward. Similar beds occur on the coast 3 miles south of Bandon. The whitish Miocene shale closely resembles that found in the Coaledo formation associated with the coal, but it may be readily distinguished by the fact that the latter does not contain microscopic fossils. The whole thickness of the Miocene in the Coos Bay region can scarcely be as much as 500 feet.

Miocene white shale similar to the Monterey shale of California.

The Empire formation rests unconformably upon the Arago, which had previously been folded and eroded. The unconformity may be seen on the shore a short distance west of Coos Head.

SURFICIAL ROCKS.

PLEISTOCENE PERIOD.

At the time the Empire beds were laid down along the coast the region of the Coast Range had been reduced by long-continued erosion to a lowland of very gentle relief, from which the fine sediments of the Empire formation were derived. This formation was afterwards bent and in part raised above sea level. In the Coast Range region the uplifting was greater than along the shore, and as the region rose by intervals the ocean cut terraces upon the western slope of the range at each halt, the terraces varying in breadth according to the duration of the pause and the hardness of the rocks covered. Although the movement was generally upward it was occasionally downward, submerging the wave-cut terraces to receive a thick deposit of marine sediments.

Coos conglomerate.—The Pleistocene deposits, which were formed mainly during the epoch of uprising, are almost wholly unconsolidated, but at the east side of the mouth of South Slough there is a conglomerate which is a remarkable exception. It has been named by Dr. Dall (Eighteenth Ann. Rept., Part II, 1898, p. 336) the Coos conglomerate, but is generally known as "Fossil Rock" on account of the large number of conspicuous fossil shells it contains. Some of the shells represent species still living in the adjacent waters, but the larger part were derived by erosion directly from the fossiliferous Empire beds, upon the eroded surface of which the Coos conglomerate rests unconformably. According to Dr. Dall this conglomerate is probably Pleistocene. Its thickness is not over 30 feet and it contains cross-bedding dipping to the southwest. Some of the fossiliferous fragments from the adjacent Empire beds are a foot in diameter. Most of the pebbles are of sandstone, but the small, smooth ones, which appear to have traveled a long distance, are of igneous rocks and chert, like those associated with the Myrtle formation. This Coos conglomerate is completely lithified, so that it is as ancient in appearance as the Miocene and presents a strong contrast to all the unlithified Pleistocene deposits of that region.

A consolidated conglomerate.

The exposed extent of the Coos conglomerate is very limited, covering less than an acre, and is therefore not represented on the map. At one time it had a much more extensive distribution along the coast. Much of it may have been removed by erosion, for after its deposition there was an upward movement of the land which raised it at least 200 feet above its present level and exposed the Coos conglomerate to igneous erosion. It has since been covered by over 20 feet of marine sands and gravels.

Marine sand.—The unconsolidated Pleistocene deposits are almost wholly sand, although local accumulations of pebbles have been observed which look much younger than the Coos conglomerate. The highest deposit of this sort noted is upon the wave-cut terrace about the summit of Bill Peak, at an elevation of 1500 feet. The neighboring hilltops are generally flattish, and many of the slopes, where not abrupt, have a covering of sand ranging in thickness from a few feet to over 100 feet. As would be expected, the thickest deposits are near sea level. At Empire is a prominent bluff, 100 feet in height, of clearly stratified sand of this epoch, and similar deposits occur in South Slough near the bridge. At both of these points the base of the deposit lies below sea level. The sand is white in places, as on the road at the head of Big Creek and also upon a branch of Bill Nye Slough near its mouth.

Pleistocene marine sand 1500 feet above sea level.

The largest mass of this deposit in the Coos Bay quadrangle occurs upon the coastal plain stretching along the coast southward from Seven Devils. This plain becomes a prominent feature south of Threemile Creek. In the vicinity of Bandon it is 4 miles in width, and rises to over 200 feet above sea level along its eastern border, where it terminates in a series of more or less well-defined terraces which mark ancient coast lines. Sections of the Pleistocene sands and gravels of this plain are well exposed in some of the black sand mines and ravines to a depth of nearly 100 feet. This is the only area of "Pleistocene marine sands" represented on the map, partly because it is better defined than any of the other areas, but largely also for the reason that to represent the areas about South Slough and Coos Bay would in a measure obscure the general features of the coal field, which are of much greater importance.

Canyon erosion.—The evidence of uplift after the close of the Empire epoch (Miocene) is found not only in the elevated beaches but also in the canyons carved in the land by the streams. As the land was raised the streams acquired greater slope to the sea, and consequently greater power to carry away sediment and deepen their valleys. The Coos and Coquille rivers and their tributaries then cut deep valleys, with steep slopes that extend far below the level not only of their present flood plains but of the sea. This feature was discovered by borings made near the edge of the flood plains at Newport and Kentuck Slough.

