A Beginner's Fossil Guide to the Northern California Coast

Unearthing Evidence

OF CREATURES FROM DEEP TIME

By Leslie Scopes Anderson

Acknowledgements:

This book would not have been possible without the help of my advisor, Humboldt State University professor Dr. William Miller, who was an invaluable resource of knowledge, wisdom and guidance. He conceived the idea for this guide and was instrumental in its progress and completion.

Also thanks to HSU graduate students Adam Jackson and Christa Jackson for their asssistance.

Disclaimer: The author, publisher and affiliates assume no liability for accidents happening to, or injuries sustained by readers who engage in activities described in this book.

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Other publications by the author:
- *Marsh Moments,* with Charles M. Anderson
- *Common Birds of the Arcata Marsh & Wildlife Sanctuary,* with Ken Burton and David Fix

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Finding Fossils

Humboldt County, California offers an impressive array of interesting geologic features exposed by the ocean and local rivers. These layers of deep time contain evidence of conditions on earth and the ancient creatures who lived here millions of years ago. Their fossil remains have been preserved and can be uncovered at several sites in the area. In this guide, you will find maps, directions and samples of the kind of specimens that can be discovered. All it takes is curiosity, a desire to learn more, and the proper tools.

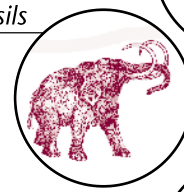
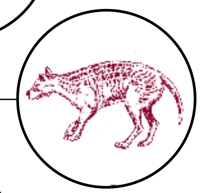
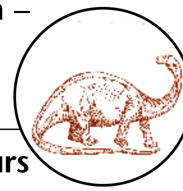
Basic equipment for field geology includes:

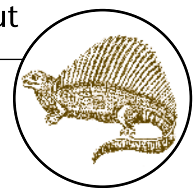
- Hand trowel
- Field camera
- Rock hammer
- Work gloves
- Waterproof notebook
- Pencil, marker
- Compass
- Ruler
- Eye protection
- Hand lens
- Small plastic bags
- Boots, hat, sunscreen

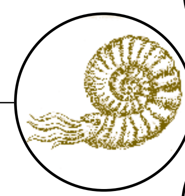
Whenever you venture into the field, take water and maps, allow enough time, and be aware of the weather conditions, tide levels and other cautions for the area. Always respect private property and the environment when fossil hunting. Leave specimens for future explorers.

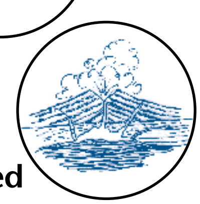
Geologic Time Scale

EON	ERA	PERIOD	YEARS BEFORE PRESENT (million)	EPOCH	
PHANEROZOIC	CENOZOIC	QUATERNARY		HOLOCENE	**Age of man**
			0.01	PLEISTOCENE	*Mad River & Elk Head fossils* *Moonstone Beach fossils*
		NEOGENE	1.64	PLIOCENE	*Centerville Beach fossils*
			5.2	MIOCENE	*Scotia Bluffs fossils*
		PALEOGENE	24	OLIGOCENE	
			33.5	EOCENE	
			55	PALEOCENE	
	MESOZOIC	CRETACEOUS	66		Mass extinction – dinosaurs replaced
		JURASSIC	144		**Age of dinosaurs**
		TRIASSIC	208		Mass extinction
	PALEOZOIC	PERMIAN	248		Largest mass extinction – 95% of all species wiped out
		PENNSYLVANIAN	286		
		MISSISSIPPIAN	325		**Age of plants**
		DEVONIAN	360		Mass extinction
		SILURIAN	408		First fish
		ORDOVICIAN	438		
		CAMBRIAN	505		Mass extinction
PROTEROZOIC		VENDIAN	543		Explosion of animal life
					Eukaryotes appear Age of stromatolites
ARCHAEN			2500		
			3500		First fossils – Prokaryotes
			4500		**Solar system & earth formed**





The Setting:

A Brief Geologic History of Northern California

Between Fire and Water

Look around you! The spectacular sea cliffs on the beautiful Northern California coast are the leading edge of the North American tectonic plate. The ground beneath your feet was once on the ocean bottom! Our area is composed mainly of the Franciscan complex, which is an assemblage of sedimentary and volcanic rocks formed in a marine environment. Sand and mud deposited on the sea floor over millions of years became graywacke sandstone and shale. Undersea ridges spewed volcanic basalt in bulging pillows. Some magma became small islands. Mafic greenstone was sheared and heated under pressure to form serpentinite. Billions of tiny sea creatures accumulated on the bottom to become layers of ribbon chert and limestone. This seafloor material, along with the small islands, was scraped off by the westward-moving North American plate and added to its leading edge.

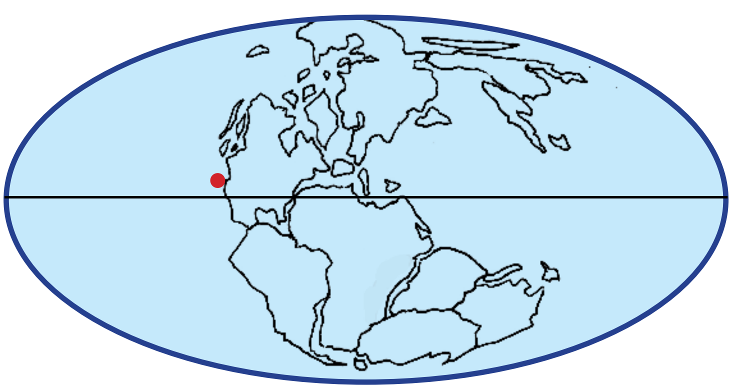


Figure 1 – Configuration of continents 200 million years ago
● *Approximate position of NW California*

Mesozoic activity

About 200 million years ago, during the age of dinosaurs, the supercontinent of Pangea began to break up, creating the North American plate. The early western continental margin extended from what is now southern California, up along the eastern borders of Nevada, Oregon and Washington, so our area was submerged. As this plate broke away from the European continent and moved westward, it overtopped

