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GEOLOGY OF STATE PARKS NEAR CAPE ARAGO, COOS COUNTY, OREGON

By Judi Ehlen*

Introduction

One of the most beautiful and geologically interesting parts of the Oregon coast is in the vicinity of Cape Arago near Charleston, 10 miles west of Coos Bay. Three very fine state parks have been developed here. They are (from north to south): Sunset Bay, Shore Acres, and Cape Arago State Parks (see plate 1). Sunset Bay State Park is situated near sea level in the valley of Big Creek, which flows into Sunset Bay. This park has a large camping area as well as places for picnics. Shore Acres and Cape Arago are perched about 100 feet above the ocean, but trails lead down to coves at water level; both parks have viewing and picnic sites. A surfaced road leading southwest from Charleston connects the parks.

At all three parks, erosion of tilted and faulted sandstone beds of varying hardness has resulted in a peculiar rocky scenery that has no counterpart anywhere else on the Oregon coast (figure 1). In addition to the rocks, fossils, and other geologic features, the area possesses a wide variety of plants and animals and an interesting historical background.

Previous work

Geologists who have studied the area include Diller (1899, 1901), Dall (1909), Schenck (1928), Turner (1938), Weaver (1942, 1945), Allen and Baldwin (1944), Moore (1963), Dott (1966), and Baldwin (1966). Except for direct quotations, the normal system of geological reference is used sparingly in this paper, but all references consulted are listed at the end of the article.

History

The first people to visit Cape Arago were probably the ancestors of the Coos Indians. No one knows how far back in history their sojourns in this area go, but, from the size of the shell mounds they left behind them, they must have gathered and prepared clams here for centuries. All that remain today of their activities in the

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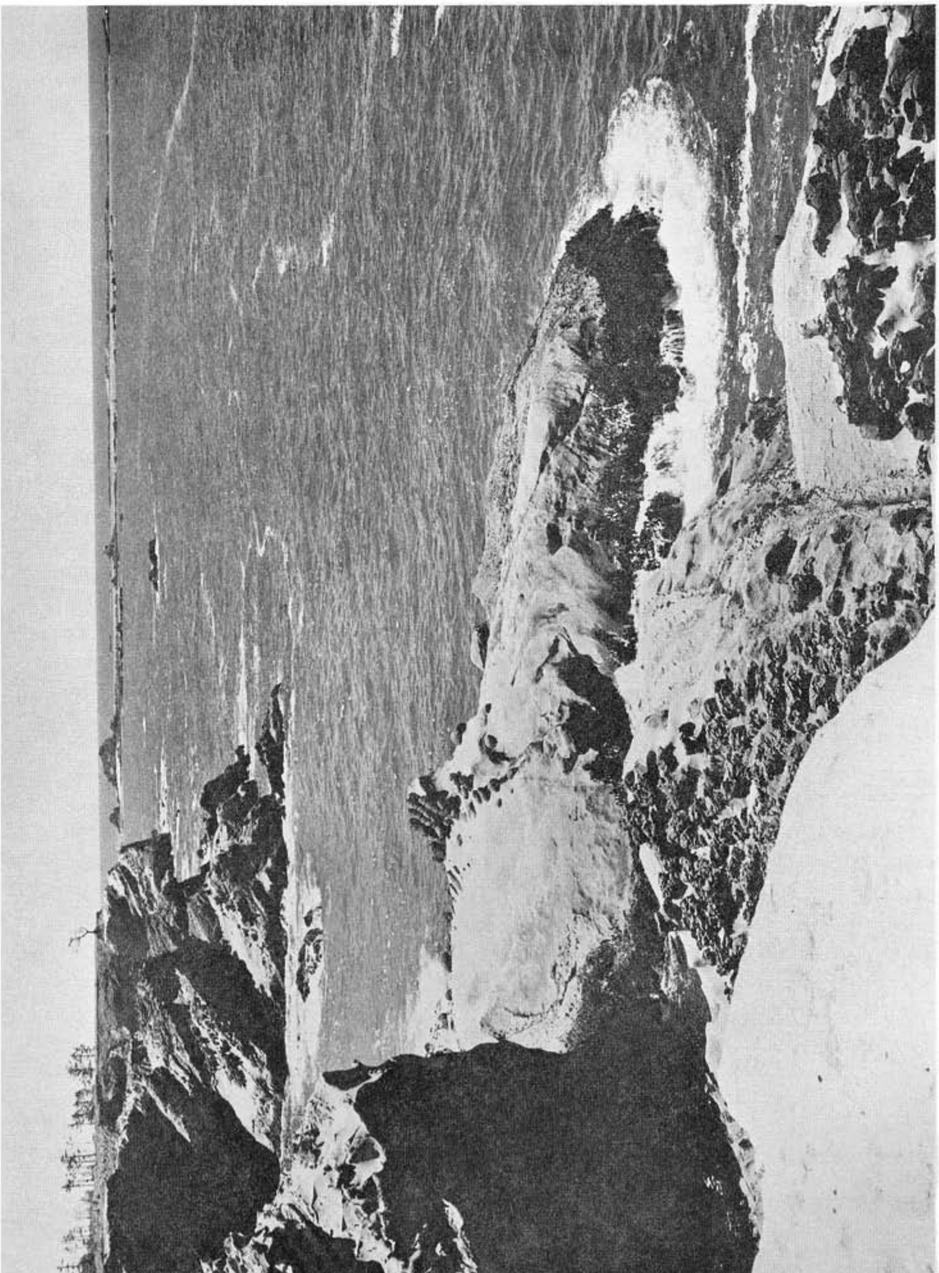

Figure 1. Etching of tilted sandstone beds of varying hardness by waves produces these peculiar features near Cape Arago.

Cape Arago region are the whitish layers of shells now buried under soil and vegetation, and in places, such as Lighthouse Point and Mussel Reef, exhumed by wave erosion.

Cape Arago may have been seen as early as 1775 by Spanish explorers sailing along the coast, but if the Spaniards saw the cape they failed to note its location. The first person to take a sight on the cape from the sea was Captain James Cook, who charted its location on March 12, 1778, while searching for the "Straits of Anian," a mythical connection between the Atlantic and Pacific Oceans. He named the headland "Cape Gregory" in honor of the saint of the day. This name was lost, however, and when the first survey of the Oregon Coast was made in 1850, Cape Gregory was renamed "Cape Arago." The name "Gregory Point" is now applied to Lighthouse Point on topographic maps.

Since the days of the Indians and explorers, many people have visited Cape Arago with its scenic grandeur and recreational potential.

Plants and Animals

There are many types of plants and animals native to the Cape Arago region. Among the mammals are black-tailed deer, Roosevelt elk, raccoon, beaver, and muskrat. In the vicinity of Shore Acres and Cape Arago many domestic cats, abandoned by their owners, have gone wild. Among the fish caught off the coast in this area are red-tailed perch, salmon, ling cod, and smelt. Smelt dipping is done in a small cove south of Mussel Reef. Abundant marine life in the tide pools of Sunset Bay and Cape Arago includes starfish, sea anemones, crabs, and sea urchins. Seals and sea lions swim or sun themselves on rocks off Cape Arago, and spouting whales are sometimes observed. Murres, cormorants, and other sea birds nest on the offshore rocks.

An unusual mature stand of timber can be seen in the area behind the University of Oregon Marine Biology Station near Charleston. It includes Douglas fir, Port Orford cedar, western hemlock, and Sitka spruce. Common shrubs in the area are red and blue elderberry, salal, salmonberry, thimbleberry, rhododendron, Oregon grape, gorse, and Scotch broom. Lupine, wild strawberry, nettles, trillium, skunk cabbage, wild iris, and many types of ferns are abundant.

