

GEOLOGY OF THE QUIMPER PENINSULA

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A thesis submitted for the degree of

BACHELOR OF SCIENCE IN  
GEOLOGY

UNIVERSITY OF WASHINGTON

1927

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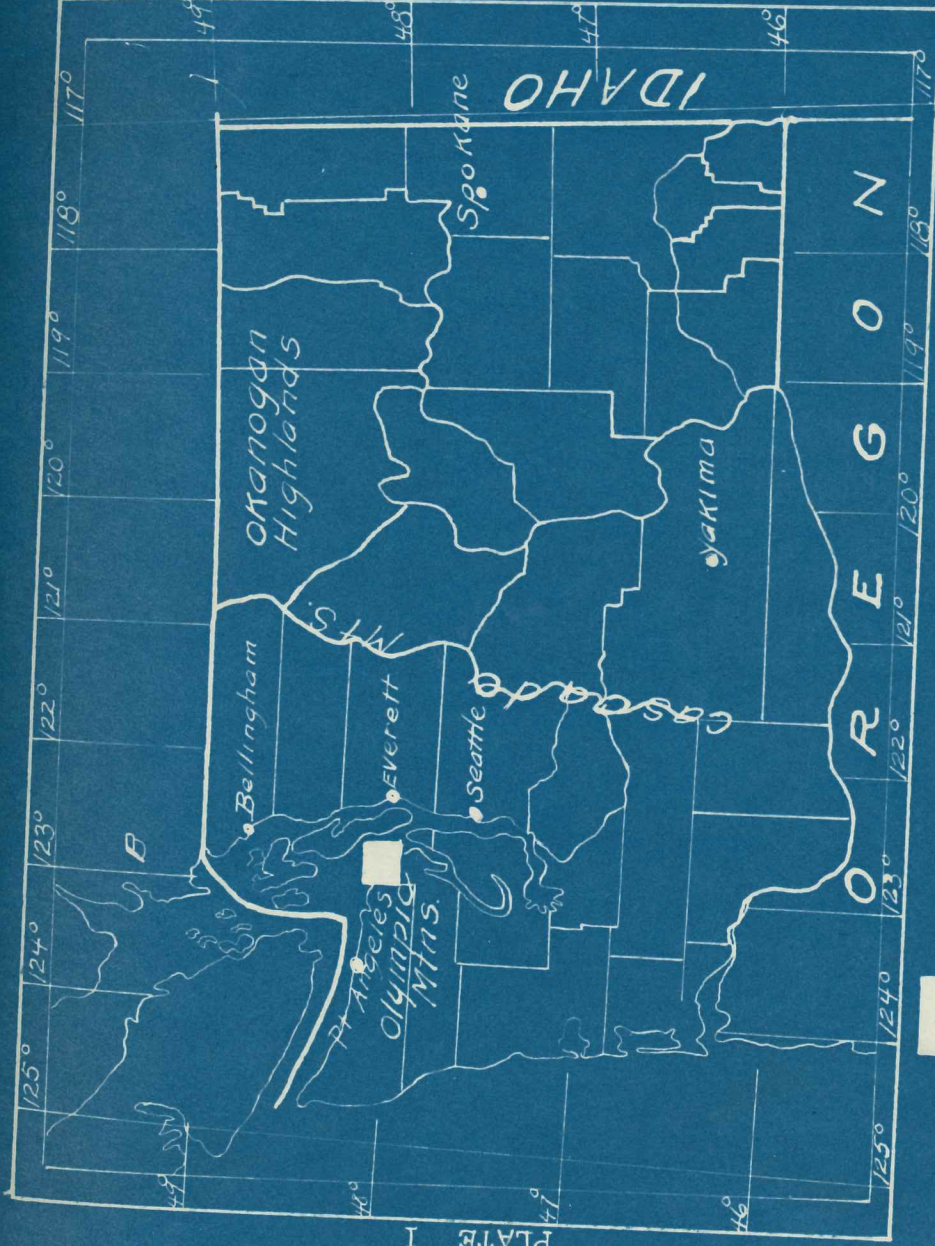
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PLATE I

INDEX MAP  
of  
WASHINGTON



QUIMPER PENINSULA AREA

PLATE I

## GEOLOGY OF THE QUIMPER PENINSULA

## INTRODUCTION

This thesis was written at the suggestion of Dr. Charles E. Weaver. The field work was done during the latter part of August 1926 and the second week of June 1927. The author was assisted in the field upon both of these occasions by Mr. Ralph Alexander of Arlington, Washington. The preparation of all specimens and of this manuscript was done during the first two weeks of August 1927.

The survey of the geology of this area was carried on largely by plane table. A traverse of all outcrops exposed along the beaches of the various bays surrounding the Quimper Peninsula was made by plane table on a scale of 600 feet to the inch. Each traverse made was tied in to a section line or corner for control. All outcrops not located on these various bays were located by compass bearings and pacing. Fully 95% of the outcrops in this area, however, are located on the shores and cliffs of the bays about the Quimper Peninsula.

While the outcrops are easily accessible and it is possible to obtain good sections, it is sometimes difficult to survey along these outcrops. In almost all cases a dense vegetation starts a few feet from shore, and in some instances the outcrops occur as cliffs with very little if any beach. For these reasons, it was impossible at some stages of the tide to work for more than four or five hours a day.

## ACKNOWLEDGMENTS

The writer is greatly indebted to Dr. Weaver for aid in solving the many problems that have come up from time to time in the preparation of this thesis. The writer is equally indebted to Prof. G. E. Goodspeed for assistance in the Petrographic Analyses and in other phases of the work as well. Thanks is also due and gratefully given to Aaron Waters, A. Allen Weymouth, T. J. Etherington and others of the Department of Geology at the University of Washington for assistance in the preparation of this thesis.

## GEOGRAPHY

## LOCATION

The Quimper Peninsula forms the north-eastern tip of the Olympic Peninsula. It is located in the north-eastern tip of Jefferson County, Washington, and is in Township 30 North, Range 1 West, Willamette Meridian. Its approximate latitude is 48'06" North, and its approximate longitude is 122'49" West.

## SIZE OF AREA

The area included in this survey includes Narrowstone and Bay Islands together with the western shore of Port Discovery Bay and the region about Uncas in addition to the Quimper Peninsula proper. The total area covered by this report is approximately 156 square miles half of which is covered by the various bays of Puget Sound which lie in this area.

## CLIMATE

The climate of this region is very mild. It is typical Puget Sound climate in all respects save rainfall. Shut off from the warm, moisture-laden winds of the Pacific by the Olympic Mountains there is a belt reaching from Port Townsend on the east to Dungeness on the west that is much dryer than either the Puget Sound Basin or the country to the west. The annual rainfall at Port Townsend is about 20 inches per year in contrast to a rainfall of approximately 40 inches per year at Seattle and about 120 inches per year at Cape Flattery.

## VEGETATION

The Quimper Peninsula is quite thickly timbered except,



of course, those parts which are under cultivation or which have been cut over and grown up in a tangle of second growth saplings. As is generally true in Puget Sound forests, the Douglass Fir, Western Hemlock and the Western Red Cedar are the dominant species.

While quite thickly timbered, the timber is not as large as is usual for forests having the above named species as the predominant ones. This is due, perhaps, to the fact that in many places the soil is very poor and to the rather scant rainfall. The Chimacum valley which has been cultivated for many years was, no doubt, heavily covered with timber as it is the most fertile part of the peninsula and should have had a stand of timber rivalling that of the fertile valleys of the mainland such as the Skagit.

Madronnas and Rhododendrons are fairly abundant especially along the shores of the sound. There are also many small shrubs such as different varieties of the Rose Family which are not usually found east of Puget Sound. Their presence is due, it is believed, to the dryer climate of the peninsula. Small, park-like openings in rather scanty timber were noticed in several places, notably at Port Hadlock and north of Tukeys on Port Discovery Bay, which remind one of the Steilacoom Praries and the praries in the San Juan Islands. Their existence is due to the poor, sterile soil of glacial outwash and to the dry climate.

## PHYSIOGRAPHY

The topography of the Quimper Peninsula is almost entirely the result of Pleistocene glaciation. Whatever the previous topography may have been it is impossible to say as almost the entire area has been scoured over by the glaciers and then covered with drift and other glacial materials to an unknown depth. It is only along the shores of the various bays of Puget Sound, in the gorges of a few of the small streams and on the high hills along the south-eastern shores of Port Discovery Bay that any tertiary rocks are exposed.

The Quimper Peninsula lies on the western edge of the Puget Sound Basin. Its south-western portion borders the edge of the Olympic Mountains where they rise up very abruptly almost from the waters of Puget Sound as south of Port Discovery Bay at the headwaters of the Salmon River. The greater part of the surface is gently rolling, however, and averages about 300 to 400 feet in elevation.

The shore line of the sound is usually in this vicinity an abrupt cliff with little and sometimes no beach. Along the northern side of the peninsula there are bluffs of glacial materials from 80 to 100 feet high. Port Townsend, Port Discovery, and Scow Bays are much the same. Along the north shore of Oak Bay there are fairly high bluffs and banks of glacial material and Oligocene sediments. At the south end of the bay for some distance the sea wall formed by the outcropping Oligocene shale is only thirty to forty feet high. It is not covered by glacial till.

The south-eastern shore of Port Discovery Bay is quite precipitous. Between Woodman and Fairmont for some distance there is a cliff about 100 feet high of basalt. The hill rising back of this cliff is about 1000 feet high. South of Fairmont and east of Uncas there arises a hill, which is the continuation of the hill east of Fairmont, which has an equal elevation. The lower half was found to be composed of basalt and the upper half was composed of conglomerate. This conglomerate was not overlain by glacial material nor was it polished or grooved as if by a glacier. Because of its height and unaltered and uncovered position it is thought that this hill was not over-ridden by a glacier. This hill constitutes the only pre-pleistocene topography on the Quimper Peninsula.

The principal streams draining the region are Chimacum Creek, Snow Creek and the Salmon River. None of these streams are of sufficient size to justify calling them a river. Chimacum Creek drains the Chimacum Valley which is a low, flat valley with very little gradient with low hills on either side. The stream flows out of Anderson Lake through quite a well developed gorge. It also flows through quite a well developed canyon near its mouth north of Irondale where it empties into the sound from a canyon in glacial till about 100 feet deep.

Salmon River drains the territory south-west of Maynard. It flows through a well developed canyon several hundred feet deep. The Haley branch which flows south into the main channel flows through a deep gorge about 200 feet deep and as many feet wide. Snow Creek drains the territory south of Uncas to a point about midway between Lake Crocker and Lake Hooker

by a moderately deep valley which has somewhat of a flood plain. Both Snow Creek and Salmon River follow channels which were evidently in existence prior to the Pleistocene glaciation. The heads of these streams rise at an elevation in excess of 1500 feet and the channels were probably widened and deepened by alpine glaciers which formed at their heads.

