

# DESCRIPTION OF THE PORT ORFORD QUADRANGLE.

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## TOPOGRAPHY.

*Situation and general aspects.*—The Port Orford quadrangle lies along the coast of Oregon, on the western slope of the Coast Range, nearly 40 miles north of the California line. It is bounded on the south and north by the parallels  $42^{\circ} 30'$  and  $43^{\circ}$ , respectively, with the meridian  $124^{\circ}$  on the east and the coast on the west, and has an area of about 870 square miles. It is decidedly mountainous, and the mountains are very irregular in contour, but relatively even crested, ranging in altitude from about 2000 to nearly 4000 feet. Near the coast in places there is a broad coastal plain, with terraces on the slopes above. Viewed from the narrow valleys the topography is bold and imposing, but above the steep slopes gentle ones extend to divides, which correspond in general in summit elevations and thus give to the view in many parts the aspect of a dissected plateau. The special features in the topography of the Port Orford quadrangle may therefore be considered under three heads—coastal plain and higher marine terraces, river valleys, and Klamath Plateau.

*Coastal plain and higher marine terraces.*—These features of the coast are well displayed in a profile of the slope from White Mountain to the sea. They are well marked as far south as Port Orford, but beyond that point the terraces are rarely conspicuous.

The coastal plain, having a width of from 1 to 5 miles, borders the coast, as shown on the map, from the northern end of the quadrangle to Port Orford; and although in general higher along its eastern or inner border than next the coast, it attains its highest level, 225 feet, in Cape Blanco. Much of the soil is sandy, but in places it is a dark loam, and the plain affords the largest agricultural tracts of the region. Swamps prevail in many places, and ridges of dune sand are common near the coast, where the smaller streams are ponded by sand bars, forming lagoons. Of these Crooks, New, and Floras lakes, as well as Garrison Lagoon, are good examples. Sixes and Elk rivers are strong streams and maintain an open channel across their bars, but the smaller Floras Creek flows for over  $2\frac{1}{2}$  miles along the beach before it finds an opening. The mouths of these streams vary much with the season. The winter storms from the south and southwest drive the waves and sand up the coast, and the stream mouths are moved in the same direction, but when the northwest winds of summer prevail they bend down the coast again.

East of the coastal plain, on the prominent spurs, the rise of the mountain is by terraces more or less distinctly marked. Short, steep slopes, which are ancient sea cliffs with ancient beaches at their bases, alternate with long, gentle ones marking the corresponding wave-cut terraces. The altitudes of these terraces were measured by an aneroid, and the readings were taken in each case upon the best-developed portion of the terrace. Next above the coastal plain lies the 500-foot terrace, which is narrow on the spur north-east of Denmark, but has a larger development near Fournile Creek, as well as between Elk River and the Sixes. At the 1000-foot level, on the White Mountain trail, is a terrace having a width of over a mile. It is well marked by the road on the next spur northward, 2 miles west of Hare, and is cut on a variety of hard rocks intermingled with soft sandstones. On this terrace are some well-rounded pebbles which mark the ancient sea beach. Marshy spots of the coastal plain also occur at this level. The 1000-foot terrace, like the one next below it, has its greatest development near the northern border of the quadrangle and in the neighborhood of Sixes and Elk rivers.

Eastward on the White Mountain trail from the 1000-foot level the ascent becomes steeper to

a terrace along whose eastern border there is a well-marked sea cliff at an elevation of about 1500 feet. There is an abrupt change from the flat terrace to a steeper slope, and then a more gradual change through a gentle slope to the plateau-like summit of White Mountain, at an elevation of 2200 feet. The 1500-foot terrace is rarely well developed, although the sea cliff is usually distinct and has been traced for many miles along the coast. It is perhaps most prominent on the divide north of Edson Creek, and may be seen to best advantage from near the same elevation on the ridge between Edson Creek and the Sixes.

*River valleys.*—A person looking northeast down Salmon Creek from the north slope of Salmon Mountain, at an elevation of about 2550 feet, sees clearly the general profile of a cross section of the valley. The upper, gentler slopes belong to the earlier portion of the valley and the steeper ones below to the later portion, and for convenience in distinguishing them they may be referred to as earlier and later valleys. Earlier valleys do not occur below an altitude of about 1000 feet above the sea. They are broad, and rise to the plateau summits with rolling slopes. The later valleys are narrow, in many places veritable canyons. The earlier valley streams had their mouths approximately at the level of the 1000-foot terrace, when the coast was at that point, and the valleys and terrace are closely related in genesis.

Corresponding earlier and later valleys may be recognized along most of the large streams, especially those which traverse harder rocks, in which the forms of the older valleys are best preserved. The earlier valley of Sixes River may be seen to advantage looking east from Elephant Rock, the bottom being over 1000 feet lower than the summit of Mount Avery, while still below it is the canyon of more recent development. To the east, where softer rocks greatly facilitate erosion, the canyon disappears and a wider valley occurs about Eckley. A similar widening of the later valley is noticeable locally along the South Fork of the Coquille near the mouths of Salmon and Beaver creeks, and also along Rogue River at Big Bend. In all of these cases the widening of the valley is due to the presence of soft Eocene rocks.

Along Rogue River for many miles below the mouth of the Illinois the later valley is a canyon, but if one mounts upon the steep slopes to an elevation of over 1000 feet the aspect changes on reaching the remnants of the earlier valley, the bottom of which is well preserved just beyond the southern border of the quadrangle a few miles east of the mouth of Silver Creek, in a flat-topped hill rising abruptly over 1000 feet from the river.

Similar earlier and later valleys occur along Elk River, but the contrast is not so great, especially for 10 miles below the forks, as the steep slopes have occasioned many landslides, overloading the streams and filling the valleys with gravel, which partly buries the trunks of the adjacent forest trees. During the severe winter of 1893 the ground became so thoroughly saturated with water that there were many slides, and some of the streams have not yet removed the debris.

*Klamath Plateau.*—To see this feature it is necessary to ascend to one of the higher summits, whence a general view of the uplands may be obtained. Notwithstanding many small irregularities, which will be better understood after the development of the topography has been considered, an approximation to a general level will be noted, with an inclination toward the coast. Near the eastern border of the quadrangle, as seen from Barklow Mountain, the crest of the Coast Range presents a comparatively even sky line, at an elevation of approximately 3500 feet, but rising gently southward. The flattish summits are best marked to the north, beyond the limits of the quadrangle, where they present in a

marked degree the appearance of a plateau deeply trenched by its streams. Westward throughout the Port Orford quadrangle, and, in fact, over the greater portion of the Klamath Mountains, which extend from Rogue River to Sacramento Valley, there is a general summit level marking the plateau, with occasional peaks rising clearly above the others, and yet there are but few places where a considerable extent of the original plateau surface is preserved. In Iron Mountain the plain rises to 4000 feet. Toward the sea it gradually declines to nearly 2000 feet, and Mount Butler and Mount Avery rise a few hundred feet above the general plain. Between the Sixes and Floras Creek the rolling plateau surface is marked in Edson Butte, and declines gently westward to Eightmile Prairie and White mountains. Traces of the plateau, which was once continuous over the whole country, are still preserved south of Elk River in the flat-topped mountains about Blackberry and Panther creeks, at an altitude of 2500 feet; and just north of Rogue River the undulating plain forms the crest of the divide in the Prairie Mountains east of Lobster Creek, with altitudes increasing eastward from 2200 to 3000 feet.

The terraces of the coast, the river valleys, and the plateau are all effects of the processes of land sculpture by marine and river erosion, influenced by changes in the relative position of land and sea, and their development will be considered briefly in the sketch of the geological history of the region.

Of the features noted above, the coastal plain is by far the most distinctly represented on the map. The development of the earlier valleys became so advanced as to obscure considerably the plateau feature.