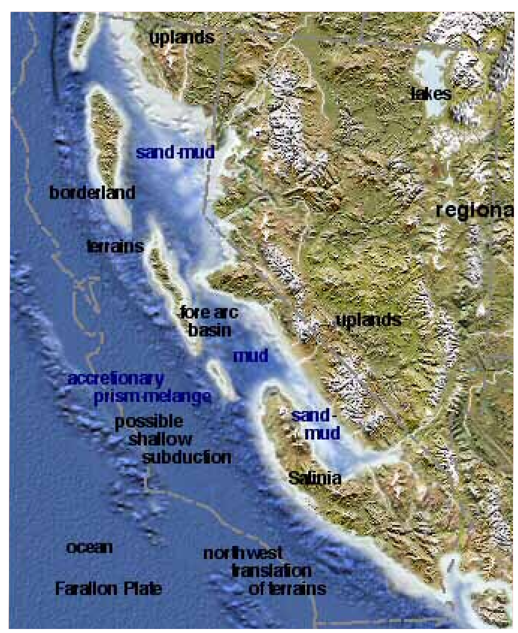


Figure 2 – California 100 mill. yrs. ago
Source: Ron Blakely, NAU Geology, 2008

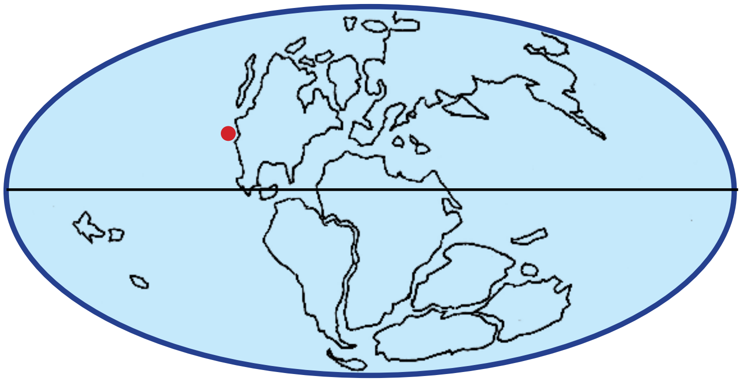


Figure 3 – Configuration of continents 140 million years ago.
● *Approximate position of NW California*

the Farallon plate. The subduction zone resulted in the collision and accretion of belts of oceanic rock that built the continental margin westward, and filled in the northern portion of what is now California with this mélange. (Figure 2)

The diving Farallon plate melted at depth, causing chains of andesitic volcanoes and plutons of granitic magma to form inland. Plutonic rocks from this period are found in the Klamath Mountains and Sierra Nevada. The Farallon plate was then completely subducted and consumed beneath the North American plate.

Cenozoic activity

After the dinosaurs died out, about 28 million years ago, the North American plate collided with the Pacific plate along the San Andreas transform fault. The North American plate ceased its westward movement and began a more southwest course, sliding past the Pacific plate, rather than overtopping it. These shearing forces metamorphically deformed greenstone from the ocean floor to create serpentinite. This formation decomposes through weathering to form “blue goo” – unstable blue-gray mud found in our area. The North American plate then came in contact with the Juan de Fuca plate and the Gorda Plate, which subducted and began to melt at depth. The resulting magma surfaced in a volcanic arc to form the Cascade range, including Mt. Lassen and Mt. Shasta. (Figure 5)

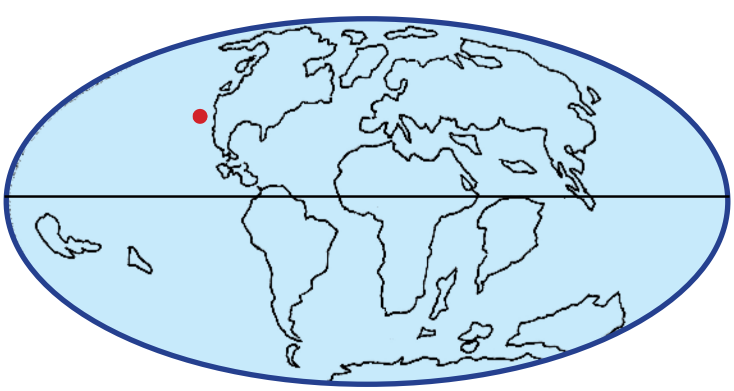
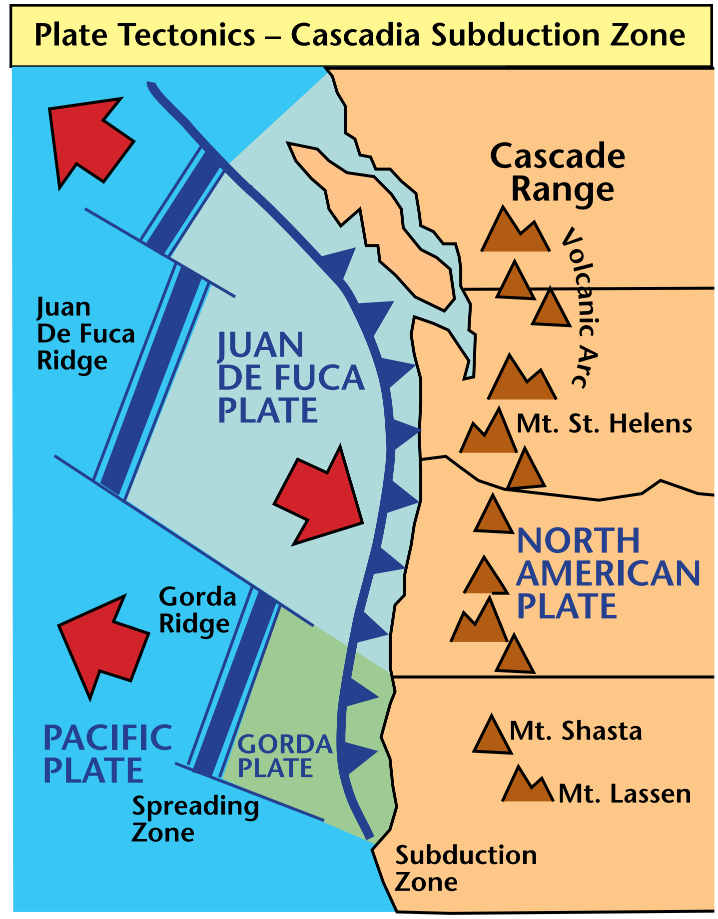


Figure 4 – Configuration of continents 65 million years ago
● *Approximate position of NW California*

Source: Institute for Geophysics, University of Texas at Austin, 1997



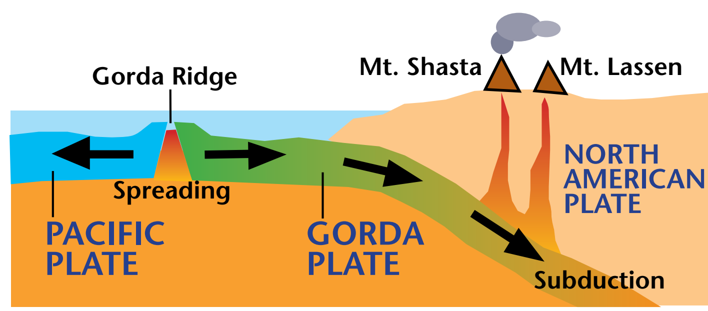


Figure 5 – The mechanics of subduction and volcanic arcs
After Humboldt State University, Geology Dept., 1996.

Quarternary events

The plates continue their movements to the present day, and are responsible for the numerous earthquakes felt along the California coast. Sediment washed from the land by rivers is deposited in layers of mud and sand along the coast.