The Quimper Peninsula, being the north-west shore of Puget Sound, was, no doubt, near the outlet for Lake Russell at the close of the glacial period. As Lake Russell had an altitude of 160 feet above the present tide water level, it would have been impossible for any outlet to have passed over the Quimper Peninsula. The center of the peninsula is higher than the level of Lake Russell and the cliffs about its borders nearly approach that height. There exists upon the peninsula no channel of sufficient size to have formed the outlet of as large a body of water as Lake Russell had the elevation of the peninsula have been such as to make this possible. It is probable that the outlet is now occupied by the waters of Puget Sound.

It has been suggested by J~~ill~~son\* however that there are several channels on the peninsula which were outlets for the lake underneath the ice which impounded the waters of Lake

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\*Jillson, Willard Rouse. A PRELIMINARY REPORT ON THE STRATIGRAPHY AND PALEONTOLOGY OF THE QUIMPER PENINSULA. A Thesis presented for the Degree of Master of Science. University of Washington, March 1915. p. 41.

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Russell. Portage Bay, the south end of Scow Bay and the parade grounds at Fort Warden are cited as examples for this type of channel. This view seems to have some field evidence

for its support. It may be summed up as follows:

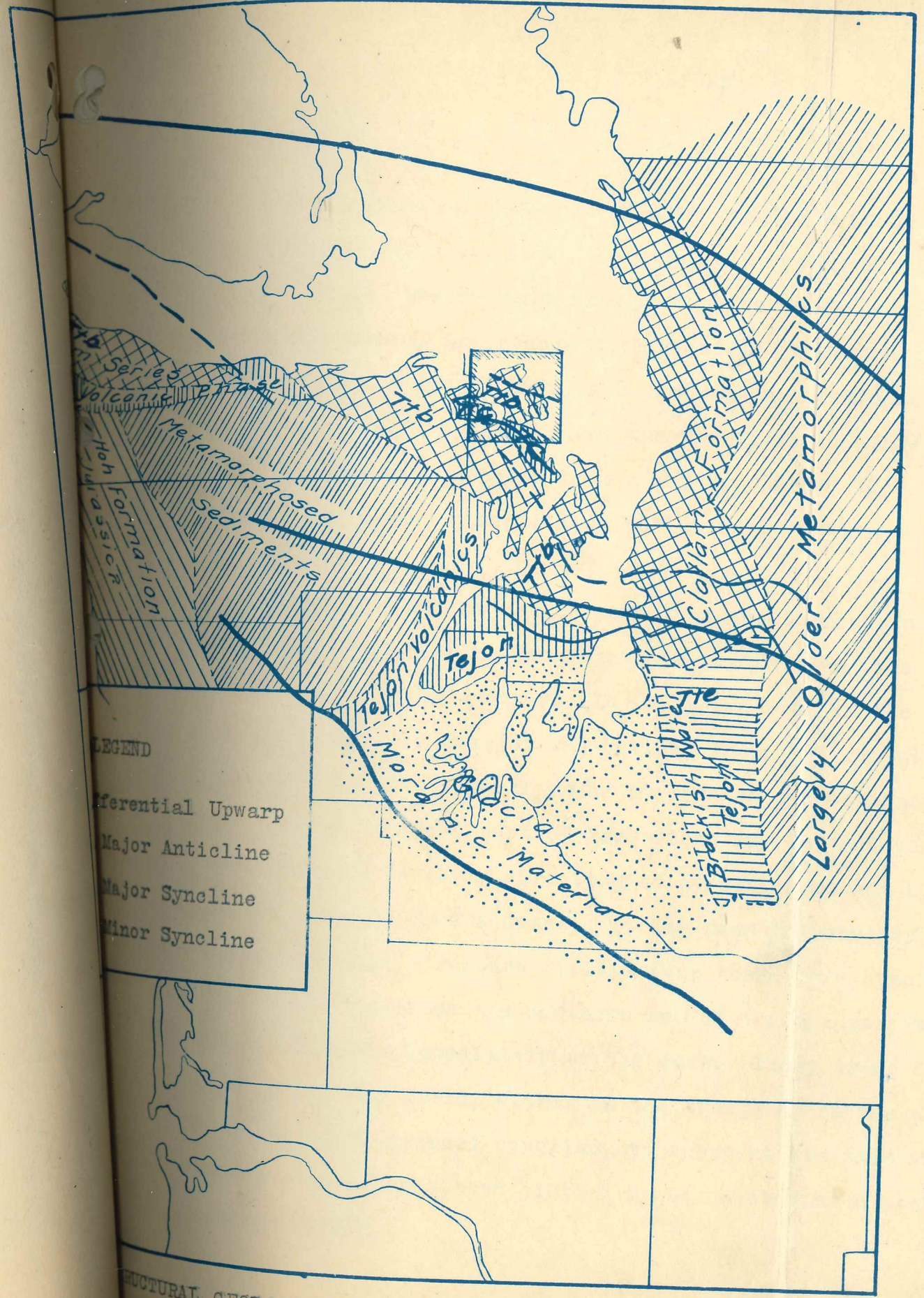
(1) Two of these channels are not parallel to the line of advance of the glacier and for this reason could not have been formed by its advance. The channel at Portage Bay was, perhaps, the channel of a drainage system existing before the glacial epoch which followed a plane of weakness through the Oligocene sediments.

(2) None of these channels are typical of stream erosion and for that reason could not have been formed by a normal stream outlet. As has already been stated the elevation of Lake Russell was about 160 feet above the present tide level. Any stream emptying from Lake Russell to the Straits of Juan de Fuca would have had a very steep gradient and would have eroded its channel correspondingly.

(3) The absence of eskars which are usually found in this type of channel may be explained by the fact that the amount of sediments carried was very small compared to the water when flowing from a lake. A stream flowing from a glacier and out on an outwash plain would leave a channel with a typical eskar. In this case, however, the large volume of water would keep the channel eroded clean of any sediments that might be carried by the stream.

(4) Erosion since the glacial epoch on the Quimper Peninsula has been very slight. Any subsequent change to these channels would have been large by stream action, and none of these channels are typical of stream erosion.

It is true, however, that this hypothesis calls for an under-ground stream of considerable length as it is a matter of some eight or nine miles from the south end of Scow Bay, named Long Harbor on the map accompanying this thesis, to the Strait of Juan de Fuca north of Port Townsend, which was the ultimate outlet of any such stream. Eskars have been found, however that approach this length very closely.



LEGEND

Differential Upwarp

Major Anticline

Major Syncline

Minor Syncline

STRUCTURAL GEOLOGIC MAP OF WESTERN WASHINGTON

## STRUCTURE

## REGIONAL

The structural features of most magnitude in the Puget Sound Basin are three, roughly parallel, region of differential upwarp. These three upwarps together with other structural features of importance with regard to the structure of the Quimper Peninsula have been plotted on a geologic map of Western Washington which forms the frontpiece of this thesis. This map has been adapted from a map by Charles E. Weaver which constitutes plate XXX of Bulletin 15, Washington Geological Survey.

From this map it can be seen that the Quimper Peninsula lies about half way between the most northern and the middle of the three major upwarps. It is, therefore, in the center of the structural warp or sag between them. It can also be seen that an anticline of major importance starts somewhat west of the southern part of Port Discovery Bay and continues on in a south-westerly direction to a point somewhat south of the entrance of Hood's Canal. It has been inferred by Dr. Weaver from the structure visible that there is a synclinal axis which traverses the northern end of the Quimper Peninsula and the islands immediately to the east. There is no direct evidence in the field, either in the trough or on the northern flank of this supposed syncline, to substantiate this view, however, and it has been plotted by Dr. Weaver as a probable synclinal axis.



A glance at the map, Plate II, will show that the greater part of the area and practically all of the outcrops of this region are on the north limb of the anticline which passes through this area. It is only by the aid of two observations for strike and dip on the south-west slope of the anticline that it is possible to place the location of the anticlinal axis on the evidence that can be found in this territory. The axis drawn upon Plate II is copied from that drawn by Dr. Weaver on his map. While this axis is somewhat more reliable being the result of more observations made upon the southwestern flank in the region about Port Ludlow as well as those observations made upon the north-eastern flank of the anticline, it is only approximate due to the lack of outcrops away from the shores of the sound and bays of the region.

Structures of minor importance are found on the north-eastern limb of the anticline in this area. These will now be described in more detail.

#### LOCAL

The Oligocene deposits in Port Discovery Bay have a prevailing northwesterly strike with a dip of a few degrees to the north. They are slightly undulating, however, and it can be seen from the map (Plate II) that there are developed here a small anticline and a small plunging syncline. The axis of the major anticline can be located in the basalts a short way north of Fairmont.

In Port Townsend bay the Oligocene sediments have a pre-

vailing northwesterly northwesterly strike on the west side of Portage Bay with an average dip of 12 degrees to the northeast. On the east side of Portage Bay and continuing on with very little change to the northern limit of the outcrop, the prevailing strike is east and west with a dip to the north averaging somewhat greater than that of the west side of the bay. This fact together with the total unsimilarity of the lithology of the outcrops on the opposite sides of Portage Bay would indicate that they are cut off from each other by a fault which follows the channel of Portage Bay. The east side of the bay has been the uplifted block and the face of the sandstone cliff immediately north of the ferry landing and directly opposite from Port Hadlock is the fault scarp of this uplifted block.

In Oak Bay the shales have a predominant northwesterly strike with low dips to the north. As is the case at Port Discovery Bay there are several minor oscillations.

The structure on both sides of Scow Bay is remarkable for its uniformity. The strike is east and west and the dips range from 20 to 36 degrees north.

At Liplip point there is developed an anticlinal and a synclinal structure. Though small they are rather markedly developed and sharp cut because of the fairly steep dip. The predominant strike is east and west except at the northern end of the exposure where it is north and south.

There are some indications of a fault of considerable size in this area. The possibility of such a fault has been mentioned to the writer by Dr. Weaver, who asked that all information possible be found which had any bearing on this subject.

About one third of a mile north of Woodman there occurs for a short distance an outcrop of conglomerate. There is then an exposed section between this conglomerate and the sandstones which the Oligocene fossils are found in. There is no contact with the conglomerate either from above with the shales and sandstones at Woodman or with the basalt which outcrops about one half mile south and also somewhat east in Section 9 on the east side of Anderson's Lake. Dr. Weaver mentions an outcrop in the gorge of the creek that empties Anderson Lake. At this outcrop about one fourth of a mile south of the lake the basalt is covered by the conglomerate.

At City Lake which is southwest of Fairmont and located in Section 19 the author found the conglomerate and basalt in close proximity to each other but not in actual contact. On the east side of this lake a hill rises up 500 to 600 feet high which is composed entirely of conglomerate. On the western and northeastern side of this lake slightly above the level of the water of the lake there occurs outcroppings of basalt. It would seem possible that there is a fault passing across the lake from the south and to the northeast as there is a small canyon between the outcrop of the basalt and that of the conglomerate. If such a fault occurs at this place, it would seem that the conglomerate, being the higher in elevation of the two, should have been the uplifted block or the fault escarpment. However, this cannot be the case as the conglomerate, which is above the basalt stratigraphically and younger in age than the basalt, should have been eroded away leaving the basalt as the fault escarpment with

the conglomerate on the downthrow side where it would have been protected more from erosion. In this case the basalt, which in every instance in this locality has been found in under the conglomerate, is the lowest in elevation.