*Population.*—The population of the whole quadrangle is scarcely 2000, but most of the people are on the coastal plain. The fertile alluvial flats along the South Fork of the Coquille have attracted settlers, but the narrow valleys along most of the streams are inhabited only by miners. The high precipitation of the region (68 inches) gives it a dense coat of vegetation, much of which is underbrush. Coniferous forests of great extent occur and have yielded much lumber, but a large portion of the wooded tracts is of little importance.

## GENERAL GEOLOGY.

### SKETCH OF GEOLOGICAL HISTORY.

Fourteen formations have been recognized in the Port Orford quadrangle and outlined on the Areal Geology map. Nine of these are of sedimentary origin, and the remainder are igneous. They record the geological history of the region, and to facilitate their consideration in detail we may note briefly the general series of events.

The history of the Port Orford quadrangle, as far as the formations there exposed are concerned, begins beneath the ancient ocean in which the sediments of the Colebrooke schist were deposited, but of the date of that beginning no more can be determined in the Port Orford quadrangle than that it was pre-Cretaceous and that the sediments had been crushed and partially altered to schists before the beginning of that period. It is possible, however, that the Colebrooke schist is pre-Devonian, for in the southern part of the Klamath Mountains similar schists lie unconformably beneath the Devonian. Further investigation in the Klamath Mountain region is required to determine what geologic ages intervened between the Colebrooke epoch and that of the lower Cretaceous Myrtle formation. Part of this time is recorded in the Port Orford quadrangle by marine deposits recognized on Sucker Creek, but not mapped, which correspond to the Mariposa slate of the western part of the Sierra Nevada in California. They show that at least a large part

of the Klamath Mountain region was beneath the sea in late Jurassic time.

Just before the beginning of the Cretaceous the Klamath Mountain district was raised above the sea in the course of an important mountain-forming epoch, and that portion of the coast moved westward some distance past its present position to the margin of the continental plateau, now beneath the ocean. After an interval of erosion, but during the Cretaceous, especially during the portion represented by the upper portion of the Knoxville and the Horsetown Chico beds (Myrtle formation), the land subsided and the sea advanced inland until it completely or almost completely covered the Klamath Mountain region and the waves of the ocean swept to the foot of the Blue Mountains of eastern Oregon and the Sierra Nevada of California. The sea, advancing over the irregular slopes of the Klamath Mountains, which occasioned great irregularity in the Cretaceous deposits.

Following the deposition of the Myrtle formation, toward the close of the Chico epoch, the rocks of the Klamath Mountain region were again folded and crushed, igneous rocks were extruded, and the whole was raised above the sea, thus being subjected to extensive erosion, by which the later Cretaceous sediments, those of the Chico phase, were almost completely removed, leaving only a trace of them near Custer in the Port Orford quadrangle and a larger mass along the coast, near Pistol River, where they are deeply infolded with older strata.

During the Eocene period the widely leveled land again subsided, admitting the sea over the whole of western Oregon to the Cascade Range as far south as Canyonville, whence the coast trended southwestward to beyond Rogue River. Over the Port Orford quadrangle the sea of the Arago epoch was shallow, sometimes even swampy, affording an opportunity for the vegetation to accumulate and form the coal beds of Coos Bay as well as those near Eckley and on Shasta Costa Creek; and with the close of the Arago stage the Klamath Mountains and Coast Range of Oregon were uplifted to a moderate elevation and subjected to extensive erosion, so as completely to remove the Eocene strata at Cape Blanco and permit the Empire formation of the next epoch to be laid down directly upon the Myrtle formation.

During the Miocene epoch the Klamath Mountains and the exposed portion of the Coast Range of Oregon were reduced by long-continued erosion to a gentle-featured plain—a peneplain—near sea level, and at the same time correlative deposits of material washed from the land in producing the peneplain were laid down by the sea along the coast. The records of this epoch are well exposed in the Empire formation at Cape Blanco, and contain, besides the ordinary sediment derived from the adjacent land, a bed of volcanic dust which undoubtedly was blown a long distance and may have come from some one of the volcanoes then active along the Cascade Range. The peneplain which we see in the general evenness of upland crests of the Klamath Plateau is the one which originated at this time (Miocene) near sea level and has since been lifted up by stages, in the process of mountain making. By this movement, or one closely associated with it, the Empire beds were tilted to an angle of  $25^{\circ}$ .

The total uplifting by various stages to nearly 1000 feet gave the streams greater fall to sea level and therefore greater corrasive power, and at the same time new shore lines were successively exposed to the action of the waves for terrace cutting. There were several uplifts and halts for longer or shorter intervals at intervening levels before the place of the 1000-foot terrace was reached, and at some of these the halt was sufficient to leave a record in the eroded forms as well as in deposits capping the terraces. At the

level of the 1000-foot terrace the relative position of land and sea remained the same for a period long enough to permit the waves to cut a broad terrace. After each uplift the streams at first cut canyons, but the long halt at the 1000-foot terrace level enabled them to widen their valleys, producing what have already been called earlier valleys and reducing the areas of the original peneplain to mere remnants on the divide crests.

The earlier valley epoch was brought to a close, as far as the records of the Port Orford quadrangle are concerned, by an uplift of 1000 feet or more, with halts at intervals, permitting the development of small terraces along the coast while the streams were cutting canyons inland along the bottoms of the earlier valleys. The principal halt, which is recorded in the coastal plain north of Port Orford, was made apparently at a point less than 200 feet below the present level. The absence of this plain along the coast south of Port Orford, where harder rocks occur, indicates that the development of the coastal plain is due rather to the presence of soft rocks at Cape Blanco than to a particularly long halt at this level. This view is emphasized by the fact that both portions of the coast are equally well exposed to the action of the waves.

The Port Orford quadrangle does not contain a complete record of all the important events of the later history of the Klamath Mountains. Large glaciers were once present among the higher peaks in northern California, and their records extend far down into the later valleys of the adjacent streams. Among the sediments, too, fossiliferous beds occur along the Californian coast, but have not been discovered in this quadrangle, and their absence suggests that at the time of their deposition the Oregon coast was farther seaward and the records, if they still exist, would be found beneath the sea. That the Port Orford district did once stand higher than now is indicated also by the deep valley of Coos River, which extends far below tide level, and to cut which the land must once have occupied a position at least 200 feet above its present level. The latest coastal movement has scarcely affected the Port Orford region. Its results are seen in the long tide running up Coquille River to near Myrtle Point. None of the rivers of the Port Orford quadrangle have a tide run of more than a few miles, and the subsidence has not been appreciable along this portion of the coast.

#### SEDIMENTARY ROCKS.

##### PRE-CRETACEOUS.

*Colebrooke schist.*—Among the hills immediately north of Rogue River and extending from Lake of the Woods to the coast, and also about White Mountain and farther northward, there is a group of more or less completely metamorphosed rocks which are undoubtedly the oldest in the quadrangle. Lobster Creek and Brushy Bald Mountain afford fine exposures. The rocks are in part mica-schist intermingled with slates in which the cleavage is highly developed but without definite crystalline structure visible to the unaided eye. The rocks are always fine grained, with decided schistose structure, and where most highly metamorphosed have much fine silky mica (sericite) on the foliated surface, so that they may be more definitely designated sericite-schists, or phyllites. They are much folded and crumpled. The schistose structure varies a great deal in direction, but the strike usually lies between northwest and west, with a vertical dip. On the south end of Brushy Bald Mountain the phyllite is so fine that its micaceous nature can be discovered only under the microscope. It looks in places like roofing slate and is composed chiefly of sericite and quartz, the former containing a multitude of minute rutile needles. Farther north on Brushy Bald Mountain it becomes coarser and fragmental, indicating its origin in sedimentary rocks. Quartz is the chief constituent, but there is some plagioclase feldspar and much sericite. On the summit of Brushy Bald Mountain the schist is coarser and the schistosity is so wavy as to give apparently a rough fibrous structure to the mass. Fine granular quartz largely predominates over the sericite which marks the structure, and is most prominent on

the cleavage faces. Scattered through the quartz are small rhombohedral cavities containing oxide of iron. It is most likely that they were once occupied by crystals of carbonate of iron.

