DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

GEOLOGIC ATLAS

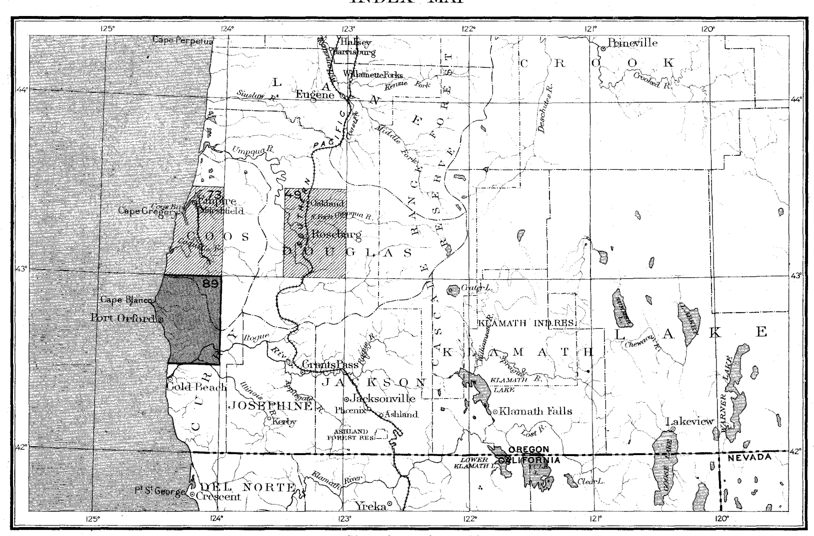
OF THE

UNITED STATES

PORT ORFORD FOLIO

OREGON

INDEX MAP



SCALE: 40 MILES-1 INCH

AREA OF THE PORT ORFORD FOLIO

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LIBRARY EDITION

PORT ORFORD FOLIO
NO. 89

WASHINGTON, D. C.

ENGRAVED AND PRINTED BY THE U. S. GEOLOGICAL SURVEY

GEORGE W. STOSE, EDITOR OF GEOLOGIC MAPS S. J. KUBEL, CHIEF ENGRAVER

1903

EXPLANATION.

The Geological Survey is making a geologic map of the United States, which necessitates the preparation of a topographic base map. The two are being issued together in the form of an atlas, the parts of which are called folios. Each folio consists of a topographic base map and geologic maps of a small area of country, together with explanatory and descriptive texts.

THE TOPOGRAPHIC MAP.

The features represented on the topographic map are of three distinct kinds: (1) inequalities of surface, called *relief*, as plains, plateaus, valleys, hills, and mountains; (2) distribution of water, called *drainage*, as streams, lakes, and swamps; (3) the works of man, called *culture*, as roads, railroads, boundaries, villages, and cities.

Relief.—All elevations are measured from mean sea level. The heights of many points are accurately determined, and those which are most important are given on the map in figures. It is desirable, however, to give the elevation of all parts of the area mapped, to delineate the horizontal outline, or contour, of all slopes, and to indicate their grade or degree of steepness. This is done by lines connecting points of equal elevation above mean sea level, the lines being drawn at regular vertical intervals. These lines are called *contours*, and the uniform vertical space between each two contours is called the *contour interval*. Contours and elevations are printed in brown.

The manner in which contours express elevation, form, and grade is shown in the following sketch and corresponding contour map:

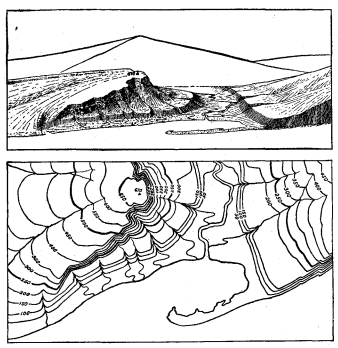


Fig. 1.—Ideal sketch and corresponding contour map.

The sketch represents a river valley between two hills. In the foreground is the sea, with a bay which is partly closed by a hooked sand bar. On each side of the valley is a terrace. From the terrace on the right a hill rises gradually, while from that on the left the ground ascends steeply in a precipice. Contrasted with this precipice is the gentle descent of the slope at the left. In the map each of these features is indicated, directly beneath its position in the sketch, by contours. The following explanation may make clearer the manner in which contours delineate elevation, form, and grade:

1. A contour indicates approximately a certain height above sea level. In this illustration the contour interval is 50 feet; therefore the contours are drawn at 50, 100, 150, 200 feet, and so on, above sea level. Along the contour at 250 feet lie all points of the surface 250 feet above sea; and similarly with any other contour. In the space between any two contours are found all elevations above the lower and below the higher contour. Thus the contour at 150 feet falls just below the edge of the terrace, while that at 200 feet lies above the terrace; therefore all points on the terrace are shown to be more than 150 but less than 200 feet above sea. The summit of the higher hill is stated to be 670 feet above sea; accordingly the contour at 650 feet surrounds it. In this illustration nearly all the contours are numbered. Where this is not possible, certain contours—say every fifth one—are accentuated and numbered; the heights of others may then be ascertained by counting up or down from a numbered contour.

2. Contours define the forms of slopes. Since contours are continuous horizontal lines conforming to the surface of the ground, they wind smoothly about smooth surfaces, recede into all reentrant angles of ravines, and project in passing about prominences. The relations of contour curves and angles to forms of the landscape can be traced in the map and sketch.

3. Contours show the approximate grade of any slope. The vertical space between two contours is the same, whether they lie along a cliff or on a gentle slope; but to rise a given height on a gentle slope one must go farther than on a steep slope, and therefore contours are far apart on gentle slopes and near together on steep ones.

For a flat or gently undulating country a small contour interval is used; for a steep or mountainous country a large interval is necessary. The smallest interval used on the atlas sheets of the Geological Survey is 5 feet. This is used for regions like the Mississippi delta and the Dismal Swamp. In mapping great mountain masses, like those in Colorado, the interval may be 250 feet. For intermediate relief contour intervals of 10, 20, 25, 50, and 100 feet are used.

Drainage.—Water courses are indicated by blue lines. If the streams flow the year round the line is drawn unbroken, but if the channel is dry a part of the year the line is broken or dotted. Where a stream sinks and reappears at the surface, the supposed underground course is shown by a broken blue line. Lakes, marshes, and other bodies of water are also shown in blue, by appropriate conventional signs.

Culture.—The works of man, such as roads, railroads, and towns, together with boundaries of townships, counties, and States, and artificial details, are printed in black.

Scales.—The area of the United States (excluding Alaska) is about 3,025,000 square miles. On a map with the scale of 1 mile to the inch this would cover 3,025,000 square inches, and to accommodate it the paper dimensions would need to be about 240 by 180 feet. Each square mile of ground surface would be represented by a square inch of map surface, and one linear mile on the ground would be represented by a linear inch on the map. This relation between distance in nature and corresponding distance on the map is called the scale of the map. In this case it is "1 mile to an inch." The scale may be expressed also by a fraction, of which the numerator is a length on the map and the denominator the corresponding length in nature expressed in the same unit. Thus, as there are 63,360 inches in a mile, the scale of "1 mile to an inch" is expressed by $\frac{1}{63,360}$. Both of these methods are used on the maps of the Geological Survey.

Three scales are used on the atlas sheets of the Geological Survey; the smallest is $\frac{1}{250,000}$, the intermediate $\frac{1}{125,000}$, and the largest $\frac{1}{62,500}$. These correspond approximately to 4 miles, 2 miles, and 1 mile on the ground to an inch on the map. On the scale $\frac{1}{62,500}$ a square inch of map surface represents and corresponds nearly to 1 square mile; on the scale $\frac{1}{125,000}$, to about 4 square miles; and on the scale $\frac{1}{250,000}$, to about 16 square miles. At the bottom of each atlas sheet the scale is expressed in three different ways, one being a graduated line representing miles and parts of miles in English inches, another indicating distance in the metric system, and a third giving the fractional scale.

Atlas sheets and quadrangles.—The map is being published in atlas sheets of convenient size, which are bounded by parallels and meridians. The corresponding four-cornered portions of territory are called *quadrangles*. Each sheet on the scale of $\frac{1}{250,000}$ contains one square degree, i. e., a degree of latitude by a degree of longitude; each sheet on the scale of $\frac{1}{125,000}$ contains one-quarter of a square degree; each sheet on a scale of $\frac{1}{62,500}$ contains one-sixteenth of a square degree. The areas of the corresponding quadrangles are about 4000, 1000, and 250 square miles, respectively.