Fig. 1 illustrates the borings made a few years ago by Mr. Campbell while prospecting for coal below the Newport vein near Newport. The boring was started in sandstone at the foot of a steep slope near the edge of the marsh. As reported by Mr. Campbell, it passed through about 20 feet of sandstone and then struck the marsh deposits,

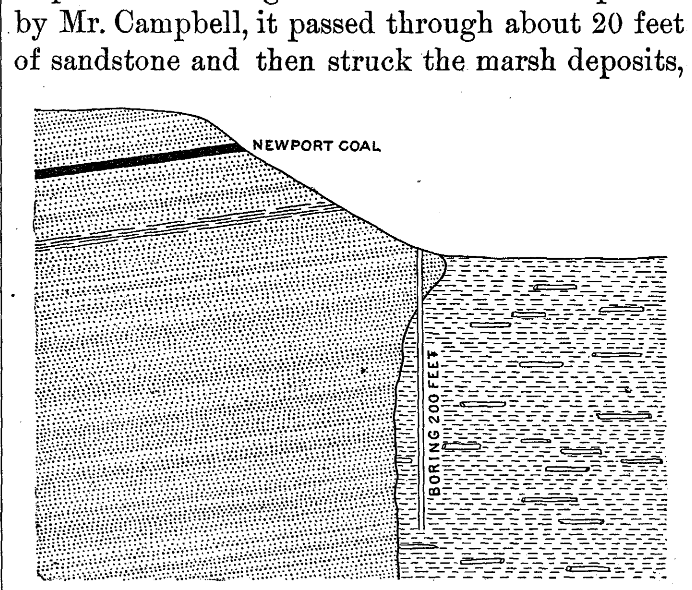

FIG. 1.—Section of bluff and marsh near Newport (Libby) mine, showing buried cliff revealed by boring.

which it penetrated to a depth of 200 feet without reaching solid rock. The deposit contains logs in the mud, which is so soft that the boring could not be kept open and had to be abandoned. The outline of the valley below the surface of the flood plain, as indicated in the figure, must be a cliff.

From evidence which is not displayed in the Coos Bay region but is abundant on the slopes of the Sierra Nevada in California, the epoch of canyon cutting belonged to the earlier portion of the Pleistocene, lately called by Professor Le Conte the Sierran. It preceded the Glacial epoch. The large glaciers, which sculptured more or less deeply the upper valleys of the Cascade Range, the Sierra Nevada, and the Klamath Mountains, did not reach the Coos Bay region, and the streams there continued their activity through the Glacial epoch.

Canyon cutting is of Sierran age.

River terraces.—The rise of the land recorded in the elevated beaches also affected the rivers. Their courses were extended in the valleys which they had carved out during their period of previous elevation. They found the valleys to some extent filled by marine deposits which had accumulated during submergence. This material was worked over by the streams and augmented by the large amount of loose marine sediments spread over the surface during the submergence, which at first overloaded the streams. However, they soon gained control and swept their narrow valleys, leaving only a few terraces here and there in protected places to mark their original gorged condition.

The best-marked terraces of the Coquille are those on which the town of Myrtle Point is situated. They are near the junction of the North and South forks of the Coquille. The river at that place enters a narrow gap through a sandstone ridge. Farther downstream terraces occur in protected places near the mouths of tributaries and rise occasionally to a height of over 200 feet. The higher terraces appear to be cut in sandstone and capped by a comparatively thin layer of sand and gravel.

On the Coos River the river terraces are in general lower. At about 25 feet above sea there is one well developed near the forks of the river, as well as others at many points along the east side of the bay between the mouth of the river and Jordan Point.

Some years ago the Harrison brothers discovered the tusk of a mastodon in the river bank along the North Fork of the Coquille about 1¼ miles east of Myrtle Point. The bone, although not waterworn, was found close to the stream about 5 feet above low water, resting on a terrace of sandstones and shales and covered by a thin layer of alluvium. A fragment of this tusk was examined by F. A. Lucas, of the National Museum, who reports it to contain bands of enamel which are characteristic of a mastodon that lived probably during the Pliocene. If the tusk had not been transported, it would indicate that the canyon may have been cut as early as the Pliocene.

Tusk of mastodon in river bank.