On Lobster Creek, a few miles below the trail crossing, black glossy slates (phyllites) are common. They contain much sericite, with fine granular quartz, and a large amount of dark carbonaceous matter which gives color to the mass. They are greatly crumpled, giving the cleavage face a decidedly wavy profile. The rocks contain many small veins of quartz, which on weathering yield numerous white fragments of quartz to the soil.

As to the geological age of these rocks we have no decisive evidence in the Port Orford quadrangle, except that they are pre-Cretaceous. Elsewhere in the Klamath Mountains, however, as stated above, there is evidence that the Colebrooke schist is possibly of pre-Devonian age.

*Unconformity between the Colebrooke schist and Myrtle formation.*—The Colebrooke schist and Myrtle formation are unconformable, and the break represents a large interval of time. On the coast a short distance north of the mouth of Mussel Creek a fossiliferous sandstone and fine conglomerate of Cretaceous age contain small fragments of the adjacent Colebrooke schist. The Cretaceous rocks, although somewhat changed since their deposition, are much less altered than the Colebrooke schist and contain but few veins of quartz, while the schist has many veins. The two formations are obviously unconformable and contrast strongly near their contact. But to get a closer estimate of the time represented by the unconformity we must go beyond the limits of the Port Orford quadrangle to northern California. On the South Fork of Trinity River a mica-schist, probably of the same age as the Colebrooke schist, is overlain by strata containing Devonian fossils. The schist of that region is therefore the result of pre-Devonian metamorphism, and if the Colebrooke schist is of the same age it must be older than the Devonian. The break between the Colebrooke schist and the Myrtle formation appears to represent a very long time interval, including the Devonian, Carboniferous, Triassic, and possibly the early part of Jurassic time, to the subsidence which marks the beginning of the period during which the Myrtle formation was deposited.

##### CRETACEOUS.

*Myrtle formation.*—This formation takes its name from Myrtle Creek, in the Roseburg quadrangle, which is separated from the Port Orford by the Coast Range. As the Coast Range is made up of Eocene sediments which cover the Myrtle formation, it is not possible to trace it through the mountains, but the character of the sediments, their contained fossils, and their relations to other formations afford conclusive evidence that they are the same.

The Myrtle formation is more widely distributed than any other in the Port Orford quadrangle, but because it is so intersected by igneous rocks and partially covered by later formations its surface distribution is very irregular. The most abundant rock is sandstone, although shale and conglomerate are common. The sandstone is generally gray in color and is crushed into small fragments, so as to partially or wholly obscure the planes of bedding and render it extremely difficult in most parts of the field to work out the structure. In many places the crushing has resulted in the development of schistose structure, but it is only in the neighborhood of intruded igneous masses that the strata are distinctly altered. The shales are only local thin beds, sometimes slaty, among the sandstones, but the conglomerates are of greater importance, and yet no continuous stratum of conglomerate was found anywhere that could be traced more than a few miles. In general the basal portion of the series contains the most conglomerate, and none was found among the higher strata containing Horse-town fossils.

In the Rogue River section, near the mouth of the Illinois, there is much shale mixed with the relatively thin-bedded sandstone, and although the rocks are highly tilted their stratification is well preserved. The beds are folded and the

exposed series on Rogue River has a thickness of approximately 1500 feet. They contain numerous Cretaceous fossils belonging to the Horsetown and the upper part of the Knoxville beds. Two forms of *Aucella* are found in the Myrtle formation. Of these *A. piochii* as determined in California is the older form, while *A. crassicolis* characterizes the top of the Knoxville beds adjoining those of the Horsetown stage. The base of the series on Rogue River below Agnes is a heavy conglomerate, best exposed perhaps in a prominent bluff near the trail  $1\frac{1}{2}$  miles northwest of Agnes. *A. crassicolis*, which is the later form, characterizes this portion of the section where it is separated from the Colebrooke schist by a belt of serpentine.

The most extensive section of the Myrtle formation is exposed on Elk River, beginning to the east in Copper Mountain with large masses of conglomerate and sandstone overlying shales and sandstones, the whole containing *A. piochii*. Along Elk River, between the forks and the mouth of Blackberry Creek, shales and sandstones are well exposed and contain numerous fossils in place. Concerning these Mr. T. W. Stanton has reported the following forms belonging to the upper Knoxville:

Spondylus ?? sp.  
Aucella crassicolis (Keyserling).  
Aucella sp.  
Inoceramus sp., related to *I. ovatus* (Stanton).  
Turbo morganiensis (Stanton).  
Olostephanus mutabilis (Stanton).  
Perisphinctes ? sp.  
Hoplitites sp.  
Belemnites impressus (Gabb).

In the bed of Elk River, among the rocks which contain the above upper Knoxville fossils in place, some loose pieces of shale were found containing plant remains. They were studied by Prof. Wm. M. Fontaine, who describes eight species, and remarks: "The above-described plants are all that can be made out with any degree of probability in the collection made from Curry County. They indicate with a high degree of probability that the strata which yield them are of the same age as the Jurassic strata of Douglas County, in the vicinity of Buck Mountain. The abundant plant fossils of these beds show that they are of Lower Oolite age."

The fossil plants were not found in place, but upper Knoxville fossils were found at many points not only below but above the forks on both branches of Elk River. It is certain that the plants belong to the drainage of Elk River near the forks, for the shale fragments could not withstand long transportation. Their location being unknown, the strata from which they came are probably included in the Myrtle formation.

A similar case occurs on Johnson Creek a short distance northeast of the head of Elk River, where fragments of shale containing *Aucella* were found in the stream bed. Dr. T. W. Stanton remarks that "it seems from the few fossils representing it to belong in the upper Jurassic Mariposa beds. This opinion is based on the characteristics of the *Aucella*." Slaty shales like those containing the Jurassic *Aucella* occur at the mouth of Sucker Creek, but no fossils were observed in place. Farther eastward on Johnson Creek, in overlying rocks, only *Aucella piochii*, one of the Knoxville forms, was found. It is certain that near the divide between Elk River and Johnson Creek, which flows into the South Fork of the Coquille, Jurassic slates occur, but their area must be small. The Jurassic sediments closely resemble those of the Myrtle formation, and in the field they were not separated. The crest of Barklow Mountain is well characterized by an abundance of *Aucella crassicolis*, and the whole was mapped as belonging to the Myrtle formation.

The distribution of fossils is interesting in showing general structural features. *Aucella piochii* is most common from Hoods Mountain southwestward along the west base of Johnson Mountain to Copper Mountain, and even beyond, at Cedar Point, in the southwestern part of the quadrangle. Close to this line on the east, in the Johnson Creek drainage, must lie the Jurassic slates, and beyond it a short distance *A. piochii*, as if brought up by an anticlinal arch in connection with the Jurassic slates along the line already

indicated. On the west the Jurassic plant-bearing shales must occur somewhere along Elk River, toward its head. On both sides of the belt in which the Jurassic fossils occur *Aucella crassicolis* has been found at many points, indicating that the associated strata are of later age.

