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FIELD TRIP GUIDEBOOK

GEOLOGY OF THE NEWPORT AREA, OREGON [1/]

By Parke D. Snavely, Jr.[2/], Norman S. MacLeod[2/], and Weldon W. Rau[3/]

Cape Foulweather, first sighted by Captain Cook in 1778, is a former center of middle Miocene volcanism on the central Oregon coast.

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Scope and Arrangement of Guidebook

This guidebook is designed to provide a general geologic background for the Newport area of west-central Oregon, and a field trip route along which a representative sequence of Tertiary rock units can be best studied. The guidebook consists of two parts: Part I, "Geologic Sketch of the Newport Area, Oregon," and Part II, "Geologic Field Trip Guide, Newport Area, Oregon." Part I is presented in this issue of The ORE BIN and Part II will be published in the March issue.

Acknowledgments

The writers acknowledge unpublished geologic mapping and stratigraphic studies by H. C. Wagner which are included in this article. Paul Carlson and H. C. Wagner critically reviewed this report and offered valuable suggestions. The assistance in the field of Parke D. Snavely III during the planning phase of this field trip is appreciated.

PART I - GEOLOGIC SKETCH OF THE NEWPORT AREA, OREGON

Introduction

The Newport area (figure 1) provides an exceptional locale for an introduction to Oregon Coast Range geology, as this area contains one of the thickest and most complete sequences of Tertiary sedimentary and volcanic rocks (figure 2). The sequence exposed here contains rock units that are correlative with lithologically similar Tertiary rocks that crop out elsewhere in the Oregon Coast Range (figure 3). This report summarizes published and new data on the geology of the Newport area in the central part of the Oregon Coast Range. Several other recent publications concerned with the geology of the area have been written by Wilkinson (1959), Snavely and Wagner (1963, 1964), Baldwin (1964), and Snavely and others (1964, 1965, 1968, and 1969).

Several formational units referred to in this report are informally named. Some of the locations referred to in this part of the guidebook article are shown on the geologic strip maps contained in Part II.

Although the authors are cognizant of the biostratigraphic value of the molluscan faunas that occur in the late Tertiary sequence, checklists of these fauna are not given here since they have previously been published (Vokes and others, 1949; Snavely and Vokes, 1949; Snavely and others, 1964). Lists of selected foraminiferal species are presented in this report inasmuch as this information is not available in the literature.

Geologic Setting

In early to middle late Eocene time an elongate marine trough (figure 1) occupied the area between the Klamath Mountains and Vancouver Island, Canada. It extended eastward at least as far as the present site of the Cascade Range and westward to the present edge of the continental shelf (Snavely and Wagner, 1963). The Eocene sedimentary and volcanic rocks that accumulated in this trough were deformed in middle late Eocene time, and a number of smaller basins were produced, which

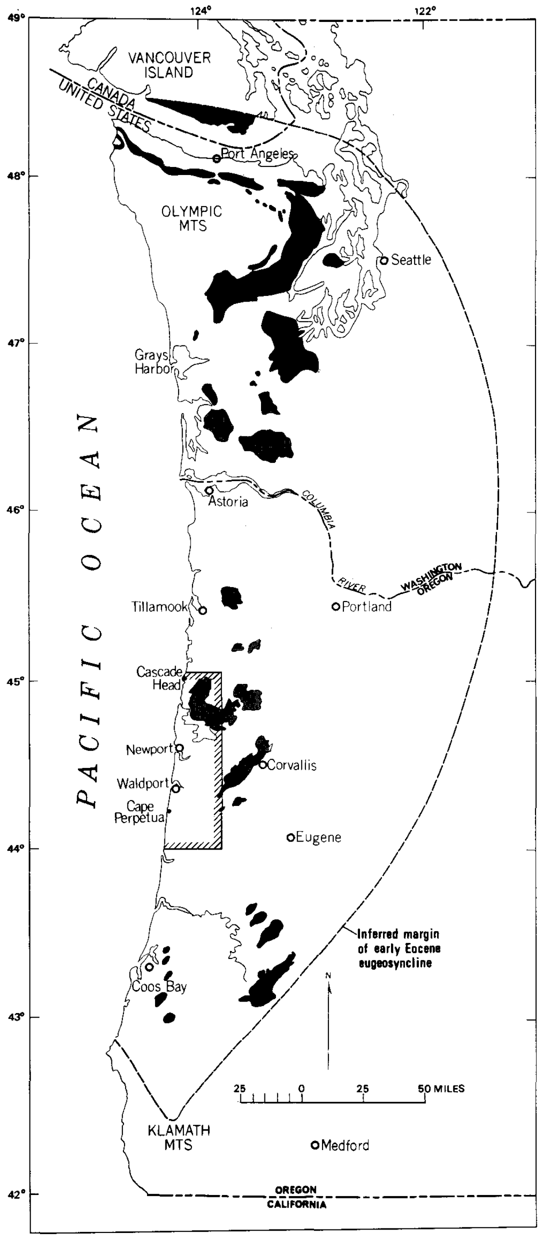

Figure 1. Map of western Oregon and Washington showing the location of the Newport area. The inferred margin of the eugeosyncline that occupied this area in early Eocene time is shown by the dashed line and the present distribution of lower and middle Eocene volcanic rocks by shaded areas.

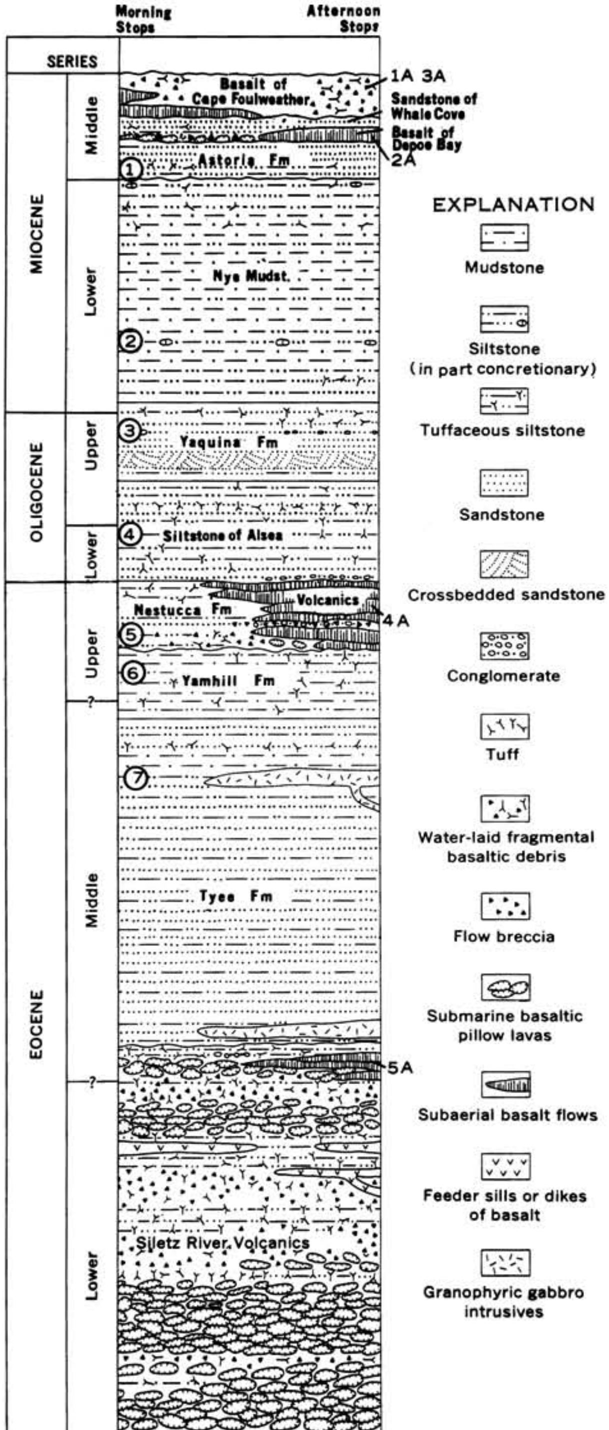

Figure 2. Composite section showing formational units and lithologies of the Tertiary sedimentary and volcanic rocks exposed in the Newport area. Stratigraphic position of outcrops visited on morning segment of the field trip (1-7) are shown on the left, and of afternoon segment (1A-5A) on the right.

