STRATIGRAPHY OF THE MIOCENE AGATE BEACH FORMATION IN LINCOLN COUNTY, OREGON

by

JOHN EMANUEL HERRON

A THESIS

submitted to

OREGON STATE COLLEGE

in partial fulfillment of
the requirements for the
degree of

MASTER OF SCIENCE

June 1953

APPROVED:

Redacted for Privacy

Professor of geology

In charge of major

Redacted for Privacy

Head of Department of geology

Redacted for Privacy

Chairman of School Graduate Committee

Redacted for Privacy

Dean of Graduate School

Date thesis is presented May 13, 1953

Typed by John Herron

ACKNOWLEDGMENTS

The writer is grateful to Drs. Ira S. Allison, and L. F. Hintze for time spent in constructive analysis of the manuscript.

To Mr. Harold Boyd, Jr., his major professor, the writer is indebted for his invaluable aid in the organization of the project, his aid in both field and laboratory, and his constructive suggestions in the preparation of the manuscript.

The writer is grateful to members of the department of paleontology at the University of California in Berkeley for their kind cooperation in the use of their Miocene molluscan assemblages from Western Oregon.

Too numerous to mention are the many fellow students who have put to practice the principle that the scope of individual projects can be increased by the mutual sharing of individually-owned equipment.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

STRATIGRAPHY OF THE MIOCENE AGATE BEACH FORMATION IN LINCOLN COUNTY, OREGON

INTRODUCTION

The purpose of this paper is to describe the stratigraphy of the lower Miocene sediments of Lincoln County, Oregon, defined herein as the Agate Beach formation.

The Agate Beach formation crops out along the coast of Lincoln County in the north half of Yaquina quadrangle and the south half of Cape Foulweather quadrangle. It has previously been referred to as the "Miocene sandstone" (22, p. 30) or the "Astoria formation in Lincoln County." (19, p. 1981).

The present paper is part of a larger project at Oregon State College, the stratigraphy of the Coast Range in the Yaquina Bay region. Beacock (13) has described the lithology and micropaleontology of the upper half of the Nye formation. This paper continues westward and upward from the top of the Nye section.

The stratigraphic sections were measured with the aid of Brunton compass, steel tape, and pacing, in September and October of 1952.

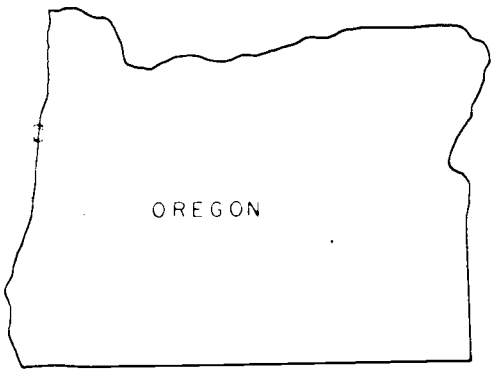
The best exposures of the Agate Beach formation are in the sea cliffs along the coast from Newport to Otter Rock, in the inner bay at Depoe Bay, and at the mouth of Fogarty Creek. All of these exposures are

discontinuous, being often interrupted by slumps. At the mouths of the larger creeks the Agate Beach formation has been eroded and covered with sand. Marine terrace deposits frequently conceal the underlying strata. All cliff sections south of Otter Rock and at Fogarty Creek are accessible at medium tide (below 3 feet). A few are accessible at high tide. The section at Depoe Bay is accessible only at low tide, as a wave-cut terrace is the only means of access.

The Agate Beach formation is also exposed in low reefs projecting through the beach sand at Nye Beach and Agate Beach. These are accessible only at extremely low tides (below 0.5 foot).

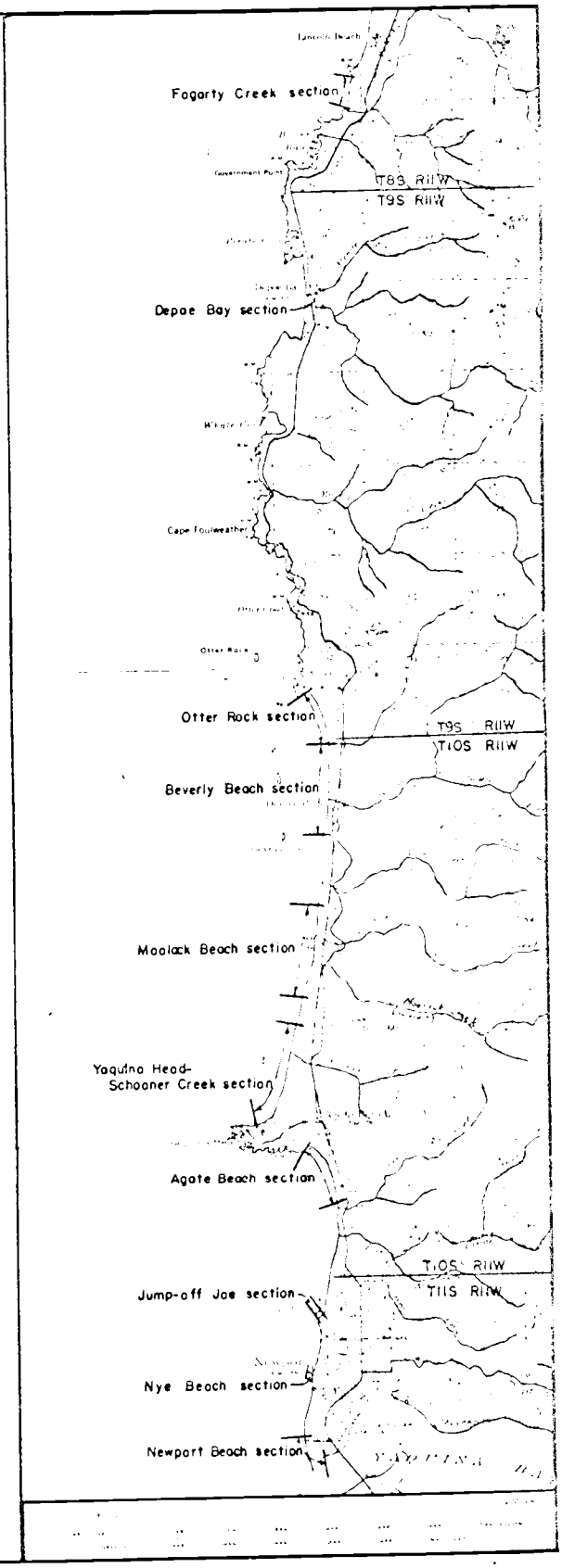
Highway cuts on the new and old coast highways were found, in general, to duplicate the beach sections. They do not form good continuous sections. From Moolack Creek to Johnson Creek, highway fill on the new highway has obscured part of the cliff exposures. East of the highway, the bedrock is concealed by soil, brush, and trees. Close to the new highway, the Agate Beach sediments are occasionally exposed in creek bottoms, but attempts to follow these outcrops upstream failed. Abundant log-jams in the streams, small volume of water, and low gradient have caused a cover of silt to accumulate to considerable thickness.

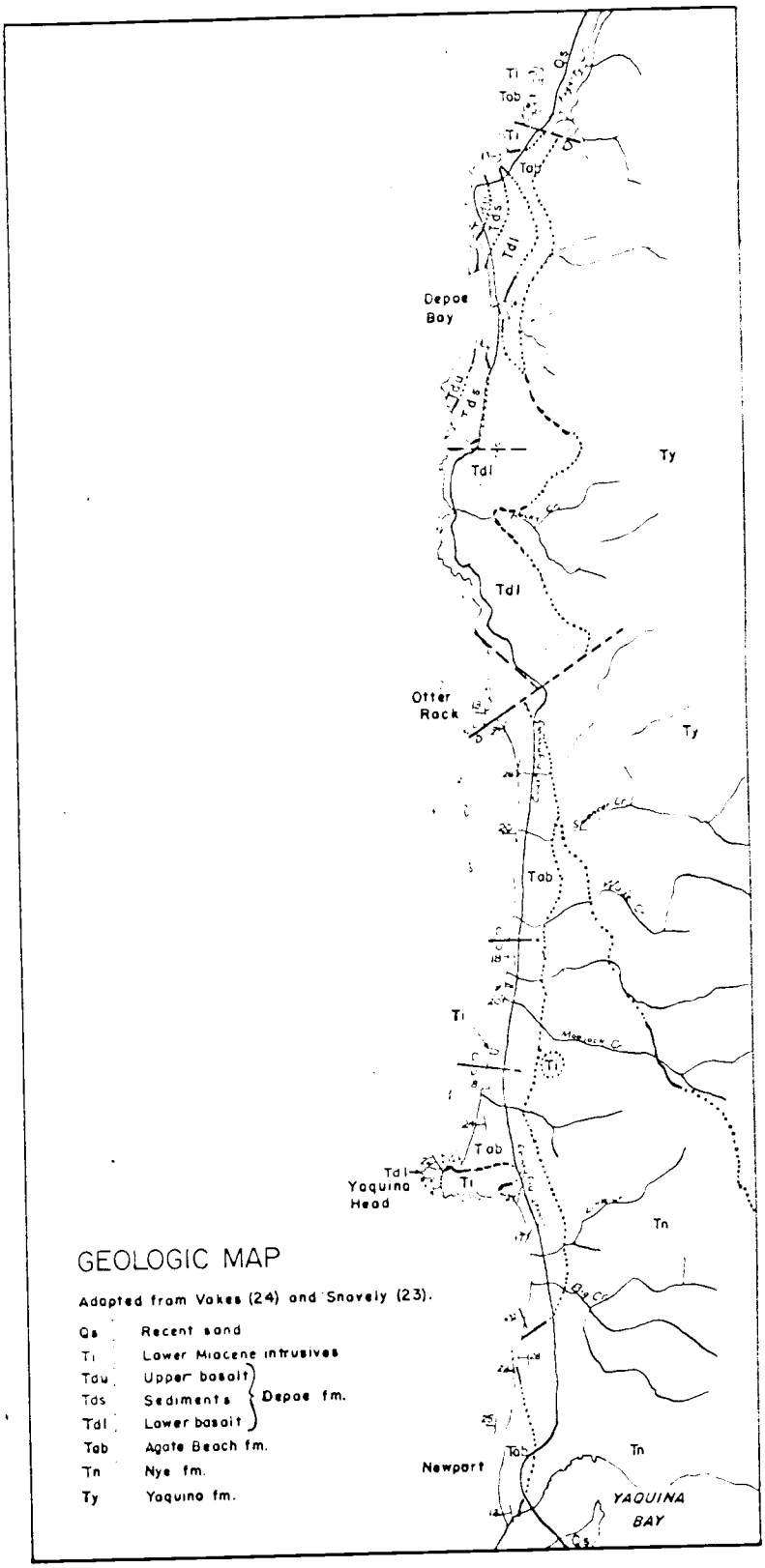
A marine Miocene formation overlies the Agate Beach formation in the Depoe Bay region. This unit is described and formally named the Depoe formation in this report.



LOCATION MAP

Based on Yaquina and Cape Foulweather quadrangles, Lincoln County, Oregon. Shaded rectangle on map of Oregon above shows location of topographic map at right.




Depoe Bay
Otter Rock
Yaquina Head
Newport
YAQUINA BAY
Qs
Ti
Tab
Tdl
Tds
Tdu
Ty
Tn
GEOLOGIC MAP
Adapted from Vokes (24) and Snavely (23).
Qs Recent sand
Ti Lower Miocene intrusives
Tdu Upper basalt
Tds Sediments
Tdl Lower basalt
Depoe fm.
Tab Agate Beach fm.
Tn Nye fm.
Ty Yaquina fm.

REVIEW OF THE LITERATURE

As the Agate Beach formation has often been referred to as part of the Astoria formation, we will first review the general history of the name "Astoria."

Among the earliest references to Miocene rocks in Oregon is that of Newberry (18, p. 29) who, in 1855, discussed the "fossiliferous sandstones of Monterey, Santa Clara, San Francisco, Port Orford, Coose Bay, Astoria, and the Cowlitz." He noticed that "they have a common character both in their lithological features and in their fossils, and are to referred to a common period -- certainly not later than the Miocene."

