EXPLANATION

The Survey is making a geologic map of the United States, which necessitates the preparation of a topographic base map. The two maps are combined in the form of an atlas, the parts of which are called folios. Each folio consists of a topographic base map and a geologic map 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 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 mappèd, 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 on the contour at the same elevation. The line of a gradient when traced at regular vertical intervals of ten feet is called a gradient line. The gradient lines are connected by a series of lines called contours, the distance between two contours is called the contour interval. Contours and elevations are printed in black.

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

Fig. 1.—Sketch of a river valley between two hills. In the foreground is the sea, with a bay which is partly closed by a sand-hill bar. On either side of the bar is a small terrace on the river, and on the right a hill rises gradually, while from that on the left the ground ascends steeply in a precipice. Contrast with this precipice is the gentle descent of the left-hand slope. 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, 250, and so on, above sea-level. Along the contour at 250 feet lie all points on the surface 250 feet above sea; and similarly with any other contour. In the space between any two contours are found all elevations from the lower and below the higher contour. Thus the contour at 100 feet falls just below the edge of the terraces, while that at 250 feet lies above the terraces; therefore all points on the contour at 200 feet are shown to be more than 200 but less than 250 feet above sea level. The summit of the hill is shown to be above the 300-foot contour, and accordingly the contour at 300 feet surrounds it. In this illustration nearly all the contours are numbered. When this is not possible, three contours—say every fifth one—are accented and numbered; the heights of others may then be ascertained by counting or up 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 around and over the ridgetop, from one reentrant angle of ravines, and project in passing above promontories. 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 the descent is to a valley or on a gentle slope; but to rise a given height on a gentle slope one must go farther than on a steep slope. The critical elevation on a gentle slope 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 Geologic Survey is 10 feet. We use this for regions like the Mississippi delta and the Dismal Swamp. In mapping great mountain masses, like the Andes, the contour interval is 100 feet. An intermediate relief contour interval of 100, 200, 500, and 100 feet are used.

Drainage.—Watercourses are indicated by blue lines. If the stream flows the year round the line is drawn unbroken, but if the channel is dry the line is dotted. A dry channel will be found where a stream sags and reappears at the surface; the supposed underground course is shown by a dotted line. Separate areas of deposition may be shown by extending the drainage lines above the surface and below land areas may be indicated by extending the stream lines.

The geologic map represents areal geology by colors and conventional signs, on the topographic base map, the distribution of rock formations on sheets, the names of the rocks, 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 is called the parent material, and the surface on which the weathering has worked are called the parent rocks, and all other rocks have been derived from them in one way or another. Later the erosional processes gradually break up igneous rocks, forming superficial, or surficial, deposits of clay, sand, and gravel. Deposits of this class are collectively called sediments, and since the earliest geological time. Through the transporting agencies of streams the superficial materials of all land areas are eventually carried to the sea, where, along with material derived from the land by the motion of the waves on the coast, they form sediments. The sediments are usually hardened into conglomerates, sandstones, silt, and limestones, but they may remain unconsolidated and still be called sediments. The second class of rocks are called sedimentary, in which they have been changed into a solid state. As has been explained, sedimentary rocks were deposited on the original igneous rocks. Through the slow process of weathering, the rocks of all ages have been worn away. Molten material has from time to time been forced forward toward or near the surface, and there contact the sediments, which by this process of metamorphism is changed into igneous rock. The third class of rocks are the metamorphic, which substances of which 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 sandstones to quartzites, limestones 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 divided into three classes, but the younger formations have generally succeeded marked metamorphism, and the oldest sediments known, though not of the same kind as the oldest 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 divided into three classes, but the younger formations have generally succeeded marked metamorphism, and the oldest sediments known, though not of the same kind as the oldest strata, at any angle. Rocks divided by such planes are called slates or schists.

Surficial rocks.—These embrace the soils, clays, sands, gravels, and boulders that cover the surface, whether derived from the breakdown 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 they form the beds of good fertility. Soils and gravels are the most important. Residual accumulations are often washed or blown into valleys or else deposited along the edges of streams, or when they lodge and form beds of pebbles, and gravel deposits that grade into the sedimentary class. Surficial rocks that are due to glacial action are more firmly cemented than the colluvial detritus, together with boulders and fragments of rock rubbed from the surface and ground together. These are laid down in the territory occupied by the ice, and form a mixture of clay, pebbles, and boulders which is known as till. They may occur in large quantities under forms of moraines, drumlins, and other special forms. Most of this mixed material was washed away from the ice, not absorbed by water, and redeposited as beds of sands and clay, thus...
DESCRIPTION OF THE TACOMA QUADRANGLE

INTRODUCTION

Purpose—It is the purpose of this description to set forth, in plain language, the facts observed in a study of the geology of the Tacoma Quadrangle. The features to be described are the hills and valleys and streams, the deposits of sediments beneath the earth, the atmosphere and or forces which reside in the earth. Their activities constitute several processes.

The modeling of the earth’s surface through the action of the climate, generation of forces by plate tectonics, subsidence of areas, the generation of volcanoes and geysers, the formation of sedimentary basins and other geological processes, are results of processes which act on the earth through the atmosphere or forces which reside in the earth. Their activities constitute several processes.

A second process in the distribution and deposition of the great abundance of sedimentary beds beneath the earth, and the waters of lakes and seas. The process has been called sedimentation, and its chief result, the world over, is the formation of beds of sediments which constitute sedimentary rocks, such as sandstone, sandstone, shale, and clay, siltstone, limestone, sandstone, and shale, which are forced in among sedimentary beds.

The three processes of deformation, erosion, and sedimentation are related of each other, as is the cycle of metamorphism. The processes of erosion, deposition, and sedimentation are interlaced, and it is the cycle of metamorphism.