Physiographic Features

The area around Cape Arago is an excellent place to study physiography, the science of land forms. One can see countless examples of the way varying hardness and structure of bedrock have controlled erosion by streams and waves, thus producing a diversity of physiographic features.

The higher hills in the area are formed of resistant sandstone and the stream valleys of softer, siltier rock. Big Creek, which flows into Sunset Bay, is an excellent illustration of how a stream will form a broad valley where it follows a softer bed and a narrow valley where it crosses a resistant layer. Many streams and bays in the area follow weak strata. South Slough, however, does not follow weak rock but lies in the axis of the South Slough syncline (a downfold in the bedrocks) and is, therefore, structurally controlled.

A short distance off the coast there are numerous sea stacks of various shapes and sizes. Some are typical conical masses. Some take the form of blocks of rocks, such as at Lighthouse Point, while others are ridges which parallel the shoreline, such as at Sunset Bay and Shore Acres. Sea stacks are composed of resistant rock which was at one time connected to the coast proper, but because this connection was softer, it has been removed by wave action. One of these stacks, Squaw Island, located near Sunset Bay, is unusual in that it is connected to the sea cliff by a thin strip of sand. This strip, called a tombolo, is visible even at high tide. The reefs in this area, such as Simpson Reef off Cape Arago and Baltimore Reef off Lighthouse Point, were also formed by this type of differential erosion.

Along the strand line itself are more land forms related to the bedrock. Many of the bays, such as the coves at Sunset Bay and Shore Acres, are surrounded by steep cliffs made of resistant material. These coves were made by the ocean eroding along a zone of weakness caused by faulting. The large beaches develop wherever easily eroded rocks occur. Examples are Bastendorff Beach, formed in shale, and Lighthouse Beach, formed in silty strata. The headlands in this area, such as Cape Arago and Coos Head, are composed of resistant sandstone which retards erosion.

Sequence of Sedimentary Rocks

The consolidated rocks of the Cape Arago area were formed from sediments deposited in marine, near-shore, and terrestrial (lagoon) environments. Ages of these rocks range from late Eocene to Pliocene. The environment of deposition can be inferred from the presence of marine fossils and sedimentary structures indicative of wave action and shallow water, and from the presence of coal beds and fossil remains of continental origin. Total thickness of these sedimentary rocks in the map area is about 11,700 feet.

Geologists have divided the sedimentary rocks into a series of fairly distinctive units (geologic formations), as shown on the stratigraphic column of plate 1. In the order in which they were deposited, from oldest to youngest, they are: Coaledo Formation, made up of lower, middle, and upper members, Bastendorff Formation, Tunnel Point Formation, and Empire Formation.

The strata have been folded into a large syncline, the axis of which trends northward under South Slough (see cross section A - A' on plate 1). Overlying the eroded edges of the tilted rocks is a nearly horizontal blanket of unconsolidated sands and silts of Pleistocene age. Although formal names have been applied to these sediments in some areas, they are generally referred to as terrace deposits. Each of the above units is described below.

Coaledo Formation

The Coaledo Formation of Eocene age is divided into three parts -- lower, middle, and upper. The whole formation is about 6000 feet thick and crops out from the southern end of the map to the southern end of Bastendorff Beach (plate 1). The three members of the formation are nearly conformable.

Lower Coaledo: The lower member of the Coaledo Formation forms the rugged coastline between the southern end of the map and the north side of Lighthouse Point (Gregory Point) (figure 2), and the trend of the coastline is nearly parallel to the regional strike of the beds. The unit comprises alternating strata of massive, buff-colored sandstone, thinly laminated gray siltstone, and silty sandstone (figure 3). Many of the beds contain small pieces of charcoal; one light-green bed exposed at Squaw Island and in the sea cliff at Shore Acres State Park contains many of these fragments. There is also some coal in the lower member of the Coaledo Formation.

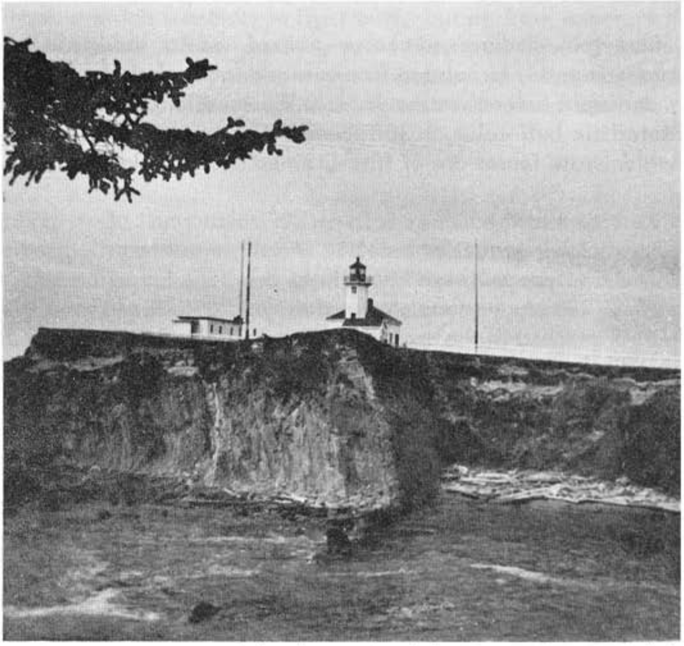

Figure 2. Type section of the lower Coaledo Formation at Lighthouse Point. Cape Arago Lighthouse in background.

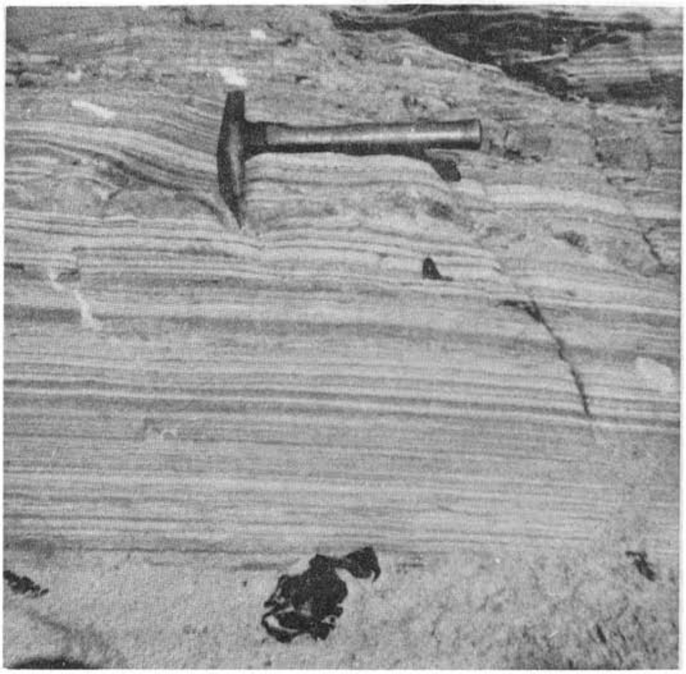

Figure 3. Typical sedimentary structure in lower Coaledo Formation.

Allen and Baldwin (1944) describe the lower Coaledo as follows:

> "Blue-gray medium- to coarse-grained nodular sandstone predominates with some grit and intercalated fine-grained sandy shale beds which are usually darker in color than the sands. The sandstone, which weathers to a characteristic buff color, is tuffaceous, and many of the pebbles in the few conglomerate lenses are of fine-grained basaltic material."

They also state that the matrix is in places calcareous. Dott (1966) likens the depositional environment to that of a delta. Among the interesting sedimentary features in the lower Coaledo beds are beautifully developed cross bedding which can be seen at Sunset Bay, intraformational truncation, and details of flame structures and sole markings, all exposed in the sea cliff of North Cove, Cape Arago. Fossils in the lower Coaledo include the pelecypods Pachydesma aragoense (Turner) and Venericardia hornii (Gabb), the scaphopod Dentalium, and the gastropod, Turritella uvasana (Conrad), as well as shark teeth.