The name "Astoria shales" was first defined in print by Cope (4, p. 457) in 1880. He stated:

> "In the existing Geological maps of Oregon, the Coast range is represented as composed of Archaean rocks. This is a serious error. Prof. Newberry has already stated that the fossils of the range are of an age not older than Miocene. The unpublished notes of Prof. Condon, formerly State Geologist, state that the backbone of the Coast range consists of argillaceous shales, which contain invertebrate and vertebrate fossils, frequently, in concretions. Some of the latter are Physoclystous fishes, with strongly ctenoid scales. To this formation, Dr. Condon gives the name Astoria shales. Above this is an extensive tertiary deposit, rich in Mollusca, which is usually interrupted by the central elevations of the mountain axis. Prof. Condon refers this to an Upper Miocene age, under the name Solen beds. On the flanks of the mountains, this is overlain by a pliocene formation, containing some of the fossils of the Equus beds of Central Oregon. This is both underlaid

> and overlaid by basalt, and other volcanic products."

In 1892, the name "Astoria" took on a triple meaning. Dall (7, pp. 223-225) proposed the name "Astoria sandstone" for the sandstone overlying the Astoria shale, and proposed the term "Astoria group" to include both units "but not the subjacent Eocene Aturia bed." He further stated that the Aturia bed is no longer accessible due to expansion of the city, as it was located at the water level.

This usage was revised by Dall (6, p. 338) in 1898, as follows.

> "So far as can be judged from the fauna collected, the Empire beds are the exact equivalent of the upper part of the Miocene beds at Astoria, called by Dall, in 1892, the Astoria sandstone, to distinguish them from the (Oligocene,) Astoria shales (formerly called Miocene), which conformably underlie them. . . . If the double use of the name Astoria in this manner is regarded as objectionable, the name Empire beds might be taken for the sandstones."

"Empire beds" was a name given to a sandstone formation at Coos Bay by Diller in 1896 (8, p. 475).

As early as 1913, Arnold and Hannibal (1, p. 577) tried to restrict the use of the name Astoria to its original definition.

> "As in the instance of other Tertiary formations named before the modern exact method of describing a type section or area and basing a formation on it came into use, the

> definition of the Astoria Shales is vague, and has led to the inclusion under that name of nearly all the Lower Miocene-Oligocene of northwestern Oregon in spite of unconfirmed suspicions on the part of several California geologists that more than one horizon was represented there. Under the circumstances it is desirable to go back and see what Condon intended the name to cover."

The authors concluded that Condon's Astoria includes two conformable horizons: the Seattle formation, and the San Lorenzo shales of Clatsop and Columbia counties. Further, that the "Solen beds" probably include the Empire formation, the Solen beds at Astoria which unconformably overlie the Astoria formation, and the basal San Lorenzo tuffs at Eugene.

Subsequently, a few authors accepted the term "Astoria shale" in its original definition, among them Washburne (26, pp. 15-20), Harrison and Eaton (11, p. 13), Hertlein and Crickmay (12, p. 259).

Hertlein and Crickmay (12, p. 259) in 1925 stated:

> "Recently Howe (Unpublished thesis, Leland Stanford Junior University 1922) investigated the Astoria locality and states that the two sandstones present, one underlying the Astoria shales and one overlying the shales have been confused by several writers."

In 1926, Howe (14, pp. 297-301) described three members at Astoria, which he referred to as the "lower sandstone," the Astoria shale, and the "upper sandstone." "The lowest portion visible is at the corner of Fifth and Commercial streets. Here rather massive, fine-

grained sandstones alternate with sandy shales in which coal pebbles, small, round concretions the size of marbles, and fossils are abundant." Above this he described thin beds of sandstone and shale, overlain by the massive Astoria shale. The upper sandstone consists of widely-separated fragmentary outcrops on the south side of the peninsula. "There is no reason to suppose that these sandstones are separated by any great stratigraphic break, but as they are unfossiliferous in the Astoria area, it is quite impossible to demostrate this point." The lower sandstone, on the northern side of the peninsula, is fossiliferous.

The name "Astoria" was extended by Etherington "to include the Washington Miocene, to which the names Clallam formation, and . . . Wahkiakum and Chehalis (not Lawson's Chehalis formation) have been applied." (9, p. 40). "In the area studied, the Astoria formation is composed of sandstones with a minor amount of finer clay-shales near the top. . . . Westward, shales become much thicker replacing the sandstones."

Beginning in 1934, the name Astoria formation was extended to include the Miocene in Lincoln County. These references will be discussed more fully at the end of this section, along with earlier literature on the Agate Beach formation.

Use of the name was extended to include Miocene sandstones and shales "extending southward along the Coast in Tillamook County" by Warren (25) in 1945, who used the term "Astoria formation" in its more liberal sense to include the sandstones. "In Tillamook County the Astoria formation is mostly massive sandstone and tuffaceous sandy shale."

We shall now review the literature on the Miocene strata of Lincoln County, Oregon.

Among the earliest references was that of Diller in 1896 (8, pp. 473-475). Diller described the strata between Otter Rock and Yaquina as "Miocene shales," including those now known as the Nye and Agate Beach formations. He recognized what is now known as the Yaquina formation as a distinct unit, and believed it to be continuous between Yaquina and Coos Bay where he named the sandstones the "Empire beds."

In 1914, Washburne (26, p. 95) mentioned that from Otter Rock "the Miocene strata continue along the beach as far south as Newport, all dipping toward the sea and all representing horizons high in the Miocene."

A good description of the stratigraphy of Yaquina Bay appeared in 1920, by Harrison and Eaton (11, pp. 13-14). They describe the Nye formation under the term "Acila shales." They correlated this with the Astoria

shale.

> "The shales in the town of Astoria have been studied by a number of geologists and this occurrence has been given as a type locality of upper Oligocene of Oregon. The division of Acila shales used in this report possibly could be properly called Astoria shales. . . Following the Oligocene, and with slight unconformity we find in the coastal region of Tillamook, Lincoln and Clatsop counties, the sandstones and shales of the Miocene period. A good section can been seen just west of Newport along the coast. . . . The Miocene of Newport is a dense sandy shale, tuffaceous in character. In the weathered surfaces it is yellow to gray-brown, and in the unweathered olive-gray to bluish in color."

Howe, in 1926, (14, p. 306), correlated the Miocene at Newport with his "lower sandstone" at Astoria, and the "Miocene beds of middle California, especially that on the Kern River."

Schenck (22, p. 30), described the individual formations of the Oregon Coast Range. He says, in part,

> "Miocene sandstone. The sandstone and shales exposed at Jump-off Joe and elsewhere along the coast between Newport and Yaquina Head and farther north are described under this term. The beds were not observed to extend inland for more than half a mile. The sandstone . . . is blue to gray in color, fine to medium grained, tuffaceous, feldspathic, and glauconitic. . . .(with an) abundance of molluscan fauna."

Packard and Kollogg (20, p. 5-16), in 1934, applied the name "Astoria" to these beds:

> "The overlying marine Miocene of the Newport region has never been described in detail nor given a formation name. For the purpose of this paper it may be referred to

> as the "Astoria Miocene beds of the Newport region." Such a designation carries no implication that the entire section as developed at Astoria, Oregon, is present, but follows Howe who correlated these rocks with the lower Astoria, known as the Alsea sandstone." (20, pp. 5-6).

> "These Miocene rocks consist of sandstones and sandy shales usually occurring in beds not over 20 feet in thickness, except in the upper portion of the section at Otter Rock. . . The lower sandstones are typically blue-gray medium grained rocks that are places tuffaceous or may be feldspathic or even glauconitic. . . Coarse to fine sandy shales constitute a large part of the Miocene sediments. These shales are dark colored, micaceous, readily weathered, and oxidize to a reddish brown. . . A fine-grained tuffaceous shale, nearly white in color, occurs in the lower part of the section west of Newport and at a few localities farther north." (20, p. 16).

In 1941, Packard (19, p. 1981) used the name "Astoria formation" in describing marine mammals which occur in the lower beds of the Astoria formation "between Waldport, Lincoln County, and Astoria in Oregon, and even in Washington."

Weaver (27, p. 167), in 1937, described these beds under the name "Miocene sandstone" as "cross-bedded massive coarse-grained tuffaceous sandstone which occasionally shows shows stratification. Grayish-brown micaceous sandy shales occur with these in subordinate amounts and are the equivalent of at least a portion of the Astoria sandstones exposed in the city of Astoria."

In 1944, the same author referred these sediments

to the Astoria formation. (28, p. 590).

Cushman, Stewart, and Stewart (5, p. 43), in 1947, described the Foraminifera from a locality at Agate Beach, and continued this use of the name Astoria. They describe the formation at Agate Beach as "composed largely of westerly dipping, medium- to coarse-grained, predominantly massive, tuffaceous sandstones. Associated with these sandstones in minor amounts are dark, grayish, micaceous sandy shales which weather to reddish-brown."

Vokes, Norbisrath, and Snavely (24), in 1949, stated,

> "Unconformably overlying the Nye mudstone is a series of sandstones and sandy shales that outcrop in the sea cliffs between Yaquina Bay and the south side of Otter Rock. . . It has been the practice to refer to this series of strata as the "Astoria Miocene beds of the Newport region" or as the Astoria formation. This terminology is here accepted, although it is recognized there is no evidence that the limits of the sequence as developed in the Newport-Waldport area conform with those at Astoria. In fact, Howe has suggested that only the lower part of the Astoria, the equivalent of the so-called Aturia-sandstones, is represented in the Newport areas.
>
> "The formation assigned tentatively to the Astoria is dominantly sandy, but the lithology is variable. The predominant rock types consist of gray to blue-gray, fairly soft, fine- to medium-grained sandstone that is often feldspathic and in places tuffaceous. Dark-colored, micaceous and sandy shales are commonly interbedded with the sandstones. . .
>
> "The correlation of the Astoria formation with the Temblor formation of California has

long been established, and is further confirmed by the faunas obtained during the present study."

In 1949, Snavely and Vokes (23) applied the name "Astoria" to the Miocene rocks at Depoe Bay, Fogarty Creek, and Cape Kiwanda. In the Depoe Bay region "the Astoria formation . . . consists of sandstone and siltstone with interbedded volcanic rocks." The lower part of the section, at Fogarty Creek and the inner bay at Depoe Bay is "medium-grained, micaceous sandstone with interbedded siltstone." The "upper beds," in the outer bay at Depoe Bay and at Whale Cove are described as "rather massive, cross-bedded, yellowish, friable sandstone containing sporadic moderately large calcareous concretions and occasional smaller ironstone concretions."

The last two references are part of a series of three geologic maps by the U. S. Geological Survey. The three together cover the coastal area from the Columbia River to the Alsea River. The northernmost of the series, by Warren, Norbisrath, and Grivetti (25), is a reconnaissance geologic map. It covers the coast from Astoria to just north of Cape Kiwanda. The Oligocene and Miocene sediments are shown as a single unit, the contacts within this unit not being shown. Twelve individual localities are listed as "Astoria formation," which seems to include the Astoria group and the lower

sandstone, but it is not possible from this reconnaissance to determine the total extent of each unit.

The other two preliminary maps in the series (23 and 24) are complete geological maps which together cover the area in which the Agate Beach formation outcrops. It is shown on both maps as the "Astoria formation." The Depoe Bay region is included in the report by Snavely and Vokes (23). The Otter Rock-Newport area is shown on the map by Vokes, Norbisrath and Snavely (24).

Meacock (13, p. 9), in 1951, described the lowest part of the Agate Beach formation as follows.

> "The lowest beds of the "Astoria" formation are a siltstone which grades, in about 15 feet, into sandstone containing concretions. At the contact with the Nye formation the siltstone contains small fragments, up to six inches in diameter, of Nye mudstone. The lower siltstone is greenish gray. . . The concretions in the sandstone are limy, discoidal, and attain diameters up to three feet. These concretions are aligned along a single bedding plane."

A list of megafossils found by earlier investigators is given in Appendix A. Microfossils are listed in Appendix B.

Summary

It is evident from the above that the name "Astoria formation" is used very loosely. It cannot be applied to Lincoln County for two reasons. The stratigraphy at the mouth of the Columbia River is not the same as that of Lincoln County. The Astoria formation at its type locality is shale; the Agate Beach formation is primarily tuffaceous silty sandstone. The writer here follows Condon's (4, p. 457) usage and restricts the term Astoria formation to the shale strata at Astoria.

The stratigraphy at Astoria, as described by earlier authors, appears to consist of a basal sandstone (Howe's "lower sandstone," Packard's "Asturia sandstone"), conformably overlain by a middle shale (Condon's "Astoria shale"), which, in turn, is disconformably or unconformably overlain by an upper sandstone member of unknown extent (Howe's "upper sandstone"). The term "Astoria sandstone" has been applied to both the upper and lower sandstones. The lower sandstone and the Astoria shale are both quite extensive in southwestern Washington (9, p. 40). Locally, these three marine clastic units are overlain by Columbia River basalt (25).

