**Canyonlands 1**

1. Of the eight National Parks in the Colorado Plateau, only the Grand Canyon and Canyonlands expose a section of Paleozoic strata worthy of our study of Divergent Continental Margins.
2. This lesson will focus on Canyonlands National Park which as you can see on this geologic map of Utah …
3. ... Lies within an area of southeastern Utah that exposes mostly Pennsylvanian and Permian rocks.
4. Zion, Bryce Canyon, and Arches National Parks expose mostly Mesozoic strata, during which time western North America was undergoing too much mountain building to be considered a DCM.
5. Part of the reason why Paleozoic rocks are exposed in Canyonlands National Park, rather than the younger Mesozoic strata exposed elsewhere in the region, is due to the fact that Canyonlands is located on the edge of the Monument Uplift - a broad, Laramide arch that caused most of the Mesozoic strata to be denuded in the area.
6. Canyonlands’ proximity to the confluence of the Colorado River and its largest tributary, the Green River, also played a role. Like the Grand Canyon, erosion rates where high enough to uncover the older Paleozoic strata.
7. But because Canyonlands National Park is located more towards the center of the Colorado Plateau than the Grand Canyon, erosion was not as severe and only exposed upper Paleozoic strata of the Pennsylvanian and Permian periods.
8. Let’s take a look at the paleotectonic situation that led to the formation the Pennsylvanian and Permian strata in Canyonlands. The key interaction here is the closing of the Rheic Ocean as South America collides with North America.
9. Notice the reduced size of the Rheic Ocean as we enter the Mississippian.
10. By the Pennsylvanian period, North and South America have collided and uplift has begun in the Ancestral Rockies.
11. Enlarging North America a bit we can see that the Ancestral Rockies consisted of several ranges and basins surrounded by the shallow seas of the old divergent continental margin. This is the situation that made Canyonlands and nearby Arches National Parks special, because it is within one of these basins that the shallow seas where so completely surrounded by ranges that they evaporated and deposited a thick layer of salt.
12. Throughout the Permian these ranges eroded. By the Triassic, clastic sediments derived from the erosion of the Ancestral Rockies had completely buried the salt deposits.
13. The Pennsylvanian basin in which the salt deposited is known as the Paradox Basin. You can see that it becomes covered up by sand dunes in the Permian. Recall that this was the same time that sand dunes stretched from Mexico to Montana, forming the Coconino Sandstone in the Grand Canyon. By the Triassic, the Ancestral Rockies had been worn down and the Canyonlands region was covered by a low elevation mud plain. Other sediments will deposit during the Jurassic and Cretaceous periods, but like the Grand Canyon, the Mesozoic section will be denuded from much of the park following Laramide uplift.
14. So the main units exposed in Canyonlands National Park are the Paradox Formation – a sequence of salt, gypsum, shale and limestone; the Honaker Trail Formation – composed of shallow marine sediments; and the Cutler Group – a complex series of sandstones and shales that deposited in a variety of depositional environments as shorelines oscillated and interfingered with deposits on beach dunes, sand bars and alluvial fans.
15. Sometime after the Laramide uplift of the Colorado Plateau but before the weight of the Mesozoic section was removed by erosion, salt anticlines formed. Salt will basically flow towards the surface because the density of salt is very low, and under pressure, it becomes rather plastic. The rising salt anticlines folded and fractured the brittle overlying rocks and joint systems developed parallel to the axis of the anticline. These provided conduits for groundwater flow, which dissolved the salt and thereby removed the support holding up the overlying rocks. Salt valleys formed where the overlying rocks collapsed along faults roughly parallel to the joint systems.
16. Although nearby Moab, Utah lies in a large salt valley, …
17. … and there are several other salt valleys nearby (shown in yellow), none of these lies within the boundaries of Canyonlands.
18. Nonetheless, several salt anticlines do lie beneath the strata of Canyonlands which are important because they fractured the overlying rocks along joint systems …
19. … that generally follow the northwest to southeast trend of the salt anticlines and salt valleys produced by Laramide compression.
20. Although salt valleys do not occur in Canyonlands, related landforms known as a salt grabens do. Notice that the salt grabens do not share the same orientation as the salt anticlines and salt valleys. They parallel the Colorado River instead.
21. Another important difference is that the transition from higher to lower elevations is far more abrupt with salt grabens and that the landscape appears decidedly two-tiered. Moreover, notice that the borders of these landforms often fit together as if they where pulled apart.
22. Indeed, the landscape bears a striking resemblance to stretch marks!
23. Taking all these features into account and noting that the grabens occur just downstream from the confluence of the Green and Colorado Rivers, but on only one side, geologists came up with a convincing theory for salt graben origin.
24. First, the Laramide “Monument Uplift” gently tilted the Canyonlands’ strata to the northwest,…
25. … which, much later will end up being from the graben area towards the Colorado River.
26. Energized by water freshly added from the Green River, the Colorado River rapidly down-cut towards the underlying salt deposits, thereby removing lateral support from the rocks up-dip from the river and initiating a series of faults parallel to the canyon.
27. As erosion continues, rock is removed whose weight is effectively “holding-down” the underlying salt, so the plastic, low density salt flows upward, hastening the time when the Colorado will make contact with the salt. Meanwhile the faults deepen as more lateral support is taken away.
28. Once the Colorado River begins to dissolve the salt, rock begins to slide rapidly over the plastic salt towards the river. Since the Colorado only made contact with the salt a scant 100,000 years ago, …
29. …the grabens are far too young for erosion to have smoothed their features appreciably.
30. Upheaval Dome is another Canyonlands landform which has been attributed to the action of salt.
31. The conspicuous light-colored rock in the center is the White Rim Sandstone.
32. So named for its common occurrence in the park around the rim of both the Green and Colorado River Canyons.
33. It makes for a handy marker bed usually separating the Paleozoic from the Mesozoic.
34. Although the Mesozoic section has been eroded from most of the Canyonlands, significant thicknesses remain in the northern part of the park …
35. … in a wedge-shaped district between the Green and Colorado Rivers known as “Island in the Sky”. This is also where Upheaval Dome is located.
36. The Mesozoic rocks exposed in Upheaval Dome…
37. …are arranged in a ring like structure with progressively older units in the center …
38. … where the Permian rocks are exposed.
39. The dome has long been interpreted as originating from uplift associated with the intrusion of a salt diapir from the Paradox salt unit below.
40. Driven upwards by their relative buoyancy…
41. …salt diapirs routinely fold and ultimately pierce the overlying strata.
42. Salt diapers are something entirely different. One can find most anything on Google Image search!
43. A gentle syncline (downward fold) surrounds the central uplift. This arrangement …
44. …is not unlike that produced by the impact of a drop of water onto water.
45. Impact origin is also supported by the complex fracture patterns in the central uplift, …
46. … shatter cones in the White Rim Sandstone, ….
47. … and shock-fractured quartz grains. Despite the compelling indirect evidence pointing towards meteorite impact forming Upheaval Dome, the idea has not been universally accepted, because no meteorites have ever been found in the area. Of course they could have been eroded, but the idea that a meteorite would strike an area where so many salt-induced structures occur, just seems a little too coincidental for proponents of the salt diapir theory. Personally, I think the two hypotheses are mutually compatible. If a meteorite hit an area underlain by salt, the salt would rise diapirically towards the impact site because the pressure on the salt would be lower there due to the removal of all the rock that was blasted away by the impact.