

## Chapter 6

# Up to 45,000 Feet of Differential Vertical Tectonics Wyoming

Differential vertical tectonics has helped shape the world as we know it. Wyoming is an excellent example of how tectonics has shaped the Earth's surface.

### Enormous Uplift and Subsidence in Wyoming

The Rocky Mountains is a series of smaller, predominantly north-south mountain ranges separated by valleys or basins. They consist of blocks of rock that have been raised up mostly along faults. The intervening valleys and basins have sunk and been filled with sediments at the same time, which have since hardened to sedimentary rocks.

The Basin and Range Province west of the Rocky Mountains is similar to that of the Rocky Mountains and consists of block faulted mountains and downdropped valleys. (A province is the name given to a region that has similar geomorphology). Therefore, much of the western United States reflects Psalm 104:8a: "The mountains rose; the valleys sank down," in reference to the draining of the Floodwater.

Wyoming is probably the best Rocky Mountain state for easily demonstrating differential vertical tectonics. The state consists of uplifted mountains and downdropped basins filled with sedimentary rocks (Figure 6.1). The crust of the earth was likely more or less horizontal and covered with thick sedimentary rocks and sediments in the middle of the Flood on Day 150 (Figure 6.2). Uniformitarian scientists also assume the Earth's surface in Wyoming was basically flat before differential vertical tectonics. I would concur with this deduction because of the spread of quartzites rocks several mountain ranges from their source in the western Rocky Mountains (see Part IV). The mountains must not have been a barrier at the beginning of quartzite transport.

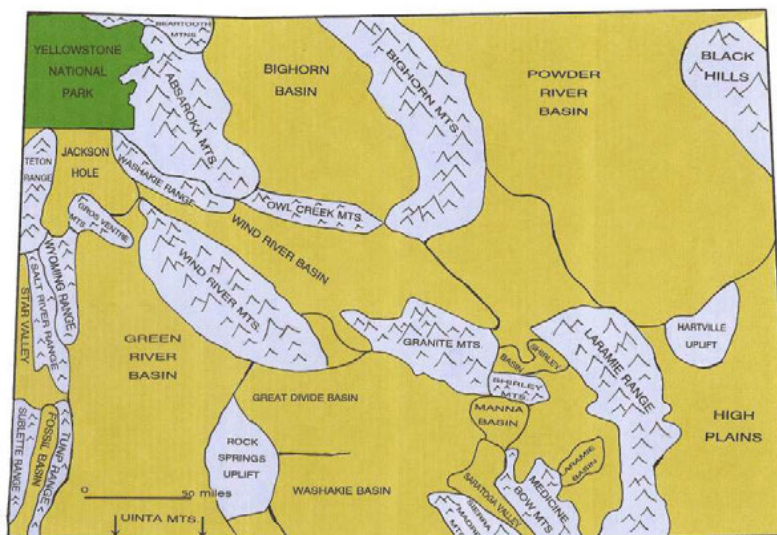


Figure 6.1. Map of major basins and mountain uplifts in Wyoming (from Love, 1960, p. 204, and redrawn by Mrs. Melanie Richard).

Also, the same thick sedimentary rocks found as erosional remnants at the tops of the mountains (Figure 6.3) match those tilted sedimentary rocks at the edges of the adjacent basins that continue underneath the flat sedimentary rocks in the middle of the basins. Since sediments are generally laid horizontal, it indicates a generally flat upper crust over long distances at the time of deposition. The upper continental crust is composed of granite type rocks, and the cores of the uplifted mountains in Wyoming are



Figure 6.2. The Precambrian granite and sedimentary rocks below generally horizontal Paleozoic and Mesozoic sedimentary rocks in Wyoming at the end of the Mesozoic (drawn by Mrs. Melanie Richard).

mostly granitic. Granite is composed of large crystals of quartz, feldspar, flat biotite mica, and needle-shaped black hornblende. Feldspar can come in a variety of chemical compositions that give the granite either a distinctive white or red color.

So, Wyoming was under the ocean before uplift, just as the Flood paradigm would predict. Most of these sedimentary rocks were washed off the mountains and into the basins when the surface uplifted.

### **The Beartooth Mountains Rose While the Bighorn Basin Sank**

The Beartooth Mountains of south central Montana and north central Wyoming are mostly at an altitude of about 10,000 feet (3,000 m) relative to mean sea level (msl) with



Figure 6.3. Beartooth Butte with marine fossils in a low spot on top of the Beartooth Mountains, 1,600 feet (490 km) above the adjacent Beartooth Lake, south-central Montana and north-central Wyoming.

the highest peaks at an altitude of about 13,000 feet (4,000 m) msl (Figure 6.4). The mountains are composed mostly of granite and gneiss and represent essentially a large faulted planation surface (see Volume II).