The Miocene stratigraphy of Lincoln County may be summarized as follows. Unconformably overlying the Yaquina and Nye formations is a formation consisting of

fine-grained tuffaceous silty sandstone with a minor amount of siltstone (Vokes' and Packard's "Astoria formation," and Snavely's "lower part" of the "Astoria formation"). Overlying this is a basalt formation at Yaquina Head and Depoe Bay. This in turn is overlain by sandstone (Snavely's "upper beds" of the "Astoria formation"). This is overlain by more basalt, at Depoe Bay. The sandstone lying between the basalt flows is not extensive.

These strata may be divided into two formations, which the writer here calls the Agate Beach formation and the Depoe formation.

Definitions of New Names

Agate Beach Formation

The Agate Beach formation is defined as those sedimentary strata lying stratigraphically between the top of the Nye formation and base of the basalt flow on the north side of Yaquina Head, in Yaquina quadrangle, Oregon. The type section extends from the top of the Nye formation in the cliff on the south side of Yaquina Bay State Park in Newport, 950 feet west of the Yaquina Bay highway bridge, northward to the mouth of Johnson Creek in the NE¼ Sec. 5, T 10 S, R 11 W. The highest member is the sedimentary unit underlying the basalt flow on the north side of Yaquina Head, and the basalt is not included in

this formation. Additional and less complete exposures are found along the coast from Johnson Creek to Otter Rock, at the inner bay at Depoe Bay, at Boiler Bay, and at the mouth of Fogarty Creek.

Depoe Formation

The type section of the Depoe formation includes the basalt and interbedded sediments overlying the Agate Beach formation at Depoe Bay. The base of the section is at the base of the basalt flow at the west end of the north side of the inner bay at Depoe Bay. The section continues along the south shore to the Pacific Ocean at the west end of the south side of the outer bay at Depoe Bay. The extent of this formation beyond the shoreline is not known. Additional exposures occur from Otter Crest continuously northward along the coast to Boiler Bay, as well as between Boiler Bay and Fogarty Creek, and on the north side of Yaquina Head.

REGIONAL STRATIGRAPHY

The stratigraphy of the Yaquina Bay area has been discussed by several authors, among whom are Harrison and Eaton (11, pp. 13-14), Schenck (22, pp. 25-30), and Weaver (27, pp. 167-180).

Two preliminary geologic maps have been prepared by the Geological Survey, with accompanying texts (23 and 24).

A general summary of the stratigraphy of this area is presented below.

Yaquina Formation

The Yaquina formation is the oldest formation exposed in this area. It is described by Weaver (27, p. 167) as

> "3100 feet of coarse-grained brownish-gray massive micaceous sandstones in the lower half, and fine- to medium-grained micaceous sandstones in the upper half. Occasional carbonaceous layers appear interstratified with the sandstone and also lenses of grit or fine conglomerate occur near the base."

The Yaquina formation has recently been shown, by Vokes et al (24), to belong to the uppermost Oligocene. The upper part of this formation is in contact with the Agate Beach formation at Otter Rock. Here it is a pale olive-gray, fine-grained, silty, micaceous sandstone, finely cross-bedded throughout.

Nye Formation

The Nye formation disconformably overlies the Yaquina formation (24). It is dark greenish gray, massive mudstone with occasional sandy layers, and occasional hard calcareous layers, and has abundant fish scales, Foraminifera, occasional pelecypods, and some carbonized plant remains. It is best exposed along three miles of coastal cliffs extending south from Henderson Creek, which is about two miles south of the south end of the Yaquina Bay bridge. It may be seen unconformably underlying the Agate Beach formation in the cliff just west of the north end of the Yaquina Bay bridge, and at Jump-off Joe. The upper part of the Nye mudstone has been dated lower Saucesian, or upper "Oligo-Miocene," by Heacock (13, p. 25), who has made a detailed study of the Foraminifera of the upper Nye formation. Its total thickness is 4380 feet (13, p. 7).

Agate Beach formation

The Agate Beach formation unconformably overlies the Nye and Yaquina formations. It is discussed in greater detail on the following pages. In general, it is a greenish gray, fine-grained, tuffaceous, micaceous, silty sandstone, with intercalated layers of tuffaceous, sandy siltstone and occasional layers of tuff, and coarse sandstone. Its outstanding feature is the abundance of pelecypods. Its age is lower Miocene, or upper Saucesian. Its total thickness is more than 1000 feet.

Depoe Formation

A flow of dark black "glassy basalt" (23) overlies the Agate Beach and Yaquina formations. This flow forms the outer wall of the inner bay at Depoe Bay, and its basal contact with the Agate Beach formation is exposed at the west end of the north side of the inner bay. A flow is also exposed on the north side of Yaquina Head and from Otter Crest to Depoe Bay. At the south end of the beach on the north side of Yaquina Head, the basal contact may also be seen on two small islands north of the point. The presence of occasional islands, such as Gull Rock, forming a chain of islands northward, strongly suggests that this flow is continuous with that at Cape Foulweather. The basal contact is conformable at

Depoe Bay and unconformable at Yaquina Head. At Yaquina Head the basalt shows columnar jointing, whereas at Depoe Bay pillow structure is prevalent.

The thickness of the lower basalt flow at Yaquina Head is at least 330 feet. The total thickness is unknown, the upper part of the flow having been removed by erosion. At Cape Foulweather this flow is at least 1000 feet thick, according to Snavely and Vokes (23); in the type section of the Depoe formation, at Depoe Bay, the thickness of this member is 175 feet. A five-foot thick flow of basaltic volcanic breccia is present at Boiler Bay. Its stratigraphic position between sediments typical of the Agate Beach formation and those of the middle member of the Depoe formation suggests that it is the northern end of this flow.

"A massive, cross-bedded, yellowish, friable sandstone" (23) overlies this basalt. It is exposed in the sea cliffs on the north and south sides of the outer bay at Depoe Bay, at Whale Cove, and Boiler Bay. Its total thickness on the south side of the outer bay at Depoe Bay is 145 feet. Its extent is very limited. This sedimember is overlain by another flow, exposed on the north and south sides of outer Depoe Bay and at Boiler Bay. At these points it is composed of volcanic breccia having fragments of basalt and sandstone. It is at least 240

feet thick.

Because of the limited extent of the upper two members, these three members are included under a single formational name: the Depoe formation. More flows and interbedded sedimentary units may exist beyond the coastline. The total exposed thickness is 560 feet at Depoe Bay. The age of this formation is not older than Lower Miocene, or Upper Saucesian, as it conformably overlies the Agate Beach formation at Depoe Bay. It may be Relizian.

Intrusive bodies are associated with both flows. The largest of these is Yaquina Head, which served as a source for at least part of the lower extrusive member, and possibly for the later flow also. Yaquina Head is a large mass of basalt and volcanic breccia, with several dikes cutting through the main mass, and containing inclusions of Agate Beach sediments. The intrusive contact is very sharp, irregular, but generally vertical. The intrusive basalt at Yaquina Head is described by Vokes et al (24) as follows:

> "The basalts are hemicrystalline with porphyritic and glomeroporphyritic textures. Phenocrysts include plagioclase (calcic andesine and labradorite), augite, olivine, and magnetite. The groundmass ranges from intergranular to hyalopilitic in texture, and consists largely of granules of augite, laths and microlites of plagioclase, magnetite, and glass. Most of the basalts contain a high percentage of magnetite, as do also the extrusive rocks of this region."

A small mass of volcanic breccia may be seen on the beach about half way between Schooner and Moolack creeks, and a small dike of black glassy basalt may be seen between Moolack and Coal creeks. Both were intruded into the Agate Beach formation.

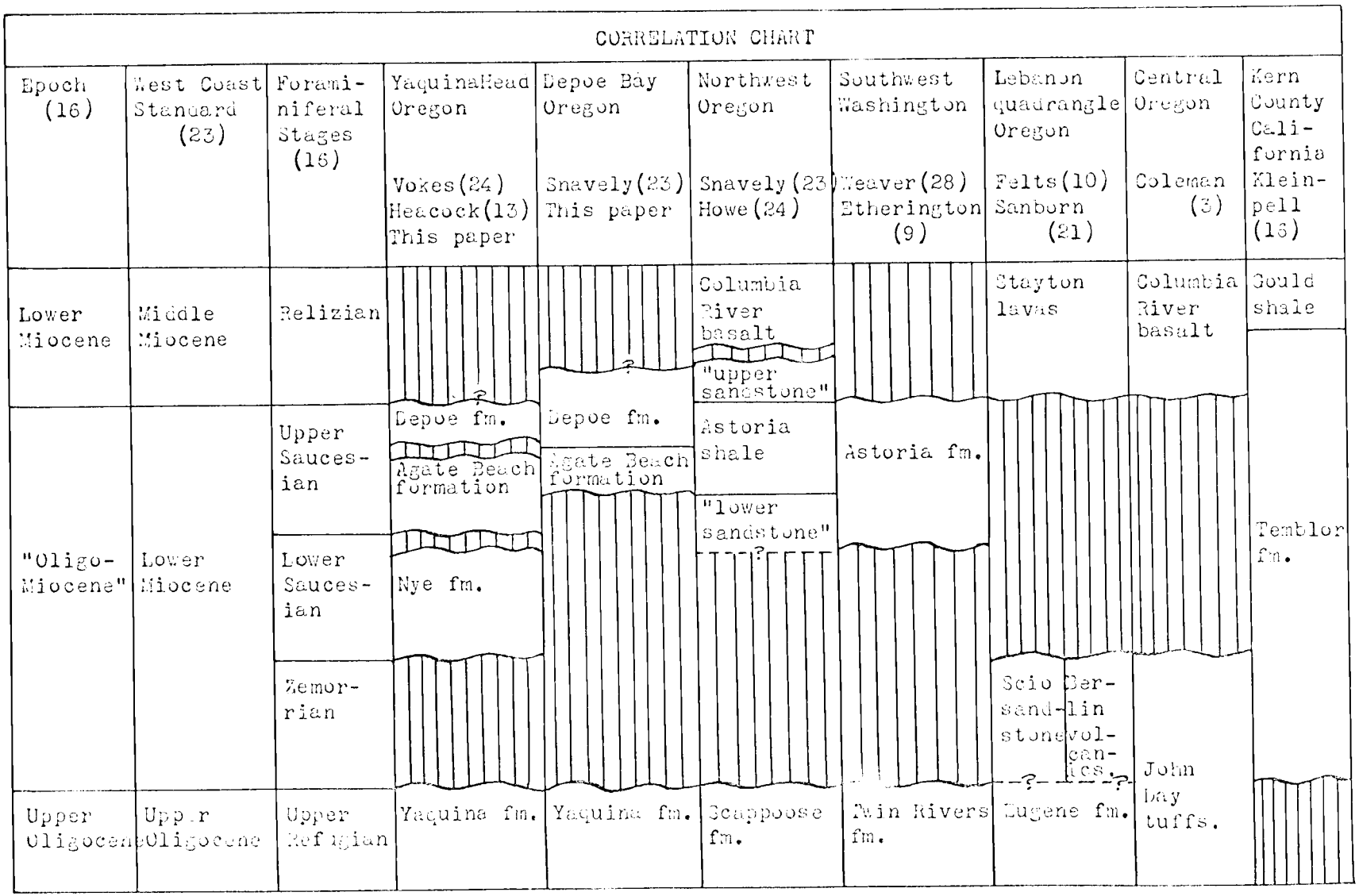
Between Fogarty Creek and Lincoln Beach a large mass of volcanic breccia has been intruded into the Agate Beach formation. Here the intrusive contact is gradational. Abundant inclusions of gray sandstone and siltstone from the Agate Beach formation range in size from twelve feet across to sand-grain size. In the sea-cliff north of Fogarty Creek, the breccia contains predominantly sedimentary material, with basalt becoming more abundant toward the north end of the beach.

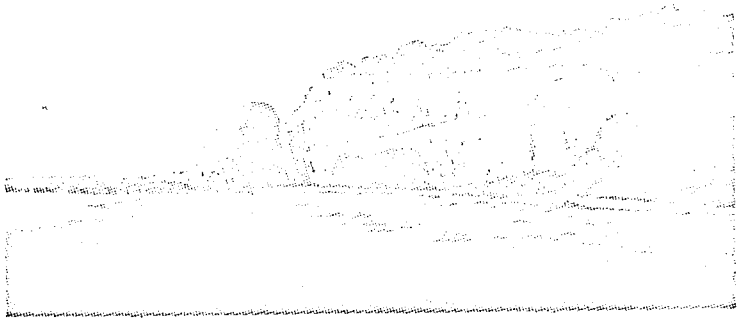
Quaternary deposits

Upper Pleistocene (2, p. 80) estuarine and terrace deposits unconformably overlie all earlier sediments and volcanic rocks in a narrow belt along the coast. These are exposed along the sea cliffs and probably do not extend far inland. The principal lithology is a yellowish gray, poorly consolidated, fine- to medium-grained sandstone. Locally conglomerate lenses occur.

