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MIOCENE STRATIGRAPHY OF THE YAQUINA BAY AREA, NEWPORT, OREGON [1]

By

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Introduction

Marine sedimentary rocks of Miocene age occur in structural basins along the Oregon coast at Astoria, Tillamook, Newport, and Coos Bay (see index map on plate 1). Inasmuch as these basins open to the west, thicker sequences of marine Miocene and younger rocks undoubtedly are present on the continental shelf. Furthermore, potential source beds and reservoir rocks for petroleum are known from surface outcrops of Miocene age in the three northern embayments. These Miocene and younger strata unquestionably will be major objectives in the aggressive petroleum exploration program now under way in offshore Oregon and Washington. Therefore, this report summarizes the lithologic characteristics and fauna of the Miocene sequence in the Yaquina Bay area of the Newport Embayment [4] in the hope that these preliminary data will prove useful in biostratigraphic interpretations of the Miocene rocks encountered in drilling on the continental shelf.

The writers wish to express their appreciation to Philip Grubaugh of the U. S. Corps of Engineers, Portland District, for his efforts in making the cores from their Yaquina Bay and Harbor exploration project available for study. We wish to thank W. O. Addicott for paleontological data on molluscan faunas and E. W. Wolfe for heavy mineral determinations. W. O. Addicott and J. G. Vedder read and criticized the report and offered valuable suggestions. Norman S. MacLeod aided measurably in the assembly of data.

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[1] Publication authorized by the Director, U.S. Geological Survey.
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[4] As used in this report, the Newport Embayment is a broad structural basin outlined by a westward-facing arcuate pattern of uppermost Eocene to Miocene rocks. Biostratigraphic studies of marine Eocene and Oligocene strata exposed in the Newport Embayment have recently been completed by the U.S. Geological Survey and reports on these units are in preparation.

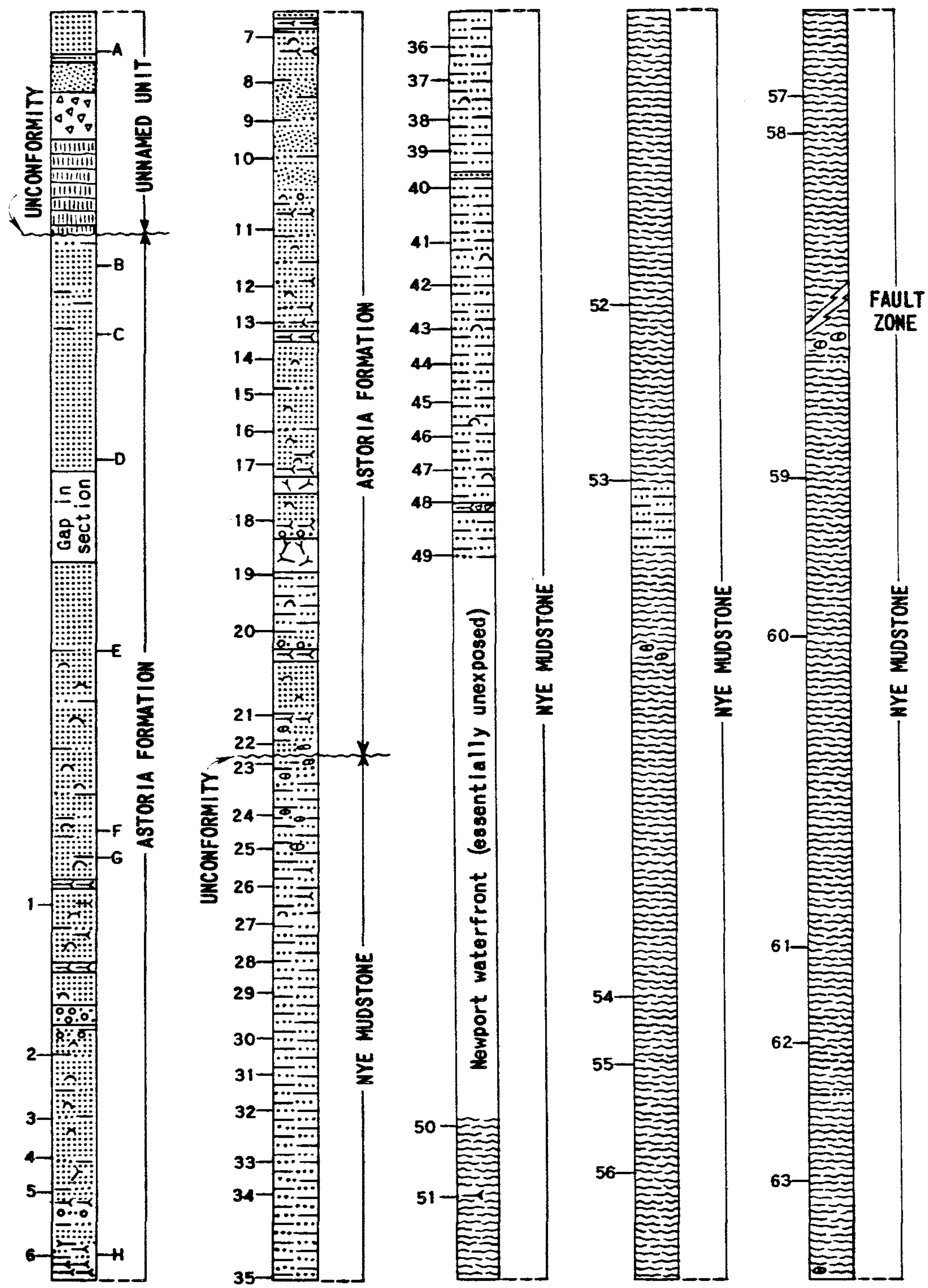


Figure 1. Generalized stratigraphy of Miocene strata at Yaquina Bay, Newport, Oregon. (Figures 1–48 indicate subsurface foraminiferal samples; 49–83 surface foraminiferal samples. Letters A–H indicate samples for which physical properties were determined.)

