**Great Basin Overview**

1. Alright, now we’re going to start exploring our National Parks. Our organizational structure will be to group the parks according to the dominant type of plate boundary shaping each park. First we’ll cover divergent, then convergent and transform.
2. Moving through the plate boundaries we’ll follow the Wilson Cycle, so with divergence first we’ll cover continental rifting and then we’ll look at parks like the Grand Canyon that are largely comprised of rocks deposited on the divergent continental margins formed by rifting.
3. National Parks that formed largely by continental rifting are found mostly within the relatively modern Basin and Range and Rio Grande Provinces, but we’ll also see that there are ancient rifts within the interior of the craton.
4. But for now let’s concentrate on the area of our continent that is currently rifting – the Basin and Range Province. Although typified by the landscape of Nevada, Basin and Range topography extends into southern Oregon and Idaho, eastern California, southern Arizona and New Mexico, and eastern Texas. The area along the Rio Grande River is known as the Rio Grande Rift.
5. Starting with Grand Tetons National Park, we’ll work our way south though …
6. … four more Basin and Range parks before moving on to the parks in the Rio Grande Rift. But first, let’s have a look at what Basin and Range structure is and how it formed.
7. If you’ve ever driven east-west across central Nevada, you have a pretty good idea of what’s meant by Basin and Range, that is if the journey didn’t make you completely insane. Depending on where you cross Nevada you will be greeted, or should I say tormented, by this recurring scene some 18-or-so times, as you crest the summit of one range and look forward to the next half-hour, straight as an arrow, mind-numbingly repetitive drive through the next basin. Your reward for cresting the next summit? Blink your eyes once and you’ll get the picture.
8. Like giant caterpillars crawling out of California, the dozens of north-south oriented ranges separated by nearly-level, sediment filled basins are clearly seen in this radar image of Nevada.
9. Quite literally, these are the continent’s “stretch-marks”, formed by a particular style of faulting produced by extension. Up to 200 miles of extension has occurred in Northern Nevada.
10. In cross-section you can see the faults, which are referred to as “normal” because the rock above each fault moves down; in the direction that gravity pulls it.
11. Notice how the block above the fault, called the hanging wall, rotates as displacement on the fault occurs such that an originally horizontal layer would end up tilted back towards the normal fault. Such rotation is partly because the faults are curved and …
12. … partly because as extension occurs, the fault blocks topple like a series of dominoes.
13. Small amounts of extension make basins bounded by steep fault scarps on one side and gentler, back-tilted slopes on the other. Such asymmetrical basins are called half-grabens. Larger amounts of extension make the basins more symmetrical. OK, that’s pretty cool, I know, but what caused all this extension you ask?
14. To answer that question let’s look at a quick and simple geologic history for southwestern North America. The west to east cross sections here are drawn along the latitude of San Diego. During the Paleozoic, most of the Great Basin was tectonically quiet and receiving the typical platform sediments of a divergent continental margin– sandstone, shale and limestone.
15. During the Mesozoic, subduction of the Farallon Plate formed a volcanic arc and the associated compression folded and thrust-faulted the Paleozoic sediments. Note the overall thickening of the continent, which will produce the gravitational potential energy which will help extend this region once compressional forces relax.
16. But that relaxation will have to wait, because during the Early Cenozoic, rapid sea floor spreading in the Atlantic thrust the North American Plate so quickly over the Farallon Plate that the angle of subduction greatly flattened. That shifted the volcanic arc inland and placed tremendous compressional stresses on that part of the North American Plate, which resulted in an intense period of mountain building throughout the Great Basin known as the Laramide orogeny. The gravitational potential energy produced by Laramide uplift will be a significant driving force propelling Great Basin extension when compressional forces relax in the Late Cenozoic.
17. Compression will end once the Pacific Plate makes contact with the North American Plate, which happens first in southern California about 30 mya.
18. The Pacific Plate is diverging from the Farallon Plate at the East Pacific Rise, …
19. While at the same time the entire Pacific sea floor is moving pretty much due north.
20. When we add the two motions for the Pacific Plate we see that the resultant motion is sideways relative to North America. Thus the arrival of the Pacific Plate replaces compression and subduction with shear stress and a transform plate boundary which will become the San Andreas Fault.
21. The Farallon Plate will continue to sink into the mantle …
22. … but since the mechanism by which ocean crust is produced is effectively shut off once the East Pacific Rise hits the continent’s margin, newer Farallon lithosphere does not follow the previously subducted Farallon Plate, and the mantle rises to replace the region where the Farallon Plate once existed. Such mantle upwelling has a number of affects on the Basin and Range including; decompression melting, bimodal volcanism, thermal expansion and softening of the continental crust.
23. The area left vacant by the subduction of the Farallon Plate is highlighted. You can see that it increases in size through time, …
24. … and eventually covers an area crudely coincident with the Basin and Range. Differences between the two are due to variations in the strength of the overlying crust and also the degree to which that crust was uplifted during the Laramide orogeny.
25. The ultimate mechanism of spreading is really quite simple. To visualize how it works, just squish some slime together into a pile, then remove the compression and watch as gravity spreads the slime laterally. What’s more complicated is how the Basin and Range got to the point where gravitational spreading could take place.
26. We had to squish the continent up during the various orogenies of the Mesozoic and especially the Early Cenozoic, and then by contact with the Pacific Plate, remove that compression and give the continent room to spread, while simultaneously weakening the crust to a point that would allow spreading, by mantle upwelling in the wake of the subducted Farallon Plate!
27. The areas that were unaffected by Basin and Range spreading were either too thick and solid to stretch, like the Sierra Nevada and Peninsular Ranges batholiths, …
28. … or like the Colorado Plateau, never squished up into mountain ranges during Mesozoic and Cenozoic orogenies