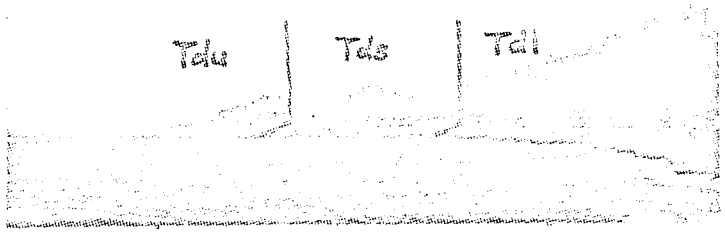
The Recent deposits include beach sand, gravel, and dune sands of limited extent.

A chart showing correlations with other West Coast sections is shown on the following page.


CORRELATION CHART
Epoch (16)
West Coast Standard (23)
Foraminiferal Stages (16)
Yaquina Head Oregon
Vokes (24) Heacock (13) This paper
Depoe Bay Oregon
Snavely (23) This paper
Northwest Oregon
Snavely (23) Howe (24)
Southwest Washington
Weaver (28) Etherington (9)
Lebanon quadrangle Oregon
Felts (10) Sanborn (21)
Central Oregon
Coleman (3)
Kern County California Kleinpell (16)
Lower Miocene
Middle Miocene
Relizian
Columbia River basalt
"upper sandstone"
Stayton lavas
Columbia River basalt
Gould shale
Depoe fm.
Depoe fm.
Astoria shale
Astoria fm.
Upper Saucesian
Agate Beach formation
Agate Beach formation
"lower sandstone"
Temblor fm.
"Oligo-Miocene"
Lower Miocene
Lower Saucesian
Nye fm.
Zemorrian
Scio sandstone
Berlin volcanics
John Day tuffs.
Upper Oligocene
Upper Oligocene
Upper Refugian
Yaquina fm.
Yaquina fm.
Scappoose fm.
Twin Rivers fm.
Eugene fm.

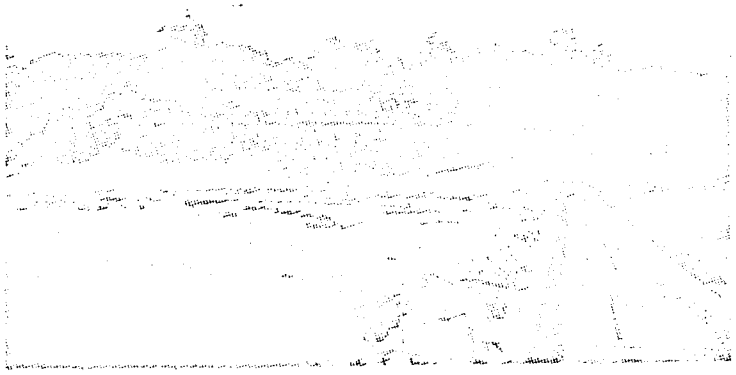


Unconformity: Terrace deposits above, Agate Beach fm. below. Resistant tuffaceous sandstone (unit A26) is shown in the center of the outcrop. North end of Yaquina Bay State Park, Newport.



Depoe formation on the north side of the outer bay, Depoe Bay, showing the three members: lower basalt (Tdl), middle sandstone (Tds), and upper basalt (Tdu).

Yaquina formation at Otter Rock.



Base of Newport Beach section, showing an unconformities between Nye fm. (Tn), Agate Beach fm. (Tab), and terrace deposits (Qt). Yaquina Bay State Park, Newport.

Unconformity between Nye (Tn) and Agate Beach (Tab) formations at Jump-off Joe.

Columnar basalt overlying Agate Beach formation. North side of Yaquina Head.

Low-tide reefs at Nye Beach. Agate Beach formation.

DETAILED STRATIGRAPHY

Ten stratigraphic sections were selected in the Agate Beach formation between Lincoln Beach and Newport. These sections overlap stratigraphically, as shown in the columnar sections on the last page.

The principal rock type found in all sections is a greenish gray, silty, fine grained, massive sandstone, very loosely consolidated, containing some mica, pumice and carbon. Foraminifera and small pelecypods are generously scattered throughout. Commonly interstratified with this sandstone is a greenish gray, sandy, tuffaceous siltstone. Coarse sandstone, hard calcareous sandstones, and concretions also occur in lesser amounts.

Two hard calcareous sandstone layers, rich in pelecypods, especially Anadara devincta Conrad recur in several of the sections, and these were found to be extremely useful for correlation between sections north of Yaquina Head.

Also useful is a sequence of tuffaceous layers occurring in the Newport Beach and Nye Beach sections. Parts of this sequence occur in the other sections.

On the following pages the sections are individually described and correlated, and the reader is referred to the columnar sections shown on the plate on the last page.

The color of the rocks, in the following descriptions, is followed by the numerical color designation used in the Rock Color chart (17).

Molluscan and foraminiferal localities listed are Oregon State College localities, and the specimens are deposited at the Paleontology Laboratory of the College in Corvallis. Locality numbers bearing an asterisk are those whose exact stratigraphic location cannot be determined from available information.

NEWPORT BEACH SECTION

The base of the Newport Beach section rests unconformably on the Nye formation in the cliff on the north shore of Yaquina Bay, 950 feet west of the north abutment of the Yaquina Bay bridge on the coast highway. The section continues westward and northward along the sea-cliff to the north boundary of Yaquina Bay State Park, and ends with the highest member exposed in the sea cliff.

Exposures consist of good sea-cliff outcrops, where the Agate Beach formation is exposed between the terrace deposits and the beach sand. Fresh samples were available except in the lowest part of the section, which is badly weathered.

Measurements were made with a ten-foot tape and Brunton compass. Occasional use was also made of fifty-foot tape and pacing. At the north (upper) end the beds strike N 10°E and dip 13°NW. At the south end the strike is N 10°W and the dip is 12°SW.

NEWPORT BEACH SECTION

Unconformably overlain by Recent beach sands and terrace deposits.

Unit	Agate Beach formation	Feet
A31.	Siltstone, medium gray N5, fine grained, massive, sandy, slightly indurated with carbonates. Foraminifera rare; some carbonaceous matter. Occasional small pelecypods.	8.4
A30.	Sandstone, greenish gray 5GY6/1, very fine grained, silty, finely crossbedded, indurated, with interbedded fine layers of medium light gray, tuffaceous siltstone having few Foraminifera.	4.1
A29.	Sandstone, greenish gray 5GY6/1, fine grained, silty, massive. Occasional small pelecypods. Foraminifera rare.	2.5
A28.	Sandstone, light gray N7, coarse grained, in a calcareous matrix. Basal shale 0.1 foot thick.	0.6
A27.	Sandstone, greenish gray 5GY6/1 fresh, weathers to moderate yellowish brown 10YR5/4, coarse grained in a fine-grained silty sandstone matrix, massive, somewhat micaceous, slightly tuffaceous. Casts of pelecypods. Molluscan localities 4026 and 4038.	1.4
A26.	Sandstone, medium light gray N6 fresh, weathers to very light gray N8, fine grained, massive, very tuffaceous, micaceous, some carbon. Molluscan locality 4018*.	15.7
A25.	Sandstone, medium dark gray N4, fine grained, silty, heavy. Occasional small pelecypods.	0.6
A24.	Sandstone, medium gray N5, fine grained, silty, micaceous and carbonaceous. Interbedded with this is a medium dark gray N4, tuffaceous siltstone. Foraminifera rare.	2.6

Newport Beach section, continued

Unit	Agate Beach fm., continued	Feet
A23.	Sandstone, greenish gray 5GY5/1, fine grained, silty, micaceous, carbonaceous. Foraminifera rare. Occasional pelecypods. Molluscan locality 4030*.	3.5
A22.	Sandstone, light gray N7.5, medium grained, micaceous. Has middle layer of sandstone, light gray N7.5, composed of mica and quartz, fragments mostly angular and platy. Occasional small pelecypods throughout.	2.4
A21.	Siltstone, dark greenish gray 5GY5/0.5, sandy, massive, tuffaceous, micaceous. Occasional small pelecypods; abundant Foraminifera. Foraminiferal locality 4133.	5.2
A20.	Siltstone, medium light gray N5.5, sandy, massive, tuffaceous, micaceous.	4.7
A19.	Sandstone, greenish gray 5GY5/0.5, fine grained, massive, micaceous.	16.1
A18.	Sandstone, dark greenish gray 5GY4/1, coarse grained, massive, slightly indurated with carbonates but very poorly consolidated.	1.0
A17.	Tuff, pale greenish yellow 10Y8/2, sandy, massive, very finely crossbedded. Some wood fragments.	5.3
A16.	Concealed by terrace deposits.	13.9
A15.	Sandstone, greenish gray 5GY5/1, very fine grained, silty, very finely laminated, micaceous.	6.0
A14.	Mudstone, medium light gray N6, massive, with leaf impressions. Molluscan locality 4025*.	2.6
A13.	Sandstone, greenish gray 5GY5/0.5, fine grained, silty, massive, somewhat micaceous. Rare Foraminifera and ostracods. Foraminiferal locality 4132.	13.4
A12.	Eroded and concealed by sand.	34.6

Newport Beach section, continued

Unit	Agate Beach fm., continued	Feet
A11.	Sandstone, medium light gray, weathers to light olive gray 5Y6/1, medium grained, silty, heavy, well indurated, micaceous. Occasional small pelecypods. Some carbonaceous fragments.	1.5
A10.	Claystone, medium gray N5.5, tuffaceous, massive, slightly micaceous.	1.1
A9.	Sandstone, medium gray N5, fine grained, silty, massive, somewhat micaceous. Common small pelecypods and carbon fragments. Molluscan localities 4017, 4020, 4021, 4024, 4029, 4037.	6.7
A8.	Siltstone, dark greenish gray 5GY4/1, sandy, massive, tuffaceous.	2.9
A7.	Sandstone, medium light gray N5.5, fine grained, silty, massive, somewhat micaceous.	1.3
A6.	Siltstone, greenish gray, massive, tuffaceous.	0.9
A5.	Sandstone, greenish gray 5GY5/1, fine grained, silty, massive, micaceous.	18.5
A4.	Siltstone, medium light gray, weathers to greenish gray 5GY6/1 and to moderate yellowish brown 10YR5/4, sandy, massive, tuffaceous. Rare small gastropods.	2.7
A3.	Sandstone, light olive gray 5Y6/1, fine grained, silty, massive, with large calcareous concretions.	10.8
A2.	Siltstone, medium light gray N6, sandy, massive, tuffaceous, with carbon particles.	2.4
A1.	Sandstone, light olive gray, fine grained, silty, massive.	3.6

Total exposed thickness of Agate Beach fm. -- 197 feet.

Unconformably overlies the Nye mudstone.

NYE BEACH SECTION

The base of this section is in the sea cliff at the point at the south end of Nye Beach where the lowest cliff outcrop of the Agate Beach section disappears under the terrace deposits. The section continues N 82°W across the beach and includes a series of outcrops exposed on the beach at very low tides. This section is accessible only at negative tides and most of it is normally covered by beach sand except after a storm. The exposures are very poor and fragmentary. The details are therefore incomplete.

The section was measured by pacing and with the use of a Brunton compass. The bedding strikes N 6°E and dips 25°W.

This section can be correlated with the Newport Beach section by lateral tracing of beds. A tuffaceous bed, unit B4, can be seen to be continuous with unit A26 of the Newport Beach section. Also, another tuffaceous bed, unit B12, can be traced laterally to a point above the top of the Newport Beach section.

NYE BEACH SECTION

Unconformably overlain by the Pacific Ocean.

