The Ore Bin

Vol. 29, No. 5
May 1967

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

• The Ore Bin •

Published Monthly By

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
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Subscription rate $1.00 per year. Available back issues 10 cents each.

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Second class postage paid
at Portland, Oregon

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State of Oregon
Department of Geology
and Mineral Industries
1069 State Office Building
Portland, Oregon 97201

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GEOLOGY OF CAPE LOOKOUT STATE PARK, NEAR TILLAMOOK, OREGON

By Doris Mangum*

Introduction to the Park

Cape Lookout is probably the most striking and scenic headland on the Pacific Coast. The two-mile-long cape is a narrow wedge of basaltic lava with vertical sea cliffs 800 feet high. Extending north from it is Netarts Spit, a six-mile-long, dune-covered ridge of sand that separates Netarts Bay from the open ocean. North of Netarts Bay is Cape Meares, another basalt headland.

Cape Lookout State Park provides excellent recreation facilities on the fine beaches of Netarts Spit adjoining Cape Lookout. The park is situated on the northern Oregon coast off U.S. Highway 101 southwest of Tillamook. It may be reached from Tillamook by way of Netarts and Whiskey Creek roads, a total distance of 12 miles (figure 1).

Overnight camping facilities include 53 trailer sites, with hookups for water, sewage, and electricity, and 196 tent sites. Fresh water, firewood, laundry, and showers are available near campsites. Sheltered electric stoves are provided in the day-use area at nominal charges. Group camping by reservation will accommodate 100 people, thus permitting organized groups to convene apart from the main-use area. Park facilities are generally available to the public year-round according to public demand and weather conditions. Other parks (including federal, state, and county) with overnight camping facilities are available in the proximity of Tillamook; their general locations are shown on figure 1.

There are many interesting and scenic places for the park visitor to see at Cape Lookout and in the surrounding areas. Four trips, including both hikes and drives, to points of interest are outlined in this report. Their locations are shown on figure 1. But first, a review of the geographic setting and the geology of the region should help make these excursions more enjoyable.

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* Doris Mangum is doing graduate work in soil science and geology at Oregon State University. Her report on Cape Lookout State Park is the result of a cooperative arrangement between the State of Oregon Department of Geology and Mineral Industries and the State Parks and Recreation Division of the Highway Department to present the geology of the area in a way that is interesting and understandable to park visitors.

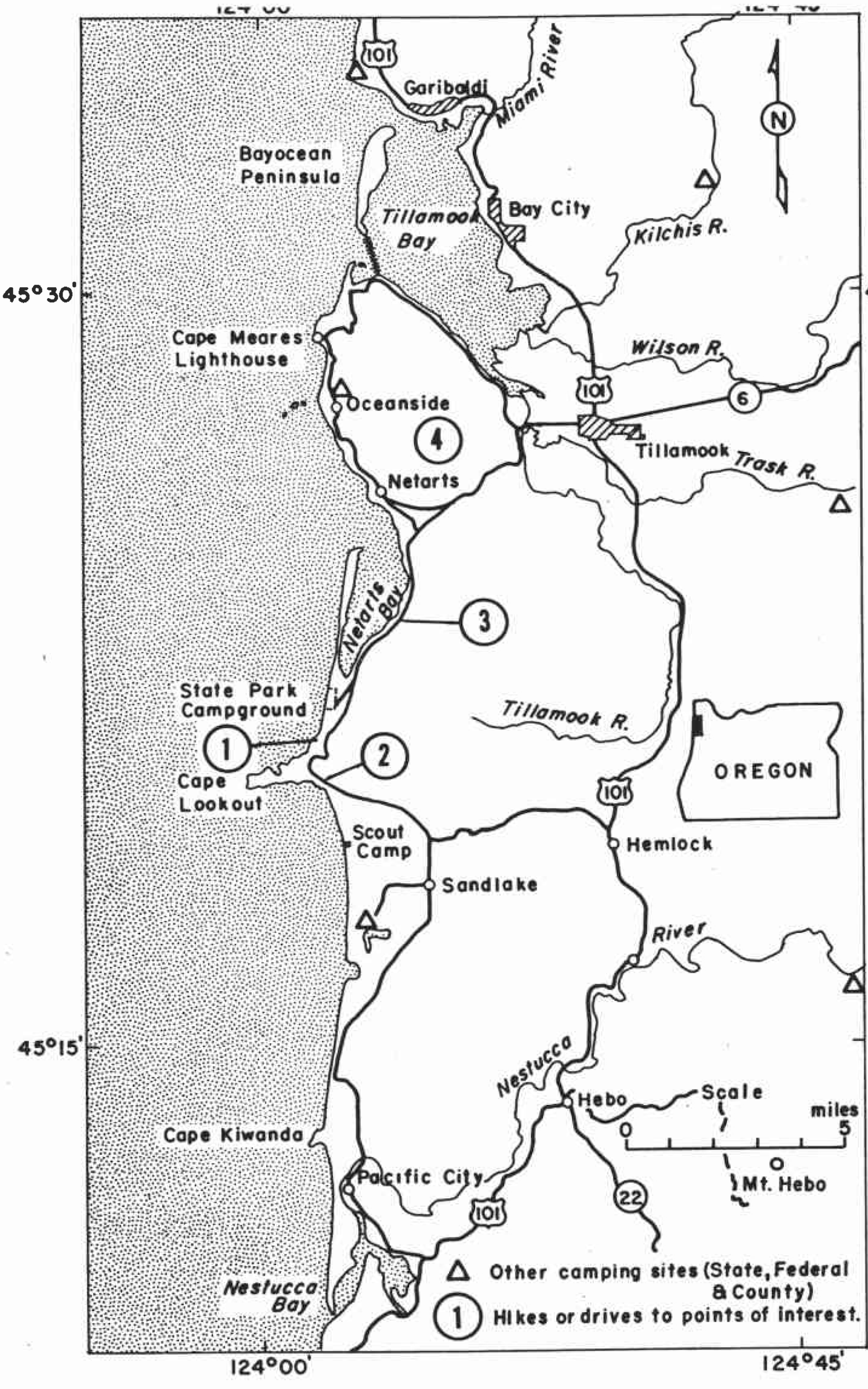


Figure 1. Index map of the Tillamook region, showing location of Cape Lookout State Park and other geographic features. Numbers 1 through 4 refer to hikes and drives described in text.

Geographic Setting

History

Historians claim that in 1788 John Meares, an English sea captain, applied the name "Lookout" to the present Cape Meares 10 miles to the north. Then, through some misunderstanding, the Coast Survey adopted the name Cape Lookout on its charts of 1850–53 for a point 10 miles south of Meares' original location and the name still stands (Armstrong, 1965).

Tillamook, which means "Land of Many Waters," was the name of a large tribe of Salish Indians who lived in the area south of Tillamook Head. Early explorers writing in their journals spelled the name Killamook, Callemex, and various other ways, but finally the present spelling was adopted. In 1853 Tillamook County was created by territorial legislature, and in 1866 a post office named Tillamook was established.

The first 20 years were difficult ones for the settlers, especially since they had to pack all of their supplies in from the north over the treacherous Neahkahnie Mountain. Several shipping attempts failed. Thirty-two shipwrecks (Orcutt, 1951) between Neahkahnie Mountain and the Nestucca bar attest to a dangerous Pacific Coast.

Climate and vegetation

The Tillamook area is located in a marine climate typical of the west coasts of continents between 40° and 50° latitude. The average January and July air temperatures are 42° and 59° respectively. Tillamook records about 90 inches of rain a year, with the months November through March receiving more than 10 inches, while July and August each average less than 2 inches. The warm Japanese current passes the Aleutian Islands and continues south along the Pacific Coast. Ir provides moisture as clouds and fog which are channeled upward by the Coast Range, where they cool to produce rain. The prevailing winds are from the southwest during the winter and the northwest during the summer.

A humid transition vegetation zone extends from the Pacific Ocean to the middle slopes of the Cascades. Major trees are the western hemlock (Tsuga heterophylla), western red cedar (Thuja plicata), Douglas fir (Pseudotsuga menziesii), and Sitka spruce (Picea sitchensis). Species of maple, alder, Pacific yew, salal, red elderberry, huckleberry, salmonberry, thimbleberry, and trailing blackberry form a dense understory. Many fern species abound in the cool, moist shade.