To the east of the Beartooth Mountains is the northern Bighorn Basin at about 5,000 feet (1,535 m) msl. The granitic Bighorn Mountains are located the east of the basin. The Bighorn Basin is filled with horizontally bedded sandstone and shale. As you approach the Beartooth and Bighorn Mountains, the deeper sedimentary rocks are banked at high angles against the mountains, indicating huge uplift (Figure 6.5).

The uppermost 2,000 feet (610 m) or so of the Bighorn Basin layers have been eroded, based on erosional remnants of the valley fill sedimentary rocks. Tatman Mountain



*Figure 6.4. The top of the granitic Beartooth Mountains, which represents a large faulted planation surface. The higher levels in the background at about 12,000 to 13,500 feet (3,660 to 4,115 m) are very flat, while lower levels (foreground) at 10,000 to 11,000 feet (3,050 to 3,350 m) have been roughened.*



*Figure 6.5. Tilted Paleozoic and Mesozoic strata at the northwest edge of the Bighorn Basin at Clark Canyon adjacent to southeast Beartooth Mountains.*

and Sheets Mountain in the center of the Bighorn Basin are 6,229 feet (1,900 m) and 6,295 feet (1,920 m) msl, respectively, about 2,000 feet (610 m) above the Greybull River to the northeast. Since the tops of these valley fill erosional remnants are hard



sedimentary rocks, it is likely that the thickness of the valley fill was considerably higher, since it probably takes a significant thickness of overburden to cement sediments (see Chapter 8).

The amount of erosion can also be shown by the base of the limestone on Heart Mountain (Figure 6.6). Heart Mountain represents one of about 50 limestone blocks that broke up from one large block of limestone that originated near Yellowstone National Park. The block slid southeastward over a very low slope at high speed (well over 100



Figure 6.6. Heart Mountain north of Cody, Wyoming.

mph or 160 kph) and ended up in the western Bighorn Basin.<sup>1,2,3</sup> This slide likely was caused by catastrophic tectonic uplift and earthquake shaking in the Yellowstone National Park area during uplift late in the Flood. The valley fill was probably the thickest at this time, and erosion of the valley has left limestone at the base of Heart Mountain

at about 1,500 feet (450 m) above the adjacent western Bighorn Basin.

Interestingly, the valley fill in the Bighorn Basin, that lies on the granite upper crust, is about 15,000 feet (4,750 m) thick in the north and 25,000 feet (7,620 m) thick in the south. Therefore, the granite in the Bighorn Basin is about 10,000 feet (3,000 m) below sea level adjacent to the northern Beartooth Mountains and 20,000 feet below sea level in the southern Bighorn Basin.

If the granite of the Beartooth Mountains and the northern Bighorn Basin were at the same elevation at one time in the middle of the Flood (Figure 6.2), the difference now is 23,000 feet (7,000 m). The greatest change is in the western part of the basin adjacent to the Beartooth Mountains at the Beartooth Fault.<sup>4</sup> Figure 6.7 shows a cross section from the Beartooth Mountains through the Bighorn Basin to the Bighorn Mountains. The evidence is clear; the Beartooth Mountains rose and/or the Bighorn Basin sank. The in-depth section at the end of the chapter describes how the Bighorn Basin was filled with sediment that became sedimentary rock during differential vertical tectonics.

<sup>1</sup> Oard, M.J., 1996. Possible analogue for the Heart Mountain Detachment, *Journal of Creation* 10(1):3–4.

<sup>2</sup> Oard, M.J., 2006. The Heart Mountain catastrophic slide, *Journal of Creation* 20(3):3–4.

<sup>3</sup> Oard, M.J., 2010. The Heart Mountain slide becomes more catastrophic. *Journal of Creation* 24(2):11–12.

<sup>4</sup> Wise, D.U., 2000. Laramide structures in basement and cover of the Beartooth uplift near Red Lodge, Montana. *AAPG Bulletin* 84 (3):360–375.