Unit	Agate Beach formation	Feet
B16.	Siltstone, greenish gray, very tuffaceous.	10.6
B15.	Mostly sandstone, greenish gray, fine grained, silty, massive, interbedded with siltstone, greenish gray, somewhat tuffaceous. Details not clear.	33.0
B14.	Sandstone, greenish gray, coarse grained.	0.8
B13.	Sandstone, greenish gray, fine grained, silty, massive.	1.2
B12.	Siltstone, greenish gray, weathering to light gray, very tuffaceous.	16.9
B11.	Sandstone, gray, very well indurated, hard.	0.4
B10.	Sandstone, like unit 13.	1.3
B9.	Siltstone, greenish gray, sandy, somewhat tuffaceous.	4.6
B8.	Sandstone, like unit B13.	7.2
B7.	Siltstone, like unit B9.	0.2
B6.	Sandstone, like unit B13.	7.2
B5.	Completely concealed by beach sand.	50.7
B4.	Tuff, greenish gray weathering almost to white, sandy, silty. (also exposed in cliff).	21.1
B3.	Sandstone, greenish gray 5GY5/1, fine grained, silty, tuffaceous, somewhat carbonaceous. Occasional small pelecypods. Good exposure on sea cliff.	18.9
B2.	Siltstone, greenish gray, sandy, tuffaceous.	1.5
B1.	Sandstone, like unit B13.	7.0

Total exposed thickness of Agate Beach fm. -- 183 feet.
Base concealed by terrace deposits.

JUMP-OFF JOE SECTION

The Jump-off Joe section extends along the north-facing sea-cliff at Jump-off Joe, from the top of the angular unconformity between the Nye and Agate Beach formations to the highest member exposed near the top of the sea cliff. The exposure consists of a single, large sea-cliff in which the Agate Beach formation is exposed between the Nye shale, beach sand, and terrace deposits.

The Agate Beach formation here strikes N 14°W and dips 22°W. The underlying Nye formation strikes N 1°E and dips 28°W.

The section was measured directly with a ten-foot steel tape, fifty-foot tape, and Brunton compass.

This section can be correlated by field observation with the Nye Beach section, and by inference with the Newport Beach section. The basal member of the Nye Beach section, a sandstone, can be traced into the uppermost member of the Jump-off Joe section. By this it can be seen that the tuff bed in this section, unit C8, is stratigraphically lower than the lowermost tuffaceous unit of the Nye Beach section, unit B4. It can therefore be concluded that unit C8 of the Jump-off Joe section is equivalent to unit A17 of the Newport Beach section.

JUMP-OFF JOE SECTION

Unconformably overlain by terrace deposits.

Unit	Agate Beach formation	Feet
C9.	Sandstone, greenish gray 5GY6/0.5, fine grained, silty, massive, concretionary.	15.8
C8.	Tuff, medium light gray N6, silty, massive.	14.4
C7.	Sandstone, greenish gray 5GY6/1, fine grained, silty, massive, micaceous. Foraminifera rare.	1.4
C6.	Siltstone, like unit C2.	0.4
C5.	Sandstone, greenish gray 5GY6/1, fine grained, silty, massive.	5.3
C4.	Siltstone, like Unit C2.	0.1
C3.	Sandstone, greenish gray 5GY5/0.5, fine grained, silty, massive, micaceous. Occasional small pelecypods. Foraminifera rare. Foraminiferal locality 4131.	11.5
C2.	Siltstone, medium gray N5.	0.3
C1.	Sandstone, light olive gray 5Y6/1, fine grained, silty, massive. Occasional small pelecypods.	6.3

Total exposed thickness of Agate Beach formation -- 94 ft.

Unconformably overlies the Nye formation:
Mudstone, dark greenish gray 5GY4/1 fresh, weathers to greenish gray 5GY5/1. Foraminifera common. Abundant fish scales. Some plant remains.

AGATE BEACH SECTION

The base of the Agate Beach section is in the sea-cliff 1,070 feet north of the mouth of Little Creek and includes the lowest exposed unit at that location. The top of the section is against the basalt intrusion, on the south side of Yaquina Head.

The exposures consist of weathered outcrops in the cliff. Much of the section is concealed by slumping and by soil and brush. The uppermost unit consists of low outcrops through the beach sand, accessible at very low tides.

The section was measured with a Brunton compass, ten- and fifty-foot tapes, and pacing.

The beds at the north (upper) end strike N 14°E and dip 27°W. Near the southern end they strike N 27°E and dip 17°NW. At the extreme southern end a strike of N 22°E and dip of 26°W were recorded. The latter is probably a local variation due to slumping.

Lateral eye-tracing of units indicates that the bulk of this section is stratigraphically lower than the Jump-off Joe section. The irregularity of the surface of unconformity between the Agate Beach and Nye formations can be observed closely along the sea-cliff north of Jump-off Joe, where both formations are present. The tuff bed of the Jump-off Joe section can be seen as a

low-tide reef striking out to sea in the direction of the upper end of the Agate Beach section. Since only two of the tuffaceous layers were in this section, and those only in weathered outcrops in an area in which slumping is frequent, it is not possible to obtain an exact correlation. The two very tuffaceous siltstones of this section, units D22 and D26, are here tentatively correlated with units A20 and A26 of the Newport Beach section.

AGATE BEACH SECTION

Unconformably overlain by terrace deposits and recent sand.

Unit	Agate Beach formation	Feet
D27.	Sandstone, varying in color from dark gray N3, to medium light gray N5.5, fine grained, silty, massive, somewhat micaceous, slightly indurated. Has interbedded layers, 0.1 to 0.4 foot thick, of siltstone, sandy, somewhat tuffaceous and micaceous. A concretionary layer is found 55 feet down within this unit. At the top is a layer rich in a single species of pelecypod: Anadara devincta Conrad. Other pelecypods are found throughout but are especially abundant near the top and bottom of this unit. Few Foraminifera, some pyritized. Occasional carbonized plant remains. Poor outcrops as low-tide reefs on beach. Details incomplete. Foraminiferal localities 4136 and 4137.	124.9
D26.	Siltstone, medium gray N5, sandy, very tuffaceous. Occasional small molluscs and carbonized plant remains.	9.3

Agate Beach section, continued

Unit	Agate Beach fm., continued	Feet
D25.	Sandstone, medium dark gray 5GY3.5/0.5, fine grained, silty, massive, heavy, hard, well indurated, somewhat micaceous. Small pelecypods common.	3.0
D24.	Concealed by slumping.	13.4
D23.	Sandstone, like unit D25.	0.1
D22.	Siltstone, light gray N7.5, very fine grained, very tuffaceous.	0.4
D21.	Concealed by slumping.	39.5
D20.	Sandstone, pale olive gray 10Y5/1, fine grained, silty, massive, Pelecypods rare. Poor outcrop in slump area.	3.3
D19.	Concealed by sand.	8.6
D18.	Sandstone, dark greenish gray, 5GY4.5/1.5, very fine grained, silty, massive, somewhat micaceous. Occasional small pelecypods. Lower portion has abundant Foraminifera. Foraminiferal locality 4134 and probable locality of Cushman, Stewart, and Stewart (5, p. 43). Poor outcrops, details not available.	49.9
D17.	Concealed by slumps and sand.	5.8
D16.	Sandstone, massive, like unit D18.	12.8
D15.	Concealed by erosion and terrace deposits.	77.4
D14.	Siltstone, dark greenish gray 5GY5/1.5, very weathered. Very poor outcrops.	0.3
D13.	Sandstone, dark greenish gray 5GY5/1, fine grained, silty, somewhat micaceous.	7.9
D12.	Slump area, but apparently mostly sandstone, like unit 13.	27.0
D11.	Concealed by slumping.	31.9

Agate Beach section, continued

Unit	Agate Beach fm., continued	Feet
D10.	Siltstone, dark greenish gray 5GY4.5/1.5, sandy, somewhat micaceous. Foraminifera common. Very poor outcrops in a slump area, but appears to be continuous. Foraminiferal locality 4135.	74.2
D9.	Siltstone, yellowish gray 5Y6/2, sandy, tuffaceous. Very weathered outcrop.	2.2
D8.	Sandstone, greenish gray 5GY5/0.5, very fine grained, silty, slightly tuffaceous, with two layers of large calcareous concretions. Poor outcrops in slump area.	119.7
D7.	Siltstone, medium light gray N5.5, sandy, very tuffaceous, somewhat micaceous, massive.	10.7
D6.	Sandstone, greenish gray 5GY5/0.5, fine grained, silty, massive, Occasional small pelecypods.	9.0
D5.	Concealed by slumping.	4.3
D4.	Sandstone, light gray N6.5, weathering to light olive gray 5Y6/1, fine grained, silty, massive, hard, heavy, well indurated.	12.4
D3.	Sandstone, greenish gray 5GY5/0.5, very fine grained, silty, massive, micaceous, slightly indurated, some carbon.	5.0
D2.	Siltstone, light gray N7, tuffaceous, massive.	4.3
D1.	Sandstone, greenish gray 5GY5/1, fine grained, silty, massive.	4.0

Total exposed thickness of Agate Beach fm. -- 661 feet.

Base of section concealed by recent sand, terrace deposites, soil, and brush.

YAQUINA HEAD-SCHOONER CREEK SECTION

The base of this section is on the south (upthrown) side of a fault, in the sea cliff 1,625 feet north of the mouth of Schooner Creek, at the northern end of the continuous cliff extending northward from Schooner Creek and immediately south of a long slump area. The section continues southward along the coast to the north side of Yaquina Head, and terminates at the base of the unconformably-overlying basalt of the Depoe formation. Included in this section is a high, concealed cliff, located at 90 feet elevation, due east of, and directly uphill from the point where the beach trail from the end of Shell Ridge Road meets the beach, in the NE¼ Sec. 30, T 10 S, R 11 W. This isolated section was incorporated into the Yaquina Head-Schooner Creek section because the equivalent portion of the sea-cliff is completely concealed by a large slump block.

The outcrops are good sea-cliff exposures. Much of the section is concealed by slumping, erosion, and recent sand.

Measurement was by ten-foot steel tape, Brunton compass, and pacing. The attitude of the beds varies gradually. At the south (upper) end the bedding strikes N 24°E and dips 15°NW. At the north (lower) end the strike is N 7°W, dip 8°W. The overlying basalt strikes

N 29°E and dips 22°NW.

This section can be correlated beyond doubt with the sections to the north on the basis of the Anadara beds, units E4 and E5, which also appear in the Moolack Beach and Beverly Beach sections. Two tuffaceous layers, units E7 and E10, are present, underlain by sandstone. The interval immediately above them is completely concealed by a large slump block. The occurrence of two higher tuffs in the Otter Rock section, in addition to these two, and the absence of tuff layers below, strongly suggests that these should be correlated with the lowermost tuffaceous beds of the sections to the south. Hence their correlation with units A17 and A20 of the Newport Beach section.

YAQUINA HEAD-SCHOONER CREEK SECTION

Unconformably overlain by the lower basalt member of the Depoe formation, and terrace deposits.

Unit	Agate Beach formation	Feet
E43.	Sandstone, greenish gray 5GY5/1, fine grained, silty, massive, somewhat micaceous and carbonaceous.	5.0
E42.	Claystone, dark greenish gray, 5GY3/1. Foraminifera rare. Foraminiferal locality 4147.	5.3
E41.	Sandstone, medium light gray 5GY5/0.5, fine grained, silty, massive, somewhat micaceous; with six very thin lenses of siltstone, pale olive gray 10Y5/1, sandy, somewhat micaceous and carbonaceous. Occasional small pelecypods throughout. Foraminifera rare in the siltstone lenses.	10.1
E40.	Siltstone, pale olive gray, sandy, tuffaceous, somewhat micaceous and carbonaceous, becoming more sandy upward.	0.9
E39.	Sandstone, greenish gray 5GY5/1, fine grained, silty, massive, somewhat micaceous and tuffaceous, with one shale lens.	3.0
E38.	Concealed by slumping.	39.3
E37.	Sandstone, greenish gray 5GY5/1, fine grained, silty, finely crossbeddod, somewhat micaceous, Two thin shale lenses at base. Occasional small pelecypods.	17.1
E36.	Sandstone, greenish gray 5GY6/1, medium grained, silty, massive, tuffaceous, somewhat indurated with calcium carbonate. Interbedded in this unit are 20 one-inch uneven layers of siltstone, yellowish gray 5Y7/2, sandy, very tuffaceous, indurated; and 13 uneven layers of greenish gray shale, scattered throughout the sandstone.	15.1