Physiographic features

The Tillamook area lies in the Coast Range physiographic province, which extends from the Columbia River on the north to the Coquille River and the Klamath Mountains on the south and to the Willamette Valley on the east (Highsmith, 1957). The average elevation of the Coast Range is about 1,500 feet, but peaks such as Mount Hebo south of Tillamook rise about 3,000 feet. The narrow coastal plain is interrupted by headlands mainly of basalt, which is more resistant to erosion than sedimentary rocks such as sandstones and shales. Cape Lookout and Cape Meares are fine examples of basaltic headlands surrounded by softer, more easily eroded rock.

The work done by ocean waves is well illustrated in the Cape Lookout-Cape Meares area. Waves have a tendency to straighten out the coast line by eroding

Figure 2. Aerial view of seaward end of Cape Lookout.

headlands and building sand spits, such as Netarts Spit. These long ridges of sand are connected at one end with the mainland. They form when waves meet the shore at an angle and move sand along it. Wind accentuates the height of the spits by blowing the dried sand into dunes.

Waves are constantly eating away any rock that juts into the ocean at Cape Lookout and Cape Meares. Erosion is accomplished in several ways. When a wave washes over a rock, air becomes trapped and compressed in cracks and joints; when the water leaves, the air expands explosively and acts like a wedge to break the rock. When waves hurl sand, gravel, and boulders against the rock they chip it away. The force of the waves is tremendous. Pieces of rock have been thrown as much as 200 feet up the cliffs at Cape Meares and have damaged the lighthouse. When the lower part of the sea cliff is undermined by the waves, the upper portion loses its support and breaks off. During this process, caves sometimes develop where the rock is weak. Retreat of the sea cliff forms a wave-cut bench. The end of Cape Lookout has both a cave and a bench (figure 2). When a portion of a headland is cut off from the mainland, sea stacks, like those at Cape Meares, are created (figure 3).

Geologic History

Most of the rocks that underlie the Tillamook area were laid down in seas during Eocene, Oligocene, and Miocene epochs (see geologic map on plate 1-A). These rocks consist of lava flows and sediments, some of which contain marine fossils. At various times in the geologic history of the area the strata were uplifted from the sea, gently folded, faulted, and eroded. The old marine beds and lavas are now overlain in places by terrace deposits, dunes, and river silts of Pliocene, Pleistocene, and Recent age.

Eocene epoch

About 60 million years ago (see geologic time chart), during the early part of the Eocene epoch, a huge trough-like basin or geosyncline occupied the site of the present Olympic Mountains, Coast Range, and Puget-Willamette lowland. It extended from Vancouver Island in the north to the Klamath Mountains in the south. Sediments were eroded from the adjacent land and accumulated in the basin. At the same time, lava erupted from vents on the sea floor. At places the lava piled up to form volcanic islands, perhaps like the Hawaiian Islands today.

Tillamook Volcanics: In the northern Coast Range these rocks are known as the Tillamook Volcanics. They are the oldest rocks exposed in the Tillamook area and are, in part, equivalent to the Siletz River Volcanics in the central and southern portions of the Coast Range (Baldwin, 1959). The Tillamook Volcanics may be seen east of Tillamook in the Wilson, Trask, Nehalem, and Nestucca drainages (see geologic map, plate 1). They are dark greenish and gray, fine-grained to porphyritic (contain visible crystals) basalts with pillows, breccia, and related structures. Circulating chemical solutions have altered the basalts and have precipitated zeolites, quartz, and calcite in cavities. Tuffs, agglomerates, and water-laid marine sediments are interbedded with these lavas.

The Tillamook Volcanics continued to accumulate during middle Eocene time. The basalts attained thicknesses of 20,000 feet at several centers of volcanism, one of which was northeast of the present Tillamook area (Snavely and Wagner, 1963).

Figure 3. Erosional features in the Cape Meares headland. Cape Lookout can be seen in the distance.

Figure 4. Pillow lava in basalt flows at Cape Lookout along cape road.

Geologic Time Chart

Era	Period	Epoch	Beginning
Cenozoic	Quaternary	Recent	0.011 million years ago
		Pleistocene	1
	Tertiary	Pliocene	13
		Miocene	25
		Oligocene	36
		Eocene	58
		Paleocene	63
Mesozoic			230
Paleozoic			600
Pre-Cambrian			4,600

Nestucca Formation: By late Eocene time the geosyncline was divided into several basins, and volcanism and sedimentation continued in the marine water surrounding volcanic islands. The early and middle Eocene rocks in the highlands were eroded and contributed basaltic and arkosic sands to form about 5,000 feet of the Nestucca Formation. Contemporaneous basalt flows formed pillows and breccias as they poured onto the basin floor from local vents. Tuffaceous siltstones of the Nestucca Formation crop out along the Mount Hebo road.

Oligocene epoch

During Oligocene time, a large land mass rose above sea level east of Tillamook. The uplifted rocks were attacked by erosion and the sediments were redeposited on the sea floor to the west. Several thousand feet of tuffaceous mudstones, siltstones, and micaceous sandstones accumulated in the area. These marine sedimentary rocks now crop out in the hills along U.S. Highway 101 both north and south of Tillamook. Fossils equivalent to those found in the Keasey Formation of Columbia and Washington Counties have been reported from the Oligocene sediments (Warren, Norbisrath, and Grivetti, 1945).

Miocene epoch

Fairly early in Miocene time, the Coast Range was elevated and the older Tertiary rocks were folded and faulted along northerly trends. Most of western Oregon was then above sea level, excepting its western margin, where local downwarps resulted in shallow marine embayments. One of these embayments was in the Tillamook area. Others were situated in the Astoria, Newport, and Coos Bay regions. Sediments eroded from the adjacent uplifted land were deposited in these bays along with shells of mollusks and other marine animals. These beds have been named the Astoria Formation after outcrops in Astoria where the formation was first described.

While the Astoria Formation was being deposited, basalt was extruded onto the sea floor from a north-trending group of submarine volcanic vents. This volcanism was contemporaneous with the outpourings of Columbia River Basalt in the Columbia Gorge region. In the Tillamook area there were two centers of volcanic extrusion --

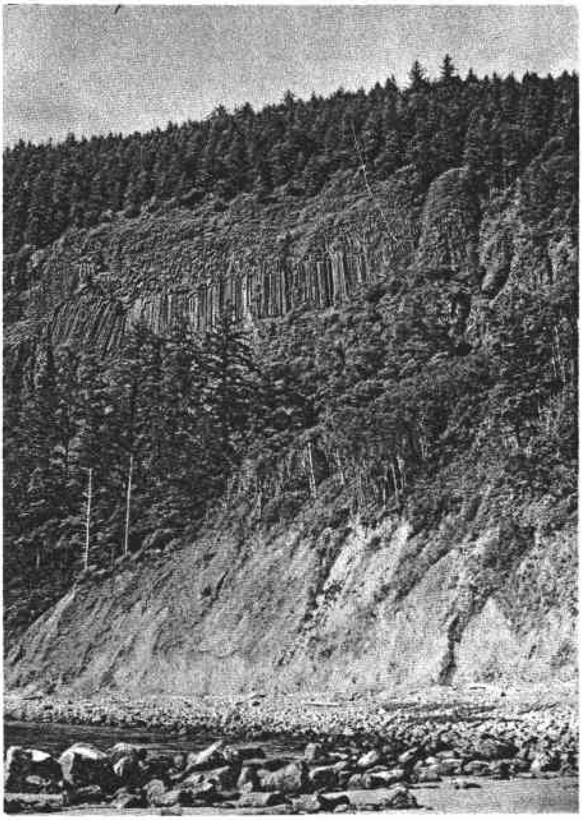


Figure 5. Basalt columns on south side of Cape Lookout.

Figure 6. Sloping surface on Cape Lookout, showing predominant 10° dip.

one at Cape Lookout and the other at Cape Meares.

Since Cape Lookout State Park and the surrounding area are almost entirely underlain by these Miocene rocks, the two formations are described in detail below.

Astoria Formation: In the Tillamook area, the Astoria Formation is composed of massive, micaceous sandstone and tuffaceous, sandy shale. It is gray on fresh exposure, but the typical weathered rock is yellowish and iron stained. The massive sandstone crops out along the south side of Tillamook Bay where it forms vertical cliffs. It underlies basalt on the south side of Cape Lookout, where it is well exposed in cuts along the cape road now under construction. Another place where the massive sandstone crops out is in Cape Kiwanda near Pacific City (figure 1). Here it forms one of the few headlands along the Oregon coast that is not made of basalt (Snavely and Vokes, 1949).