The geologic history of the Puget Sound region has involved a cycle of mountain building and mountain erosion, which has been an important part of the history of the Pacific Northwest.

The growth of these mountains was accompanied by volcanic eruptions. A long time, covering the Eocene, Neocene, and

Pliocene periods, the processes of erosion and accumulation have continued to form the

sedimentary rocks formed, and in them the events of their history are recorded. Among the latest of the deposits of volcanic rocks is the Tertiary period, the countless millions of square miles in extent and hundreds of feet thick, which is melting left the region.

This subject will be considered more fully later under the heading “Geology history.”

GENERAL RELATIONS

Situation—The Tacoma Quadrangle is bounded by the meridians 122° 30’ W. and 123° 30’ W. and the parallels 47° and 49° 30’. Its area is 812.4 square

miles, of which about 643 square miles fall in the limits of Puget Sound. It lies in the southeastern part of the Puget Sound Basin and includes a portion of Admiralty Inlet, the southern part of Puget Sound, and the extreme outliers of the Cascade Range and Mount Rainier. Within the quadrangle the Puget Sound Basin has a surface level below sea level in the depths of Admiralty Inlet to 2750 feet (1412 meters) above sea level in the back of Puget Sound. Parts of King and Pierce counties are within it, and the city of Tacoma lies on its western margin.

Geologic conditions—One of the features of the North American continent is a depression parallel to the Pacific coast extending from latitude 49° 30’ N. along the United States from Point Conception, California, the Willamette Valley, and the sounds of the northern coast to latitude 57° N. beyond Mount St. Helens, Washington. It forms a section of this downfold about 90 miles in length.

Western Mountain ranges or uplands lie on either side of the Pacific coast downfold. On the east rise the Sierra Nevada of California, the Cascades of Oregon, Washington, and the Coast Ranges of British Columbia; on the west extend the Coast Ranges of California, Oregon, and Washington, and the towns of Vancouver Island, British Columbia. These mountain ranges are in part an expression of the geologic structure of the United States, and in part a result of the recent movement of the earth’s crust.

The climate and precipitation of the Pacific Northwest is a depression parallel to the Pacific coast extending from latitude 49° 30’ N. along the United States from Point Conception, California, the Willamette Valley, and the sounds of the northern coast to latitude 57° N. beyond Mount St. Helens, Washington. It forms a section of this downfold about 90 miles in length.

Western Mountain ranges or uplands lie on either side of the Pacific coast downfold. On the east rise the Sierra Nevada of California, the Cascades of Oregon, Washington, and the Coast Ranges of British Columbia; on the west extend the Coast Ranges of California, Oregon, and Washington, and the towns of Vancouver Island, British Columbia. These mountain ranges are in part an expression of the geologic structure of the United States, and in part a result of the recent movement of the earth’s crust.

The climate and precipitation of the Pacific Northwest is a depression parallel to the Pacific coast extending from latitude 49° 30’ N. along the United States from Point Conception, California, the Willamette Valley, and the sounds of the northern coast to latitude 57° N. beyond Mount St. Helens, Washington. It forms a section of this downfold about 90 miles in length.

Western Mountain ranges or uplands lie on either side of the Pacific coast downfold. On the east rise the Sierra Nevada of California, the Cascades of Oregon, Washington, and the Coast Ranges of British Columbia; on the west extend the Coast Ranges of California, Oregon, and Washington, and the towns of Vancouver Island, British Columbia. These mountain ranges are in part an expression of the geologic structure of the United States, and in part a result of the recent movement of the earth’s crust.

The climate and precipitation of the Pacific Northwest is a depression parallel to the Pacific coast extending from latitude 49° 30’ N. along the United States from Point Conception, California, the Willamette Valley, and the sounds of the northern coast to latitude 57° N. beyond Mount St. Helens, Washington. It forms a section of this downfold about 90 miles in length.

Western Mountain ranges or uplands lie on either side of the Pacific coast downfold. On the east rise the Sierra Nevada of California, the Cascades of Oregon, Washington, and the Coast Ranges of British Columbia; on the west extend the Coast Ranges of California, Oregon, and Washington, and the towns of Vancouver Island, British Columbia. These mountain ranges are in part an expression of the geologic structure of the United States, and in part a result of the recent movement of the earth’s crust.

The climate and precipitation of the Pacific Northwest is a depression parallel to the Pacific coast extending from latitude 49° 30’ N. along the United States from Point Conception, California, the Willamette Valley, and the sounds of the northern coast to latitude 57° N. beyond Mount St. Helens, Washington. It forms a section of this downfold about 90 miles in length.

Western Mountain ranges or uplands lie on either side of the Pacific coast downfold. On the east rise the Sierra Nevada of California, the Cascades of Oregon, Washington, and the Coast Ranges of British Columbia; on the west extend the Coast Ranges of California, Oregon, and Washington, and the towns of Vancouver Island, British Columbia. These mountain ranges are in part an expression of the geologic structure of the United States, and in part a result of the recent movement of the earth’s crust.

The climate and precipitation of the Pacific Northwest is a depression parallel to the Pacific coast extending from latitude 49° 30’ N. along the United States from Point Conception, California, the Willamette Valley, and the sounds of the northern coast to latitude 57° N. beyond Mount St. Helens, Washington. It forms a section of this downfold about 90 miles in length.

Western Mountain ranges or uplands lie on either side of the Pacific coast downfold. On the east rise the Sierra Nevada of California, the Cascades of Oregon, Washington, and the Coast Ranges of British Columbia; on the west extend the Coast Ranges of California, Oregon, and Washington, and the towns of Vancouver Island, British Columbia. These mountain ranges are in part an expression of the geologic structure of the United States, and in part a result of the recent movement of the earth’s crust.