## Uplift Was Rapid

The steeply tilted sedimentary rocks that flank of the Beartooth and Bighorn Mountains (Figure 6.5) and the thick layer of boulders deposited on the east sides of the mountains indicate the uplift was rapid. If uplift was very slow over millions of years, weathering and erosion would whittle down the sedimentary rocks to fine particles that would be

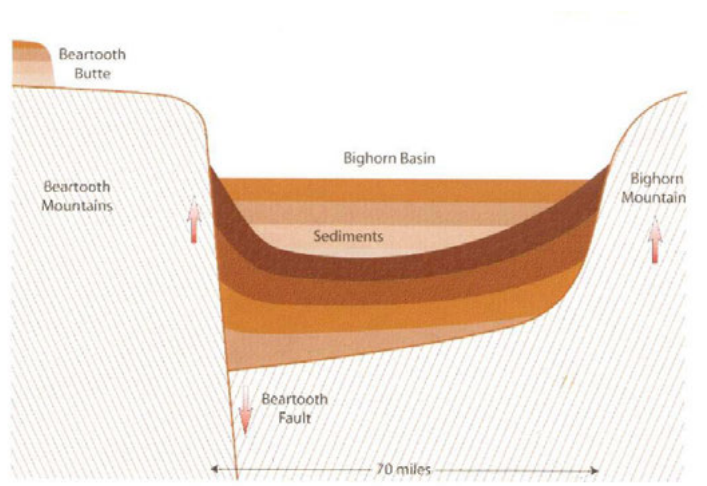


Figure 6.7. Schematic of Beartooth fault showing about 23,000 feet (7,000 m) of vertical displacement (taken from Coffin, 1983 and redrawn by Mark Wolfe).

carried away by streams and rivers. The steeply banked sedimentary rocks would have eroded over millions of years of uplift. Secondly, the thick pile of boulders would not have accumulated east of the uplifts, if uplift were slow.

The size of the boulders east of the Bighorn Mountains is immense (Figure 6.8). They are practically all rounded granite and gneiss from the core of the uplifted mountains. They once formed a generally continuous apron at the flank of the mountains, like a gigantic

alluvial fan the length of the mountain range. The thick pile of boulders was subsequently eroded, leaving behind erosional remnants over 1,000 feet (300 m) thick.<sup>5,6,7</sup> The



Figure 6.8. Nine-foot (3 m) long subrounded granitic boulder from large granitic boulders spread east of the Bighorn Mountains (Dr. Harold Coffin for scale).

largest boulder is about 25 feet (7.6 m) in length! These boulders were at one time thought to be from the Ice Age, but are now considered to be around 50 million years old, the suggested uniformitarian time for the uplift of the Bighorn Mountains.

The conglomerate east of the Beartooth Mountains consists of deposits of cobbles and boulders over 2,300 feet (700 m) thick cemented together into a conglomerate. The cobbles and boulders were shed from the sedimentary rocks that once overlaid

<sup>5</sup> Hoy, R. and K.D. Ridgway, 1997. Structural and sedimentological development of footwall growth synclines along an intraforeland uplift, east-central Bighorn Mountains, Wyoming. *GSA Bulletin* 109:915–935.

<sup>6</sup> Hoy, R.G. and K.D. Ridgway, 1998. Deformation of Eocene synorogenic conglomerate in the footwall of the Clear Creek thrust fault, Bighorn Mountains, Wyoming. *The Mountain Geologist* 35(3):81–90.

<sup>7</sup> Stone, D.S., 2003. New interpretations of the Piney Creek thrust and associated granitic ridge tear fault, northeastern Bighorn Mountains, Wyoming. *Rocky Mountain Geology* 38(2):205–235.





*Figure 6.9. Thirteen hundred-foot (400 m) high erosional remnant of limestone conglomerate along the southeast flank of the Beartooth Mountains (view south from the road to Clark Canyon).*

high of limestone conglomerate with the beds dipping about 30° to the east, indicating that deposition of boulders occurred early during uplift of the mountains. Figure 6.10 is a close up of the conglomerate in another erosional remnant just to the north of the one



*Figure 6.10. Close up of the conglomerate in another erosional remnant just to the north of the one shown in Figure 6.9.*

the granite of the Beartooth Mountains.<sup>8</sup> The rocks change from mostly limestone in the south to mostly granite to the north, which implies that the conglomerate in the south is from the sedimentary rocks that once capped the Beartooth Mountains, while those cobbles and boulders in the north must have been laid down after the sedimentary rocks above the granite were first eroded. Figure 6.9 shows a small erosional remnant about 1,300 feet (400 m) high of limestone conglomerate with the beds dipping about 30° to the east, indicating that deposition of boulders occurred early during uplift of the mountains. Figure 6.10 is a close up of the conglomerate in another erosional remnant just to the north of the one shown in Figure 6.9. The largest limestone boulder was observed to be around 20 inches (0.5 m) long. This limestone conglomerate once consisted of a continuous blanket along the east flank of the Beartooth Mountains, like a monstrous alluvial fan. What is especially interesting is that these erosional remnants are now found about 2 miles (3.2 km) from the edge of the Beartooth Mountains. At one time they must have been continuous to the edge of the mountains.