Tuffaceous sandy shale beds of the Astoria Formation underlie most of the area between Cape Meares and Cape Lookout (see geologic map, plate 1). They are exposed in a road cut at the Netarts-Cape Lookout junction. Small patches of Astoria sandstone and siltstone lie high on the flanks of the basalt mass east of Cape Lookout (plate 1-B). These sediments interfinger with the lavas and are exposed in the sharp curves of the new cape road. Astoria sands (not mapped) also occur on Cape Meares.

According to Warren, Norbisrath, and Grivetti (1945), the Astoria Formation in the Tillamook area is about 2,000 feet thick.

Fossils typical of the Astoria Formation have been collected from several places along the Oregon coast. These include the Cape Lookout-Cape Meares area, Cape Kiwanda, Beverly Beach, and Coos Bay. In the vicinity of Cape Lookout and Cape Meares there are at least two fossil localities. One is in the sandstone cliff near road level on the south side of Tillamook Bay across from the oyster-processing plant. The other is on the south side of Cape Lookout in road cuts through the sandstone on the new cape road. Following are some of the species identified from the latter location by W.D. Addicott of the U.S. Geological Survey (written communication, 1967).

Gastropods: *Nassarius* cf. *N. arnoldi* (Anderson); *Tectonatica vokesi* Addicott?; and *Searlesia carlsoni* (Anderson and Martin).

Pelecypods: *Anadara* sp.; *Macoma* sp.; *Macoma albaria* (Conrad)?; and *Spisula albaria* (Conrad).

Columbia River Basalt: In the Tillamook area the Columbia River Basalt is a dark gray, fine-grained lava. It forms the two large, resistant masses of rock that make up Cape Meares and Cape Lookout (see geologic map, plate 1-A). In both areas the basalt intrudes and interfingers with the Astoria Formation.

In places the lava flowed under water into the soft marine sediments of the Astoria Formation, while in other places the lava piled high enough to build islands above sea level. At Cape Lookout subaerial (on land) lava flows can be traced into pillow lavas interbedded with marine sediments. There are good examples of pillow lavas at the base of Cape Lookout both on the north and south sides and in cuts along the cape road (see figure 4).

Whereas pillow structures are usually associated with subaqueous (under water) volcanism, columnar-jointed basalts are considered subaerial flows. After cooling and solidifying, columnar jointing occurs when shrinkage cracks form in the basalt perpendicular to the cooling surface over which the lava flowed. Figure 5 shows

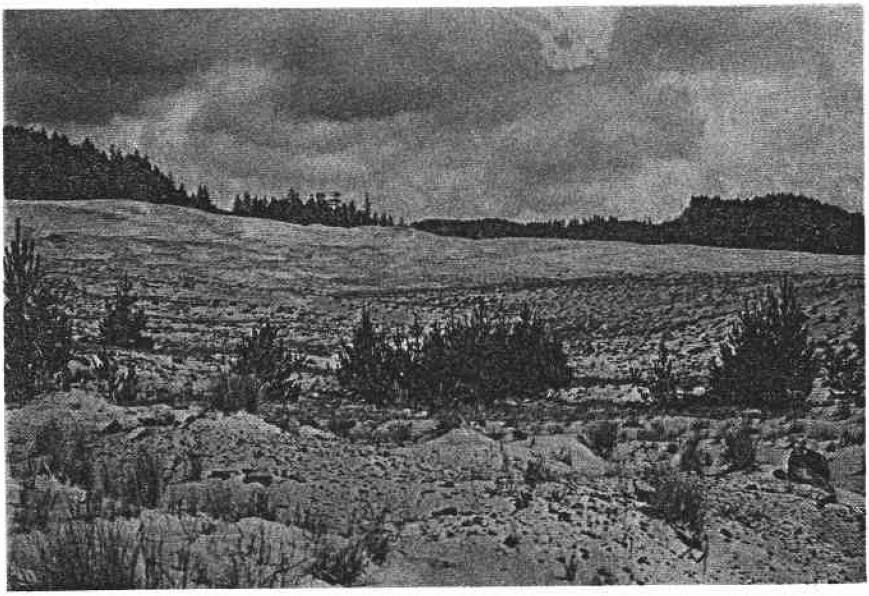


Figure 7. Sand dunes in the Sand Lake area south of Cape Lookout. Forest in background is growing on stabilized dune.

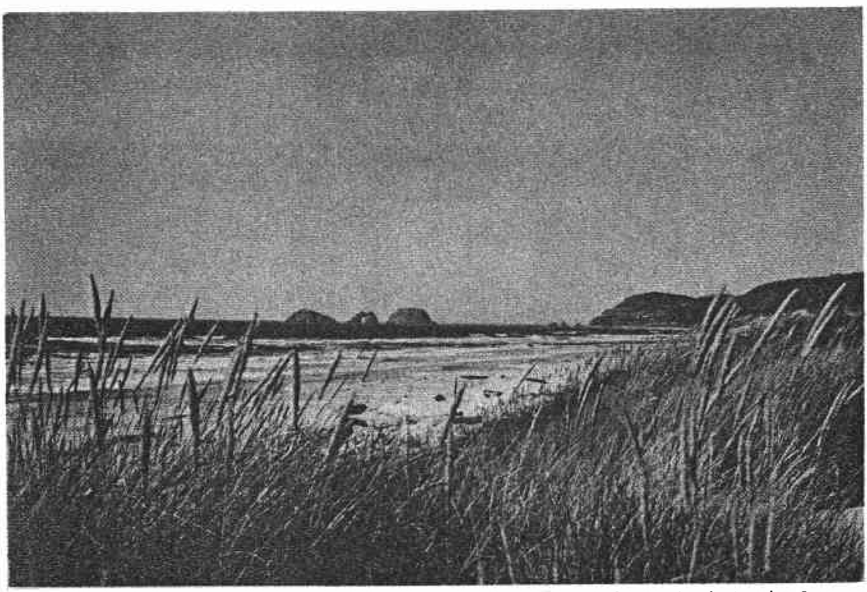


Figure 8. Looking north toward Cape Meares and Three Arch Rocks from grass-covered dune between campground and beach.

basalt columns on the south side of Cape Lookout that look like a long row of closely packed telephone poles, perhaps as much as 100 feet high and more than half a mile in length.

Columbia River lavas are quarried and used for road construction. Two quarries beside the road along Netarts Bay and one on the road between Oceanside and Cape Meares show good exposures of the basalt.

Pliocene epoch

There are no marine beds of Pliocene age in the Tillamook area, and so it is probable that the shore line was farther west than it is now.

During the Pliocene epoch the Coast Range was elevated to its present height and the Miocene strata were deformed. A small downwarp or syncline may have developed in the Tillamook area, its axis trending east-west through Netarts Bay between the two capes (Wells and Peck, 1961). In the high slopes behind Cape Lookout, flows of Columbia River Basalt -- once horizontal -- can be seen dipping at about a 10° angle toward the northwest (figure 6). Out on the end of the cape the layers of basalt dip northward (figure 2). If the strata in Cape Meares tilt in the opposite direction (toward Cape Lookout), it is possible that the two masses of basalt are joined at depth beneath an upper member of the Astoria Formation.

Pleistocene and Recent epochs

After deformation and uplift of the coastal region in Pliocene time, erosion became the dominant geologic process. Coast Range streams excavated their present valleys, and softer rock materials were carried westward into the ocean leaving the harder volcanic rocks in bold relief. Erosion of tilted lava flows on Cape Lookout has produced a topographic feature that is similar to a cuesta, with a steep cliff on one side and a gentle dip slope on the other (figure 6).

Former levels of the ocean are visible as remnants of terraces perched above sea level and covered by layers of sand, clay, peat, and wood. These Pleistocene terrace deposits occur in sea cliffs south of the town of Cape Meares and south of Cape Lookout State Park and are particularly evident along the east side of Netarts Bay (plate 1-B).

During and since Pleistocene time, the relative position of the ocean and land has been oscillating very slowly. At the present time the coast in the Tillamook area is one of submergence. Melting of continental glaciers of the ice age (Pleistocene) has gradually raised the sea level. As a result, waves are cutting away portions of the land to form stacks, caves, arches, sea cliffs, and narrow beaches. Mouths of rivers have drowned and bays have formed. Submerged tree roots and layers of peat now occur below tide level. Old dunes, once stabilized by vegetation, are being sliced into by the waves and reactivated. Cooper (1958) has shown that Netarts Spit and Bayocean Spit are the eroded remains of two elongate dunes that trended northeasterly. Their northern ends were joined to the mainland and their southern ends were the outlets for drainage to the sea. A large dune mass (figure 7) in the Sand Lake area is being cut away at its southern end by the advancing sea.