Most of the fossils found in our area are quite recent, geologically speaking. They were deposited along the coast in environments quite similar to those we see today. Many of the species of sea creatures have evloved slowly, with their contemporary counterparts looking much the same as they do now.

The remains of sea creatures that lived here were covered by beach sand and mud brought in by rivers, which consolidated and preserved them. The sea cliffs in which the fossil deposits are found have been uplifted by tectonic activity and worn away by the action of ocean waves.

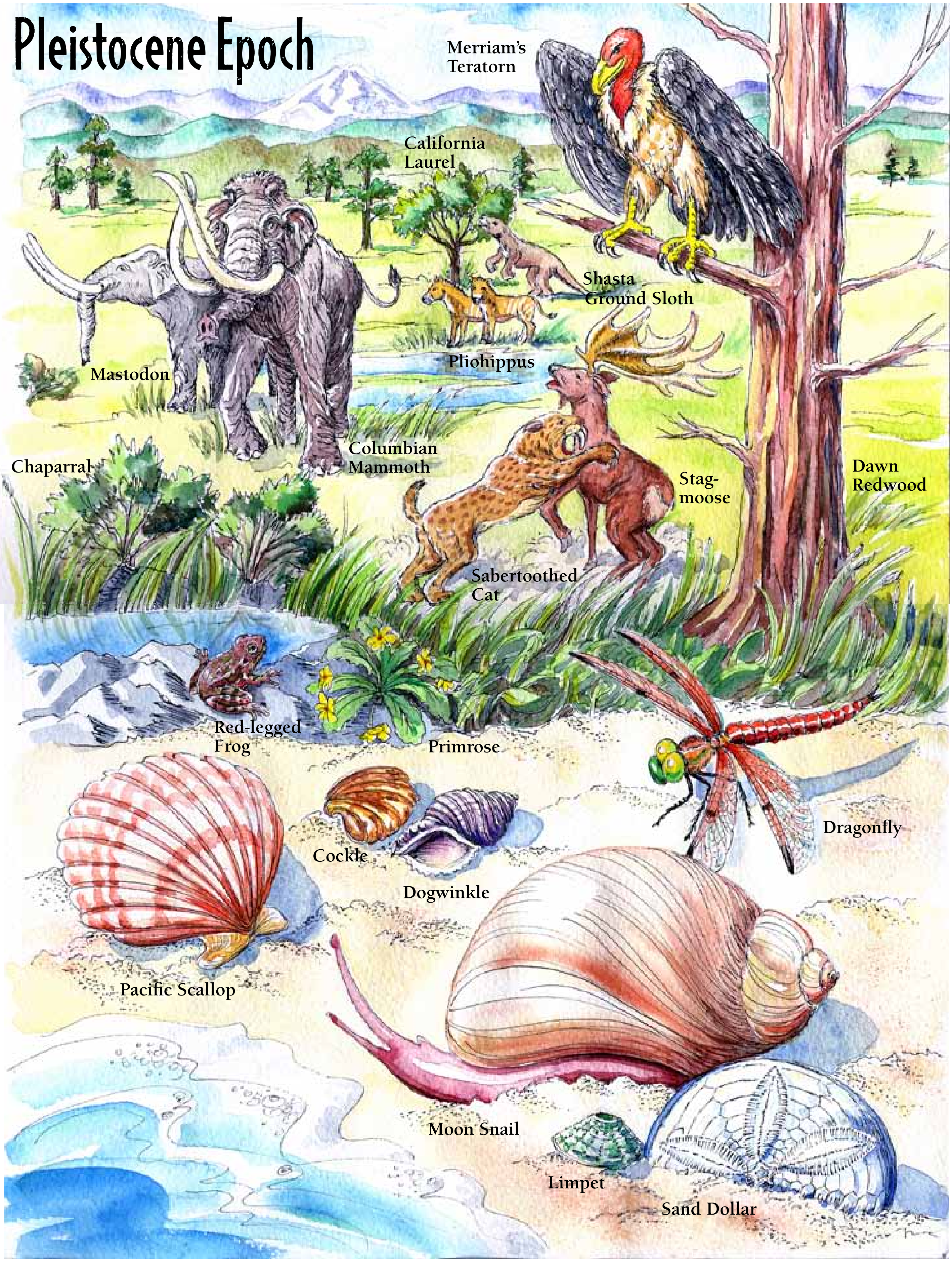


Figure 6 – A representation of the flora and fauna that may have existed in California around the time most of the invertebrate fossils we find were deposited. *Illustration by Leslie Scopes Anderson. Source: National Academy of Sciences, 2008*

Site One:

Sandstone cliffs and Scotia Bluffs trail

Railroad bridge showing gaps!

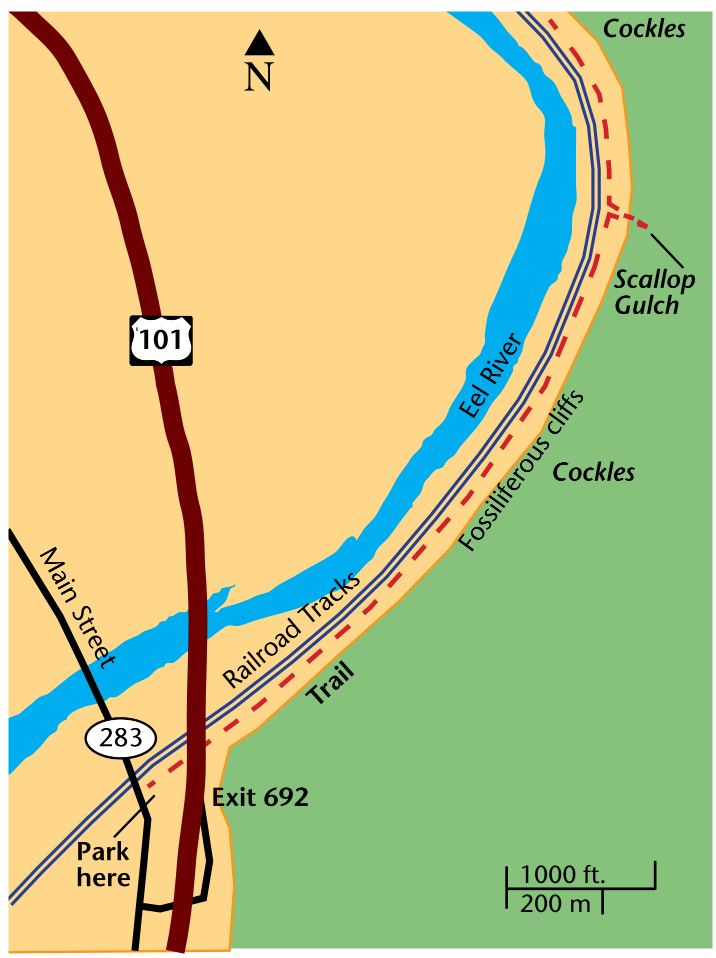
Scotia Bluffs

This location involves a long walk, but yields many impressive specimens. The Scottia Bluffs Sandstone is part of the upper Wildcat Group, composed of massive tan and grey fine-grained, poorly consolidated sandstone with some mudstone. This sedimentary layer was deposited in a shallow marine environment around 2 million years ago in the Pleistocene epoch.

