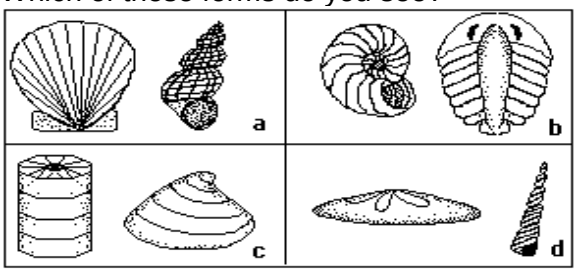
SELF GUIDED FIELD TRIP
TO
TOURMALINE SURFING PARK

DIRECTIONS: Take I-5 to Pacific Beach and get off at the Grand/Garnet exit. Take Grand Ave. towards the beach all the way to Mission Blvd. Turn right on Mission Blvd. and drive north until you arrive at the stop light where La Jolla Blvd. forks-off from Mission Blvd. Turn left on La Jolla Blvd. and quickly turn left again where you see the sign in the center divider for Tourmaline Surfing Park. Drive down the steep hill and park in the parking lot. Take this handout, a pen/pencil, a DataLink form, and your geology textbook to stop #1 and begin answering these questions to the best of your ability.

STOP #1: Here you will see the tan, fossil-bearing sandstones of the San Diego formation (~3-5 million years old) overlain by the somewhat reddish-brown Bay Point formation (~80,000 years old) at the very top of the cliff. The Bay Point formation is comprised of rocks formed from sediments deposited on a wave-cut platform which was later uplifted to become a marine terrace, whereas the environment of deposition for the San Diego formation was a protected bay. There are two kinds of fossils in the San Diego formation here.

STOP 1

1. Which of these forms do you see?



2. Will a wooden stick scratch this formation?
   a. yes
   b. no

STOP #2: At the base of the parking lot you will see some rather large greenish-purple boulders placed there to protect it from wave erosion. Large boulders used for structures like this are known as rip-rap. The boulders where taken from a quarry next to Mission Gorge Rd. near Cowles Mountain. These are some of the oldest rocks in San Diego. They were quarried from a wide spread but discontinuous rock unit known as the Santiago Peak Volcanics (138-118 million years old). The Santiago Peak Volcanics owe their origin to magmas generated by the subduction the Farallon Plate (an ancient oceanic plate in the Pacific) beneath a narrow slab of oceanic crust attached to the western margin of the North American continental plate. Hence, they were deposited in an island-arc environment. Although their age is equal to that of dinosaurs, volcanic environments are not conducive to the preservation of fossils. Furthermore, the greenish color of these rocks is due to the presence of iron-bearing metamorphic minerals (chlorite and epidote) formed from the heat of magmas which got stuck in the ever-thickening volcanic pile. Metamorphism tends to destroy fossils.

STOP 2

3. The texture of these volcanic rocks is best described as
    a. phaneritic
    b. porphyritic
    c. aphanitic
    d. vesicular
    e. pyroclastic

4. What name would they be given?
    a. scoria
    b. volcanic breccia
    c. tuff
    d. obsidian
    e. pumice

STOP #3: Here again you will see the Bay Point formation overlying the San Diego formation, but a third formation is visible now at the base of the cliff - the interbedded sandstones and shales of the Mt. Solidad formation (about 48 million years old).

5. How does the degree to which the Mt. Solidad formation is lithified compare to that of the San Diego formation?
    a. they are equally lithified
    b. the Mt. Solidad Formation is more lithified
    c. the San Diego Formation is more lithified

6. Why might this be the case?
    a. sediments become more lithified with age
    b. sediments become less lithified with age
    c. the San Diego Formation has more cement
    d. the Mt. Solidad Formation is predominately cemented by calcite whereas the San Diego Formation is predominately cemented by silica

STOP #4: As you walk northward you will be seeing deeper and older layers of rock. About 100 feet north of the first white pipe you come to notice how the layers of gray to orange shale below are tilted more than the layers of sandstone and shale above.

STOP 4

7. How can you explain this?
   a. there is a fault which separates the lower shales from the upper sandstones and shales
   b. the lower shales where tilted and eroded, and then the upper sandstones and shales where deposited upon this erosional surface
   c. because metamorphism's effects depend (in part) on the composition of the parent rock, the lower shale has been foliated at a higher angle than that in the upper sandstones and shales

Notice also a clear to white mineral that is filling the irregular cracks here. This is gypsum.

8. Can you scratch it with your fingernail?
   a. yes
   b. no

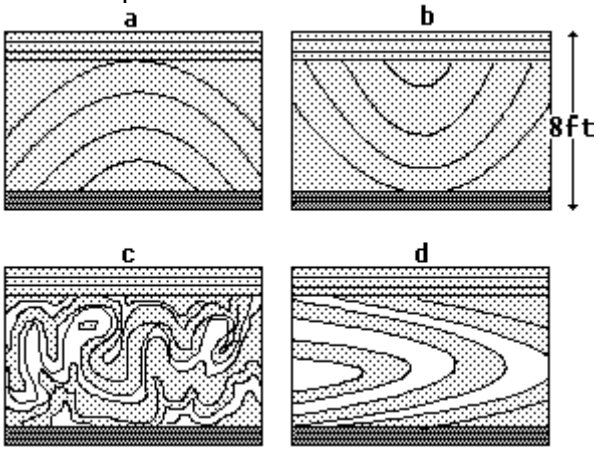
9. What is the chemical formula for gypsum as indicated in your book?
   a. CaPO4
   b. CaSO4.2H2O
   c. NaCl
   d. KAlSi3O8

Gypsum is commonly formed from the evaporation of seawater; however, here the gypsum has formed from the action of groundwater. Groundwater percolating downward through soil and rock has leached their soluble components and precipitated them as gypsum in the numerous fractures which occur here. There are three varieties of gypsum; selenite is clear and transparent, satin spar has a grain to it in cross section somewhat like cooked fish, and alabaster is a compact aggregate of fine-grained gypsum crystals.