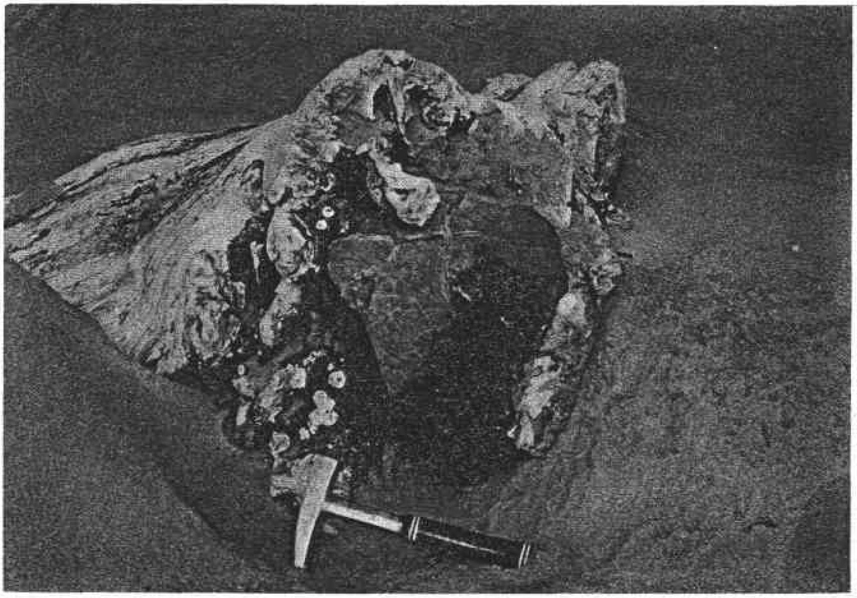


Figure 9. Tree-rafted rock carried onto beach by a high tide.

Figure 10. Flame structure in sediments exposed in sea cliff at Cape Lookout.

Trips to Points of Interest

1. Park area and beach hike

A short and interesting hike may be taken along the beach and sea cliffs beginning at the day-use parking lot. See the enlarged inset of local area on the geologic map of Cape Lookout (plate 1-B) for route of this hike.

A. South of the day-use area parking lot there is a rain forest with huge Sitka spruce and western red cedar trees. There are winding trails, bridges that cross meandering streams, and picnic tables located in the deep shade under the big trees. Many of the large spruce trees began as seedlings which obtained their nourishment from fallen, decaying red cedar logs. Some of the "mother" cedars have rotted away and have left the spruce trees standing on roots exposed above ground.

B. A large sand dune (figure 8) between the park and the ocean extends most of the length of Netarts Sand Spit. This dune protects park visitors from storm tides and some of the ocean breezes. It is important to help preserve these dunes, for when they are eroded away the park will have to go also.

C. The beach, which is the area between high and low tide, has five distinct zones, each with its own plant and animal communities (Zim and Ingle, 1955). The first and highest is the dry beach or dune area. The second is the uppermost beach, reached only by the highest tides, storm waves, and ocean spray. Next is the upper beach, which gets wet by tides twice daily, but plants and animals living on it are more adapted to land and air than to water. The middle beach is covered with water most of the time; plants and animals are less exposed to air and more harmed by drying. The lower beach is always submerged except during the lowest tides; it is exposed no more than twice monthly.

The tides result from the gravitational pull of the moon and sun, but because the moon is closer to the earth it has a stronger pull than the sun. The west coast has two high and two low tides each day, with about 6 hours between high and low tide, and they come about 50 minutes later each day.

High tide brings driftwood and other floating objects onto the upper beach. Figure 9 illustrates how rocks from distant places may come to rest on the beach. Tree roots sometimes grow around rocks, and when these trees become uprooted by floods and are washed to sea they carry the "exotic" rocks with them.

D. South of the creek, dune sands cap 20-foot cliffs of Pleistocene terrace and landslide debris. Waves have undercut the terraces and rocks have accumulated as talus. In the cavities of some of these rocks one can find silica, zeolite, and calcite fillings. Agates may form when some of the silica fillings fall out and become worn by the ocean waves.

E. At this location there are interesting sedimentary features in the terrace deposits (figure 10). The outcrop illustrates the flowing of coarse-textured sediments into finer textured ones causing a streaming or "flaming" of the lower unit into the upper one. The source of the coarse material appears to have been from the east, and deposition occurred when the finer material was still in a plastic state.

F. There is a small exposure of dark gray basalt with many prominent fractures and joints at this location. It represents an erosional remnant of Columbia River Basalt that makes up the cape, with terrace sediments deposited around it. Several zones in the terrace sediments contain fossil woody material that may be many thousands of years old. The old tree trunks and branches were deposited before the

GENERALIZED GEOLOGIC MAP OF THE TILLAMOOK REGION, OREGON

EXPLANATION

QUATERNARY — PLIOCENE-PLEISTOCENE-RECENT

Qal — Alluvium
(River gravels, sands, and silts)

Qd — Dune, bar, and beach sands

Qt — Terrace deposits
(Sands with layers of gravel, peat, wood, and clay capping wave-cut terraces)

TERTIARY — MIOCENE

Tcr — Columbia River Basalt
(Submarine and subaerial volcanic flows from local vents; pillow lavas and columnar basalt characteristic)

Ta — Astoria Formation
(Massive micaceous marine sandstone; tuffaceous siltstone interbedded with Tcr)

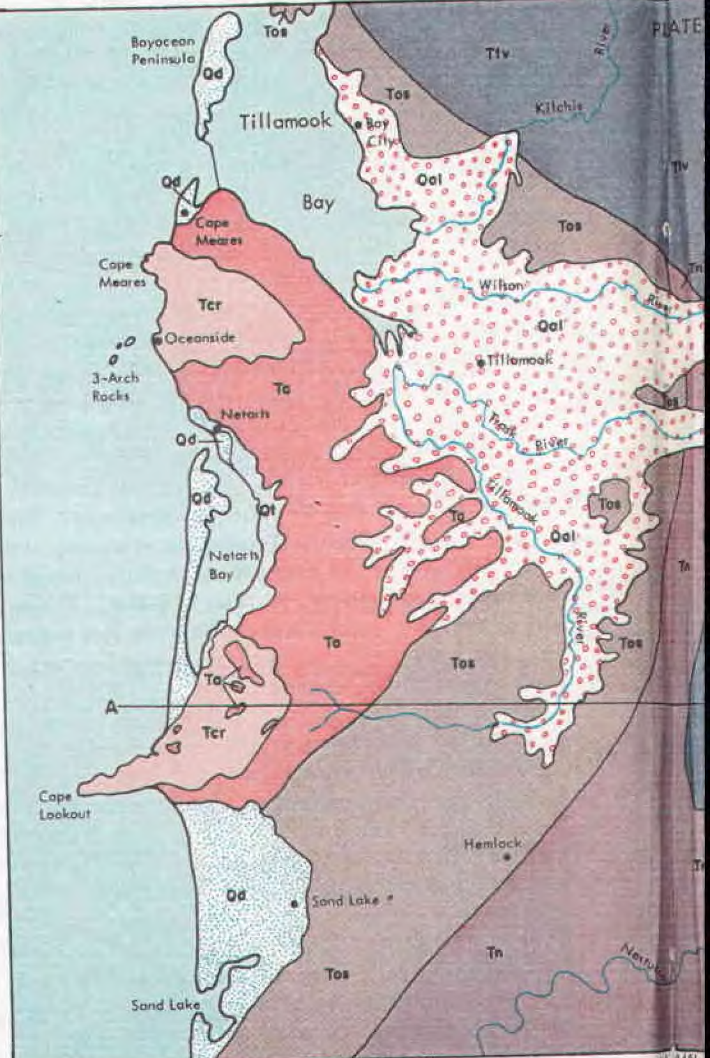
TERTIARY — OLIGOCENE

Tos — Oligocene sediments
(Tuffaceous marine siltstone, mudstone, and sandstone)

TERTIARY — EOCENE

Tn — Nestucca Formation
(Dark gray tuffaceous marine shale and thin-bedded sandstone with interbedded volcanic rocks)

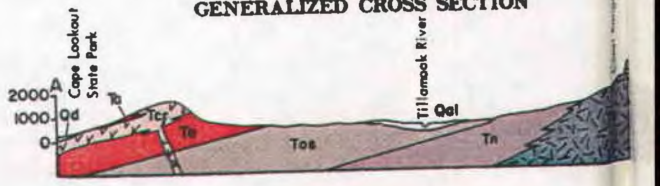
Ttv — Tillamook Volcanics
(Submarine basalt flows and interbedded sediments)