At the south end of Oak Bay the Oligocene shales rest directly upon the basalt in actual contact. Dr. Weaver has suggested that there may have been a fault which has placed these shales directly on top of the basalt. This would account for the absence of the conglomerate which is found in connection with the basalts at Anderson Lake, City Lake and east of Uncas. There is, however, no evidence at Oak Bay to substantiate this view that such a fault has occurred. The shales are in very intimate contact with the eroded basalts and have every appearance of having been laid down directly on top of an eroded surface, billing in the inequalities of eroded surface. Nothing in the nature of a fault plane or twisted or contorted strata was found.

The writer feels that there is not enough evidence so far, at least, to substantiate the view that a fault has placed the Oak Bay shales on top of the Basalts. He is of the opinion that the shales are more or less contemporaneous with the sandstones and conglomerates about Port Discovery Bay and that the difference in lithology is probably due to the depth of water in which the sediments were laid down in. A detailed petrographic analysis of the different sediments and a careful examination of the fossils at the contact in Oak Bay would probably throw considerable light on this problem.

## PALEONTOLOGY

## INTRODUCTION

While in the field in this area, the author collected a fairly representative fauna from the different fossil localities of Oligocene Age. Due to the limited time at the disposal of the author for the preparation of this thesis and the large amount of work necessary for a proper determination, the writer has not attempted a systematic determination of the fossils taken in the field. These specimens are now in the possession of the Department of Geology at the University of Washington, and it is hoped that they will be studied at some future time, particularly those from the base of the shales of Oak Bay, which the author believes may have an important bearing on the structure and stratigraphy of the region. It is the purpose of this discussion on Paleontology to summarize the work previously done in the field in this area, and a description of the locations of the various fossil beds collected from by the author is given.

## EOCENE

In the basalts at Olele Point there are intercolated, water-lain beds of tuff. The writer found such a bed at a point about 500 feet south of Olele Point. No fossils, however, were found. Dr. Weaver has reported that there are marine, Eocene fossils (presumably Tejon, as he has termed this formation the basaltic phase of the Tejon) in the tuffs near Olele Point. The bed of tuff found by the author did not ex-

ceed ten feet in thickness.

#### OLIGOCENE

Fossils are found in several localities in the sandstones and shales of the Quimper Peninsula. They are usually quite well preserved and in some cases fairly abundant.

About one half mile north of Woodman on the east shore of Discovery Bay there are abundant, fairly well preserved fossils in the sandstones and lenticular masses of conglomerate. The fossils are found from tide level to a height of about ten feet on a cliff which is about thirty feet high at this point. The entire length of the best exposed beds does not exceed 75 feet. This is the best fossil locality on the Quimper Peninsula.

Midway between Blake Island and Portage Bay there occur fossils in a highly siliceous sandstone member of a low cliff on the south shore of Port Townsend Bay. These fossils, while not numerous nor greatly varied as to species, are excellently preserved. This locality is the best around the shores of Port Townsend Bay. Fossils are found scattered at intervals along the east shore of Port Townsend Bay from the mouth of Portage Bay north to the end of the first outcrop which ends a short distance south of Car's Point. There also occur fossils in a sandstone cliff which extends a short way north of Car's Point.

Fossils were reported by Dr. Weaver to occur on the point in the north end of Oak Bay which is immediately south of the eastern entrance to the Port Townsend Ship Canal. A careful search was made but the author was unable to find any fossils.

at this point. Fossils were found, however at several places along the low sandstone and shale cliff south of this point in Section 18. Fossils were also found in the shale at the contact with the basalts in the southern part of Oak Bay. These fossils occurred within a foot of the contact with the basalt. No fossils were found in Scow Bay or along the shores of Admiralty Inlet between Liplip Point and Nodula Point.

The fossils found in this area have been called Oligocene by Dr. Weaver. In regard to their age he says, "Poorly preserved fossils occur scattered through the strata at different localities. They are most abundant north of Woodman Station on Port Discovery Bay and near the north end of Oak Bay. The species are somewhat different from those in the *Acila gettysburgensis* Zone and seem to have closer affinities with the *Turitella porterensis* and *Molopophorous lincolnensis* Zone."\* These zones represent the base of the Oligocene in Washington. The Oligocene in Washington has been called by

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\* Weaver, Charles E. The Tertiary Formations of Western Washington. Washington Geol. Survey, Bull. 13, 1916. p. 196.

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Dr. Weaver the Clallam Formation. This he has divided into the Lincoln, Porter and Blakely Horizons. These three horizons are characterized by the following fossils; *Molopophorous lincolnensis*, *Turitella porterensis* and *Acila gettysburgensis*. The *Molopophorous lincolnensis* Horizon is thought to be the shore phase of the *Turitella porterensis*. There is no difference in age between these zones but a difference in the depth of water in which the fauna of the two horizons lived.

The type locality for the Molopophorous Zone is located in Thurston County along the banks of the Chehalis River between five and ten miles west of the city of Centralia and west to the mouth of Lincoln Creek. It is also exposed to the west along Porter Creek. The Porter type section is located in Chehalis County in the vicinity of the junction of Porter Creek and the Chehalis River. It is also found along the bluffs of the Chehalis River both east and west of the town of Porter. The type locality for the *Acila gettysburgensis* Zone is situated at the entrance to the Bremerton Navy Yard. The Molopophorous *lincolnensis* and *Turitella porteren-* *ensis* Zones do not have a wide geographic distribution in Washington. It has been suggested by Dr. Weaver, however, that the extreme lower portion of the section exposed at the entrance to the Bremerton Navy Yard may belong to the Porter. In the light of present evidence it has been deemed to separate the Clallam Formation into three separate formations but rather into three faunal Zones such as those just described.

No occurrences of strata of the same age as that on the Quimper Peninsula occur in the immediate vicinity. Oligocene rocks belonging to the *Acila gettysburgensis* zone are found to the east near Cathcart in Snohomish county and in two sections to the west along the Straits and Cape Flattery. From a point two miles west of Gettysburg westerly to a point half way between Twin River and Pyscht, there occurs an exposure of Oligocene rocks of *Acila gettysburgensis*, age and along the north portion of Cape Flattery and along the Straits of Juan



de Fuca easterly to the mouth of the Sekiu River there also occur strata containing fauna of this age.

Along the south shore of Vancouver Island there occur scattered outcrops of sandstones and shales which have been given the name Sooke Formation. According to Dr. Weaver,\*

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\*Weaver, Charles E. Lecture in Geology 132, University of Washington, Spring 1926.

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they represent the base of the Oligocene in the Juan de Fuca region. Recent studies, however, show a possibility of their being of Lower Miocene age. If this be true the Oligocene of the Straits and of the Puget Sound embayment is all Miocene or younger.

In a paper on the Sooke Formation of Vancouver Island\*\* by Bruce L. Clark and Ralph Arnold the Sooke is correlated

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\*\*Clark, Bruce L. and Arnold, Ralph. Fauna of the Sooke Formation Vancouver Island. University of California Publications, Bulletin of the Department of Geological Sciences. Vol. 14, No. 5.

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for the most part with the *Acila gettysburgensis* Zone of Weaver. Near Carmanah Point lighthouse a section was found which contained in its lower portion a typical Lincoln fauna and in its upper portion a Blakely fauna was found throughout. Heavy conglomerates separate the beds containing the two faunas. Two localities of special interest were found near the top of the section which contained an interfingering of the typical Blakely and Sooke Faunas. The authors of this paper sum up

the correlation of the Sooke with the following statement, "Whether the Sooke Fauna will be found to be characteristic of the upper part of the Blakely or whether it represents a facies which might be repeated over and over again in the same section is a question which must be settled by future work. It is our opinion that the first condition is the most probable." From the various interpretations as to the age of the Oligocene occurrences along the shores of the Straits of Juan de Fuca it can be readily seen, the writer believes, that a great amount of detailed work will be necessary to reach a more favorable conclusion.

In the light of the present evidence, the author believes it is justifiable to consider the beds of the Quimper Peninsula together with the basal part of the Sooke as the basal part of the Oligocene in the San Juan region and of contemporaneous age with the *Molopophorous lincolnensis* and *Turitella porteren-sis* Zones of the Chehalis Valley.

In the sandstones and lenticular masses of conglomerate at Woodmans a typical *Molopophorous* fauna is found. *Acila schumardi*, a characteristic Lincoln form, is, perhaps, the most abundant fossil at this locality. This locality is near the base of the Oligocene on Port Discovery Bay. There is no actual contact at this point with the underlying Eocene Basalt. At the foot of Oak Bay fossils are found in the shales within a foot of the contact with the underlying basalt. No study, to the author's knowledge has been made in detail at this locality. A detailed study of this fauna would be interesting in that it would help to determine the base of the Oligocene in this region and that it would, perhaps, help solve the structure at

this point which is somewhat uncertain due to the lack of a basal conglomerate at the contact with the basalt. An accurate determination of this fauna would make possible a correlation between the base of the shales in Oak Bay and the sandstones at Woodman. It is possible that the two are contemporaneous, the difference in lithology being caused by the difference in depth of water in which the two were deposited. The fauna at the base of the shales in Oak Bay should, in this event, prove to be a typical, deep water Porter phase.

The following faunal lists are those of fossils found by Dr. Weaver and Jillson in this area.

**Jillson's Collection from Woodman**

Pelecypoda

Nucula (Acila) conradi - Dall  
 Solen (Pleclasten) curtus, Var. Conradi-Dall  
 Spisula (Hemimactra) precursor-Dall  
 Tellina eugenia-Dall  
 Venericardia chehalisensis-Weaver  
 Yoldia oregona-Dall

Gastropoda

Acmea sp?  
 Cancellaria oregonensis-Dall  
 Conius sp ?  
 Drillia chehalisensis-Weaver  
 Cuma byslicala Var. Quadradosuon-Weaver  
 Epitonium (Arctoscola) condoni-Dall  
 Eudolium petrosus-Conrad-Dall  
 Leomesus sulculatus-Dall  
 Natica (cryponatica) consors-Dall  
 Phalium (Bezoardica) adquisulcatum-Dall  
 Polinices (Euspira) - Dall  
 Strepsidura oregonensis-Dall  
 Turris sp ?

Schapoda

Dentalium conradi-Dall

Jillsons Collection From South Port Townsend Bay.

Pelecypoda

Chione cathcartensis- Weaver  
 Nucula (Acila) conradi-Dall  
 Solen (Plectosolon) conradi-Dall  
 Spisula (Hemimactra) precursor-Dall  
 Lucina sp?

## Gastropoda

Epitonium (Arctosecala) condoni-Dall  
 Natica (Cryponatica) consors-Dall

## Schapoda

Dentalium porterensis-Weaver.

Jillson's Collection from Oak Bay (north)

## Pelecypoda

Chione sp ?  
 Nucula (Acila) conradi-Dall  
 Spisula (Hemimactra) precursor-Dall  
 Venericardia chehalisensis-Weaver  
 Polinice euspira-Dall  
 Trochita sp ?