In addition to the shell fossils found here, there have been reports of other evidence of ancient life including fossil plants, turtles, starfish and agatized whale bone.

Length: About 2 miles out and back
Difficulty: Hard approach, Easy, level trail (see cautions!)
Hiking time: About 3 hours
Directions: Traveling south on Hwy. 101 from Arcata, take the Scotia exit. (exit 679) Turn right at the T-intersection, and park immediately on the right, before the bridge. Access here is difficult since new ownership closed the trailhead (gate to your right.) But you can get down under the bridge from either side of the road. Be careful – very steep! Then proceed to the right (NE) along the railroad

CAUTION:
Watch for eroded sections of trail. Cross the railroad bridge with care – there are missing sections! Watch for poison oak along the trail!



tracks for about 3/4 mile. Soon you will see cliffs of the buff-colored Scotia Bluffs sandstone on your right. Cockles and clam fossils that have eroded out of the cliff may be seen near the trail.

"Scallop Gulch" is a small side canyon off to the right, just before the railroad bridge. Look carefully for a faint trail through the brush, which opens into a steep gulch. Giant Pacific Scallop fossils can be found here. Also look for cockle shells.

After a long trek across the railroad bridge, there are more exposed cliffs and more mollusk fossils. Be careful on the bridge, as it is in disrepair.

Left: Giant Pacific Scallops
Above: Cockle shells

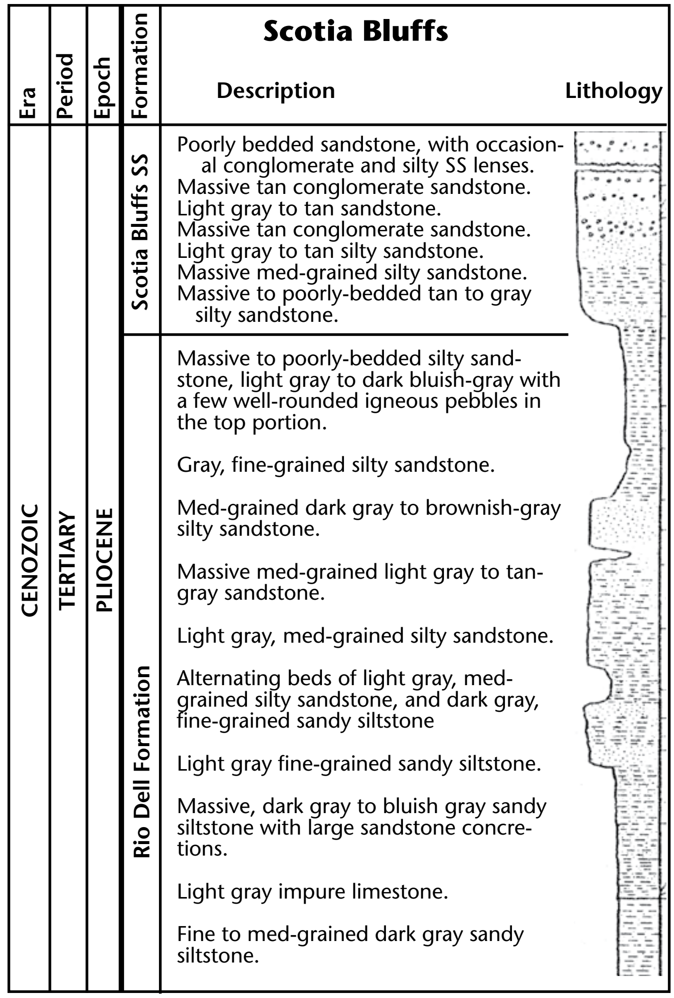


Figure 7 – Stratigraphic column of wildcat group
After Walter F. Faustman, 1964

Fossils and fragments from Scotia Bluffs: 1 & 6. Giant Pacific Scallop (*Petinopecten* sp.) 2. Clam (*Thrasia* sp.) 3 & 4. Cockle Shell (*Clinocardium meekianum*) 5. Sand Dollar (*Scutellaster* sp.) 7. Moon Snail (*Nautica clausa*) 8. Pandora shell (*Pandora sp.*) 9. Razor Clam (*Siliqua oregonensa*) 10. Shelly sandstone (*Psephidia* sp.)

Site Two:

Start of the trail from Centerville Beach County Park

Mouth of Fleener Creek

Unconsolidated mud cliffs where fossils are found

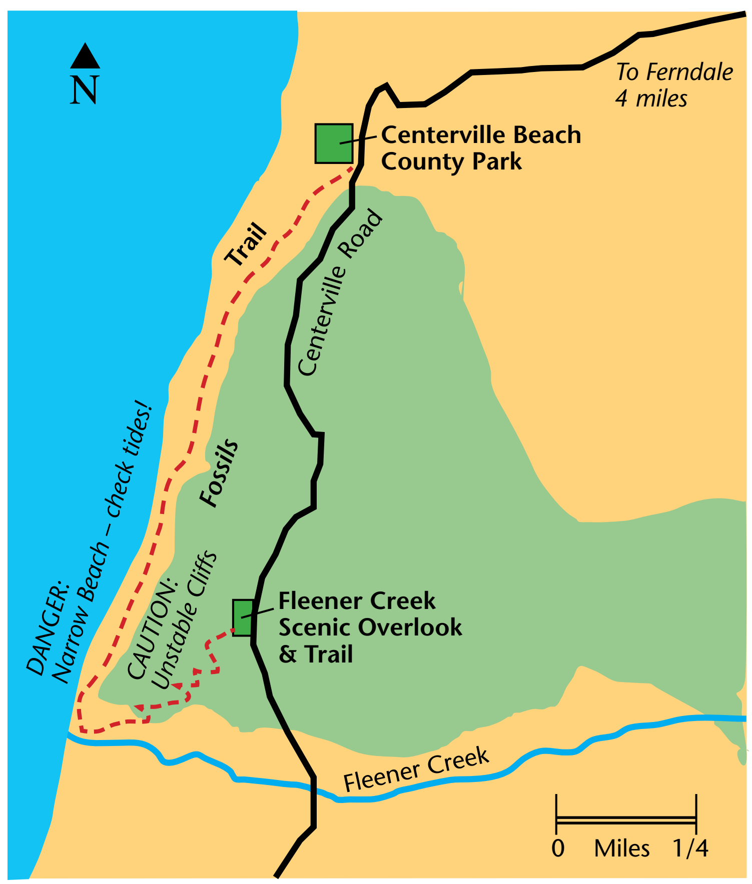
Centerville Beach

From this remote location, an easy walk along the beach gives the fossil hunter access to the rich sedimentary deposits of the Rio Dell Formation in the Wildcat Group.This mud-rich layer accumulated on the edge of a shallow sea.