Geology modified from Wells and Peck, 1961

Scale 0 1 2 3 4 5 Miles

GENERALIZED CROSS SECTION



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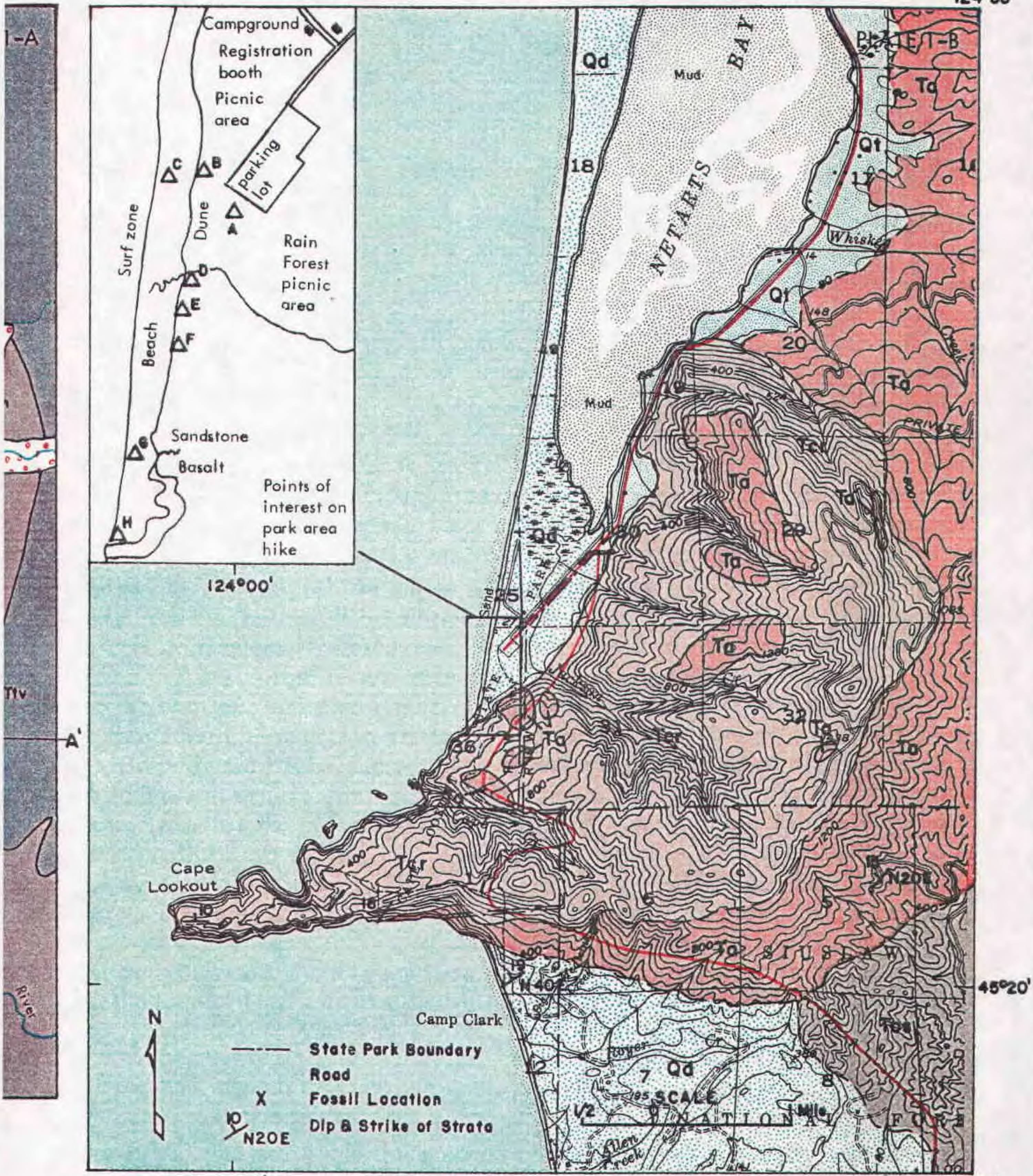
GEOLOGIC MAP OF CAPE LOOKOUT AND VICINITY



sediments accumulated above them.

G. At this location a contact between sandstone and basalt is exposed. The lower portion of the sandstone contains blocks of vesicular basalt as large as one foot in diameter. They probably broke off the sea cliff eons ago and were buried when the sediments were accumulating.

H. At the base of Cape Lookout there are some good exposures of pillow lava (see figure 11). Origin of pillows in lava is discussed in more detail under Trip No.2.

2. Cape drive and hike

There is a new road over the cape and a trail that goes out to the end of the promontory (see figure 2). It is best reached from the park by driving back to the Jackson Creek spur road and turning right just outside the park entrance (see plate 1-B). On the way to the top of the cape there is a viewpoint for looking north toward Cape Meares. The lack of trees on the surrounding hills is due to recent logging by the clearcut method.

Road cuts expose Columbia River Basalt and interbedded siltstones of the Astoria Formation. Immediately beyond the huge fill crossing Cape Creek, there are "pillow" structures in lava on the left side of the road. Many of these pillows are elongate, with iron oxide and glassy rims and internal radiating columnar jointing (figure 12). They formed when hot lavas were extruded into sea water or wet sediments and congealed in pillow-shaped bodies. Lava flowing into a liquid cools quickly on the outside, forming a glassy skin, and more slowly on the inside, forming radiating shrinkage cracks. Some forms are more rounded than those illustrated and do not have the radiating joint structures. Pillows are usually separated by sediments, chert, or angular basalt fragments called breccia (Snyder and Frazer, 1963).

Good exposures of columnar jointing may be seen where the new road crosses the top of the cape. Rounded cobbles at the base of the columnar-jointed basalt in the road cut indicate possible beach erosion prior to the subaerial flow of basalt.

At the top of the cape there is a parking area where the trail to the end of the cape begins. The trail winds through the Sitka spruce rain forest where ferns, salal, and other vegetation provide a dense understory. In places the trail follows the edge of a sheer, 800-foot cliff and hikers should proceed with caution. From various points along the trail there are excellent views of the coastline south of the cape.

During World War II, a bomber crashed on the top of the cape and evidence of the wrecked plane may be seen stewn about. A memorial plaque (figure 13) has been erected a short distance from the start of the trail to honor the nine men who lost their lives and the one who survived.

3. Netarts Bay and Sand Spit drive

By driving north along Netarts Bay and keeping left along the bay, one can get a good view of both the bay and the spit.

Netarts Bay: Netarts Bay is very shallow (figure 14) and occupies a re-entrant in the coastline. Differential rates of erosion between the basalt headlands of Cape Lookout and Cape Meares and the softer sedimentary rocks of the Astoria Formation have formed the depression occupied by Netarts Bay. At one time, the bay may have been a fresh-water lake either with an outlet to the south or with no permanent outlet. According to Cooper (1958), the dunes at the northern part of the spit were

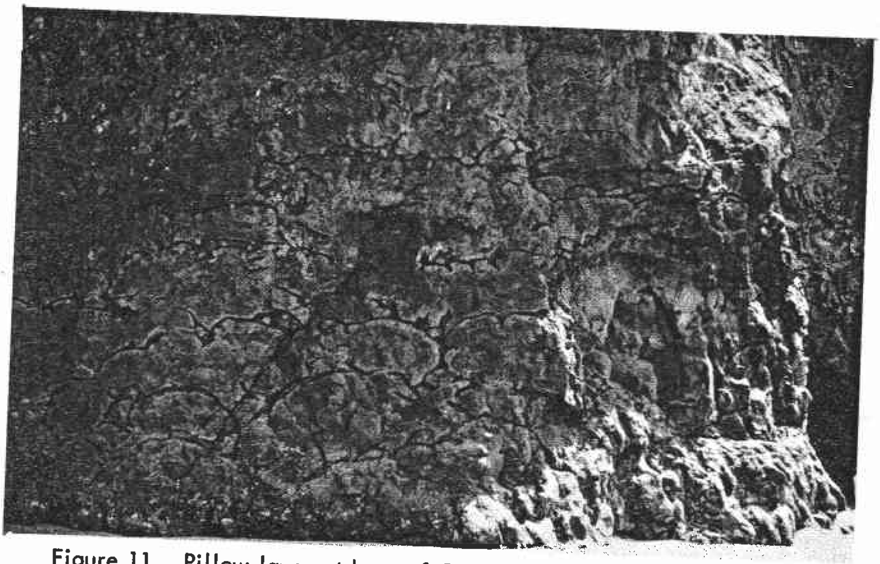


Figure 11. Pillow lavas at base of Cape Lookout at southern end of beach area.

