Name: _____

Field trip guide to the Marin Headlands (Golden Gate National Recreation Area) and the Point Reyes National Seashore

Geology of the National Parks
San Francisco State University
April 20, 2002

DRIVING DIRECTIONS

Start at SFSU
Drive 19th Avenue (Highway 1) north toward the Golden Gate Bridge
Cross the Golden Gate Bridge
Exit Highway 1/101 north at the 2nd exit after the bridge (not the Vista Point exit) to Alexander Ave.
Turn left and cross underneath Highway 101
Turn right onto Barry Rd. just before re-entering Highway 101 to cross back over the bridge
Stop at the top of the hill at the first dirt parking area — this is STOP #1
Return to Highway 101 north
Drive north past San Rafael and exit Lucas Valley Road to the west
Turn right onto Nicasio Valley Road after about 10 miles
At the T-junction, turn left onto Point Reyes Road
Stop at the junction with Laural Canyon Road — this is STOP #2
Continue on Point Reyes Road
Turn right onto Point Reyes/Petaluma Road
Turn left onto Shoreline Road toward Highway 1 south
Turn right onto Sir Francis Drake Blvd. toward Inverness
Drive to the Point Reyes lighthouse — this is STOP #3
Return along Sir Francis Drake Blvd.
Turn left onto Pierce Point Road
After about 5 miles, we will park and take the trail down toward the beach — this is STOP #4
Return along Pierce Point Road and turn left onto Sir Francis Drake Blvd.
Turn right onto Bear Valley Road
Turn right into the Visitor's Center and Park Headquarters — this is STOP #5
Return via Sir Francis Drake Blvd.

ROUTE MAP


Dillon Beach
Tomales
1
STOP #4
Marin County
Tomales Bay
Marshall
Point Reyes - Petaluma Rd
Novato Blvd.
Novato
STOP #2
Inverness
Inverness Park
Point Reyes Station
Nicasio
101
Lucas Valley Road
Seashore Visitors Center
Olema
Drakes Bay
STOP #5
Sir Francis Drake
STOP #3
1
San Rafael
National Parklands
N
W
E
S
Bolinas
Stinson Beach
Mill Valley
Muir Beach
STOP #1
Golden Gate Bridge

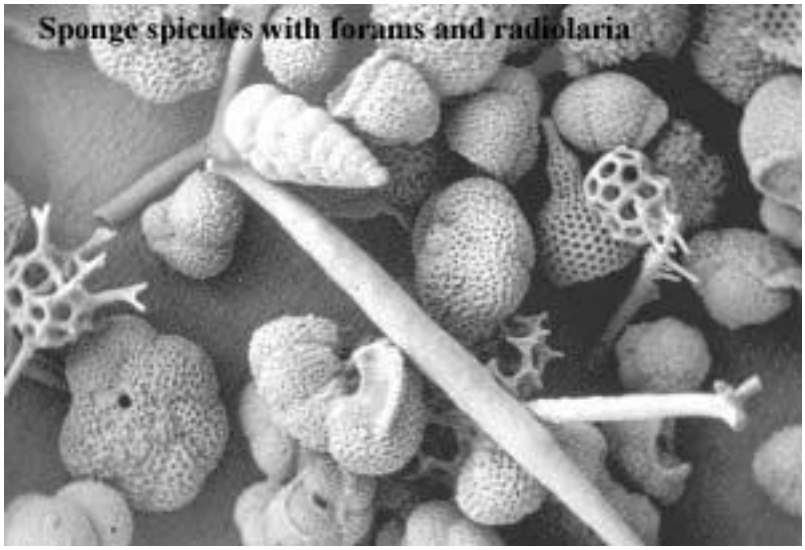
GEOLOGY STOPS AND QUESTIONS TO ANSWER

STOP 1 — Marin Headlands, Golden Gate National Recreation Area

Questions to answer

What is chert?

What is the name of the micro-fossils that comprise the chert here?