Yaquina Head-Schooner Creek section, continued

Unit	Agate Beach fm., continued	Feet
E35.	Sandstone, pale olive gray 10Y6/2, medium to fine grained, silty, massive, somewhat micaceous, fairly well indurated. Occasional small pelecypods.	4.7
E34.	Concealed by slumping.	16.9
E33.	Sandstone, greenish gray 5GY6/1, fine grained, silty, finely stratified, tuffaceous, somewhat micaceous, carbonaceous, slightly indurated.	5.4
E32.	Siltstone, medium dark gray N4, well indurated with carbonate.	5.5
E31.	Concealed by slumping.	12.8
E30.	Sandstone, greenish gray 5GY6/1, fine grained, silty, massive, micaceous. Five interbedded layers of siltstone, greenish gray 5GY6/1, tuffaceous. Few pelecypods throughout.	21.2
E29.	Claystone, greenish gray 5GY6/1, massive, tuffaceous. Small pelecypods rare.	3.7
E28.	Sandstone, pale olive gray 10Y5/1, very fine grained, silty, massive, micaceous. Occasional small pelecypods.	3.0
E27.	Slump area, appears to consist essentially of sandstone like unit 28.	87.0
E26.	Sandstone, greenish gray 5GY5/0.5, fine grained, massive, micaceous, containing fragments of tuff and of earlier sandstones. Few small pelecypods near base of unit.	7.0
E25.	Claystone, greenish gray 5GY5/0.5, tuffaceous.	1.3
E24.	Sandstone, greenish gray 5GY6/1, fine grained, silty, micaceous, having tuff gragments and thin layers of muscovite.	10.9
E23.	Claystone, medium gray 5GY5/0.5, somewhat tuffaceous.	1.3

Yaquina Head-Schooner Creek section, continued

Unit	Agate Beach fm., continued	Feet
E22.	Sandstone, like unit E24.	5.1
E21.	Sandstone, light gray N7, fine grained, silty, somewhat tuffaceous, slightly micaceous, hard, heavy, very indurated.	1.8
E20.	Sandstone, olive black 5Y2/1, very coarse grained, massive, very poorly consolidated, with two thin shale lenses.	5.8
E19.	Sandstone, greenish gray 5GY6/1, fine grained, silty, massive, somewhat micaceous and tuffaceous, with five thin shale layers.	14.6
E18.	Sandstone, medium gray N5.5, fine grained, silty, massive, micaceous, somewhat tuffaceous. Becomes more silty toward base. Occasional small pelecypods.	17.5
E17.	Siltstone, greenish gray 10GY5/1, very finely crossbedded, tuffaceous, well indurated with calcium carbonate.	2.3
E16.	Sandstone, greenish gray 5GY5/1, very fine grained, silty, massive, tuffaceous, somewhat micaceous, carbonaceous. Occasional small and medium pelecypods. Common Foraminifera. Foraminiferal locality 4146.	17.1
E15.	Siltstone, greenish gray 5GY5/1, sandy, massive, somewhat tuffaceous, micaceous, and carbonaceous. No distinct boundary between this and overlying unit E16.	2.2
E14.	Sandstone, like unit E18.	1.0
E13.	Concealed by a large slump block.	54.0
E12.	Sandstone, medium olive gray 10Y5/1, very fine grained, silty, massive, micaceous. Very rare pelecypods. Unreliable outcrop, probably a slump block.	11.5
E11.	Concealed by slumps and beach sand.	78.7

Yaquina Head-Schooner Creek section, continued

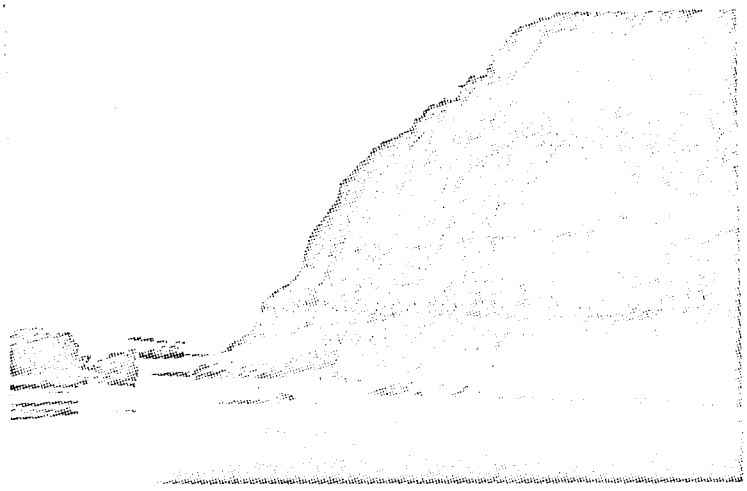
Unit	Agate Beach fm., continued	Feet
E10.	Siltstone, very tuffaceous, similar to unit E7, exposed as a small outcrop through the beach sand. Often completely concealed by sand.	2.0
E9.	Sandstone, like unit E12.	11.7
E8.	Concealed by slumping and beach sand.	3.8
E7.	Tuff, light greenish gray 10Y8/1 weathering almost to white, silty, massive.	17.0
E6.	Sandstone, greenish gray 5GY5/1, very fine grained, silty, massive, micaceous. Has occasional shale beds. Occasional small pelecypods. Foraminifera rare. Poor outcrops, partly concealed by valley fill where crossed by Schooner Creek, and by slumps.	110.1
E5.	Three layers of sandstone, greenish gray 5GY5/1, fine grained, silty, hard, very indurated with calcium carbonate; each layer underlain by one layer of sandstone, medium olive gray 10Y5/1, fine grained, silty, poorly consolidated. The top four of the six members of this unit have common pelecypods of all sizes. The bottom two members are barren.	7.0
E4.	Sandstone, medium light gray N6, fine grained, silty, very indurated with calcium carbonate. Very abundant large and medium pelecypods: Anadara devincta Conrad, Marcia angustifrons (Conrad), and Acila sp. Occasional pectens. Foraminifera common.	0.9
E3.	Sandstone, greenish gray 5GY6/1, fine grained, silty, massive, with a layer of large calcareous concretions near the base. Occasional pelecypods scattered throughout, including some pectens.	17.0
E2.	Siltstone, dark greenish gray 5GY3/1, sandy, somewhat micaceous and calcareous; occasional small pelecypods.	0.6

Yaquina Head-Schooner Creek section, continued

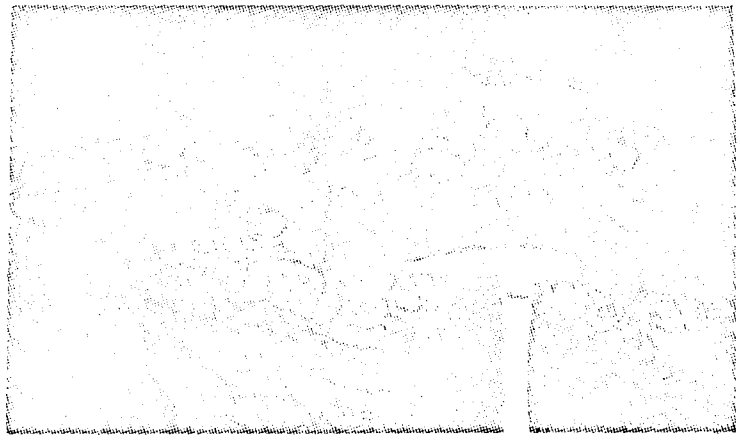
Unit	Agate Beach fm., continued	Feet
E1.	Sandstone, greenish gray 5GY5/1, very fine grained, silty, massive, micaceous. Occasional pelecypods and Foraminifera.	7.0

Total exposed thickness of Agate Beach fm. -- 665 feet.

The base of the section is a fault surface.



Anadara beds north of Schooner Creek (Units E4 and E5).



Anadara bed (Unit E4) north of Schooner Creek.

MOOLACK BEACH SECTION

The base of the Moolack Beach section is a fault on the north side of the first prominent vertical-cliff headland south of Wade Creek. The section continues southward along the sea-cliff across Coal and Moolack Creeks to a point 1,300 feet south of Moolack Creek, at the north end of a large slump area.

The exposures are in sea cliffs. The upper part of this section consists of poor, partly concealed, weathered outcrops, in which the details are not visible. The lower portion, below unit H13, or north of Coal Creek, consists of generally good, sea-cliff outcrops.

Measurement was by Brunton compass, ten- and fifty-foot tapes, and pacing. The strike is N 2°W throughout the section. The dip varies from 20°W in the southern (upper) part to 15°W in the northern (lower) part.

The Anadara beds of this section, unit F5, can be directly correlated with those of the Yaquina Head-Schooner Creek section. Also present in the two sections are the two tuffaceous layers, units F18 and F20 of this section, unit E7 and E10 of the Yaquina Head-Schooner Creek section.

MOOLACK BEACH SECTION

Unconformably overlain by recent sand and terrace deposits.

Unit	Agate Beach formation	Feet
F24.	Medium-bedded alternation of sandstone, greenish gray, 5GY5/1, fine grained, silty, massive; with siltstone, greenish gray 5GY6/1, sandy, somewhat tuffaceous, micaceous, and carbonaceous. Occasional small pelecypods scattered throughout.	13.1
F23.	Concealed by slumping.	10.6
F22.	Sandstone and siltstone, like unit F24.	14.1
F21.	Concealed by slumping.	26.5
F20.	Sandstone, as in unit F24, with one layer of siltstone, greenish gray, very tuffaceous.	7.0
F19.	Concealed. Partly eroded and filled in with Recent deposits and partly concealed by highway fill across Moolack Creek.	18.1
F18.	Siltstone, medium gray N5.5 weathering to pale greenish yellow gray 10Y8/1, very tuffaceous. Good outcrop.	13.6
F17.	Concealed by slumping and roadfill.	17.6
F16.	Sandstone, greenish gray, fine grained, silty, massive, somewhat tuffaceous, micaceous, and carbonaceous.	5.1
F15.	Concealed by slumping.	14.3
F14.	Sandstone, greenish gray 5GY5/1, fine grained, silty, massive, concretionary. Siltstone at base. Small pelecypods in the concretions.	14.1
F13.	Concealed by highway fill at Coal Creek.	36.1

Moolack Beach section, continued

Unit	Agate Beach fm., continued	Feet
F12.	Sandstone, greenish gray 5GY5/1, fine grained, silty, having in it three layers which are well indurated and have abundant large pelecypods.	7.5
F11.	Concealed by slumps.	5.6
F10.	Sandstone, greenish gray 5GY5/1, fine grained, silty, massive. Occasional small pelecypods.	8.0
F9.	Siltstone, greenish gray 5GY5/1, somewhat indurated. Abundant Foraminifera. Foraminiferal locality 4145.	0.9
F8.	Sandstone, greenish gray 5GY5/1, very fine grained, silty. Occasional small pelecypods. Rare Foraminifera.	0.9
F7.	Sandstone, dark greenish gray 5GY4/1, very fine grained, silty, micaceous, slightly indurated. Small pelecypods rare. Abundant Foraminifera. Foraminiferal locality 4144.	0.9
F6.	Sandstone, greenish gray 5GY5/1, fine grained, silty, somewhat micaceous and tuffaceous and carbonaceous. Scattered small and medium pelecypods. Molluscan locality 4032.	14.0
F5.	(Same as units G14-18 in the Beverly Beach section). Three layers of sandstone, medium gray N5, fine grained, silty, very well indurated; separated by two layers of sandstone, medium gray N5, fine grained, silty. Pelecypods common in the top two top layers, and large pelecypods abundant in the lowest layer, including *Anadara devincta* Conrad, *Macoma angustifrons* (Conrad), and *Acila* sp. Molluscan localities 4019, 4022*, 4027, 4028, 4031, 4039, 4040.	5.9
F4.	Sandstone, dark greenish gray 5GY5/1, very fine grained, silty, massive, with scattered calcareous concretions, and scattered medium pelecypods. Molluscan locality 4023*.	20.7

Mocklack Beach section, continued

Unit	Agate Beach fm., continued	Feet
F3.	Sandstone, medium gray N5.5, fine grained, silty, well indurated. Occasional small pelecypods.	1.0
F2.	Sandstone, dark greenish gray 5GY4/1.5, very fine grained, slity, becoming coarser upward.	1.0
F1.	Sandstone, like unit F4. Scattered medium pelecypods.	15.5

Total exposed thickness of Agate Beach fm. -- 272 feet.

The base of the section is a fault surface.

BEVERLY BEACH SECTION

The base of the Beverly Beach section is on the sea-cliff at the mouth of Johnson Creek. The section continues southward along the shore across Spencer Creek to a point midway between Spencer and Wade Creeks where the bedrock is completely concealed by highway fill. The upper part of this section follows very closely the strike of the bedding.

The section consists of good cliff outcrops, but parts of the section are concealed by highway fill on the new coast highway.