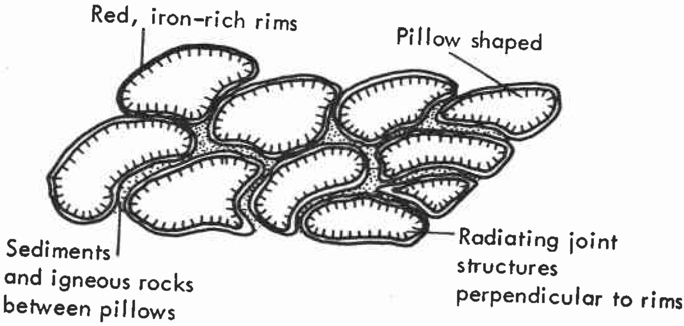


Figure 12. Sketch of pillow lava that has flowed into wet sediment.

Figure 13. Memorial plaque on Cape Lookout trail.

connected to those at Netarts until they were cut through by storm waves. Once an outlet at the northern end became well established, tidal currents and stream flows maintained it. Tree stumps exposed at low tide represent former forests inundated by a rising sea level. The bay is shallow, and at low water as much as 70 per cent of the bottom is exposed. Figure 14 shows the tidal channel at the northern end of Netarts Bay and the view looking in a northerly direction towards the Three Arch Rocks and Cape Meares.

Netarts has a public boat landing where boats can be rented for use in the bay. Since the bar at the mouth of Netarts Bay is very rough, few boats can cross it safely. The bay is a good place to get blue, cockle, quahog, littleneck, and soft-shell clams. Few razor clams live in the bay. Crabs are found in all the channels south to Whiskey Creek.

Many shore birds can be seen in the Netarts Bay area including herons, pelicans, gulls, and murres, handsome black and white birds.

<u>Netarts Sand Spit</u>: Netarts Spit is approximately six miles long, and can be divided into three sections. The northern part has dunes and blowouts and is only sparsely vegetated with dune grasses. Some of the plants growing on the dunes are Indian paint brush, dune strawberry, dune lupine, and tansy. The middle section is densely covered with conifers and brush. Some of the plants of the middle section are salal, Sitka spruce, beach pine, bracken, and thimbleberry. On the bay side there is a marsh area with tall marsh grasses, sedges, and salt rushes. Drift logs attest to periodic invasion by the sea during high tide and severe storms. The southern part of the sand spit next to the mainland resembles the northern part, but it is narrower and has no large dune. The southern end was cut completely through during two storms in 1939, leaving only a barrier beach between the bay and the ocean.

The prehistoric Tillamook Indians lived in several of the enclosed meadows on Netarts Spit. Newman (1959), who did a study on the Indian tribes in the Tillamook

Figure 14. Aerial view of Netarts Bay and Sand Spit, looking north toward Cape Meares.

area, located and dated by carbon-14 method three levels at which people had lived (1400, 1670, and 1850 A.D.) on the spit. The 1400 A.D. level is the earliest evidence of a Northwest Coast culture in Oregon.

The Northwest Coast Indians were the only North American Indians that learned to build good wooden houses. They emphasized water travel; their favorite pastime was gambling; and their greatest art was basket weaving. Many of the apparent disadvantages of the wet and rugged coastal strip were exploited and used advantageously. That they made good use of the local clams for food is evidenced by layers of shells buried by the dunes on Netarts spit (figure 15).

4. Cape Meares Loop Road trip

The 25-mile drive from Cape Lookout and around Cape Meares is a must in anyone's itinerary.

Oceanside: From Cape Lookout, drive along Netarts Bay and through Netarts to Oceanside, a total distance of about 7 miles. At Oceanside there is a good access to the beach. Oceanside, sheltered from northwest winds by Maxwell Point, has one of the best bathing beaches along the Oregon coast, as well as excellent rock and surf fishing, beautiful scenery, and agate hunting.

Maxwell Point is part of the large Cape Meares headland composed mainly of Columbia River Basalt. A tunnel through Maxwell Point provides access to the rest of the beach at high tide. Note the "pillow" structures and the fault beside the tunnel. Lost Boy Cave is between Oceanside and Short Beach. Legend has it that a boy became lost in the cave and was never found. The boy returned home, but the story of his safety never caught up with that of his loss.

Off shore from Oceanside are the Three Arch Rocks which Captain Meares called the Three Brothers. This nationally famous refuge is the nesting place for countless murres and the permanent home of a large herd of northern sea lions. Sea-lion pups are born in May and June and can be seen playing along the beach at many times during the year.

The Three Arch Rocks are good examples of sea stacks, which are portions of the resistant headland that have been detached from the shoreline. They formed when waves cut in on two sides of a promontory and then cut behind it. An island is left removed from the mainland. Other sea stacks at Oceanside are pictured in figure 16.

Cape Meares: About two miles beyond Oceanside there is a sign indicating a left turn into Cape Meares State Park. Cape Meares is a basalt headland with much rock and debris fall along wave-cut cliffs (figure 17).

The two main features are the lighthouse (not in use) and the octopus tree. There is also a picturesque picnic area with excellent views of the rugged sea cliffs and the Three Arch Rocks.

From the small parking lot a path leads down to the lighthouse (figure 18). According to Don Benskin in a Tillamook Chamber of Commerce brochure, the lighthouse was leased to Tillamook County in 1964 by the U.S. Coast Guard so it could be preserved as a historical site. It was built in 1890 from sheet iron and lined with bricks that were formed and baked on location. The beam of light could be seen from 21 miles at sea and it sent out an alternating red and white beam from sunset to sunrise, regardless of the weather. The unusual lens has eight sides. Four sides are covered with deep red panes of glass that produced a red beam of 160,000 candle power and four clear white sides which produced 180,000 candle power.

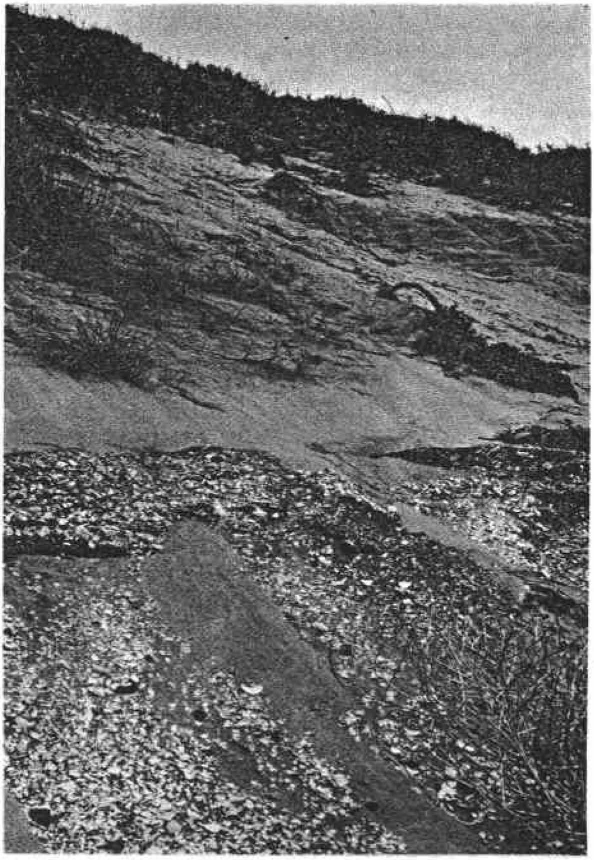


Figure 15. Shell mounds buried by dune sand on Netarts Spit.