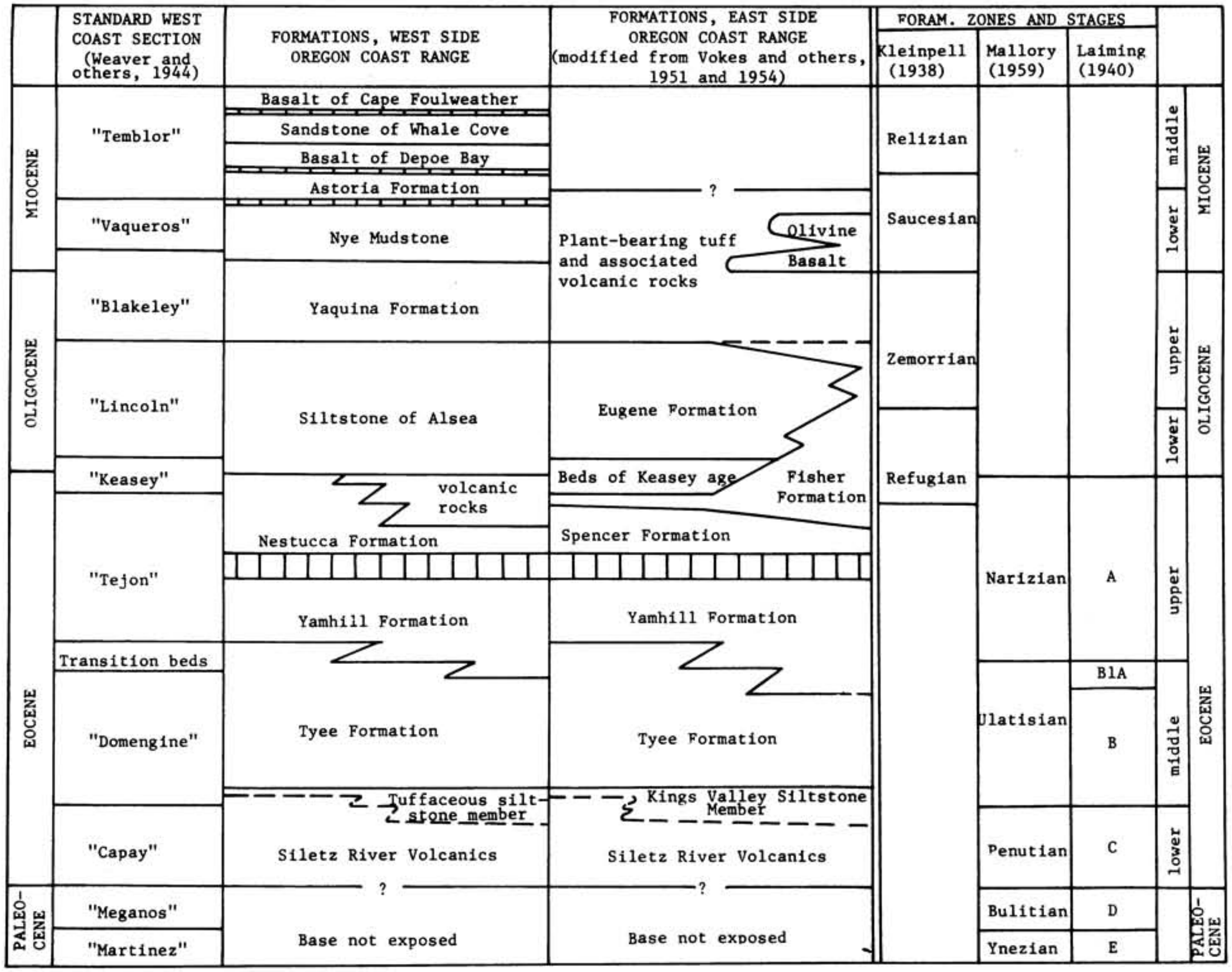

Figure 3. Chart showing the correlation between formations on the west (Newport area) and east sides of the Oregon Coast Range.

were interconnected and open to the sea. The eastern strand line shifted generally westward with time, and by mid-Oligocene time lay near the present coastline except for several structural embayments such as those near Astoria, Tillamook, Newport, and Coos Bay. Sedimentation in these embayments continued through middle Miocene time. Post-middle Miocene marine sedimentation occurred principally west of the present Oregon coast.

A composite thickness of more than 25,000 feet of marine sedimentary and volcanic rocks that range in age from early Eocene to middle Miocene crop out in the Newport area. Unconformities of regional extent are present within the upper Eocene and middle Miocene sequences. Local unconformities between Tertiary formations occur in many places, such as along the margins of lower to middle Eocene volcanic buildups, but most contacts between formations are gradational.

Stratigraphy

Siletz River Volcanics

The oldest rocks exposed in the Oregon Coast Range are a thick eugeosynclinal accumulation of basaltic pillow lava and breccia with interbedded tuffaceous siltstone and basaltic sandstone of early to early middle Eocene age. This sequence of predominantly volcanic rocks is referred to as the Siletz River Volcanics (Snavely and Baldwin, 1948; Snavely and others, 1968) and probably is as much as 20,000 feet thick near former centers of volcanism.

The Siletz River Volcanics has been divided on petrochemical criteria into two parts, a lower submarine tholeiitic basalt unit and an upper unit characterized by alkalic basalt and porphyritic basalt flows and breccia which is in part subaerial (Snavely and others, 1968).

The lower unit forms the bulk of the Siletz River Volcanics and is chiefly of early Eocene age. It crops out in a northeast-trending belt just west of Corvallis and in the Newport area where it is overlain by the upper unit. The lower unit consists predominantly of submarine lava composed of close-packed radial-jointed ellipsoidal pillows that are typically 3 to 4 feet in diameter. The pillows have chilled selvages up to half an inch thick of waxy greenish-black clay minerals which have replaced former basaltic glass. Tuff-breccia that contains broken pillows or small isolated pillows is interbedded with or grades laterally into the pillow flows. Massive to rudely columnar-jointed basalt sills and flows up to 100 feet thick occur locally in the pillow and breccia sequence. Zeolites and calcite commonly form the cementing material in the breccia, fill interstices between pillows, and occur as amygdules in the basalt.

The predominant rock type of the lower unit is amygdaloidal dark greenish-gray aphanitic to fine-grained tholeiitic basalt. Older rocks in this unit differ somewhat in composition from younger rocks (table 1, cols. 1 and 2). Tholeiitic basalt of the Siletz River Volcanics is similar in composition to oceanic basalt (Snavely and others, 1968).

The upper unit resulted from restricted volcanic activity that continued into early middle Eocene time at some major volcanic centers in the Tertiary basin. This upper unit is best known from exposures in the Ball Mountain area, 20 miles northeast of Newport. The late stage of volcanism that formed the upper unit was sporadic, moderately explosive, and produced a differentiated alkalic suite consisting of flows of alkalic basalt, porphyritic basalt, porphyritic augite basalt, feldspar-phyric

Table 1. Average chemical composition of volcanic rocks in the central part of the Oregon Coast Range (analyses recalculated water-free to 100 per cent).