How big are these micro-fossils?

Where did this chert form and how did it get where it is today?

STOP 2 — Nicasio Reservoir Terrane

Questions to answer

What is this rock type?

Where did it form?

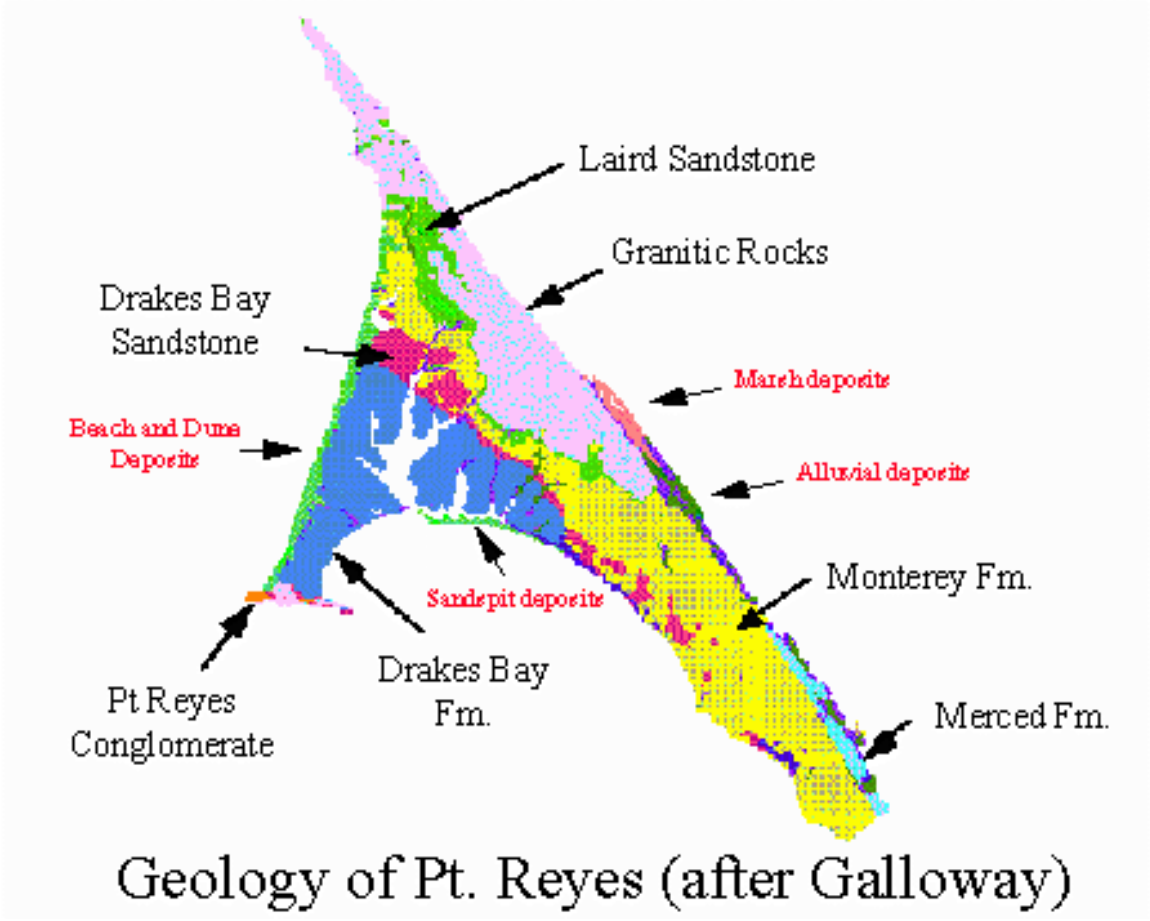
How did it get here?

Why is it dark-colored?

What gives these rocks their pillow shape?