The atlas sheets, being only parts of one map of the United States, are laid out without regard to the boundary lines of the States, counties, or townships. To each sheet, and to the quadrangle it represents, is given the name of some well-known town or natural feature within its limits, and at the sides and corners of each sheet the names of adjacent sheets, if published, are printed.

Uses of the topographic sheet.—Within the limits of scale the topographic sheet is an accurate and characteristic delineation of the relief, drainage, and culture of the district represented. Viewing the landscape, map in hand, every characteristic feature of sufficient magnitude should be recognizable. It should guide the traveler; serve the investor or owner who desires to ascertain the position and surroundings of property to be bought or sold; save the engineer preliminary surveys in locating roads, railways, and irrigation ditches; provide educational material for schools and homes; and serve many of the purposes of a map for local reference.

THE GEOLOGIC MAP.

The maps representing areal geology show by colors and conventional signs, on the topographic base map, the distribution of rock formations on the surface of the earth, and the structure-section map shows their underground relations, as far as known and in such detail as the scale permits.

KINDS OF ROCKS.

Rocks are of many kinds. The original crust of the earth was probably composed of *igneous rocks*, and all other rocks have been derived from them in one way or another.

Atmospheric agencies gradually break up igneous rocks, forming superficial, or *surficial*, deposits of clay, sand, and gravel. Deposits of this class have been formed on land surfaces since the earliest geologic time. Through the transporting agencies of streams the surficial materials of all ages and origins are carried to the sea, where, along with material derived from the land by the action of the waves on the coast, they form *sedimentary rocks*. These are usually hardened into conglomerate, sandstone, shale, and limestone, but they may remain unconsolidated and still be called "rocks" by the geologist, though popularly known as gravel, sand, and clay.

From time to time in geologic history igneous and sedimentary rocks have been deeply buried, consolidated, and raised again above the surface of the water. In these processes, through the agencies of pressure, movement, and chemical action, they are often greatly altered, and in this condition they are called *metamorphic rocks*.

Igneous rocks.—These are rocks which have cooled and consolidated from a liquid state. As has been explained, sedimentary rocks were deposited on the original igneous rocks. Through the igneous and sedimentary rocks of all ages molten material has from time to time been forced upward to or near the surface, and there consolidated. When the channels or vents into which this molten material is forced do not reach the surface, it may consolidate in cracks or fissures crossing the bedding planes, thus forming dikes, or spread out between the strata in large bodies, called sheets or laccoliths, or form large irregular cross-cutting masses, called stocks. Such rocks are called *intrusive*. Within their rock inclosures they cool slowly, and hence are generally of crystalline texture. When the channels reach the surface the lavas often flow out and build up volcanoes. These lavas cool rapidly in the air, acquiring a glassy or, more often, a partially crystalline condition. They are usually more or less porous. The igneous rocks thus formed upon the surface are called *extrusive*. Explosive action often accompanies volcanic eruptions, causing ejections of dust or ash and larger fragments. These materials when consolidated constitute breccias, agglomerates, and tuffs. The ash when carried into lakes or seas may become stratified, so as to have the structure of sedimentary rocks.

The age of an igneous rock is often difficult or impossible to determine. When it cuts across a sedimentary rock it is younger than that rock, and when a sedimentary rock is deposited over it the igneous rock is the older.

Under the influence of dynamic and chemical forces an igneous rock may be metamorphosed. The alteration may involve only a rearrangement of its minute particles or it may be accompanied by a change in chemical and mineralogic composition. Further, the structure of the rock may be changed by the development of planes of division, so that it splits in one direction more easily than in others. Thus a granite may pass into a gneiss, and from that into a mica-schist.

Sedimentary rocks.—These comprise all rocks which have been deposited under water, whether in sea, lake, or stream. They form a very large part of the dry land.

When the materials of which sedimentary rocks are composed are carried as solid particles by water and deposited as gravel, sand, or mud, the deposit is called a mechanical sediment. These may become hardened into conglomerate, sandstone, or shale. When the material is carried in solution by the water and is deposited without the aid of life, it is called a chemical sediment; if deposited with the aid of life, it is called an organic sediment. The more important rocks formed from chemical and organic deposits are limestone, chert, gypsum, salt, iron ore, peat, lignite, and coal. Any one of the above sedimentary deposits may be separately formed, or the different materials may be intermingled in many ways, producing a great variety of rocks.

Sedimentary rocks are usually made up of layers or beds which can be easily separated. These layers are called *strata*. Rocks deposited in successive layers are said to be stratified.

The surface of the earth is not fixed, as it seems to be; it very slowly rises or sinks over wide expanses, and as it rises or subsides the shore lines of the ocean are changed: areas of deposition may rise above the water and become land areas, and land areas may sink below the water and become areas of deposition. If North America were gradually to sink a thousand feet the sea would flow over the Atlantic coast and the Mississippi and Ohio valleys from the Gulf of Mexico to the Great Lakes; the Appalachian Mountains would become an archipelago, and the ocean's shore would traverse Wisconsin, Iowa, and Kansas, and extend thence to Texas. More extensive changes than this have repeatedly occurred in the past.

The character of the original sediments may be changed by chemical and dynamic action so as to produce metamorphic rocks. In the metamorphism of a sedimentary rock, just as in the metamorphism of an igneous rock, the substances of which it is composed may enter into new combinations, or new substances may be added. When these processes are complete the sedimentary rock becomes crystalline. Such changes transform sandstone to quartzite, limestone to marble, and modify other rocks according to their composition. A system of parallel division planes is often produced, which may cross the original beds or strata at any angle. Rocks divided by such planes are called slates or schists.

Rocks of any period of the earth's history may be more or less altered, but the younger formations have generally escaped marked metamorphism, and the oldest sediments known, though generally the most altered, in some localities remain essentially unchanged.

Surficial rocks.—These embrace the soils, clays, sands, gravels, and bowlders that cover the surface, whether derived from the breaking up or disintegration of the underlying rocks by atmospheric agencies or from glacial action. Surficial rocks that are due to disintegration are produced chiefly by the action of air, water, frost, animals, and plants. They consist mainly of the least soluble parts of the rocks, which remain after the more soluble parts have been leached out, and hence are known as residual products. Soils and subsoils are the most important. Residual accumulations are often washed or blown into valleys or other depressions, where they lodge and form deposits that grade into the sedimentary class. Surficial rocks that are due to glacial action are formed of the products of disintegration, together with bowlders and fragments of rock rubbed from the surface and ground together. These are spread irregularly over the territory occupied by the ice, and form a mixture of clay, pebbles, and bowlders which is known as till. It may occur as a sheet or be bunched into hills and ridges, forming moraines, drumlins, and other special forms. Much of this mixed material was washed away from the ice, assorted by water, and redeposited as beds or trains of sand and clay, thus forming another gradation into sedimentary deposits. Some of this glacial wash was deposited in tunnels and channels in the ice, and forms characteristic ridges and mounds of sand and gravel, known as osars, or eskers, and kames. The material deposited by the ice is called glacial drift; that washed from the ice onto the adjacent land is called modified drift. It is usual also to class as surficial rocks the deposits of the sea and of lakes and rivers that were made at the same time as the ice deposit.

AGES OF ROCKS.

Rocks are further distinguished according to their relative ages, for they were not formed all at one time, but from age to age in the earth's history. Classification by age is independent of origin; igneous, sedimentary, and surficial rocks may be of the same age.

When the predominant material of a rock mass is essentially the same, and it is bounded by rocks of different materials, it is convenient to call the mass throughout its extent a *formation*, and such a formation is the unit of geologic mapping.

Several formations considered together are designated a *system*. The time taken for the deposition of a formation is called an *epoch*, and the time taken for that of a system, or some larger fraction of a system, a *period*. The rocks are mapped by formations, and the formations are classified into systems. The rocks composing a system and the time taken for its deposition are given the same name, as, for instance, Cambrian system, Cambrian period.