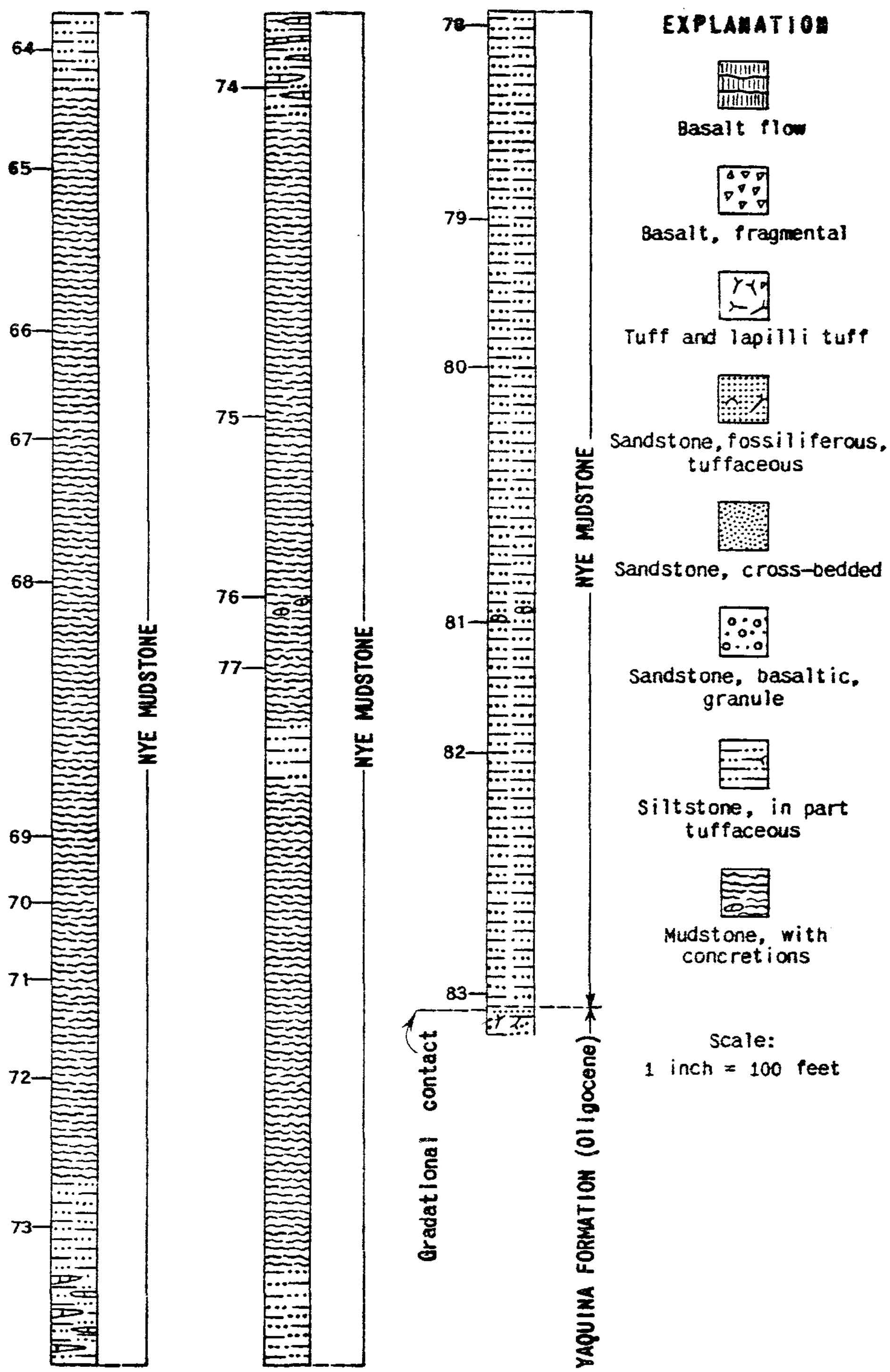


Figure 1, Continued.

Stratigraphy

In the Yaquina Bay area marine Miocene strata consist of two mappable lithologic units: an older siltstone-mudstone sequence of early Miocene age referred to the Nye Mudstone (Harrison and Eaton, 1920); Schenck, 1927; and Vokes and others, 1949) and a younger sandstone-siltstone sequence of middle Miocene age referred to the Astoria Formation (Packard and Kellogg, 1934; Schenck, 1936; Weaver, 1937; Vokes and others, 1949; and Moore, 1963). An unnamed late(?) Miocene unit, consisting of a basal basalt flow, associated waterlaid basaltic fragmental debris, and arkosic sandstone, is known in the map area (plate 1) only from cores obtained by the U.S. Corps of Engineers near the mouth of the Yaquina River. The generalized stratigraphic section of the Miocene sequence that is shown on Figure 1 was compiled from outcrop data along the north shore of Yaquina Bay and from descriptions of cores from holes drilled in the channel of the Yaquina River. The locations of the outcrop and subsurface samples from core holes referred to in this report are shown on Plate 1.

Nye Mudstone

The Nye Mudstone is best exposed in road cuts and on tidal flats along the north shore of Yaquina Bay, in highway cuts along U.S. Highway 20, and in sea cliffs 3 to 7 miles south of Newport between Henderson and Beaver Creeks. Within the city limits of Newport, late Pleistocene marine terrace deposits unconformably overlie the Nye Mudstone and limit the area of outcrop to a narrow belt along the bay. Immediately south of the bay, the Nye is largely concealed by these terrace deposits, dune sands, and bay muds. Landslides are common in areas underlain by the Nye, and several large slides occur on the north side of Yaquina Bay (plate 1).

The Nye Mudstone overlies by gradational contact sandstone beds of the late Oligocene Yaquina Formation (Harrison and Eaton, 1920; Schenck, 1927; and Vokes and others, 1949). In the map area (plate 1) the Nye consists predominantly of medium to dark olive-gray, massive, organic-rich mudstone and siltstone. A strong petroliferous odor is apparent when a fresh sample is broken. In many outcrops the unit is closely jointed; the joints are emphasized by iron-oxide staining and commonly contain a lacework of gypsum crystals. The Nye weathers to rusty brown hackly or conchoidal fragments, and most outcrops are partly covered with a scree of shaly rubble. The more deeply weathered outcrops are commonly stained with yellow jarosite.

Inasmuch as the Nye is composed of mixtures of clay, silt, and very fine sand-size particles in varying proportions, the lithologic designation differs from place to place, but commonly is mudstone or siltstone, and less commonly silty, very fine-grained sandstone. These grain-size variations are slight, and in the field much of the formation is classified as mudstone. However, in the Yaquina Bay section the Nye is predominantly sandy siltstone in its lowermost and uppermost parts. Mechanical analyses of five samples of Nye Mudstone indicate that the clay fraction ranges from 17 to 32 percent, silt from 54 to 83 percent, and very fine sand from a trace to as much as 27 percent. A sample near the base of the formation was composed of about equal proportions of sand, silt, and clay.

The Nye Mudstone commonly contains abundant brown fish scales and vertebrae,

Figure 2. Dolomitic beds and lenses in the lower part of the Nye Mudstone, north side of Yaquina Bay about half a mile east of McLean Point.

Figure 3. Unconformable contact between the dark-gray Nye Mudstone (Tn) and light-gray Astoria Formation (Ta) at Jumpoff Joe, $1\frac{1}{2}$ miles north of Yaquina Bay, Newport, Oregon. Units are overlain by late(?) Pleistocene terrace deposits (Qt).

locally abundant Foraminifera, and a meager molluscan fauna. In the uppermost part of the sequence, however, mollusks are abundant. Calcareous and dolomitic concretions, as much as 4 feet across, and lenticular beds 2 inches to more than 1 foot thick occur locally. Carbonate-cemented thin beds are common in the lower part of the sequence; large, isolated concretions generally occur in the upper part. A prominent zone of lenticular, dolomitic concretionary beds occurs about 1,200 feet above the base of the formation and is well exposed in a large cut between localities 73 and 74 (see plate 1 and figure 2). Beds of light-gray tuff and thin-bedded, fine-grained sandstone several inches thick occur in a few outcrops.

X-ray diffraction studies of the clay fraction in the Nye Mudstone show that it is composed predominantly of mixed-layered montmorillonite-illite and smaller quantities of illite and kaolinite. This composition contrasts with that of the clays in upper Eocene siltstone, where a few samples studied by X-ray techniques show a larger proportion of illite and kaolinite and lesser amounts of montmorillonite. A chemical analysis of the Nye Mudstone collected from a U.S.C.E. core hole (locality 59, plate 1) is shown in table 1, column 1.

The Nye Mudstone is about 4,400 feet thick as calculated from plane-table traverses made along the north shore of Yaquina Bay. Steep reversals in dip recorded just west of McLean Point are interpreted as being the result of faulting; however, the possibility that the landslide mapped in that area may be responsible for the anomalous dips cannot be discounted.