Middle Coaledo: The middle member of the Coaledo Formation crops out along Lighthouse Beach. The contact with the lower Coaledo on the southwest is marked by the steep cliff of massive sandstone of the lower Coaledo Formation at Lighthouse Point. To the north, however, the contact with the upper Coaledo is gradational. In this report, the upper contact is placed on the south side of the southernmost outcrop of massive sandstone near Mussel Reef (Yokam Point). The middle Coaledo is distinguished by being much siltier than either the upper or lower members. It consists of thin beds of sandstone, silty sandstone, and siltstone and contains no coal. Allen and Baldwin (1944) describe the middle Coaledo as "... a medium gray tuffaceous shale with some sandy lenses."

Upper Coaledo: The upper member of the Coaledo Formation crops out at Mussel Reef, the type locality of the upper member. It extends from the last prominent sandstone outcrop on Lighthouse Beach to the west end of Bastendorff Beach. Massive buff-colored sandstone is predominant. To the southwest, however, the unit becomes more and more thin bedded and gradational with the middle Coaledo. As described by Allen and Baldwin (1944), the upper Coaledo is "...a gray medium- to fine-grained tuffaceous sandstone which contains less indurated carbonaceous shale and coal. Concretions, as well as coarse sandstone, grit, and coarse grit lenses, occur in places." According to Allen and Baldwin (1944), a bed of sub-bituminous coal which crops out at Mussel Reef may be an extension of the Beaver Hill bed which was successfully mined near the town of Coos Bay. A six-foot-thick layer containing fossil bivalves is exposed above one of the coal beds on the south side of Mussel Reef. The upper contact of the Coaledo is marked by a layer of black-weathering, concretionary sandstone about one foot thick, below which is a thin, pebbly bed. Concretions in the black material commonly contain many fossils, generally very small pelecypods and gastropods.

Bastendorff Formation

The Bastendorff Formation of late Eocene and early Oligocene age crops out along Bastendorff Beach from Mussel Reef to Tunnel Point. Along the beach, the Bastendorff Formation is very weathered and does not form a sea cliff. It is about

2300 feet thick and lies conformably on the Coaledo Formation. The rock is a thinly laminated siltstone which weathers to light buff, but on fresh exposure along the coast it is dark gray. Schenck (1928) used the name "Bassendorf shale" for this "...thinly laminated blue to steel gray shale with some strata of carbonaceous sandy shale and feldspathic sandstone." The Bastendorff Formation contains abundant microfossils.

Tunnel Point Formation

The Tunnel Point Formation of Oligocene age crops out near the middle of Bastendorff Beach. The formation, which is 800 feet thick, lies conformably on the Bastendorff Formation. The Tunnel Point consists of fine-grained, massive, buff-colored sandstone with some fossiliferous layers in the lower part (at the southern end of its exposure) at Bastendorff Beach. The lower part of the formation is commonly iron stained. The Tunnel Point Formation is described by Schenck (1928) as follows:

> "At the base of the formation, on the west side of Tunnel Point, is a massive concretionary bed composed chiefly of quartz and feldspar with an admixture of tuffaceous material and glauconite. Near the top, the sandstone is interbedded with brittle shale and a thin bed of tuff, in which glass shards are conspicuous."

The contact of the Tunnel Point Formation with the Empire Formation is covered with thick underbrush, but the relationship appears to be an angular unconformity because of the change in dip.

Unnamed Miocene beds

No Miocene beds were known until about 1950, when samples containing fauna of Miocene age were dredged from Coos Bay (Moore, 1963). Until recently, no outcrop was known on land. John Armentrout, who is doing a master's thesis at the University of Oregon on the Empire Formation, has found a concretionary, fossiliferous sandstone bed of Miocene age near Sitka Dock in Coos Bay (plate 1). According to Baldwin (1966), there is probably a lower Miocene equivalent of the Nye Mudstone of the Newport area below the newly discovered Miocene formation.

Empire Formation

The Empire Formation of Pliocene age extends from the northeastern third of Bastendorff Beach into the South Slough area. Around the town of Empire it is covered with terrace deposits, but it does crop out in a low sea cliff along Coos Bay. The Empire Formation lies unconformably on the Tunnel Point Formation, where it is present, and elsewhere on the Bastendorff and Coaledo Formations. It is about 1600 feet thick at Coos Head. Baldwin (1964) describes the Empire Formation as "...massive, poorly bedded sandstone with minor interbeds of siltstone...." The sandstone is jointed, and there is much iron staining along the joints.

Fossils in the Empire Formation include Patinopecten. Some very thin fossiliferous layers are exposed on the south side of Coos Head. The most interesting occurrence of fossils, however, is in the Coos Conglomerate, a member of the Empire Formation. The Coos Conglomerate crops out at Fossil Point on Coos Bay. Here such fossils as the clams Cerastoderma sp. and Marcia angustifrons (Conrad) and the

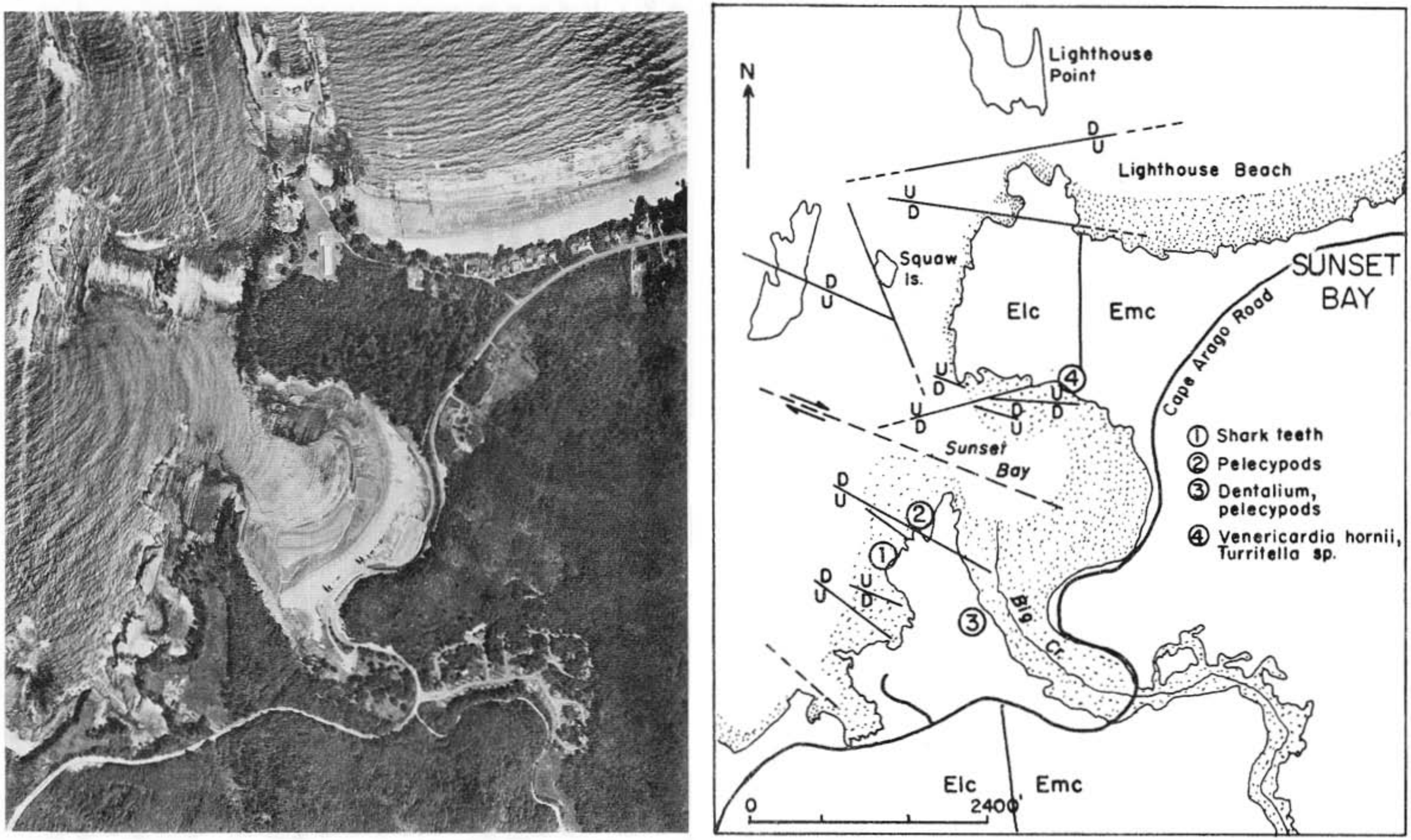

Figure 4. Aerial photograph of Sunset Bay and geologic sketch map of corresponding area.