The fossils exposed here are from the late Pliocene to early Pleistocene Epoch, around 2 million years ago. They are found in a layer of poorly consolidated mud and silt. This north-dipping clay layer contains Giant Pacific Scallop fossils, as well as a variety of other mollusks.

Length: About 2 miles out and back
Difficulty: Easy, level trail (see cautions!)
Hiking time: About 3 hours
Directions: Traveling south on Hwy. 101 from Arcata, take the Ferndale exit (exit 692.) Follow the signs and continue 5 miles to the town of Ferndale. Go through

> ***CAUTION:***
> ***Unstable cliffs along the south end of trail.***
> ***Narrow beach – go only at low tide!***
> ***Watch for returning tide and big waves!***



town and turn right on Ocean Ave., which becomes Centerville Road. Follow the signs to Centerville Beach County Park parking area.

To reach the fossil beds, walk south along the beach. You will see a gold-colored layer of sandstone, then farther along, a grey layer of unconsolidated mud begins to be exposed. Look closely in the mud to find fossils of scallops, cockles, snails, and clams protruding from the cliff face. The fossil-bearing mud layer continues almost to Fleener Creek. Beyond that the beach is too narrow to be safe.

Cockle shell in mudstone.

You can also access the beach and the cliffs from the Fleener Creek trailhead farther south along Centerville Road. The trail is somewhat steep down to the beach, then walk north along the mud cliffs.

Fossis and fragments from Centerville beach: 1, 11, 15. Moon Snails (*Natica clausa*) 2, 7, 10. Giant Pacific Scallop (*Patinopecten* sp.) 3. Pandora shell (*Pandora* sp.) 4, 18. Clam (*Macoma* sp.) 5. Channeled Dogwinkle (*Nucella canaliculata*) 6, 9, 13. Snails (*Antiplanes* sp.) 8. Modest Tellin (*Tellina modesta*) 12,17. Cockle (*Clinocardium meekianum*) 14. Cardita (*Cyclocardia* sp.) 16. Nassa shell (*Nessarius* sp.)

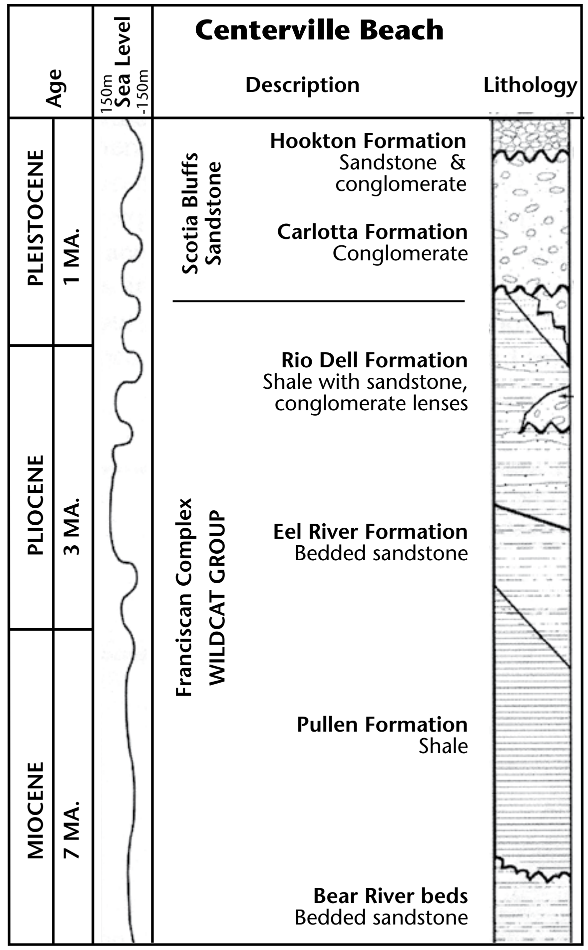


Figure 7 – Stratigraphy of Centerville Beach
After McCrory, 2000 and Gulick et al., 2002.

Site Three:

The north end of the beach showing the path of the faint trail up the cliff

Moonstone Beach

The layers exposed in the Moonstone pocket beach are composed of sedimentary and metamorphic rocks from the Jurassic and Cretaceous Franciscan Formation, capped by more recent sand and gravel deposits.

The fossils are from the Pleistocene Epoch, around 700,000 years ago.They are found in layers of poorly consolidated fine- to medium-grained sandstone and coquina.

Length: About 1 mile out and back
Difficulty: Easy trail with difficult sections (see cautions!)
Hiking time: About 2 hours
Directions: Traveling north on Hwy. 101 from Arcata, take the Westhaven exit. Follow the signs to the Moonstone Beach parking area. To reach the fossil beds, walk to the north end of the beach. You will see a buff-colored section of sandstone in the cliff. Look closely to find an indistict trail going straight up, between the conglomerate boulders. Look along the trail to see fossils everywhere! Continue up to a ledge where the entire fossil bed is exposed. Look for sand dollars, clam and mussel shells and barnacles.

CAUTION:
The last part of the trail is very steep and sandy! Limited space for small groups only. Beware of Poison Oak at the top!

