Student Name: **Physical Geology 101 Lab** **Grade:**

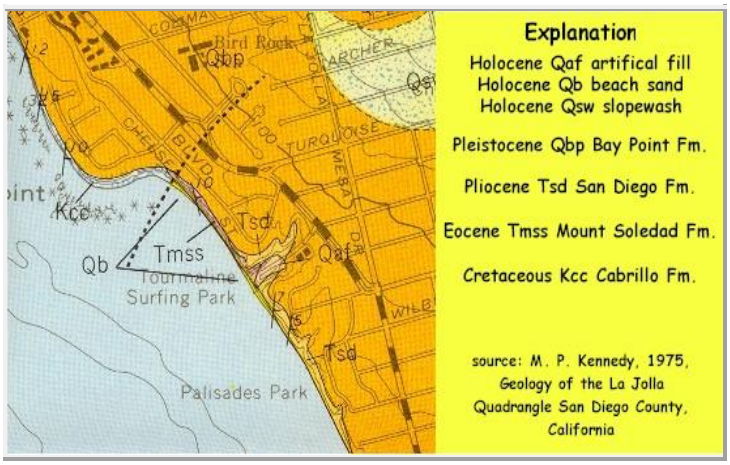
Geology of Tourmaline Surfing Park, San Diego CA

Introduction & Purpose: The coastal geology of San Diego County is beautifully exposed in bluffs of Tourmaline Surf Park. Sedimentary rocks of Mesozoic and Cenozoic ages were deposited there within various types of coastal marine depositional settings over time. Several unconformities and an ancient fault are also exposed there. The purpose of this lab is to observe, describe, sketch, photograph, and interpret various geologic features in the sea cliff at Tourmaline Surf Park. We will walk north past the end of the beach to Pacific Beach Point (False Point), about 50 to 100 yards past where the shoreline takes an abrupt turn to the left. From this most northern leg of our beach hike, we will work our way back south observing the entire stratigraphic package form the lowest oldest unit to the highest youngest unit.

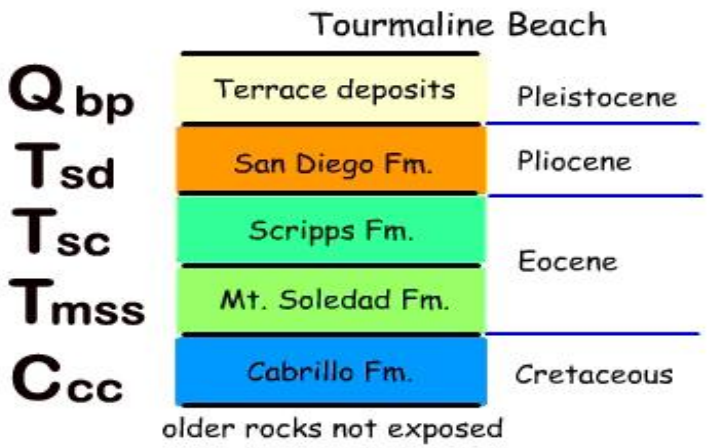
Geologic Background of Tourmaline Surf Park, San Diego, California

If we travel approximately 10 miles west of campus to the coast - north of Mission Beach - to Tourmaline Beach we find rocks exposed along the sea cliffs. Because of the strike and dip of these rocks a traverse northward along the base of the cliffs provides exposures of progressively older and older rocks. The oldest rocks are found at the base of the cliffs are at False Point. Although these rocks are all sedimentary, they have different lithologies, have different names, and represent somewhat different time intervals than those around the campus area. Using similar techniques of geologic mapping the relationships of these rocks are known. An important task for geologists is to determine how the rocks from these two areas are related. This technique is known as stratigraphic correlation.

Geology Map of Area



Stratigraphic Column



Tourmaline Beach - Meosozic Time

The oldest rocks exposed along the cliffs at Tourmaline Beach are to the north end of the beach at False Point. These are sedimentary rocks that are mostly conglomerate and some very coarse grained sandstone called the Cabrillo Formation. These rocks were probably deposited in shallow marine to beach conditions. Although few fossils have been found in the Cabrillo, fossils in associated formations provide evidence of a Cretaceous age, but somewhat younger (perhaps 40 million years younger) than that of the Santiago Peak Formation exposed a bit further inland.

Tourmaline Beach - Cenozoic Time

Cenozoic rocks exposed at Tourmaline Beach are sedimentary rocks that include conglomerate, sandstone, and mudrock. The oldest of these are pebble to cobble conglomerate and sandstone

of the Mt. Soledad Formation. These rocks were deposited as channel fill in beach environments. Conformably above the Mt. Soledad Formation are mudstone and siltstone of the Scripps Formation. These rocks were deposited in environments ranging from tidal flat to submarine fan. Fossils in these and laterally equivalent formations in other local areas indicate that both formations are of Early Cenozoic age (Eocene), but are slightly older than those at SDSU.