THE SAN ANDREAS FAULT IN CALIFORNIA

GENERAL GEOLOGY MAP OF THE POINT REYES NATIONAL SEASHORE



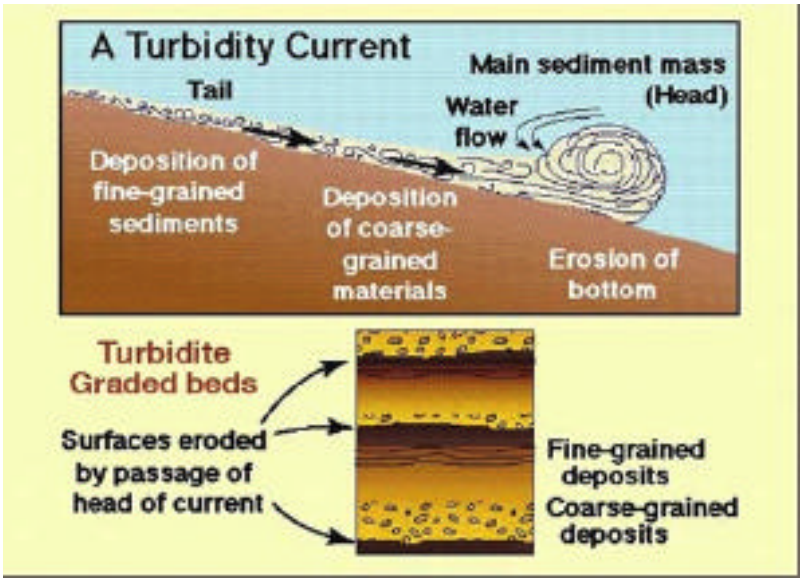
STOP #3 — POINT REYES LIGHTHOUSE

Granitic Rocks of Pt. Reyes
In the far distance past (110 million years ago) molten rocks formed (sometimes invading and literally "cooking" the prexisting rocks and creating the peninsula's metamorphic rocks). Unlike the molten rocks we see erupting at volcanic sites today, the geologic evidence indicates that these rocks cooled very slowly deep inside the Earth's interior, perhaps under a long vanished island or mountain arc of volcanoes.

Sierran granites or an "exotic" origin?
For a long time geologists pointed to the origins of the Salinian granites by tracing back along the San Andreas Fault to the Tehachapi Mountains where the first granites can be found on the East side of the San Andreas. Recent studies however indicate that 60 million years ago Pt. Reyes was attached to the west of Monterey, California where similar Salinian granitic rocks are common. Fault movement along a large, largely offshore, fault of the San Andreas System is believed responsible for moving Pt. Reyes from this location. Support for the non-Sierran, "exotic" nature of the Salinian block comes from geochemical studies of the southern Sierra and Salinian granitics which indicate some large discrepancies in the two areas. One interesting discrepency is that the correlative rocks in the Southern Sierra, Tehachapi Mountains are sites of intense mineralization, gold, silver, tungsten and antimony having been productive of several