## Schapoda

Dentalium conradi-Dall

## Arthropoda

Crustacea- rock crab- Weaver.

Jillson's Collection From Oak Bay ( South part of Sec. 18)

## Pelecypoda

Nucula (Acila) conradi-Meek-Dall  
 Spisula (Hemimactra) precursor-Dall  
 Venericardia chehalisensis-Weaver

## Gastropoda

Cuma sp ?  
 Drillia sp ?  
 Natica (Cryponatica) consors-Dall

## Scaphopoda

Dentalium conradi-Dall

## Arthropoda

Crustacea-rock crabs-Weaver.

Jillson's Collection From Center of Bay Island, Section 6.

## Pelecypoda

Mytilus edulis-Deshayes  
 Paphia staminea  
 Schizothaerus nuttali-Conrad

## Gastropoda

Thais lamollosa-Gemlin

Jillson's Collection From Raised Beaches of Port Townsend Bay

## Pelecypoda

Cardium corbis-Deshayes  
 Ostrea lurida-Carpenter  
 Paphia staminea-Conrad  
 Saxodonus giganteus-Deshayes  
 Schizothaerus nutalli-Conrad

## Gastropoda

Thais lamallosa

The following faunal lists are those prepared by Dr.  
 Weaver. They are given in Bulletin 13 of the Washington Geol-  
 Survey.

Wash. Geol. Sur. Localities 158, 159, 267.  $\frac{1}{2}$  Mile north of  
 Woodman, East Shore of Port Discovery Bay.

## Pelecypoda

Acila schumardi-Dall  
 Marcia Oregonensis-Conrad  
 Malletia chehalisensis-Arnold  
 Solen curtus-Conrad  
 Tellina oregonensis-Conrad

## Gastropoda

Calyptraea inornata (Gabb)  
Crepidula princeps-Conrad  
Epitonium washingtonensis-Weaver  
Epitonium rugiform-Dall  
Eudolium petrosus-Conrad  
Molopophorous gabbi-Dall  
Natica oregonensis-Conrad  
Strepsidura oregonensis-Dall

Wash. Geol. Survey Locality 165. In Oak Bay, just south of  
Ship Canal Spit in Section 7, Twp. 29 N., R. 1 E.

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Pelecypoda

Cardium lorenzanum-(Arnold)  
Tellina oregonensis-Conrad

Gastropoda

Epitonium washingtonensis-Weaver  
Natica oregonensis-Conrad  
Scaphander washingtonensis-Weaver

STRATIGRAPHY OF THE QUIMPER PENINSULA

Unconformable Pleistocene or Eroded Surface			
Unexposed	Unexposed	Scow Bay Sandstones and Shale	Unexposed
	Port Townsend and Portage Bay Sandstones and Shales 4050 feet?	3800 feet?	
	Unexposed		Liplip to Nodula Pt. 1200 feet
Woodman Ss. 400 feet	Oak Bay Shales 1800 feet	Unexposed	Unexposed
Congl at Uncas City Lake, Etc. 500 feet?			
Unconformably overlain, Eocene Basalt			

## STRATIGRAPHY

## EOCENE

## CONDITIONS OF SEDIMENTATION

During Upper Eocene time in Washington, there was considerable oscillation of the sea floor. As can be seen from the very small section of Eocene sediments in this area sandstones and shales alternated rapidly. At this time the Olympic Mountains were an uplifted region as was the San Juan Island region. The country to the east of the Sound was a low, flat region having a dense tropical flora and numerous embayments and swamps. It was in these estuaries and swamps that the coal-formation of Eocene time in Washington took place. To the east in the vicinity of Roslyn and the Swiak Formation of the eastern Cascades the coal formation which took place in fresh-water lakes was probably of contemporaneous age and it is possible that the estuaries from the sound at times connected with these fresh water lakes. In the Eocene of the coal measures marine, brackish water, and fresh water faunas are found intercolated.

The writer believes that the tuffaceous sandstones and shales found in the Eocene of this area are reworked and water-lain materials from the surrounding Olympic Mountain and San Juan Island land mass. That the oscillation were of short duration is readily shown by the fact that the interbedded sediments, which are thought to be marine, are of very small thickness and that neither the underlying basalt nor the uppermost shale have been eroded in the slightest. Although the author



was unable to find any fossils in this area, it is thought that these sediments are marine due to the well stratified condition and to the fact that marine invertebrate fossils have been found in interbedded sediments in this vicinity. The fact that the sediments themselves are reworked volcanic material and the fact that they are found interbedded with lava flows gives ample proof that volcanic activity was predominant at this time in this area at least.

#### LITHOLOGY

About 500 feet south of Olele Point interbedded with basalts, the following section was found.

4 feet of badly weathered shaley sandstone  
 1 foot of tuffaceous sandstone  
 1 foot of weathered shale  
 8 feet of tuffaceous sandstone

So far as the author was able to determine, this section constitutes the entire representative of the Eocene sedimentary rocks in this section of the Olympic Peninsula. The contact both above and below the sediments was conformable. The base of the section rests upon a massive basalt. The top of the section is covered by a flow about one foot thick which is quite badly weathered and exhibits fine columnar structure.

#### OLIGOCENE

##### CONDITIONS OF SEDIMENTATION

The Oligocene here, as well as the rest of Western Washington, was laid down entirely in marine embayments. The lower or *Molopophorous lincolnensis* is not generally thought

to have extended into the Sound or the Straits of Juan de Fuca. Recent work by Arnold and Clarke on the Sooke, which has already been mentioned and Dr. Weaver's statements as to the fauna of the Quimper Peninsula and the bottom of the section at the Bremerton Navy Yard, which has been quoted in the chapter on Paleontology, would indicate that the Lower Seas of the Oligocene Period did cover parts, at least of the Sound and the Juan de Fuca regions. It is possible that more sediments of this age may be covered by sediments of later age and by deposits of glacial material.

The land area were at this oscillating quite rapidly as is shown by the rapid succession of shales and sandstones of moderately thin beds. The sea or embayment in which these sediments were laid down was probably, however, moderately shallow as a rule as the sediments are predominantly sandy shales and sandstones, many of which are of fairly coarse texture. The sandstones and conglomerates of Woodman, as well as the fauna contained in them indicate shore line conditions. The conglomerate that is usually found on top of the basalt also indicates very shallow water conditions. The volcanic activity that was fairly common at this time is recorded in the sandstones of this area which usually carry varying amounts of ash and tuff. Sandstones of noticeably tuffaceous material occur as the softer members of the exposure at Woodman.

The Cascade Mountains, as such, did not exist during the Oligocene. Their central and southern portion was composed of a low land mass containing numerous, small

water lakes. The Northern Cascades were, however, an elevated mass. The Olympic Mountains and Vancouver Island were at this time elevated though perhaps not quite to a height equal to that of the present time. It was, perhaps, from the Olympic Mountains and the elevated portion of the Cascades that the sediments of this locality were derived; predominantly it is supposed from the nearby Olympics because of the somewhat coarse character of the sediments.

Perhaps, early in the Oligocene and without doubt during the *Acila gettysburgensis* horizon, the Juan de Fuca region was depressed and covered by marine waters. A similar embayment was made in south-western Washington. It is probable that there was a land bridge between these two embayments and that they at no time were connected. The northern boundary of this land bridge would be fairly well indicated by the southern contact of the Clallam Formation on Plate II.

At the close of the Oligocene nearly all of the land in Western Washington was brought above sea level. Just how much sooner the Quimper Peninsula may have been brought above sea-level it is impossible to tell, as the top of the section is eroded away. Sediments of the Blakely Formation may have been laid down in this area and subsequently eroded away prior to the present time. Whenever found the base of the Oligocene in this area rests unconformably on the Eocene Basalts and the top of the section was always found to be eroded whether uncovered or overlain by glacial materials.

## GENERAL STATEMENT

As has been previously stated, the large mantle of glacial material which covers so much of locality makes the study of the underlying tertiary rocks difficult and does not allow as complete an interpretation of the past geological history as revealed in the rocks as could be desired. No matter how detailed or accurately a survey of this area is made it will never be possible to determine definitely the thickness of the strata exposed on the Quimper Peninsula. At no one exposure is the entire section visible, and it is very difficult to tell how much the various exposures overlap. As there are very few exposures inland between the beach exposures and because the character of the sediments change so rapidly both vertically and laterally, a correlation by ordinary lithological characteristics is practically impossible. A detailed petrographic study of these sediments would, perhaps, help determine the relative positions of these various exposures. The unexposed thickness between outcrops is, of course, also a matter of approximation.

As has been mentioned both under Paleontology and Stratigraphy there is somewhat of a discrepancy between the basal beds of the Oligocene at various places in this area. It has already been stated that the author chooses to consider the shales of Oak Bay as the equivalent of the conglomerates and sandstones of Port Discovery Bay in age; the difference in lithology has been considered to be due to the depth of water in which the two have been deposited, supposedly simultaneously.

Using these contemporaneous beds as the base of the section, the author believes the stratigraphic sequence of the Quimper Peninsula to be as given on Plate III. The total thickness of the Oligocene sediments on the Quimper Peninsula as calculated on this chart is shown to be approximately 6500 feet. For convenience the discussions of the detailed stratigraphy will now be given by localities.

#### Port Townsend Bay and Portage Bay.

Starting at a point 275 feet from the west end of the Port Townsend Ship Canal, there is an exposure on the west side of Portage Bay which extends uninterrupted up around the point into Port Townsend Bay and to the slough or marsh which is just around this headland. This exposures differs from that of the opposite side of Portage Bay and more closely resembles the exposures along Oak Bay. It consists of a dark, brownish grey, shale which is quite sandy, with which is interbedded harder seams of a grey sandstone quite firmly cemented with silica. The thickness of the beds ranges from 1 to 20 feet, the sandy shale being always of greater thickness. An average occurrence would be one foot of hard sandstone followed by about 6 feet of the shale.

Across the small, swampy region the outcrop again appears and is composed of about the same type of sediments. Around toward Blake Island, however, the character of the sediments changes slightly and becomes more sandy with fewer of the harder sandstone members. The outcrop extends to and about 500 feet southwest of a point on the shore immediately south of Blake Island. The same sandstone is also found on the

ern tip of Blake Island.

The hard sandstone ledges are often lenticular in shape and are sometimes merely large sandstone boulders arranged as if stratified. These large boulders suggest a sea cliff gradually being destroyed by wave action which embedded the broken fragments from the cliff in the beach sand.

From a point about a quarter of a mile north of the south section line of Section 6 there occurs an outcrop practically continuous to the south side of the spit at Carr's Point in Section 20. From the north side of the point, there is a short outcrop of the Oligocene sediments till they dip out of sight under a covering of glacial till.