Alluvium.—This formation includes the material deposited by the larger streams along their borders and forming their present flood plains. It is generally fine silt and is deposited by the highest floods. When the plains are sufficiently dry to be arable the soil is found to be very fertile. The fertility is renewed with every flood. The same material is carried by Coos River into the bay and its many slough branches, where it forms mud flats. The tidal motion of the water is so gentle as not to remove it, excepting in the channels, so that the sloughs and the bay are gradually filling up. On approaching the mouth of the bay, where the tidal motions are stronger and the force of the waves is felt more fully, the fine material is removed and carried out to sea, leaving the flats and beaches composed of sand. At this point the alluvium merges into the dune sand which results from the combined action of the sea and the winds. The sand carried out by the water of the bay, joined with that thrown up by the waves of the sea and drifting along the coast, makes the bar at the mouth of the bay which is such an obstruction to navigation.

Sand dunes.—The sea shore is one of nature's greatest mills for grinding rocks to furnish the sediments spread over the sea floor. The waves are unceasingly pounding the shore and knocking the rocks against one another, breaking them to pieces, and if this action is continued long enough the fragments are ground to sand and mud. The sand is in some cases thrown upon the beach and under favorable circumstances is gradually carried inland by the strong winds, forming irregular hills and ridges called dunes. The drifting sand destroys vegetation, and the dunes are barren wastes so long as the moving sand prevents vegetation from gaining a foothold. However, the plants soon take root and hold the sand in places, reclaiming the dune tracts. The largest dune area is along the shore north of Coos Bay, where the dune belt has a width of about 2 miles. The landward portion of the belt is partly covered with trees. There are numerous ridges parallel to the coast and numerous lakes inclosed behind them by bars thrown up by the wind.

Sand dunes occur along the coast north of the mouth of the Coquille and about the mouth of Fourmile Creek, and there is evidence that sand dunes of long ago, now covered with vegetation and in places thickly forested, extend inland in some cases over a mile.

IGNEOUS ROCKS.

In the Coos Bay quadrangle igneous rocks are much less abundant than sedimentary rocks, and are of two types, serpentine and basalt.

Serpentine.—Only one small mass of serpentine was observed in the quadrangle, and that occurs by the road one-fourth mile southeast of Gravelford. It has the mesh structure characteristic of serpentine derived from olivine, which once formed by far the greater part of the rock. Some of the serpentine has the fibrous structure of bastite, like that derived from enstatite, so that the original rock was apparently an olivine-enstatite rock or saxonite.

South and southeast of this area serpentine occurs in large masses throughout the Klamath Mountains. The Gravelford outcrop is the most northern exposure of serpentine known in the Coast Range of Oregon. It is only about 200 feet in diameter and is surrounded by sandstone of the Pulaski formation, with no trace of metamorphic rocks upon its borders. It is most likely, therefore, that it was intruded before the surrounding rocks were deposited. It appears to be an irregular hill projecting up through the Eocene beds and exposed by erosion.

Basalt.—Along the eastern portion of the quadrangle, in range 12, extending from the head of Kentuck Slough to the Middle Fork of the Coquille, there are four igneous masses which are generally basaltic in character. They are all composed essentially of plagioclase feldspar (anorthite or labradorite) and augite, with more or less olivine and magnetite, and differ chiefly in crystallization and structure.

North of Coos River are a half dozen apparently separate outcrops, which are in all probability connected beneath the adjacent sandstone. The basalt is well exposed about the head of Kentuck and Willanch sloughs and along Coos River below the forks, but the intermediate divides are capped by sandstone belonging to the Pulaski formation. Where unaltered the rock is in many places rich in olivine and pyroxene, but upon the surface it is generally weathered, the olivine being replaced by serpentine, oxide of iron, and carbonate of lime, and the augite chiefly by chlorite.

In places the basalt is rather coarse grained. The grains of feldspar have crystallographic boundaries and the augite occupies the irregular spaces between them, giving rise to the ophitic structure which characterizes diabase, but generally the structure of the rock when wholly crystalline is granulitic. The largest grains are olivine, sometimes in well-defined crystals, surrounded by many small grains of augite and small lath-shaped crystals of feldspar. Generally the rock is holocrystalline, but in places some of the matter is amorphous and the rock has the appearance of a lava which flowed out upon the surface. This view is supported by the fact that the basalt is not infrequently amygdaloidal and is associated with fragmental volcanic rocks, tuff, due to explosive eruptions upon the surface. The fragmental material may be regularly stratified and interbedded in the sandstones of the Arago formation. Strata of this character occur at Jordan Point and in the road a short distance east of Glasgow, where they are within the Coaledo beds of the coal field. This is the only place in which igneous material was seen in the coal field. Where the relation of the Pulaski formation and the basalt are best exposed the sheets of basalt either lie conformably between the beds of Pulaski sandstone or break through them. It is evident from these facts that the eruption of the basalt occurred during the Pulaski epoch and before the deposition of the coal beds in the Coos Bay region. The igneous material of the Glasgow locality may possibly indicate a later eruption at that place, although the sediments may have been derived from such material farther east.