The picture that emerges from these conglomerate erosional remnants is catastrophic erosion piled up a thick layer of boulders at least two miles thick on the east side of the Beartooth Mountains. A similar situation occurred east of the Bighorn Mountains (see above). It is interesting that the thick layers of boulders lie east of these mountains and not west. This implies the Flood-

<sup>8</sup> DeCelles, P.G., M.B. Gray, K.D. Ridgway, R.B. Cole, R. Srivastava, N. Pequera, and D.A. Pivnik, 1991. Kinematic history of a foreland uplift from Paleocene synorogenic conglomerate, Beartooth Range, Wyoming and Montana. *GSA Bulletin* 103:1,458–1,475.

water flowed from west to east as the mountains were rising. Then erosion at the base of the mountains removed 95 to 99% of the boulders leaving isolated remnants of the conglomerate well out from the base of the mountains. The tilt of the erosional remnants of up to 30° probably means that the mountains were starting to rise as the boulders were piling up, but then erosion removed most of the boulders later during uplift. Figure 6.11 is a schematic of what must have happened east of the Beartooth Mountains during rapid uplift and erosion.

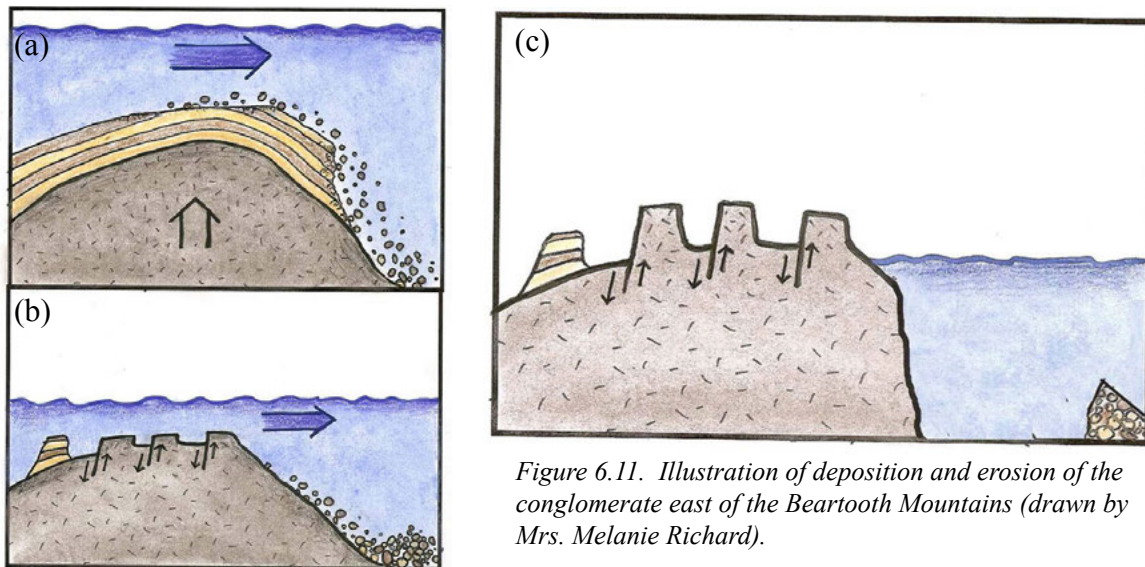


Figure 6.11. Illustration of deposition and erosion of the conglomerate east of the Beartooth Mountains (drawn by Mrs. Melanie Richard).

a) and b) As the sedimentary rocks are eroded off the top of the Beartooth Mountains, a thick debris fan piles upon the east side.

c) The Beartooth Mountains emerge above the Floodwater and the water is channelized and moving toward the north down the Bighorn Basin. Most of the debris fan is eroded, leaving behind erosional remnants as much as 2 miles (3.2 km) out from the base of the mountains, as shown in Figure 6.9.

### Differential Vertical Tectonics Late in the Flood

I have already stated that all the above activity occurred during the Flood. Besides the catastrophic tectonics and erosion shown in this area, all this activity can be placed in the Retreating Stage of the Flood.