gastropod Crepidula princeps (Gabb) are abundant. The sand dollar, Anorthoscutum oregonense (W. B. Clark) is another distinctive fossil of the Coos Conglomerate. In addition, there are pieces of whale and sea-lion bone of reddish-brown color. Boulders within the conglomerate are quite soft and are also fossiliferous. There has been much discussion as to the origin of the Coos Conglomerate; the best explanation appears to be that it is very similar to a channel deposit.

Terrace deposits

Lying unconformably above the Empire Formation are Pleistocene terrace deposits which range in thickness from about 6 feet to 20 feet. These terrace deposits have been called by many names, Elk River Beds being the most commonly used. They can be seen lying horizontally above all of the formations in the area mapped. They consist primarily of unconsolidated sand, and cross bedding is evident in them. The terraces themselves have been given several names: the Whiskey Run Terrace being the youngest and lowest, followed by the Pioneer Terrace, which, in turn, is followed by the higher terraces. The terraces are at different elevations because of differential movement of the South Slough syncline.

Structure of the Rocks

The regional trend of bed rocks in this area is about N. 15° W. and the dips vary from 30° in the Empire Formation to about 75° in the Bastendorff and Tunnel Point Formations. The dominant structure in the map area is the South Slough syncline (plate 1). This fold had a complex development, beginning in the middle to late Oligocene with folding of the Coaledo, Bastendorff, and Tunnel Point Formations. Extension caused faulting on the west limb of the fold, as illustrated by the numerous transverse faults between Sunset Bay and Cape Arago. These faults are discussed in more detail later in the report. Folding was renewed again after the deposition of the Pliocene Empire Formation.

The Cape Arago fault and parallel faults (figure 12, page 78) are not transverse to bedding and therefore are probably not related to the transverse faults on the limb of the South Slough syncline. They may have formed about the same time, however. The small syncline off Cape Arago, here called the Simpson Reef syncline, and the small Cape Arago anticline belong to this period of deformation but probably formed prior to faulting.

Description of the State Parks

Sunset Bay

Sunset Bay State Park is located 3 miles southwest of Charleston, Oregon on Cape Arago Road. Facilities in the park include a picnic area with covered sinks and stoves, three large parking lots, and a well-kept campground with 127 camping and trailer sites. Camping sites are attractive and private, and restroom facilities are clean and spacious.

The inner part of Sunset Bay is located in the middle Coaledo Formation and the narrow entrance is cut through the lower Coaledo Formation. Both the lower and middle members are quite fossiliferous in this area, containing shark teeth, a few crab claws, Venericardia hornii (Gabb) [a clam], Dentalium [a scaphopod, or tooth shell],

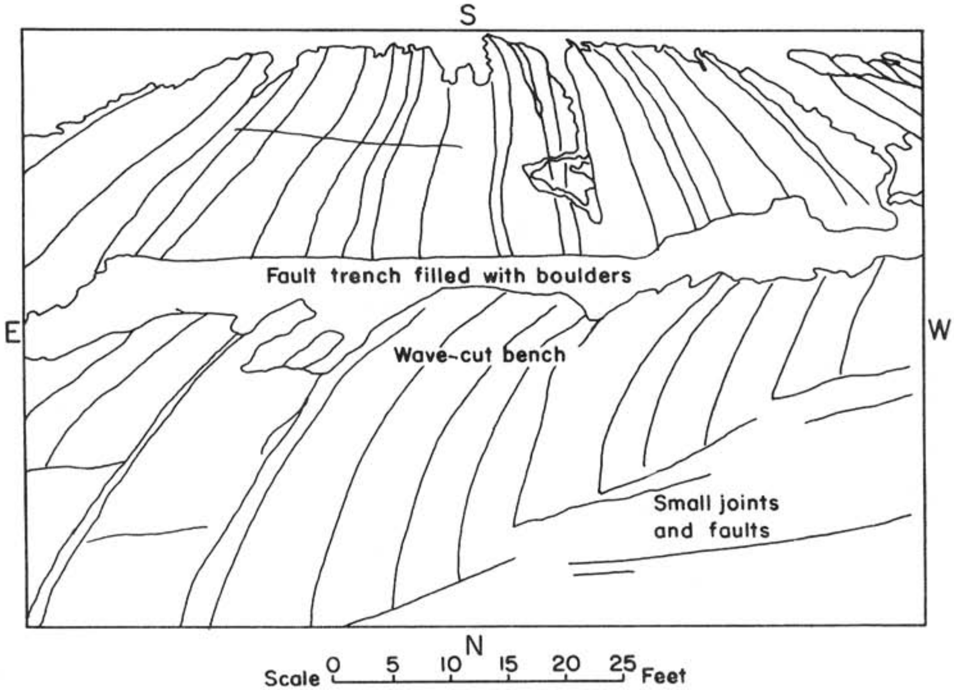

Figure 5. Sketch showing drag folding visible at low tide on wave-cut bench, north side of Sunset Bay.

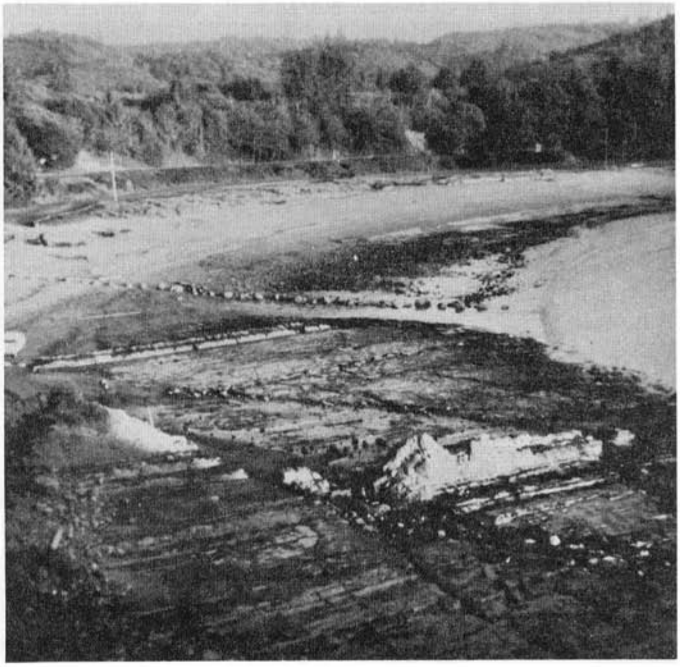

Figure 6. Faults and displaced beds on the wave-cut bench, north side of Sunset Bay.

Figure 7. Small fault on the wave-cut bench at Sunset Bay. The car is parked on the side of the fault that moved up.