Amygdaloidal lava and tuff.

Age of the eruption.

In the region immediately north of Coos River the basalt is chiefly exposed in the valleys, while the adjacent hills are made of the overlying sandstone. In the Blue Mountain, however, the basalt occurs at a greater altitude and forms a prominent elevation, from which the overlying sandstone has been removed. The basalt is in all respects like that in the masses farther north.

The third large area of basalt lies southeast of Coquille, forming the prominent hills about the head of Glen Aiken Creek. The rock is generally of the normal type, but occasionally it is coarse grained, with a structure somewhat like that of granite, and is especially rich in olivine and augite. This, however, is only a local variation from the typical rock. It was seen best developed on the North Fork of Coquille River just below the bridge near Lee, where the mass of basalt is bordered by tuff.

The fourth large area is about Sugarloaf, a few miles east of Myrtle Point. Along the Middle Fork of the Coquille the relation of the basalt to the sandstones is well exposed. In some places it lies conformably between the beds of sandstone and at others it breaks through them. A number of small outcrops occur along the coast south of Bandon, especially near the mouth of Crooked Creek. In the valley of Twomile Creek there are a few areas of considerable size. The rocks are basaltic, but more highly altered than those already noted, and are associated with the Myrtle formation. They are probably of greater age than those found in the Pulaski formation and are the product of eruptions occurring at the close of the Cretaceous. In some of these altered rocks the feldspar is largely oligoclase, and such varieties should probably be separated from the rocks in which the feldspar is nearer the basic end of the series. One of these, 2 miles northwest of Bill Peak, is quite rich in ilmenite partly altered to leucoxene.

ECONOMIC GEOLOGY.

COAL.

The Coos Bay coal field is the only productive field yet discovered in Oregon. It is described in greater detail than is here possible in a paper entitled "The Coos Bay Coal Field," in the Nineteenth Annual Report of the Geological Survey, Part III.

Newport Basin.—The Newport Basin is named from its principal mine, the Newport, at Libby. Its length north and south, from Yokam Hill to the neighborhood of Marshfield, is about 3 miles. Excepting the trace of coal at North Bend, no coal has been found north of the ravine containing the Marshfield waterworks, although it is probable that the Newport Basin extends somewhat farther in that direction. The average breadth of the basin is about a mile, and it occupies the greater part of secs. 4 and 9, T. 26 S., R. 13 W., as well as sec. 33, T. 25 S., R. 13 W., besides small portions of several adjoining sections, so that the total area of the coal basin is nearly 3 square miles.

The Newport Basin is well defined, and in it the outcrop of coal has been traced more carefully than in any other portion of the field. It is the most conveniently situated with reference to coal shipment of all the productive portions of the coal field, and the attitude of the strata is such as greatly to facilitate mining. The basin is shallow, with gentle dips on both sides. It lies in a ridge so high above local drainage that the mine not only drains itself but the coal is readily brought out by gravity. Three mines have been worked in this basin, but only one, the Newport, is now in operation. The Eastport mine was closed some years ago. The most complete section of the strata involved in the Newport Basin is furnished by the borings made at Libby in prospecting for coal near the mouth of the Newport mine. One of the borings penetrated 800 feet. The section revealed, together with that afforded by the exposures near the mine, is shown in fig. 34 on the Coal Section sheet.

The Newport Basin has only one bed of coal that is extensively worked. The bed is generally known throughout the region as the Newport bed. It contains about 6 feet of coal, in three benches, yielding 5 feet of workable coal.

The Newport bed.

Fig. 2 illustrates a section of the Newport bed in the Newport mine. The roof is generally sandstone but locally shale, and requires very

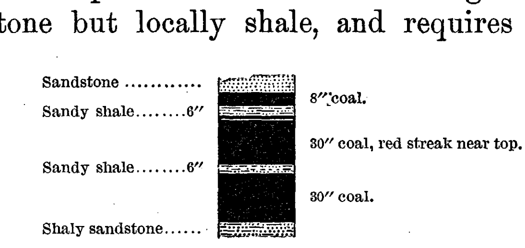

FIG. 2.—Section of Newport coal bed at Newport mine.

little timbering. Where shale occurs in the roof it is often full of brackish-water fossils. The top bench is usually left with the upper parting to form the roof. It occasionally contains small veins of pitch coal which intersect the other coals. The middle bench within a few inches of its top contains a red streak that is characteristic of the Newport bed, and is used by some as a means of identifying the Newport bed in various portions of the coal field. The bottom bench is regarded as the best coal at Newport, although it contains a little bony coal at the base. The different benches vary somewhat in thickness, but the triple arrangement extends throughout the Newport Basin, and even a considerable distance beyond, for it is possible to recognize the Newport bed over a wider area than any other one in the Coos Bay coal field, and in working out the structure of the field it is found to be of much importance.

