NAMES_____

Stop 1 – Prospect Point Lookout

1) Look across the water to the North Shore. Much of Vancouver's early prosperity came from logging those slopes. Far to the left is Point Atkinson (or Lighthouse Park), followed by Cypress Mountain, then Grouse Mountain. The Lions were visible as we crossed the overpass in the Park and looked down to **Lions Gate Bridge**.

   The rocks of these mountains were formed deep underground by the slow cooling of **magma**, making them _____. They formed in a large intrusive feature called a _____. If we investigated those rocks we would expect the crystals to be *large / small?* Why?_____

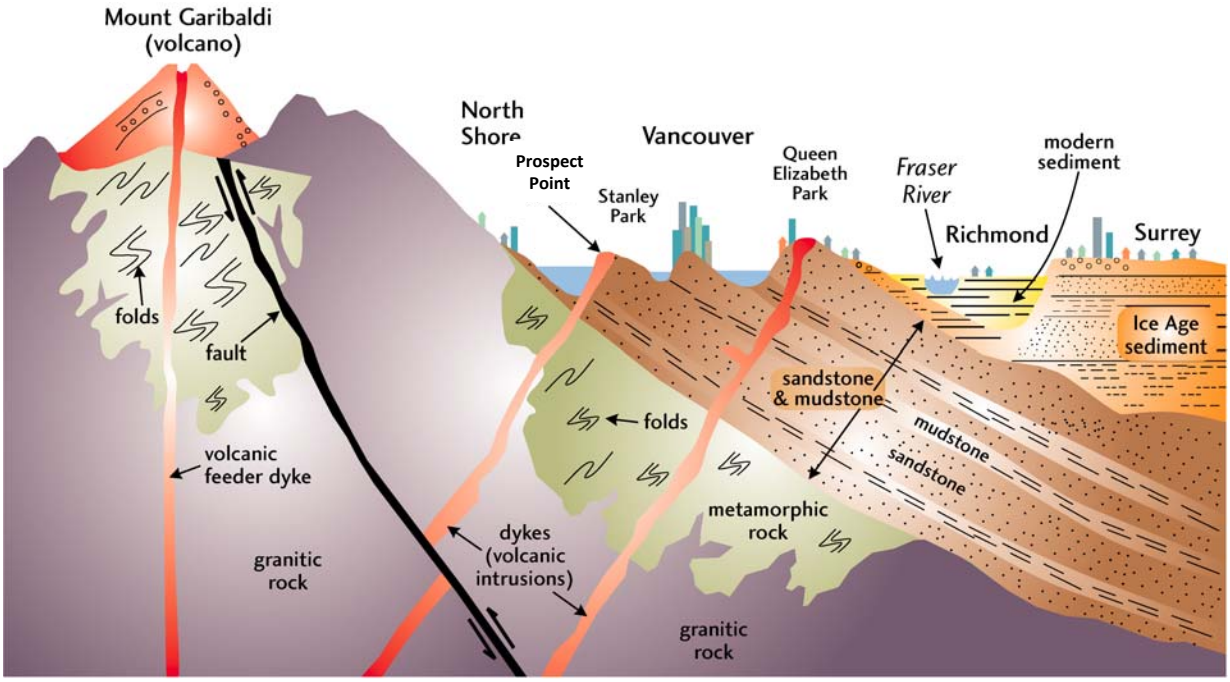


Figure 1 – North-South cross-section looking east from the North Shore Mountains to the Fraser River Delta. Modified from Clague and Turner (2003).

2) Across the water you can see the **Capilano River** entering **Burrard Inlet**. What feature is forming at the mouth of the river?_____. Explain why this forms:_____

3) This feature is continually being dredged out. What do you think would eventually happen if the natural processes were allowed to continue without human intervention?_____

4) Study the cross-section above and identify the types of rock we should be looking for today along the Stanley Park seawall._____

Stop 2 – Beginning of the Seawall

Figure 2 *– View to North Shore Vancouver Wharves from Stanley Park*

1) The yellow piles you see across **Burrard Inlet** in North Vancouver are not from the TANG factory. What are they?_____
What do you think the large red cranes are for that line the waterfront?_____

Plate Tectonics – 150 million years ago the Coast Mountains did not exist. Looking out from this spot would have been out to open ocean. **Vancouver Island** and the bedrock under the **Strait of Georgia** are **continental crust** that collided with the mainland. In a continent / continent collision describe what happens. _____

2) Look east towards **Burnaby Mountain** and SFU sitting at the top of it. The shape of this hill and its south-facing slope is exactly the same as Stanley Park, Queen Elizabeth Park, and even Sumas Mountain near Abbotsford. Look at the diagram below to help with your explanation for why is this so?