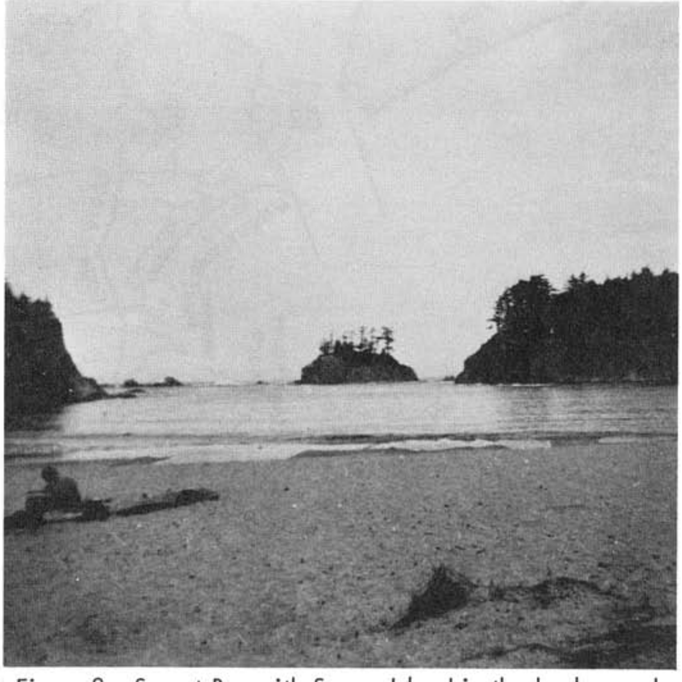

Figure 8. Sunset Bay with Squaw Island in the background.

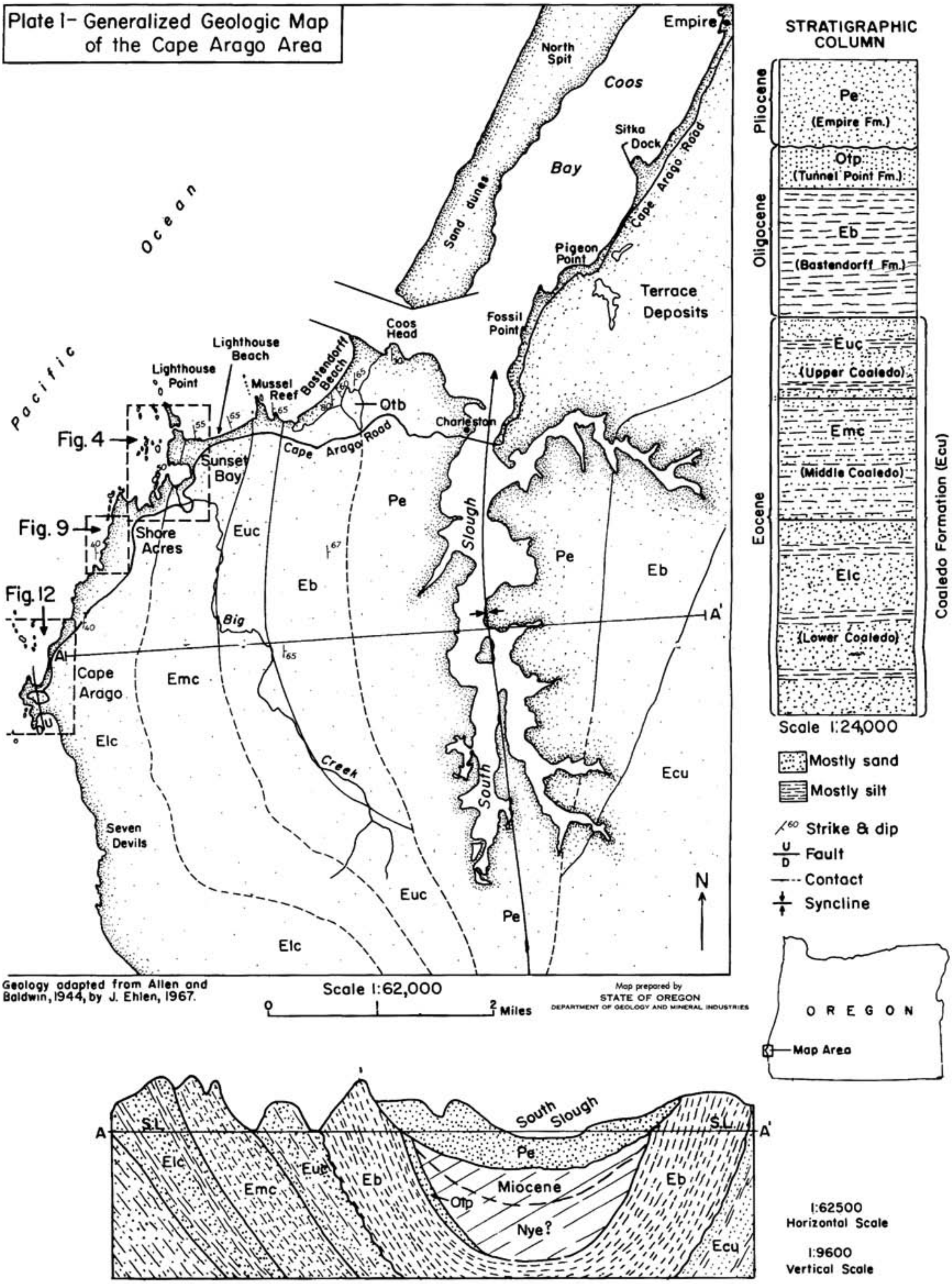
Plate 1- Generalized Geologic Map of the Cape Arago Area
Empire
North Spit
Coos
Bay
Sitka Dock
Cape Arago Road
Sand dunes
Ocean
Pacific
Pigeon Point
Terrace Deposits
Fossil Point
Coos Head
Lighthouse Beach
Lighthouse Point
Mussel Reef
Bastendorff Beach
Otb
Charleston
Fig. 4
Sunset Bay
Fig. 9
Shore Acres
Fig. 12
Cape Arago
Big
Creek
Slough
South
Seven Devils
Pe
Eb
Euc
Emc
Elc
Ecu
A
A'
N
Geology adapted from Allen and Baldwin, 1944, by J. Ehlen, 1967.
Scale 1:62,000
0
2 Miles
Map prepared by
STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
STRATIGRAPHIC COLUMN
Pliocene
Oligocene
Eocene
Pe (Empire Fm.)
Otp (Tunnel Point Fm.)
Eb (Bastendorff Fm.)
Euc (Upper Coaledo)
Emc (Middle Coaledo)
Elc (Lower Coaledo)
Coaledo Formation (Ecu)
Scale 1:24,000
Mostly sand
Mostly silt
Strike & dip
Fault
Contact
Syncline
OREGON
Map Area
South Slough
S.L.
Miocene
Otp
Nye?
1:62500
Horizontal Scale
1:9600
Vertical Scale

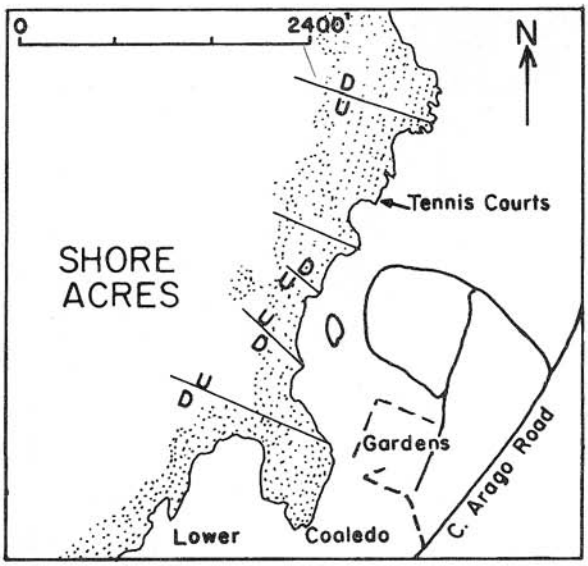

Figure 9. Aerial photograph of Shore Acres and geologic sketch map of corresponding area. Map shows location of faults and direction of movement (D = down; U = up) on either side of fault.