The only coal bed of considerable size found in the Newport Basin as far north as the waterworks west of Marshfield is the one close to the pipe line where it descends the rocky bluff about a quarter of a mile from the reservoir. It has been recently prospected again by James Flanagan, and a section of it is shown in fig. 3. This coal is supposed

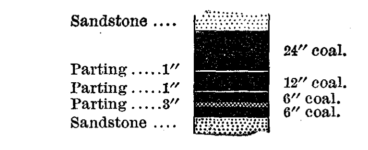

FIG. 3.—Section of coal near conduit of Marshfield waterworks.

to overlie the Newport coal and to have been dropped by a fault in the strata between the reservoir and the South Marshfield mine.

The outcrop of the coal about the northern end of the Newport Basin, especially upon the slope of Pony Slough, has not been traced so continuously as around the southern end and eastern side of the basin. North of the Eastport mine the Newport bed outcrops at the head of Galloway Gulch and swings around to the South Marshfield

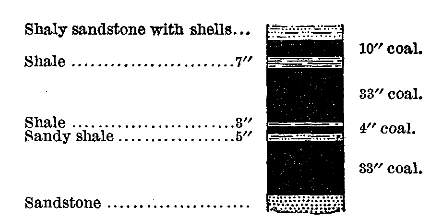

FIG. 4.—Section of Newport coal at South Marshfield mine.

mine, which is at an elevation of about 200 feet above tide and scarcely a mile from Marshfield. The mine was operated for some time to supply local demand. Fig. 4 shows the section of the Newport bed at that point.

Beaver Slough Basin.—The Beaver Slough coal basin takes its name from Beaver Slough, which lies near the middle of the most important portion of the basin. The basin has a length of over 20 miles, extending from the neighborhood of Riverton northeast between Isthmus and Catching sloughs to the northern limit of Coos Bay. Its widest part is in the Coquille Valley, where it is about 5 miles across. To the north it narrows as it approaches Coos Bay. A short distance beyond Glasgow it joins the South Slough Basin. Its position, shape and relation to the Newport Basin can be best seen upon the Economic Geology sheet.

Beaver Slough Basin, although many times as large as the Newport Basin and containing much more coal, has not yet yielded so great an output, for the reason that it is not so conveniently located for economical mining. The basin is deep, extending far below sea level, so that the removal of the coal to the surface, as well as the drainage and ventilation of the mine, is in general considerably more expensive than at Newport. Many mines have been started in this basin. The Timon and Liberty (Ferrey) mines at Riverton, and the Beaver Hill and several others farther northeast, are yet active, while the Glasgow, Southport, Henryville, and Utter mines are among those which have ceased operations. Only the lower portion of the Coaledo formation contains coal beds worthy of consideration. These crop out close to the border of the basin, or farther within the basin where brought to the surface by an upward bend of the strata. The coal-bearing series of the Beaver Slough Basin is nearly 600 feet in thickness and contains about six beds of coal. One of the best sections occurs in sec. 9, T. 27 S., R. 13 W., and is illustrated in fig. 8 of the Coal Section sheet. The coal beds are shown at the side of the principal section on an enlarged scale. The position, association, composition, structure, and size of the lowest coal bed of this section tend to show that it is the Newport bed. If so, the bed of coal mined at Beaver Hill and Beaverton is the same as that mined at Newport. The section measured in that region is shown in fig. 9. At this point a coal bed of considerable size appears beneath the Newport. The Newport bed has not yet been traced with certainty much farther southwest than Beaverton, nor farther northeast than the vicinity of Henryville. A coal bed resembling it to a considerable extent, as illustrated in fig. 14, occurs near the western edge of sec. 19, T. 27 S., R. 13 W. The coal mined at Riverton is called the Timon bed and has the

The Newport bed at Beaverton.

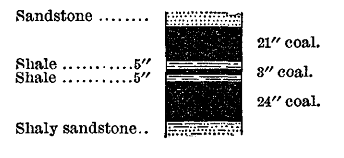

FIG. 5.—Section of Timon coal in Timon's mine, Riverton.

section shown in fig. 5. It is also shown as the second coal bed from the top in fig. 10. Both the Timon and the Liberty (Ferrey) mines are operating upon this bed.