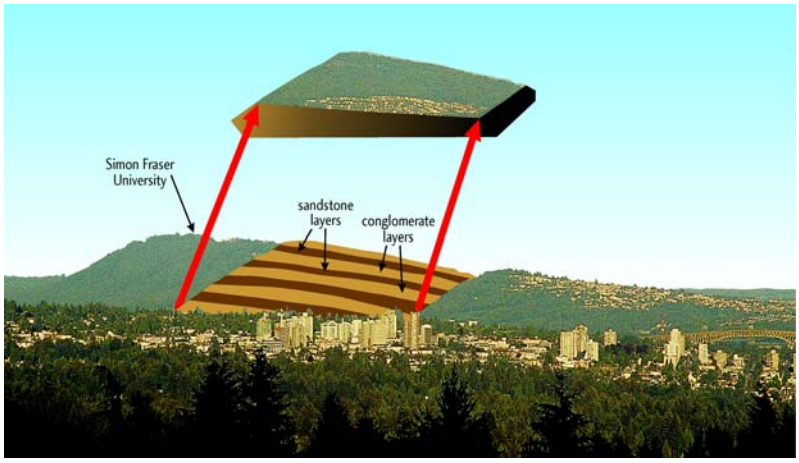


Figure 3 *- View to East from Stanley Park to Burnaby Mountain showing the gently-dipping bedrock which forms it. From Clague and Turner (2003).*

3) These sedimentary rocks also once covered much of the North Shore Mountains. Why do you think there is no evidence of them on the North Shore anymore?_____

_____

4) What does this tell us about the weathering of sedimentary rocks compared to weathering of igneous rocks, and why do you think there is a difference?_____

_____

_____

Stop 3 – Under Lions Gate Bri*dge*

1) This is the site of one of the **landslides** that occurred during the storm of November 2007. The *failure surface* was the *contact* between the **glacial till** and this **bedrock**. Identify the bedrock and state your observations as evidence of your interpretation._____

_____

_____

2) The footings of the Lions Gate Bridge are in this same rock at depth. City engineers have some concerns over this. Can you suggest some reasons why? (Note: Strong tidal currents travel past this point.)_____

_____

_____

Stop 4 – Just past White Beacon (below Prospect Point)

Stand back and observe this outcrop from afar. Try to spot the two very different rock types.

Figure 4 *- View of the base of Prospect Point showing the contact between two different rock types. The* ***contacts*** *are marked by dashed lines.From Turner and Clague (2003).*

1) Get a sample of rock from your teacher and try to identify it. You may refer to the cross-section on Page 1.
Name of rock _____. Evidence:_____

_____

_____

2) Look at this entire rock outcrop and the photo on Page 3 to interpret the geologic events recorded here. (Hint: the sandstone was here first.)_____

3) The distinctive structural feature in this rock tells us it cooled *quickly*. What is the name of this type of **jointing**?_____

4) Write three statements about the **weathering** of both rock types that you observe here.

a)_____

b)_____

c)_____

5) What evidence would you look for to determine which rock is older? Sketch two examples of evidence that will support your interpretation in question 2.

Evidence #1

Evidence #2

6) Looking across the water to the North Shore, can you spot where this rock might crop out again? If yes, describe the location. _____

Between here and our next stop, look for signs of slope instability and the engineering solutions to these problems.

Stop 5a (cliff outcrop just before the benches) – Sedimentary Structures

1) A **sedimentary structure** is noticeable in outcrop here defined by the black sand particles. Draw what you see and label it. Be sure to include a bar scale to indicate the size of the structure. Using an arrow, also indicate what this structure tells us about the environment of deposition.

Structure Name: _____

_____

Stop 5b – Benches

1) Looking out from this location, use your imagination to travel back *20,000 years ago* at the peak of the last **glaciation**. We would be under the glacial ice here. All around us, at the base of the ice, a compact mixture of different sediment types and sizes, which geologists call _____, is being deposited.

2) The North Shore Mountains were covered by a **continental glacier** that was ~1.5 km thick and terminated at the ocean, calving off into icebergs. How is the thickness of the glacier determined?_____

_____

_____

Today, the snow on these mountains does not last all year and there are no **alpine glaciers** visible. However, there are alpine glaciers in many other high elevation areas of this coastal mountain range.
How would the landscape look different if the North Shore Mountains were being carved by alpine glaciers today?_____

_____

_____

Spend some time here to get your work complete to this point.

3) Go down the stairs and look at the **boulders** on the beach. What type of rock are most of these boulders?_____

_____

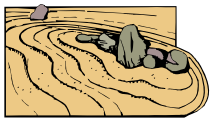
Where are they from and how did they get here?_____

_____

4) Pick up loose sand at the base of the cliff. What is it made of? _____

_____

Pick up loose sand deposited between the boulders in the intertidal. How is it different from the sand at the base of the cliff? _____



What modern sedimentary structures do you see in the loose sand in the intertidal? How did they form? _____

_____

Stop 6 – Caution: Falling Rock

1) Note the **gravel lenses** in this rock. Consider these deposits as well as the sandstone at Stop 4. What type of depositional environment might these strata have been deposited? _____

_____

_____

If the gravels formed a thicker, more continuous layer, what would be the proper name of this rock type?

