**Wilson Cycle 4**

1. Alright then, let’s see how this ocean basin is destroyed and we’ll build some mountains in the process.
2. Somewhere within the oceanic crust, subduction begins. Subduction tends to occur near the edges of the ocean basin, where the oldest and therefore coolest and densest oceanic crust is, but it can happen anywhere mantle down welling occurs.
3. This creates the “Island Arc Type” of subduction orogeny. Orogeny refers to a mountain building event.
4. Subduction drags sea water into the mantle which, under the high temperatures and pressures there, migrates into the overlying mantle. The addition of water to the mantle lowers its melting point, promotes “wet melting” and leads to island arc formation.
5. Where the ocean crust is subducted, a new, convergent plate boundary is formed.
6. On the sea floor where the ocean crust is subducted, the crust is bent down forming a deep ocean trench.
7. Wet melting occurs where the oceanic plate first encounters the soft, asthenospheric portion of the mantle.
8. Only a part, or fraction, of the mafic to ultramafic mantle is melted. The melted fraction becomes richer in silica and the resulting magma tends to be…
9. .. intermediate in composition.
10. The mantle fraction that does not melt forms an ultramafic residue that remains in the mantle.
11. The ultramafic residue typically consists of the rock peridotite. If peridotite is mostly olivine like this one, then it is called dunite.
12. The residual (not melted) part of the oceanic crust becomes the rare and attractive rock “eclogite”. It often contains red garnet and green pyroxene.
13. Now getting back to that intermediate magma, we see that it rises, like blobs in a lava lamp, as balloon-shaped masses that are usually a few miles across. These rise until they encounter rocks within the crust that are less dense than they are. At that point they slowly cool into masses known as plutons. Typical plutonic rock types in this situation include …
14. … diorite, which usually contains about an equal amount of light dark minerals.
15. Granodiorite and plagiogranite (tonolite) are also fairly common, but tonolite is a secondary rock which forms from ….
16. … re-melting and fractionation of diorite and granodiorite. Remember fractionation refers to only melting the low-melting point, light-colored, high-silica minerals. Think of fractionation as distilling silica. Thus tonolite ends up a fairly light colored rock.
17. A massive composite of numerous plutons is known as a …
18. … batholith.
19. The “Island Arc Type” of subduction orogeny forms batholiths that are intermediate in overall composition.
20. But some of this intermediate magma makes it to the surface. Because it was made by wet melting, subduction-derived magma is typically steam-rich and therefore prone to violent, ash-producing eruptions like Mount Saint Helens here. Notice the medium-gray color of the ash and exposed volcanic rocks - indicating their intermediate composition.
21. Andesite is the most common rock formed in these locations. It is commonly porphyritic because the magma here often spends considerable time inside a magma chamber beneath the volcano before erupting. The slow cooling inside the magma chamber promotes the formation of larger crystals which after the eruption are surrounded by quick-cooling, smaller crystals.
22. Due to reasons that have to do with the curvature of the earth, trenches and the system of volcanic islands that form from subduction tend to be curved. Hence the term island **arc**.
23. Going from the trench to the arc, the region before you get to the arc is known as the forearc. The area behind the arc is the backarc.
24. The forearc region is strongly affected by the scraping action that occurs between the two plates. The upper plate acts like a giant bulldozer, scraping off and piling up huge masses of ocean sediment against its leading edge. Because of its wedge-like shape and the fact that it is added-on or accreted to the overriding plate, the mass of scraped off sediments is known as an accretionary wedge.
25. This is not to be confused with the legendary accretionary **wedgie**, which is reputed to be so severe that the wedgied material becomes permanently fused to the victim and can only be removed by surgery.
26. Between the accretionary wedge and the arc lies the forearc basin. You can visualize how this basin forms by pushing the fingertips of your right hand against the palm of your left hand while holding the fingers of your right hand as straight as possible. If you push hard enough, you should see that your fingers bend in a manner analogous to how a forearc basin forms.
27. Because of the nearby volcanic arc, forearc basins receive sediments that are rich in lithics (rock fragments).
28. In tropical climates where coral can grow, carbonates may sometimes deposit along with the lithic-rich forearc basin sediments. Trench sediments are mostly comprised of accretionary wedge material that has moved down by submarine landslides and sediment avalanches.
29. Two entirely different types of metamorphism occur in this setting. Below the volcanic arc, rocks are subject to progressively higher temperature and pressure at greater depth. The temperatures and pressures vary within a range known as Barrovian metamorphism - a common type of regional metamorphism, which implies that a very large region of rocks is affected. Greenschist, amphibolite and granulite refer to different grades of Barrovian metamorphism. Near the trench, rocks are subjected to increasing pressure at greater depth, but because the subducted oceanic lithosphere is relatively cool, temperature increases slowly with increased depth. This high pressure/low temperature metamorphism is known as blueschist metamorphism after the characteristic rock type formed there.
30. OK, if you’re still there and haven't completely freaked out over the massive amount of information you’ve just been exposed to, then spend some time studying this diagram, which now shows all three rock types: igneous in red, metamorphic in green and sedimentary in brown. Bear in mind that you will be exposed to all this information again, but one National Park at a time. I know this is a lot of information to handle right now, but this is the only opportunity I have to show you the larger context into which all these geological pieces fit. Hang in there!
31. Eventually the Island Arc collides with the continent.
32. This produces the continent-island arc type of collision. Think of it as a “soft” collision compared to the “hard” collision that will ultimately take place between two continents.
33. Because the island arc was initially formed well offshore of the continent it is known as the hinterland. The continent itself is known as the foreland. The hinterland is generally thrust on top of the foreland.
34. The contact between the foreland and hinterland is known as a suture zone.
35. Because continental crust is made of low-density, felsic rocks, it can’t sink into the mantle, so subduction eventually dies out.
36. Without subduction, seawater can’t be carried into the mantle, so wet melting stops and the volcanic arc becomes inactive.
37. Orogenic activity continues for some time after subduction ends as great slabs of the hinterland are pushed on top of one another along thrust faults.
38. The tremendous compressive forces here fold and fault the sediments originally deposited on the divergent continental margin of the foreland.
39. As the foreland is thrust under the hinterland, the associated subsidence creates a foreland basin.
40. Foreland basins fill with “clastic wedges” which are thick sequences of sediment derived from rapid erosion of the vigorously uplifting mountain range nearby. The term clastic here implies that the sediment is made of rock fragments.
41. Clastic *wedgies* on the other hand, must therefore be particularly dirty wedgies.
42. In the foreland basin, sediment is evolving along the path of the red arrow, because the original lithic-rich, island arc sediments get uplifted, eroded and reworked. The lithics break down by weathering, leaving progressively more quartz.
43. We’ll hear much more about clastic wedges when we explore the Appalachian National Parks. There’s one more important element here. Note the broad shallow sea next to the clastic wedge.
44. These are known as epeiric seas, and are important not only as a depositional environment for shallow water sediments, especially carbonates, but also as an environment teaming with fossil-making marine life.
45. The mid-west of North America was awash in epeiric seas for much of the Paleozoic and Mesozoic eras.
46. Alright, we are getting close to the end now. This would be a good time to take the Wilson Cycle 4 Quiz before moving on to Wilson Cycle 5.