As sedimentary deposits or strata accumulate the younger rest on those that are older, and the relative ages of the deposits may be discovered by observing their relative positions. This relationship holds except in regions of intense disturbance; sometimes in such regions the disturbance of the beds has been so great that their position is reversed, and it is often difficult to determine the relative ages of the beds from their positions; then *fossils*, or the remains of plants and animals, are guides to show which of two or more formations is the oldest.

Strata often contain the remains of plants and animals which lived in the sea or were washed from the land into lakes or seas or were buried in surficial deposits on the land. Rocks that contain the remains of life are called fossiliferous. By studying these remains, or fossils, it has been found that the species of each period of the earth's history have to a great extent differed from those of other periods. Only the simpler kinds of marine life existed when the oldest fossiliferous rocks were deposited. From time to time more complex kinds developed, and as the simpler ones lived on in modified forms life became more varied. But during each period there lived peculiar forms, which did not exist in earlier times and have not existed since; these are characteristic types, and they define the age of any bed of rock in which they are found. Other types passed on from period to period, and thus linked the systems together, forming a chain of life from the time of the oldest fossiliferous rocks to the present.

When two formations are remote one from the other and it is impossible to observe their relative positions, the characteristic fossil types found in them may determine which was deposited first.

Fossil remains found in the rocks of different areas, provinces, and continents afford the most important means for combining local histories into a general earth history.

Colors and patterns.—To show the relative ages of strata, the history of the sedimentary rocks is divided into periods. The names of the periods in proper order (from new to old), with the colors and symbol assigned to each, are given in the table in the next column. The names of certain subdivisions and groups of the periods, frequently used in geologic writings, are bracketed against the appropriate period names.

To distinguish the sedimentary formations of any one period from those of another the patterns for the formations of each period are printed in the appropriate period-color, with the exception of the one at the top of the column (Pleistocene) and the one at the bottom (Archean). The sedimentary formations of any one period, excepting the Pleistocene and the Archean, are distinguished from one another by different patterns, made of parallel straight lines. Two tints of the period-color are used: a pale tint is printed evenly over the whole surface representing the period; a dark tint brings out the different patterns representing formations. Each formation is furthermore given

Period.		Symbol.	Color.
Cenozoic	Pleistocene	P	Any colors.
	Neocene { Pliocene, Miocene }	N	Buffs.
	Eocene, including Oligocene	E	Olive-browns.
Mesozoic	Cretaceous	K	Olive-greens.
	Juratrias { Jurassic, Triassic }	J	Blue-greens.
Paleozoic	Carboniferous, including Permian	C	Blues.
	Devonian	D	Blue-purples.
	Silurian, including Ordovician	S	Red-purples.
	Cambrian	€	Pinks.
	Algonkian	A	Orange-browns.
	Archean	Æ	Any colors.

a letter-symbol composed of the period letter combined with small letters standing for the formation name. In the case of a sedimentary formation of uncertain age the pattern is printed on white ground in the color of the period to which the formation is supposed to belong, the letter-symbol of the period being omitted.

The number and extent of surficial formations, chiefly Pleistocene, render them so important that, to distinguish them from those of other periods and from the igneous rocks, patterns of dots and circles, printed in any colors, are used.

The origin of the Archean rocks is not fully settled. Many of them are certainly igneous. Whether sedimentary rocks are also included is not determined. The Archean rocks, and all metamorphic rocks of unknown origin, of whatever age, are represented on the maps by patterns consisting of short dashes irregularly placed. These are printed in any color, and may be darker or lighter than the background. If the rock is a schist the dashes or hachures may be arranged in wavy parallel lines. If the metamorphic rock is known to be of sedimentary origin the hachure patterns may be combined with the parallel-line patterns of sedimentary formations. If the rock is recognized as having been originally igneous, the hachures may be combined with the igneous pattern.

Known igneous formations are represented by patterns of triangles or rhombs printed in any brilliant color. If the formation is of known age the letter-symbol of the formation is preceded by the capital letter-symbol of the proper period. If the age of the formation is unknown the letter-symbol consists of small letters which suggest the name of the rocks.

THE VARIOUS GEOLOGIC SHEETS.

Areal geology sheet.—This sheet shows the areas occupied by the various formations. On the margin is a *legend*, which is the key to the map. To ascertain the meaning of any particular colored pattern and its letter-symbol on the map the reader should look for that color, pattern, and symbol in the legend, where he will find the name and description of the formation. If it is desired to find any given formation, its name should be sought in the legend and its color and pattern noted, when the areas on the map corresponding in color and pattern may be traced out.

The legend is also a partial statement of the geologic history. In it the symbols and names are arranged, in columnar form, according to the origin of the formations—surficial, sedimentary, and igneous—and within each group they are placed in the order of age, so far as known, the youngest at the top.

Economic geology sheet.—This sheet represents the distribution of useful minerals, the occurrence of artesian water, or other facts of economic interest, showing their relations to the features of topography and to the geologic formations. All the formations which appear on the historical geology sheet are shown on this sheet by fainter color patterns. The areal geology, thus printed, affords a subdued background upon which the areas of productive formations may be emphasized by strong colors. A symbol for mines is introduced at each occurrence, accompanied by the name of the principal mineral mined or of the stone quarried.

Structure-section sheet.—This sheet exhibits the relations of the formations beneath the surface.

In cliffs, canyons, shafts, and other natural and artificial cuttings, the relations of different beds to one another may be seen. Any cutting which exhibits those relations is called a *section*, and the same name is applied to a diagram representing the relations. The arrangement of rocks in the earth is the earth's *structure*, and a section exhibiting this arrangement is called a *structure section*.

The geologist is not limited, however, to the natural and artificial cuttings for his information concerning the earth's structure. Knowing the manner of the formation of rocks, and having traced out the relations among beds on the surface, he can infer their relative positions after they pass beneath the surface, draw sections which represent the structure of the earth to a considerable depth, and construct a diagram exhibiting what would be seen in the side of a cutting many miles long and several thousand feet deep. This is illustrated in the following figure:

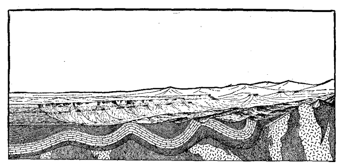


Fig. 2.—Sketch showing a vertical section in the front of the picture, with a landscape beyond.

The figure represents a landscape which is cut off sharply in the foreground by a vertical plane, so as to show the underground relations of the rocks.

The kinds of rock are indicated in the section by appropriate symbols of lines, dots, and dashes. These symbols admit of much variation, but the following are generally used in sections to represent the commoner kinds of rock:

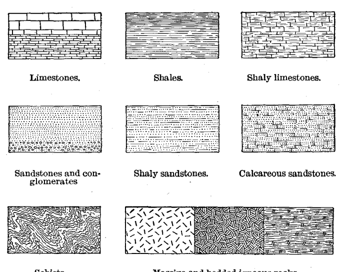


Fig. 3.—Symbols used to represent different kinds of rock.

The plateau in fig. 2 presents toward the lower land an escarpment, or front, which is made up of sandstones, forming the cliffs, and shales, constituting the slopes, as shown at the extreme left of the section.

The broad belt of lower land is traversed by several ridges, which are seen in the section to correspond to beds of sandstone that rise to the surface. The upturned edges of these beds form the ridges, and the intermediate valleys follow the outcrops of limestone and calcareous shales.

Where the edges of the strata appear at the surface their thickness can be measured and the angles at which they dip below the surface can be observed. Thus their positions underground can be inferred. The direction that the intersection of a bed with a horizontal plane will take is called the *strike*. The inclination of the bed to the horizontal plane, measured at right angles to the strike, is called the *dip*.

When strata which are thus inclined are traced underground in mining, or by inference, it is frequently observed that they form troughs or arches, such as the section shows. The arches are called *anticlines* and the troughs *synclines*. But the sandstones, shales, and limestones were deposited beneath the sea in nearly flat sheets. That they are now bent and folded is regarded as proof that forces exist which have from time to time caused the earth's surface to wrinkle along certain zones. In places the strata are broken across and the parts slipped past one another. Such breaks are termed *faults*.

On the right of the sketch the section is composed of schists which are traversed by masses of igneous rock. The schists are much contorted and their arrangement underground can not be inferred. Hence that portion of the section delineates what is probably true but is not known by observation or well-founded inference.