The climate and precipitation of the Pacific Northwest is a depression parallel to the Pacific coast extending from latitude 49° 30’ N. along the United States from Point Conception, California, the Willamette Valley, and the sounds of the northern coast to latitude 57° N. beyond Mount St. Helens, Washington. It forms a section of this downfold about 90 miles in length.

Western Mountain ranges or uplands lie on either side of the Pacific coast downfold. On the east rise the Sierra Nevada of California, the Cascades of Oregon, Washington, and the Coast Ranges of British Columbia; on the west extend the Coast Ranges of California, Oregon, and Washington, and the towns of Vancouver Island, British Columbia. These mountain ranges are in part an expression of the geologic structure of the United States, and in part a result of the recent movement of the earth’s crust.

The climate and precipitation of the Pacific Northwest is a depression parallel to the Pacific coast extending from latitude 49° 30’ N. along the United States from Point Conception, California, the Willamette Valley, and the sounds of the northern coast to latitude 57° N. beyond Mount St. Helens, Washington. It forms a section of this downfold about 90 miles in length.

Western Mountain ranges or uplands lie on either side of the Pacific coast downfold. On the east rise the Sierra Nevada of California, the Cascades of Oregon, Washington, and the Coast Ranges of British Columbia; on the west extend the Coast Ranges of California, Oregon, and Washington, and the towns of Vancouver Island, British Columbia. These mountain ranges are in part an expression of the geologic structure of the United States, and in part a result of the recent movement of the earth’s crust.

The climate and precipitation of the Pacific Northwest is a depression parallel to the Pacific coast extending from latitude 49° 30’ N. along the United States from Point Conception, California, the Willamette Valley, and the sounds of the northern coast to latitude 57° N. beyond Mount St. Helens, Washington. It forms a section of this downfold about 90 miles in length.

Western Mountain ranges or uplands lie on either side of the Pacific coast downfold. On the east rise the Sierra Nevada of California, the Cascades of Oregon, Washington, and the Coast Ranges of British Columbia; on the west extend the Coast Ranges of California, Oregon, and Washington, and the towns of Vancouver Island, British Columbia. These mountain ranges are in part an expression of the geologic structure of the United States, and in part a result of the recent movement of the earth’s crust.

The climate and precipitation of the Pacific Northwest is a depression parallel to the Pacific coast extending from latitude 49° 30’ N. along the United States from Point Conception, California, the Willamette Valley, and the sounds of the northern coast to latitude 57° N. beyond Mount St. Helens, Washington. It forms a section of this downfold about 90 miles in length.

Western Mountain ranges or uplands lie on either side of the Pacific coast downfold. On the east rise the Sierra Nevada of California, the Cascades of Oregon, Washington, and the Coast Ranges of British Columbia; on the west extend the Coast Ranges of California, Oregon, and Washington, and the towns of Vancouver Island, British Columbia. These mountain ranges are in part an expression of the geologic structure of the United States, and in part a result of the recent movement of the earth’s crust.

The climate and precipitation of the Pacific Northwest is a depression parallel to the Pacific coast extending from latitude 49° 30’ N. along the United States from Point Conception, California, the Willamette Valley, and the sounds of the northern coast to latitude 57° N. beyond Mount St. Helens, Washington. It forms a section of this downfold about 90 miles in length.

Western Mountain ranges or uplands lie on either side of the Pacific coast downfold. On the east rise the Sierra Nevada of California, the Cascades of Oregon, Washington, and the Coast Ranges of British Columbia; on the west extend the Coast Ranges of California, Oregon, and Washington, and the towns of Vancouver Island, British Columbia. These mountain ranges are in part an expression of the geologic structure of the United States, and in part a result of the recent movement of the earth’s crust.
The holhows: their distribution and character.—

Admiralty Inlet is the principal stem, the outer mouth of which is called the Long Whitby Canal on the west and the Dungeness-Puyallup Valley on the east. The southwesterly group of sounds is a detached strip of the coast at its southern end.

In this plan of the holhows there is a zone of influence on a system of river valleys converging westward, and it is probable that such a system lies beneath the present topography. The existing heights above sea level are superficially built up of deposits from glaciers. Probably, like other glacial forms, to which they resemble the older topographic relief.

Delta, which are continually being extended by melting water into the hollows, discharging into them and replacing the water of the sounds. This is occurring actively at the mouths of the Dungeness and Long Whitby Canals, where the valley lands along these latter parts of the streams are flood plains spread over the delta deposits of earlier stages. That part of the holhows which is filled by alluvium differs from the above which is filled by water only in the incident of very recent history; in their origin the broad valleys and the sounds are alike.

The plateau, their distribution and character.—

The major elevations of the Puget Sound Basin are essentially plateaus. They are essentially flat-topped, though diversified by hills and trenches by channels, and they are bounded by steep slopes. These hills are 300 to 500 feet above the alluvial plains and to the waters of the Sound. From the south to the north the valley along which the Sound rises as branches to 1200 feet above sea. The plateaus are the crest of the Cascade Mountains, and the mainland on the west are long and narrow, and resemble islands, with major axes trending parallel to the crests of the plateaus. The tops of the slopes are wholly, but in details entirely, in the sense that the edge of a leaf is said to be not only its broad, but also the slide and the edge of the same. The outlines along the slope above sea level are being modified by waves, while the island portions of the slopes are generally broken by streams. The slopes of the Puget Sound plateau are so intimately related to the latest stages of geologic history that the form can not intelligently be discussed without a knowledge of the events leading up to their development. Their discussion is therefore postponed to the end of the account of the geologic history.