The structure, size, and general relations of the Urquhart coal at Riverton (fig. 6) suggest that it corresponds to the Newport coal mined at Beaverton, but of this correlation there is as yet no completely satisfactory evidence. This is especially true since the reported discovery by J. H. Timon of promising coal west of Lamprey Creek.

Newport bed possibly at Riverton.

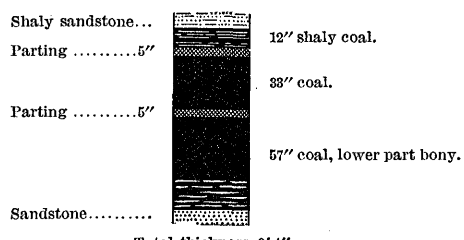

FIG. 6.—Section of Urquhart coal at Riverton.

The Beaver Slough Basin joins the South Slough Basin a short distance south of Riverton, where the coals swing around and strike northwest, as shown on the Structure Section sheet. A columnar section of the coals and associated rocks on Fat Elk Creek is shown in fig. 13, while that of the old Utter mines on a branch of Beaver Creek is shown in fig. 15, and that of the Glasgow region in fig. 11, on the Coal Section sheet.

Many prospects have been opened in the Beaver Slough Basin and some of the sections exposed are given in figs. 16 to 33. Individual beds can not be traced for any considerable distance. They change rather rapidly, and generally near the eastern borders of the basin contain much sediment. The best coal of this basin is near the western side, especially in the Beaverton and Beaver Hill region, where, all things considered, the outlook appears more promising for successful mining than in any other portion of the basin, excepting, perhaps, Riverton, where the coals are of smaller size.

On December 16, 1900, Beaverton was practically closed, but development continued at Beaver Hill under the direction of W. S. Chandler. Since the report on the Coos Bay coal field was published (Nineteenth Ann. Rept., Part III, 1899, p. 333), the openings northeast of Caulfield Marsh have been extended. A slope is down 400 feet from the adit, with gangways at 340 feet, and the mine will evidently soon be in condition to yield a good output.

Mr. Chandler reports that north of Beaver Hill, in sec. 26, T. 26 S., R. 13 W., a drill hole was sunk 550 feet, showing a disturbed condition of the rocks and no coal. The Southport coal was opened at several promising points in sec. 22, and if the coal is found where drilling was going on, as is expected, this portion of the coal field will be opened up.

Near Coos City, W. A. Maxwell was sinking a prospecting shaft, which was down about 250 feet, and it was expected that the Henryville coals would be reached.

A promising prospect has been recently opened along the eastern border of the Beaver Slough Basin near the mouth of Coos River, in sec. 4, T. 26 S., R. 12 W. Three beds are exposed, but the middle one is of most importance. It is known as the Lillian and has the section shown in fig. 7. Coal from this mine is well spoken of by local users in Marshfield. It is supposed to be the same coal as that at Nortons, which cokes.

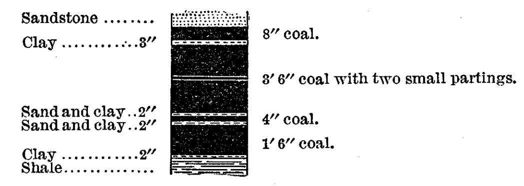

FIG. 7.—Section of Lillian coal (sec. 4, T. 26 S., R. 12 W.) 2 miles southeast of mouth of Coos River.

The following analyses show the composition of the coal in the three benches. The analyses were made by Dr. W. F. Hillebrand, who reports as follows concerning them:

When heated in the usual manner for the determination of fixed and volatile combustible matter—that is, by applying suddenly the full heat of a burner—it became manifest at once that the results, especially in the case of 5329, could not be at all exact, because of the ejection of much undecomposed coal by the force of the escaping gases. In order to correct for this error, separate ash determinations were made in such a manner as to preclude any mechanical loss, and with the data thus obtained, were calculated the values for volatile and fixed combustible matter given under the heading for recalculated values.

Results actually obtained by analyses.

	No. 5327. (Top.)	*No. 5328. (Middle.)*	*No. 5329. (Bottom.)*
Moisture in vacuo over sulphuric acid	7.84	8.34	8.82
Volatile combustible........	43.64	43.08	46.11
Fixed carbon........................	41.47	37.58	38.22
Ash	7.05	11.00	6.85
	100.00	100.00	100.00
Sulphur............................	.54	.44	.42

Coke sandy, hardly sintered at all. Ash buff colored.

Analyses recalculated on basis of separate ash determinations.