The Jurassic strata in the base of the Myrtle formation are overlapped in a way to suggest deposition in a sea having islands. Near the coast from Colebrooke Butte to White Mountain the Myrtle formation surrounds a number of small areas of Colebrooke schist, with which it is in contact, and the basal portion is a conglomerate containing many fragments of the schist. The conglomerate commonly contains *Aucella crassicolis*. The older portion of the Knoxville and the Jurassic slaty shales, which belong chronologically between the conglomerate-bearing *A. crassicolis* and the Colebrooke schist of the same region, are locally absent, and their absence indicates that during the early Cretaceous epoch there were islands in the sea, to which the apparent inequalities of deposition are largely due.

*Deformation and volcanic activity near the close of the Cretaceous.*—After the deposition of the Myrtle formation, near the close of the Chico epoch, the rocks of the Port Orford quadrangle were greatly folded and crushed and volcanoes became active in the region. Many of the chimneys of these old volcanoes are represented by prominent rock stacks like Silver Butte.

*Chert.*—The chert of the Port Orford quadrangle is a highly siliceous rock, resembling jasper, and varies greatly in color, from green through gray to yellowish brown and red. The reddish varieties are most common. It occurs many where as lentils in the Myrtle formation, but the exposures are never large. So small are most of them, in fact, that their area must be exaggerated to appear on the map at all. They are abundant in the northern portion of the quadrangle, but decrease southward, and no exposures of importance were found beyond Elk River.

The most striking exposure seen anywhere is on the ridge near Calf ranch, 5 miles directly northwest of Eckley. Here there is a prominent ledge of banded chert, the layers ranging from one-half inch to 4 inches in thickness, with a thin parting of red shale between. The layers are much contorted, overlapping like spring deposits, and although generally reddish are often mottled green and gray. The reddish varieties are made up very largely of radiolarian shells, the structure of which is fairly well preserved by oxide of iron. In the other colors round spots appear, but the structure is indistinct. The associated rocks are shales and sandstones of the Myrtle formation. No igneous rocks were noticed in the immediate vicinity. In this respect it differs from the chert on Johnson Creek about 15 miles southeast of Eckley, where reddish and brownish banded chert is interbedded with thin layers composed wholly of volcanic material.

On Salmon Creek, near the southwest corner of section 23, occurs a reddish mass of radiolarian shale, similar to the least siliceous red chert, but softer. It contains many round forms similar to those which characterize the chert, but no structure is visible where it might be expected. They occur in an irregular reddish shaly mass inclosed in gray shales. No sharp boundary could be found between the reddish and gray portions, and none of the minute animal remains were noticed in the gray shale. Their association with shales in which a Cretaceous form of *Aucella* has been found fixes their geological horizon. All the ledges of chert in the Port Orford quadrangle are associated with sandstones and shales in which Cretaceous fossils have been found, so there seems to be but little room for doubt concerning the age of those areas mapped, and they must therefore be regarded as lentils in the Myrtle formation.

In conglomerate which occurs at various places in the Myrtle formation and which contains Cretaceous fossils cherty pebbles have been found, indicating possibly that there are chert masses which are older than the Myrtle formation. They do not certainly show radiolarian structure. The suggestion that there may be older cherts of radiolarian origin is emphasized also by the occurrence of chert full of common round sili-

ceous spots at a number of places in the Klamath Mountains where it is associated with limestones of Paleozoic age.

**Amphibole-schist.**—Under this designation are included certain crystalline rocks which are clearly related in structure, mode of occurrence, and origin, although they differ widely in composition and general appearance. Their outcrops are usually small, but occasionally form prominent rocky ledges. In the northern portion of the quadrangle they are abundant, but from Sixes River southward they are rare. In the same region frequently occur cherts and small masses of basaltic rocks which are so intermingled with the amphibole-schists and more or less altered sandstones and shales of the Myrtle formation that it is not possible to represent their areal distribution in detail on a map of the scale herein used. An attempt was made on the slope of Hoods Mountain, but it failed.

The finest exposure of these interesting rocks is on Woodward Creek over a mile above its mouth, in sec. 6, T. 31 S., R. 11 W. The area is one of the largest and contains numerous prominent ledges, in which there is great variation in mineralogical and chemical composition.

These rocks may be divided according to their mineralogical composition into glaucophane-schists, actinolite-schists, epidote-schists, and mica-schists, but they all grade into one another and are of the same origin. Glaucophane-schist is perhaps the most abundant. Much of it is composed almost exclusively of glaucophane and has a decidedly blue color; but generally it contains more or less epidote, muscovite, actinolite, or quartz, with some garnet or feldspar, and any one of the first four of these minerals may become almost as abundant as glaucophane, giving rise to epidote-glaucophane-schist, quartz-glaucophane-schist, etc. The epidote and glaucophane are occasionally arranged in alternating bands, giving the rock a foliated structure, but generally the minerals are intermingled with apparent uniformity.

Intimately associated with the glaucophane-schist in its various forms, and of nearly equal abundance, is actinolite-schist, which is decidedly green in color. When best developed the blade-like cleavage of the deep-green actinolite is plain, but generally the particles are small and inclined to be fibrous, giving the rock an indefinite schistosity. Actinolite is so common a mineral in the glaucophane-schist, and glaucophane is so abundant in the actinolite-schist, that the two rocks evidently have the same origin. In the few schists in which epidote predominates, glaucophane, garnet, and quartz occur also, and occasionally a deeper green variety of hornblende is present. Mica rarely becomes sufficiently abundant to characterize the rock, and then for very small masses only. Chlorite, zoisite, rutile, and magnetite occur here and there in traces.

The origin of these glaucophane-schists and others closely associated with them has long been a matter of interest. Their occurrence in places along the contact between igneous and sedimentary rocks has supported the view that they result from contact metamorphism, and a closer study of them microscopically and chemically tends to show that the original rock from which they are derived is igneous in some cases and sedimentary in others.

By far the larger part of the glaucophane-schist in the Port Orford region is derived from the alteration of rocks of the basalt type. In many places these rocks have been changed, as already noted, to plagioclase-hornblende rocks, and they pass into actinolite-schists derived from a phase especially rich in pyroxene. The pyroxene alters generally to green hornblende, but sometimes to blue, and in such cases gives rise to glaucophane-schist. Generally the alteration is complete, so that the stages of the process can not be seen, but a volcanic neck that is only partially altered occurs on a private road in the southeast corner of sec. 32, T. 34 S., R. 14 W., on the slope of Colebrooke Butte. The prominent ledge is about 200 yards in diameter, rising above the surrounding softer schists, and in the field the rock looks like the most common type. Under the microscope, however, it is seen that the augite in the northern portion of the mass is changing to glaucophane

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and is well advanced toward the formation of glaucophane-schist. The feldspar has changed chiefly to epidote, and some green hornblende and chlorite are present.

**Unconformity between the Myrtle and Arago formations.**—The uplift which probably accompanied the volcanic activity about the time the cherts and amphibole-schists were produced inaugurated vigorous erosion, which swept away much of the later Cretaceous sediments and volcanic material. Subsidence followed, and the sea again covered the Port Orford quadrangle, to deposit the Arago formation unconformably upon the Myrtle formation.

#### Eocene.

**Arago formation.**—The Arago formation is composed of yellowish sandstone with a large proportion of shale and but little conglomerate. The sandstone is generally softer than that of the Myrtle formation, and although tilted, not having been crushed like the latter, its stratification is well preserved. It occurs in several separate areas within the quadrangle and occupies the whole of the eastern border, rising at a number of points to an altitude of over 3000 feet in the summit of the Coast Range. The Coos Bay quadrangle, which lies adjacent on the north, is almost completely covered by the Arago formation (see folio No. 73, Coos Bay), which was formerly equally extensive in the Port Orford. A large mass lies about Eckley, and another southwest of the forks of the Sixes, while smaller areas occur at the head of the Middle Fork of Floras Creek, on Johnson Creek near the mouth of Sucker, upon the eastern slope of Iron Mountain, and on the South Fork of Lobster Creek. All of these occurrences contain sandstone and shales characterized by Eocene marine fossils and were evidently once connected not only with one another but with the main mass of the Coast Range on the north and east. The present fragmental distribution is due entirely to erosion, which has removed a great part of the former cover.