10. Which variety is found here?
    a. selenite
    b. satin spar
    c. alabaster

STOP #5: Here the near-horizontal layering in the Mt. Solidad formation is disturbed.

11. Which of these is the most accurate representation of the deformation found here?



12. How can you account for the fact that the layers above and below the folded rocks were not affected by the folding process?
    a. these are metamorphic rocks
    b. the folding occurred after the uppermost layers were deposited
    c. the folding must have occurred due to submarine slumping while these rocks were still soft sediments
    d. the folded rocks where brought into contact with the non-folded rocks via movement along horizontal faults

STOP #6: Directly below the first spotlight about halfway to the top of the cliff notice how the thinly bedded, nearly horizontal sandstone and shale on the left terminate abruptly against a broad, upwardly curved surface that slopes to the right.

STOP 6

Examine this feature closely and formulate a reasonable hypothesis for its origin.

13. This feature is probably
    a. a reverse fault
    b. a normal fault
    c. an ancient landslide
    d. the edge of a submarine canyon that was eroded by turbidity currents and later filled with sediment

STOP #7: The lower part of the cliff is coated with a thin, discontinuous, whitish encrustation of the mineral halite (salt).

STOP 7

14. How might this have formed?
    a. the salt formed from the evaporation of ocean-spray on the cliffs
    b. it was secreted by cliff-dwelling organisms
    c. it was left there as a residual product after wave erosion removed other minerals from the cliff base

15. This 10’ by 7’ by 3’ block of sandstone and shale stood for almost 10 years until being largely destroyed sometime during 2018. Find the remnants of the block. Which is true?
    a. the entire block appears to have toppled over like a domino
    b. the upper part may have toppled over or eroded, but the lower foot-or-so has not moved

STOP #8: As you walk northwards along the beach, you will notice that just after the black pipe, the rock types in the cliff change.

STOP 8

16. The sandstones and shales of the Mt. Solidad formation change abruptly to the _____ of the Cabrillo formation (about 70 million years old) as you continue walking north.
    a. limestones and shales
    b. black shales
    c. sandstones and breccias
    d. sandstones and conglomerates

This is due to offset along a fault. Rocks near faults are typically sheared, broken, and pulverized due to the

grinding action associated with the displacement of the large blocks of rock on either side of the fault plane. Hence fault zones are typically weathered and eroded faster than adjacent rocks - explaining the poor rock exposure in the fault zone here.

17. If the fault plane dips towards the Cabrillo formation (that is, the fault plane is tilted such that water running down the fault plane would run towards the Cabrillo formation), and the Cabrillo formation has moved up relative to the Mt. Solidad formation, what kind of fault is this? (use your text as a reference)
    a. right strike-slip
    b. left strike-slip
    c. normal dip-slip
    d. reverse dip-slip

18. Why do you suppose large cobbles and boulders are more common on the beach here and to the north, but become less common to the south?
    a. a river north of here carried the cobbles to the shore and beach drift transported them southward leaving these cobbles on the north end of this beach
    b. they were placed on the beach by home owners to slow coastal erosion
    c. they could be eroded from the conglomerates in the cliffs at the northern end of the beach, but not from the sandstones and shales to the south

STOP #9: A filled submarine canyon is clearly seen in the cliff here.

STOP 9

19. What rock types fill the ancient submarine canyon?
    a. conglomerate only
    b. sandstone only
    c. shale only
    d. conglomerate and sandstone
    e. conglomerate, sandstone and a few fragments of shale

STOP #10: Look at this small canyon.

STOP 10

20. Is there evidence for faulting in the Cabrillo formation here? (Hint: See if you can determine if there has been any displacement of the rock units on the left side of the canyon relative to the right side.)
    a. yes
    b. no

At the base of the cliff in this small canyon you can sometimes see the shale and sandstone of the Point Loma formation (about 70 million years old). If you can't see it here look for it elsewhere at the base of the cliff further out on the point. In this formation, fossils of duck-billed dinosaurs, giant marine reptiles (mosasaurs), an armor- plated nodosaur, and giant ammonites have been found. It is exposed along portions of the La Jolla and Point Loma shorelines. Examine the Point Loma formation.

21. Would you expect the coastal erosion rate of the Point Loma formation to be faster or slower than that of the Cabrillo and Mt. Solidad formations?
    a. faster
    b. slower

Examine the rocks which comprise the majority of the cliffs of Pacific Beach Point.

22. Why does Pacific Beach Point jut farther out into the ocean than does the rest of the shoreline you have just seen?
    a. Smaller waves strike the point.
    b. It was made that way by developers for the aesthetic pleasure of the area's home owners.
    c. It is made of rocks that are more resistant to erosion than the rest of the cliff.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Location of Stops
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