The outcrop thickness of the Nye Mudstone decreases rapidly northward, and about 4½ miles north of the bay in the vicinity of Moloch Creek it is less than 1,000 feet. The rapid narrowing of the outcrop belt northward is the result of onlap of the 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, which suggests that the Nye sea became shallower in that direction. Inasmuch as the sandstone of the Yaquina Formation thickens north of the bay, it is speculated that the Nye sea shoaled northward onto a constructional high formed by a broad submarine fan or delta of Yaquina time. The molluscan fauna contained in the very fine-grained sandstone of the Nye supports the suggested shoaling of the Nye sea.

Astoria Formation

In the immediate vicinity of Newport, strata of the Astoria Formation are exposed only in a narrow belt along sea cliffs and on the wave-cut platform from the Yaquina jetty northward for 1½ miles to Jumpoff Joe. The thickest and most continuous section of the Astoria Formation exposed along this part of the Oregon coast occurs 2½ to 6 miles north of Newport on the wave-cut platform and sea cliffs between Yaquina Head and Beverly Beach where more than 500 feet of strata are exposed. The succession of stratigraphic units in the Astoria Formation is difficult to determine, as the best outcrops occur in discontinuous patches on the wave-cut platform, which is largely covered by sand most of the year. The sequence also is complicated by north-trending en echelon faults that parallel the coastline for at least 15 miles north of Newport. On the basis of a study of cores from the U.S.C.E. holes drilled near the mouth of the Yaquina River and of the distribution of key lithologic units on the wave-cut platform west of Newport, faults of this type appear to have resulted in the duplication of section as shown on plate 1. The basalt "reef" about three-quarters of a mile offshore also appears to be offset by a north-trending fault near the north border of the map.

The Astoria Formation unconformably overlies the Nye Mudstone, but the contact is poorly exposed and difficult to recognize in the sea cliff at the mouth of the Yaquina River (just south of the lighthouse). The precise location of the contact is made even more difficult in this area because thick-bedded, very fine-grained sandstone in the Astoria Formation overlies weathered massive sandy siltstone of the Nye. However, the unconformity between the two formations is sharp and well exposed in the sea cliff at Jumpoff Joe, about $1\frac{1}{2}$ miles north of Yaquina Bay (fig. 3), 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 the sandy siltstone exposed at the mouth of the Yaquina River.

The Astoria Formation consists of a variety of near shore marine rocks, of which olive-gray, fine- to medium-grained micaceous, arkosic sandstone and dark-gray carbonaceous siltstone are the most common. Most of the sandstone ranges from well sorted to moderately sorted despite the fact that it commonly has a dirty appearance in hand sample. A few granule- to coarse-grained basaltic sandstone beds occur in the lower and middle parts of the formation; the thickest bed, about 15 feet thick, occurs near the middle of the unit. 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 part of the formation.

The most distinctive stratigraphic markers in the Astoria Formation are light yellowish-gray waterlaid fine tuff beds that in places contain altered pumice fragments and carbonaceous material. The beds range in thickness from a few inches to 18 feet and, being more resistant to erosion than the adjacent sandstone and siltstone, generally form ribs in the outcrops on wave-cut platforms. The andesitic to dacitic composition of these tuffs (see table 1, col. 2) and the presence of grains of hypersthene and hornblende in some tuffs suggest that their source was from pyroclastic eruptions in an ancestral Cascade Range to the east.

Sandstone beds in the Astoria Formation 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. The thin bedding ranges from planar to irregular, contorted, or crenulated. Commonly the original bedding has been greatly disturbed by the activity of marine organisms, which have produced a "churned" appearance. Small-scale crossbedding, 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.

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. Higher in the sequence mollusks occur sparingly, and no megafossils were found in the upper 250 feet of the core-hole section.

Determinations of physical properties of seven core samples of sandstone from the Astoria Formation are given in table 2. Their relative stratigraphic positions are

Table 1. Chemical compositions of Miocene rocks in the Newport Embayment, Oregon

	1	2	3	4
SiO_2	60.8	55.2	49.0	50.1
Al_2O_3	13.9	15.3	12.5	13.3
Fe_2O_3	4.0	4.3	6.4	4.5
FeO	2.0	2.0	9.3	9.3
MgO	2.2	2.4	3.8	3.8
CaO	1.0	3.5	7.2	8.1
Na_2O	2.2	3.2	2.9	3.2
K_2O	1.7	.85	.79	.75
H_2O-	5.0	6.4	1.9	1.6
H_2O+	4.7	4.8	2.4	1.1
TiO_2	.74	.84	2.8	3.0
P_2O_5	.25	.33	.68	.65
MnO	.04	.12	.22	.21
CO_2	.58	1.0	$<.05$	.06

Columns 1-3 were analyzed using methods described in U. S. Geological Survey Bull. 1144-A. Analysts: Paul Elmore, Samuel Botts, Gillison Chloe, Lowell Artis, and H. Smith, U. S. Geological Survey.

Column 4, Standard rock analysis. Analyst: Dorothy F. Powers, U.S. Geol. Surv.

1. Nye Mudstone from U.S.C.E. core hole at locality 59, plate. 1.
2. Waterlaid tuff bed between samples 17 and 18 in figure 1.
3. Basalt flow in unnamed unit; samples in westernmost core hole.
4. Waterlaid volcanic debris at Government Point, 14 miles north of Newport, Ore..

Table 2. Partial mechanical analyses, porosities, and permeabilities of sandstone samples from Miocene rocks in the Yaquina Bay area, Newport, Oregon.

(From U.S.C.E. core holes)

Size fraction[1/]	Sample[2/]							
(Mn)	A	B	C	D	E	F	G	H
1.0		0.2	0.3	0.1				
0.5		4.9	9.2	1.9				
0.25	Trace	57.9	61.5	42.9	0.1	0.2	0.1	0.3
0.125	0.2	22.6	19.2	33.2	12.8	10.7	26.8	5.7
0.062	33.9	5.3	3.7	9.1	45.6	55.0	42.2	36.1
0.004	63.0	9.1 (0.004 and <0.002 combined)	6.1 (0.004 and <0.002 combined)	12.8	36.4	30.3	28.5	53.1
<0.002	<2.9			0.0	5.1	3.8	2.4	4.8
Effective porosity (in percent)	22.1	----	----	29.2	26.6	26.0	25.6	20.4
Permeability (in milli-darcies)	21.4	----	----	1682.0	31.2	20.1	29.2	3.0

1/ Figures given are in percent retained on the respective screen sizes and pan. Columns A and D through H were analyzed by Robert Gantnier, U. S. Geological Survey. Columns B and C were analyzed by Martin Sorenson, U. S. Geological Survey.

2/ Location of sample is shown on plate 1; stratigraphic position is shown on figure 1.