The Eocene strata, where preserved in spite of erosion, occur in basins sunk in the older rocks. The great belt along the eastern border of the quadrangle forms the crest of the Coast Range and is a broad syncline including a number of minor folds. To the west lies the arch which brings up the oldest fossiliferous rocks of the region, Knoxville and Jurassic, and sends a tongue of older rocks northeast from Hoods Mountain. To the west of the arch, in a shallow but crumpled syncline, lies the mass of Eocene strata about Eckley, as shown in sections A—A and B—B on the Structure Section sheet.

Coal has been found in the Arago formation at a number of points in the Port Orford quadrangle, and generally, but not always, close to the base of the formation. This shows that the peculiar conditions which obtained during the Eocene were those of a shallow sea alternating here and there with swampy land on which accumulated the vegetation for the coal beds.

Near Coos Bay the Arago formation has a thickness of approximately 10,000 feet, but in the Port Orford region it is much less, probably not averaging half that amount, and decreases to the southward as it overlaps the older rocks of the Klamath Mountains. During its deposition the sea floor and adjacent land were subsiding and the sea was transgressing upon the northern slope of the Klamath Mountains.

#### NEOCENE.

**Empire formation.**—The Empire formation is composed chiefly of sandstone, with some conglomerate and shale and a bed of volcanic dust. It occupies but a narrow strip along the coast for half a mile northeast of Blacklock Point and a similar strip for about 2 miles southeast of Cape Blanco to the mouth of Elk River, where the following section was observed:

##### Section of Empire formation near Cape Blanco.

	Feet.
Gravel.....	25
Fine whitish sandstone full of minute organisms..	100
Tuff.....	25
Yellowish sandstones and near top very shaly sandstones.....	475
Total.....	625

The strata are tilted southerly at an angle of 25°, rest directly upon the Myrtle formation, and are overlain unconformably by marine sands of the coastal plain. Fossils are very abundant, and after an examination of a large number of them Dr. W. H. Dall reports that the strata are Miocene and of the same age as the Empire formation of Coos Bay.

Much of the formation has been washed away, but it probably never extended far inland along this portion of the coast. To the north, however, along Coos River and also near the Columbia, it reaches farther inland.

#### PLEISTOCENE.

**Marine sands and gravels.**—The marine terraces near the coast, especially the coastal plain from Port Orford northward, are capped with sand and gravel of marine origin and of much later date than the Empire formation. Traces of these sands and gravels were observed on the 1500-foot terrace, but are much better developed at lower levels, where the gravels are deep enough to have been mined for gold. The highest of the mines noted is on the divide between Crystal and Edson creeks, at an elevation of nearly 1000 feet. Stratified whitish sand 18 feet thick, containing some small gravel, overlies 2 feet of coarse gravel which rests upon the bed rock. The gravel is derived largely from the adjacent Cretaceous sandstone. The 1000-foot terrace is well developed about Sixes and Elk rivers, and is generally capped by a deposit of marine sands, evidently laid down when the sea stood at that level.

The marine sands and gravel of the coastal plain are younger and were deposited after the 1000-foot terrace had been raised above the sea. They are well exposed near Port Orford and Cape Blanco along the coast, and also on the inland border of the plain in the Sixes and Blanco mines. Gravel prevails at the base of the deposit in the mines, and marks the shore line against the bluff from which it was derived. It is overlain by sand with smaller layers of gravel to a thickness of over 20 feet.

In the sea bluff at the mouth of Elk River a larger section is exposed, with 75 feet of stratified sand below, overlain by 12 feet of gravel. Near the base of the sand, where it comes in contact with the Miocene, it is locally very rich in fossils. A large number were collected, and concerning them Dr. Dall reports: "They are probably Pleistocene, all the species seeming recent, but they may be of the Merced horizon [a Pliocene terrane of California]. A larger collection is needed to determine this point. They are not older than newer Pliocene."

Near the mouth of Elk River the Pleistocene appears to rest on the Miocene unconformably, but farther north, near Cape Blanco, the Pleistocene is greatly reduced in thickness and unconformably overlaps the Empire formation, with a rich fossil bed at its base.

**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, deposited by the highest floods. Where the plains are sufficiently dry to be arable the soil is very fertile, and the fertility is renewed by every flood.

The streams, for the most part, flow in narrow valleys; only here and there, where soft beds occur, do they carve out wider portions and form a flood plain of alluvium, so that areas of alluvium in the Port Orford quadrangle are few and small. The most important deposits are probably those occurring at three points along the South Fork of the Coquille. Elk River and the Sixes have considerable areas along their lower portions, but Rogue River, which is by far the largest stream, has areas worthy of mention at only two points, at Big Bend and near the mouth of the Illinois. In respect to extensive flood plains and tidal flats Rogue River, by their absence, is in strong contrast with the Coquille and the Coos, where recent subsidence has flooded the streams near the coast and greatly extended their alluvial plains.

#### IGNEOUS ROCKS.

The igneous rocks of the Port Orford quadrangle may be considered in four groups—serpentine, gabbro, basalt, and dacite-porphyrty. The

serpentine is distinct from the gabbro, but the gabbro and basalt are closely related, being apparently different grades in the crystallization of one magma; and the dacite-porphyrty in places also has relations to the gabbro, although it is in the main distinct.

**Serpentine.**—Serpentine is a common rock in the Port Orford quadrangle, forty areas being represented on the map, but only about a dozen are of considerable size. The serpentine is all derived by alteration from an igneous rock, which was originally, for the most part, composed chiefly of olivine and belonged to the peridotites, but the associated pyroxene was locally so abundant as to place the rock among the pyroxenites. The alteration, though in many masses complete, is sometimes only partial, and the various stages of change from the original condition to serpentine are illustrated.

The Iron Mountain mass of serpentine (specimens Nos. 5238 and 5242, table of chemical analyses, p. 4) is the largest in the quadrangle and in places contains enough of its original components to show clearly the mineral composition of the rock at the time of its eruption. Besides olivine, which is the chief constituent, a considerable part consists of more or less bronzy monoclinic pyroxene, which generally, but not always, shows many twinning bands and is probably diallage. Here and there are traces of an orthorhombic pyroxene, which, on weathering, yields whitish or bronzed bastitic patches. In other places a pale-brown hornblende is associated with the diallage, and in such cases the olivine is usually less abundant than the pyroxene. Coffee-brown grains of picotite or chromite are common, and magnetite is always abundant, especially where the alteration of the rock is well advanced.

The age of the serpentine is not very closely determined. It clearly traverses the Myrtle formation, and is therefore later than the lower Cretaceous. This relation is further established by the fact that no serpentine pebbles were found in the conglomerates of the Myrtle formation, even in the vicinity of large outcrops. On the other hand, the serpentine does not intersect the Arago formation, of Eocene age, and the intrusion therefore occurred some time during the later portion of the Cretaceous.

**Gabbro.**—The term gabbro is used here in a broad sense to include not only rocks which are in various stages of alteration between normal fresh gabbro and metagabbro, having a composition approximating that of 5268 in the table of analyses, but also others which differ from gabbro in containing greater or less amounts of silica but which are closely related to it genetically. In the field they were found in connection with the more nearly normal gabbro masses, from which they could not be separated by definite boundaries. Those having quartz are an acid phase and approach the diorites; those having less silica are a basic phase and range toward the peridotites and pyroxenites.