**GEOLGIC HISTORY.**

**INTRODUCTION.**—The earliest period which it is necessary to consider in the account of the geologic history of the Puget Sound quadrangle is the Eocene. By reference to the section entitled "Explanation", which is printed on the cover of this folio, we shall see that the Eocene is one of the later periods of the geologic time, and is of the whole of geologic time, the interval between the present and the beginning of the Eocene is shorter than would appear from that list, since the three latest periods, Eocene, Neocene, and Pleistocene, were all short as compared with those which preceded them. Nevertheless, the changes which have occurred since the beginning of the Eocene have been marked, in all aspects of the North American continent. At that time the sea overtopped the Atlantic and Gulf coasts of the Eastern States more than a hundred miles. It occupied the whole of the Gulf of Mexico, and western Louisiana and western Texas. A great part of the western margin of the earth's crust was submerged, and it is in the fact that the temperature never rises very high, because the inland heat is lost during the early portion.

The humidity of the climate would seem most unfavorable for all species adapted to an arid habitat. But local soil and conditions exist which permit a few species capable of surviving in the dry desert region. South of the desert is a known, designated as the Baja California, which is characterized by a high range of meridional 300 miles of desert, with a climate of semiarid, very arid, with a chance of sparse rainfall. The rainfall is probably about 24 inches per year, but the more precipitation is mostly in the fall, and is in most years. It is in the fact that the temperature never rises very high, because the inland heat is lost during the early portion.

The humidity of the climate would seem most unfavorable for all species adapted to an arid habitat. But local soil and conditions exist which permit a few species capable of surviving in the dry desert region. South of the desert is a known, designated as the Baja California, which is characterized by a high range of meridional 300 miles of desert, with a climate of semiarid, very arid, with a chance of sparse rainfall. The rainfall is probably about 24 inches per year, but the more precipitation is mostly in the fall, and is in most years. It is in the fact that the temperature never rises very high, because the inland heat is lost during the early portion.

**TOPOGRAPHY OF PUGET SOUND.**

**General aspect.**—The topographic features of Puget Sound are peculiar in that they combine to form a branching system of land-locked straits and bays, which are separated from the sea by low, irregular, and irregular plateaus, whose elevation above sea level varies from 300 to 400 feet, and the greater depths of water are from 600 to 900 feet, and the amount of relief is accordingly 1000 to 1500 feet.

During the Eocene period the Puget Sound Basin was the site of an extensive estuary or arm of the sea of vast extent; it is known that it covered part of western Washington, including portions of the Cascades. Other portions of the region, and probably the Olympic Mountains, were islands, while the coastal plains of the mainland which stretched northward and eastward.

To the south of Oregon, and probably far eastward, is the Blue Mountains. Lands adjacent to this extensive estuary and sea of vast extent, and the adjacent mountains, were composed of granite and other rocks of the same general and similar geologic character.

The establishment of the Puget Sound was formed by streams of run-off from the mountains. The volume of water in the Puget Sound was, as before stated, not large, and the lands were covered with a luxuriant flora, including species of maples, oaks, pines, and other species. The volume of the estuary was large in the incident of very recent history; in their origin the broad valleys and the sounds are alike.

The plateau, their distribution and character.—

The major elevations of the Puget Sound Basin are essentially plateaus. They are essentially flat-topped, though diversified by hills and trenches by channels, and they are bounded by steep slopes. These hills are 300 to 500 feet above the alluvial plains and to the waters of the Sound. From the south to the north the valley along which the Sound rises as branches to 1200 feet above sea. The plateaus are the crest of the Cascade Mountains, and the mainland on the west are long and narrow, and resemble islands, with major axes trending parallel to the crests of the plateaus. The slopes of the Puget Sound plateaus are so intimately related to the latest stages of geologic history that the form can not intelligently be discussed without a knowledge of the events leading up to their development. Their discussion is therefore postponed to the end of the account of the geologic history.
Knowledge on the plants collected from the Puget formation:

The flora of the Puget formation is exceedingly rich. Over 250 species of flowering plants have been named and described, and from the material in hand, some 600 to 700 may eventually be described. The number of plant species in the Puget formation is equal to that in any other area of comparable size. The leaves and flowers of the plants are well preserved, and add to our knowledge of the flora of the area.

In the Puget formation, you can see a wide variety of plant species, from small shrubs to tall trees. The flora includes such species as willows, poplars, and aspen, which are characteristic of the area. The Puget formation is known for its rich array of plant species, and it is important to study these plants in order to understand the environment of the time.

The plants collected from the Puget formation are spread across various ecological zones, from the coastal areas to the mountainous regions. Some of the plants collected include those that are unique to the Puget formation, while others are commonly found in other areas.

The Puget formation is an important site for research on the flora of the area, and it provides valuable insight into the environment of the past.
of sand and stones of all dimensions up to large blocks. Stones which are ground against the glacier’s bed are scoured and plowed off, and some part worn to a fine silt; such which are taken up by rivers flowing on, or in, or beneath the ice are relatively long, easily rounded, and partially cemented by clay and silt. All the stony detritus thus carried and modified by glaciers is called glacial drift, or moraine.

Drift may be deposited (1) by glacial ice, or (2) by ice and streams working together, or (3) by streams issuing from and dissolving the ice in water. Drift is classified according to the nature and origin of its components, which have been recognized in the Taconic quadrangle and described in detail in a report on the Geology of Taconic Mountains, Vermont. Those which have been recognized in the Taconic quadrangle and described in detail, and which are usually associated with drift, are:

1. River drift, or drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

2. Ice drift, or drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

3. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

4. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

5. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

6. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

7. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

8. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

9. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

10. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

11. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

12. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

13. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

14. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

15. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

16. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

17. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

18. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

19. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

20. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

21. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

22. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

23. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

24. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

25. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

26. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

27. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

28. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

29. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

30. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.

31. Drift associated with the glaciers of various ages and still existing in the Taconic Mountains. This drift consists of sand, gravel, and boulders, and is the material which constitutes the drift in the Taconic quadrangle.
ridges, and is in part roughly stratified. Large bedloads occur, but are not at all common. In form, protodunes are homologous to certain lateral moraines along the present Carbon Glacier on Mount Rainier. As lateral moraines they furnish a reference point shrinking of the glacial tongue that occupied Dwawasmat Valley after the Yachats Ice sheet had left the upper end of the valley.