Measurement was by Brunton compass, pacing, and ten-foot steel tape. The strike is N 1°E, varying less than one degree in the entire section. The dip varies from

21°W at the south (upper) end to 28°W at the north (lower) end at Johnson Creek.

The Anadara beds, units G14-18, can be intermittently traced to unit F5 of the Hoolack Beach section. The basal four units of this section are the same as those of the Otter Rock section. Both sections start at the mouth of Johnson Creek and diverge beginning at unit 5.

BEVERLY BEACH SECTION

Unit	Agate Beach formation	Feet
G19.	Sandstone, greenish gray 5GY5/1, very fine grained, silty, massive; scattered pelecypods of all sizes in individuals and clusters. Foraminifera abundant. Foraminiferal locality 4143.	51.0
G18.	Sandstone, medium light gray 5GY5.5/0.5, fine grained, silty, heavy, well indurated, some carbon. Abundant large pelecypods. (Anadara, Macoma).	0.9
G17.	Sandstone, like unit G11.	2.3
G16.	Sandstone, medium light gray N6, fine grained, silty, heavy, well-indurated with calcium carbonate. No fossils.	1.0
G15.	Sandstone, greenish gray, silty, very fine grained. No fossils.	1.1
G14.	Sandstone, medium gray N5, fine grained, silty, very well indurated. Very abundant pelecypods: Anadara devincta Conrad, Macoma angustifrons (Conrad), Acila sp. Molluscan locality 4042*.	1.0
G13.	Siltstone, dark greenish gray 5GY5/1, sandy, massive, somewhat tuffaceous, micaceous, and carbonaceous. Poor exposures, details not available. Common Foraminifera. Foraminiferal locality 4142. Molluscan locality 4041*.	45.9

Beverly Beach section, continued

Unit	Agate Beach fm., continued	Feet
G12.	Concealed by highway fill across Spencer Creek.	5.1
G11.	Sandstone, dark greenish gray 10Y4/1, very fine grained, silty. Occasional pelecypods. Foraminifera rare. Poor exposures in slump area.	20.4
G10.	Siltstone, greenish gray 5GY5/1, sandy, massive, somewhat micaceous and carbonaceous, partly indurated. Foraminifera common. Foraminiferal locality 4141.	2.6
G9.	Siltstone, greenish gray 5GY6/1, sandy, with carbon and tuff particles; interbedded with sandstone, pale olive gray 10Y5/1, fine grained, silty, massive, somewhat micaceous and tuffaceous. Few pelecypods. Exact lithology concealed by slumping and weathering. Foraminifera rare. Foraminiferal locality 4140.	14.1
G8.	Concealed by slumping and by highway fill.	41.3
G7.	Sandstone, greenish gray, silty, massive, micaceous, carbonaceous. Pelecypods rare. Few Foraminifera. Foraminiferal locality 4139.	43.2
G6.	Mudstone, greenish gray 5GY5/1, having mica and tuff particles. Foraminifera rare. Foraminiferal locality 4138.	3.9
G5.	Sandstone, like unit G7.	17.8
Units G4 to G1 are H4 to H1 of the Otter Rock section, as explained in the introductory note, totalling		22.9

Total exposed thickness of Agate Beach fm. -- 275 feet.

The common base to the Beverly Beach and Otter Rock section is concealed by alluvium in Johnson Creek.

OTTER ROCK SECTION

The base of the Otter Rock section is the same as that of the Beverly Beach section, on the sea cliff at the mouth of Johnson Creek. The section continues northward along the shore to the fault contact with the Yaquina sandstone at the town of Otter Rock, where the road to Devils Punchbowl State Park has been built up with rock across a small creek which follows the fault. The top unit is a columnar-jointed tuff at the top of the cliff on the south side of this creek. The Yaquina sandstone forms a very prominent headland at this point, consisting of a pale olive gray, fine grained, silty, finely-crossbedded, massive, slightly micaceous sandstone.

The section, in general, consists of poor, weathered outcrops in the sea-cliff. Much of the detail has been obliterated by slumping, soil, and brush.

The section was measured with Brunton compass, ten-foot tape, and pacing. The bedding strikes N 14°E and dips 27°W, with considerable local variations which are probably due to slumping.

This section is directly correlated with the Beverly Beach section as both sections have a common starting point at the mouth of Johnson Creek. In addition, it may be observed that two small very tuffaceous layers,

units H13 and H19, occur at the same stratigraphic elevation as units F18 and F20 of the Moolack Beach section, and units E7 and E10 of the Yaquina Head-Schooner Creek section. The two higher tuffs, units H17 and H19, are evidently to be correlated with the upper tuffaceous layers of the Nye Beach section.

OTTER ROCK SECTION

Unconformably overlain by terrace deposits.

Unit	Agate Beach formation	Feet
H19.	Tuff, very light gray N8, silty.	5.0
H18.	Sandstone, medium light gray N5, very fine grained, silty, massive, slightly tuffaceous and micaceous, slightly indurated with carbonates.	5.0
H17.	Tuff, very light gray N8, silty, massive, having columnar jointing perpendicular to the bedding plane.	20.0
H16.	Sandstone, medium gray N5, very fine grained, silty, massive, somewhat micaceous.	61.4
H15.	Siltstone, very light gray N8, sandy, massive, very tuffaceous.	1.6
H14.	Sandstone, medium light gray N6, very fine grained, silty, massive, slightly indurated.	9.1
H13.	Siltstone, light gray N7, somewhat sandy, very tuffaceous. Poor outcrop.	0.2
H12.	Sandstone, medium gray N5, very fine grained, silty, massive.	104.0
H11.	Siltstone, medium light gray N5, sandy, very tuffaceous.	0.6
H10.	Sandstone, medium gray N5, fine grained, silty, massive, heavy, micaceous, somewhat tuffaceous, well cemented with calcium carbonate.	1.1

Otter Rock section, continued

Unit	Agate Beach fm., continued	Feet
H9.	Siltstone, medium gray 5GY5/0.5, sandy, somewhat tuffaceous.	2.8
H8.	Sandstone, medium gray N5, very fine grained, silty, massive, slightly micaceous and tuffaceous. Has occasional siltstone lenses. Poor outcrops in a slump area.	51.6
H7.	Concealed by slumping.	170.0
H6.	Sandstone, like unit H8.	5.6
H5.	Mudstone, greenish black 5GY3/1, sandy, micaceous, carbonaceous.	0.9
H4.	Sandstone, dark greenish gray 5GY4/0.5, fine grained, silty, somewhat micaceous, with shaly inclusions and large calcareous concretions. Abundant large, medium and small pelecypods. Occasional pectens. Rare gastropods.	8.6
H3.	Sandstone, greenish gray 5GY5/0.5, very fine grained, silty, massive, slightly micaceous and tuffaceous. Occasional small pelecypods, fish scales, Foraminifera.	6.4
H2.	Sandstone, light gray N5.5, very fine grained, silty, heavy, micaceous, very indurated. Occasional small pelecypods.	0.9
H1.	Sandstone, like unit H3.	7.0

Total exposed thickness of Agate Beach fm. -- 462 feet.

Base is concealed by alluvium in Johnson Creek.

DEPOE BAY SECTION

The Depoe Bay section includes the entire north shore of the inner bay at Depoe Bay. The base is against the recent sand at the east end of the north shore. The top of the section is against the conformably overlying basalt of the Depoe formation at the west end of the north shore of the inner bay.

The section consists of four main fault-blocks with other minor faults throughout, exposed in a single sea-cliff.

The lowest fault block is 290 feet thick, consisting of siltstone, greenish gray, sandy, massive, tuffaceous, micaceous, carbonaceous, slightly indurated with carbonate. At the base there is a lens, 0.4 foot thick, of siltstone, greenish gray, tuffaceous. The unit has occasional small pelecypods and abundant Foraminifera. The bedding in this block strikes N 20°E and dips 18°W.

The next fault block is 5.5 feet thick and is lithologically the same as the previous unit. The bedding strikes N 20°E and dips 18°W.

The next fault block is 37 feet thick, consisting sandstone, greenish gray, fine grained, silty, massive, micaceous, tuffaceous, carbonaceous, slightly indurated, rarely having Foraminifera. The bedding strikes N 34°E and dips 21°W.

The uppermost fault block is 93 feet thick, and consists essentially of sandstone, greenish gray, fine grained, silty, finely crossbedded, micaceous, tuffaceous. There are no fossils in this upper unit. The bedding strikes N24°E and dips 16°W.

Overlying the Agate Beach formation is the lowermost basalt unit of the Depoe formation, and terrace deposits.

Foraminiferal locality 4148 is in the lowest fault block. Locality 4149 is in the third fault block mentioned above.

FOGARTY CREEK SECTION

The Fogarty Creek section extends from the south end of the sea-cliff north of the mouth of Fogarty Creek to the main intrusive mass of basaltic volcanic breccia which forms a prominent headland approximately 2,250 feet north of Fogarty Creek.

The entire section is broken up by faults and dikes. A measurable thickness of 60 feet is exposed between the beach sand and the beginning of the intrusion. In addition large and small blocks of sedimentary material from the Agate Beach formation is included in the intrusive mass. The bulk of the sedimentary material is a sandstone, varying between medium gray and greenish gray,

fine grained, silty, massive, partly indurated with carbonates. Interbedded with this are minor amounts of tuffaceous siltstone, and a hard, calcareous sandstone rich in large pelecypods. Foraminifera are abundant in the lower part of the section.

The beds at the south end strike N 52°E and dip 16°NW. At the north end they strike N 1°E and dip 18°W.

Foraminiferal locality 4150 is in the lower part of this section.

BIBLIOGRAPHY

1. Arnold, Ralph and Harold Hannibal. The marine tertiary stratigraphy of the north Pacific coast of America. Proceedings of the American philosophical society 52:559-605. 1913.

2. Baldwin, Ewart M. Pleistocene history of the Newport, Oregon region. Geological news letter 16:77-81. 1951.

3. Coleman, Robert Griffin. The John Day formation in the Picture Gorge quadrangle, Oregon. Master's thesis. Corvallis, Oregon State college, 1949. 211p.

4. Cope, E. D. Corrections of the geological maps of Oregon. The American Naturalist 14:457-458. 1880.

5. Cushman, Joseph A., and Roscoe E. and Katherine C. Stewart. Astoria Miocene Foraminifera from Agate Beach, Lincoln county, Oregon. Portland, 1947. 13p. (Oregon. Dept. of geology and mineral industries. Bulletin 36).

6. Dall, William Healy. A table of North American Tertiary horizons. In U.S. Geological survey. Eighteenth annual report, 1896-97. Part 2. Washington, Government printing office, 1898. pp. 323-348.

7. _____ and Gilbert Dennison Harris. Correlation papers: Neocene. Washington, 1892. 349p. (U. S. Geological survey. Bulletin 84).

8. Diller, Joseph S. A geological reconnaissance in northwestern Oregon. In U. S. Geological survey. Seventeenth annual report, 1895-96. Part 1. Washington, Government printing office, 1896. pp. 441-515.

9. Etherington, Thomas John. Stratigraphy of the Astoria Miocene of southwest Washington. Berkeley, University of California press, 1931. 112p. (University of California publications. Bulletin of the department of geological sciences 20).

10. Felts, Wayne Moore. The geology of the Lebanon quadrangle, Oregon. Master's thesis. Corvallis, Oregon state college, 1936. 83p.

11. Harrison, G. H. and A. Eaton. Report of investigation of oil and possibilities of western Oregon. Portland, 1920. 40p. (Oregon. Bureau of mines and geology. Mineral resources of Oregon, vol. 3, no. 1).

12. Hertlein, Leo G. and Colin H. Crickmay. A summary of the nomenclature and stratigraphy of the marine Tertiary of Oregon and Washington. Proceedings of the American philosophical society 64:224-282. 1925.

13. Heacock, Robert Leon. Stratigraphy and Foraminifera of the upper part of the Nye formation, Yaquina Bay, Oregon. Master's thesis. Corvallis, Oregon state college, 1952. 48p.

14. Howe, Henry V. Astoria: Mid-Tertic type of Pacific coast. Pan-American geologist 45:295-306. 1926.

15. Jenkins, Olaf P. (ed.). Geologic formations and economic development of the oil and gas fields of California. San Francisco, 1943. 773p. (California. Dept. of natural resources. Division of mines. Bulletin 118).

16. Kleinpell, Robert M. Miocene stratigraphy of California. Tulsa, American association of petroleum geologists, 1938. 450p.

