Bedrock Geologic Map and Cross-sections of Glacier National Park

Having previously studied the geologic map of surficial deposits in Glacier National Park, we now move on to the bedrock geology of the park. As with all geologic maps we’ve studied this term, our goal is to decipher the information on this map, using it to figure out the geologic story recorded in the rocks. By the end of this exercise, you should be able to tell a complex, interwoven story of rock formation, deformation, and erosion.

# Part 1: rock formation

I suggest beginning with the legend, as always. During what periods of geologic time were rocks forming in this region? Conversely, during what time periods were they eroding, or not forming? (Make sure you look up the epochs of the Tertiary period on the geologic time scale in chapter 8 of your book. How many periods of erosion or non-deposition can you find even within the Tertiary period?)

Consider figure 1, showing the stratigraphy of the Proterozoic rocks of the park, along with several disconformities. When was the Middle Proterozoic? How did those disconformities form? Read the descriptions of the Proterozoic rock units. Are they igneous, sedimentary, or metamorphic? What clues are there to the origins of these rocks, in their descriptions? (Rock type? Sedimentary structures? Fossils?) How and in what sort(s) of environments did they form?

Next, consider the younger rock units. Are they igneous, sedimentary, or metamorphic? What clues are there to the origins of these rocks, in their descriptions? How and in what sort(s) of environments did they form? Read the description of Tkp, the conglomerate member of the Pinchot Creek Formation: what rock unit eroded to produce the pebbles and boulders of this conglomerate? Read the description of Qg: what rock unit was eroded to produce the boulders in this till? Did the glaciers that deposited this till come from far away? (How unlike the glaciers in Ohio!!) Read the description of Qal: what rock unit is eroded to form the gravel of these deposits?

# Part 2: deformation

Clearly, rock formation is not the only story, here. If it were, the rocks would make dendritic patterns on the map, like the flat-lying sedimentary layers of the Grand Canyon. But they don’t. To get a handle on what has happened to the rock layers, next study the cross-sections. Find the lines of cross-section on the map, so you know which one corresponds to which part of the map. Also, remind yourself that a cross-section shows what you would see if you could slice vertically through the Earth’s outer crust.

On cross-section A-A’: what kind(s) of faults are shown? Do they indicate extension, compression, or both? Are the Flathead and Nyack Faults older or younger than the Lewis Thrust? How can you tell? Considering which happened first, do these faults indicate extension followed by compression, or compression followed by extension? Now look at the faults in the eastern part of the cross-section. Are they reverse or normal? Do they indicate compression or extension? Look at the Akamina Syncline. This is a broad, open fold, with a long wavelength compared to its amplitude. Find this structure on the map. How do the map distributions of rock units clue you in to the presence of the fold? For example, where do you find the younger rock units, relative to the older rock units, within the folded region?

On cross-section B-B’: what kind(s) of faults are shown? Do they indicate extension, compression, or both? Is the Blacktail Fault older or younger than the Lewis Thrust? How can you tell? Considering which happened first, do these faults indicate extension followed by compression, or compression followed by extension? Now look at the faults in the eastern part of the cross-section. Are they *primarily* reverse or normal? Do most of them indicate compression or extension? Similarly, are the faults on the western end of the cross-section *primarily* reverse or normal? Do most of them indicate compression or extension?

Find the Lewis Thrust Fault on the map. Hint: it is the easternmost thrust fault, and is nearly continuous across the eastern side of the park. This fault places Proterozoic rocks (mostly the Altyn and Apekunny Formations) on top of what ages of rocks? (Quaternary is the obvious answer, but that is actually not correct. The Quaternary deposits right next to the Lewis Thrust actually are on top of the fault itself, covering up the fault. The other rocks right next to the fault are the ones that are legitimately below the fault.) One measure of the significance of a thrust fault is the difference in ages between the rocks above the fault and the rocks below…. The Lewis Thrust is famous among geologists, in part, because of this difference in ages. What is the *minimum* difference in ages of rocks above and below the Lewis Thrust? A second measure of the significance of a thrust fault is how far the rocks have been moved along the fault surface. This is called the fault displacement. Read the section on “Structure” in the map description. How far, and in what direction, have rocks moved on the Lewis Thrust fault? If Springfield, Ohio, were on a fault that moved that far, in that direction, approximately where would we end up?

Look at the map distribution of Qg. It is most common between which two faults? Do those two faults form a horst or a graben (look those terms up in your book if you need to)? Why does the Qg fill that area? Which came first, those faults or Qg?

# Part 3: putting it all together

Now, think about sequencing. Put the following events in order, from oldest to youngest: deposition of the Quaternary rocks, deposition of the Cretaceous and Tertiary rocks, deposition of the Proterozoic rocks, movement on the Lewis Thrust Fault (and other reverse faults), movement on the normal faults. How do you know when the fault motion occurred? The Rocky Mountains were formed by collisions occurring from around 110 million years ago to 50 million years ago. Does that fit with your sequence of events? (It better!)

Finally, put the details of rock formation into your sequence of events. What is the story of Glacier National Park, recorded in its rocks?