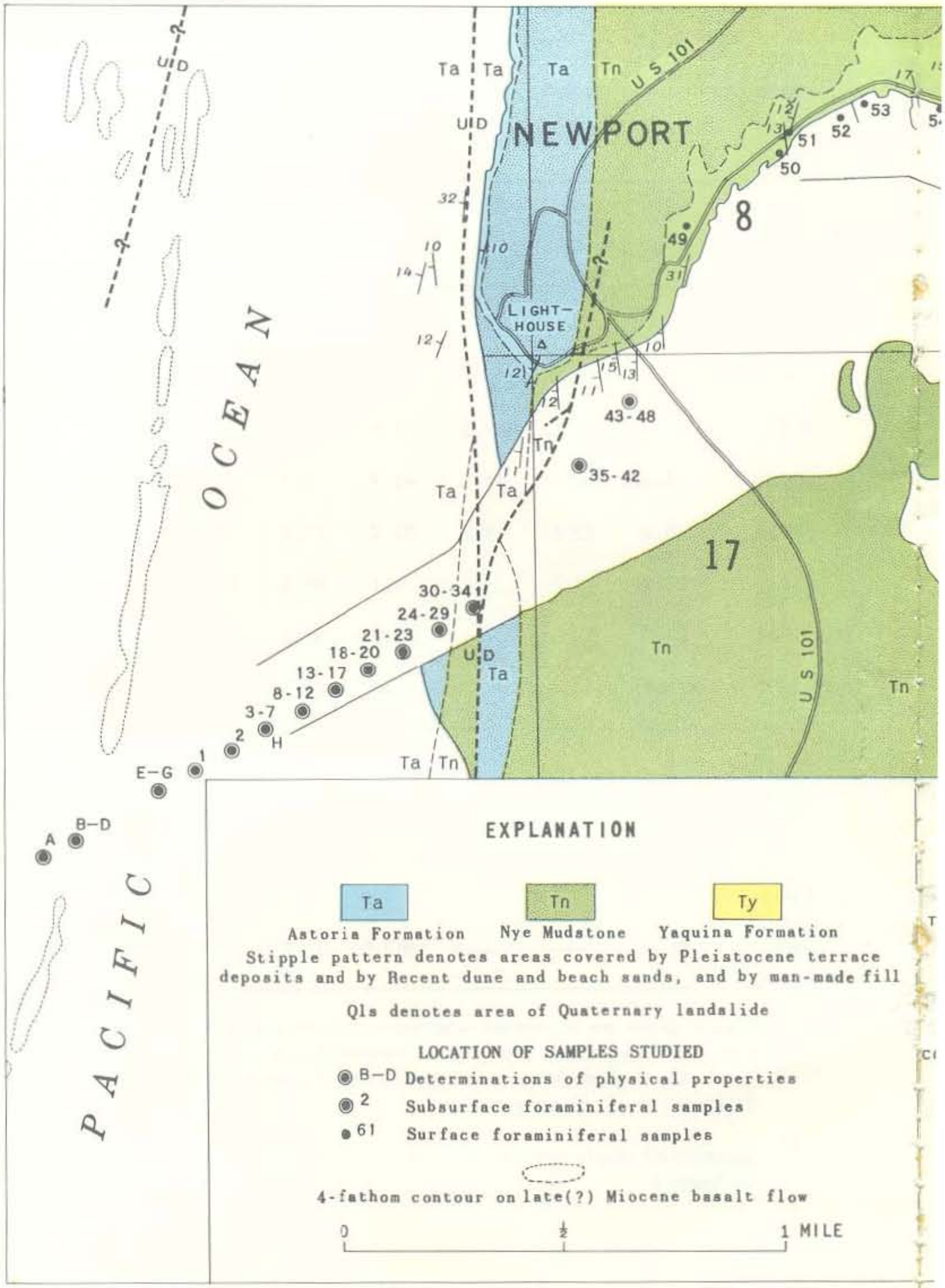
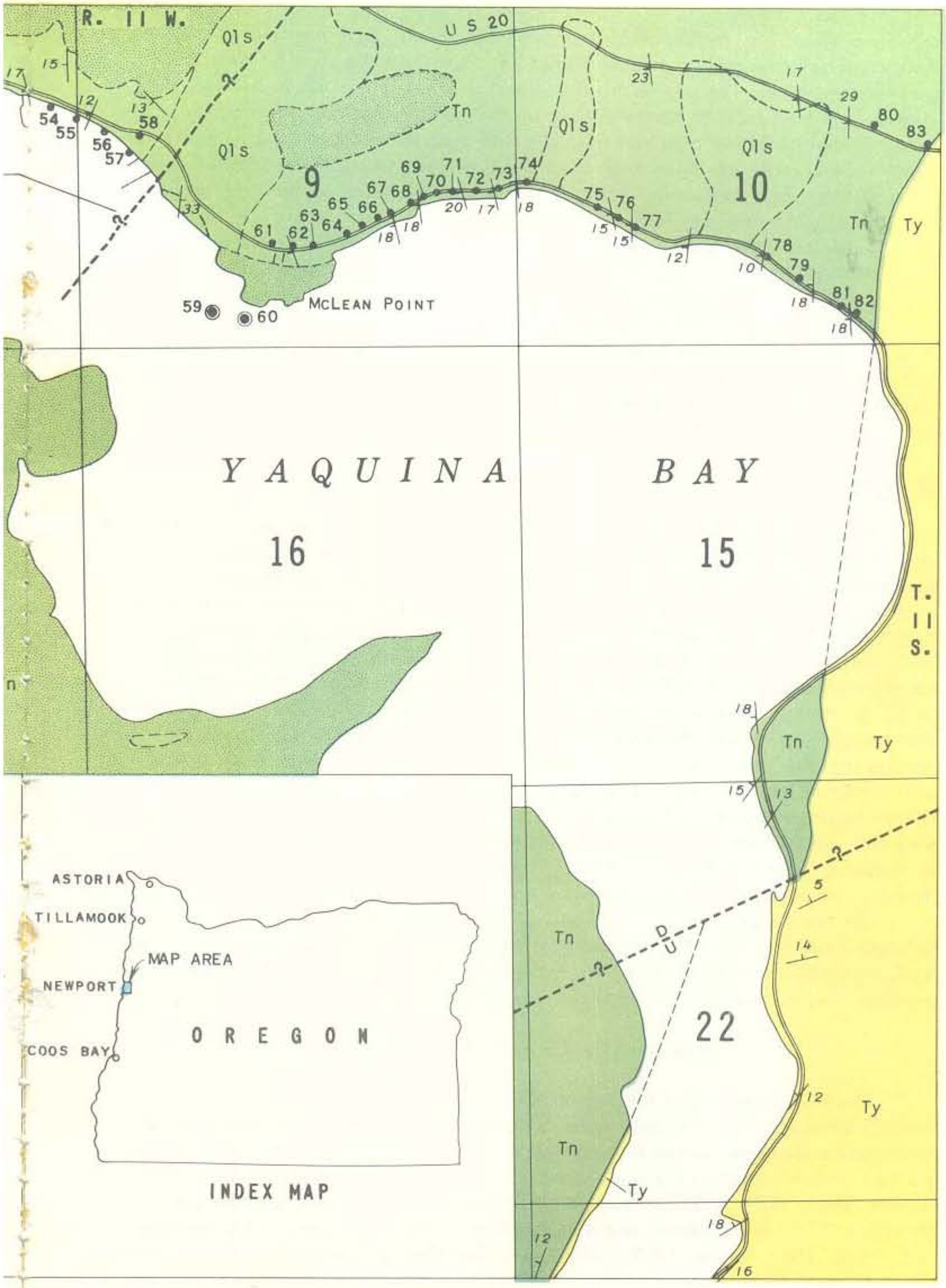


Plate 1. Geologic map of the Yaquina Bay area



ea, Newport, Oregon, showing sample locations.

shown on figure 1 by alphabetical designations B through H. Mechanical analyses indicate a range in grain size from medium-grained sandstone to silty, very fine-grained sandstone. The coarser sandstone occurs in the upper part of the formation. Porosity and permeability determinations on the medium- to fine-grained silty sandstones (B through E) indicate that even the fine-grained sandstones are potential reservoir rocks. Although these determinations have not been made on friable coarse- to medium-grained sandstones, hand-lens examination indicates that their porosities probably would be even higher.