Turritella sp. [a gastropod], and other mollusks in easily accessible localities, which are shown on figure 4.

One outstanding feature of the bay is the complicated system of faults, well exposed on the wave-cut bench. This bench is formed by the waves in the bay wearing back the cliff. On the basis of orientation of drag folds, movement on the faults was oblique slip. The fault on the bench on the north side of the bay shows this type of drag (figure 5). Apparently the block to the south of the fault moved down and seaward. Details of movement on other faults have not been worked out. Further study of this topic is needed, since it may provide important information about the stresses (forces) which deformed the whole area. There is probably a strike-slip fault below sea level in the center of the bay, also transverse to bedding. Evidence of such a fault is seen in the prominent drag folding on either side of the bay.

As one walks along the north side of the bay, either on the wave-cut bench or on the path on the sea cliff, he may see many other interesting features. Most of the faults on this side of the bay (and at Shore Acres and Cape Arago State Parks) are marked by lines of boulders in small trenches eroded along weak beds or fault zones (figures 6 and 7). The contact between the middle and lower Coaledo is located near the first knob of resistant sandstone which sticks out from the sea cliff. The beds west of here are much sandier and crop out more prominantly than those to the east. Squaw Island, located further west, is connected to the mainland by a narrow strip of sand called a tombolo, one of the few along the Oregon coast (figure 8).

Walking from the north side of the bay to the south side at low tide, one can see the roots of trees imbedded in the beach sand in several places. These roots are evidence that sea level was once much lower than it is today. The majority of the roots are found on the south side of the bay, but the one or two on the north side are more interesting because they are associated with peat which is exposed at very low tide.

Continuing along the south side of the bay, one crosses the mouth of Big Creek, which flows into Sunset Bay from the south; it is the same stream that flows through the campground. This area is lower and flatter than the cliffs which surround the bay, because the rock was less resistant to erosion. As one moves west and back toward the ocean, he may see long ridges in the wave-cut bench which are parallel to the strike of the beds. These ridges are made of resistant sandstone, and the troughs between are cut in softer, siltier sandstone that is more easily eroded. In the same area, one can also see the beautiful cross bedding in the sea cliff mentioned earlier.

A delightful feature of the Sunset Bay area is the abundant animal life in the tide pools on the wave-cut benches. At low tide, one can find sea anemones, sea urchins, several kinds of crabs, and starfish as well as worms, tunicates, and algae in these tide pools. Many people think these are nice souvenirs to take home, but collecting here is illegal. A number of areas along the Oregon coast have been depopulated by heavy collecting and are now restricted. Sunset Bay and Cape Arago are two of the off-limit areas. Permission to take these animals for scientific study may be obtained from the Oregon Fish Commission.

Shore Acres

Shore Acres State Park is located 4 miles southwest of Charleston, Oregon on Cape Arago Road (figure 9). There is a small view house on the terrace immediately above the sea cliff, and there are picnic facilities with convenient restrooms. One of the outstanding features of the park is the formal and sunken garden built by the

Figure 10. Sunken gardens at Shore Acres State Park.

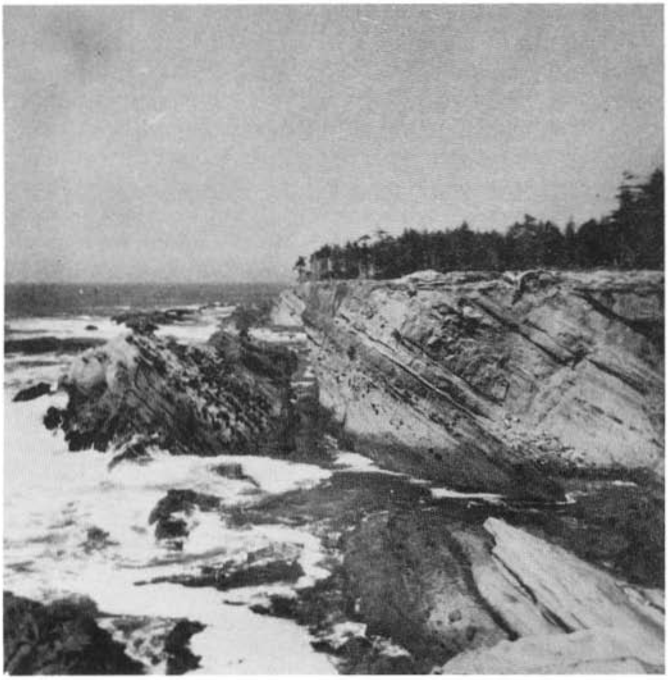

Figure 11. Tilted beds of lower Coaledo Formation north of view house.

Louis Simpson family. Both native plants and specimens brought here from all over the world can be seen in these gardens (figure 10). The gardens are now being tended by the Parks Division of the State Highway Commission. A greenhouse immediately east of the sunken garden contains large and beautiful begonias raised and cared for by the park manager, Bruce Barker. The residence of the park manager, who supervises all three parks, is situated here.

Shore Acres was developed as an estate by the Louis Simpson family, prominent in lumbering and shipbuilding in the Coos Bay area. A manor house built on the present site of the small viewhouse is described by W. A. Langille (1947b): "This large, unpainted three-story structure was over one hundred feet long, had fifteen guest rooms, a large living room, with a huge fireplace..." Located in the basement was a swimming pool, and north of the house was a tennis court. The manor house burned in the late 1930's and another was started to replace it, but in 1942 the Simpson family donated the property to the State. From 1943 to 1945, the area was occupied by the coast defense forces. Some of their gun mounts can still be seen on the terrace between Shore Acres and Cape Arago. During World War II, the gardener from Cape Arago State Park, Anton Jensen, tended the gardens so that they still retain much of their original beauty. Since it was never completed, the manor house was torn down by the State after the war. Part of it, the playroom of the Simpson children, was salvaged and moved, and is now the residence of the park manager.

Shore Acres lies in the lower Coaledo Formation and, as at Sunset Bay, there are many faults transverse to bedding. Each of the five small coves in the park area has developed along faults where waves have differentially eroded these zones of weakness. The faults are probably normal, with little displacement. The largest is located in the southernmost cove, directly west of the gardens. The plane of this fault dips 54° S. and the block to the south has moved down. The movement did not offset the terrace, showing that faulting occurred long before the terrace was formed.

Interesting features at Shore Acres include ridges like those at Sunset Bay. These ridges are again parallel to both the coastline and the alignment of beds, and are also made of resistant sandstone (figure 11). On their sloping backs are roundish dark shapes which stand out from the surface of the rock (figure 1). These objects are called concretions, and are composed of sandstone which is much harder than the surrounding rock. Differential erosion by the breaking waves causes them to stand out in relief. The concretions can be seen from the view house and also from an observation point west of the tennis court.

Cape Arago

Cape Arago, the southernmost and largest of the three state parks, is located about 5 miles southwest of Charleston at the end of the Cape Arago Road (figure 12). Cape Arago State Park is divided into three parts -- North Cove, Middle Cove, and South Cove. Each of these three areas has picnic facilities with spectacular views of the ocean. There are also restrooms and a large parking area. The terrace is about 100 feet above sea level, and well-made paths with steps lead down into the coves.