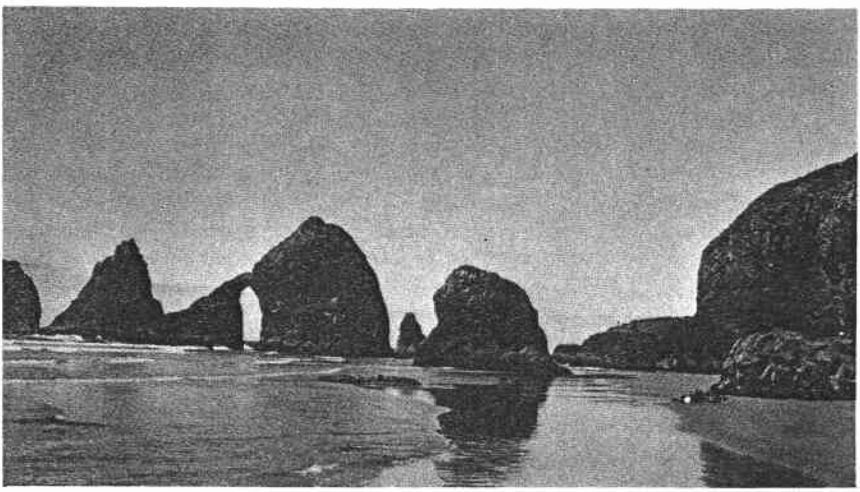


Figure 16. Sea stacks and arches at Oceanside.

Only one other eight-sided light of this type was ever constructed, and it is still operating in the Hawaiian Islands. The giant lens of the Cape Meares light was hand ground by Henry Lepaute in Paris, France, in 1887 and weighs more than a ton. It was carried around Cape Horn and hoisted up and over the 200-foot cliff. The first illumination was by a five-wick kerosene lamp, which was replaced by an incandescent oil-vapor lamp used until 1934, when the structure was electrified.

The lighthouse was designed to be built at Cape Lookout. Through an error, an ox-team trail was made to the summit of Cape Meares. The mistake was not learned until the lighthouse was finished in 1890.

The giant "octopus tree" was featured in Ripley's Believe It or Not as "seven trees in one." It is a huge Sitka spruce tree that has grown candelabrum-shaped in response to the strong winds. It may be reached by taking the trail from the parking lot and through the picnic area.

Cape Meares -- Bayocean Peninsula: After leaving Cape Meares State Park, drive north about 2 miles and turn left at the junction to visit the town and beach of Cape Meares, or turn right to continue the loop drive. When the jetty was built on the north side of Tillamook Bay, the sand transport equilibrium was upset and rapid erosion occurred at the town of Cape Meares. The terrace on which the town is situated has been receding at about 30 feet per year and it retreated 75 feet in 1960-61, taking part of the streets of Cape Meares with it (North and Byrne, 1965) (figure 19).

Significant changes have also taken place along the Bayocean Peninsula north of Cape Meares, probably accelerated by the building of the Tillamook Jetty. It is hard to believe that this uninhabited, dune-covered sand spit was once the site of a resort town. Beginning in 1907, Bayocean became a realtor's dream and was advertised widely as "the Queen of Oregon Resorts." Although it never achieved that status, nearly 2000 lots were sold, houses were built -- some quite costly -- and a few streets were paved; there was a natatorium and the beginnings of an elegant hotel. A ferry service operated from Garibaldi. By World War I time, the resort dream had died under insolvency and litigation, but some of the year-round residents continued to live there. According to newspaper accounts, there was a school with 16 pupils as late as 1932. In 1939, two winter storms in January and February cut through the road and undermined a long stretch of the sand bluff, including the natatorium and other buildings. A few people held on at Bayocean until 1948, when winter seas broke through three gaps in the peninsula. By 1961, the high sand bluff had receded 500 feet from its 1939 position. A rock-fill causeway now bridges the southernmost gap and one can drive north to the dune area.

Tillamook Bay: From Bayocean Peninsula, continue on the loop drive for 7 miles along Tillamook Bay. The bay resembles Netarts Bay, but it has a larger drainage area and so must have always had an outlet. Like Netarts Bay, its opening was also probably at the southern end, and its dunes once connected with those across the bay to the north.

There is a good fossil locality in an outcrop of the Astoria Formation across the road from the oyster-processing plant. It is interesting to note that there is a difference of 20 million years in the ages of the mollusks on either side of the road.

Five rivers: Five rivers drain into Tillamook Bay: the Miami, Kilchis, Wilson, Trask, and Tillamook. These rivers and the bay are "drowned"; that is, gradual rise in the sea level because of melting of ice-age glaciers has caused the ocean waters to invade low areas and back up into the rivers.

Figure 17. Aerial view of Cape Meares with fog rolling in from southwest.

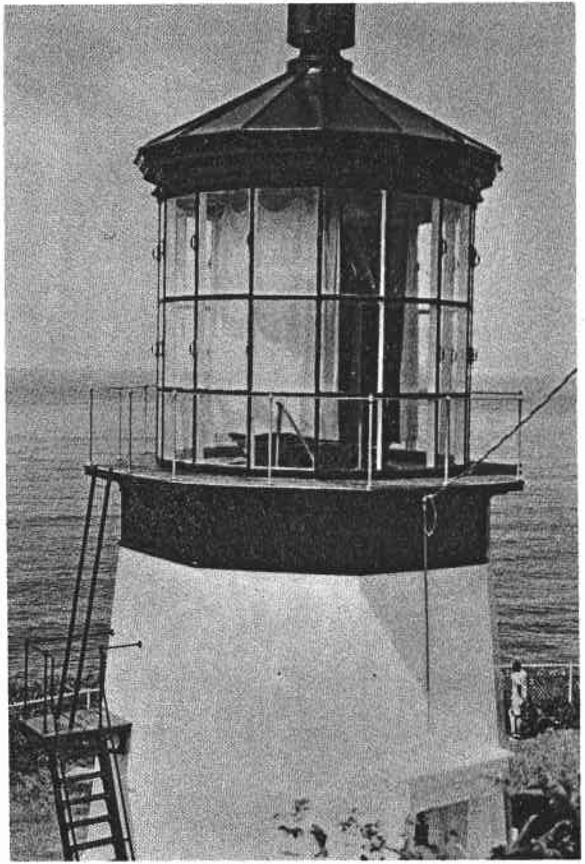


Figure 18. Lighthouse at Cape Meares.

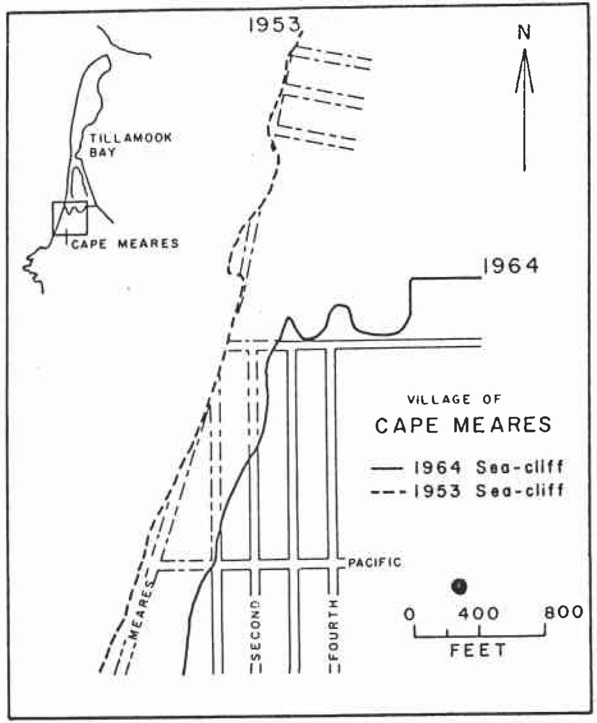


Figure 19. Sketch map showing coastal retreat at town of Cape Meares, 1953-64. (From North and Byrne, 1965)

All of these rivers have scenic drives and attractive picnic parks or campsites. The influence of the tides on the rivers is very noticeable in the alluvial valley surrounding Tillamook. At high tide the rivers are levee-bank full, but during low tide one can see logs that are being floated down stream lodged in the river-bottom sediments.

At the intersection, turn left for Tillamook or right to return to Cape Lookout State Park.

Acknowledgments

Acknowledgments are extended to Margaret Steere, Hollis Dole, and Raymond Corcoran of the State of Oregon Department of Geology and Mineral Industries for invaluable aid in preparing this report. Considerable help in the field was obtained from Irene and Edgar Schroeder, Jim Gettle, and Dick Windsor, personnel of Cape Lookout State Park. Unpublished field data and aerial photographs were made available by Parke D. Snavely of the U.S. Geological Survey, and fossils were identified by W. D. Addicott, also of the Survey.