Overlying these Eocene rocks are sedimentary rocks consisting of conglomerate and fine grained sandstone called the San Diego Formation. The conglomerate has cobble sized clasts and occurs at the base of the formation. The remainder of the formation consists of sandstone. These rocks are not well cemented and tend to crumble easily. They were formed in intertidal and beach environments. Fossils are abundant in some layers of the formation, and indicate an age of Quaternary (Pliocene).

The youngest rocks at Tourmaline Beach are terrace deposits that are probably of Pleistocene age. They consist of mud, sand, pebbles and cobbles that are weakly cemented together and tend to erode easily. Not a great place to build a house! The stratigraphic relationships of these rocks are illustrated below.

Richard Miller - SDSU - Author

I. LOWER SECTION STOPS: THE ROCKS AT PB POINT:

Here at the point, we will observe the **Cabrillo Formation** and its overlying neighbor, the **Mt Soledad Formation**. The rock unit exposed in the wave-cut platform belongs to the Cabrillo Formation (lowest formation), whereas the similar looking Mt Soledad is exposed in the cliff. Cabrillo Formation Fm is late Mesozoic (72 million years) and Mt Soledad Fm. early Tertiary (52 million years).

A. OBSERVATIONS AND ANALYSIS OF THE CABRILLO FORMATION:

1) What specific rock type(s) make up the Cabrillo Formation? (Hint: it's detrital sedimentary)

Rock type(s):_____.

2) Name the three major rock types that make up the cobbles in the Cabrillo Formation.

_____, _____, and _____

3) What type of material makes up the matrix between the large clasts? _____

4) Estimate rock fragment size and shape in the Cabrillo Formation (pebble and cobble clasts)

Clast Size Range: _____ (centimeters) **Clast Shape Range:** _____

5) Is the Cabrillo Fm rock a clast- or matrix-supported conglomerate? _____

6) Is this sedimentary deposit poorly sorted or well sorted (rock fragments exhibit a wide range of sizes? or are the rock fragments are all about the same size)**?**

_____

8) Are the rock cobbles younger, older or the same age as the Cabrillo Fm? Explain.

9) What two sets of evidence within the Cabrillo Formation indicates that the sediment in this formation was a) *moved far from its source*, and b) *deposited in a high energy environment?*

Answer: _____ and _____

10) What's the most likely depositional environment for the Cabrillo Fm? _____

11) <u>LIST, SKETCH, and LABEL</u> the Cabrillo Formation on your Stratigraphic Column Worksheet.

B. OBSERVATIONS AND ANALYSIS OF THE MT SOLEDAD FORMATION:

1) What specific rock type(s) make up the Mt Soledad Formation? (Hint: it's detrital sedimentary)

Rock type(s):_____.

2) Name the three major rock types that make up the cobbles in the Mt Soledad Formation.

_____, _____, and _____

3) What type of material makes up the matrix between the large clasts? _____

4) Estimate rock fragment size and shape in the Mt Soledad Formation (pebble and cobble clasts)

Clast Size Range: _____ (centimeters) **Clast Shape Range:** _____

5) Is the Mt Soledad Fm rock a clast- or matrix-supported conglomerate? _____

6) What 2 sets of evidence in the Mt Soledad Fm indicates that the sediments in this formation were also a) *moved far from its source*, and b) *deposited in a high energy environment?*

Answer: _____ and _____

7) What evidence indicates that the Mt Soledad Fm's depositional setting was a river system?

Answer: _____

8) Compare the pebbles and cobbles that comprise the Mt Soledad Formation with those that you observed in the underlying Cabrillo Formation. Are there any differences or similarities? Make sure to mention:

a) Clast size ***b) Clast rock type,*** ***c) Clast- or Matrix-supported?***

9) What type of unconformity bounds the Cabrillo and Mt Soledad Formations? _____

10) The Mt Soledad Formation contains a unique set of cobbles, called the "Poway" clasts, which have an exotic origin.

	Rock Type	*Age*
a) List the *rock type* and *age* for the "Poway" clasts.	_____	_____

b) Explain *Where* and *How* those clasts ended up in this formation.

11) Why are there no "Poway" clasts in the Cabrillo Formation?

12) LIST, SKETCH, and LABEL Mt Soledad Formation on your Stratigraphic Column Worksheet.