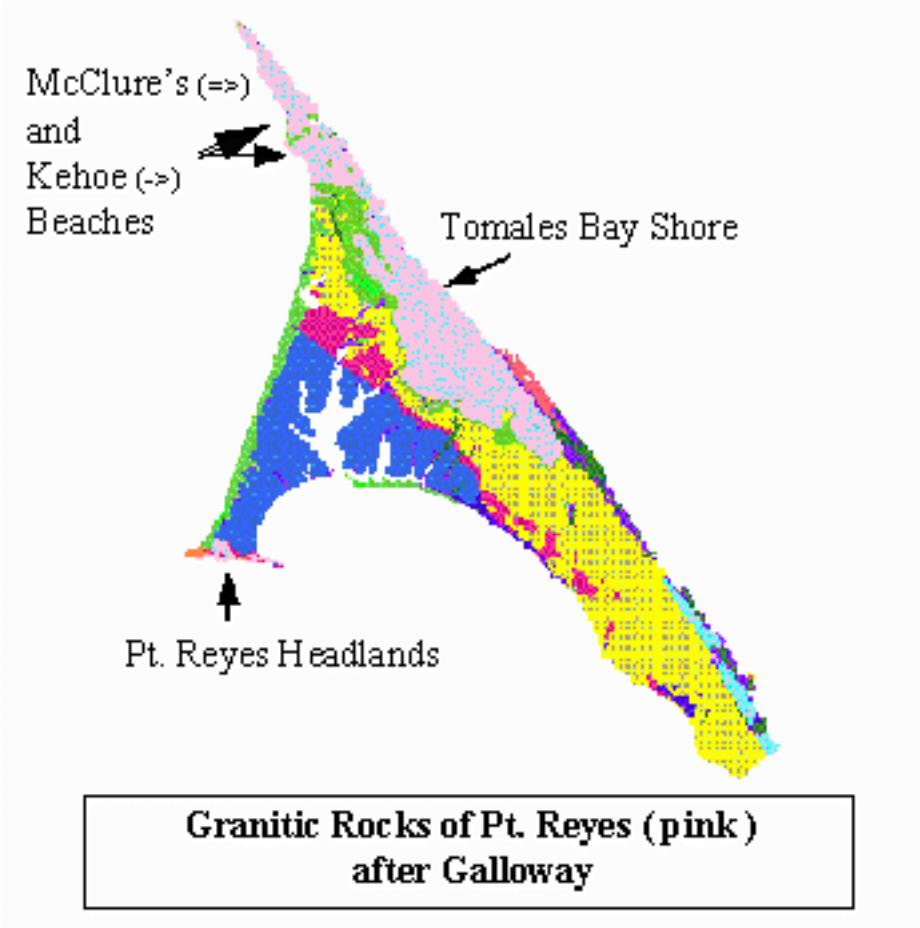
millions of dollars. The Salinian block on the other hand is quite barren of mineralization to the same degree.

The Pt. Reyes Conglomerate
This rock can be seen in exposures on the peninsula's headlands. Particularly good exposures can be seen in the exposures around the visitor's center for the lighthouse. These rocks are quite convincingly correlated with the Paleocene turbidites (Carmelo Fornation) found well exposed in the Pt. Lobos Marine Reserve south of Carmel, California and may well have been directly adjacent to Carmel during their formation some 50-60 million years ago.



Galloway's Pt. Reyes Conglomerate
Conglomerate of subangular to subrounded granitic cobbles and boulders and well-rounded pebbles and cobbles of resistant volcanic porphyries in a coarse sandstone matrix, with interbeds of fine-grained, laminated sandstone and mudstone.

MAP OF GRANITE OUTCROPS AT POINT REYES



Granitic Rocks of Pt. Reyes (pink)
after Galloway

Questions to answer

What kind of contact is there between the granitic rocks and the Point Reyes Conglomerate?

If these rocks correlate to similar rocks in the Monterey Bay area, how far must they have been translated along the San Andreas fault to get here?

STOP #4 — KEHOE BEACH

The Laird Sandstone
Seen best in exposures on Kehoe Beach, the Laird Sandstone was likely a sandy, near shore or beach deposit, sometimes fossiliferous, that marks the return of the sea onto the Pt. Reyes Peninsula. There is are boulder conglomerate and abundant barnacle fragments in the basal member of the unit. Fossiliferous units are more well cemented and resistant to erosion.

Between the formation of the Pt. Reyes Conglomerate and the Laird Sandstone, Pt Reyes likely experienced a prolonged period of elevation and erosion. As the sea rose (or land sank) to create the Laird rocks, the environment quieted and the deposition of the Monterey Formation, which is also well exhibited in Kehoe Beach exposures, began and produced this great example of a transgressive sedmentary sequence.

Galloway's Laird Sandstone (Tl) description
Medium- to coarse-grained, commonly silty sandstone; friable; base commonly contains rounded to subangular granitic clasts from 2 to 24 inches in diameter; largely unbedded except where interbedded with siliceous shale near contact with Monterey Formation.