The character of the sediments in this outcrop varies greatly. They range from fine-grained, carbonaceous shales to massive sandstones which are in some cases bordering on grits for short distances. The width of the shale beds varies from an inch up to as much as twelve feet. The shales vary in composition and texture. In some cases they are, as has already been stated, fine grained and carbonaceous. They are sometimes fine-grained but not carbonaceous and they also grade into sandy shales and shaly sandstones. The contacts in this outcrop are, however, quite sharp. Sandstone is often found in contact with fine-grained, black, carbonaceous shale. The sandstone varies in thickness from a few inches to as much as 100 feet. It is predominantly massive. Slightly north of the feery landing in section 6 it is exposed in a cliff some 75 to 100 feet high. Along the shore it extends out into the

the bay so that there is no beach exposed here even at low tide. In many places it has been carved into caves by the action of the waves. There is probably four or five times as much sandstone in this outcrop as there is shale. North of Carr's point the outcrop consists predominantly of a shaly sandstone which in places grades into a fairly hard, grey sandstone and of a minor amount of fine-grained, brittle shale. The total thickness of the Oligocene sediments in Port Townsend and Portage Bays, estimating the unexposed thickness at Crane's Point as 300 feet, is slightly in excess of 4000 feet.

#### Scow Bay

On the west side of Scow Bay there is an outcrop exposed from a point somewhat south of the north, east and west, section line of Section 6 to a point about  $\frac{1}{4}$  of a mile north of the south, east and west, section line of Section 5. The sediments consist of alternating beds of shale, which are usually somewhat carbonaceous, and sandstones. The sediments are much like those exposed along the east side of Port Townsend Bay and they are undoubtedly a continuation of these sediments. The shales comprise from  $\frac{1}{2}$  to one third of the entire exposure. The exposure is remarkably uniform from the bottom to the top of the section. The thickness of the sediments exposed on the west side of Scow Bay is approximately 1400 feet.

Starting on the west side of Mystery Bay somewhat south of the entrance to Scow Bay, there is an exposure which continues on with very little interruption to

west section line of section 5. The sediments exposed are in part the same as those exposed on the opposite side of the bay and nearly all the continuation of the exposure in Port Townsend Bay. The exposure is found in the cliff along the shore and in some places on the shore itself. Due to the difference in hardness of the shale and the harder sandstone, the sandstone members stand out as miniature hogsback ridges along the beach in many places at low tide. The lithological characteristics and proportions are practically the same as those found on the west side of this bay. The thickness of the sediments exposed in Mystery Bay and along the east side of Scow Bay is approximately 3100 feet. The total thickness of all the sediments exposed along the shores of Scow Bay is about 3800 feet.

Nodula Point to Liplip Point.

Starting in Oak Bay at the point in Section 16 there is a bed of flat-lying, massive shale which is about 15 feet thick. This extends along the beach for a distance of half a mile till it is covered over by glacial material. At the point where the south, east and west, section line of section 9 strikes the beach this shale is again found with a dip to the north. At Liplip Point sandstone forms the reef which extends out into the sound. There are also scattered outcrops of this sandstone along the shores and in the bay itself between Liplip and Nodula Points. The outcrop contains a very few shaly members immediately south of Nodula Point. The end of the outcrop is reached a short way north of Nodula Point. The estimated thickness of the beds in this bay is 1100 feet.



In Oak Bay there is an outcrop of firm, grey sandstones and sandy shales which starts on the north side of the spit in Section 7. It continues on around the point to the section line between sections 7 and 18. The character of the sediments changes here, and the outcrop for the next half mile is a soft, badly-weathered, sandstone. From this point the sediments are composed of sandy shales with very few interbedded layers of hard grey sandstone, which is often rather lenticular in character. This type of outcrop continues, with minor interruption where it is covered by glacial material, to the contact of the shale with the underlying basalt at the foot of Oak Bay slightly north of Olele Point. Although exposed for some distance the total thickness of the sediments is not great due to the very slight dip and the somewhat undulating structure. The total thickness is estimated at about 1800 feet.

## Woodman

About 1000 feet north of Woodman there is an outcrop of conglomerate on the beach for about 200 feet. From here there is an outcrop of alternating sandstones, containing noticeable amounts of tuff and harder, grey sandstones. The thickness of these beds varies from 1 to 20 feet. Toward the north end of the outcrop there are a few carbonaceous shales interbedded in massive sandstones. These sandstones are, in a few instances, intercolated by lenticular beds of conglomerate. A tunnel has been driven into this sandstone at one place in search of coal. Several seams of coal half an inch thick were noticed

near the mouth of the tunnel. The total thickness of the sediments exposed here is not over 400 feet.

#### Miscellaneous Exposures.

On the opposite side of Port Discovery Bay from Woodman there was found an outcrop of massive shale in several places. It was impossible to estimate the thickness of it.

As has already been stated, there are at several localities beds of conglomerate which occur stratigraphically above the basalt. This conglomerate is found near Anderson's Lake, East of City Lake, at the headwaters of Snow Creek and it is probably in part, at least, represented at Woodman. The greatest thickness of this conglomerate occurs, perhaps, near Uncas and it is estimated to be about 500 feet thick. It is composed of fragments of basalt, usually not intensely rounded, in a matrix of grey sand similar to that of the harder sandstones at Woodman. It is impossible to state definitely that these various occurrences are all of the same material.

On the Haley Branch of the Salmon River an outcrop of grey sandstone was found in the gorge of the creek. It was impossible to estimate the thickness of this exposure because of the massive character of the sediments. As it is on the south limb of the anticline, it is perhaps the same beds that are exposed along the Shores of Port Townsend and Port Discovery Bays.

## HISTORICAL GEOLOGY

## PALEOZOIC

## Carboniferous

The record of the Paleozoic in the Puget Sound Region is very fragmental and incomplete. Certain Crinoid stems found in metamorphosed sediments in the San Juan Islands and in the Northern Cascades indicate a Carboniferous age. It is thought that probably a large part of Western Washington was an extensive marine embayment which connected with other embayments more definitely known to have existed in Idaho, Oregon, Nevada and California. From the indications found in the Northern Cascades and on Vancouver Island there occurred many islands many of which seem to have been in the nature of volcanic cones. Volcanic activity is recorded during the Carboniferous by lavas and volcanic ash which are found interbedded with the typical marine sediments of this period.

## MESOZOIC

## Triassic

It has been impossible as yet to distinguish between the Carboniferous and the Triassic in Western Washington. Tropical conditions occurred throughout the two periods and a detailed faunal study would be necessary to differentiate between the two.

The Peshastin formation in Eastern Washington and the

Gunn Peak Formation near Index together with the metamorphosed rocks of the Skagit Valley are all thought to have been laid down during this period. Northwestern Washington, including the present site of the Cascades was involved in a large embayment. In southwestern Washington and northwestern Oregon rocks of tertiary age cover up any materials of this age that might be present. Therefore, nothing can be determined regarding the Carboniferous or Triassic.

#### Jurassic

The Hoh Formation on the western slope of the Olympic Mountains is at present assigned to the Jurassic Period. It consists of a thick series of semi-metamorphosed sediments which are unfossiliferous. Any determination of its age at the present time is provisional only. If the Hoh proves to be Jurassic, the Olympic Peninsula was at that time below sea level.

Late in Jurassic time there occurred volcanic activity on a large scale. From Mexico to Alaska there were great intrusions of predominantly granitic rocks. The peridotite and Mt. Stuart granodiorite of that region and the Index granodiorite are examples of this activity in Washington. No intrusions are known to have taken place in the Olympic Mountains. Should such an intrusion have taken place the overlying cover has not eroded sufficiently to have exposed any intrusive rocks thus far. The Olympic Mountains are apparently composed of metamorphosed sediments entirely. The close of the Jurassic was marked by diastrophic movements of considerable magnitude.

## Cretaceous

No rocks of Lower Cretaceous or Knoxville age are known to exist in Washington. It is possible that such may exist beneath the large amount of younger rocks which cover a large part of the Puget Sound Region.

During Chico time an embayment entered the state from the northwest. This embayment occupied the present site of the northeastern part of Vancouver Island, the San Juan Islands and Whatcom County. During the earlier part of this period deep water conditions prevailed. Toward the close, however, the seas were shallower as is evidenced by the massive sandstones and conglomerates which constitute the upper part of the Chico on Vancouver Island.

## TERTIARY

## Eocene

There exists no definite evidence in Western Washington as to rocks of early Eocene age. It is thought that the region was at that time an area slightly above sea level. In southwestern Washington and in the Puget Sound Basin there occur formations of upper Eocene age which have been correlated with the Tejon Eocene of California. These latter formations in the Puget Sound Basin include the basalts found upon the Quimper Peninsula. These basalts are the oldest known rocks on the Quimper Peninsula.

During the upper Eocene the Cascade Mountains did not exist. The Olympic Mountains were, however, of

height and cut off from Vancouver Island by a structural sag which was at times below sea level. Early in Tejon time an embayment from the sea came into southwestern Washington. The embayment eventually reached the present western border of the Cascade Mountains and a branch of it extended up into Puget Sound and for some distance into the Straits of Juan de Fuca. Large estuaries existed to the east of the main embayment.

The upper Eocene was a time of oscillation of the land area. This fact is attested by the intercalation of marine and brackish water fauna and sediments. Along the shores of the estuaries and the embayment a rich tropical flora flourished which was preserved in the form of coal seams and carboniferous shales. Some basic lavas were outpoured both on the surface of the land and on the sea floor. Deposits of ash were also laid down on land and on the sea floor. These deposits of basalt are about the only activity of volcanic origin that took place in the tertiary in Western Washington save in the western foothills of the Cascade Mountains. The Eocene is unconformably overlain by the Oligocene. In the vicinity of the Quimper Peninsula there seems to have been an unconformity between the two due to both erosion and folding.

#### Oligocene

During the Oligocene the embayments in Western Washington reached greater size than during the Eocene. The estuaries of Eocene time were covered by the Oligocene sea which nearly reached to the Cascade Mountains in the Puget Sound region. It is possible that the embayment reached the Puget Sound Basin through the Straits of Juan de Fuca.

ern Washington. If so there was a land bridge between the Olympic and Cascade Mountains. By the middle of Oligocene time the Olympic Mountains which had been eroding since the beginning of Cretaceous time had reached a condition of peneplanation. The fauna during Oligocene time had changed radically but still showed at the end of the period marks of a tropical environment.

#### Miocene

At the beginning of the Lower Miocene a slight elevation brought nearly all of Western Washington above sea level. Two small localities, in the Grays Harbor region and in the region along the lower course of the Columbia River, remained below sea level and received sediments during this time. At the close of Lower Miocene time marked diastrophic movements brought the entire western portion of the state above sea level, and the Oligocene and Lower Miocene sediments were folded at this time.

Beginning the early Upper Miocene Time, two local embayments were developed in Western Washington. One of these was in southwestern Clallam Count and the other was east and north of Grays Harbor. These embayments were very shallow and contained a fauna quite characteristic and markedly different from that of the Oligocene or Lower Miocene. As was the case during the lower Miocene, colder climatic conditions than those of the Oligocene prevailed. The sediments were coarse grained and cross-bedded and indicate the existence of sand bars and

spits similar to those around Grays Harbor at the present time. The land area of Western Washington was apparently greater than that of today and extended to the westward of the present shore of the Pacific.

