**Kenai Fjords**

1. Kenai Fjords National Park is only about 80 miles south of Anchorage, Alaska, but unless you’re in a plane or boat, it might as well be 8,000 miles, because there are no roads into the park. This is one of the most rugged and isolated National Parks in America.
2. It is also one of the most beautiful.
3. Much of the park’s rugged beauty is attributed to the submergence of a heavily glaciated landscape. During the last glacial age this scene would have been much different.
4. Alpine glaciers would have filled most of Kenai’s present valleys and flowed much farther across the continental margin towards a much lower sea level.
5. When the ice melted and sea level sea level rose, three kinds of spectacular glacial landforms resulted. First let’s look at how the park’s namesake landforms where created.
6. The recipe for fjord formation is pretty simple. Take a long alpine glacier and let it erode a U-shaped trough down to sea level. This is the Seward Glacier. Since it extends all the way to the ocean it is called a tidewater glacier. If and an alpine, tidewater glacier like this were to melt and …
7. … sea level rose enough to fill the glacial trough the resulting long, steep-sided inlet would be a fjord.
8. This is the Aialik Glacier. Another of the many tidewater glaciers in Kenai Fjords National Park. The bluish color results from snow that has compressed into solid ice.
9. Ice of course floats on water so when tidewater glaciers meet the ocean the water buoys up the ice …
10. … causing the buoyed ice to break free of the rest of the glacier in a spectacular process known as calving. Icebergs result from this process.
11. Along the sides of the relatively straight fjords a complex and intriguing shoreline comprised of numerous rounded bays develops known as biscuit-board topography.
12. The name derives from the shape of the dough remaining on the board after several biscuits have been cut from it.
13. The pattern is best developed on plutonic rocks - shown in pink on this geological map of the park. This is because plutonic rocks will have fracture patterns …
14. … that facilitate ice plucking and therefore the formation of cirques.
15. Circular bays form when the cirques are submerged. The resulting islands often have a sinuous shape that follows the original arête – the sharp ridge separating the cirques.
16. Horns and arêtes are the highest glacial landforms and therefore the last land areas to be submerged.
17. Thus, several of the park’s sea stacks were originally arêtes …
18. … and horns.
19. Differential erosion of weaker rocks along arêtes results in unusual, spire-like sea stacks. At one time there may have been arches that connected these stacks, …
20. … much like at “3 Hole Rock”, - a popular view point with the numerous cruise ships that come to the park.
21. Like many of the rocks exposed along the Kenai coast, 3-Hole Rock is comprised of Cenozoic granodiorite.
22. Even better outcrops of the granodiorite occur above the tree line, …
23. … where thick, Pleistocene ice sheets smoothed and polished the granodiorite,
24. … and left vast areas of this rock exposed. In fact, the granodiorite pluton here is probably the largest near-trench pluton in the world. The geologic story of how this pluton formed in such close proximity to the trench is, I think, one of the most fascinating in the park.
25. First let’s see where we are in the plate tectonic scheme of things. Kenai Fjords National Park lies on the North American Plate very close to the Aleutian Trench where the Pacific Plate is currently subducting under Alaska.
26. The physiography clearly shows the classic elements of a subduction zone. Notice that Kenai Fjords is located within the accretionary wedge.
27. The granodiorite plutons were emplaced within accretionary wedge material that ranges in age from Triassic to Eocene.
28. Since the trench was (and still is) east-southeast of the park, rock age generally becomes younger to the east. Remember that rocks also became younger towards the trench in the Olympic accretionary wedge. The oldest rocks in Kenai Fjords National Park outcrop mostly towards southwest and are represented by the McHugh Complex.
29. The McHugh Complex is similar to the Franciscan Complex both in age and in rock types. Its Triassic to Cretaceous age makes it a little older than the Jurassic to Cretaceous Franciscan Complex, but both are tectonic mélanges of many rock types including the radiolarian chert you see here as well as basalt, limestone and argillite – all scraped off the ocean floor during subduction. Notice how subduction has contorted the rock strata here.
30. In this northwest to southeast geologic cross-section superimposed on a Google Earth view of the park to the northeast, you can see the variable rocks of the McHugh Complex steeply dipping to the northwest - the general structure of the accretionary wedge here.
31. An entirely different type of material accreted following the McHugh Complex …
32. … and is represented by the Cretaceous Valdez Group.
33. The Valdez Group is flysch - not mélange. Flysch is essentially a thick sequence of turbidite shed from a rapidly uplifting and eroding nearby mountain range. The long period of subduction represented by the McHugh Complex built mountains that eroded to produce large amounts of flysch during the Cretaceous. The turbidites of Olympic National Park are somewhat analogous, but much younger.
34. The Valdez Group is the most common unit in the park …
35. … and is therefore the foundation for many of its beautiful waterfalls.
36. The youngest accreted material is a sequence of pillow basalts, sheeted dikes and gabbro – all of which are the same age, about 57 million years old.
37. The pillow basalts are particularly well exposed around Humpy Cove just outside the park’s borders, …
38. … where for about $250 a night you can rent a yurt and contemplate the origin of your basement.
39. That’s right, the pillow basalt is the top of the oceanic crust …
40. … and collectively the three rock types represent a classic ophiolite sequence. Due to its proximity to Resurrection Bay, this sequence has been named the Resurrection Ophiolite. Since ocean crust usually subducts, special conditions had to exist in order for it to be accreted. Now here’s the cool part! Those conditions are directly related to the special situation that led to the emplacement of near-trench plutons within the accretionary wedge. You see, one of the factors that determine whether ocean crust obducts rather subducts is its age. Younger ocean crust is warmer, less dense and therefore less likely to subduct. And the youngest ocean crust is at an ocean ridge, so the Resurrection Ophiolite suggests that an ocean ridge collided with the subduction zone.
41. But what ridge?
42. The traditional tectonic model shows only the Kula Plate subducting under Alaska during the time when the near-trench plutons were emplaced.
43. Later on the Kula Plate will be …
44. …completely subducted…
45. … leaving the present situation where only the Pacific Plate is subducting under Alaska.
46. So if the Kula Plate was completely subducted, there is room for interpretation as to what it may have looked like. The preferred model now appears to be C, where a previously unrecognized plate called the Resurrection Plate is added bordering the Kula and Farallon Plates. Thus the emplacement of the Resurrection Ophiolite was probably due to the subduction of the ridge that separated the Kula and Resurrection Plates. This same interaction led to the emplacement of near trench plutons …
47. … due to the fact that oceanic crust can no longer be made at an ocean ridge if that ridge is subducted. Depending on the orientation of the ridge relative to the trench, the geometry of the subducted plates will vary, but in all cases the continuing subduction of the older oceanic crust away from the ridge combined with the lack of new oceanic crust produced at the ridge, results in a gap between the two subducting plates called a slab window.
48. By making the overriding plate transparent we can see how hot asthenosphere would well-up into the slab window and come in contact with the base of the overriding plate.
49. Now let’s make the overriding plate non-transparent so we can see where magmatic activity would occur. Notice that magma could form directly under the accretionary prism because no subducted oceanic crust would separate it from the hot, upwelling asthenosphere. Magmatism could happen pretty much anywhere above the slab window, but because there is no subducted oceanic crust in the slab window, subduction-generated, wet melting stops and there will be a gap in magmatism along the volcanic arc. The intriguing consequences of ridge subduction will be revisited when we study the tectonics of the Southern California continental borderland later in this course.