The normal gabbro, composed originally almost wholly of a lime-soda variety of feldspar and pyroxene, has been greatly changed since its eruption, and to indicate this alteration it may be called metagabbro. The pyroxene in most cases has largely become hornblende. The feldspar is generally much altered, yielding among other things many minute grains of epidote, but its characteristic twinning is still preserved in places. The hornblende, although generally green, is in some places light brown, and both forms appear to have been derived from the pyroxene.

The prevailing texture is like that of granite, and the grains of feldspar and pyroxene are for the most part irregular, although many of those of feldspar are well-defined crystals, giving to the rock a tendency toward an ophitic or porphyritic structure. Of the material analyzed, that most nearly normal in composition is 5268, which forms part of the summit of Bald Mountain. It is composed of plagioclase, brown and greenish hornblende, with occasional traces of clear cores apparently of pyroxene. Numerous grains of magnetite or ilmenite are present.

The basic phase of the metagabbro is represented by the mass midway between Iron Mountain and Eden Ridge, bordering the Arago formation, which covers its eastern extension.



the underlying older rocks. Here the coal-bearing beds at the base of the series have a thickness of not much over 50 feet and are overlain by nearly 100 feet of firm sandstone. The coal-bearing series are shales and soft sandstones and contain two beds of coal, one of which is so much crushed that its thickness (said to be 20 feet) can not be definitely measured. Near it are a few feet of vertical sandstones and shales, and then a 5-foot bed of the best looking coal seen in the region. An analysis of this coal (5392) is given below. Marine Eocene shells occur close to the coal beds, so there can be no question concerning their age. A number of other outcrops occur on the small streams tributary to the main stream flowing through section 35 and along the North Fork within a mile below Eckley, but the best coal could not be identified at any other point.

The occurrence of coal at many points along the border of the Arago beds from Sugarloaf Mountain and east to the Middle Fork of the Sixes suggests that the Eckley area of the Arago beds represents a coal basin and that coal occurs under the whole region, but in all probability this is not the case. The coal beds vary greatly and abruptly, indicating that they are not of great extent. Aside from the difficulties of transportation, it is not believed that there is sufficient coal in that region to warrant the expectation of profitable mines.

Analyses of coals in Eckley region, with notes, by W. F. Hillebrand, March 21, 1901.

	5392	5493
Moisture in vacuo	6.78	4.72
Volatile combustible	43.51	41.40
Fixed combustible	47.27	54.91
Ash	2.44 (light reddish)	18.97 (white)
	190.00	100.00
Sulphur	8.87	6.78

Coke in both cases slightly sintered and non-coherent. The sulphur, at least in 5493, appears to be almost wholly in organic combination. The ash of the latter, being white, can, and in fact does, carry but little iron, hence there can be little pyrite in the coal. There is likewise little, if any, gypsum in 5493.

No. 5392 is from a 5-foot vein in the Holmes prospects, sec. 35, T. 31 S., R. 13 W., about 1½ miles west of Eckley. No. 5493 is from the "Big" vein of the Holmes prospects, upper tunnel, sec. 14, T. 32 S., R. 13 W., from a point ¼ miles southwest of Eckley.

Near the mouth of Shasta Costa Creek there has been prospecting for coal, and on account of transportation its location with reference to Rogue River and the coast gave it for a time considerable promise, but an attempt to mine the coal has not proved successful. It has a thickness of 4 to 6 feet, and looks on the whole to be of poor quality, but in composition it is remarkable, resembling in some respects the pitch coal and in others the normal lignite of the Coos Bay coal field. The specimen analyzed, No. 1 of the table following, was collected by Mr. McCubbin, but is quite like the material which the writer collected later at the same place. It contains a remarkably low percentage of water, and when heated partially fuses like pitch coal, but, like the normal lignite, it contains a larger percentage of ash and much more nearly equal amounts of volatile and fixed carbon. It appears to coke well, but the large amount of non-combustible ash in the coke reduces its value. For purposes of comparison analyses of pitch coal and other coal are given in the table. Where exposed on Shasta Costa Creek the coaly shale has a thickness of 10 feet.

Analyses of Shasta Costa and Riverton coals.

No. of analysis.	Moisture at 105 C. 1 hour.	Moisture over H <sub>2</sub> O, in vacuo, 48 hours.	Volatile combustible in vacuo.	Fixed carbon less ash.	Ash.	Sulphur.	Phosphorus.
1	.79	.....	48.90	36.58	13.73	6.25	.....
2	2.08	2.02	82.91	10.45	4.62	1.00	0.006
3	11.22	12.92	44.31	36.77	6.00	1.96	1.31

1. Coal obtained by Mr. McCubbin on Shasta Costa Creek. Analyzed by George Steiger, who reports "coke good."  
2. Pitch coal from Ferry's mine, Riverton, Coos County, Ore.  
3. Coal from same mine as 2; both analyzed by W. F. Hillebrand, who reports that coke of 2 was in hard, black lumps, adhering to crucible, while that of 3 was loose and sandy.

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The coal is underlain by 300 feet of conglomerate, whose lower part is composed largely of gabbro pebbles, while near the top the pebbles are smaller and largely of Cretaceous sandstone. Below the conglomerate at the base of the Arago beds there lie 100 feet or so of sandstones and shales, which separate it from the Myrtle formation.

Traces of coal have been found on Coal Creek and near Rogue River above Big Bend, as well as at other localities, but none of them are of importance.

#### GOLD.

Nearly all of the gold which has thus far been obtained in the Port Orford quadrangle has come from placer mines, some of which are along beaches in marine deposits and the rest in river gravels, especially along the South Fork of the Sixes and at the heads of Salmon and Johnson creeks, with a smaller area at the head of Boulder and Rock creeks near the south end of Iron Mountain. There is one quartz mill in the region.

The gold belt of the Port Orford quadrangle has long been the most active mining region of the Oregon coast. It has yielded considerable gold in the past, and is yet a moderate producer. The total product from the quadrangle since 1852 is probably not far from a million.

The belt runs approximately N. 70°-80° W. from the mouth of Johnson Creek on the South Fork of the Coquille, and has a width of several miles. West of Johnson Creek it crosses the head of Salmon Creek, passes along the South Fork of the Sixes, and reaches the coastal plain south of Denmark. On this belt the principal formation is the Myrtle, composed of more or less altered sandstones and shales which locally contain veins of quartz. It is penetrated by serpentine, gabbro, basalt, and dacite-porphry, and it is probable that the mineralization of the belt occurred in connection with one or more of these igneous intrusions. Some of the dacite-porphry dikes are too small to be represented on the map.

Placer mining.—Placer mines were once active along Johnson Creek throughout the greater part of its course, and paid moderately, but in the severe weather of the spring of 1890 landslides so filled up the stream bed that mining has since been unprofitable. A number of years must pass before this mass of material can be carried away and the gold sufficiently concentrated to make mining profitable, if indeed it ever becomes so again. Some of the miners believe that the bed of Johnson Creek, which is chiefly mined out, is not fed with gold now. The placers extended a short distance up Sucker Creek and Poverty Gulch from the main stream of Johnson Creek, and in nearly all cases the mining was confined to the present stream bed, although some of the benches were worked in the early days to 50 and 75 feet above the stream bed. The most successful mines have been near the head, close to the belt of dacite-porphry which crosses the divide toward the Salmon Mountain mine.

The Salmon Mountain mine, on the north slope of Salmon Mountain, at an elevation of 2100 feet, is hydraulic, using water with nearly 200 feet head, brought across the divide from the upper part of Johnson Creek. The cut is about 50 feet deep, the same in width, and 500 feet long, with a range of 200 feet in height. It is in rather fragmental material of igneous origin, except at the lower end, where Eocene shales and sandstones occur. Although closed at the present time, it has been worked during the rainy season at intervals for a number of years. When running under good head the mine paid \$75 to \$100 a day, and the gold is said to be rather uniformly distributed through the whole mass. This fragmental material of volcanic origin forms a bench with small depressions on the steep slope of Salmon Mountain, and appears to be due to a slide.