	No. 5327.	*No. 5328.*	*No. 5329.*
Moisture	7.84	8.34	8.82
Volatile combustible................	42.40	41.23	39.93
Fixed carbon........................	42.53	39.01	43.46
Ash	7.23	11.42	7.79
	100.00	100.00	100.00

The application of corrections made as above seems theoretically justifiable for all coals which give off quantities of sparks on sudden heating—a sure indication of mechanical loss—for in the analyst's opinion the results for volatile combustible matter and fixed carbon thus obtained will be more strictly comparable with those for non-sparking coals than if they were determined directly by slow application of heat, as is sometimes done. It is well known that in practically all coals the values for these two components differ largely according as they are determined by rapid or by slow heating.

South Slough Basin.—The South Slough Basin has the South Slough for its central topographic feature, and lies to the west of the Newport and Beaver Slough basins, from which it is separated by the Westport arch. Except at the southern end, where it joins the Beaver Slough Basin, the limits of the South Slough drainage mark approximately the outline of the basin. The coal exposed at several localities near Empire, as well as farther southwest in secs. 8, 17, and 18, T. 26 S., R. 13 W., and sec. 1, T. 27 S., R. 14 W., belongs to the eastern arm of the basin. In sec. 2 the coals turn and extend west, then northwest, cropping out at several points, and reach the coast near the mouth of Big Creek. This basin extends south to Hatchet Slough, where it swings across the end of the Westport arch and joins Beaver Slough Basin.

In sec. 2, T. 27 S., R. 14 W., near South Slough, the principal coal is evidently the Newport bed. It is well developed and crops out with gentle dip under conditions favorable for mining. In the surrounding territory, however, the rocks are highly tilted, and it is probable that the area promising the most favorable conditions for mining is less than a square mile in extent. The same coal occurs farther south, and in that part of the basin there is a larger bed lower in the section, which has been traced northwest and southeast for about 6 miles. Part of the coal in this latter bed is of good quality, but, like the associated strata, it is generally soft and inclined at a high angle. At first this coal was regarded as the probable equivalent of the Newport coal, but later investigations tend to show that it lies far below the Newport bed. These two large beds occur nearest together in sec. 10, T. 27 S., R. 14 W., where their outcrops are about a mile apart and each has a dip of 80° E. On this basis, if the beds are not faulted, about 5000 feet of strata lie between them. If it is so far below the Newport bed and widely developed, it may underlie the whole of the Westport arch. It has not been definitely recognized in any other part of the coal field beyond that already noted, although it is probable that it may yet be positively identified farther south. This basin was extensively prospected in 1897, and a number of the sections then exposed are shown in figs. 35 to 44.

Newport bed in South Slough Basin.

Coquille Basin.—The Coquille Basin embraces the coal beds extending from the town of Coquille southward past Harlocker Hill to the upper portion of Hall Creek. The complete outline of this basin is shown on the Economic Geology sheet.

The coals of the Coquille Basin have been prospected at Coquille and Harlocker Hill near the river, but they have not yet proved of sufficient value to be worked. Sections of the coals and their associated rocks in the basin at Coquille and Harlocker Hill are shown in figs. 45 and 46.

"*Pitch coal.*"—In the mine at Newport and in the Old Ferrey mine at Riverton, a dark-brown coaly substance, commonly known in that region as "pitch coal," occurs associated with the lignite. It is brittle, and readily ignites from a match, yielding an odor like that of burning asphalt. At Newport, according to P. Hennessey, the superintendent of the mine, it forms vertical seams and sometimes passes directly through portions of the coal bed. In chemical composition as well as in its other properties it appears to be asphalt rather than coal. Investigations tend to show that it has been derived from petroleum. While the presence of "pitch coal" in Oregon offers interesting suggestions with reference to the occurrence of petroleum, too little is known of the facts to warrant any predictions.

BUILDING STONE.

Sandstone.—Sandstone occurs in both the Myrtle and Pulaski formations. In the former it is generally too much fissured to furnish stones of sufficient size for building, and in the latter the rock is generally too soft to stand great pressure and resist weathering. On the forks of Coos River quarries have been opened to obtain stones for making the jetties at the mouth of the bay. The rock is a micaceous sandstone, and when fresh is bluish in color, but weathers yellowish owing to the oxidation of its contained iron. No buildings have been made of this stone so far as known. From one of the quarries on the North Fork of Coos River much stone has been taken for the jetties, although it is far less durable material than is desired for such purpose. The beds are thick, but easily quarried, and very conveniently located for transportation on the river. A large amount of such stone may be obtained in that locality.