One other area of modified drift is worth mentioning, being of a type somewhat different from that of the areas already described. In the extreme northern portion of the plateau, about a mile east of the shore of the Sound, is a group of rounded hills and ridges whose longer axes are parallel with the coast and whose crest is facing the south. This small hill gap is known as the Yachats Gap. The central hill is oval in plan, and somewhat over 100 feet high. Two of the smaller hills or mounds in the central gap have a dome-like surface, and their crests have a slight elevation above the adjacent coastal flats.

About 4 miles further south are similar terraces and lowland areas composed of stratified till, which are covered with a thin sandy till and have a definite surface sculpturing that indicates a fairly long period of stability. The parent material is derived from the erosion of the hills to the north and the unconformity of the Yachats Gap. These terraces resemble the Yachats Gap in several important features of their outline, but they are much smaller in extent and are confined to a relatively narrow belt along the flank of the mountain range. The terrace is of the same age as the Yachats Gap, but it is not as well developed, and it is not so strongly sculptured.

The terrace to the south of the Yachats Gap is a well-marked moraine, extending from the valley of South Prairie Creek to the north and Siuslaw River to the west. It is a steep-sided ridge, smooth on the crest, and with a gentle slope on the sides. The moraine is best developed on the east side of the valley, where it forms a high, almost vertical wall. The moraine is composed of a mixture of sand, gravel, and clay, and is well drained. The surface of the moraine is level, and the slope is smooth and regular. The moraine is well defined, and it extends for several miles along the course of the Siuslaw River. The moraine is well developed, and it is well preserved.
flowed transversely between the land mass and an ice mass Lingering in the broad adjacent hollow.

East and south of the Dwanjina-Paypal Valley are several plateau masses, apparently distincted one from another by the channels of Cedar, Green-white, White South, Pecwan, Carlen, and Paypal rivers, but in fact related through the topographic zones which affect them. From Cedar River on the north to Tsou on the west the valley is bounded by a broad hilly belt, behind which lie plateaus that extend to the foothills of the Cascades. The hilly belt is coincident with the zone mapped as modified Vashon drift. The plateaus correspond to the extent of the Stealcoom and Oceola formations.

The hilly belt is characterized by ridges which trend southeast, south, and southwest, diverging from the Dwanjina-Paypal Valley. The ridges rise 50 to 150 feet above the general surface. Between them streams flow through swamps and in ill-defined channels, which have not been materially cleared out since the retreating ice left them confinedly obstructed. The larger streams, Big Soos, Friend, and Clover creek, head in the plateau margins near the valley and flow into the interior away from the valley. The two former reach the lowland by short courses in recently cut channels. Lakes occupy many basins among the ridges. Embankments of the type of lateral moraines occur along the sides of the hollow now occupied by Big Soos Creek west of Swan Lake.

Interpreting this group of facts as significant of the distribution of the glaciers during their retreat at the close of the Glacial epoch, it may be inferred that the northern ice at one stage occupied the northwestern portion of the plateau, its marginal line lying east and south as the hilly belt now extends. The ice margin had then withdrawn from confusion with the Oceola Glacier. The ice contained great quantities of gravel, and other volumes were brought by streams flowing in the plateau, and southward from the higher glacial mass to the stagnant tongue. Thus irregular ridges were heaped under and on the ice, open the plateau, and among them were buried masses of ice, which, as melted, left lake basins. One of the late lingering tongues occupied the hollow of Big Soos Creek, and recorded its transient occupation by the lateral moraines already referred to.

The plains along the eastern side of the quadrangle, which are mapped as conforming to the Oceola till, extend over an area on which the piedmont glacier of the Cascades lingered after separating from the North Fork. The name between the two ice fronts north of Green River became temporarily, first the source of tumbled deposits from the glacier. The position and extent of these tumbled gravels is discussed in detail in an article on the Decline of the Glacier. The following sections are records of detailed measurements of the Piedmont formations:

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Gneiss and mica schiste, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Gneiss or granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.

Character of material: Structure of deposit: Condition of deposit: Probable conclusion: Formation name:
Granite, granite, forming a generally level surface, with considerable horizon, a number of large bimens.
Temporarily exposed by streams that flow up to 50 feet in elevation.
ECONOMIC RESOURCES.

COAL.

Location of coal field. The southern coal fields of the Puget Sound basin are located on either side of the meridian of 133°, extending 10 miles east and 10 miles west, with irregular outlines. Benoni Coal, from north to south they stretch, through less than a degree of latitude, from near 47° 35' to about 48° 45'.

The beds now developed lie between the latitude of 47° 35' and 48° 45', a north-south distance of 40 miles. Their relative positions are indicated on the outline map.

With reference to Puget Sound, this productive district lies from 7 to 9 miles east and southeast from, and extends parallel to, the southeastern inlet, which ends in Commencement Bay. The western foothills and valleys of Mount Rainier reach into the southern portion of the area of coal-bearing rocks. By railroads 12 to 15 miles in length the mines are connected with the cities of Seattle and Tacoma.

The coal districts included in the Tahoma quadrangle are the Rattlesnake Island, the western margin of the Green River, and the Wilkinson-Cortlandt. The Newcastle-Gilman district and the central portion of the Green River is just beyond the eastern limit of the quadrangle. Their relative positions are indicated on the accompanying index map.