View from the top of the Moonstone Beach trail

Exposed fossil layers

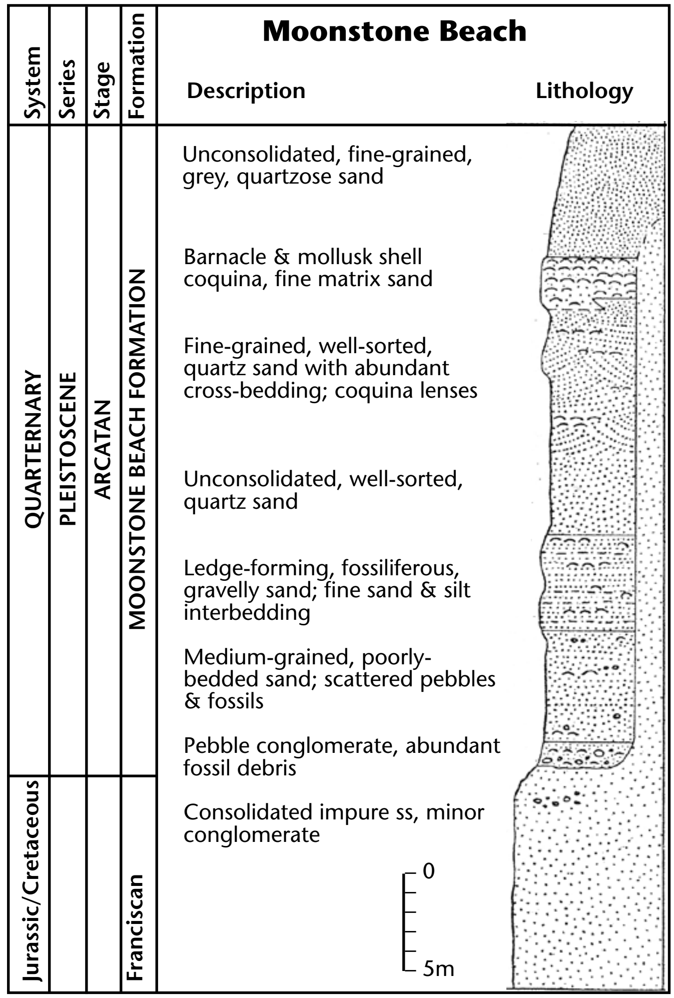


Figure 8 – Stratigraphy of Moonstone Beach
After Barry Roth, 1979

Fossils and fragments from Moonstone Beach: 1. Mussel (*Myliticus californianius*) 2. Cockle (*Clinocardium* sp.) 3. Sand Dollar (*Scutellaster* sp.) 4. Plate from a Giant Barnacle (*Balanus nubilis*) 5, 8, 9. Channeled Dogwinkle (*Nucella canaliculata*) 6. Common Barnacle (*Balanus perforatus*) 7. Olive Shell (*Olivella* sp.) 10. Keyhole Limpet (*Diodora* sp.) 11. Hinge of a Clam shell (*Tresus Nutalli*) 12, 14, 15. Mussels (*Mytilus californianus*) 13. Cockle (*Clinocardium* sp.) 16. Part of a Giant Barnacle (*Balanus nubilis*)

Cliffs south of the fault, showing pockets of gray, fossil-bearing mud.

From the top of the cliff, looking toward the small marshy lagoon and the sea.

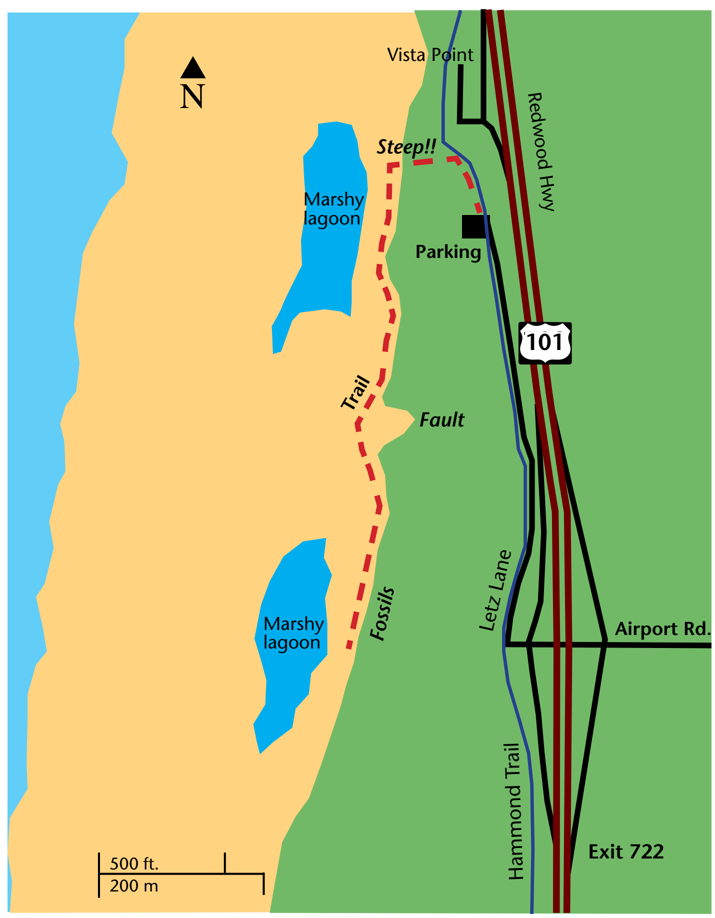
Mouth of the Mad River

This location is VERY hard to get to, and the variety of specimens is limited. It is an interesting place to see uplifted marine terraces, and study sea level fluctuations. It is known as the "mouth of the Mad River," although the actual mouth migrates over time, and is now farther south.

Fossils found here are from the late Pleistocene Epoch, around 200,000 years ago. They were deposited in an open ocean setting near a river mouth. They are located in pockets of gray sandy mud in a matrix of golden-tan fine- to medium-grained sand.

Length: About 1 mile out and back
Difficulty: Very difficult sections (see cautions!)
Hiking time: About 2 hours
Directions: Traveling north on Hwy. 101 from Arcata, take the Airport exit (722.) Turn right at the stop sign, then right again onto the frontage road. Park in the Hammond Trail parking lot, and start along the trail. In about 20 yards, look for a trail to the left going into the forest.

CAUTION:
The trail is very steep and strenuous! *Beware of constant landslides at the bottom of the cliff! Stay clear!*



Follow it toward the ocean where it bears left to the edge of the cliff – an old marine terrace. The trial goes straight down the cliff and is very difficult! Use caution! At the base of the cliff, (note the location of the trail for your return) walk to the left, (south) and follow the faint trail. The cliff is constantly eroding, so be careful to avoid frequent sandslides! Continue past the golden sand layer, to a gully that marks the location of a fault. Soon you will start to see pockets of gray, fossil-bearing mud, where you can find oysters and clams. This outcropping is uphill from a second small lagoon. To return, walk north – the trail up the cliff is opposite the first lagoon (marked with a cairn?)

Looking north from the base of the cliff

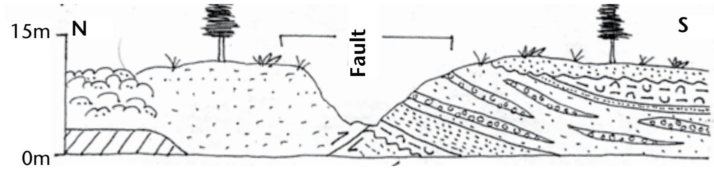


Figure 9 – Stratigraphic cross section *William Miller, 2005, unpublished sketch*