	Lower to lower middle Eocene			Upper Eocene to lowermost Oligocene			Middle Miocene	
	1	2	3	4	5	6	7	8
SiO_2	49.0	48.3	48.2	51.4	47.1	41.7	55.8	51.8
Al_2O_3	14.5	14.6	16.0	17.6	15.5	12.7	14.1	13.9
Fe_2O_3	3.9	5.3	4.1	4.1	5.0	7.7	2.2	3.5
FeO	7.7	8.5	7.9	6.8	7.0	8.8	9.9	11.0
MgO	8.3	5.8	6.1	3.6	6.6	7.8	3.6	3.9
CaO	12.2	11.5	7.4	8.7	10.3	10.3	7.1	7.9
Na_2O	2.3	2.6	4.3	3.6	3.0	2.1	3.3	3.1
K_2O	0.17	0.14	1.9	1.0	1.3	2.7	1.3	1.0
TiO_2	1.6	2.7	3.3	2.6	3.3	4.4	2.0	3.0
P_2O_5	0.15	0.31	0.71	0.59	0.78	1.6	0.36	0.69
MnO	0.19	0.25	0.20	0.16	0.23	0.23	0.21	0.23
Number of Analyses	3	5	9	20	12	4	8	11

1. Tholeiitic basalt from older part of lower tholeiitic unit, Siletz River Volcanics (Snavely and others, 1968, Table 3).
2. Tholeiitic basalt from younger part of lower tholeiitic unit, Siletz River Volcanics (Snavely and others, 1968, Table 3).
3. Alkalic basalt from upper unit of Siletz River Volcanics (Snavely and others, 1968, Table 7, cols. 14 and 15, and Table 8, cols. 1-3 and 4a-7a).
4. Basalt near Yachats, Oregon.
5. Basalt near Cascade Head, Oregon.
6. Camptonitic volcanics from near Cannery Mountain, lower Siletz River, Oregon.
7. Basalt of Depoe Bay (Snavely and others, 1965, Table 1).
8. Basalt of Cape Foulweather (Snavely and others, 1965, Table 1).

Analyses used in above averages were done by Paul Elmore, Ivan Barlow, Samuel Botts, Gillison Chloe, Lowell Artis, H. Smith, Leonice Beatty, and Albert Bettiger, U.S. Geological Survey, using chemical and (or) x-ray fluorescence methods.

basalt, and picrite-basalt interbedded with basaltic tuff and breccia. An average composition of alkalic basalt from the upper unit is shown in table 1, column 3. A few flows and numerous sills of tholeiitic basalt are also present. Massive beds of water-laid basaltic fragmental debris, as much as 100 feet thick, and thick- to thin-bedded fine tuff to lapilli tuff and tuffaceous siltstone are common in the upper unit. Some tuff beds contain abundant euhedral augite crystals up to three-fourths of an inch in width.

Foraminiferal assemblages from sedimentary interbeds in the Siletz River Volcanics can be compared variously with those of Laiming's (1940) B zones and possible C zone, and may, therefore, be referred to Mallory's (1959) Ulatisian and possibly Penutian Stages of middle and possible early Eocene age. Some more common and well-known species of Foraminifera, most of which are from the upper unit, are listed below:

Amphimorphina californica Cushman and McMasters
Asterigerina crassaformis Cushman and Siegfus
Bifarina nuttalli Cushman and Siegfus
Bulimina lirata Cushman and Parker
Cibicides spiropunctatus Galloway and Morrey
Cibicidoides venezuelanus (Nuttall)
Discocyclina sp.
Eponides mexicana Cushman
Globanomalina micra (Cole)
Globorotalia aragonensis Nuttall
Operculina sp.
Robulus ulatisensis Boyd
Silicosigmoilina californica Cushman and Church
Spiroplectammina directa (Cushman and Siegfus)
Vaginulinopsis asperuliformis Nuttall
Vaginulinopsis mexicana var. B. (of Laiming)

Tyee Formation

A sequence of more than 6000 feet of rhythmically bedded sandstone and siltstone (turbidites) of middle Eocene age, the Tyee Formation (Diller, 1898), disconformably overlies the Siletz River Volcanics. Fifty to 100 feet of siltstone is present in many places at the base of the Tyee, overlying limey sandstone and conglomerate at the top of the Siletz River Volcanics. This siltstone unit probably thickens away from areas of volcanic highs and represents pelagic clays deposited in the eugeosyncline prior to the turbidite deposition which formed the bulk of the Tyee (Snavely and others, 1964).

The Tyee Formation consists of graded beds 2 to 10 feet thick (figure 4). The lower part of individual beds consists of medium-grained micaceous arkosic, lithic, or volcanic wacke (argillaceous sandstone) and grades upward into carbonaceous siltstone. In some graded beds the upper siltstone part has been completely eroded by the succeeding turbidity current, producing a sandstone-upon-sandstone relationship. Angular to sub-round siltstone clasts are common in the sandstone and were derived by erosion of underlying beds by the turbidity currents. The base of each recurrent graded unit is sharply defined and commonly contains casts of sedimentary structures; groove casts are most common, but flute casts occur locally as do a variety

Figure 4. Rhythmically bedded sandstone and siltstone of the Tyee Formation of middle Eocene age. Road-cut exposure along the Siletz River between the towns of Siletz and Kernville, Oregon.

of drag marks and load casts.

A paleocurrent analysis based on more than 600 sedimentary structures indicates that the Tyee Formation was formed by turbidity currents that transported sediment northward down the basin axis (Snavely and others, 1964). The principal source of the sediment, as indicated by paleocurrent data and petrographic studies, was an igneous and metamorphic terrain along the south end of the eugeosyncline in the present area of the Klamath Mountains.

Although fossils are rare within the turbidite units that constitute the bulk of the Tyee, Foraminifera occur in the siltstone unit at its base, and in siltstone interbeds near the top of the formation. Foraminifera also occur in thin (1/4- to 1-inch) light-gray discontinuous claystone layers at the tops of a few graded beds. Although mixed-layer montmorillonite-illite or montmorillonite is the principal clay mineral in the graded beds, illite is the predominant clay material in the thin Foraminifera-bearing claystone beds. These claystone beds probably represent hemipelagic clay deposited in the geosyncline during intervals between turbidite deposition.

Foraminiferal assemblages from the Tyee Formation are virtually indistinguishable and, therefore, suggest a relatively short period of deposition during middle Eocene, Ulatisian, time. Furthermore, a somewhat uniform environment of deposition (open-sea at substantial depths, probably at least upper bathyal) is also suggested. Some of the more commonly occurring and well-known species of Foraminifera in the Tyee Formation are:

Amphimorphina californica Cushman and McMasters
Asterigerina crassaformis Cushman and Siegfus
Bifarina nuttalli Cushman and Siegfus
Bulimina corrugata Cushman and Siegfus
Bulimina lirata Cushman and Parker
Cibicides cushmani Nuttall
Cibicides spiropunctatus Galloway and Morrey
Globigerina decepta Martin
Globorotalia aragonensis Nuttall
Globorotalia cerro-azulensis (Cole)
Silicosigmoilina californica Cushman and Church
Spiroplectammina directa (Cushman and Siegfus)
Tritaxilina colei Cushman and Siegfus

Yamhill Formation

The Tyee Formation is conformably overlain by more than 2000 feet of dark-gray siltstone named the Yamhill Formation by Baldwin and others (1955). Interbeds of similar siltstone also occur within the upper part of the Tyee, and north of the 45th parallel the Tyee intertongues with the lower part of the Yamhill Formation.

Strata mapped as the Yamhill Formation by the writers were included in the lower member of the Toledo Formation by Vokes and others (1949). Although poorly exposed in most places in the Newport area, a thick and unweathered sequence of beds crops out along the banks of the Siletz River immediately west of the town of Siletz.