Monterey Formation
The Monterey Formation is widely distributed over the Pt. Reyes Peninsula. Evidence has been obtained that although superficially similar to the Monterey, the rocks of the Bolinas area mapped by Galloway as Monterey are actually much younger. The Monterey Formation of Pt. Reyes is strongly correlated with the type locality deposits in the city of Monterey, California. Thus the suggestion that Pt. Reyes was still in the Monterey area up until Miocene times.

Galloway's Monterey Formation Description
Siliceous shale and minor chert; shale weathers white to gray or pinkish brown, and is commonly laminated to thin bedded, variously micaceous, silty, porcelaneous, or cherty, and locally contains calcareous concretions or sandstone or siltstone interbeds; chert is dark gray-brown and laminated with thin shale and sandstone interbeds; fish scales, carbonaceous material and molds of foraminifers, diatoms, and fish remains are variably present.

Questions to answer

Look for fossils in the Laird Sandstone — can you identify any?

What kind of contact exists between the granitic rocks and the Laird Sandstone?

What kind of contact exists between the Laird Sandstone and the Monterey Formation?

STOP #5 — POINT REYES PARK HEADQUARTERS AND VISITOR'S CENTER

The "Earthquake Trail" along the San Andreas Rift Zone

Questions to answer

How much offset was there on this trace of the San Andreas fault during the 1906 earthquake?

What man-made evidence is there (or was there) for that much offset in 1906? List at least two (2) things.

What is the name of the group of rocks on the Pacific Plate side of the San Andreas fault?

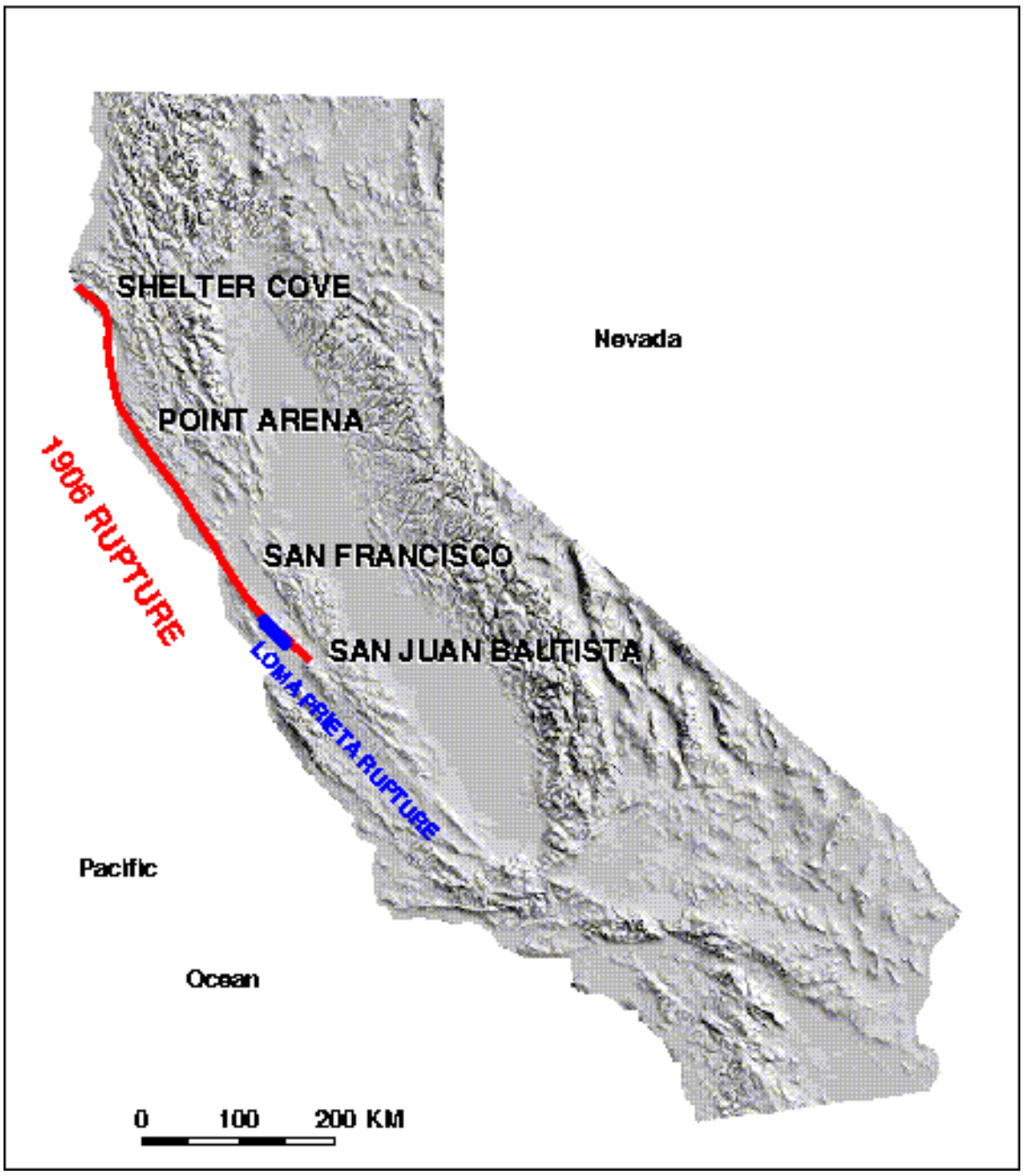
Name at least three (3) rock types that compose this group of rocks.