Cape Arago was originally part of the Simpson estate mentioned earlier; the Simpson family donated it to the State in 1932. Improvements on the original 134-acre tract were made by the Civilian Conservation Corps during the winter months of 1934 to 1937. According to W. A. Langille (1947a), park historian, these improvements included "...the park road and trails, fire breaks, fire hazard reduction, clearing the picnic areas, setting up tables and stoves, providing a water system and

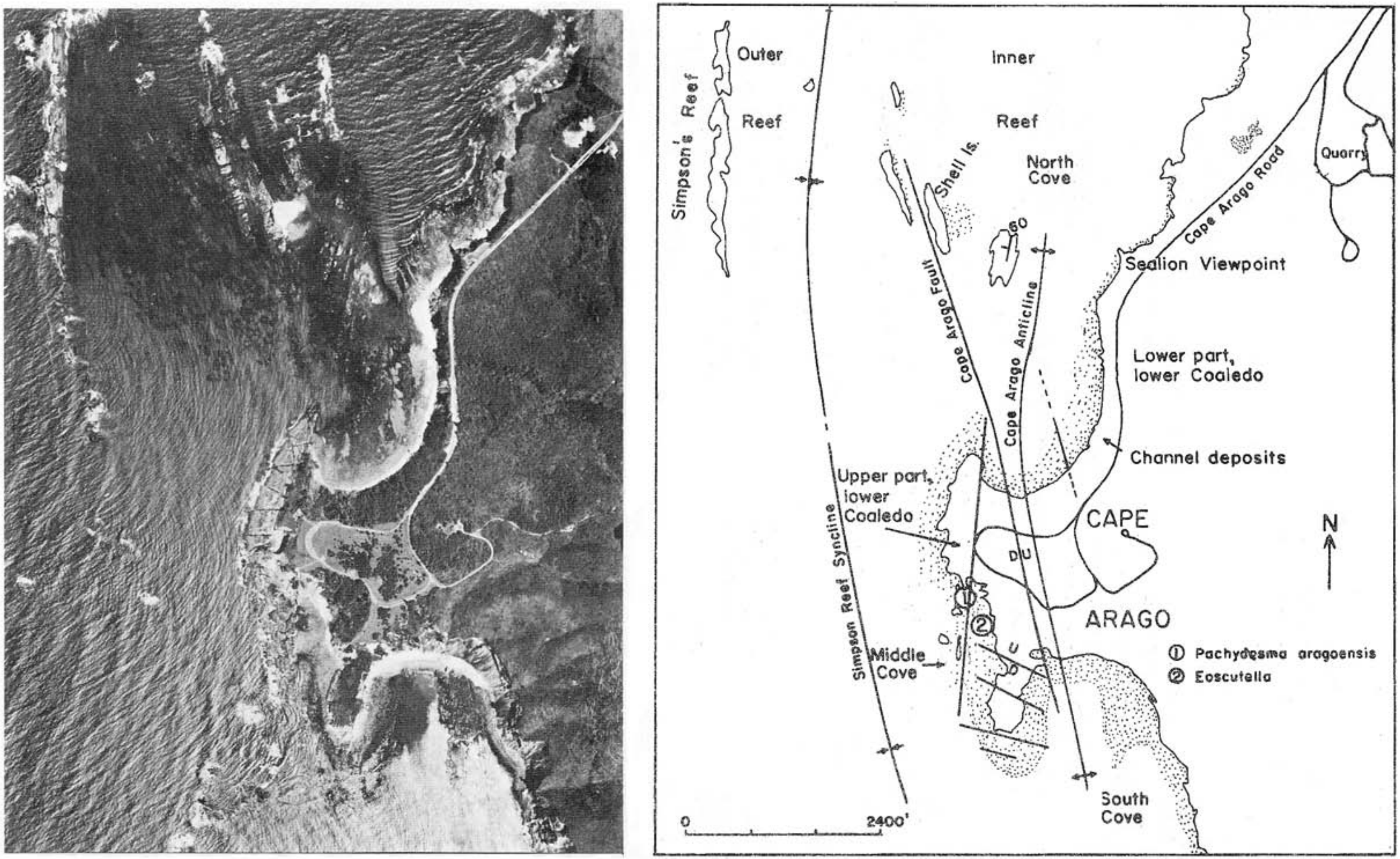

Figure 12. Aerial photograph of Cape Arago and geologic sketch map of corresponding area.

the erection of a park residence." The State Parks Division has since added parking space and restrooms.

The lower Coaledo Formation is the bedrock exposed in the park. The geology here is more difficult to interpret than at either Sunset Bay or Shore Acres because of the complex structural pattern. The dominant feature is the Cape Arago fault, which cuts through the cape (see figure 12). It is a normal fault down-dropped on the west with several hundred feet of displacement, so that beds on the east side of the break are appreciably older than those on the west. Another large fault runs through Middle Cove and appears to intersect the Cape Arago fault in North Cove. A set of faults transverse to bedding, similar to those at Sunset Bay and Shore Acres, is located on the neck of land between Middle and South Coves and smaller ones (not shown on figure 12) on the wave-cut bench on the west side of the cape.

In addition to the faults in this area, there are two large, north-trending folds called the Cape Arago anticline and the Simpson Reef syncline in this paper. The anticline underlies the terrace from South Cove to North Cove. The syncline axis, on the other hand, lies between the inner and outer parts of Simpson Reef, off the cape itself. Both fold axes are indicated on figure 12.

While walking along the beach in North Cove, one sees many interesting things. In the walls of the sea cliff are ancient channel deposits marked by beds thickening and pinching out. As one continues northward, he soon sees an unusual waterfall. Most waterfalls have a tendency to wear back into a cliff, forming an indented surface. This one sticks out from the cliff itself. This may be due to alternate wetting and drying of the cliff on either side of the falls in contrast to the constant wetness of the rock under the waterfall. Cementing minerals are loosened in the rock that is wetted and dries, making it more vulnerable to erosion than rock that is constantly wet.

Next to the waterfall is a small alcove in the cliff. On the walls of this alcove can be seen flame structure, so called because the silt patterns resemble flames (figure 13). The flames are dark gray and were formed by sandy sediment being deposited above silty sediment. The sand was heavier and coarser, and so it sank into the silt, causing the fine, dark-gray particles to squeeze upward. On the ceiling of this same alcove are sole markings. They show up as an uneven surface on the bottoms of the layers of rock and represent places where sand scoured a small hole and then filled it in. Flame structures and sole markings are some of the small sedimentary features that had their origin during the deposition of the lower Coaledo Formation back in Eocene time.

In Middle Cove (figure 14) there is more to be seen. Pieces of rock can be found that look scraped and polished on all sides. These marks, called slickensides, were produced by movement along the fault that cuts the rocks in the middle of the cove. Also, one can find several varieties of fossils in Middle Cove. Inside some of the concretions are sand dollars replaced by calcite. Another distinctive fossil found here is Pachydesma aragoensis Turner, a small clam about 2 inches across, which is unique in that it has retained some of its brown and black coloring.