The rock is dark, often purplish or greenish, sometimes brecciated, much fractured, and easily goes to pieces. Although much altered, it retains traces of its ophitic structure which connects it with the basalts. Near the upper limit of its exposure, above the bulkhead, it is more solid and is associated with a rock rich in glaucophane, with sandstones and indurated shales bounding it on both sides.

The gold of the mine appears to be derived from small quartz veins, such as have been prospected in the immediate vicinity. Its intimate association with this igneous rock is exceptional and unlike anything else seen in the region. The branch of Salmon Creek which heads near the mine contains much of the same sort of debris in its bed and yields a small amount of gold annually to several miners.

Passing westward from the head of Salmon Creek in Coos County, the gold belt enters Curry County on the headwaters of the South Fork of Sixes River, in the vicinity of Rusty Butte, where interesting discoveries have been made recently. Many years ago there was great activity along the Sixes, in mining the benches, which rise to about 50 feet above the river. The mines were most abundant from the forks westward, and are represented by a number of cabins long since deserted. The bed rock is generally Cretaceous conglomerate, sandstone, and shales, and the gravel is composed of pebbles of the same material. At the mouth of Elephant Creek the terrace mined exposes about 25 feet of gravel, of which about an acre has been removed. Above the junction on the Middle Fork there has been but little mining, the region being covered largely by Eocene sediments; on the South Fork mining in a small way is still carried on, but is confined to the present stream beds during the low water of summer. Some of the earlier mines were in gravel benches as high as 130 feet above the present stream. The Guerin Brothers were ground sluicing just above the mouth of Butcher Gulch, and the Wagner claim, about a mile below, worked by Mr. J. L. Searle and others from the State of Washington, was operated on a larger scale. The whole stream was dammed to a height of about 5 feet and two lines of sluice boxes were suspended on numerous logs felled across the stream. A steam pump and nine men were employed. The bed of Butcher Gulch, on the northeast slope of Mount Butler, has been washed for a long distance from its mouth. Above the mouth of Rusty Gulch the bed and benches of the South Fork have not been found productive.

For 5 or 6 miles below the forks of the Sixes the placer mines have been idle for many years, but before reaching Edson Creek four active mines are found, one operated by Mr. Corbin, and the others by the Messrs. Divelbiss. The most extensive, operated by N. C. Divelbiss, is on the left bank, in the sharp bend 2 miles above the mouth of Edson Creek, and covers a large part of an acre. The gravel bank, worked by water under pressure, is 50 feet high and rests on Cretaceous sedimentary rocks. Farther west, near the mouth of Edson Creek, on the right bank, is an upper terrace of large extent which has been mined on the edge, but with scarcely sufficient success to warrant the extensive fluming necessary to supply the water that is needed to do the work satisfactorily. The Sixes, especially in its lower course, is overloaded by the large amounts of debris brought in by the great slide of February, 1890. One slide, 200 by 150 feet in extent, covered a house and other buildings and killed 3 persons and 21 head of stock.

Beyond the mouth of Edson Creek in the Sixes region all the placer mines are in marine deposits ranging from the present beach up to nearly 1000 feet above sea level. Mining on the higher benches has not been successful, but it continues at intervals along the present beach, and with greater success along the ancient beach of the coastal plain, about 120 feet above sea level. The Blanco and the Sixes mines are the most important. They have been in operation during the winter for a number of years.

The Blanco mine is about midway between Port Orford and Langlois, along the inner border of the coastal plain, at the foot of Madden Butte, in the NE. ¼ sec. 4, T. 32 S., R. 15 W. It is operated by Mr. Cyrus Madden, with about 500 feet of sluices and 7 burlap tables for catching the fine gold, which constitutes about one-half of the total product. Platinum-like metals occur with the gold at this point and are about one-twentieth as abundant. The section exposed in the mine includes about 8 feet of wind-blown material next to the surface, and below it 12 to 20 feet of sand with small black layers and some gravel.

Some of the dark layers are bordered by oxide of iron, and one of these is used as a bed rock on which to wash the overlying material. The real bed rock, which lies 10 feet below, is Cretaceous shale, but it is too low for drainage across the plain. The working season usually runs six months, from November to May, and the mine has recently yielded over \$1100 annually. The beds of sand and gravel of the ancient beach dip gently (10°) westward and overlap the older rocks at the base of Madden Butte. The mine already covers an area of several acres, and there is reason to expect that it will continue profitable farther along the shore, especially at deeper levels if possible to drain to bed rock.

The Sixes mine is located about 2½ miles south of Denmark, near the line between secs. 27 and 34, T. 31 S., R. 15 W., and is operated by Mr. W. P. Butler, of Lakeport, Cal. Like the Blanco mine, it lies along the eastern border of the coastal plain, at an altitude of nearly 200 feet above sea level. The mine covers about an acre and has a depth below the surface of about 12 feet, exposing along the eastern border the following section:

Section at the Sixes mine, 2½ miles south of Denmark.

	Feet.
Surface material, wind-blown sand and soil	5
Gray sand with bowlders	2
Black sand with bowlders	2½

The whole 9½ feet of material is more or less distinctly stratified and dips gently westward, away from the shore, which is formed of crushed sandstone and shale of Cretaceous age. This bed-rock series is well exposed in the eastern portion of the mine, and contains rock oyster borings. The decomposed fine sediments yield tough bluish clay, which on the surface for 6 inches or so is stained reddish and becomes more granular, affording a good bed rock for mining. The gravel is washed into a pool and raised 15 feet by an hydraulic elevator, to get drainage for sluicing and tables. Much of the gold is fine and is associated with platinum metals in sufficient quantities to make the saving of them a matter of some importance.

The lack of adequate water supply and good drainage renders mining so expensive as to retard the development of hydraulic mining along this promising old beach.

Oregon gold was first discovered along the beach at Gold Beach, Port Orford, and the mouth of Whiskey Run, where work was commenced in 1852. Four years later the gravels of Johnson Creek and the Sixes were prospected; and work on the elevated beaches at the eastern edge of the coastal plain, the Blanco and the Sixes mines, followed in 1871. The beach mines were very rich in places and were extensively mined, but within the last few years they have received little attention.

The original source of the gold is in the quartz veins of the Myrtle formation. The supply for the stream gravels has been direct, but at least some of that on the beach is derived from Tertiary beds by wave action on the beach, and this indicates that the auriferous quartz veins in the Myrtle formation were formed before the beginning of the Tertiary.

Quartz mining.—Attempts have been made to trace the placer gold to the veins from which it came, and some of the efforts have been successful. A good 5-stamp mill was early erected in connection with the Divelbiss mine in Poverty Gulch. It is generally idle, so that its output is very small. The ore is obtained half a mile southeast and 500 feet above the quartz mill, with which it is connected by tramway and cabled slope. The mine is an open cut in a steep slope, exposing a very ferruginous seamy quartz mass, containing also much oxide of manganese, on the contact of a form of dacite-porphry and slates mingled with other igneous rocks which the dacite-porphry intersects. The black oxide of iron and manganese interferes mechanically to a considerable degree with the amalgamation of the gold. Mr. Ira Buzan and several associates operated the mill for a short time in the summer of 1900.

Near the stream of Poverty Gulch a mile and a quarter above its mouth a number of tunnels have been run westward into the gabbroic mass of Granite Peak, bringing out much material like

serpentine. The ore is pyritiferous iron-stained quartz, which occurs in veins up to 5 inches thick, between walls of gabbro. Among the iron pyrites there is a trace of those bearing copper.