#### Pliocene

At the close of the Upper Miocene the embayments were raised and became land areas. This condition continued throughout the Pliocene. It was a time of erosion. The Cascade Mountains were eroded to a peneplain. The Olympic Mountains while somewhat higher than the Cascade Mountains were practically in a peneplained condition. As the Pliocene was a time of erosion only its history is not well known.

#### QUATERNARY

##### Pleistocene

At the close of the Pliocene or at the beginning of the Pleistocene, mountain-making movements took place along the entire Pacific coast. The Olympic Mountains and Vancouver Island were elevated. The Cascades were differentially raised, giving rise to a series of Northwest and Southeast folds. The drainage of the Cascade Mountains today follows largely the pattern which originally was dependent upon these structural features. Immediately after this elevation, streams began dissecting and carving the recently uplifted peneplains. Many of the higher peaks of the Olympic and Cascades today are erosion-remnants or knobs which stood on the ancient Pliocene peneplain. The higher peaks of the Cascades



canic cones which were built up on the peneplain surface during the early part of the Pleistocene. No such volcanic cones exist in the Olympic Mountains which are composed of metamorphosed sediments. In the Olympic Mountains the monadnocks are merely more resistant blocks of the metamorphosed sediments.

The early part of the Pleistocene in the Puget Sound Region has left very little evidence as to its history. It is thought, however, that this unrecorded portion of the Pleistocene occupied a considerable portion of the whole period. During the period of glaciation which followed, more definite evidence as to the movements of the crust and as to the sequence of events was left by the action of the glaciers and the agencies that operated during the inter-glacial period. The climate, which had steadily been growing colder since Eocene time, now reached a maximum and large continental glaciers advanced over the Puget Sound Basin and in some cases even into the canyons of streams emerging from the Cascade and Olympic mountains. These glaciers arose in the mountains of British Columbia. The known Pleistocene of Puget Sound is divided into three major divisions which are:

Admiralty Epoch	(Glacial)
Puyallup Epoch	(Inter-glacial)
Vashon Epoch	(Glacial)

The first or Admiralty glaciation has not left many evidences of its existence. The exposures of Admiralty Till are few in number and small in size.

author was unable to find any exposures in this area that could be classified as Admiralty. All till that was found in conjunction with other glacial materials was in every case overlying the stratified glacial sands and gravels. No mention is made by Bretz with respect to this area and it's glaciation. He includes a picture, however, called "Vashon Till on Marrowstone Island, Admiralty Inlet", as Fig. 2 of Plate XIX, Bulletin 8 of the Washington Geological Survey. Jillson in his thesis on this area has marked fairly numerous exposures of supposedly Admiralty Till.

Nothing is known of the topography of the surface of the Admiralty Till. It is supposed to have been, however, somewhat lower than the general level at present, as marine organisms are no found in the Admiralty Till several feet above the present tide level. Till has been found which is more badly weathered than is usual with the Admiralty and it has been thought that it represents an older till. There is no other evidence to substantiate this hypothesis than the condition of the till itself.

With the decline of the Admiralty Glacier and its retreat to the north, there was aggraded before the edge of the retreating glacier a great plain of terrestrial deposits which reached nearly from the Olympics to the Cascades. It is thought that this material comprises as much as 90 % of all the glacial deposits in the Puget Sound Basin. Lense structure is characteristic of these sediments which are now exposed for miles along the present sea cliffs of Puget Sound. Most of the deposits show stream bedding with here and there a lense of till show-

ing that the retreat of the glacier was not a continual uninterrupted process but rather a matter of several advances with intervening retreats. At this time the area was still at approximately the same level as today.

Following the formation of this extensive plain in the basin, the entire area was uplifted to an elevation approximately 1000 feet greater than that of today. Erosion immediately set in and a drainage system of consequent pattern was established. Part of the drainage was to the south and to Grays Harbor by way of the Chehalis River and the rest of the drainage was by way of the Admiralty River through the Juan de Fuca Valley. Deep valleys were incised in the soft glacial sediments and by the time the Vashon glaciers appeared a mature topography had been formed.

The Vashon glacier at its greatest reached as far if not farther than the Admiralty glacier. Its farthest point of advancement is marked by a terminal moraine which is now rather inconspicuous. There was, however, a large amount of outwash from the Vashon Glacier which produced the prairies in the region immediately south of the Sound. The streams from the outwash of the glacier in some cases reached the head of Grays Harbor. Numerous recessional moraines marking the edge of the ice as it retreated are also found.

In the extreme southern part of the glaciated area the load of material carried was so great that it filled the old valleys formed during the inter-glacial period and completely eradicated the former topography. Farther north, however, the load carried was lighter and the thin veneer

ed and deepened the valleys of the streams rather than filling the valleys as had been done farther south.

The retreat of the ice of the Vashon Glacier after the first, short, marginal retreat was quite rapid. The large mass of material in the terminal moraine and from the outwash of the glacier prevented drainage to the Chehalis River to the south and lakes were formed which finally overflowed the rim of the outwash plain and joined the Chehalis River. As the ice retreated numerous lakes were formed in the different inter-glacial valleys. As the ice retreated the levels of these lakes changed and they eventually discharged their waters into the great, master lake of the old Admiralty River drainage system. When the ice had melted back to the Straits of Juan de Fuca, Lake Russell, the master glacial lake, was drained and the marine waters replaced those of the lake in the channels which were below sea level. The level of the land had become less by this time and was approximately the same as that of today, perhaps 50 feet higher. This subsidence placed the channels of the inter-glacial drainage system well below sea level and their valleys form the channels and bays of the sound today.

#### Recent

After the retreat of the Vashon glacier there was a general subsidence of the land. Fossils have been found above Vashon Till and as much as 250 feet above tide water level. Mention of raised beaches along Portage, Port Townsend, and Scow Bays is made by Jillson, who says, " One of

very noticeable characteristics of the shore line of Portage Bay, Port Townsend Canal and Scow Bay is the large number of fossil beach deposits."\* The fossils identified by Jillson at

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\* Jillson, Willard Rouse. A Preliminary Report on the Stratigraphy and Paleontology of the Quimper Peninsula. Thesis, University of Washington, 1915. p. 32.

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these beach localities are listed together with others found in this locality by Jillson and Dr. Weaver under the heading of Paleontology. An especially well preserved bed of recent fossils in a raised beach deposit about 30 feet above tide water was noticed by the author immediately south of Crane Point.

Jillson also mentions an occurrence of recent fossils well removed from the present beach line. In regard to these fossils he states that they are found in scattered beds over an area of several acres, the average elevation being well over one hundred feet. This area is located on the south end of Bay Island about half way between Port Townsend Bay and Scow Bay.

As the beach lines of Lake Russell are very plain and the beaches of the recent period, especially the older, higher ones, are not very strongly marked, it is thought that the subsidence was for a very short time. At the time of maximum subsidence, the waters of the sound united with the embayment from Grays Harbor and the Olympic Peninsula was an island. Although there was a fair amount of vertical displacement of the pleistocene deposits they have

ed to any extent. A few instances of pleistocene sediments having been displaced are known to exist. \*

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\*Arnold, Ralph. Bull. 17, Geol. Society of Amer. pp. 451-468

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Glacial materials cover the Quimper Peninsula so thoroughly that the previous sediments and lavas are exposed for the most part along the shores of the sound only. As any information of much value with regard to these deposits would call for a detailed study of these deposits a study of them was not attempted. Only along the shores of Narrowstone Island where they are excellently exposed was any attempt at a study made.

Starting at the south end of the island the section was found to be as follows:

15 feet of Vashon ? Till

40 feet of cross-bedded, coarse, sand.

15 feet of flat-lying Oligocene massive shales.

The sand was found to be lenticular and varied a great deal in lithology both vertically and laterally. The thickness was also subject to very great change. The Vashon till followed the contour of the sand and was fairly constant in thickness and lithology. As would be expected because of its position close to the outlet of Lake Russell, there were found no sediments of glacial age above the Vashon till. There would have been little time for the accumulation of such near the last stages of the glacier as the ice covered this territory till the time of draining of Lake Russell.

## ECONOMIC GEOLOGY

No mineral resources of any value have been discovered on the Quimper Peninsula. Prospecting for coal and oil has gone on to a limited extent. Several quarries have operated in this vicinity but none are now in operation.

A well was drilled on the east side of Scow Bay some years ago in Section 32. It was drilled to a depth unknown to the author and then abandoned. North of Woodman in the Oligocene sandstone a tunnel was noticed which presumably was driven in search of coal as a seam about 2 inches thick was noticed in the cliff near the mouth of the tunnel. At a time when building stone was in more demand than at present, two quarries were operated on Port Townsend Bay and the other on the west side of Scow Bay. Those in Port Townsend were located at the fault scarp in the small cove near the ferry landing in the northeast quarter of Section 6, Twp. 29 N., R. 1 E. and at the west side of Blake Island.

There are a large number of sand and gravel deposits of large size in this area. Many of these could undoubtedly be used for constructional purposes should the demand arise. At present they are unused save for a small amount which is used for road material.

## PETROGRAPHY

## Introduction

The igneous rocks on this area are probably all extrusive. They might be easily divided into two major divisions for ease in studying. The first and larger division is a representative of the Basaltic Phase of the Tejon of Western Washington. The second class includes all other igneous rocks found on the Quimper Peninsula.

## Tejon Volcanics

The basaltic phase of the Tejon in Washington can be seen by Plate II to cover an appreciable part of the margins of the Olympic Peninsula. The portion of it that lies in the Quimper Peninsula has been brought up into sight by the anticline whose axis its outcrops so closely follows. Starting on the east this belt reaches from below Hood Head to Olele Point. This belt becomes narrower as it goes west and on the eastern shore of Port Discovery Bay it is only a little over a mile in width. It has been plotted by Dr. Weaver as continuing on westerly to the east shore of Washington Harbor. No evidences of its occurrence were found farther west than Fairmont on this area.

The base of these volcanic flows is found nowhere on the Quimper Peninsula. The top is always eroded and is usually covered unconformably by Oligocene conglomerates or in the case of Oak Bay it is covered by Oligocene shales. The thickness of this series of flows as exposed in Port Discovery Bay is estimated to be about 2000 feet.



As has already been stated, there are found in this series of flows a few intercalated tuffs, sandstones and shales. The greater part of it, however, was found to be composed of typical flows with intercolated agglomerates.

Due to the dense vegetation, the scarcity of outcrops and the fairly steep dip of these flows, it was impossible to trace any one flow for any distance. The thickness of the flows was found to range from 1 foot up to an unknown thickness. The average thickness was, perhaps, from 25 to 30 feet.

Typical flows of andesite and basalts, many of which exhibited columnar structure, were found to be intercolated with the agglomerates. The agglomerates were found in some cases to apparently grade into the typical flows. The agglomerates were composed of fragments of various sizes, usually about 6 inches in diameter, which were found interbedded in a badly weathered matrix which was, perhaps, originally composed of very vesicular lava, volcanic ash, pumice and other extrusive and explosive volcanic materials. The lava has weathered to a greater extent than the included fragments of andesite and has turned into a red, sticky clay. The included fragments of andesite were stained and apparently somewhat altered by the lava.