Study of heavy mineral separations made for 25 samples of arkosic sandstone of the Astoria Formation suggests that the heavy mineral assemblage is similar throughout the unit. The mineral grains in the assemblage are predominantly subangular and consist of about 60 percent hornblende, 20 percent epidote, 8 percent garnet, 6 percent sphene, and less than 2 percent each of zircon, tourmaline, apatite, kyanite, and staurolite. Traces of red oxyhornblende(?) occur in nearly half of the samples. This heavy-mineral suite contrasts with that of the Nye Mudstone, which is characterized in general by a garnet-sphene-apatite assemblage.

Unnamed unit

In the Yaquina Bay area an unnamed unit of late(?) Miocene age unconformably overlies the Astoria Formation and consists of a basalt flow, waterlaid fragmental basaltic debris, and fine-grained sandstone. The unnamed unit is known only from the two westernmost core holes drilled about 1¼ miles west of the mouth of the Yaquina River. The basalt flow at the base of the unit forms a north-trending "reef" indicated by the 4-fathom contour line on plate 1. This flow consists of a slightly porphyritic basalt about 60 feet thick that rests on black carbonaceous sandstone which is interpreted as an ancient soil zone. The basalt is massive and amygdaloidal throughout its thickness; the upper part is very vesicular. These data lead to the conclusion that this basalt flow was of subaerial origin and flowed out on the surface after uplift of the land and withdrawal of the sea. The flow is overlain by about 25 feet of waterlaid fragmental basaltic debris, which in turn is overlain by micaceous, very fine-grained sandstone and sandy siltstone of unknown thickness. The sandstone is irregularly bedded and crossbedded. The results of a mechanical analysis, and of porosity and permeability determinations, are given in table 2, column A.

On the basis of mineralogical similarities, as well as chemical data given in columns 3 and 4 of table 1, the basalt flow and breccia of the unnamed unit in the Yaquina cores are correlated with the volcanic rocks at Yaquina Head, Cape Foulweather, and northward as far as Government Point (14 miles north of Newport).

Age of the Miocene Sequence

The biostratigraphy of the sequence of Miocene strata exposed along Yaquina Bay has attracted many workers, because a practically uninterrupted succession of fossiliferous strata can be readily sampled here. Despite the fact that many of these workers have reported on the age and faunas of the Nye Mudstone and Astoria Formation (Dall, 1909, 1922; Howe, 1922; Schenck, 1928; Packard and Kellogg, 1934; Weaver, 1937, 1942; Warren and others, 1945; Vokes and others, 1949; Snavely and Vokes, 1949; Moore, 1963; and others), checklists of species in the order of their stratigraphic occurrence in the Miocene sequence have not been published. Table 3 presents the stratigraphic occurrence of Foraminifera in the Nye and Astoria collected systematically from both surface outcrops and from cores in U.S. Corps of Engineers test holes (localities 1-83 of plate 1). An alphabetical listing of species is given in table 4. Similar checklisting of the molluscan fauna in the Miocene sequence of the Yaquina Bay area must await further studies.[1/]

Foraminiferal fauna

Although Foraminifera are abundant in both the Nye Mudstone and Astoria Formation exposed along the north side of Yaquina Bay, the number of species is limited. Individual assemblages are usually composed of two or three species that are represented by large numbers of individuals together with a few species that are poorly represented.

A two-fold subdivision of the Miocene foraminiferal sequence at Yaquina Bay has proved to be reasonably dependable in biostratigraphic work in the Newport Embayment. Fifteen species that occur in the Nye Mudstone are not found in the overlying Astoria Formation. Most significant among this group is Uvigerinella obesa impolita Cushman and Laiming, which occurs consistently throughout the Nye Mudstone. Additional species characteristic of the Nye, although not as consistently distributed, are Cassidulina laevigata carinata Cushman, Gyroidina soldanii d'Orbigny, and Uvigerina auberiana d'Orbigny.

Species confined to the overlying Astoria Formation are Buliminella elegantissima (d'Orbigny), Robulus mayi Cushman and Parker, Valvulineria menloensis Rau, and Uvigerinella californica ornata Cushman. Individual assemblages of the Astoria Formation are, therefore, differentiated from those of the Nye Mudstone primarily by the presence of one or more of these species. Inasmuch as none were found to occur either in large numbers or in many samples, it is entirely possible to encounter foraminiferal assemblages in the Astoria that do not contain any of these key species. In such cases it is not possible to differentiate Astoria assemblages from those of the Nye Mudstone.

Because of the many species found in the Nye Mudstone, but not in the Astoria Formation, Nye assemblages commonly are much more easily recognized, at least within the Newport Embayment, than assemblages of the Astoria Formation. These faunal distinctions, however, are not necessarily recognizable in the Tertiary sequence of other Pacific Coast areas. Therefore, only broad correlations with the Yaquina Bay foraminiferal sequence are justified.

The age of the lower part of the Nye Mudstone is firmly established as no older than the Saucesian Stage of Kleinpell (1938) on the basis of the present of Nonion costiferum (Cushman), Bolivina advena Cushman, Epistominella parva (Cushman and Laiming), and Uvigerinella obesa impolita Cushman and Laiming. The Saucesian Stage has been regarded as early Miocene by some workers (Kleinpell, 1934, 1938; Bandy and Kolpack, 1963); "Oligo-Miocene" by others (Weaver and others, 1944), and Oligocene and Miocene(?) by still others (Kleinpell and Weaver, 1963). In this

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1/ Biostratigraphic studies of Oligocene and Miocene molluscan faunas are currently being undertaken by W. O. Addicott of the U.S. Geological Survey.

Table 3. Checklist of Foraminifera from the Nye Mudstone and Astoria Formation, Yaquina Bay area, Newport, Oregon.

Species:

1. Nonionella miocenica Cushman
2. Buliminella subfusiformis Cushman
3. Buliminella elegantissima (d'Orbigny)
4. Bulimina ovata d'Orbigny
5. Quinqueloculina sp.
6. Nonion costiferum (Cushman)
7. Nonion incisum (Cushman)
8. Robulus mayi Cushman and Parker
9. Bolivina advena Cushman
10. Eponides mansfieldi oregonensis Cushman and R. E. and K.C. Stewart
11. Robulus spp.
12. Globigerina spp.
13. Valvulineria menloensis Rau
14. Uvigerinella californica ornata Cushman
15. Nonion incisum kernensis Kleinpell
16. Cibicides sp.
17. Epistominella parva (Cushman and Laiming)
18. Pseudoglandulina cf. P. inflata (Bornemann)
19. Virgulina californiensis Cushman
20. Lagena costata (Williamson)
21. Cassidulina laevigata carinata Cushman
22. Uvigerinella obesa impolita Cushman and Laiming
23. Elphidium cf. E. minutum (Reuss)
24. Gyroidina soldanii d'Orbigny
25. Uvigerina auberiana d'Orbigny
26. Plectofrondicularia californica Cushman and Stewart
27. Bolivina marginata adelaidana Cushman and Kleinpell
28. Nodogenerina advena Cushman and Laiming
29. Bulimina alligata Cushman and Laiming
30. Plectofrondicularia vaughani Cushman
31. Cassidulinoides sp.
32. Entosolenia sp.
33. Lagena substriata Williamson
34. Eponides cf. E. nanus (Reuss)
35. Marginulina subbullata Hantken
36. Dentalina cf. D. quadrulata Cushman and Laiming