Character of the coal. The character of the coal varies from field to field, as it has undergone chemical change by loss of water and concentration of fixed carbon to a greater extent in some districts than in others. The coals range in character, therefore, from lignites, whose representative analyses have the limits—

<table>
<thead>
<tr>
<th>Moisture</th>
<th>13 to 19%</th>
<th>Volatile matter</th>
<th>30 to 45%</th>
<th>Fixed carbon</th>
<th>25 to 65%</th>
</tr>
</thead>
</table>

...to bituminous lignites or steam coals, in which the moisture is refined to 6 per cent or less and the fixed carbon ranges from 40 to 50 per cent, or to bituminous coaling coals, which are fairly represented by the figures—

<table>
<thead>
<tr>
<th>Moisture</th>
<th>1 to 5%</th>
<th>Volatile matter</th>
<th>25 to 35%</th>
<th>Fixed carbon</th>
<th>45 to 50%</th>
</tr>
</thead>
</table>

The ash of these coals is frequently as much as 10 per cent, particularly in commercial samples taken to represent the marketable product. But the earthy constituents occur largely in distinct streaks in bands of pure coal, and the proportion which goes to market is determined by the cost of removing the associated and slate. Methods of mining and preparing the coals depend on the characteristics of individual beds, but for each district there are also general factors which determine the handling of the product. One of these is hardness. The lignites are hard, the bituminous lignites of the Green River district are softer, but still firm. The bituminous coaling of the Wilkeson field are very soft. The two former may be handpicked; the last must be hand-raked.

The variations from lignites to bituminous coaling coal are of regional extent, that is, so far as lignites are found they may be expected to maintain a uniform composition over a rather wide area, and bituminous varieties are equally common in some areas and absent in others, the former being more or less critical structures, due to sharing under pressures which caused movement within the rocks, the resulting chemical effect was to expel it 4 per cent of water. Beyond the area of this mechanism, the influence of the rocks is little, the coals then by processes of chemical alteration, the coals of the Wilkeson field, and those of the extreme eastern portion of the Green River field, have been solidified out between their sediments and crushed. Their softness and their consequent test conditions have resulted from this chemical alteration. The further transformation of the coal to anthracite and coke occurs in the vicinity of igneous rocks, to whose influence it is due.

Newcastle-Gilman district. The lignites of Seattle, beyond Lakes Washington, is the valley of Issaquah Creek, which flows northward through Summit Mountain into Summitt Lake. Summit Mountain has a height of 1000 feet, and an area of 1000 square feet, and it is 30 feet high. The Summit Mountain range of hills, rising to a height of 200 feet, extends for 3 miles between Lakes Washington and Squakamish. Newcastle is situated on the western side of the valley, and Coal Creek and Tintic Creek flow northward, parallel to Issaquah Creek and about a mile west of it, also emptying into Summitt Lake. The town of Issaquah, formerly called Gilman, is situated on Issaquah Creek and 5 miles south of Summitt Lake, at an elevation of about 40 feet above the sea. The valley here is a mile broad, and wide and fertile bottom lands extend to the lake. A mile south of the town the pass through Summit Mountain approaches to a vital height, bounded by Broad Pass, and the passage is through the center of the valley.

The Gilman coals are opened in the northern spur of Squakamish, and are well known to lie near the summit of the mountain, and beyond the valley of Tintic Creek into the Newcastle hills. The Newcastle mine, situated near the summit of the mountain, was opened along Coal Creek on the western slopes of these hills. A few miles east of the Newcastle hills, the Gilman mines are reached from Seattle by the steamer route of the Seattle and Issaquah and Tintic Creek, to the summit of the mountain, and along the northeastern side of Lake Washington and along the northern slope of Namuak Creek, and the principal mines are situated on the slopes of its minor waters. There is no direct connection, except by wagons or rail, between these two mining points.

No complete catalogue of the coal-bearing strata could be made up here, as the field has been described with detail and forest so as to make us the mines. From the mine maps, however, the following intervals between coal beds were noted—

<table>
<thead>
<tr>
<th>Veins</th>
<th>4 thickness 1 foot, highest of the known series.</th>
<th>Interval of 250 feet, including 1 thickness 8 feet.</th>
<th>Vein No. 5 thickness 8 feet.</th>
<th>Interval of 150 feet, including 1 thickness 14 feet.</th>
<th>Vein No. 6 thickness 14 feet.</th>
<th>Interval of 600 feet, including 4 thickness 5 feet.</th>
<th>Vein No. 7 thickness 14 feet.</th>
<th>Interval of 300 feet, including 1 thickness 24 feet.</th>
<th>Vein No. 8 thickness 14 feet.</th>
<th>Interval of 300 feet, including 1 thickness 14 feet.</th>
</tr>
</thead>
</table>

The detailed cross-sections of all the veins except Vein No. 6 are given in Fig. 2.

The structure of the district is that of a simple monocline, dipping northward. Squak Mountain, extending south of the mines, is a mass of igneous rock, which may have caused the northern dipping of the coal measures, or may simply have been uplifted with them. The strata strike S. 80° W. from Issaquah Creek to Tintic Creek, and have dips varying from 30° to 40°. They are remarkably free from faults, only one importance being found with met in the course of mining. This fault, which was encountered in the water-level gangway of Vein No. 4, and extended about 400 feet. The veins were the original structure, andVein No. 4 was afterwards altered into a non-recalled coal strata, which, however, was often sutured to a fraction of an inch. At several points the rock beds made it evident that they had simply slid past one another in such a manner as to bring two continuous surfaces into opposition and to force the coal out from between them. This fault does not traverse the strata, but is limited wholly to the vein in which it occurs, and gives no occasion to infer the existence of similar faults in the other veins.

The relation of the Gilman section to that of Newcastle has not been determined. There are resemblances between the veins in the two sections, and it is possible that they present opposite sides of the same coal basin. This opinion is rendered more plausible by the fact that younger strata of Miocene age are known to occur in the same eastern portion of the Newcastle Hills, where the center of the basin should be. The extent of the coal-bearing district, if it be continuous from Gilman to Newcastle, is not less than 5 square miles, and may be 12 square miles. The relations of the district beyond the immediate vicinity of the mines have not been studied.