In fig. 2 there are three sets of formations, distinguished by their underground relations. The first of these, seen at the left of the section, is the set of sandstones and shales, which lie in a horizontal position. These sedimentary strata are now high above the sea, forming a plateau, and their change of elevation shows that a portion of the earth's mass has swelled upward from a lower to a higher level. The strata of this set are parallel, a relation which is called *conformable*.

The second set of formations consists of strata which form arches and troughs. These strata were once continuous, but the crests of the arches have been removed by degradation. The beds, like those of the first set, are conformable.

The horizontal strata of the plateau rest upon the upturned, eroded edges of the beds of the second set at the left of the section. The overlying deposits are, from their positions, evidently younger than the underlying formations, and the bending and degradation of the older strata must have occurred between the deposition of the older beds and the accumulation of the younger. When younger strata thus rest upon an eroded surface of older strata the relation between the two is an *unconformable* one, and their surface of contact is an *unconformity*.

The third set of formations consists of crystalline schists and igneous rocks. At some period of their history the schists were plicated by pressure and traversed by eruptions of molten rock. But this pressure and intrusion of igneous rocks have not affected the overlying strata of the second set. Thus it is evident that an interval of considerable duration elapsed between the formation of the schists and the beginning of deposition of the strata of the second set. During this interval the schists suffered metamorphism; they were the scene of eruptive activity; and they were deeply eroded. The contact between the second and third sets, marking a time interval between two periods of rock formation, is another unconformity.

The section and landscape in fig. 2 are ideal, but they illustrate relations which actually occur. The sections in the structure-section sheet are related to the maps as the section in the figure is related to the landscape. The profiles of the surface in the section correspond to the actual slopes of the ground along the section line, and the depth from the surface of any mineral-producing or water-bearing stratum which appears in the section may be measured by using the scale of the map.

Columnar section sheet.—This sheet contains a concise description of the rock formations which occur in the quadrangle. It presents a summary of the facts relating to the character of the rocks, the thicknesses of the formations, and the order of accumulation of successive deposits.

The rocks are described under the corresponding heading, and their characters are indicated in the columnar diagrams by appropriate symbols. The thicknesses of formations are given in figures which state the least and greatest measurements. The average thickness of each formation is shown in the column, which is drawn to a scale—usually 1000 feet to 1 inch. The order of accumulation of the sediments is shown in the columnar arrangement: the oldest formation is placed at the bottom of the column, the youngest at the top, and igneous rocks or surficial deposits, when present, are indicated in their proper relations.

The formations are combined into systems which correspond with the periods of geologic history. Thus the ages of the rocks are shown, and also the total thickness of each system.

The intervals of time which correspond to events of uplift and degradation and constitute interruptions of deposition of sediments are indicated graphically and by the word "unconformity."

CHARLES D. WALCOTT,
Director.

Revised January, 1902.

DESCRIPTION OF THE PORT ORFORD QUADRANGLE.

By J. S. Diller.

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° 30′ and 43°, respectively, with the meridian 124° 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 2½ 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 northeast of Denmark, but has a larger development near Fourmile 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 débris.

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, presented a shore bordered with many islands, 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°.

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 Horsetown 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. crassicollis* 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. crassicollis*, 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 crassicollis (Keyserling).
Aucella sp.
Inoceramus sp., related to I. ovatus (Stanton).
Turbo morganensis (Stanton).
Olcostephanus mutabilis (Stanton).
Perisphinctes ? sp.
Hoplites 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 crassicollis*, 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 crassicollis* 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 crassicollis*. The older portion of the Knoxville and the Jurassic slaty shales, which belong chronologically between the conglomerate-bearing *A. crassicollis* 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 manywhere 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 siliceous 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, antinolite, 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 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-porphyry. 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-porphyry 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 rock differs from the normal type in containing much less feldspar, and therefore a larger percentage of pyroxene or hornblende, according to the stage of alteration. At one point the rock is chiefly colorless pyroxene; nearby it contains considerable olivine, and at no great distance it is almost wholly green hornblende derived from the original pyroxene. Plagioclase is only sparingly present, but the character of the minerals is just the same as in the normal metagabbro, to which it is closely related in origin. This type, as also the normal type, is not found to contain any quartz, except small grains of secondary origin, but magnetite and in some places ilmenite, both of which are primary minerals, are common.

This basic type occurs also on the southeast slope of Panther Mountain, where specimen 5271 was obtained for analyses. The rock is much altered, although in the hand specimen it appears fresh. The pale-green hornblende is somewhat fibrous, like uralite, and the feldspar has lost its individuality, but shows faint lamellar twinning in places. Fine scales of mica and groups of epidote resulting from the alteration of the feldspar are common.

Turning now to the acid type, which is a common phase of the rock, it may be noted that primary quartz plays an important rôle. Biotite occurs in considerable quantities, and while much of the hornblende appears to be derived from the alteration of pyroxene, it is possible that some of it is primary. Much of the feldspar has a decided zonal structure, and well-defined crystals are more abundant than in the other phases of the metagabbro. Lamellar twinning is common, but some of the apparently untwinned grains may be orthoclase. The quartz, like that of granite, lies between the feldspars and is the final product of crystallization. Some of the biotite is altered to chlorite, and possibly also some of the hornblende. The acid type, which is at times decidedly dioritic, predominates on the southwest slope of Bald Mountain near the head of Brush Creek, where 5262 was collected. Its analysis, shown in the table, differs much from that of 5268, collected on the top of Bald Mountain. The two exposures are nearly a mile and a half apart and, owing to soil covering, there are many interruptions in the exposures between them, but the impression gained by several hours' examination was that they are parts of the same geological body and are not separated by any sharp line. This view was strengthened by finding in the slates small intruded aplitic masses which were regarded as apophyses from the adjacent gabbro mass, to which it was thought in the field they could be clearly traced. This type is especially rich in quartz and feldspar, much of which has the characteristic lamellar twinning of plagioclase, but others without such twinning must be orthoclase, judging from the chemical analyses given in the table. The ferromagnesian silicates are very subordinate. Chemically this rock is most closely related to the dacite-porphyry 5217.

A short distance west of Brush Creek, by the road near the summit of the Mussel Creek divide, a somewhat fresher rock (5140) was collected from the same general mass. It is composed chiefly of feldspar and pyroxene, part of which has changed to hornblende. Some of the feldspar is clearly plagioclase, but most of the grains lack lamellar twinning. There is but little quartz present. Its chemical composition, given in the table, lies generally between 5268 and 5262, although it has more magnesia and soda than either of them.

Notwithstanding this difference in chemical composition, which covers practically the whole range of the gabbroic rocks, it is believed that the Bald Mountain mass is essentially a unit and that its variations are the result of differentiation in the mass while yet in a more or less completely molten condition.

The geological age of the gabbro intrusion is fixed approximately by its penetrating the Myrtle formation (Cretaceous) on the one hand and by being covered by the Arago formation (Eocene) on the other. Although this relation with the Cretaceous rocks may be seen at many places, it is perhaps best exposed in Bald Mountain.

The gabbro mass of Bald Mountain has decidedly altered the shales and sandstones of the Myrtle formation. Many little knots appear in the indurated shale near the contact, and they become more crystalline toward the gabbro, with the development of numerous scales of biotite, as in hornfels.

Basalt.—A striking feature of the quadrangle is the occurrence of numerous small areas of basaltic rocks. They are especially abundant in the northern portion, and frequently form prominent stack-like ledges rising above the general level. A good example is Silver Butte, a few miles north of Port Orford, and another is Sawtooth Rock, near Rogue River. They vary considerably in texture. Rarely they are granitic or slightly porphyritic, but generally they are compact, greenish, and more or less schistose. The habit is igneous and generally in strong contrast with that of the enveloping sedimentary rocks. The mode of occurrence strongly suggests that these rock stacks are volcanic necks coming up from larger masses of gabbro below, and the chemical analyses (S. 6, 5250, 5215) show their close relation to the gabbro in composition.

Specimen 5215, from Sawtooth Rock, is made up largely of feldspar and pyroxene, with some quartz. The texture is like that of granite, but finer, and the feldspar is much altered and full of inclusions. The percentage of lime is remarkably high.