17. National research council. Rock-color chart committee. Rock-color chart. Washington, The Council, 1948.

18. Newberry, John S. Report upon the geology of the route. In U.S. War department. Reports of explorations and surveys to ascertain the most practical and economical route for a railroad from the Mississippi River to the Pacific Ocean. Vol. 6, pt. 2. Washington, 1855. 68p.

19. Packard, Earl L. Additions to the vertebrate fauna of the Astoria formation of Oregon (abstract). Bulletin of the geological society of America 52:1981-1982. 1941.

20. Packard, Earl L. and Remington Kellogg. A new Cetothere from the Miocene Astoria formation of Newport, Oregon. Washington, 1934. 62p. (Carnegie institution of Washington. Contributions to paleontology. Publication no. 447).

21. Sanborn, Ethel I. The Delo flora of western Oregon. Corvallis, Oregon state college, 1947. 47p. (Oregon state monographs. Studies in geology. Number 4).

22. Schenck, Hubert G. Stratigraphic relations of western Oregon Oligocene formations. Berkeley, University of California press, 1928. 50p. (University of California publications. Bulletin of the dept. of geological sciences 18).

23. Snavely, Parke D. Jr. and H. E. Vokes. Geology of the coastal area from Cape Kiwanda to Cape Foulweather, Oregon. Washington, 1949. 1p. (U.S. Geological survey. Oil and gas investigations. Preliminary map 97).

24. Vokes, H. E., Hans Norbisrath, and Parke D. Snavely, Jr. Geology of the Newport-Waldport area. Washington, 1949. 1p. (U. S. Geological survey. Oil and gas investigations. Preliminary map 86).

25. Warren, W. C., Hans Norbisrath, and R. M. Grivetti. Geology of northwestern Oregon. Washington, 1945. 1p. (U. S. Geological survey. Oil and gas investigations. Preliminary map 42).

26. Washburne, Chester W. Reconnaissance of the geology and oil prospects of northwestern Oregon. Washington, 1914. 111p. (U. S. Geological survey. Bulletin 590).

27. Weaver, Charles E. Tertiary stratigraphy of western Washington and northwestern Oregon. Seattle, 1937. 266p. (University of Washington publications in geology. Vol. 4).

28. Weaver, Charles E. Correlations of the marine Cenozoic formations of western North America. Bulletin of the geological society of America 55:569-598. 1944.

APPENDIX

APPENDIX A -- LIST OF THE MOLLUSCA REPORTED FROM THE AGATE BEACH FORMATION

Mollusca and lists of Mollusca from three sources were examined by the writer in an attempt to determine whether these fossils showed any significant variation within the formation which would be of aid in correlating the various section. No significant changes were found.

Below is a list of the Mollusca reported. The three sources are the University of California Museum of Paleontology in Berkeley, the two Oil and Gas Investigations maps of the Geological Survey (23 and 24), and reports made by students in the Advanced Paleontology class at Oregon State College in the Spring of 1951.

Howe (14, p. 306) has correlated the Agate Beach formation with the Temblor formation of California on the basis of Mollusca.

PELECYPODS:

Acila (Truncacila) conradi (Meek)
A. (T.) decisa Conrad
Anadara devincta Conrad
A. devincta montereyana Osmont
Chione ensifera (Dall)
C. lamellifera
Cronella sp.
Glycimeris sp.
Katherinella arnoldi (Weaver)
Lucina acutilineata Conrad
Macoma arctata Conrad
M. andersoni Clark
M. identata flageri Etherington
M. angustifrons (Conrad)
M. angustifrons brevilineata (Conrad)

Pelecypods, continued:

M. oregonensis
Y. yoldiformis
Mytis sp.
Mytilus sp.
Nucula washingtonensis Weaver
Nucula chehalisensis (Weaver)
N. impressa Conrad
N. ochsneri elmana Etherington
Panope generosa Gould
P. remondensis Clark
Pecten andersoni clemonensis Etherington
P. eldridgei Arnold
P. (Patinopecten) propetulus Conrad
Pholadidea sp.
Pitar oregonensis (Conrad)
Solen curtus Conrad
S. sicarius Gould
Spisula albaria (Conrad)
Tapes perilis (Conrad)
Tellina arcata
T. emaceratа Conrad
T. obruta Conrad
T. oregonensis Conrad
Teredo sp.
Thracia trapezoides Conrad
Thyasira bisecta (Conrad)
Venericardia subtenta (Conrad)
Volsella directa Dall
Yoldia (Kalayoldia) oregona (Shumard)
Y. tomblorensis Anderson & Martin

GASTROPODS:

Acmaea oregonense
Alectrion lincolnensis (Anderson & Martin)
Argobuccinum dilleri Anderson & Martin
Bruclarkia oregonense (Conrad)
B. vaquinana (Anderson & Martin)
Calliostoma dolezinensis Weaver
Calyptraea inornata (Gabb)
Cancellaria vetusta Gabb
Crepidula praerupta Conrad
Echinophoria petrosa (Conrad)
Epitonium (Boreoscala) coosensis Burham
Ficus modestus (Conrad)

Gastropods, continued:

Fusinus (Priscofusus) carlsoni (Anderson & Martin)
F.(P.) lincolnensis (Anderson & Martin)
F. (P.) oregonensis (Conrad)
Marinoa petrosa Conrad
Megasurcula carpenteriana (Gabb)
M. condonana (Anderson & Martin)
Mioplelonia indurata (Conrad)
Molopnorus andersonana (Anderson)
Nassarius lincolnensis Anderson & Martin
Natica (Tectonatica) clarki Etherington
N. (T.) oregonensis Conrad
N. (T.) saxea Conrad
Neverita inezana (Conrad)
Polinices (Euspira) galicanoi Dall
Scaphander lucularis (Conrad)
Spirotropsis washingtonensis Etherington
Thesbia antiselli (Anderson & Martin)
Trophon oregonensis Anderson & Martin
Tritonia (Antillophos) dumblei chehalisensis (Weaver)
Turritella oregonensis (Conrad)
Turris lincolnensis

SCAPHOPODA:

Dentalium conradi Dall
D. petricola Dall

APPENDIX B -- FORAMINIFERA

Following is a checklist of the Foraminifera reported from the Agate Beach formation. Seven localities are represented, and they are arranged in stratigraphic order.

When compared with Kleinpell's chart (16, pp. 137-151) giving the range of species in California, the species present in the Agate Beach formation indicate an Upper Saucesian age for the formation.

The genera present indicate that the environment of deposition was cool, shallow water in a temperate climate (16, chart in pocket).

A sample from the lowermost part of the Astoria shale from Oregon State College locality 4129 at Tongue Point, east of Astoria, was also examined. Comparison with these samples from the Agate Beach formation appeared to confirm Howe's (14, p. 302) correlation of the "lower sandstone" at Astoria with the Agate Beach formation.

The localities listed are as follows:

1. Kleinpell (16, p. 70) locality 118. "Sandy shale near Newport, SE¼ Sec. 7, T 11 S, R 11 W."

2. Oregon State College locality 4133, reported by the writer in 1953. From a dark greenish gray, sandy, micaceous siltstone, on the sea cliff 100 feet south of the sea-stack on the beach at the north end of Yaquina Bay State Park, Newport, Oregon, in SE¼ SE¼ Sec. 7, T 11 S, R 11 W.

3. Cushman, Stewart and Stewart (5, p. 43) locality: "from the base of the cliff about 700 feet southeast of Yaquina Head."

4. Oregon State College locality 4134, reported by the writer in 1951, from a gray shale outcrop located at the base of the cliff about sixty feet south of a small creek at the foot of the trail leading to the beach from the parking lot on the highway at Agate Beach, Oregon.

5. Oregon State College locality 4150, reported by the writer in 1953. This sample was obtained from the base of a very fine grained, massive, greenish gray, silty, concretionary sandstone located 514 feet N 13°E of the mouth of Fogarty Creek, between Lincoln Beach and Boiler Bay, Cape Foulweather quadrangle, Lincoln County, Oregon. SE¼ SE¼ Sec. 29, T 8 S, R 11 W.

6. Oregon State College locality 4146, reported by the writer in 1953, from north of Yaquina Head, in NE¼ Sec. 30, T 10 S, R 11 W. A greenish gray, silty, tuffaceous, very fine grained, micaceous, sandstone at the north end of a concealed cliff at 90 feet elevation which is due east of, and directly uphill from the point where the beach trail from the end of Shell Ridge Road meets the beach. Shell Ridge Road is reached by turning west off highway U. S. 101 at the north end of the town of Agate Beach, north of Yaquina Head.

7. Oregon State College locality 4147, reported by the writer in 1953. On the north side of Yaquina Head, Yaquina quadrangle, Lincoln County, Oregon. NW¼ NE¼ Sec. 30, T 10 S, R 11 W. At the base of the arched rock, a dark greenish gray claystone, 7.0 feet stratigraphically below the basalt flow. The arched rock is located at the extreme southern end of the beach.

CHECKLIST OF FORAMINIFERA

Locality:	1	2	3	4	5	6	7
Cyclammina cancellata Brady var. obesa Cushman and Laiming							
C. incisa (Stache)					F		
C. cf. simiensis					F		
Cyclammina sp.				F			
Quinqueloculina cf. vulgaris d'Orbigny			R				
Quinqueloculina sp.				R			
Pyrgo sp.			R				
Robulus americanus (Cushman)		F		C	F		
R. nikobarensis (Schwager)					R		
R. cf. orbicularis (d'Orbigny)			R				
Robulus sp.			R				
Lagena acuticosta Reuss					R		
L. costata (Williamson)				R			
Nonion costiferum (Cushman)	X		C	A	A	A	R
N. incisum (Cushman)?	X						
Nonionella miocenica Cushman		F	F		R		
Buliminella bassendorfensis Cushman and Parker		C	C		F	R	
B. elegantissima d'Orbigny			R				
Bulimina ovata d'Orbigny			F		F		C
B. pyrula d'Orbigny	X	R					
Virgulina punctata d'Orbigny		R	R				
Bolivina advena Cushman	X					A	F
B. astoriensis Cushman and Stewart			A	C			
B. basiseata Cushman and Stone							R
Uvigerina subperegrina Cushman and Kleinpell				R			
Angulogerina astoriensis Cushman and Stewart				R			
Eponides mansfieldi Cushman var. oregonensis Cushman and Stewart		F	F	C	C	R	
Pseudoparella parva (Cushman and Laiming)			F		F	R	
Cassidulina laevigata d'Orbigny var. carinata Cush.	X				F		
Globigerina bulloides d'Orbigny		R		F	R		

X - Present
R - Rare
F - Few
C - Common
A - Abundant

APPENDIX C
FOSSIL LOCALITIES IN THE AGATE BEACH FORMATION

As a convenient means of cross-reference, the Oregon State College fossil localities occurring within the Agate Beach formation are listed below along with the stratigraphic unit in which they occur. The localities are also listed in the individual columnar sections. The specimens are deposited in the Paleontology Laboratory at Oregon State College.

Foraminifera:

4131 - C3
4132 - A13
4133 - A21
4134 - D18*
4135 - D10
4136 - D27
4137 - D27
4138 - G6
4139 - G7
4140 - G9
4141 - G10
4142 - G13
4143 - G19
4144 - F7
4145 - F9
4146 - E16
4147 - E42
4148 - Depoe Bay
4149 - Depoe Bay
4150 - Fogarty Creek

Mollusca:

4017 - A9
4018 - A26*
4019 - F5
4020 - A9
4021 - A9*
4022 - F5*
4023 - F4*
4024 - A9
4025 - A14
4026 - A27*

Mollusca:

4027 - lower F5
4028 - upper F5
4029 - A9
4030 - A23*
4031 - F5
4032 - F6
4037 - A9
4038 - A27
4039 - F5
4040 - F5
4041 - G13*
4042 - G14*

A - Newport Beach section
B - Nye Beach section
C - Jump-off Joe section
D - Agate Beach section
E - Yaquina Head-Schooner Creek section
F - Moolack Beach section
G - Beverly Beach section
H - Otter Rock section
* - Exact stratigraphic location uncertain.

Newport Beach

Nye Beach

Jump-off Joe

Yaquina Hd.-Schoonер Cr

Agate Beach

Moolack Beach

Depoe Bay

Fogarty Creek

Otter Rock

Beverly Beach

COLUMNAR SECTIONS
Agate Beach formation
Lincoln County, Oregon

Sections arranged south to north.
Vertical scale: 1 inch = 100 feet

- Silty sandstone
- Coarse-grained sandstone
- Siltstone
- Basalt
- Tuffaceous
- Concretions
- Partly concealed
- Concealed