Newcastle-Gilman district. The leading to this region is the town of Seattle, which takes its name from that of the coal coal mines worked in the fields above it. Newcastle lies 11 miles southeast of Seattle, and is connected with it by the Northern Pacific Rail Road, and by the Summitt Lake and New Castle Coal Company's line.

The structure of the Newcastle-Gilman district is rendered the same as the Newcastle-Gilman district, and its relations to the Newcastle district also the same. The nature of the Newcastle-Gilman district was determined by the coal mines worked in the New Castle Coal Company's line opened a new deep, and the Seattle-Boston-Taltan coal company opened its results. In the Newcastle-Gilman district, the northern and the strata of
The stragglers of the Green River coal field were seen as minor members of the Wilson-Carbondale field. The upper portion of the series on Green River is generally barren of coal seams, and the total thickness of the strata of the Wilson-Carbondale field is comparatively thin. It consists, broadly speaking, of a sheet of strata belonging to the west and southeast and of broken blocks, these blocks the McKinley coal beds and the Black Diamond coal beds are mined in the west and to the southeast. The general strike of the important McKinley coal seams is N 82° E, the distance between the two seams being from 15 to 20 miles.

In the Light Ash beds are 80 feet from the surface, a number of small, well-developed coal seams, from 3 to 4 feet in thickness, are present in the strata which are exposed north of Black River, and might well be developed in the near future.

The northern district—Red River and Tuxedo, from 15 to 30 miles east of a line connecting these two towns, is the Green River district. The strata which are exposed here are the same as those in the Coal Measures, and are the same as those in the Coal Measures, and are the same as those in the Coal Measures, and are the same as those in the Coal Measures.

In the Light Ash beds are 80 feet from the surface, a number of small, well-developed coal seams, from 3 to 4 feet in thickness, are present in the strata which are exposed north of Black River, and might well be developed in the near future.

The northern district—Red River and Tuxedo, from 15 to 30 miles east of a line connecting these two towns, is the Green River district. The strata which are exposed here are the same as those in the Coal Measures, and are the same as those in the Coal Measures, and are the same as those in the Coal Measures, and are the same as those in the Coal Measures.

In the Light Ash beds are 80 feet from the surface, a number of small, well-developed coal seams, from 3 to 4 feet in thickness, are present in the strata which are exposed north of Black River, and might well be developed in the near future.

The northern district—Red River and Tuxedo, from 15 to 30 miles east of a line connecting these two towns, is the Green River district. The strata which are exposed here are the same as those in the Coal Measures, and are the same as those in the Coal Measures, and are the same as those in the Coal Measures, and are the same as those in the Coal Measures.

In the Light Ash beds are 80 feet from the surface, a number of small, well-developed coal seams, from 3 to 4 feet in thickness, are present in the strata which are exposed north of Black River, and might well be developed in the near future.

The northern district—Red River and Tuxedo, from 15 to 30 miles east of a line connecting these two towns, is the Green River district. The strata which are exposed here are the same as those in the Coal Measures, and are the same as those in the Coal Measures, and are the same as those in the Coal Measures, and are the same as those in the Coal Measures.

In the Light Ash beds are 80 feet from the surface, a number of small, well-developed coal seams, from 3 to 4 feet in thickness, are present in the strata which are exposed north of Black River, and might well be developed in the near future.
le directly toward the dams discerned in mine No. 4. It is highly probable that the existence of both strata of sandstone and mudstone is due to a fault line, which may have been caused by the movement of the Miller's Knob and the Miller's Knob with the Miller's Knob. The further corroborations of records and field studies indicate that the Miller's Knob and the Miller's Knob with the Miller's Knob are not the same as the Miller's Knob and the Miller's Knob with the Miller's Knob. The interval distance between the two points may be different for each of the different sections of the mine. The Miller's Knob is complete in the eastern section of the mine, while the Miller's Knob is incomplete in the western section of the mine.

The Wilkeson section is complete from the lowest Carboniferous to the uppermost Carboniferous. The section is about 250 feet thick and the interval distance is about 150 feet. The interval distance between the two points may be different for each of the different sections of the mine. The Wilkeson section is the only section that is complete in the eastern section of the mine.

The Wilkeson section is complete from the lowest Carboniferous to the uppermost Carboniferous. The section is about 250 feet thick and the interval distance is about 150 feet. The interval distance between the two points may be different for each of the different sections of the mine. The Wilkeson section is the only section that is complete in the eastern section of the mine.

Formation:

The Wilkeson section is complete from the lowest Carboniferous to the uppermost Carboniferous. The section is about 250 feet thick and the interval distance is about 150 feet. The interval distance between the two points may be different for each of the different sections of the mine. The Wilkeson section is the only section that is complete in the eastern section of the mine.

The Wilkeson section is complete from the lowest Carboniferous to the uppermost Carboniferous. The section is about 250 feet thick and the interval distance is about 150 feet. The interval distance between the two points may be different for each of the different sections of the mine. The Wilkeson section is the only section that is complete in the eastern section of the mine.

Formation:

The Wilkeson section is complete from the lowest Carboniferous to the uppermost Carboniferous. The section is about 250 feet thick and the interval distance is about 150 feet. The interval distance between the two points may be different for each of the different sections of the mine. The Wilkeson section is the only section that is complete in the eastern section of the mine.

The Wilkeson section is complete from the lowest Carboniferous to the uppermost Carboniferous. The section is about 250 feet thick and the interval distance is about 150 feet. The interval distance between the two points may be different for each of the different sections of the mine. The Wilkeson section is the only section that is complete in the eastern section of the mine.
The Osoola till affords a soil of sandy clay, usually dark colored on account of a large proportion of humus. The subsoil is a blue clay, which is impervious to water, and the area was to a great extent a swamp, supporting mosses, huckleberry bushes, and alder. Being cleared with comparative ease, large areas have been brought under cultivation. When drained the soil is warm and fertile.