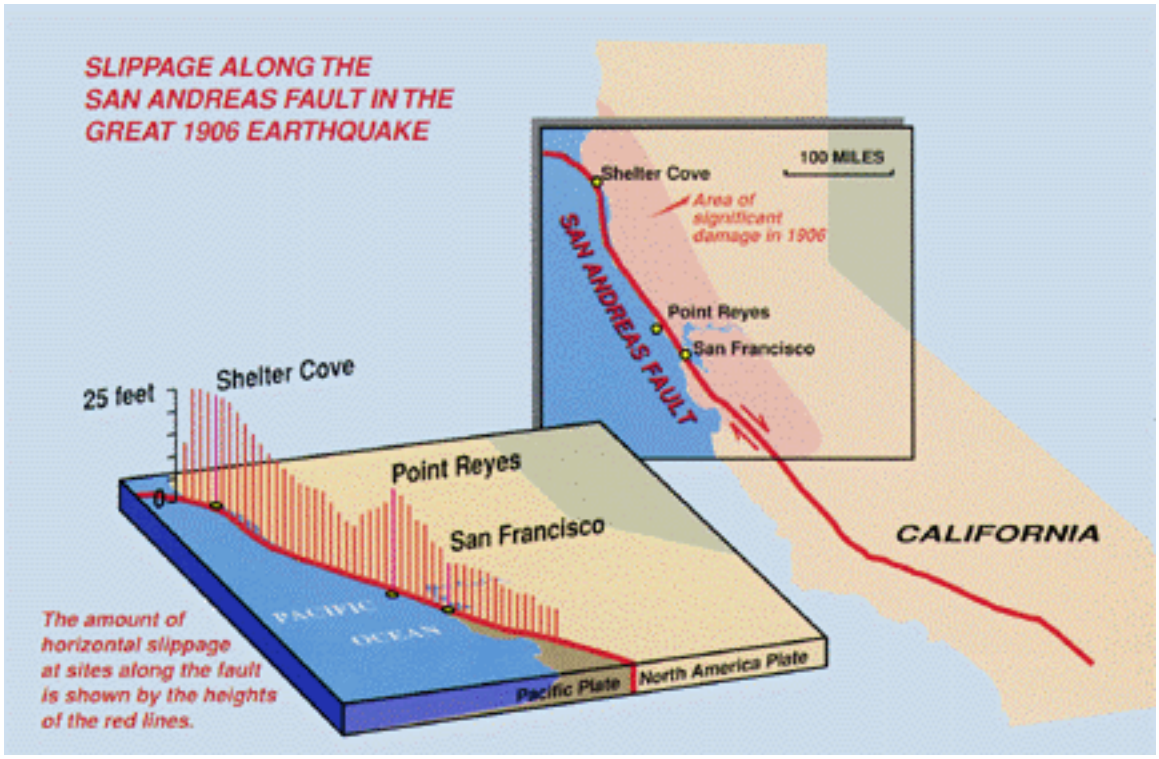
What is the name of the group of rocks on the North American Plate side of the San Andreas fault?