A short distance south, in the forks of the trail between the mouths of Sucker and Rock creeks, there is a prominent ledge (5250) in which the structure is ophitic rather than granular, and closely related to that of lava flows. Generally the structure of these masses is indistinct, but where marked this is by far the most common. The long lath-shaped crystals of plagioclase in 5250 are separated largely by chlorite, resulting from the alteration of pyroxene. The rock is much changed, as shown by the large percentage of water it contains, and yet its composition, as indicated by the analysis, is close to that of the normal gabbro. In other cases the pyroxene alters to hornblende which still clearly marks the original ophitic structure.

The least siliceous of these rocks of small area, as shown by the analyses, is S. 6, from about midway between Ophir and Cedar Point. It is composed chiefly of hornblende and feldspar, which have been broken into small rounded fragments. The pale-brownish hornblende is most abundant, but some is pale green, and both forms border grains of pyroxene, as if derived from it. There is much black dust-like material, which is apparently magnetite, judging from the large amount of iron oxides present.

The relative age of the basalt is the same as that of the gabbro, and they show that at the close of the Cretaceous there was vigorous volcanic activity in that region. The great erosion preceding the Eocene removed all the surface volcanic features and left only the necks.

In the Coos Bay region basalt occurs cutting the Eocene sediments. It is less altered and has a much fresher look than the basalt of the Port Orford quadrangle, which has not been found clearly cutting any sediments younger than the Cretaceous.

Dacite-porphyry.—The dacite-porphyry varies much in composition and appearance. Where best developed it forms distinct dikes, of which there is a good example between Salmon and Johnson mountains at the head of Johnson Creek. The rock is in some places decidedly porphyritic, but in others is without prominent crystals and looks like quartzite. The rounded crystals of quartz and broken angular ones of plagioclase are embedded in a fine groundmass of quartz and feldspar containing scattered patches of chlorite and hornblende. Only a few of the dikes have prominent grains of quartz, and they are generally poor in hornblende, as in the specimen taken for analysis (5217) to represent this type, which resembled quartzite. Some orthoclase is present, as shown by the amount of potash, but the much greater percentage of soda with considerable lime indicates that the prevailing feldspar is about oligoclase. Ferromagnesian silicates are not prominent.

Specimen 5176 in the field was regarded as belonging with the dacite-porphyry, but under the microscope is seen to be composed largely of plagioclase and hornblende. Its chemical analysis shows also that it is more closely related to the gabbro and basalt.

At the head of Boulder Creek there is a prominent hill adjoining the south end of Iron Mountain. The rock of this hill, although somewhat porphyritic, generally has the texture of granite, and the abundant quartz is of the granite type. The feldspar is altered, yielding among other products numerous grains of epidote associated with hornblende and chlorite. The chemical analysis (C. 64) shows that this rock is closely related to dacite-porphyry and to small dikes which were in the field regarded as apophyses (C. 86) from the gabbro penetrating the Cretaceous shales of Bald Mountain. On account of the close correspondence between the analyses of C. 86 and 5217 it is possible that C. 86 belongs with the dacite-porphyry.

Chemical analyses of igneous rocks in Port Orford quadrangle.

	5238	5242	5271	5268	5262	5140	5176	S. 6	5250	5215	5217	C. 64	C. 86
SiO_2	39.42	38.55	44.19	50.14	60.88	56.48	57.43	50.56	52.12	53.06	71.45	70.33	75.32
Al_2O_3	1.39	1.32	10.66	15.26	17.71	13.81	17.69	14.49	15.21	12.83	14.53	15.74	13.17
Fe_2O_3	3.42	5.55	.52	1.19	2.92	1.73	1.59	1.78	1.83	1.20	.49	1.43	.27
FeO	4.29	2.17	3.26	8.75	2.17	3.95	3.48	10.20	8.75	5.10	.94	.83	.98
MgO	39.68	39.06	11.90	7.21	2.21	8.67	2.73	5.90	6.01	7.50	.30	.53	.42
CaO	1.10	.85	10.76	9.34	4.32	6.69	5.72	10.13	3.75	13.71	2.01	3.38	1.48
Na_2O	none	.10	1.35	2.76	4.17	5.03	7.19	2.91	4.83	3.56	7.15	4.33	4.77
K_2O	none	.05	1.03	.95	2.68	.46	.58	.38	.48	.05	2.55	1.87	2.14
H_2O-	.36	1.14	.74	.23	.54	.67	.48	.20	.90	.16	.15	.20	.18
H_2O+	9.53	10.14	5.19	2.22	1.47	2.02	1.81	1.50	3.74	2.16	.38	1.16	.73
TiO_2	none	tr.	.12	1.42	.41	.31	.66	1.67	1.38	.42	.16	.27	.16
ZrO_2	......	......	none	......	......	......	none	none	none	ft. tr.	tr.	none	none
CO_2	......	.51	.06	none	none	none	.10	?	.09	.25	.08	tr.	.03
P_2O_5	none	tr.	tr.	.24	.16	.02	.17	tr.	.14	tr.	.09	.06	.04
SO_3	......	......	......	......	......	......	......	......	......	......	......	......	......
Cl	......	......	?	......	......	......	?	?	?	?	?	?	?
F	......	......	?	......	......	......	?	?	?	......	?	?	?
S	......	.03	tr.	.04	tr.	tr.	.02	(.15)*	tr.	tr.	tr.	tr.	(.05)*
Cr_2O_3	.58	.48	.15	tr.	none	tr.	......	......	none	.06	......	......	......
NiO	......	.13	.03	......	......	......	......	tr.	.03	tr.	......	......	......
MnO	none	.05	.11	tr.	tr.	tr.	.17	.25	.19	.16	tr.	tr.	tr.
BaO	none	none	.04	.03	.06	tr.	none	tr.	ft. tr.	none	.03	.09	.23
SrO	......	none	.05	none	tr.	.02	.02	none	none	none	none	tr.	.02
Li_2O	......	tr.	?	none	none	none	?	?	?	?	?	?	?
V_2O_3	......	......	......	......	......	......	......	......	......	tr.	......	......	......
FeS_2	......	......	......	......	......	......	......	.28	......	......	......	......	.09
	99.77	100.13	100.16	99.78	99.70	99.83	98.84	100.25	99.65	100.22	100.31	100.22	100.03

* Included in FeS_2.

Serpentine.
5238—12 miles north of mouth of Boulder Creek.
5242—Iron Mountain crest, near middle.

Gabbro.
5271—Southeast slope of Panther Mountain.
5268—Summit of Bald Mountain.
5262—On Brush Creek, 1½ miles southwest of Bald Mountain.
5140—Southeast ¼ sec. 7, T. 34 S., R. 14 W., on coast road.
5176—Left bank of Rogue River, 2 miles below mouth of the Illinois.

Basalt.
S. 6—Cedar Creek, 1½ miles northeast of Ophir.
5250—Near fork of West Bend trail, 2¼ miles south of Johnson Creek.
5215—Sawtooth Rock.

Dacite-porphyry.
5217—Six miles directly west of Big Bend of Rogue River.
C. 64—Head of Boulder Creek.
C. 86—South slope of Bald Mountain.

The dacite-porphyry is perhaps most commonly associated with the serpentine which it penetrates. It holds the same relation to the Myrtle formation as do the gabbro and the basalt, and in eruption, so far as the outcrops of the Port Orford quadrangle are concerned, it belongs to the interval between the Myrtle and Arago formations. It is desirable to note, however, at this point, that the conglomerates of the Myrtle formation contain many pebbles of igneous rocks which belong with the dacite-porphyry. The rocks from which these pebbles were derived must be older than the similar rocks of the Port Orford quadrangle.

ECONOMIC GEOLOGY.

COAL.

Coal has been found among the Arago beds at a number of points within the Port Orford quadrangle, but generally in quantities so small as to attract but little attention. However, in the Eckley region and on Shasta Costa Creek somewhat extensive prospects have been made, and are even yet in progress at the most promising locality a few miles southwest of Eckley.

The development of coal prospects in the Eckley region is due almost wholly to Mr. W. J. Holmes, to whom the writer is much indebted for guidance and especially for the opportunity which Mr. Holmes's many openings afford to examine the coal beds. Within the Arago formation of the Eckley area coal is known only close to its base, where it comes in contact with the Myrtle formation, and the most important outcrops yet found are along the southern border near the head of the Middle Fork of the Sixes, and 2 miles nearly west of Eckley, on the eastern slope of Sugarloaf Mountain.

