**Grand Tetons National Park – 2**

1. Now let’s see how the Tetons’ were affected by glaciation. Remember that there are two important consequences of their position at the far northeasterly tip of the Basin and Range. We just covered the first of these, which was that youthful extension yields highly asymmetrical basins bounded by steep fault scarps on one side. In this lesson we’ll focus on the second consequence of the Tetons’ location, which is that this northerly position made the Tetons susceptible to glaciation.
2. Glaciers are large masses of ice which form on land by the compaction and recrystallization of snow. They form where more snow falls in the winter than melts in the summer, which tends to be in high latitudes and high altitudes. They slide and flow downhill, carving-out spectacular U-shaped canyons and generating mass quantities of sediment in the process.
3. The glacial landforms in the Tetons were created by a series of relatively recent glacial periods. By far the most important is the Pinedale stage about 9000 years ago.
4. Glacial ages are caused by a variety of factors including plate tectonics, which controls both paleogeography and volcanic activity, which in turn influences atmospheric content.
5. For example, the rapid sea floor spreading during the Cretaceous led to unusually vigorous volcanism which released huge amounts of carbon dioxide.
6. Cretaceous CO2 levels where 10 times higher than today, causing an intense greenhouse effect that made average global temperatures 5 degrees Celsius higher than today.
7. Plate tectonic controls explain why glaciation periods occurred within the last million years or so, but they are far too slow to cause the short term variations within that period.
8. Superimposed on the plate tectonic controls are Milankovitch Cycles.
9. These involve periodic variations in the shape of the earth’s orbit and the amount and direction of tilt on the earth’s axis.
10. When the various Milankovitch cycles are combined, they produce a pattern similar to that of marine oxygen-isotope ratios which are linked to global temperature. These variations in temperature have periodicities that match nicely…
11. … with those seen for the various glacial stages of the Pleistocene and Holocene epochs.
12. Three types of glaciers are recognized, depending on where the glaciers form. Continental ice sheets cover continental sized areas like Antarctica and Greenland. Such glaciers did not shape Grand Tetons National Park, but Alpine and Piedmont glaciers did.
13. Teton Glacier is an example of the alpine type, which are confined to valleys in mountainous areas.
14. Middle Teton Glacier is also alpine…
15. … and so is Mt Moran Glacier. Since we are currently in an interglacial period these glaciers are relatively small, …
16. … but during the various glacial stages much larger glaciers occupied the mountain valleys.
17. This map shows the inferred position of Grand Teton glaciers during the Pinedale stage about 9000 years ago. When alpine glaciers leave the confines of their mountain valleys and extend onto the open basin they are called piedmont glaciers. Note the large piedmont glacier that covered the area now occupied by Jackson Lake.
18. Unlike rivers, that can only erode the bottom of a canyon, glaciers, which can completely fill a canyon, erode the sides of the canyon as well as the bottom. The result is that glacially eroded troughs are typically U-shaped in cross section.
19. That U-shape is clearly seen in Paintbrush and Leigh Canyons.
20. Glacial erosion in adjacent valleys will eventually sharpen the intervening ridge into a narrow ridge of bare rock called an arête.
21. Where arêtes join, the result is a pyramidal mountain called a horn.
22. In addition to the large scale glacial erosion, horns and arêtes are more finely sculpted by the expansion of ice in rock fractures – a process called frost wedging. Eventually blocks of rock are pried loose and tumble to the base of the slope.
23. The result is that frost wedging makes for the exceptionally angular topography seen on most of the peaks in the Grand Tetons.
24. Frost wedgies on the other hand, will give you 5 minutes in the penalty box.
25. Now let’s take a look at what happens to all the glacially eroded debris. Eventually it’s deposited as either till or outwash. Till is deposited directly from the motion of the ice. Think of till as being like the pile of debris pushed out in front of a bulldozer, but the glacier is the dozer. Till will therefore be a poorly sorted mixture of grain sizes including everything from giant boulders to finely ground rock flour that weathers quickly to clay. Due to the high clay content, water slowly seeps through till, keeping the water table high enough for Lodgepole pines to grow. On the other hand, outwash is carried by glacial melt water, in which sediments become far-better sorted quartz sands. Percolation is much better, so the water table lowers to the point that only sagebrush can grow.
26. Till typically forms pile-like masses called moraines whereas the action of water spreads outwash into plains. Outwash plains and moraines are easily distinguished from one another on the basis of vegetation. Evergreen forests grow on the till of the moraines because the unsorted sediment is less permeable and can support a relatively high water table. Outwash is very permeable and has a lower water table.
27. Is the foreground here till or outwash?... The sagebrush tells you it’s outwash. The evergreens in the mid-ground are growing near the Snake River…
28. … where the water table is closer to the surface.
29. This photo also shows the Snake River terrace, which is a remnant of an older flood plain of the Snake River.
30. You can clearly see the sandy outwash on the river’s cut banks.
31. …. Obviously till right? You can tell by the mound-like topography, trees, and boulders.
32. Unusually large particles in till are called glacial erratics. They are typically angular, because they were transported by ice, not running water.
33. Till is pushed to the sides and ends of the glacier forming lateral and terminal moraines respectively. Recessional moraines are formed as the glacier melts back.
34. You can understand the difference between the formation of terminal and recessional moraines by visualizing a glacier as a giant belt sander. Terminal moraines mark the furthest extent of the glaciers, but like a belt sander, even when a glacier is neither advancing nor retreating; it is still grinding away, producing debris. Recessional moraines form when periods of equilibrium are established between ice accumulation and melting.
35. The mound-like structure of moraines often dams glacial melt water and creates lakes.
36. Most of the major lakes in Grand Tetons National Park are moraine dammed.
37. That includes the largest lake of the all - Jackson Lake, …
38. … which formed behind the recessional moraine of a Pinedale stage piedmont glacier.
39. South of Jackson Lake there are several terminal moraine damned lakes at the base of the Tetons.
40. Jenny Lake is the largest of these. Notice the terminal moraine in the background.
41. The terminal moraine which dams Taggart Lake is especially well developed.
42. Finally, there are dozens of tiny lakes in the outwash plain, collectively known as “The Potholes”.
43. Geologically these are a type of lake know as kettle holes or kettle lakes. They form when outwash buries a block of ice that has separated from the main glacier. The melting of the ice leaves a hole which fills with water if the water table is high enough.
44. Although too small and ephemeral to offer much recreational value, the tiny Potholes nonetheless add a pleasing aesthetic counterpoint to the grandeur of the Tetons.
45. That concludes this lesson, but be sure to check out the Google Earth tour of the Tetons. You’ll find both a narrated video of the tour and the actual Google Earth .kmz file of the tour in the same folder as this video. If you are not completely proficient at using Google Earth, then I highly recommend that you check out the video first, because it covers the basics of using Google Earth. I think you’ll find that Google Earth adds a fascinating dimension to your understanding and appreciation of the geology of our National Parks.