Scattered throughout the various other formations are small patches of swamp alluvium. They consist of black mud or peat on a clay subsoil. When cleared and drained they yield a good soil, except that it is sometimes rather light and in droughts may become too dry.

**FORESTS.**

The forest may become a permanent resource of the Puget Sound district. Its character has been described. Its present value is known and it is being rapidly and destructively exploited. The fact that it may profitably reproduce itself is not yet appreciated.

Extensive tracts of the VANHON drift, of both the unmodified and modified types, are unsuited to cultivation, yet are being cleared at excessive cost to make unprofitable farms. This clearing and wasteful numbering are accompanied or followed by destructive fires, and the process involves a loss to the community. Lands unsuited to culture may be set apart for conserving forestry. Account being taken of the present stand and rate of growth of the several kinds of valuable trees, the cut may be so regulated as to yield a present profit while preserving the immature trees for the second, third, and future cuts. Fires can be prevented. Lumbering may thus become a steady and permanent resource instead of a destructive and transient activity. In a region like the Puget Sound Basin, where the forest growth is rapid and where extensive areas unfit for culture will produce magnificent forests, this practice of conservative forestry is of the first importance to individuals and to the community. The geologic map of the Tacoma quadrangle in part indicates lands suitable for aggregation for forestry.

BAILEY WILLS,
Geologist.
GEORGE OTIS SMITH,
Assistant Geologist.

June, 1899.
The Pleistocene and the Archean are distinguished from one another by different patterns on the maps that were printed on the reverse side of the paper used for the text. These patterns are based on the different petrographic frameworks present in each formation.

In cliffs, canyons, shafts, and other natural and artificial cuttings, the relations of different beds may be more clearly seen. At these cuttings, the geologist can observe the sequence and relative positions of the rocks, and the way in which they were formed. The relations of the rocks can be studied in detail by making cross-sections of the area.

The third section of formations consists of crystalline rocks. These rocks are formed by the solidification of magma, and they are characterized by the presence of minerals that were formed at high pressures and temperatures. The rocks in this section are generally harder and more resistant to weathering than the sedimentary rocks.

The fourth section of formations is the metamorphic rocks. These rocks are formed by the alteration of sedimentary or volcanic rocks under high pressure and temperature. The metamorphic rocks are characterized by the presence of minerals that are different from the original minerals.

The fifth section of formations is the igneous rocks. These rocks are formed by the cooling and solidification of magma. The igneous rocks are characterized by the presence of minerals that are distinct from the minerals in the other types of rocks.

The sixth section of formations is the sedimentary rocks. These rocks are formed by the deposition of minerals and sediments. The sedimentary rocks are characterized by the presence of minerals that are typically soft and easily weathered.

The maps in this report are designed to show the relative positions of the formations and the rocks, and to give a general idea of the geological features of the area. The maps are based on the geological data obtained from the field work, and they are designed to be used for further study and interpretation.

Figure 1: Sketch showing a vertical section in the front of the country, with a landscape beyond.

The plates in fig. 1 presents toward the lower land, an escarpment or front, which is made up of a series of ridges and valleys. The escarpment is characterized by the presence of cliffs and slopes, which are as steep as the outcrops of the rocks. The escarpment is bordered by a series of ridges and valleys, which are as steep as the outcrops of the rocks.

The middle section of the column shows the map, which is drawn to a scale of 1000 feet to 1 inch. The order of accumulation of the sediments is shown in the column arrangement: the oldest formation is placed at the bottom of the column, the youngest at the top, and the igneous rocks or other formations, when present, are indicated in their proper relations.

The formations are divided into systems, which are made up of the periods of the rocks. The periods of the rocks are characterized by the presence of certain types of rocks, which are formed under different conditions. Each period is divided into epochs, which are characterized by the presence of certain types of rocks, which are formed under different conditions.

The epochs are divided into stages, which are characterized by the presence of certain types of rocks, which are formed under different conditions. Each stage is divided into systems, which are characterized by the presence of certain types of rocks, which are formed under different conditions.

The systems are divided into provinces, which are characterized by the presence of certain types of rocks, which are formed under different conditions. Each province is divided into districts, which are characterized by the presence of certain types of rocks, which are formed under different conditions.

The districts are divided into formations, which are characterized by the presence of certain types of rocks, which are formed under different conditions. Each formation is divided into stages, which are characterized by the presence of certain types of rocks, which are formed under different conditions.

The stages are divided into systems, which are characterized by the presence of certain types of rocks, which are formed under different conditions. Each system is divided into provinces, which are characterized by the presence of certain types of rocks, which are formed under different conditions.

The provinces are divided into districts, which are characterized by the presence of certain types of rocks, which are formed under different conditions. Each district is divided into formations, which are characterized by the presence of certain types of rocks, which are formed under different conditions.

The formations are divided into stages, which are characterized by the presence of certain types of rocks, which are formed under different conditions. Each stage is divided into systems, which are characterized by the presence of certain types of rocks, which are formed under different conditions.

The systems are divided into provinces, which are characterized by the presence of certain types of rocks, which are formed under different conditions. Each province is divided into districts, which are characterized by the presence of certain types of rocks, which are formed under different conditions.

The districts are divided into formations, which are characterized by the presence of certain types of rocks, which are formed under different conditions. Each formation is divided into stages, which are characterized by the presence of certain types of rocks, which are formed under different conditions.

The stages are divided into systems, which are characterized by the presence of certain types of rocks, which are formed under different conditions. Each system is divided into provinces, which are characterized by the presence of certain types of rocks, which are formed under different conditions.