Near the southern line of sec. 14, T. 32 S., R. 13 W., a number of tunnels and open cuts have been run in various directions into a mass of coal and coaly shale that varies greatly in structure and composition. Much of it is crushed and slickensided, but other portions appear to be good coal, with bright luster on fresh fracture.

Exposures are few and the position of the coal bed has to be determined largely from the openings, where the strata are much disturbed. The greatest extent of the coal is approximately east and west, parallel to its contact with the older rocks a short distance to the south. The coal is underlain by a thin bed of shale, nearly 100 feet of gray sandstone, and some conglomerate, which rests directly upon the older igneous and sedimentary rocks of Cretaceous age at the northern base of Rusty Butte. The underlying sandstone strikes east and west, with dip of 55° to the north, as would be expected near the contact, but among the coal openings a confusion of strikes and dips was observed, ranging through all general directions. For this reason it is believed that much of the coal near the level of Mr. Holmes's house has slid from an exposure higher up the slope and that its apparently great thickness (nearly 100 feet) is due to this cause.

A short distance farther south, at an elevation of over 200 feet above the larger mass, an outcrop of coal and coaly shale similar to that already noted occurs in place and is penetrated by a tunnel running almost directly east, parallel to the strike of the bedding. The total thickness of the coal and associated carbonaceous deposits is not well exposed, but may be nearly 50 feet, and it is certain that the series of outcrops within a few hundred yards of Mr. Holmes's house all belong to essentially the same horizon and lie very close to the base of the Arago beds of that region. An average sample (5493) of the better portion of the coal exposed here in one of the tunnels was taken for analysis, and the results are given below. About a mile east of Holmes's prospects several coals occur along the Middle Fork near the southern line of section 13; they belong to essentially the same horizon as those already noted, but contain nothing of greater promise.

Another outcrop which has been developed is in section 35 at the eastern part of Sugarloaf Mountain, close to the contact of the Arago beds with 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	34.91
Ash	2.44 (light reddish)	18.97 (white)
	100.00	100.00
Sulphur	3.87	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 1¾ 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 4½ 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_2SO_4 in vacuo, 48 hours.	Volatile combustible less moisture 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.

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-porphyry, 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-porphyry 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-porphyry 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 débris 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 débris 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-porphyry and slates mingled with other igneous rocks which the dacite-porphyry 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 California 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 represents, 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.

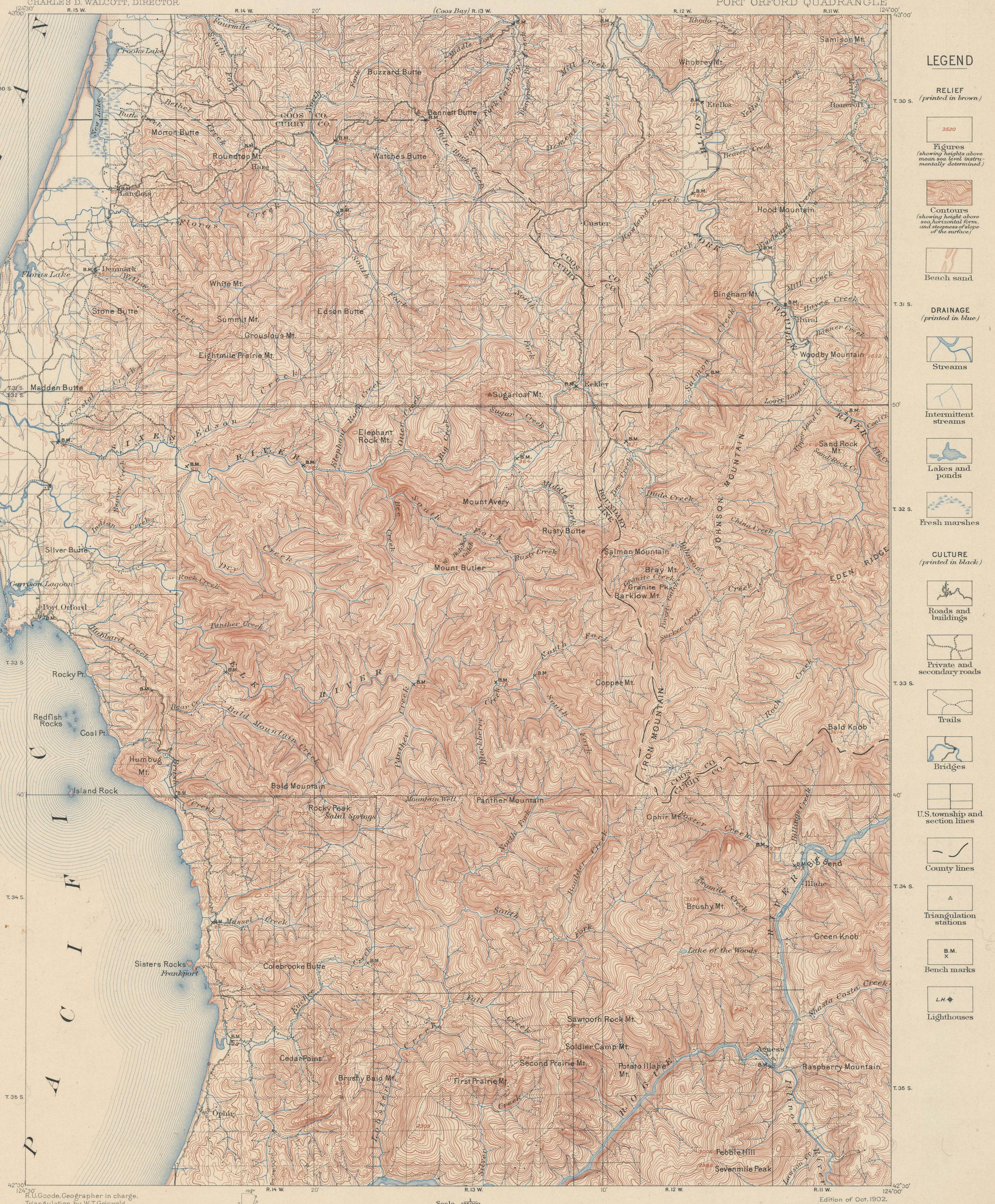
So little is known of the distribution of platinum in the placer mines that no definite indication is furnished as to its source. Where it has been traced to its source in other regions, however, it has been found in serpentine, and in Oregon it probably has the same association. Prospectors should carefully 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.

December, 1902.

U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

TOPOGRAPHIC SHEET

OREGON
PORT ORFORD QUADRANGLE



R. U. Goode, Geographer in charge.
Triangulation by W. T. Griswold.
Topography by A. E. Murlin.
Surveyed in 1897-98.

Scale 1/125000
Contour interval 100 feet.
Datum is mean sea level.

Edition of Oct. 1902.