The Yamhill Formation consists of massive to thin-bedded siltstone which in places contains thin beds of arkosic, basaltic, or glauconitic sandstone. Light-gray-weathering concretions and nodules are common within the siltstone. Megafossils are rare in the Yamhill, but most of the unit contains abundant Foraminifera. Selected species of Foraminifera that occur locally in the Yamhill Formation include:

Amphimorphina californica Cushman and McMasters
Bifarina nuttalli Cushman and Siegfus
Bolivina basisenta Cushman and Stone
Bulimina corrugata Cushman and Siegfus
Bulimina jacksonensis Cushman
Bulimina schencki Beck
Cassidulina globosa Hantken
Cibicides warreni Cushman and R. E. and K. C. Stewart
Discorbis cf. D. samanicus (W. Berry)
Eponides yeguaensis Weinzierl and Applin
Plectofrondicularia searsi Cushman and R. E. and K. C. Stewart
Robulus welchi Church
Uvigerina garzaensis Cushman and Siegfus
Vaginulinopsis asperuliformis (Nuttall)
Vaginulinopsis mexicana nudicostata (Cushman and G. D. Hanna)
Valvulineria chirana Cushman and Stone

The Foraminifera of the Yamhill Formation in the Newport area can be compared with those of Laiming's B1A and A-2 zones and therefore may be referred to the uppermost part of the Ulatisian Stage and lower part of the Narizian Stage of Mallory (1959). Furthermore, they suggest bathyal depths during deposition.

Nestucca Formation

Thin-bedded tuffaceous siltstone of the Nestucca Formation of latest Eocene age unconformably overlies the Yamhill Formation and in places completely overlaps older rocks to rest directly on the Siletz River Volcanics. The mid-late Eocene unconformity represents a major period of deformation and erosion; older rocks are in many places folded and faulted, but many structures do not extend into the Nestucca or younger formations. The deformation divided the marine trough that occupied western Oregon and Washington in the Eocene into several interconnected basins and reduced the area of marine deposition.

The Nestucca Formation varies considerably in thickness--along the Yaquina River it is about 800 feet thick, whereas in other areas it is as much as 5000 feet thick. Although thin-bedded tuffaceous siltstone is most common, thin ash beds, massive mudstone, and arkosic, basaltic, and glauconitic sandstone interbeds are abundant. Friable arkosic sandstone is particularly common in the upper part of the formation where it occurs principally in sandstone dikes and sills. The thin bedding which characterizes the Nestucca Formation differs from the more massive or thickly bedded appearance of the underlying Yamhill Formation and overlying siltstone of Alsea, both of which are also predominantly siltstone.

Sequences of basalt flows and breccia up to 2000 feet thick interbedded in the Nestucca Formation form the precipitous sea cliffs between Cape Perpetua and Heceta Head south of Newport, and at Cascade Head to the north (Vokes and others, 1949; Snavely and Vokes, 1949). Camptonitic extrusives of this same age occur interbedded in the Tertiary sedimentary rocks along the lower reaches of the Siletz River, 1 to 2 miles east of Kernville.

Most basalt flows are 10 to 20 feet thick, have scoriaceous oxidized tops, and are of subaerial origin. Some subaerial flows grade laterally into submarine pillow lavas and breccia. Conglomerate and basaltic sandstone occur interbedded in the volcanic sequence, particularly on the flanks of the volcanic accumulations. The volcanics intertongue laterally with marine tuffaceous siltstone of the upper part of the Nestucca Formation which accumulated in areas between volcanic centers. Feeder dikes are abundant; they intrude the volcanic rocks and also cut older rocks to the east of the present volcanic outcrops, suggesting that the flow sequence may have originally covered parts of the interior of the present Coast Range.

The basalt is almost always porphyritic; basalt in the flow sequence near Cape Perpetua is characterized by abundant plagioclase phenocrysts whereas in the lavas at Cascade Head augite and olivine phenocrysts generally abound. The basalt shows a large variation in composition both within individual volcanic centers and between centers. The flows are characterized by high alkali, Al_2O_3, TiO_2, and P_2O_5 content (table 1, cols. 4 and 5). Although the volcanic sequences at Cascade Head and at Cape Perpetua both show a large variation in silica content, the former tends to be lower. Consanguineous dacitic dikes cut both volcanic sequences.

Camptonitic volcanic rocks which occur in the lower reaches of the Siletz River consist predominantly of tuff breccia with some pillow flows and massive flows as well as sills and dikes. Angular fragments in the breccia consist of altered glass crowded with pyroxene, opaque mineral, and apatite microlites. Cognate xenocrysts of biotite, hornblende, and apatite are common and serve to identify the camptonites. The matrix of the breccia consists of finely comminuted altered camptonitic glass and zeolites. Dikes and sills of biotite camptonite, which fed the extrusive sequence, cut the volcanics and intrude older rocks to the east; the largest dike is exposed in a small quarry on State Highway 229 about 8 road miles east of Kernville. An average chemical analysis of the biotite camptonite extrusives and directly associated feeder dikes is shown in table 1, column 6. The camptonite is characterized by low silica and high total alkali, TiO_2, and P_2O_5 content. Some of the least silicic volcanics at Cascade Head differ only slightly in composition from the camptonites and are considered to be consanguineous.

Megafossils are not common in the Nestucca Formation but Foraminifera are abundant. Some of the more common species locally occurring in the Nestucca Formation are:

Cassidulina globosa Hantken
Cibicides haydoni (Cushman and Schenck)
Cibicides hodgei Cushman and Schenck
Gyroidina condoni (Cushman and Schenck)
Gyroidina orbicularis planata Cushman
Plectofrondicularia packardi packardi Cushman and Schenck
Uvigerina cocoaensis Cushman
Uvigerina garzaensis Cushman and Siegfus

Nestucca foraminiferal assemblages are referable to the upper Narizian and lower Refugian Stages of late Eocene age. Most assemblages suggest upper bathyal depths during deposition.

Oligocene siltstone

A massive to thick-bedded tuffaceous siltstone to very fine-grained sandstone unit, informally referred to as the "siltstone of Alsea," conformably overlies the Nestucca Formation and upper Eocene volcanic rocks in the Newport area. The siltstone of Alsea was included in the upper part of the Toledo Formation as mapped by Vokes and others (1949). This siltstone unit is about 1500 feet thick where exposed along Yaquina Bay; it is particularly well exposed on the northwest side of Alsea Bay about 10 miles to the south.

Ash is a ubiquitous and abundant constituent of the siltstone and fine-grained sandstone and was derived from contemporaneous volcanism in the Cascade Range to the east (Snavely and Wagner, 1963). The tuffaceous siltstone contains abundant concretions which commonly have small shell fragments or fossil crabs in their cores. Interbeds of glauconitic sandstone and pumiceous mudflow breccia are also present.

Both megafossils and Foraminifera occur in this unit. The latter are referable to the upper Refugian and the Zemorrian Stages of Oligocene age. A few of the characteristic Foraminifera are:

Anomalina californiensis Cushman and Hobson
Bolivina marginata adelaidana Cushman and Kleinpell
Buccella mansfieldi oregonensis (Cushman, R. E. Stewart and K. C. Stewart)
Buliminella bassendorfensis Cushman and Parker
Cassidulina galvinensis Cushman and Frizzell
Cibicides elmaensis Rau
Elphidium cf. *E. smithi* Cushman and Dusenbury
Gyroidina soldanii d'Orbigny
Plectofrondicularia packardi multilineata Cushman and Simonson
Pseudoglandulina cf. *P. inflata* Bornemann
Quinqueloculina imperialis Hanna and Hanna
Quinqueloculina weaveri Rau

In general, Foraminifera of this siltstone unit suggest open-sea, cool-to-cold water conditions ranging from neritic to upper bathyal depths, possibly 300 to 2000 feet.