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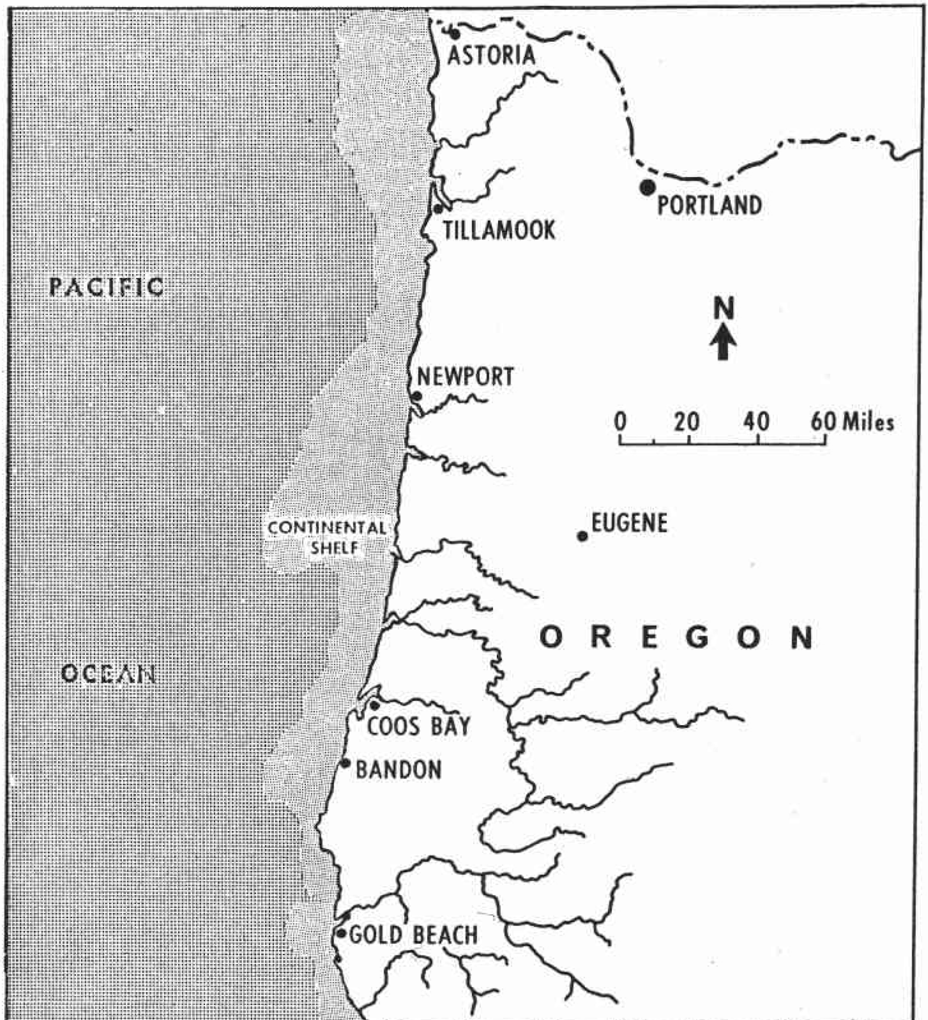

SEARCH FOR HEAVY METALS OFF OREGON Scientists of the U.S. Geological Survey, Department of the Interior, and Oregon State University, will team up in a search for heavy metals —such as gold, silver, mercury, and platinum— along the coast of Oregon and adjacent sea bottom.

Photo Credit/U.S. Department of the Interior, GEOLOGICAL SURVEY

CONTINENTAL SHELF MAY DISCLOSE HEAVY METALS

Announcement of a $77,500 research contract to the University for marine geologic investigations on the continental shelf off Oregon was made by Dr. William T. Pecora, Survey Director, who said that "the project is part of our stepped-up nationwide search for heavy metals -- such as gold, silver, mercury, and platinum -- which are in short domestic supply."

Parke D. Snavely, Jr., Chief of the Survey's Office of Marine Geology and Hydrology at Menlo Park, Cal., noted that "although the shelf area off Oregon has been a major target for oil prospecting in recent years, it has not yet been 'probed' for mineral deposits."

"Preliminary reconnaissance geologic studies of the narrow (8 to 10 miles wide) continental shelf off southern Oregon made last summer, however, indicate considerable potential for mineral resources," he said. "Through the research contract with Oregon State, detailed geologic studies will be possible within the area broadly outlined by this preliminary work."

Snavely said that sediments on the target area originated in the Klamath Mountains and the Southern Oregon Coast Ranges, long known as a source of such valuable minerals as gold, platinum, chromite, zircon, and magnetite. "These minerals, because of their high density, are concentrated by wave and current action into 'placer' deposits commonly referred to as 'black sands' because of the preponderance of dark-colored minerals within them," he said.

The Survey's marine geologist noted that gold and platinum were discovered in black sand on Oregon beaches in the 1850's and were extensively prospected during the gold-rush days. "It is probable," he said, "that similar black-sand deposits occur beneath the sea on the continental shelf."

Scientists of both organizations will be aided in their studies by a number of modern, sophisticated instruments and techniques, including the use of two research vessels of Oregon State University -- the 180-foot YAQUINA, and the 33-foot PAIUTE.

Geophysical techniques will be used to probe the sediment and the bedrock on the ocean floor, providing basic data on the sub-sea topography, structure, and distribution of rocks and sediment. Magnetometer surveys will help to outline any black-sand deposits beneath the sea. Samples of rock and sediment taken from the sea bottom will be analyzed in USGS and Oregon State University laboratories. Also, bottom photography and closed-circuit television will be employed to monitor processes that concentrate "black sands." In later stages of the contract, direct observations are planned from deep-sea research craft.

Named as principal investigators for the coast and shelf study are Dr. John V. Byrne and Dr. L. D. Kulm of Oregon State University and Dr. H. Edward Clifton, U.S. Geological Survey.

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POWER SITES ON ALSEA OUTLINED

The U.S. Geological Survey has issued "Waterpower Resources and Reconnaissance Geology of Sites in the Alsea River Basin, Oregon," as Water-Supply Paper 1610-D. Authors are L. L. Young, D. W. Neal, and D. L. Gaskill. The Alsea River drains westward from the central part of the Coast Range and enters the ocean at Waldport. Preliminary geologic examinations were made at the two most likely dam sites --one near Scott Mountain and the other near Tidewater. Also investigated were two sites for possible diversion of Alsea River water to the Willamette River basin. Water-Supply Paper 1610-D is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 70 cents.

* * * * *

MINING-CLAIM RECORDING REQUESTED

Senator Henry Jackson (Wash.) has introduced in the U. S. Senate, at the request of the Administration, a measure (S. 1651) that would require persons now holding unpatented mining claims to record their claims with the Bureau of Land Management within two years following enactment of the Act, and would require similar recordation of claims filed in the future before any such claim could be deemed valid.

In requesting the legislation, the Department of the Interior stated that clearing title to public lands is often expensive and time consuming. The problem of old mining claims has arisen in connection with the Department's proposal for oil-shale development. Secretary of the Interior Udall told Congress that a recordation statute would not only be of benefit for the oil-shale program but also for orderly administration in general.

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BANTA REAPPOINTED TO DEPARTMENT BOARD

Governor Tom McCall has announced the reappointment of Mr. Harold Banta to the Department's Governing Board for another four-year term, which began March 15, 1967, and ends March 15, 1971. Mr. Banta has been a member of the board since his original appointment by Governor Hatfield on March 13, 1959, and this will be his third consecutive term. Banta, who is senior member of the law firm Banta, Silven, and Young in Baker, is also a member of the Oregon State Bar Committee on Mineral Law and a member of the Legal Committee of the Interstate Oil Compact Commission.

Other members of the Department's Governing Board are Mr. Frank C. McColloch, Chairman, of Portland and Mr. Fayette I. Bristol of Grants Pass.

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CONDON LECTURE PUBLISHED

"Moon Craters and Oregon Volcanoes," by Aaron C. Waters, has been published by the Oregon State System of Higher Education as one of the Condon Lectures. Dr. Waters, Professor of Geology at the University of California at Santa Barbara, delivered the Condon Lectures under the above title in February 1966. The lectures have been adapted for publication and may be obtained from University of Oregon Books, Eugene, Oregon 97403, for $2.00. Included in the 70-page booklet is a map of the moon prepared by Space Sciences Laboratory.

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OXBOW GEOLOGY DESCRIBED

"Geology of the Oxbow on Snake River near Homestead, Oregon" is the title of Pamphlet 136 recently issued by the Idaho Bureau of Mines and Geology, Moscow, Idaho. Authors are Harold T. Stearns and Alfred L. Anderson. Price is 75 cents.

At the Oxbow, the site of a recently completed dam and powerplant, the Snake River canyon exposes Permian Seven Devils Volcanics overlain unconformably by Columbia River Basalt.

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