The formation of these agglomerates was probably caused by the explosive action in the vents, between periods of flowage of lava, which fed the large flows with which the flow breccias are intercolated. Fragments of andesite and basalt were taken from the sides of the vent and the freshly laid lavas and blown out with volcanic dust, glass and other materials. The

fragments may also in part represent the cooled surface of a flow which has been broken up by a flow following it; perhaps by one breaking up through it from the feeders below.

A microscopic examination of these rocks show them to be either basic andesites or basalts. The feldspars are close to the border line between andesine and labradorite. A description of these rocks is given under Petrographic Analysis, specimens No. 2 and 6.

#### Nodula Point Dike

This dike which is described under specimen No. 4. occurs at Nodula Point in section 4 on Narrowstone Island. The heat from the intrusion of this dike has baked the surrounding sandstones and hardened them so that they stand out on either side of the dike, which has weathered into the bank for some distance, and appear at a distance to be two dikes standing out in relief against the sandstone. Although their resistance to erosion shows that they have been altered by the action of the dike, these walls on either side of the dike do not appear to have been greatly affected and are not different in any respect in hand section, at least, from the sandstone some distance removed from the dike. This dike is the freshest and best preserved occurrence of igneous rock on the Quimper Peninsula. It is later, of course, than the Eocene Basalts, and perhaps has no genetic relationship with them.

#### Portage Bay Dike

This dike is badly weathered and it is difficult to secure

good specimens. It is finer grained than the dike at Liplip Point, and in a much poorer state of preservation. It is also somewhat more acidic.

#### Dike on West Side of Scow Bay.

This dike, which was about a foot in width, resembles the dike at Nodula-Liplip Point in texture. It is also in a fair state of preservation. The groundmass is somewhat finer and no olivine was found in the study of the thin section of this rock. In its field occurrence it very unobtrusive and might easily be overlooked in a rapid survey of the region.

#### Blake Island Andesite

Blake Island, which is situated in the extreme southern part, of Port Townsend Bay, is composed almost entirely of andesite. This andesite is quite strikingly different from any other igneous rocks in the area. In hand specimen it is greatly different from any other rocks of this locality. In thin section, however, it is found to be somewhat similar to the Andesite at Olele Point. The rock is composed of Andesine predominantly with a decomposition mineral, possibly palagonite. In thin section this mineral resembles palagonite. In hand specimen, however, it gives no hint of containing palagonite. At any rate, this mineral is probably altered from a glass by very rapid cooling. This, together with its porphyritic texture would indicate that this rock formed at depth, started to solidify and was then suddenly chilled, possibly by flowing out on the sea floor or in some other body of water. Palagonite

is formed when the chilling is so sudden that even magnetite has no chance to become differentiated and color the glass. The field relations of this outcrop throw little if any light on its history. It is found on a little island about 100 feet from shore. At its southern tip sandstone was found on this island, but the contact between the sandstone and the andesite was not found. It was possibly concealed by the debris from the low cliff of sandstone. It might be possible that the andesite represents a portion of the surface of the old Eocene basalts which extended as an erosion remnant up into the Oligocene sediments and has now been exposed by erosion of the sediments.

# PETROGRAPHIC ANALYSIS

Specimen number, collection, etc. No. 1 Quimper Peninsula Collection  
Locality and occurrence Blake Island, South Port Townsend Bay.

References \_\_\_\_\_

## Megascopic Description

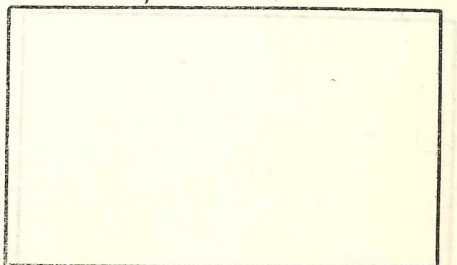
Appearance, textures, etc. A soft, brownish-grey rock having a porphoritic texture. Phenocrysts of feldspar.

## Visible Mineral Composition

Dominant	%
Fine-Grained Groundmass	85

Subordinate	%
Feldspar	15

Sketch showing note-worthy structures or textures in hand specimen.

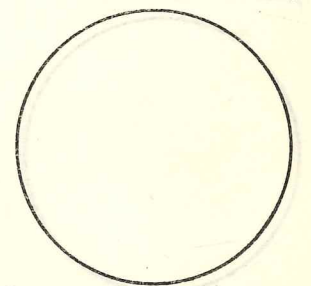


Field Name \_\_\_\_\_

## Microscopic Analysis

Characteristics under microscope Fine-grained, porphoritic, with phenocrysts about 1 mm. long of andesine. Groundmass made up of fine laths of feldspar and an alteration product, probably Palagonite, altered from glass.

Magnification 62 X



## Mineralogic Composition

Dominant	%
Andesine	85

Subordinate	%
Palagonite ?	15
Magnetite	-1

Sketch of section

Alteration Minerals	%

Chem. Anal: SiO<sub>2</sub> — Al<sub>2</sub>O<sub>3</sub> — Fe<sub>2</sub>O<sub>3</sub> — FeO — MgO — CaO — Na<sub>2</sub>O — K<sub>2</sub>O —

Source of chemical analysis \_\_\_\_\_

Rock Name Porphoritic Andesite

Remarks \_\_\_\_\_

55  
**PETROGRAPHIC ANALYSIS**

Specimen number, collection, etc. No. 2 Quimper Peninsula Collection  
 Locality and occurrence Olele Point, A flow rock

References

**Megascopic Description**

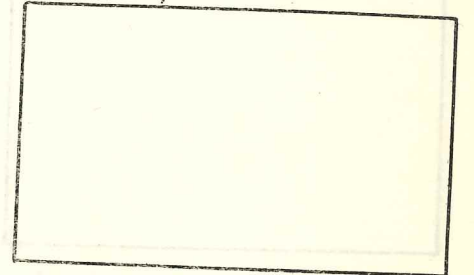
Appearance, textures, etc. A dark, fine grained, vesicular rock  
 Vesicles are usually unfilled.

**Visible Mineral Composition**

Dominant	%
Fine-grained Ground mass.	95

Subordinate	%
Feldspar	5

Sketch showing note-worthy structures or textures in hand specimen.

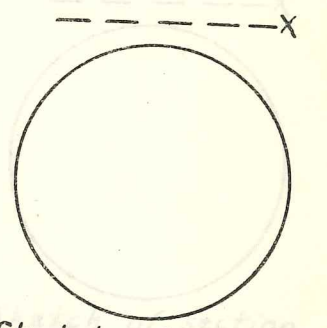


Field Name

**Microscopic Analysis**

Characteristics under microscope Typical andesitic texture, with laths of andesine intermingled with magnetite and a green alteration mineral, possibly palagonite. Vesicular with many of the vesicles filled with chlorite, zeolite, etc.

Magnification



**Mineralogic Composition**

Dominant	%
Andesine	60

Subordinate	%
Palagonite ?	35
Magnetite	5

Sketch of section

Alteration Minerals	%
Chlorite > Zeolite	Under 1%

Chem. Anal:  $SiO_2 - Al_2O_3 - Fe_2O_3 - FeO - MgO - CaO - Na_2O - K_2O$

Source of chemical analysis

Rock Name Vesicular Andesite

Remarks

**PETROGRAPHIC ANALYSIS**

Specimen number, collection, etc. No. 2 Quimper Peninsula Collection  
 Locality and occurrence Olele Point, South Port Townsend Bay.  
 References

**Megascopic Description**

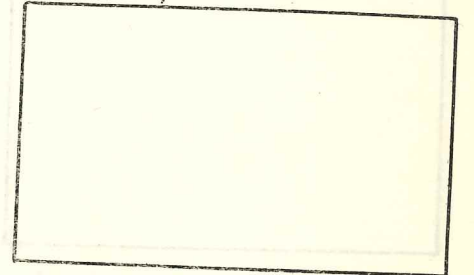
Appearance, textures, etc. A dark, brownish-grey rock having a porphyritic texture.  
 Phenocrysts of feldspar.

**Visible Mineral Composition**

Dominant	%
Fine-grained Groundmass	95

Subordinate	%
Feldspar	5

Sketch showing note-worthy structures or textures in hand specimen.

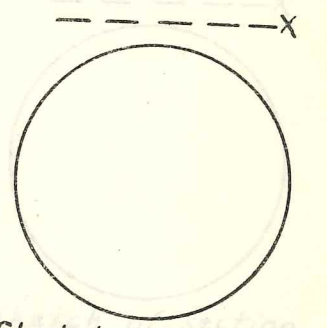


Field Name

**Microscopic Analysis**

Characteristics under microscope Typical andesitic texture, with laths of andesine intermingled with magnetite and a green alteration mineral, possibly palagonite. Vesicular with many of the vesicles filled with chlorite, zeolite, etc.

Magnification



**Mineralogic Composition**

Dominant	%
Andesine	60

Subordinate	%
Palagonite ?	35
Magnetite	5

Sketch of section

Alteration Minerals	%
Chlorite > Zeolite	Under 1%

Chem. Anal:  $SiO_2 - Al_2O_3 - Fe_2O_3 - FeO - MgO - CaO - Na_2O - K_2O$

Source of chemical analysis

Rock Name Vesicular Andesite

Remarks

56  
PETROGRAPHIC ANALYSIS

Specimen number, collection, etc. No. 3 Quimper Peninsula Collection  
 Locality and occurrence Portage Bay (East Side No. 20 B.) occurs as a dike  
 about 20 feet wide.

References

Megascopic Description

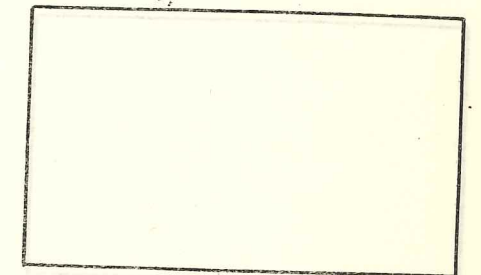
Appearance, textures, etc. A hard, dark colored, vesicular rock with vesicles  
 filled largely with feldspar. Groundmass very fine-grained.

Visible Mineral Composition

Dominant	%
Fine-grained Groundmass	95

Subordinate	%
feldspar	5

Sketch showing note-worthy structures or textures in hand specimen.