Yaquina Formation

Massive to well-bedded and cross-bedded sandstone, siltstone, and conglomerate constitute the Yaquina Formation (Harrison and Eaton, 1920; Schenck, 1927, 1928; and Vokes and others, 1949) of late Oligocene age. Along Yaquina Bay this unit is about 1700 feet thick. It thins to less than 1000 feet at Beaver Creek near the coastline 7 miles to the south, and towards the north thickens to more than 2000 feet in the area east of Cape Foulweather. Farther to the north near Siletz Bay it again thins to less than 1000 feet.

Sandstone, occurring as thin to thick beds, is the most common rock type. It varies from fine to coarse grained and commonly is pebbly. Cross-bedding and large-scale foreset bedding are common as are channel and fill structures. The sandstone is micaceous and carbonaceous; it may in part have been derived from erosion of the Tyee Formation. Pumice clasts are abundant and suggest continued volcanism in the Cascade Range to the east. Conglomerates are more common in the Yaquina Formation east of Cape Foulweather, where the formation is thickest, than near Yaquina Bay. The conglomerate occurs in beds up to several tens of feet thick which have lenslike shapes in outcrop pattern. Clasts in the conglomerate are of a variety of rock types most of which are foreign to the older Tertiary formations in the Coast Range. Thin to thick interbeds of tuffaceous siltstone, lithologically similar to that of the underlying siltstone of Alsea, and of glauconitic sandstone are also common. In places coal lenses and ash beds occur within the sandstone and siltstone. The distribution, lithology, and sedimentary structures of the Yaquina Formation suggest that it represents a deltaic deposit.

Megafossils are common in the Yaquina and indicate a late Oligocene age. Foraminifera, which occur in some siltstone beds, are largely confined to the following species of which only the unnamed species of Elphidium is common in most samples:

Bolivina cf. B. advena Cushman 1/
Buccella mansfieldi oregonensis (Cushman, R.E. Stewart, and K.C. Stewart)
Bulmina ovata d'Orbigny
Elphidium sp. (large, numerous chambers, very fine septal pores)
Elphidium cf. E. minutum (Reuss) 1/
Nonion costiferum (Cushman) 1/
Nonion incisum kernensis Kleinpell
Plectofrondicularia californica Cushman and Stewart 1/
Pyrgo sp. 1/
Robulus spp.

1/ Uppermost part of formation

Nonion costiferum in the uppermost part of the formation suggests an age no older than the Saucesian Stage (early Miocene). However, the remainder of the formation is assigned to the Zemorrian Stage (late Oligocene). Foraminiferal assemblages suggest relatively cool temperatures at shallow depths of deposition (littoral to inner neritic, not exceeding 300 feet).

Nye Mudstone

The Nye Mudstone (Harrison and Eaton, 1920; Schenck, 1927; Vokes and others, 1949; Snavely and others, 1964) is well exposed in road cuts along the north shore of Yaquina Bay. At its base it intertongues with sandstone beds of the Yaquina Formation. Along Yaquina Bay the Nye Mudstone is about 4400 feet thick. The thickness decreases rapidly northward to less than 500 feet about 4-1/2 miles north of the bay in the vicinity of Moloch (Moolack) Creek. The rapid narrowing of the outcrop belt northward is a result of onlap of the overlying Astoria Formation onto a broad pre-Astoria structural high. Also, north of the bay the Nye Mudstone contains thick interbeds of very fine-grained sandstone. Inasmuch as the sandstone of the Yaquina Formation thickens north of the bay, it is thought that the Nye sea may have shoaled northward onto a constructional high formed by a broad submarine fan or delta of Yaquina time.

The Nye consists predominantly of medium to dark olive-gray, massive, organic-rich mudstone and siltstone. Freshly broken samples have a strongly petroliferous odor. Calcareous and dolomitic concretions, as much as 4 feet across, and lenticular beds 2 inches to more than 1 foot thick occur locally. Thin carbonate-cemented beds are common in the lower part of the sequence; large isolated concretions generally occur in the upper part. A prominent zone of lenticular concretionary dolomitic beds occurs about 1200 feet above the base of the formation on the north side of Yaquina Bay.

The Nye Mudstone contains abundant brown fish scales and vertebrae, Foraminifera, and a meager molluscan fauna. In the uppermost part of the sequence, however, mollusks are abundant. Foraminiferal species found in the Nye Mudstone have been listed by Snavely and others (1964); some of the more common species are:

Bolivina advena Cushman
Bolivina marginata adelaidana Cushman and Kleinpell
Buccella mansfieldi oregonensis (Cushman and R.E. Stewart and K.C. Stewart)
Buliminella subfusiformis Cushman
Bulimina inflata alligata Cushman and Laiming
Bulimina ovata d'Orbigny
Cassidulina laevigata carinata Cushman
Epistominella parva (Cushman and Laiming)
Gyroidina soldanii d'Orbigny
Nonion costiferum (Cushman)
Nonion incisum (Cushman)
Plectofrondicularia californica Cushman and Stewart
Uvigerina auberiana d'Orbigny
Uvigerinella obesa impolita Cushman and Laiming
Virgulina californiensis Cushman

The assemblages are referable to the Saucesian Stage and the composition of the fauna suggests cold temperatures at upper bathyal depths -- perhaps 1000 to 2000 feet.

Astoria Formation

The Astoria Formation (Packard and Kellogg, 1934; Schenck, 1936; Weaver, 1937; Vokes and others, 1949; Snavely and others, 1964) unconformably overlies the Nye Mudstone. The unconformity between the two formations is sharp and well exposed in the sea cliff at Jumpoff Joe, about 1-1/2 miles north of Yaquina Bay, where sandstone of the Astoria Formation rests with slight angular discordance on typical mudstone of the Nye. This mudstone is stratigraphically lower in the Nye than sandy siltstone exposed at the mouth of the Yaquina River directly below the Astoria Formation.

Although only a narrow belt of Astoria strata is exposed along the sea cliffs and the wave-cut platform near Newport, a thicker and more continuous section crops out between Yaquina Head and Beverly Beach. Here more than 500 feet of strata is exposed. Farther to the north, in the area east of Depoe Bay where the former strand line swings to the east, the Astoria Formation attains its maximum onshore thickness in the Newport area, some 2000 feet.

The Astoria Formation consists principally of olive-gray, fine- to medium-grained micaceous, arkosic sandstone and dark-gray carbonaceous siltstone. The sandstone beds range from massive to thin-bedded and generally are thicker bedded in the upper part of the sequence. Thin bedding in the sandstone is accentuated by siltstone and claystone laminae, finely macerated plant material, or concentrations of mica. Commonly the original bedding has been greatly disturbed by the activity