Locs.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.
Astoria Formation																																				
1	R	R	R	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
2	-	F	R	F	-	F	F	R	F	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
3	-	R	-	-	-	F	?	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
4	R	R	-	-	-	F	-	-	C	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
5	-	F	R	-	-	F	?	-	C	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
6	C	R	R	R	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
7	-	-	R	R	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
8	R	R	-	F	-	R	-	-	R	R	-	R	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-							
9	-	R	-	-	-	C	-	-	C	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	C	-	-	-	C	-	-	F	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	F	-	-	-	C	-	F	F	F	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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14	-	R	-	-	-	F	-	-	R	R	-	R	-	-	-	-	R	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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16	-	-	-	-	-	R	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	R	?	-	R	-	R	-	?	R	-	-	R	R	-	-	-	-	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	F	?	F	R	R	F	-	-	C	R	-	F	-	-	-	R	R	-	?	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	-	R	-	F	-	C	-	R	C	F	-	R	-	-	-	-	-	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	R	-	-	-	-	C	-	R	F	C	R	R	-	-	-	-	R	-	R	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	R	-	-	-	-	F	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-						
Nye Mudstone																																				
23	F	-	-	-	-	F	C	-	C	R	R	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-	-	-						
24	-	-	-	-	-	F	-	-	C	R	F	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	F	-	-	-	-	F	F	-	R	R	-	R	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	C	R	-	F	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	C	-	-	-	-	C	-	-	R	F	R	R	-	-	-	-	F	-	-	-	-	C	C	-	-	-	-	-	-	-	-	-	-	-	-	-
28	C	R	-	-	-	F	-	-	F	C	-	R	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	-	R	-	-	-	R	-	-	C	-	-	F	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-
30	F	R	-	-	-	C	C	-	-	R	R	R	-	-	-	-	-	-	-	-	-	C	F	-	-	-	-	-	-	-	-	-	-	-	-	-
31	C	-	-	-	-	F	-	-	F	F	R	R	-	-	-	-	-	-	-	-	-	F	R	-	-	-	-	-	-	-	-	-	-	-	-	-

Legend

C - Common
F - Few
R - Rare
? - Questionably identified

32	-	-	-	-	R	R	-	-	-	-	R	R	-	-	-	-	-	-	-	-	R	-	F	R	F	-	-	-	-	-	-	-	-	-	-	-
33	R	F	-	-	-	R	-	-	C	-	-	R	-	-	-	-	-	-	C	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	R	R	-	-	-	R	-	-	R	R	-	R	-	-	-	-	R	-	F	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	-	C	-	R	R	R	-	-	R	R	-	R	-	-	-	-	R	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	-	C	-	R	-	C	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	R	-	F	-	-	-	F	R	R	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	-	F	-	R	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	-	C	-	-	-	C	-	-	R	-	-	-	-	-	-	-	R	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40	-	C	-	-	-	F	-	-	-	-	-	R	-	-	-	-	R	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	-	C	-	-	-	F	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	-	C	-	-	-	R	-	-	-	-	R	R	-	-	-	-	R	-	-	-	R	C	-	R	-	-	-	-	-	-	-	-	-	-	-	-
43	-	C	-	-	-	R	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	-	C	-	-	-	R	-	-	-	-	R	-	-	-	-	-	R	-	-	-	-	C	-	-	R	-	-	-	-	-	-	-	-	-	-	-
45	-	C	-	-	-	R	-	-	-	-	R	-	-	-	-	-	F	-	-	-	-	F	-	-	-	R	-	-	-	-	-	-	-	-	-	-
46	-	C	-	-	-	R	-	-	-	-	-	R	-	-	-	-	R	-	-	-	-	C	-	R	-	F	-	-	-	-	-	-	-	-	-	-
47	-	C	-	-	-	C	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	C	-	R	R	-	-	-	-	-	-	-	-	-	-	-
48	R	C	-	R	-	F	-	-	-	-	R	-	-	-	-	-	R	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
49	-	C	-	F	-	F	-	-	R	-	-	F	-	-	-	-	-	-	?	-	-	?	-	-	?	-	-	-	-	-	-	-	-	-	-	-
50	-	C	-	-	-	F	-	-	C	-	R	F	-	-	-	-	R	-	-	-	-	C	-	-	F	-	-	-	-	-	-	-	-	-	-	-
51	-	C	-	R	-	F	-	-	F	F	R	C	-	-	-	-	-	R	-	-	C	C	-	-	F	R	R	R	-	-	-	-	-	-	-	-
52	-	R	-	-	-	R	-	-	-	-	R	F	-	-	-	-	-	R	-	-	C	-	R	C	C	F	R	R	C	-	-	-	-	-	-	-
53	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	R	-	-	-	-	-	-	-
54	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	R	-	C	-	-	-	-	-	-	-	-	-	-	-
55	-	R	-	-	-	C	-	-	R	-	R	F	-	-	-	-	-	R	-	R	C	F	F	F	C	-	-	-	F	-	-	-	-	-	-	-
56	-	R	-	-	-	C	-	-	R	-	F	F	-	-	-	-	-	R	-	R	C	F	F	F	C	R	-	F	F	R	-	-	-	-	-	-
57	-	C	-	-	-	F	-	-	F	-	-	R	-	-	-	-	-	-	R	-	F	C	-	R	-	F	-	-	R	-	-	-	-	-	-	-
58	-	-	-	-	-	C	-	-	F	-	-	F	-	-	-	-	-	F	F	R	C	-	-	C	C	F	R	F	C	-	-	-	-	-	-	-
59	-	-	-	-	-	R	-	-	-	-	R	R	-	-	-	-	-	F	F	-	F	R	-	R	C	-	-	-	R	-	-	-	-	-	-	-
60	-	-	-	-	-	R	R	-	-	-	-	-	-	-	-	-	-	R	-	-	C	C	F	R	C	F	-	-	-	-	-	-	-	-	-	-
61	-	-	-	-	-	C	-	-	-	?	R	F	-	-	-	-	-	F	C	-	C	F	F	R	C	-	F	-	F	-	-	-	-	-	-	-
62	R	C	-	C	-	C	-	-	R	-	R	F	-	-	-	-	C	-	C	-	-	C	-	-	F	-	F	-	-	-	F	-	-	-	-	-
63	-	C	-	-	-	C	-	-	-	-	-	F	-	-	-	-	C	-	F	-	-	C	-	-	R	-	-	-	-	-	-	-	-	-	-	-
64	-	C	-	?	-	C	-	-	F	-	-	F	-	-	-	-	C	-	F	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65	-	C	-	F	-	C	-	-	C	-	F	C	-	-	-	-	R	-	-	R	C	C	-	R	C	R	-	-	-	-	-	R	R	-	-	-
66	-	C	-	F	-	C	-	-	C	-	F	F	-	-	-	-	-	R	-	R	-	C	-	F	C	F	-	-	-	-	-	-	-	C	-	-
67	-	C	-	F	R	C	-	-	C	-	C	F	-	-	-	-	-	-	-	F	C	F	-	-	C	F	-	-	-	-	-	R	-	R	-	-
68	-	F	-	F	-	?	-	-	F	-	C	C	-	-	F	-	?	-	?	R	?	-	-	-	C	-	?	-	F	-	-	R	-	C	-	-
69	-	F	-	-	-	-	-	-	F	-	F	F	-	-	F	-	-	F	?	-	R	-	-	F	C	-	-	F	C	-	-	-	-	-	-	-
70	-	C	-	C	-	-	-	-	F	-	R	F	-	-	C	-	-	-	?	-	?	-	-	-	C	-	-	-	-	-	-	-	-	F	-	-
71	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-
72	-	F	-	-	-	-	-	-	C	-	R	C	-	-	C	-	-	-	?	-	-	-	-	F	C	-	-	-	R	-	-	-	-	-	-	-
73	-	-	-	-	-	F	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
74	-	R	-	F	-	C	C	-	R	-	C	R	-	-	?	F	-	R	-	F	-	-	C	R	-	-	-	-	-	-	-	-	F	-	C	-
75	-	F	-	-	-	C	-	-	R	-	F	-	-	-	-	-	-	-	?	R	F	C	-	F	F	-	R	-	-	-	-	-	-	-	-	-
76	-	C	-	-	-	C	-	-	C	-	C	R	-	-	?	-	-	F	?	F	F	F	-	F	R	R	-	-	-	-	-	-	-	-	-	-
77	-	R	-	?	-	C	-	-	F	-	F	-	-	-	?	R	-	-	-	R	?	C	-	C	-	-	-	-	-	-	-	-	-	-	-	R
78	-	-	-	-	-	-	-	-	-	?	R	-	-	-	C	R	-	F	-	R	-	-	C	F	-	-	-	-	-	-	-	-	-	-	-	-
79	-	-	-	F	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	R	-	-	-	-	-	-	-	-	-	-	-	-
80	-	-	-	-	-	F	-	-	R	-	F	-	-	-	-	R	?	R	-	-	R	C	C	F	C	F	-	-	-	-	-	R	R	-	F	-
81	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	?	-	F	-	-	-	-	-	-	-	-	-	-	-	-
82	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
83	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-	R	R	-	-	-	F	C	F	F	R	R	-	-	R	-	-	R	-	-	-	-