Other prospects have been opened up within the drainage of Poverty Gulch and Sucker creeks, but none have proved to be promising. Throughout the region there is considerable low-grade ore, which in course of time renders the stream gravels rich enough to pay for mining, but the quantity of gold is not sufficient to encourage the hope of finding vein deposits that can at present be mined with profit.

A short distance southwest of the Salmon Mountain placer mine a quartz mine was opened by several tunnels running in a southerly direction into the hill. One of these showed a 2-inch quartz vein, with smaller veinlets, containing besides some pyrite occasional visible traces of free gold. Veins of this sort are found in the pebbles of Cretaceous sandstone which occur in the adjacent Eocene conglomerate, so that the formation of the veins belongs near the close of the Cretaceous.

Greater success has attended the efforts of prospectors on Rusty Butte, where the Harrisons and others have discovered some promising but small ore bodies, which occur partly in sedimentary but mostly in igneous rocks.

The first discovery was made at St. Patricks, nearly 1000 feet below the summit of Rusty Butte, on the southern slope, in slaty rocks, but not far below the contact with the overlying igneous rock which has altered the slates. Both walls are of slate, and strike N. 45° E., with a dip of 65° NW. The ore in the small irregular vein is usually quartz full of pyrite, which by its decomposition liberates the free gold, stains the rock with oxide of iron, and softens the mass. Other portions contain calcite instead of quartz, and associated with the pyrite are small quantities of bluish-gray mineral which from its cubical cleavage is regarded as galena. Tellurium is said to be present, but a test by Dr. W. F. Hillebrand for that element in the most promising specimens the writer obtained at the mine showed no trace of it. Instead, however, Dr. Hillebrand found considerable arsenic and some lead, indicating that part of what looks like pyrite is arsenopyrite and that the gray mineral is galena.

The Golden Fleece and other openings near the summit of Rusty Butte are wholly within igneous

rock, which where best developed is an altered gabbro composed of plagioclase feldspar and greenish hornblende. In places near the mines the rock is decidedly porphyritic with dark crystals of augite which are changing to hornblende. Quartz is not one of the original constituents of the rock here, but it is permeated with small veinlets of quartz of secondary origin.

These minute veins are altogether irregular as to size, direction, and distribution. The deepest openings examined were at the Mountain Daisy and Golden Fleece, where the open cut and shaft reach 15 feet into decomposed gabbro. Small irregular cavities occur in it without order, here and there containing black to reddish-brown powdery material which is generally rich in fine gold. Much of the gold is wiry and cross striated in various directions, as if from contact with striated quartz crystals, with which it is associated in the seams. The powdery material is a mixture of black oxide of manganese and reddish-brown oxide of iron resulting from the alteration of the pyrite.

At the face of the Golden Fleece tunnel the gabbro is rotten, with a belt of little seams nearly a foot in width. The seams are irregular, but more or less lenticular and approximately horizontal. They contain the auriferous black and red oxides of iron, but are not persistent. The crushing of the Cretaceous rocks near the close of that period was extensive, leaving a multitude of small fissures, and the fissures were filled with quartz and locally with calcite. They contain chiefly pyrite, a little galena, and perhaps some other ores which on alteration and concentration yielded the little pockets now sought for.

From the Mountain Daisy, which was discovered in 1899, 7½ ounces of gold were taken out in a very short time. The gold, containing considerable silver, is low grade. The pay seam in this claim was nearly vertical and soon ran out below. It is pockets and seams of this character chiefly that have supplied the placer gold of the stream and beach gravels. Their small size, irregularity, and lack of persistence are not encouraging features.

#### PLATINUM MINERALS.

The recent demand for platinum has increased its value so greatly that the metal becomes of greater economic interest. The Klamath Mountains of southwest Oregon and northwest Cali-

fornia have probably yielded more platinum than any other portion of the United States.

Platinum and iridosmine, like gold, are heavy minerals and in placer mining accumulate in the concentrates with the gold. Hitherto the beach mines have been most productive, and it is possible that much valuable material has been thrown away. At the Blanco mine Mr. Madden, who has saved platinum for the last few years, informs the writer that the platinum minerals are to the gold in the proportion of 1 to 20. A sample of sand from the Sixes mine was examined and the platinum minerals amounted to 1½ cents a ton, while the gold was valued at 23 cents a ton. The relation of the two is about the same as at the Blanco mine, but judging from samples from the Sixes mine examined by Dr. D. T. Day the average value of the platinum per ton is as much as 12 cents, and it averages about 18 per cent of the value of the gold.

In order to get a clue to the source of the platinum, if possible, concentrates were obtained from the placer mines at several points along the Sixes. Ascending the river, the first was obtained from Mr. N. C. Divelbiss's mine on the left bank of the stream about three-fourths of a mile above the mouth of Dry Creek. The sample submitted contained the concentrates from a clean-up after removing the gold. It weighed about 22.87 grams, of which 5.78 grams (about 25 per cent) were separated by the magnet. Platinum scales were found rather abundant, and non-magnetic, so they remained in the non-magnetic portion. The scales generally were very small, but one well rounded by attrition weighed .03 gram. The scales are generally malleable and sectile and of steel-gray color, distinguishable from the nearly tin-white and almost brittle scales of iridosmine, which are about one-third as abundant as those of platinum. In the estimates given below, the platinum and iridosmine are counted together. The residue was passed through a series of sieves ranging in size from 60 to 100 mesh per inch, separating it into six lots, which were then panned out. Nearly all the platinum was caught in the 60, 80, and 100 mesh. The total yield was .384 gram—about .0168 per cent of the whole sample examined. A ton of such sand containing the same proportion would have about \$7,500 worth of platinum alone. This material is highly concentrated and there is no means of determining how many cubic yards of original gravel it repre-

sents, so that the value of the platinum per ton of gravel is unknown. Besides magnetite, the other minerals are chiefly chromite and ilmenite, with much zircon, epidote, and garnet and a trace of cinnabar.

Another sample of concentrates from the same mine, weighing 60 ounces, contained platinum at the rate of about \$17 a ton, and the gold was about seven times as abundant as the platinum, but in this case as in the first the amount of gravel represented by these concentrates is unknown.

In order to get an idea of the relative values contained in the gravel of the mine, the concentrates from two pans of gravel next the bed rock were obtained from Mr. N. C. Divelbiss. They contained 32½ cents of gold, but no platinum was found. Two pans of gravel from 25 feet above the bed rock contained 3 cents in gold and no platinum.

On the right bank of the Sixes about a mile above the mouth of Dry Creek, nearly opposite Mr. N. C. Divelbiss's mine, is a placer operated by Mr. W. O. Corbin, who informed the writer that one winter he saved \$11 worth of platinum from his washings. He sent 44 ounces of sand from the mine, which was sieved and washed; it yielded .176 gram of gold, less than one-hundredth part as much iridosmine, and no platinum. The relation of the concentrates to the gravel being unknown, the value of the gravel per ton can not be given.

From one of the Guerin Brothers who works a placer along the South Fork of the Sixes, the writer obtained about 5 ounces of concentrates, to examine for platinum. Nearly 85 per cent of the concentrates was magnetite and the remainder was chiefly ilmenite or chromite (?). Numerous scales of gold were present, but no platinum or iridosmine was found.

So little is known of the distribution of platinum in the placer mines that no definite indication is furnished as to its source. Where it has been traced to its source in other regions, however, it has been found in serpentine, and in Oregon it probably has the same association. Prospectors should carefully search for platinum, following the streams which cut masses of serpentine. A particularly large mass of serpentine occurs along the Illinois River, and platinum should be looked for along that stream.

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