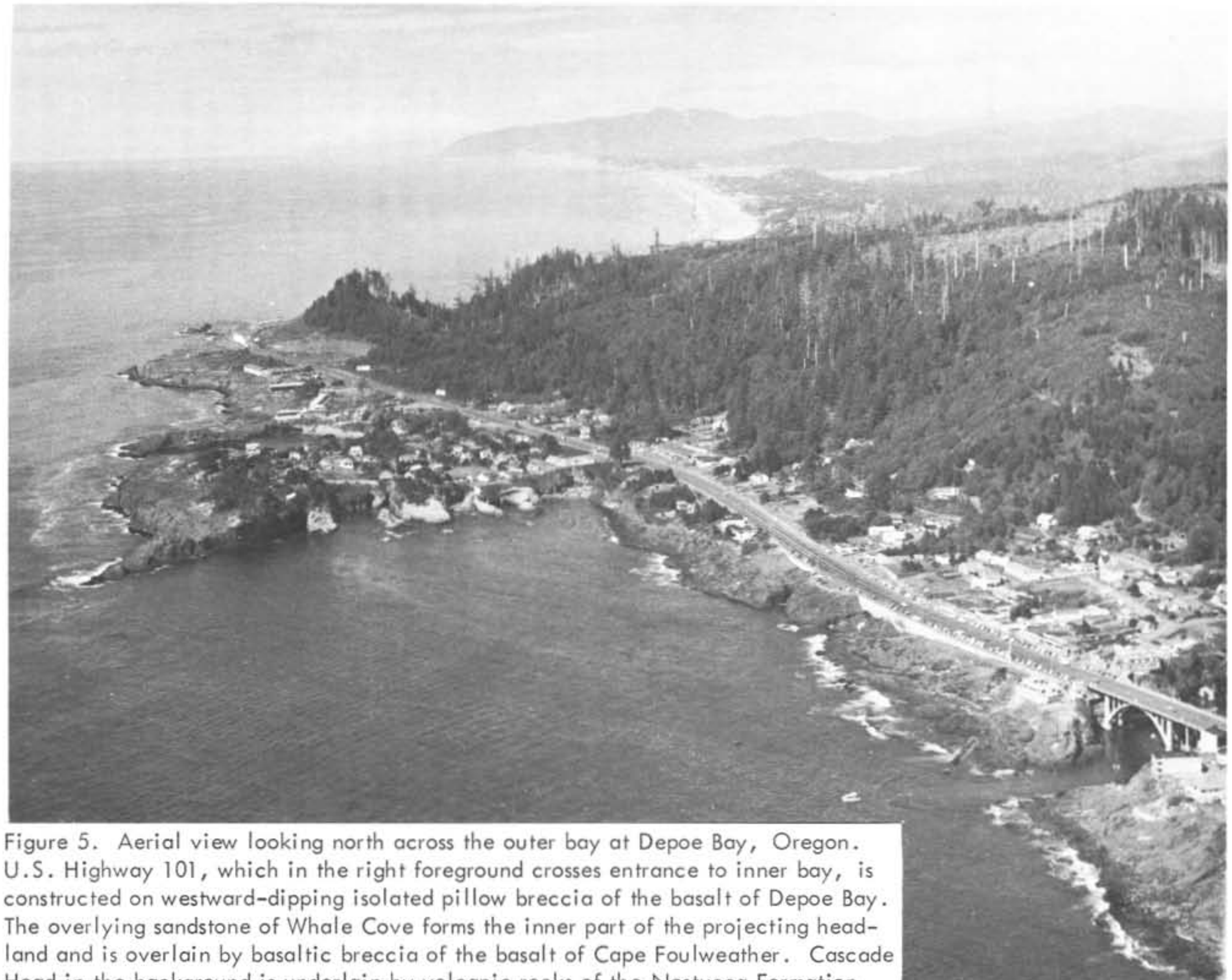

Figure 5. Aerial view looking north across the outer bay at Depoe Bay, Oregon. U.S. Highway 101, which in the right foreground crosses entrance to inner bay, is constructed on westward-dipping isolated pillow breccia of the basalt of Depoe Bay. The overlying sandstone of Whale Cove forms the inner part of the projecting headland and is overlain by basaltic breccia of the basalt of Cape Foulweather. Cascade Head in the background is underlain by volcanic rocks of the Nestucca Formation.

of marine organisms which have produced a "churned" appearance. Small-scale cross-bedding, ripple marks, and penecontemporaneous slump structures due to submarine sliding are common. The slump structures range from small overturned folds within beds only 1 inch thick to large infolds several feet in amplitude; the direction of overturning indicates a general westward to northwestward gliding of some beds during deposition.

A few granule- to coarse-grained basaltic sandstone beds up to 15 feet thick occur in the lower part of the formation. Concretionary ledges 6 inches to 2 feet thick and individual concretions 2 to 3 feet in diameter occur locally. Ledge-forming calcareous sandstone beds are more common in the lower than in the upper part of the formation. The most distinctive stratigraphic markers in the Astoria Formation are light-yellowish-gray water-laid siliceous tuff beds that in places contain altered pumice fragments and carbonaceous material. The beds range from a few inches to 18 feet in thickness and, being more resistant to erosion than the adjacent sandstone and siltstone, generally form ribs in the outcrops on wave-cut platforms. The tuff is of andesitic to dacitic composition which suggests that its source was from pyroclastic eruptions in an ancestral Cascade Range to the east.

Well-preserved mollusks are generally abundant throughout the lower part of the formation in both the sandstone and siltstone units and locally are concentrated in calcareous ledges or concretions. Many of the pelecypods have articulated valves indicating that they have not undergone extensive transport. The molluscan fauna indicates a middle Miocene age (Vokes and others, 1949; Snavely and others, 1964). Foraminifera are locally abundant in siltstone of the Astoria Formation and indicate a Saucesian age. The fauna suggests that water temperature may have been temperate, and depths possibly not more than 500 feet (Snavely and others, 1964). The following are common species:

Bolivina advena Cushman
Buccella mansfieldi oregonensis (Cushman and R.E. Stewart and K.C. Stewart)
Buliminella elegantissima (d'Orbigny)
Buliminella subfusiformis Cushman
Epistominella parva (Cushman and Laiming)
Nonion costiferum (Cushman)
Nonionella miocenica Cushman
Robulus mayi Cushman and Parker
Uvigerinella californica ornata Cushman

Middle Miocene volcanic and sedimentary rocks

A middle Miocene sequence comprising a lower unit of basalt flows, a medial massive to well-bedded sandstone and siltstone unit, and an upper unit of basalt breccia is well exposed in sea cliffs along the coast from Cape Foulweather to Boiler Bay (Snavely and Vokes, 1949; Snavely and others, 1965). Miocene basalt flows, pillow lavas, breccia, and water-laid fragmental debris form the precipitous headlands along the Oregon coast north of Newport at Yaquina Head, Cape Foulweather (see page 25), Cape Lookout, and Cape Meares; thick sills formed during the Miocene volcanism occur at Cape Falcon and Tillamook Head. These volcanic rocks were extruded from local centers near a middle Miocene strand and are of both subaerial and submarine origin (Snavely and Wagner, 1963).

The middle Miocene basalt exposed along the central and northern Oregon coast consists of two mappable and petrochemically distinctive units. The older unit, here referred to as the "basalt of Depoe Bay," is composed of subaerial basalt flows and submarine palagonitic pillow lava and breccia; the younger unit, locally referred to as the "basalt of Cape Foulweather," consists predominantly of subaerial basalt flows and breccia and subaqueous water-laid fragmental basaltic debris. Between Whale Cove and Depoe Bay (figure 5), these two basalt units are separated by a massive nearshore arkosic sandstone and thin-bedded brackish-water sandstone unit, informally called the "sandstone of Whale Cove."

Unconformities, in places marked by fossil soil zones, occur at the base of each of the two basalt units; the basalt of Cape Foulweather overlaps the basalt of Depoe Bay south of Depoe Bay where it rests on older rocks.

Basalt of Depoe Bay: A 75-foot-thick isolated pillow breccia unit forms the north-trending shoreline between the inner and outer bays of Depoe Bay (figure 5). The unconformable contact between the basalt of Depoe Bay and the Astoria Formation is well exposed in the inner bay. Pillows in the isolated pillow breccia are typically 2 to 4 feet wide; some are very elongate. Many pillows have hollow (drained) centers. The pillows are enclosed in a matrix of finely comminuted partially palagonitized basaltic glass and angular glassy to aphanitic basalt fragments. Immediately south of Depoe Bay the pillow lavas grade laterally into a rudely columnar-jointed subaerial flow approximately 50 feet thick. Numerous dikes and sills of Depoe Bay type basalt intrude the Astoria and Yaquina Formations immediately east of Depoe Bay and attest to the local origin of this unit.