Table 4. Alphabetical listing of Foraminifera from the Nye Mudstone and Astoria Formation, Yaquina Bay area, Newport, Oregon.

Species

9. *Bolivina advena* Cushman
27. *Bolivina marginata adelaidana* Cushman and Kleinpell
29. *Bulimina alligata* Cushman and Laiming
4. *Bulimina ovata* d'Orbigny
3. *Buliminella elegantissima* (d'Orbigny)
2. *Buliminella subfusiformis* Cushman
21. *Cassidulina laevigata carinata* Cushman
31. *Cassidulinoides* sp.
16. *Cibicides* sp.
36. *Dentalina* cf. *D. quadrulata* Cushman and Laiming
23. *Elphidium* cf. *E. minutum* (Reuss)
32. *Entosolenia* sp.
17. *Epistominella parva* (Cushman and Laiming)
10. *Eponides mansfieldi oregonensis* Cushman and R. E. and K. C. Stewart
34. *Eponides* cf. *E. nanus* (Reuss)
12. *Globigerina* spp.
24. *Gyroidina soldanii* d'Orbigny
20. *Lagena costata* (Williamson)
33. *Lagena substriata* Williamson
35. *Marginulina subbullata* Hantken
28. *Nodogenerina advena* Cushman and Laiming
6. *Nonion costiferum* (Cushman)
7. *Nonion incisum* (Cushman)
15. *Nonion incisum kernensis* Kleinpell
1. *Nonionella miocenica* Cushman
26. *Plectofrondicularia californica* Cushman and Stewart
30. *Plectofrondicularia vaughani* Cushman
18. *Pseudoglandulina* cf. *P. inflata* (Bornemann)
5. *Quinqueloculina* sp.
8. *Robulus mayi* Cushman and Parker
11. *Robulus* spp.
25. *Uvigerina auberiana* d'Orbigny
14. *Uvigerinella californica ornata* Cushman
22. *Uvigerinella obesa impolita* Cushman and Laiming
13. *Valvulineria menloensis* Rau
19. *Virgulina californiensis* Cushman

report the Saucesian Stage is considered to be early Miocene and the Relizian Stage middle Miocene. As Uvigerinella obesa impolita occurs in the uppermost part of the Nye Mudstone, a Saucesian age is indicated for the entire unit.

Although the species found in the Astoria Formation in the Yaquina Bay area are known to occur in both the Relizian and Saucesian Stages, the composition of the fauna suggests a Saucesian age. Farther north, in the southern part of the Astoria Embayment, strata referred to the Astoria Formation (Wells and Peck, 1961) contain a foraminiferal assemblage diagnostic of the Relizian Stage. This fact suggests that strata assigned to the Astoria Formation in western Oregon range in age from Saucesian to Relizian and that only the lower part of the sequence (Saucesian) is present in the Yaquina Bay area.

The Yaquina Formation and the upper part of the Toledo Formation (Vokes and others, 1949), which underlie the Nye Mudstone in the Newport Embayment, contain typical Zemorrian faunas. However, several samples of tuffaceous siltstone collected in the upper part of the Toledo Formation contained the following Saucesian-like forms:

Bolivina marginata adelaidana Cushman and Kleinpell - Common
Buliminella subfusiformis Cushman - Common
Cassidulina laevigata carinata Cushman - Common
Gyroidina soldanii d'Orbigny - Few
Nonion incisum (Cushman) - Few
Pseudoglandulina cf. P. inflata (Bornemann) - Rare
Uvigerinella obesa impolita Cushman and Laiming - Common
Virgulina californiensis Cushman - Few

The above fauna does not contain Nonion costiferum, which is common in the Nye Mudstone; therefore, the absence of this species suggests a pre-Saucesian age. Nonion costiferum is not known to extend below the Saucesian Stage, and in the Newport Embayment it is not known below the Nye.

The occurrence of a Saucesian-like fauna without Nonion costiferum in the Zemorrian part of the Toledo Formation suggests that environmental conditions during that time were similar to those operative during the time of deposition of the Nye.

Cool, fairly deep water conditions (more than 2,000 feet) are suggested by the presence of Uvigerinella obesa impolita, Uvigerina auberiana, and Gyroidina soldanii in the lower part of the Nye Mudstone. Nonion costiferum tends to modify this concept, suggesting temperate conditions at depths of possibly 1,000 to 2,000 feet. Some relatively minor variations of this general environment probably took place during the deposition of the remainder of the lower part, as well as the middle part, of the Nye Mudstone. Possibly the greatest water depth was attained during the deposition of the lower middle part of the unit, where Gyroidina soldanii, Cassidulina laevigata carinata, Uvigerina auberiana, and Uvigerinella obesa impolita are present in substantial numbers. A gradual decrease in the water depth and probably an accompanying increase in water temperature took place during the deposition of the upper middle part of the Nye Mudstone. In the upper part of the Nye Mudstone, Nonion costiferum, Bolivina advena, and Uvigerinella obesa impolita are the persistent species and together suggest depths possibly between 500 and 1,500 feet. By Astoria time, water temperature may have been temperate, and depths possibly not more than 500 feet, for Buliminella subfusiformis, Bolivina advena, Eponides mansfieldi oregonensis and Nonion costiferum constitute the major part of the foraminiferal fauna.