_____

2) Explain the processes that are involved in turning loose sediment, like that on the beach, into sedimentary rock, like that which you see here._____

_____

_____

The history that you are unravelling was occurring *66 million years ago* when dinosaurs were still roaming the Earth. No dinosaur bones are found in these rocks. Instead geologists use **pollen grains** and **plant fossils** to date them.

Stop 7 – Cliff in the Alcove Just before Siwash Rock

Figure 5 – *Boulder like structure in sandstone cliffs near Siwash Rock.*

It appears that there are 10-50 cm "boulders" within the sandstone here. If you look closer you should be able to see that these structures are also made of sand grains, some even exhibit bedding going right through them. These structures are called _____ _____. They formed after the sand was deposited by localized precipitation of **iron oxide cement**! Is this cement more or less resistant to weathering than the cement in the surrounding sandstone? How do you know?_____

_____

_____

2) Look up to the top of the cliff. Some have spotted a fossilized tree root in the sandstone. Do you?
3) Scour (with your eyes!) the outcrop to spot a *black seam* in the sandstone. When you find it collect a **very small** piece and take a look. What is it? _____
2) Write a short story describing how this black seam formed over time. _____

_____

_____

Stop 8 – Siwash Rock

Figure 6 *- Siwash Rock.*

1) Once again we have reached a new rock type. It should look familiar. As you walk around this point look at the features and think about what kind of rock and structure you are looking at. (Think back to Prospect Point.) Keep walking along the outcrop until the rock type changes again. **Look closely and you find pieces of sandstone within this new rock.** These inclusions are called _____. Explain how they form.

_____

_____

_____

2) Return to the sandstone outcrop and draw and label a simple diagram that shows Siwash Rock and explains how it formed in a way that someone who knows very little about rocks or weathering would understand. Be as detailed as you can; use labels to help make your diagram understandable.

3) You will note that there is a World War II gun battery on top of this cliff; also one at Prospect Point. Why do you think that these defence structures were built where they were built? _____

_____

Stop 9 – Ferguson Point

1) At the base of this outcrop on the Third Beach side of Ferguson Point is a third type of rock. What is it? _____(Geologists commonly bite these rocks to see if they are gritty, i.e. silty!)

2) Of all the rocks we have seen today, would you say this one is most or least resistant to the elements? Why?

_____

3) On our seawall tour we have three types of sedimentary rocks: _____, _____ and _____. Explain the changes in depositional environment that they record, referring to changes *water energy*).

_____

_____

_____

Stop 10 – Third Beach Rock Outcrop (Low Tide Visit)

BE CAREFUL! THE ROCKS ARE EXTREMELY SLIPPERY!

1) At this location you should be able to see the layers of sandstone expected in the intertidal and how they are oriented.

   In geology, we describe sedimentary beds as having a *strike direction,* a *dip direction,* and a *dip angle* (right).

   Referring to the line drawing (lower right), determine these three measurements for the Third Beach sandstone outcrops. Use general directions and *estimate* the dip angle of the sandstone outcrop. To get your bearings straight, the North Shore Mountains are NORTH!

   Strike direction_____

   Dip direction_____

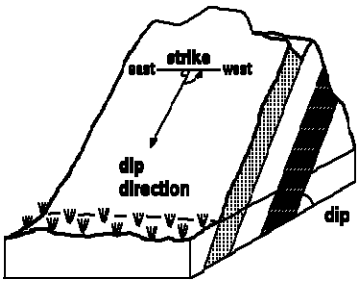
   Dip angle (circle one) (<25°) (25°-45°) (45°-65°) (>65°)

2) Look for **potholes**. Explain how these form._____

_____

_____

Figure 2 *- Gently dipping sedimentary sequence exposed at Third Beach on the west side of Stanley Park. From Clague and Turner (2003)*



3) Grab a handful of **sand**. Describe what you see. What mineral(s) seem(s) to be most abundant? Why?_____

_____

_____

_____

4) This sand was eroded from the rocks all around you including the granitic rocks from the North Shore Mountains. What happened to the rest of the minerals?_____

_____

_____

***** Make sure all your answers are complete, hand in your lab, get your lunch and enjoy the rest of the day! *****

The references below provide more information on the geology of Stanley Park and are the sources of the figures included in this activity.

- Armstrong, John E., 1990, *Vancouver Geology*: Geological Association of Canada, (Cordilleran Section), 128p.
- Clague, J. and Turner, B., 2003, *Vancouver, City of the Edge*: Tricouri Press, Vancouver, 191p.

Map of Stanley Park showing the locations of outcrop stops. Modified after Clague and Turner (2003).