The general petrography of these rocks is described by Snavely and others (1965). The basalt is medium to dark gray, glassy to fine grained, equigranular, and commonly contains patches of apple-green (on fresh breaks) to brownish-black chlorophaeite. The average composition of basalt from this unit is shown in table 1, column 7. Fresh basalt shows a very restricted range in composition and is characterized by relatively high SiO_2. Basalt of similar composition and age forms the headlands at Cape Lookout, Cape Meares, Cape Falcon, and Tillamook Head, and forms thick flows along the lower part of the Columbia River and in the northern part of the Willamette Valley. The Yakima type of basalt (Waters, 1961) of the Columbia River Group on the Columbia River Plateau is also of similar composition and age, even though extruded many tens of miles to the east. Flows in the northern part of the Willamette Valley and along the lower part of the Columbia River were derived from a Columbia Plateau source, but the Depoe Bay type volcanics along the coast were erupted from local vents near the present coastline.

Sandstone of Whale Cove: Two to three hundred feet of clastic sedimentary rocks occur in places between the basalt of Depoe Bay and the basalt of Cape Foulweather (Snavely and Vokes, 1949). These sedimentary rocks, referred to as the sandstone of Whale Cove, are best exposed along the northern and southern shores of the outer bay at Depoe Bay and in Whale Cove about 1 mile to the south. Massive to thick-bedded medium- to fine-grained arkosic sandstone and thin-bedded micaceous carbonaceous siltstone to fine-grained sandstone constitute the bulk of the unit. Crossbedding, cut-and-fill structures, convolute laminations, and slump structures are common. The chemical composition of a sandstone from this unit and of older sedimentary rocks from the Newport area are shown in table 2.

Part of the sediment that comprises younger Tertiary sandstone in the Newport area was derived by erosion of older sandstone such as that of the Tyee Formation.

Table 2. Average chemical composition of sedimentary rocks in the central part of the Oregon Coast Range (analyses recalculated water-free to 100 percent).

Formation:	Tyee Formation	Nestucca Formation	Siltstone of Alsea	Nye Mudstone	Astoria Formation	Sandstone of Whale Cove
Rock type:	Sandstone and Siltstone	Siltstone	Siltstone	Siltstone	Sandstone	Sandstone
No. of analyses	11	2	5	1	3	1
SiO_2	62.3	67.5	67.3	68.4	69.6	74.4
Al_2O_3	16.8	17.6	15.8	15.6	14.8	12.9
Fe_2O_3	2.1	4.3	4.7	4.5	2.5	2.0
FeO	4.6	2.1	1.8	2.3	2.5	2.1
MgO	3.1	2.0	1.8	2.5	2.2	1.6
CaO	3.7	1.8	3.1	1.1	2.2	1.2
Na_2O	3.1	1.3	2.0	2.5	2.8	2.3
K_2O	2.6	2.2	2.1	1.9	2.2	2.7
TiO_2	1.0	0.84	0.95	0.83	0.96	0.69
P_2O_5	0.2	0.14	0.19	0.28	0.14	0.08
MnO	0.13	0.03	0.07	0.04	0.07	0.05

Analyses used in above averages were done by Paul Elmore, Ivan Barlow, Samuel Botts, Gillison Chloe, Lowell Artis, H. Smith, Leonice Beatty, and Albert Bettiger, U.S. Geological Survey, using chemical and (or) x-ray fluorescence methods.

Consequently, younger sandstone tends to be progressively more mature and have higher SiO_2 content. Fossils are rare in this unit, but a few mollusks are present in large calcareous concretions at Whale Cove.

Basalt of Cape Foulweather: The youngest Tertiary rock unit in the Newport area, the basalt of Cape Foulweather, crops out along the coast for about 6 miles north between Cape Foulweather (see page 25) and Government Point. It forms the projecting small headland on the outer part of Depoe Bay (figure 5) where it overlies the sandstone of Whale Cove. East of Cape Foulweather this volcanic sequence overlaps this sandstone, the basalt of Depoe Bay, and much of the Astoria Formation. The basalt of Cape Foulweather is also exposed at Yaquina Head and Otter Rock Island.

The basalt of Cape Foulweather consists predominantly of basalt breccia and water-laid fragmental debris, and lesser amounts of massive flows and pillow lavas. Numerous feeder dikes and volcanic necks such as are exposed on Cape Foulweather indicate that the volcanic rocks were locally derived. Much of the basalt was erupted subaerially, but fringing aprons of marine basaltic breccias such as crop out at Government Point apparently developed around the volcanic centers.

Basalt of Cape Foulweather is glassy to very fine grained and characteristically contains a small number of yellowish plagioclase phenocrysts as much as 2 cm in length. Presence of these phenocrysts serves to distinguish these basalts from those of the basalt of Depoe Bay.

An average chemical composition of basalt from Cape Foulweather is shown in table 1, column 8. The basalt shows only slight variation in composition, is characterized by relatively high TiO_2 and P_2O_5, and is chemically distinct from basalt of Depoe Bay.

Basalt flows and intrusives of Cape Foulweather type crop out at Cape Lookout and Ecola State Park along the northern Oregon coast where they are also younger than Depoe Bay type basalt. The Late Yakima petrographic type (Waters, 1961) of the Columbia River Group of the Columbia Plateau is similar to the basalt of Cape Foulweather both in age and composition.

Fossils diagnostic of age are not present in this basalt flow--sedimentary rock sequence in the Newport area. However, farther north at Cape Meares, basalt flows equivalent in composition to the basalt of Depoe Bay are associated with siltstone of Relizian age. Based on regional geologic consideration, the basalts of Depoe Bay and Cape Foulweather are considered to be of middle Miocene age.

Post-middle Miocene sedimentary rocks

A thick sequence of marine sedimentary rocks of late Miocene and Pliocene ages underlies the continental shelf off the Newport area. Interpretation of subbottom acoustical profiles (figure 6), gravity data (Dehlinger and others, 1967), and magnetic data (Emilia and others, 1966) indicates that several thousand feet of post-middle Miocene sedimentary rocks overlie the Astoria Formation on the adjacent continental shelf off Newport. Bottom samples from an anticlinal high, Stonewall Bank, on the shelf contain Foraminifera indicative of Pliocene and middle Miocene ages (Fowler, 1966). A test hole drilled cooperatively by the Standard Oil Company of California, Union Oil Company, and Pan American Petroleum Corporation on this structure is reported to have encountered more than 10,000 feet of marine sedimentary rocks.

Quaternary deposits

Unconsolidated to poorly consolidated mud, silt, sand, and gravel of Quaternary age blanket much of the Newport coastal area (Vokes and others, 1949; Baldwin, 1950; Cooper, 1958). In most lowland coastal areas the Quaternary deposits extend several hundred yards to 2 miles inland. Along the Yaquina River, estuarine deposits occur as much as 7 miles from the coast. The Quaternary deposits include