Molluscan fauna

The rather limited molluscan assemblage contained in the Nye Mudstone has been listed by Vokes and others (1949) from collections made in the Newport Embayment. Study of these and new collections made by W. O. Addicott (written communication, May 1964) indicates that there are species in the Nye that are common also to the Astoria and Yaquina Formations; however, there seems to be a greater degree of similarity with the fauna of the Astoria. Addicott states that the Nye fauna correlates with the upper part of the Blakeley Stage or Echinophoria apta zone of Durham (1944). The fine-grained sandstone interbeds in the Nye contain upper Blakeley Stage index species such as Aforia clallamensis (Weaver), "Apolymetis" twinensis Durham, and Macoma twinensis Clark. However, some of the important guides, including Liracassis apta (Tegland), have not been found. As the upper part of the Blakeley Stage is correlated by Addicott (written communication, May 1964) with at least part of the early Miocene Vaqueros "Stage" of California, the Nye Mudstone is also considered to be of that age.

Mollusks of the Nye Mudstone suggest minimal water depths corresponding to the outer part of the sublittoral zone (low tide to 100 fathoms). Water temperatures were cool temperate in contrast to the warm-temperate environment suggested by the fauna of the overlying Astoria Formation.

Moore (1963) has recently monographed the molluscan fauna of the Astoria Formation of western Oregon and has presented evidence for correlation of that fauna with part of the Miocene of California. Of 97 Astoria species Moore lists 20 that occur in the Barker's Ranch fauna of California, which is assigned to the middle Miocene Temblor "Stage" of the informal standard section. Recent studies of the Barker's Ranch fauna by W. O. Addicott (written communication, May 1964) show an even greater number of identical species than Moore noted: 30 out of 97, or about 30 percent. According to Addicott, comparison with the fauna of the lower Miocene Vaqueros "Stage" of California reveals only 13 out of 97 species in common with the Astoria fauna.

Of particular interest to those concerned with biostratigraphic studies in the Astoria Formation in the Newport Embayment is the recognition by Addicott (written communication, May 1964) of a unique assemblage of mollusks in the upper part of the sequence exposed in the sea cliffs and on the wave-cut platform immediately north of the town of Otter Rock (locally referred to as the Marine Gardens). This high Astoria fauna is characterized by the gastropods Nassarius arnoldi (Anderson), Molopophorus matthewi Etherington, Natica (Natica) n. sp., and Chlorostoma aff. C. pacificum (Anderson and Martin). Pelecypods in these strata also occur lower in the Astoria Formation, but the most abundant mollusk in the younger beds is Spisula albaria (Conrad), represented by rather small individuals.

Moore (1963) concluded that the Astoria molluscan fauna is indicative of shallow- to moderate-water depths and a warm-temperate marine environment.

References

Bandy, O. L., and Kolpack, R. L., 1963, Foraminifera and sedimentological trends in the Tertiary sections of Tecolote Tunnel, California: Micropaleontology, v. 9, no. 2, p. 117-170.

Dall, W. H., 1909, Contributions to the Tertiary paleontology of the Pacific Coast. I, The Miocene of Astoria and Coos Bay, Oregon: U.S. Geol. Survey Prof. Paper 59, 278 p.

________, 1922, Fossils of the Olympic Peninsula [Washington]: Am. Jour. Sci., 5th ser., v. 4, p. 305-314.

Durham, J. W., 1944, Megafaunal zones of the Oligocene of northwestern Washington: California Univ., Dept. Geol. Sci. Bull., v. 27, no. 5, p. 101-211.

Harrison and Eaton, 1920, Report on investigation of oil and gas possibilities of western Oregon: Oregon Bur. Mines and Geology, Mineral Resources of Oregon, v. 3, no. 1, p. 3-37.

Howe, H.V.W., 1922, The Miocene of Clatsop and Lincoln Counties, Oregon: Unpublished doctoral thesis, Stanford Univ., Stanford, Calif., 186 p.

Kleinpell, R. M., 1934, Difficulty of using cartographic terminology in historical geology: Am. Assoc. Petroleum Geologists Bull., v. 18, no. 3, p. 374-379.

________, 1938, Miocene stratigraphy of California: Am. Assoc. Petroleum Geologists, Tulsa, Okla., 450 p.

Kleinpell, R. M., and Weaver, D. W., 1963, Oligocene biostratigraphy of the Santa Barbara Embayment, California: California Univ., Dept. Geol. Sci. Bull., v. 43, p. 1-250.

Loel, Wayne, and Corey, W. H., 1932, The Vaqueros Formation, lower Miocene of California; I, Paleontology: California Univ., Dept. Geol. Sci. Bull., v. 22, no. 3, p. 31-410.

Moore, E. J., 1963, Miocene marine mollusks from the Astoria Formation in Oregon: U.S. Geol. Survey Prof. Paper 419, 100 p.

Packard, E. L., and Kellogg, Remington, 1934, A new cetothere from the Miocene Astoria Formation of Newport, Oregon: Carnegie Inst. Washington Pub. 447, Contr. Paleontology, p. 1-62.

Schenck, H. G., 1927, Marine Oligocene of Oregon: California Univ., Dept. Geol. Sci. Bull., v. 16, no. 12, p. 449-460.

________, 1928, Stratigraphic relations of western Oregon Oligocene formations: California Univ., Dept. Geol. Sci. Bull., v. 18, p. 1-50.

________, 1936, Nuculid bivalves of the genus *Acila*: Geol. Soc. America, Spec. Paper 4, 149 p.

Snavely, P.D., Jr., and Vokes, H. E., 1949, Geology of the coastal area between Cape Kiwanda and Cape Foulweather, Oregon: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 97, scale 1:62,500.

Vokes, H. E., Norbisrath, Hans, and Snavely, P.D., Jr., 1949, Geology of the Newport-Waldport area, Lincoln County, Oregon: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 88, scale 1:62,500.

Warren, W. C., Grivetti, R. M., and Norbisrath, Hans, 1945, Geology of northwestern Oregon, west of Willamette River and north of latitude 45°15': U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 42, scale approx. 1 in. to 2¼ mi.

Weaver, C. E., 1937, Tertiary stratigraphy of western Washington and northwestern Oregon: Washington Univ. [Seattle] Pub. in Geology, v. 4, 266 p.

________, 1942, Paleontology of the marine Tertiary formations of Oregon and Washington: Washington Univ. [Seattle] Pub. in Geology, v. 5, pts. 1, 2, 3, 789 p.

Weaver, C. E., and others, 1944, Correlation of the marine Cenozoic formations of western North America [Chart 11]: Geol. Soc. America Bull., v. 55, no. 5, p. 569-598.

Wells, F. G., and Peck, D. L., 1961, Geologic map of Oregon west of the 121st meridian: U.S. Geol. Survey Misc. Geol. Inv. Map I-325, scale 1:500,000.

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NOTICE OF WELL RECORDS RELEASED

Humble Oil & Refining Co., Wicks No. 1, NE$\frac{1}{4}$ sec. 11, T. 7 S., R. 1 E., Marion County. Total depth 7,797 feet. Records were released from the Department's confidential file on July 31, 1964. Available data include: core descriptions, mud log, induction electric log, and driller's log.

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METEORITE EXHIBIT OPEN TO PUBLIC

Meteorites, tektites, and impactites are on display at the Department's museum, at 1069 State Office Building, Portland. The specimens are on loan from Dr. Erwin F. Lange, Portland State College, and from the collection of the late Ben R. Bones of Grants Pass. Shown also are photographs of famous Oregon meteorites, including a fragment of the "Port Orford Meteorite" featured in the July issue of The ORE BIN.

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