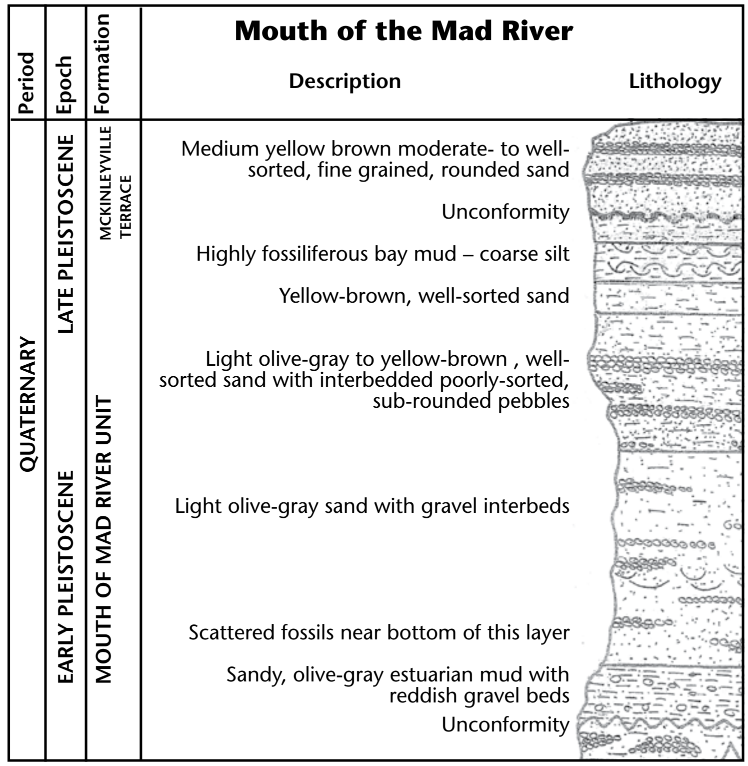
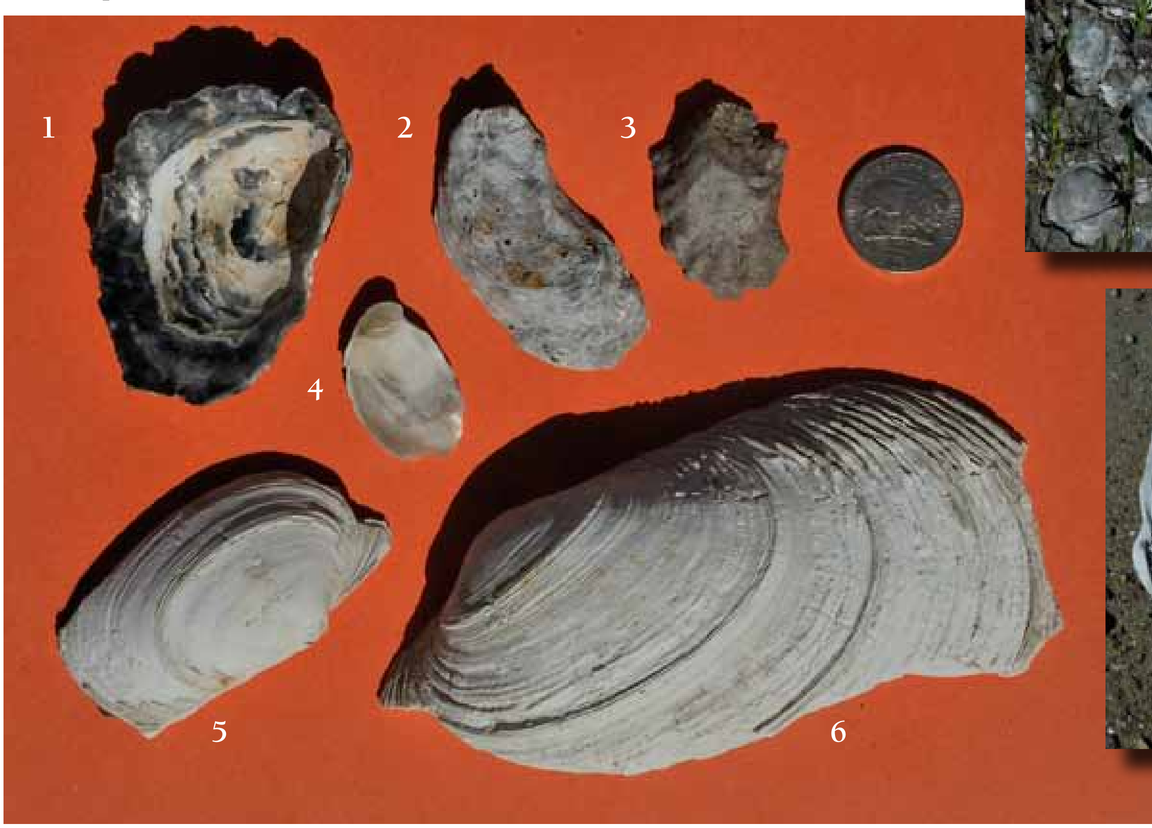


Figure 10 – Stratigraphic column *After Harvey, 1994*

Fossils from Mouth of the Mad River unit: 1 - 4. Oysters (*Ostrea* sp.) 5 & 6. Clams (*Tresus* sp.)



Fossils in the gray mud

Site Five:

Point where the trail descends

View of College Cove from the Elk Head trail

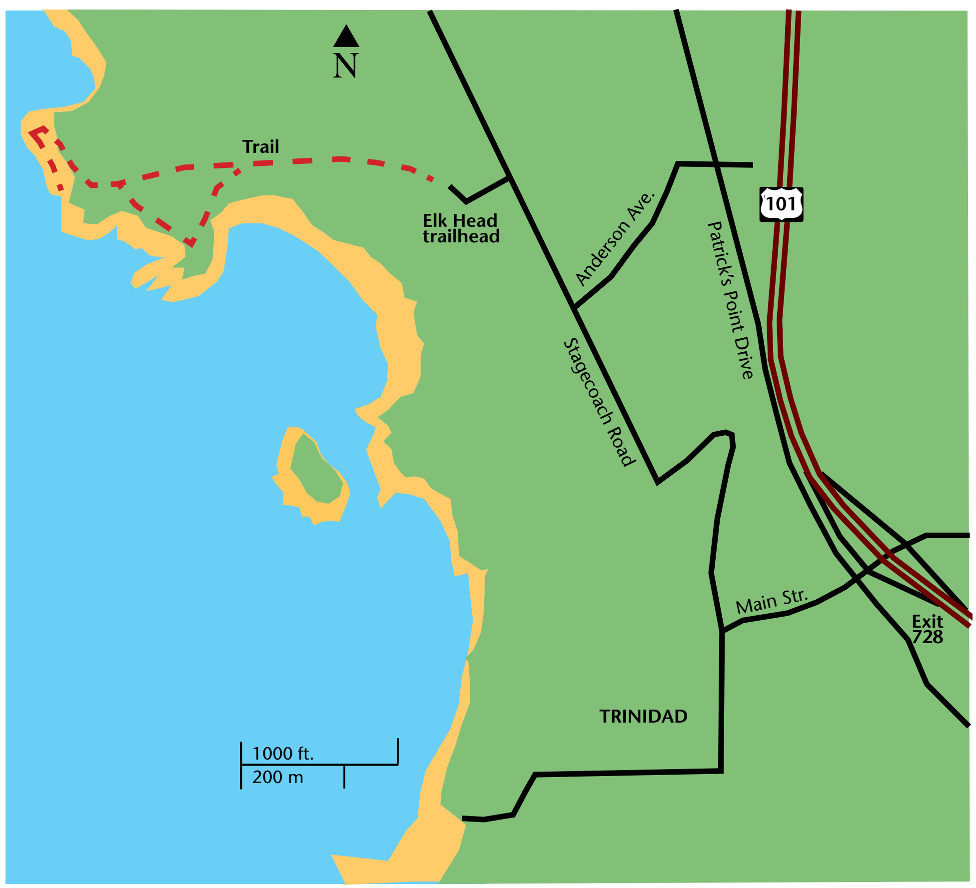
Steep drop-offs to the sea!