U. S. GEOLOGICAL SURVEY
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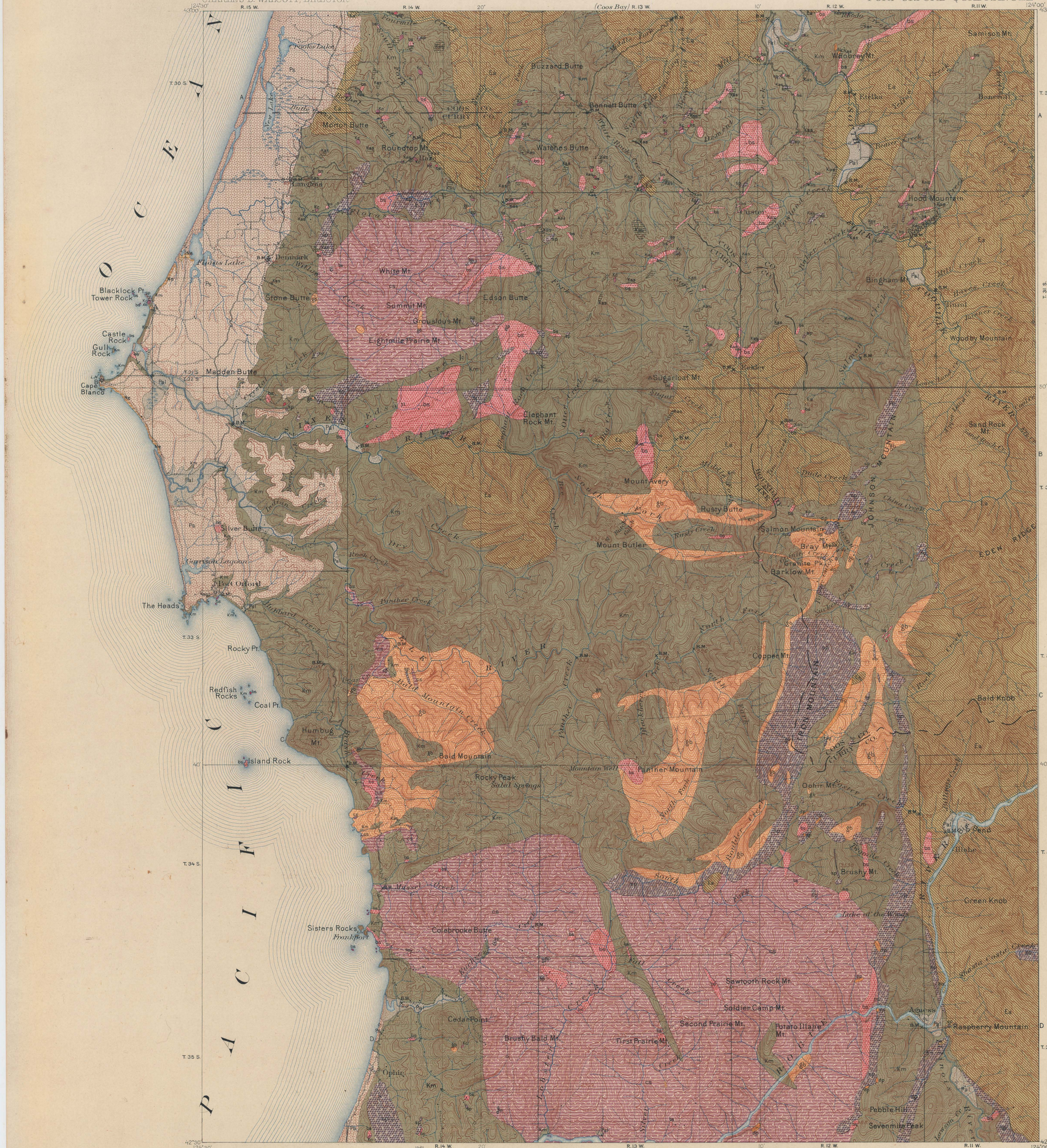
AREAL GEOLOGY SHEET

OREGON
PORT ORFORD QUADRANGLE



R.U.Goode, Geographer in charge.
Triangulation by W.T.Griswold.
Topography by A.E.Murlin.
Surveyed in 1897-98.

APPROXIMATE MEAN DECLINATION 1900

Scale $\frac{1}{125000}$

1 ½ 0 1 2 3 4 5 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 100 feet.
Datum is mean sea level.
Edition of Nov. 1902.

Geology by J.S.Diller.
Assisted by Arthur J.Collier,
Chester Washburn, and James Storrs.
Surveyed in 1898-1900.

LEGEND

SURFICIAL ROCKS

(Areas of Surficial rocks are shown by patterns of dots and circles)

PLEISTOCENE

- Pal — Alluvium
- Ps — Marine sands *(interstratified sands and gravels capping elevated marine terraces; locally auriferous)*

SEDIMENTARY ROCKS

(Areas of Sedimentary rocks are shown by patterns of parallel lines Metamorphism is indicated by short dashes combined with the parallel lines)

NEOCENE — MIOCENE

- Ne — Empire formation *(chiefly soft yellowish sandstones, with some shale, conglomerate, and tuff)*

EOCENE

- Ea — Arago formation *(yellowish sandstones, gray shales, and conglomerate, with local coal beds; equivalent to Pulaski and Coaledo formations)*

CRETACEOUS

- Kas — Amphibole-schist *(blue and green amphibole-schist with some mica- and epidote-schists; derived from local alteration of Cretaceous igneous and sedimentary rocks)*
- Kc — Chert *(siliceous shale and gray and red jaspery rocks; "radiolarian chert")*
- Km — Myrtle formation *(conglomerate, sandstone, and shale)*

PRE-CRETACEOUS

- cs — Colebrooke schist *(micaceous schists derived from sedimentary rocks)*

IGNEOUS ROCKS

(Areas of Igneous rocks are shown by patterns of triangles and rhombs)

CRETACEOUS ?

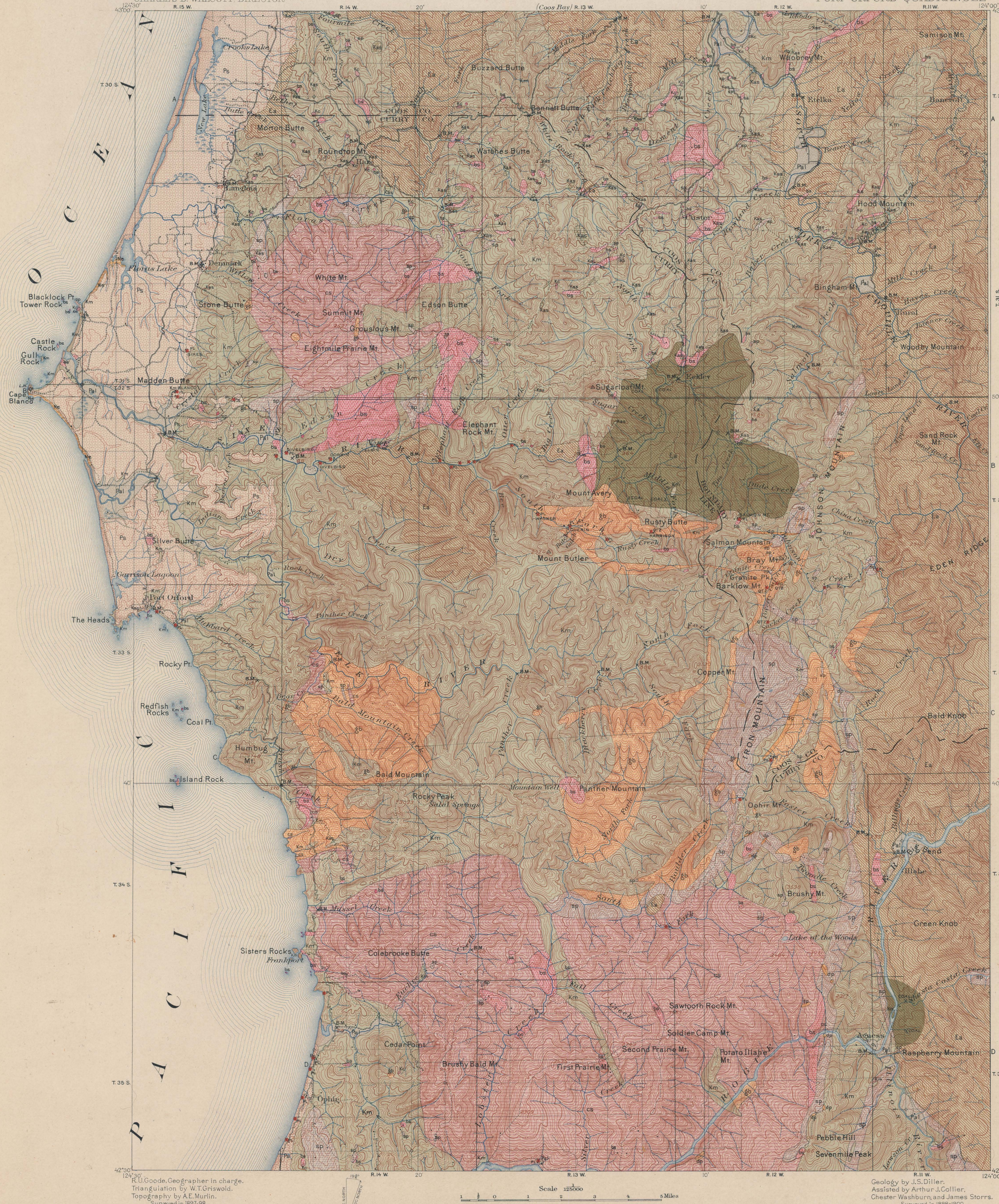
- dp — Dacite-porphyry *(chiefly dikes)*
- bs — Basalt *(lava flows and volcanic necks)*
- gb — Gabbro *(deep-seated intrusive masses, apparently corresponding to surface basalts)*
- sp — Serpentine *(derived chiefly from alteration of peridotite)*