Several other geological features can be seen in South Cove. As one walks east along the beach, he may encounter a large block of rock about 15 feet high. This rock is called a shale pebble conglomerate, and it is unusual because shale is generally too soft to last long enough to form a conglomerate. Some geologists believe that there was a shale sea cliff nearby at the time this material was being deposited and that the cliff crumbled faster than the sea could destroy it, thus the chunks of shale accumulated to form a conglomerate. There is another outcrop of the shale conglomerate in North Cove. Farther east, on the wave-cut bench which

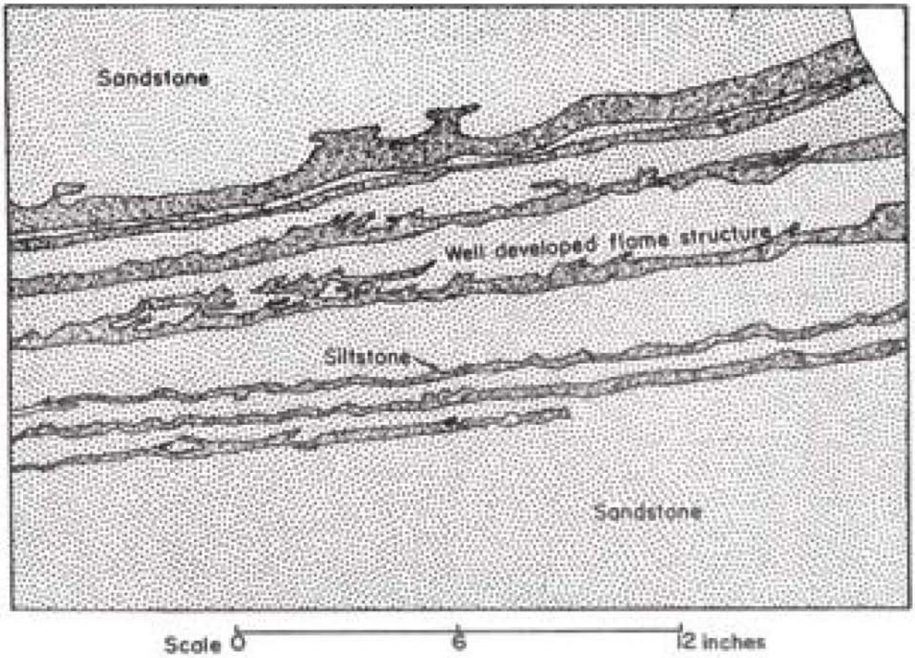

Figure 13. Sketch of flame structure near waterfall in North Cove at Cape Arago.

Figure 14. View of Middle Cove at Cape Arago.

is visible only at low tide, is a rhombic pattern of joints. This unusual pattern may be unrelated to the faulting in the cove.

Sea lions spend much of their time on Shell Island, and sometimes one can see seals on the outer reef. They can be observed from the Sea Lion Viewpoint just north of the road leading into the park proper, and their barking can be heard all along this part of the coast.

Summary of Geologic Events

The regional setting of western Oregon and Washington during the Eocene epoch, about 50 million years ago, was a long marine embayment, or geosyncline, extending from the southern boundary of Coos County northward to Vancouver Island, and eastward under what is now the Cascade Range.

During Eocene time, thousands of feet of marine sediments and submarine lavas accumulated in this slowly subsiding trough. In late Eocene time, the embayment became more restricted in size. As described by Snavely and Wagner (1963), ".... areas of local uplift and active volcanism divided the geosyncline into several separate basins and reduced the area of marine deposition." Coal swamps developed in the Coos Bay area and intermittent downwarping produced interfingering marine and nonmarine sediments of the Coaledo Formation.

By Oligocene time, about 30 million years ago, the marine embayment had withdrawn northward, but in the Coos Bay area a small arm of the sea still existed in which the Bastendorff and Tunnel Point Formations were laid down.

After deposition of the Tunnel Point Formation, the South Slough syncline began to form as a downfold in the Eocene and Oligocene strata. The transverse faults so prominent in Sunset Bay and at Shore Acres probably occurred during this period of warping. Miocene sediments were then deposited in the area, but erosion apparently removed all but the beds in the axis of the syncline before the Empire Formation was deposited.

In Pliocene time, about 10 million years ago, sands of the Empire Formation were laid down in the small marine basin that still existed in the Coos Bay area. The whole region was uplifted, and in Pleistocene time, about a million years ago, waves began to attack the new coast line, bevelling off the tilted strata and forming the level benches, or marine terraces, now so prominently displayed along the Cape Arago coast. Pleistocene sands deposited on the terraces can be seen lying unconformably on older rocks; that is, the sands are virtually horizontal, whereas the bedrock is tilted.

There is evidence in the terrace levels that the South Slough syncline is still active. The terrace at Cape Arago is about 100 feet above sea level; this same surface is near sea level at Charleston 5 miles to the northeast. This shows that there has been warping since the Pliocene epoch.

Of more recent occurrence is the drowning of the mouths of the Coos River and Big Creek to form Coos Bay and Sunset Bay. Drowning is the result of melting of the continental glaciers and consequent rise in sea level during the Pleistocene epoch. Other recent geologic events in the area include the building of the long sand spit and dunes which hem in the lower portion of Coos Bay, and the wearing away of rocky headlands to form sea stacks and reefs.

To sum it up, the deposition of the rocks, their deformation, and finally their erosion by the waves are what make the scenic geology we enjoy at Sunset Bay, Shore Acres, and Cape Arago State Parks.

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OAK MINE DRIVING CROSSCUT

The Oak Mine, Inc., of Grants Pass is running a new 280-foot crosscut at the Oak Mine to intersect a copper-zinc ore zone 100 feet below previous development work on the 150-foot level. Plans are to drift in both directions in order to develop ore indicated by a surface gossan, ore shoots developed on the 150 level, and induced-polarization geophysical interpretations.

The 5-by-7-foot crosscut being driven on the 250-foot level is planned as a main haulageway for a proposed selective flotation mill. The development work is being supervised by L. E. Frizzell, mining geologist of Grants Pass. The Oak Mine is 10 miles north of Grants Pass in the Greenback mining district, Josephine County.

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FEDERAL MINING WITHDRAWALS ANNOUNCED

At the request of the U.S. Forest Service, the U.S. Bureau of Land Management has announced the proposed withdrawal of eight parcels of land from mineral entry in southwestern Oregon. The withdrawals amount to 434 acres. Three of the areas requested by the Forest Service are for tree seed farms, the remaining five are for campground and recreational use. Withdrawn lands are in Josephine and Curry Counties.

In Benton County the Bureau of Land Management has proposed the withdrawal of 132 acres in the Alsea Falls area from mineral entry to protect the recreational use and to safeguard the existing and planned government investments there.

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THESE WITHDRAWALS ARE FOR THE BIRDS

The U.S. Bureau of Sports Fisheries and Wildlife has requested the withdrawal of a total of 346.06 acres for nesting grounds and landing strips for off-shore waterfowl. The withdrawal embraces dozens of coastal off-shore rocks, stacks, and pinnacles extending from Tillamook Head to Cape Blanco. If the withdrawal is granted, no appropriation under the mining laws will be permitted. The lands would be subject to the mineral leasing laws, however.

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OREGON ACADEMY OF SCIENCE ELECTS NEW OFFICERS

At its 25th annual meeting held February 25 at Willamette University, the Oregon Academy of Science elected the following officers for the 1967-1968 period: President, Dr. Donald Schafroth, Portland State College; Vice-President, Dr. Anton Postal, Oregon College of Education; Secretary, Dr. Keith F. Oles, Oregon State University (second year of a two-year term); and Treasurer, Dr. Darwin Reese, Oregon State University.

Co-chairmen of the geology-geography section are: Dr. Cyrus W. Field, Department of Geology and Dr. Robert E. Frankel, Department of Geography, both of Oregon State University.

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DEPARTMENT PUBLISHES TUALATIN VALLEY BULLETIN

The State of Oregon Department of Geology and Mineral Industries has just published a study of The engineering geology of the Tualatin Valley region. Authors are H. G. Schlicker, Department geologist, and R. J. Deacon, consulting geologist, Portland. This study was aided financially by the Urban Renewal Administration 701 Program of the Housing Act of 1954. The report, Bulletin 60 of the Department, is composed of a text of 103 pages, accompanied by a multicolored geologic map and cross sections, a bedrock contour map on the basalt, and a hazards map showing landslides, flood areas, and high ground-water levels.

The text discusses the geology and engineering characteristics of the rock and soils units which occur in the area. Laboratory data for quarry rock, gravel, and soils are presented in tables and discussed in the text.

The report will sell for $5.00 at the Department's office at 1069 State Office Building, Portland, Oregon 97201.