Elk Head

Fossils found at Elk Head tell us that the environment in which they were deposited was an intertidal zone with tidepools and serge channels along a rocky shore. They also show the amount of uplift that has taken place, as they are now close to 200 meters above the ocean! Here you will find interesting trace fossils – hundreds of holes made by pholads or boring clams. They excreted biochemicals that created pits in the rocks for their burrows.

The time period is the middle Pleistocene Epoch, around 500,000 years ago. The fossils are mainly mid- to high-tidal species with some low-tidal species that washed inshore. They are found in coarse brown sand which overlays older marine terraces.

> ***CAUTION:*** *Be careful on the stairs. Steep drop-offs to ocean.*



Length: About 1 1/4 miles out and back
Difficulty: Mostly level with difficult sections
Hiking time: About 2 hours
Directions: Traveling north on Hwy. 101 from Arcata, take the Trinidad exit (728). Turn left under the freeway, then right onto Patrick's Point Drive. After about 0.5 mi., turn left on Anderson Lane, then right at the T-intesection and continue about 0.2 mi. Turn left onto a dirt road to the Elk Head trailhead parking area. Take the trail west and follow the right fork out to the seacliffs. Turn right again, through a gate and out to a windy point. The trail then goes down some unstable steps – be careful! Then turn left and follow the cliff face south. Use caution around the steep drop offs! Soon you will notice layers of fossil-bearing silt within the light grayish brown sand. Most of the fossils are poorly preserved. Also, observe the many round pholad bore holes in the bedrock. Please limit collecting at this site to preserve existing specimens.

Sandy silt layer with sand dollars, muscles and polychaete worm tubes

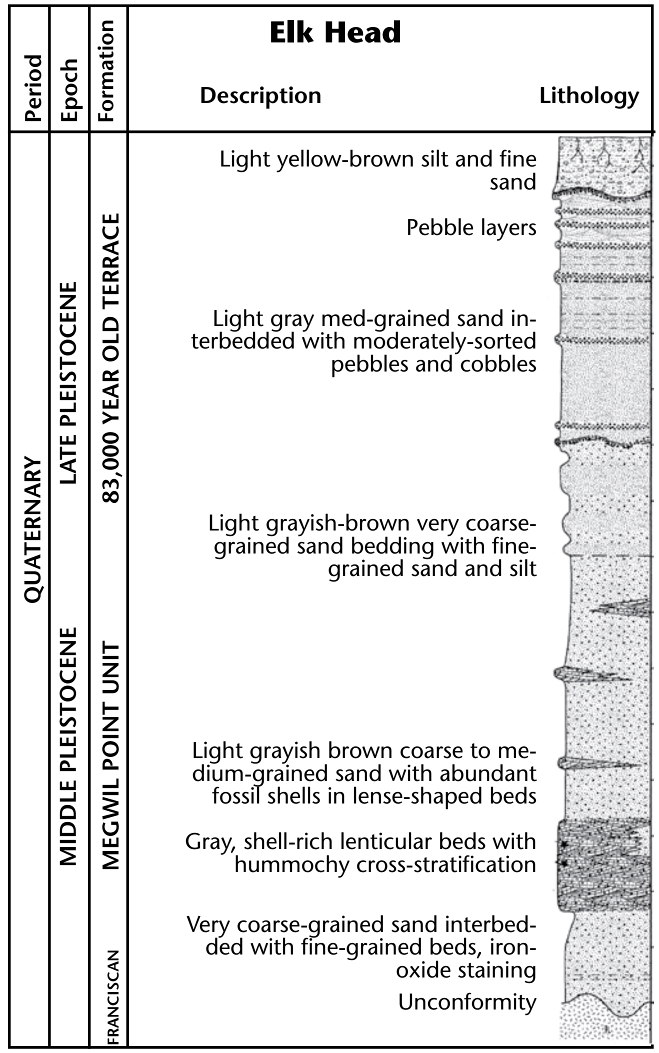


Figure 10 – Stratigraphy of Elk Head
After HSU Geology Dept., Ladinsky, Jackson & Caldwell, 2009

Fossils and fragments from Elk Head: 1. Mussel (*Mylíticus californianius*) 2. Dogwinkles (*Nucella* sp.) 3. Part of a Giant Barnacle (*Balanus* sp.) 4. Worm tubes (Polychaeta) 5. Rock Scallop (*Hinnites giganteus*)

Pholad borings in gray siltstone on top of the Franciscan formation

Glossary:

Andesitic – rock or magma with a high silica content.

Concretion – a nodule, or rounded mass of mineral material occurring in sandstone, clay, etc.

Cocquina – rock made up primarily of shell debris cemented together.

Fault – break in a rock plane along which one side has moved relative to the other.

Greenstone – a low-grade metamorphic rock formed from basalt.

Mafic – heavy, igneous rocks rich in iron and magnesium.

Melange – a body of rock composed of chaotic blocks of one strata in a matrix of another type of rock.

Pluton – an irregular or blob-shaped igneous intrusion that crystallized below the surface, ranging in size from tens of meters to tens of km.

Pholad – rock-boring clams (Family Pholadidae) that bore holes by mechanical abrasion. There they live, safe from predators, filter-feeding on plankton.

Silicic – lighter, surface rock, high in silica

Subduction zone – the region along the margin of converging tectonic plates where one sinks beneath another.

Tectonic – pertaining to the plates making up the earth's crust, or referring to the forces or conditions within the earth that cause movements of these plates.

Volcanic Arc – a curving chain of volcanos formed by the melting of a subducting plate at depth.

Resources:

Books:

Earth – Portrait of a Planet. Stephen Marshak, W.W. Norton & Company, NY, 2005

Index Fossils of North America. Hervey Woodburn Shimer & Robert Rakes Shrock, MIT Press, Cambridge, MA, 1994

Invertbrate Fossils. Raymond C. Moore, Cecil G. Lalicker & Alfred G. Fisher, McGraw Hill, NY, 1952

Invertbrate Palaeontology and Evolution. E.N.K. Clarkson, Blackwell Publishing, Oxford, UK 1998

Roadside Geology of Northern California. David D. Alt, and Donald W. Hyndman, Mountain Press Publ., CO, 1996

Websites:

California Geological Survey: **www.conservation.ca.gov/cgs**

Geology of Humboldt Bay area: **www.ebeltz.net/fieldtrips/humgeol.html**

HSU Natural History Museum: **www.humboldt.eru/~natmus**

Pacific Northwest Shell Club: **http://www.bily.com**

University of California Museum of Paleontology: **www.ucmp.berkeley.edu**

Walla Walla University: **www.wallawalla.edu/academics/departments/biology**

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