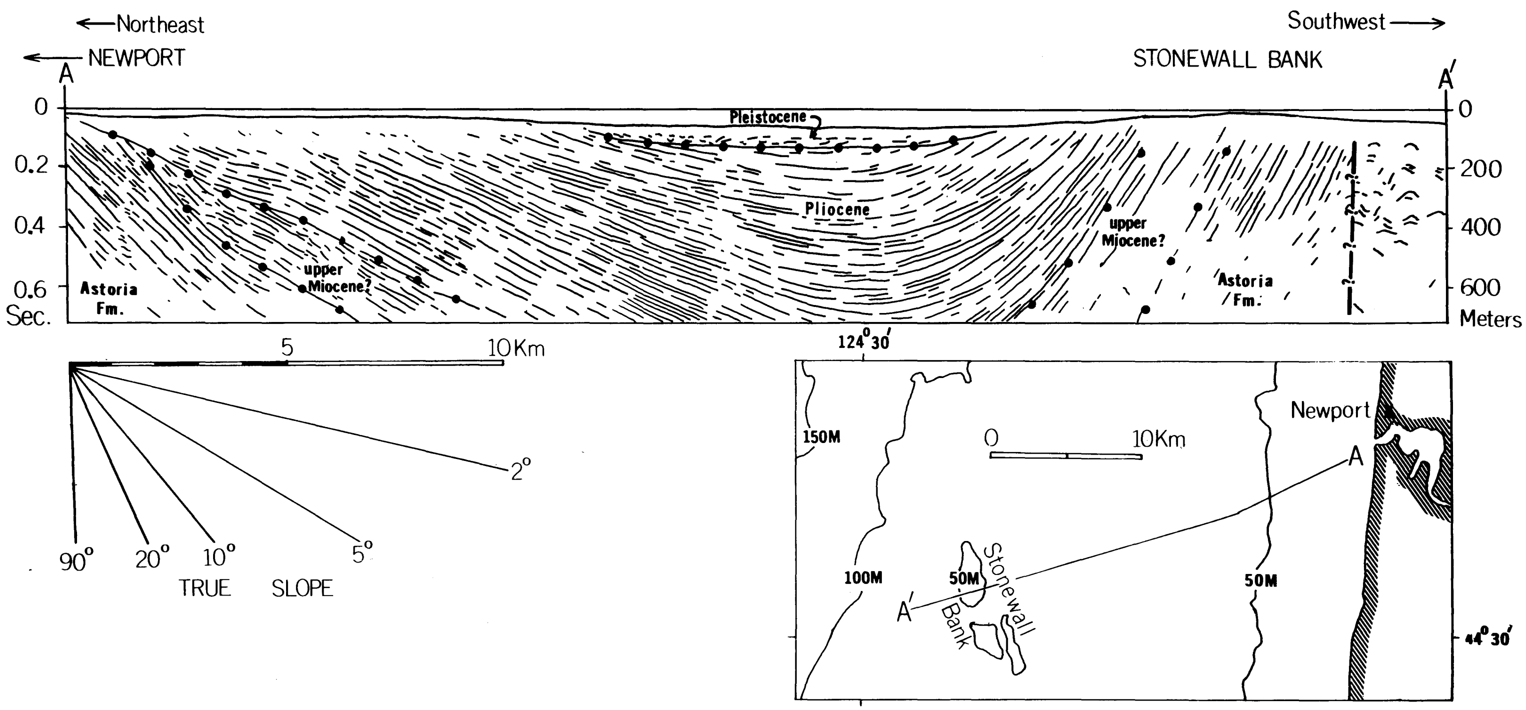

Figure 6. Acoustic reflection profile of the continental shelf off Newport, Oregon, with added geologic interpretations. Note that the profile reads with northeast on the left. Ages of acoustic units, delimited on the profile by dots, are based on extrapolation of onshore mapping and on bottom sampling near Stonewall Bank. Reflection time is given in seconds, depth is in meters based on a two-way acoustic velocity of 1000 meters/sec. Profile was provided by Gene A. Rusnak, U.S. Geological Survey.

several distinguishable units separated by disconformities; individual units differ in degree of consolidation, weathering characteristics, and composition. Several wave-cut terraces are developed along coastal stretches; one of these, the 500-foot-high flat-topped surface at Otter Crest on Cape Foulweather, is shown on page 25. Individual terraces are warped and vary more than 100 feet in elevation.

Intrusive rocks

Several suites of igneous rocks intrude the Tertiary sedimentary and volcanic rocks in the central part of the Oregon Coast Range. Several of these are consanguineous with extrusive rocks; others have no known extrusive equivalents.

The most voluminous igneous suite consists of sills and dikes of granophyric gabbro or ferrogabbro of middle Oligocene age. They cap many of the higher mountains in the Coast Range such as Marys Peak, Euchre Mountain, and Stott Mountain. Most are strongly differentiated and contain rocks ranging in composition from granophyric gabbro to aplite. They are characterized by the mineral assemblage Fe-rich olivine, ferroaugite, and quartz-feldspar intergrowth. Their petrochemistry and petrology is briefly described by Snavely and Wagner (1961).

Basalt, diabase, or gabbro sills of late Eocene to early Oligocene age and of Miocene age cap many of the higher areas along the crest of the Oregon Coast Range north of lat. 45° N. These sills and smaller bodies near the coast are intrusive equivalents of the volcanic sequences.

In addition to intrusives of basaltic composition, alkaline igneous rocks are also abundant in the central part of the Oregon Coast Range. Nepheline syenite sills, dikes, and small stocks occur over a large area 10 to 30 miles south and southeast of Newport; the most prominent of these is the 200-foot-thick sill at Table Mountain. The abundance of nepheline syenite clasts in Quaternary deposits strongly suggests that the outcrop areas of the nepheline syenite sills were considerably more extensive. The nepheline syenite intrusives are briefly described by Snavely and Wagner (1961).

Camptonite (hornblende-augite-plagioclase lamprophyre) dikes and sills are common in the area between the Siletz and Salmon Rivers extending from near the coast to the crest of the Coast Range. The largest camptonite intrusive occurs at Cougar Mountain about 24 miles northeast of Newport. Several camptonite dikes are located south of Newport in the same general area as the nepheline syenite intrusives. Several dike swarms in that area contain both nepheline syenite and camptonite dikes, suggesting a common origin for these two rock types. The camptonites vary considerably in composition and mineralogy (Snavely and Wagner, 1961); all are characterized by high alkali, TiO_2 and P_2O_5 content. Biotite camptonite dikes and extrusives are a compositional variant (higher K_2O, lower Na_2O) of the camptonite intrusives.

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GEOLOGICAL SOCIETIES TO MEET AT EUGENE

The Cordilleran Section of the Geological Society of America and the Pacific Coast branch of the Paleontological Society will hold their annual meetings on the 27th to 29th of March, 1969 at the University of Oregon in Eugene, hosted by the University's Department of Geology and Center for Volcanology. In addition to the regular presentation of papers, one symposium will be held: The late Mesozoic paleotectonic history of western Oregon and adjoining areas.

Following are the four field trips: Tuesday and Wednesday, March 25 and 26, Northern Klamath Mountains, led by E. M. Baldwin and M. A. Kays of the University and Len Ramp of the State of Oregon Department of Geology and Mineral Industries; and volcaniclastic rocks of central Oregon, led by Ernest Lund and Gordon Goles of the University; and Sunday, March 30, geology of the Newport Embayment, led by P. D. Snavely, Jr. and Norman MacLeod, U.S. Geological Survey, and engineering geology of the Blue River, Cougar, and Green Peter dam sites, led by Del Snyder, U.S. Corps of Engineers.

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33.	Bibliography (1st supplement) of geology and mineral resources of Oregon, 1947: Allen	1.00
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	(2nd vol.) Two papers on Western Oregon and Washington Tertiary foraminifera, 1949: Cushman, Stewart, and Stewart; and one paper on mollusca and microfauna, Wildcat coast section, Humboldt County, Calif., 1949: Stewart and Stewart	1.25
37.	Geology of the Albany quadrangle, Oregon, 1953: Allison	0.75
46.	Ferruginous bauxite deposits, Salem Hills, Marion County, Oregon, 1956: Corcoran and Libbey	1.25
49.	Lode mines, Granite mining dist., Grant County, Ore., 1959: Koch	1.00
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60.	Engineering geology of the Tualatin Valley region, Oregon, 1967: Schlicker and Deacon	5.00
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63.	Sixteenth Biennial Report of the State Geologist, 1966-1968	Free

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Geologic map of Oregon west of 121st meridian: (over the counter) folded in envelope, $2.15; rolled in map tube, $2.50	2.00
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