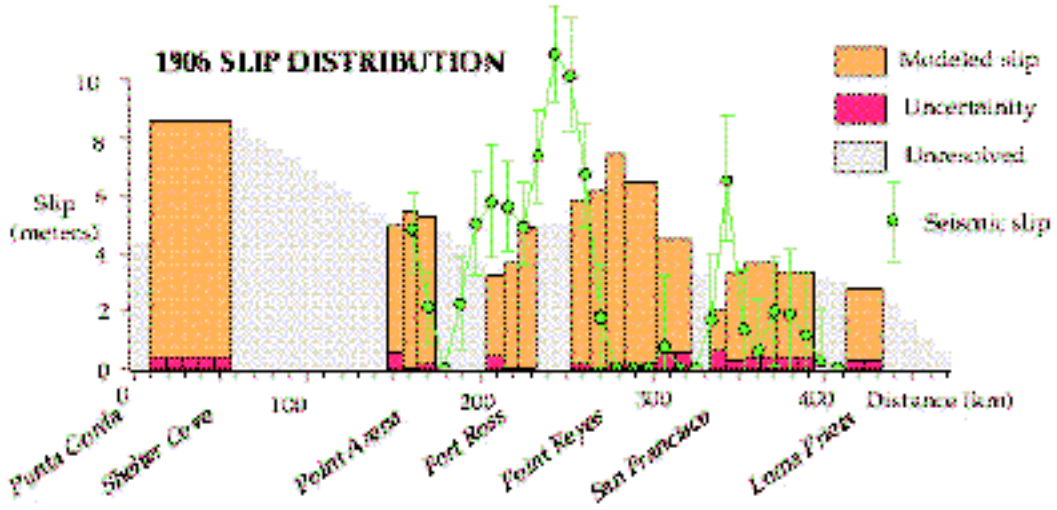
Name at least three (3) types of rocks that compose this group of rocks.

Name at least three (3) types of surficial expression of the San Andreas Rift Zone seen here.

If you live in San Francisco, what rock types does your apartment/house sit on? If you live somewhere else, what rock type type San Francisco State rest on?


SHELTER COVE
Nevada
POINT ARENA
1906 RUPTURE
SAN FRANCISCO
SAN JUAN BAUTISTA
LOMA PRIETA RUPTURE
Pacific
Ocean
0
100
200 KM


SLIPPAGE ALONG THE
SAN ANDREAS FAULT IN THE
GREAT 1906 EARTHQUAKE
Shelter Cove
100 MILES
Area of
significant
damage in 1906
SAN ANDREAS FAULT
Point Reyes
San Francisco
25 feet
Shelter Cove
Point Reyes
San Francisco
CALIFORNIA
PACIFIC
OCEAN
Pacific Plate
North America Plate
The amount of
horizontal slippage
at sites along the fault
is shown by the heights
of the red lines.


1906 SLIP DISTRIBUTION
Modeled slip
Uncertainty
Unresolved
Seismic slip
Slip
(meters)
10
8
6
4
2
0
0
100
200
300
400
Distance (km)
Punta Gorda
Shelter Cove
Point Arena
Fort Ross
Point Reyes
San Francisco
Lucia Point