On the Coquille the sandstone of the Pulaski formation is not quarried, but some years ago one of the sandstones in the Coaledo formation 2 miles southwest of Riverton was quarried for building the Light House at Bandon. The stone has not proved to be sufficiently durable.

Basalt.—A far more durable stone is the basalt, although it is much harder to quarry. It is one of the best stones that could be obtained for building the jetties, but on account of its hardness, toughness, and lack of good planes of separation it would be much more expensive to quarry than the sandstone so commonly used in the jetties. Basalt occurs upon both banks of Coos River a short distance below the forks, where it could be conveniently obtained for any purpose. Although basalt is abundant at many points in the quadrangle, the locality on Coos River is the only one conveniently situated for quarrying.

Amphibole-schist.—Amphibole-schist occurs at a number of points in the southern part of the quadrangle, but Bandon is the only point where it is quarried for any purpose. Tupper Rock, at Bandon, is a prominent ledge which once reached nearly 100 feet above the general level of the plain on which the upper part of Bandon is located. It was an attractive feature, affording a fine outlook along the coast, but now it has been largely blasted away and removed to build the jetties at the mouth of the Coquille. Although the loss of this prominent ledge is to be greatly deplored, no better rock for the jetties could be found.

CLAY.

Clay is more or less abundant at many points in the alluvium, but appears to be used only at Myrtle Point, where it is employed in the manufacture of tiles and brick.

GOLD.

The Pleistocene marine deposits at a number of points contain auriferous black sand and have been washed for gold. Wave action upon a beach results in separating the heavier and lighter materials when there is a wide range in specific gravities, and the gold, when present, is found with the magnetite and other heavy black minerals. The output of gold in Oregon has steadily increased from year to year, until in 1897 it reached $1,354,593.43. Although the greater part of this was obtained among the Blue Mountains of eastern Oregon, nearly one-fifth of the whole amount was obtained chiefly in placer mines among the Klamath Mountains, in the southwestern portion of the State.

Coos County is not an important factor in this production, and yet there is more or less active gold mining carried on all the time in the Pleistocene "black sands" within the Coos Bay quadrangle. These mines are confined to the present beach and the ancient beaches raised only a few hundred feet above the present ocean level. Many years ago the mines were of much importance, especially those near the mouth of Whiskey Run, but the gold is so fine that it is saved only with great difficulty. There has been more or less mining along the beach from Coos Bay southward, and it is the belief of miners that the deposits are renewed from year to year by the winter storms. These mines generally have paid but little. In a few cases, however, the yield has been more encouraging. For a short time in the summer of 1897, three men took out nearly a hundred dollars a day a short distance south of the mouth of Whiskey Run.

The most extensive elevated beach mining in the Coos Bay quadrangle has been carried on at the foot of a bluff extending from Threemile Creek to the head of the lagoons. The plain at the base of the sea cliff is about 200 feet above sea level, and the black sand lies about 30 feet below the level of the plain—that is, at an elevation of about 170 feet above the present sea level. The only mines of this kind that have been worked recently are the Rose mine, in sec. 21, T. 27 S., R. 14 W., and the Pioneer, at the head of the lagoons near the northeast corner of sec. 33 in the same township. The Rose mine has been worked during the season of high water for a number of years. The bedrock shale has been laid bare and the black sand is well exposed. The latter generally lies next to the bed rock and stretches along the foot of the bluff for several miles. The belt of black sand is about 150 feet in width. In cross section it is lenticular in shape; about 4 feet thick in the middle, tapering to an edge upon each side, with the coarsest material, including gold, near the landward border, where it is highest and represents the most vigorous wave action. On account of the thick coating (30 feet) of sand and gravel which overlies the black sand, an attempt has been made in some of the mines, especially in the Eagle, to remove the auriferous sand by means of tunnels. Logs and bowlders of various sizes, especially bowlders of the harder rocks of the Klamath Mountains, are found occasionally in the black sand.

Elevated beach gold mines.

The black sand is composed chiefly of garnet, magnetite, ilmenite, and chromite, with a smaller amount of zircon, epidote, and a few other minerals. Gold is generally found more or less abundantly, and platinum with iridosmine is locally found in recognizable quantities among the heavy concentrates. These metals should be looked for. In some cases they may be so abundant as to pay for saving.

The gold in the black sand is derived immediately from the Eocene shales and sandstones by the concentrating action of the streams and waves, and originally it was derived from the older rocks of the Klamath Mountains. Garnets and epidote, usually so abundant in the black sand, are contained mainly in the amphibole-schist, such as that of Tupper Rock, and it is possible that more or less gold also occurs in these masses, although no well-defined auriferous veins have as yet been discovered in them.

January, 1901.