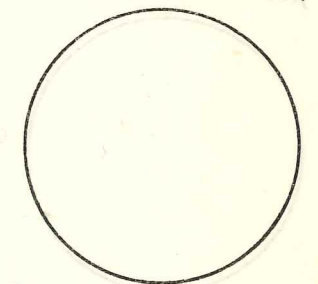
Field Name Vesicular Basalt

Microscopic Analysis

Characteristics under microscope Typically andesitic in  
 texture. Vesicular with some of the vesicles  
 filled with feldspar. Groundmass is composed of  
 laths of feldspar, andesine? which are sometimes  
 well altered to sericite, and a dark green material  
 which is an alteration product from glass, probably  
 palagonite

Magnification

-----X



Sketch of section

Mineralogic Composition

Dominant	%
Altered Glass, perhaps Palagonite	60

Subordinate	%
Andesine?	40

Alteration Minerals	%

Chem. Anal:  $SiO_2 - Al_2O_3 - Fe_2O_3 - FeO - MgO - CaO - Na_2O - K_2O$

Source of chemical analysis

Rock Name Vesicular Andesite

Remarks

PETROGRAPHIC ANALYSIS

Specimen number, collection, etc. No. 3 Quimper Peninsula Collection  
 Locality and occurrence Portage Bay, A flow rock  
 References

Megascopic Description

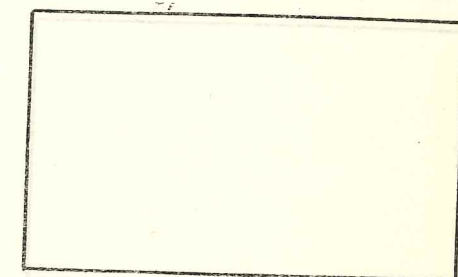
Appearance, textures, etc. A dark, fine-grained, vesicular rock  
 Vesicles are usually filled.

Visible Mineral Composition

Dominant	%
Fine-grained Groundmass	95

Subordinate	%
Feldspar	5

Sketch showing note-worthy structures or textures in hand specimen.



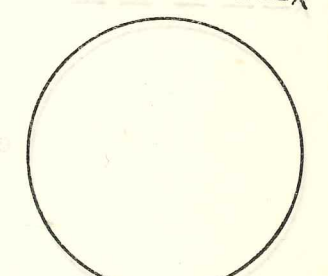
Field Name Vesicular Basalt

Microscopic Analysis

Characteristics under microscope Typical andesitic texture,  
 with laths of andesine in groundmass, possibly palagonite  
 and a green alteration product from glass, probably  
 vesicular with some of the vesicles filled with  
 feldspar, andesine, etc.

Magnification

-----X



Sketch of section

Mineralogic Composition

Dominant	%
Altered Glass, perhaps Palagonite	60

Subordinate	%
Andesine?	40

Alteration Minerals	%

Chem. Anal:  $SiO_2 - Al_2O_3 - Fe_2O_3 - FeO - MgO - CaO - Na_2O - K_2O$

Source of chemical analysis

Rock Name Vesicular Andesite

Remarks

57  
PETROGRAPHIC ANALYSIS

Specimen number, collection, etc. No. 4 Quimper Peninsula Collection  
 Locality and occurrence Modula Point. Occurs as a dike about 20 feet wide.

References

Megascopic Description

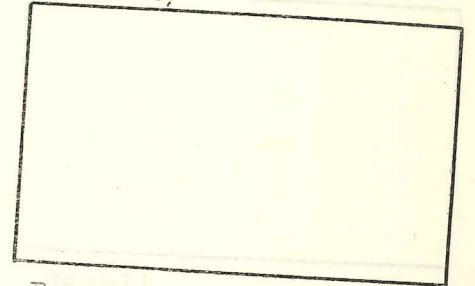
Appearance, textures, etc. A black, heavy, basic rock of fairly coarse texture

Visible Mineral Composition

Dominant	%
Feldspar	20

Subordinate	%
Undetermined	80

Sketch showing note-worthy structures or textures in hand specimen.

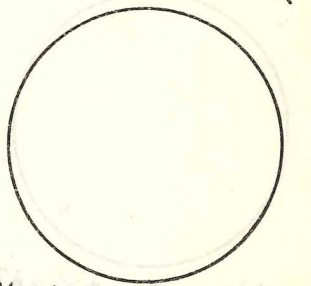


Field Name Basalt.

Microscopic Analysis

Characteristics under microscope A fairly coarse grained rock with an ophitic texture. Laths of feldspar are contained in a field of augite. Some iddingsite which is evidently an alteration product from Olivine is also found. A dark, opaque substance which is also an alteration product comprises a considerable proportion of the Rock. Magnetite is probably found in it.

Magnification  
-----X



Sketch of section

Mineralogic Composition

Dominant	%
Augite	30

Subordinate	%
Labradorite	40

Alteration Minerals	%
Unknown, in part, perhaps Magnetite.	30
Iddingsite	-1

Chem. Anal:  $SiO_2 - Al_2O_3 - Fe_2O_3 - FeO - MgO - CaO - Na_2O - K_2O$

Source of chemical analysis

Rock Name Altered Olivine Basalt

Remarks



Specimen number, collection, etc. No. 5 Quimper Peninsula Collection  
 Locality and occurrence West Side of Scow Bay. Occurs as a dike.

References .....

Megascopic Description

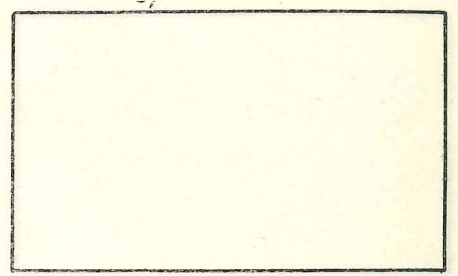
Appearance, textures, etc. Medium grained, dark, basic appearing rock.

Visible Mineral Composition

Dominant	%
Feldspar	20
Undeterminable	80

Subordinate	%

Sketch showing note-worthy structures or textures in hand specimen.



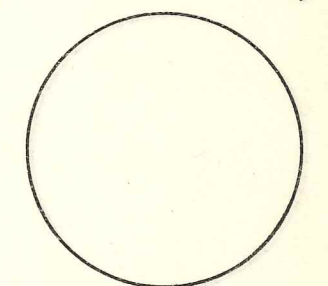
Field Name Basalt

Microscopic Analysis

Characteristics under microscope Fine-grained, ophitic texture. Labradorite laths in a matrix of augite, decomposed augite and other decomposition materials and with some magnetite.

Magnification

-----X



Mineralogic Composition

Dominant	%
Labradorite	55

Subordinate	%
Augite	10
Altered Augite	43
Magnetite	2

Sketch of section

Alteration Minerals	%

Chem. Anal:  $SiO_2 - Al_2O_3 - Fe_2O_3 - FeO - MgO - CaO - Na_2O - K_2O$

Source of chemical analysis .....

Rock Name Augite Basalt.

Remarks .....

PETROGRAPHIC ANALYSIS

Specimen number, collection, etc. No. 4 Quimper Peninsula Collection  
 Locality and occurrence Basalt Point. Occurs as a dike about 1/2 mi. N. of Scow Bay.

References .....

Megascopic Description

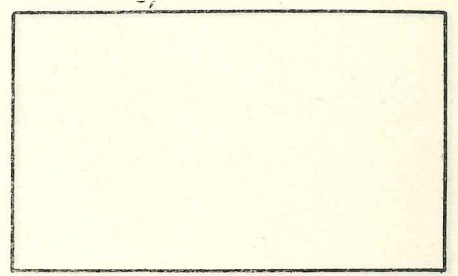
Appearance, textures, etc. A black, fine-grained, basic rock of fairly coarse texture.

Visible Mineral Composition

Dominant	%
Labradorite	20

Subordinate	%

Sketch showing note-worthy structures or textures in hand specimen.



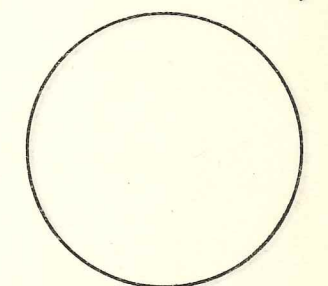
Field Name Basalt

Microscopic Analysis

Characteristics under microscope A fairly coarse grained rock with an ophitic texture. Laths of labradorite are contained in a field of augite. Some labradorite which is evidently an alteration product from olivine is also present. Magnetite is probably found in proportion of the rock.

Magnification

-----X



Mineralogic Composition

Dominant	%
Augite	30

Subordinate	%
Labradorite	40

Sketch of section

Alteration Minerals	%

Chem. Anal:  $SiO_2 - Al_2O_3 - Fe_2O_3 - FeO - MgO - CaO$

Source of chemical analysis .....

Rock Name Basalt

Remarks .....

59  
**PETROGRAPHIC ANALYSIS**

Specimen number, collection, etc. No. 6 Quimper Peninsula Collection  
 Locality and occurrence Port Discovery Bay, 1/2 mile north of Fairmont  
Occurs as a fragment in a flow breccia.

References \_\_\_\_\_

**Megascopic Description**

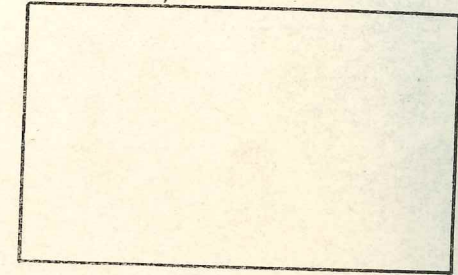
Appearance, textures, etc. A medium grained rock, quite badly weathered and somewhat stained from the surrounding lava.

**Visible Mineral Composition**

Dominant	%

Subordinate	%

Sketch showing note-worthy structures or textures in hand specimen.



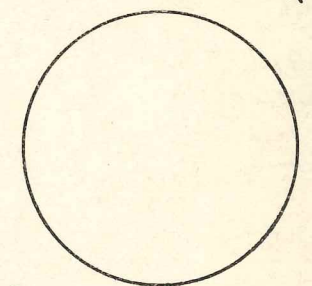
Field Name Andesite

**Microscopic Analysis**

Characteristics under microscope A medium grained rock, somewhat ophitic in texture with laths of labradorite in a matrix of augite, magnetite, alteration materials and a trace or two of iddingsite

Magnification

-----X



Sketch of section

**Mineralogic Composition**

Dominant	%
Labradorite	40
Augite	20

Subordinate	%
Alteration Products	35
Magnetite	5

Alteration Minerals	%

Chem. Anal:  $SiO_2 - Al_2O_3 - Fe_2O_3 - FeO - MgO - CaO - Na_2O - K_2O$

Source of chemical analysis \_\_\_\_\_

Rock Name Augite Basalt.

Remarks \_\_\_\_\_

**PETROGRAPHIC ANALYSIS**

Specimen number, collection, etc. No. 2 Quimper Peninsula Collection  
 Locality and occurrence Port Discovery Bay, 1/2 mile north of Fairmont  
Occurs as a fragment in a flow breccia.

References \_\_\_\_\_

Appearance, textures, etc. \_\_\_\_\_

**Megascopic Description**

Appearance, textures, etc. \_\_\_\_\_

**Visible Mineral Composition**

Dominant	%
Labradorite	40
Augite	20

**Microscopic Analysis**

Characteristics under microscope A medium grained rock, somewhat ophitic in texture with laths of labradorite in a matrix of augite, magnetite, alteration materials and a trace or two of iddingsite

Magnification \_\_\_\_\_

Sketch of section

**Mineralogic Composition**

Dominant	%
Labradorite	40
Augite	20

Chem. Anal:  $SiO_2 - Al_2O_3 - Fe_2O_3 - FeO - MgO - CaO - Na_2O - K_2O$

Source of chemical analysis \_\_\_\_\_

Rock Name Augite Basalt.

Remarks \_\_\_\_\_