II. MIDDLE SECTION STOPS - NORTHERN TOURMALINE BEACH:

Here we observe the Scripps Formation overlying the Cabrillo Formation. Note that the entire section of rocks at Tourmaline Beach are tilted (dipping) to the south. This tilting is due to the growth of Mt. Soledad a few miles to the northeast. Mt. Soledad is being pushed up along a compressional bend in the Rose Canyon Fault Zone. Therefore, as we head south we will be walking "up-section" through the whole sequence, where the Cabrillo Formation will eventually pass under the beach, giving way to the overlying Scripps Fm. Much of the section south becomes completely Scripps Formation – the thickest unit. The **Scripps Formation** is Eocene age (approx. 46 million years old) and formed in the middle to lower sections of a deep sea submarine canyon.

A. OBSERVATIONS AND ANALYSIS OF THE SCRIPPS FORMATION:

1) Note the contact between the Mt Soledad Fm and the Scripps Fm. **Briefly describe this contact. Is this contact considered an unconformity? If so, which type?**

2) There is a fault that cuts and offsets the Mt Soledad and Scripps Formations here. Closely observe the characteristics of this fault. Make observations and take measurements of the faults: **a)** Strike and dip, **b)** Apparent offset direction and amount**; c)** Slickensides?

Fault Strike and Dip: _____ **Offset Motion:** Hanging Wall moved Up? Or Down?

What type is fault is it? _____ **What type of stress caused it?** _____

3) What specific rock type(s) make up the Scripps Formation? _____.

4) Is this sedimentary deposit poorly sorted or well sorted ((rock fragments exhibit a wide range of sizes? or are the rock fragments are all about the same size)**?**

_____

5) What 2 sets of evidence in the Scripps Fm indicates that the sediments in this formation were deposited in a *submarine canyon environment?*

Answer: _____ and _____

6) Estimate the dip angle (tilt angle with respect to the horizontal) **of the Scripps Formation. Are these rocks dipping (tilted downward) toward the north or south?**

Dip angle: _____

7) As you continue walking north along the base of the sea cliff, notice how "messed up" (folded, swirled, etc.) the Scripps Formation is in some spots. These irregular swirls are the result of underwater mass movement events (slides, slumps, etc.) that occurred in this rock unit as it was being formed. **Did this deformation occur when the Scripps Formation was still soft sediment or after it hardened into a rock? Briefly explain your answer.**

8) Now, walk down the beach along the base of the sea cliff. Keep walking south until you notice a series of criss-crossing fractures filled with a very soft, clear mineral. This mineral was precipitated inside cracks in the rock by groundwater. **What mineral is this?** *Hint: it's very soft and it doesn't fizz in hydrochloric acid.*

Answer: _____

9) LIST, SKETCH, and LABEL the Scripps Formation on your Stratigraphic Column Worksheet.

III. UPPER SECTION STOPS - SOUTHERN END OF TOURMALINE BEACH:

A. OBSERVATIONS AND ANALYSIS OF THE SAN DIEGO FORMATION:

Walking south along the beach, before you reach the parking lot, high up on the sea cliff is a layer of conglomerate that overlies the Scripps Formation. This rock layer forms the base of the Pliocene **San Diego Formation** (less than 3 million years old). Observe the south-dipping contact between the underlying Eocene Scripps Formation and the overlying Pliocene San Diego Formation.

1) What type of unconformity bounds the Scripps and San Diego Formations? _____

2) What span of time does this unconformity comprise? _____

3) What specific rock type(s) make up the San Diego Formation? _____.

4) Is this sedimentary deposit poorly sorted or well sorted ((rock fragments exhibit a wide range of sizes? or are the rock fragments are all about the same size)**?**

_____

5) Further down the beach, south of the parking lot, you'll notice that the sandstone exposed in the sea cliff contains numerous fossils within the San Diego Formation.
Identify and Record all the different fossils you observe. Note: at a minimum, you should be able to find at least two different types of fossils. Look carefully! You'll see 'em!

Fossil #1: _____ **Fossil #2:** _____ **Fossil #3**: _____

6) What 2 sets of evidence in the San Diego Fm indicates that the sediments in this formation were deposited in a *rather quiet shallow offshore shelf environment ?*

Answer: _____ and _____

7) LIST, SKETCH, & LABEL the San Diego Formation on your Stratigraphic Column Worksheet.

IV. Post Trip Reflection

Each student must write a lab reflection (minimum of 120 words in length) about your experience in doing the exercises in the field lab today. Include the following: 1) The central purpose of this fieldtrip; 2) What was the most important thing that you learned from doing this excursion? 3) What was the most interesting aspect of the lab? 4) What was the biggest problem or challenge that you encountered while doing this lab? 5) Provide some constructive criticism of the fieldtrip design. Hand write (if you're neat) or type.

1) Purpose of lab: _____

_____

2) What actually learned? _____

_____

3) Most interesting aspect(s)? _____

_____

4) Most difficult or challenging aspect(s)? _____

_____

5) Thoughts on trip design and execution _____

_____

_____