Sections

U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

ECONOMIC GEOLOGY SHEET

OREGON
PORT ORFORD QUADRANGLE



R. U. Goode, Geographer in charge.
Triangulation by W. T. Griswold.
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EOCENE

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Sections

Known productive areas

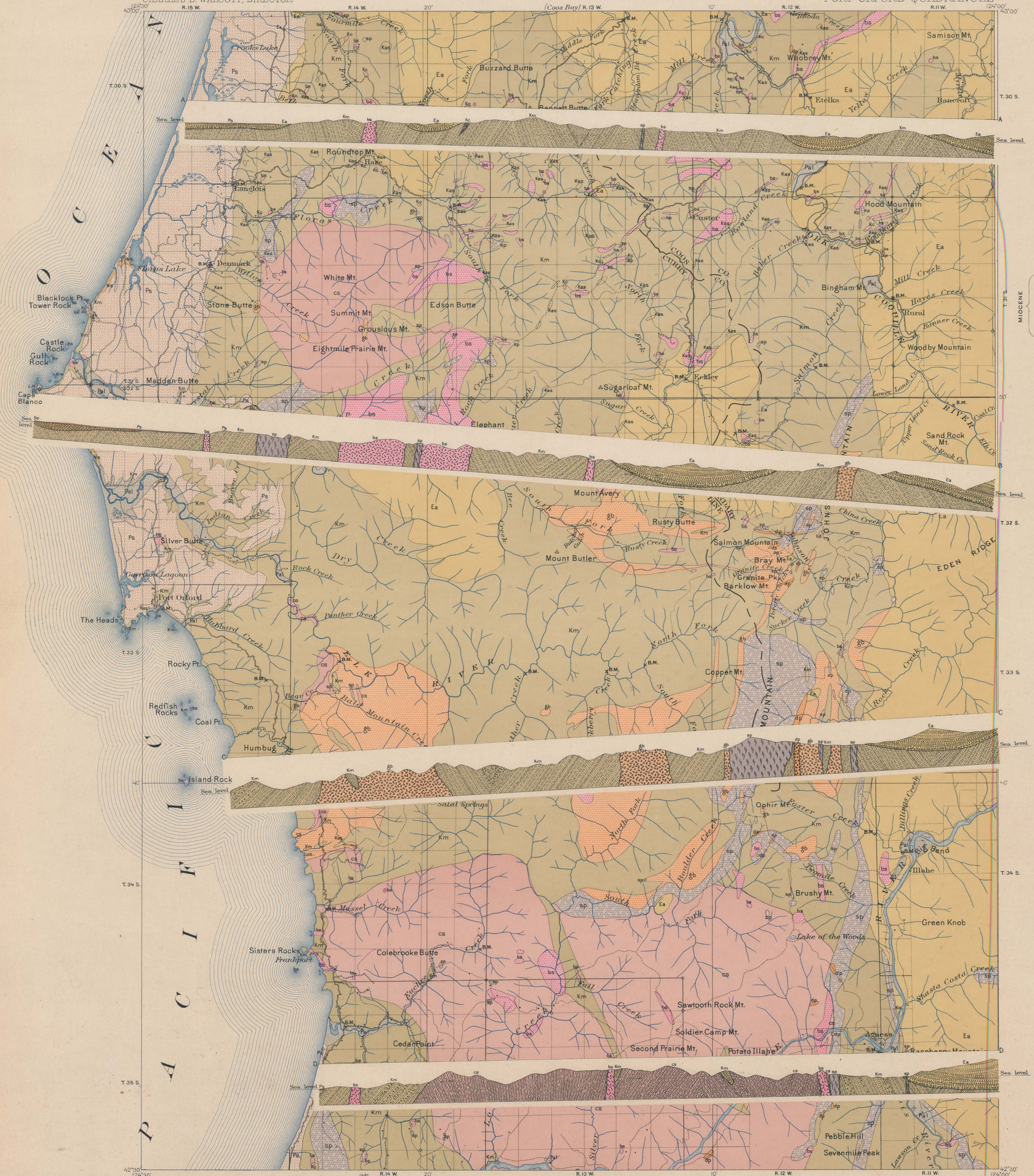
- Coal *(portions of the Arago formation known to contain beds of coal)*

- Gold mines
- Gold prospects and inoperative mines
- X Coal prospects
- PL *Placers*
- QTZ *Quartz veins*

U. S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

STRUCTURE-SECTION SHEET

OREGON
PORT ORFORD QUADRANGLE



R. U. Goode, Geographer in charge.
Triangulation by W. T. Griswold.
Topography by A. E. Murlin.
Surveyed in 1897-98.

TRUE NORTH
MAGNETIC NORTH
19½°
APPROXIMATE MEAN DECLINATION 1900.

Scale $\frac{1}{125000}$

1 ½ 0 1 2 3 4 5 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Edition of Feb. 1903.

Geology by J. S. Diller.
Assisted by Arthur J. Collier,
Chester Washburn, and James Storrs.
Surveyed in 1898-1900.

LEGEND

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25	Loudon	Tennessee	25
26	Pocahontas	Virginia-West Virginia	25
27	Morristown	Tennessee	25
28	Piedmont	Maryland-West Virginia	25
29	Nevada City Special	California	50
30	Yellowstone National Park	Wyoming	75
31	Pyramid Peak	California	25
32	Franklin	Virginia-West Virginia	25
33	Briceville	Tennessee	25
34	Buckhannon	West Virginia	25
35	Gadsden	Alabama	25
36	Pueblo	Colorado	50
37	Downieville	California	25
38	Butte Special	Montana	50
93	Truckee	California	25
40	Wartburg	Tennessee	25
41	Sonora	California	25
42	Nueces	Texas	25
43	Bidwell Bar	California	25
44	Tazewell	Virginia-West Virginia	25
45	Boise	Idaho	25
46	Richmond	Kentucky	25
47	London	Kentucky	25
48	Tenmile District Special	Colorado	25
49	Roseburg	Oregon	25
50	Holyoke	Mass.-Conn.	50
51	Big Trees	California	25
52	Absaroka	Wyoming	25
53	Standingstone	Tennessee	25
54	Tacoma	Washington	25
55	Fort Benton	Montana	25
56	Little Belt Mountains	Montana	25
57	Telluride	Colorado	25
58	Elmoro	Colorado	25
59	Bristol	Virginia-Tennessee	25
60	La Plata	Colorado	25
61	Monterey	Virginia-West Virginia	25
62	Menominee Special	Michigan	25
63	Mother Lode District	California	50
64	Uvalde	Texas	25
65	Tintic Special	Utah	25
66	Colfax	California	25
67	Danville	Illinois-Indiana	25
68	Walsenburg	Colorado	25
69	Huntington	West Virginia-Ohio	25
70	Washington	D. C.-Va.-Md.	50
71	Spanish Peaks	Colorado	25
72	Charleston	West Virginia	25
73	Coos Bay	Oregon	25
74	Coalgate	Indian Territory	25
75	Maynardville	Tennessee	25
76	Austin	Texas	25
77	Raleigh	West Virginia	25
78	Rome	Georgia-Alabama	25
79	Atoka	Indian Territory	25
80	Norfolk	Virginia-North Carolina	25
81	Chicago	Illinois-Indiana	50
82	Masontown-Uniontown	Pennsylvania	25
83	New York City	New York-New Jersey	50
84	Ditney	Indiana	25
85	Oelrichs	South Dakota-Nebraska	25
86	Ellensburg	Washington	25
87	Camp Clarke	Nebraska	25
88	Scotts Bluff	Nebraska	25
89	Port Orford	Oregon	25

* Order by number.
† Payment must be made by money order or in cash.
‡ These folios are out of stock.

Circulars showing the location of the area covered by any of the above folios, as well as information concerning topographic maps and other publications of the Geological Survey, may be had on application to the Director, United States Geological Survey, Washington, D. C.