The Heart Mountain slide, likely caused by uplift of the region to the west accompanied by extreme seismic shaking, can be shown to have occurred late in the Flood although it is dated as early Cenozoic in the uniformitarian geological column. After the slide, the gap left by the sliding mass and an extensive area east and north of Yellowstone National Park was filled in by the Absaroka Volcanics (Figure 6.12). Layer after layer of horizontal volcanic debris slid and settled in an area covering at least 9,000 mi<sup>2</sup> (23,000 km<sup>2</sup>) and up to over 6,000 feet (1,830 m) deep.<sup>9</sup> The top of this volcanic rock has been

<sup>9</sup> Sundell, K.A., 1993. A geologic overview of the Absaroka volcanic provinces. In, Steidtmann, J.R. and S.M. Roberts (editors), *Geology of Wyoming*, Geological Survey of Wyoming Memoir No. 5, Laramie, WY, p. 480.



Figure 6.12. The Absaroka Volcanics with an embedded vertical petrified tree (Paula Vail provides the scale).

eroded to a planation surface.<sup>10</sup> I will make a case that the planation surface probably occurred during late Flood runoff in volume II of this book. Moreover, valleys up to 4,000 feet (1,220 m) deep have subsequently been carved by water out of the Absaroka Volcanics (see Figure 3.6), which is typical of the Channelized Flow Phase of the Flood. The valley fill of the Bighorn Basin eroded at least 2,000 feet (610 m) during this time.

### The Maximum is 45,000 Feet for Wyoming

Similar features to the Beartooth Mountains and the Bighorn Basin can be seen in other mountain ranges and basins of Wyoming (Table 6.1). Note that the top of the granite in the relatively small Hanna Basin is as deep as 31,000 feet (9,450 m) below sea level! In the adjacent Rawlins uplift to the west, the granite is at 7,200 feet (2,320 m) msl.<sup>11</sup> Differential vertical movement in that area exceeded 38,000 feet (11,585 m)! There is no fault separating the Rawlins uplift and the granite deep in the relatively small Hanna Basin to the east, unlike the situation just east of the Beartooth Mountains. The granite simply bent without breaking into a fault. The granite in the Rawlins uplift rose while that in the Hanna Basin sank, once again, as expressed in Psalm 104:8.

If we take the greatest height of the granite above sea level and greatest depth below sea level in Wyoming, we can estimate the total differential vertical tectonics. The granite is the highest in the Wind River Mountains at a little above 14,000 feet (4,270 m) msl, while it is the lowest in the Hanna Basin at 31,000 feet (9,450 m) below sea level. Therefore, Wyoming state geologist, David Love, came to the conclusion that parts of Wyoming went up and parts went down—a total vertical shift of 45,000 feet (13,415 m)!<sup>12</sup> Given that scale of movement, is it not so difficult to understand the rise of Mount Everest and the Himalaya Mountains of more than 30,000 feet (9,150 m) out of the Floodwater during the latter stages of the Flood (see Chapter 5)?

<sup>10</sup> Love, J.D., J.C. Reed, Jr., and K. L. Pierce, 2007. *Creation of the Teton Landscape: Geological Chronicle of Jackson Hole & the Teton Range* Grand Teton Association, Moose, WY, pp. 88–89.

<sup>11</sup> Otteman, A.S. and S.W. Snoke, 2005. Structural analysis of a Laramide, basement-involved, foreland fault zone, Rawlins uplift, south-central Wyoming. *Rocky Mountain Geology* 40(1):65–89.

<sup>12</sup> Love, J.D., 1960. Cenozoic sedimentation and crustal movement in Wyoming. *American Journal of Science* 258-A:204–214.



<b>Mountains</b>		<b>Basins</b>	
Wind River Mountains	14,000 feet	Wind River Basin	-23,000 feet
Beartooth Mountains	13,000 feet	Bighorn Basin	-21,000 feet
Bighorn Mountains	13,000 feet	Powder River Basin	-14,000 feet
Medicine Bow Mountains	12,000 feet	Hanna Basins	-31,000 feet
Owl Creek Mountains	9,000 feet	Washakie Basin	-21,000 feet
Laramie Range	10,000 feet	Red Desert Basin	-23,000 feet
		Green River Basin	-14,000 feet

Table 6.1. Elevations of granitic rocks in some mountain ranges and below the sedimentary fill in adjacent basins in Wyoming.<sup>13,14</sup>

These are stupendous vertical movements in a small part of the world. Such changes are similar over many areas of the continents and along the continental margins. I think we are only beginning to understand what really happened in the catastrophe of the Flood. How this vertical change could have occurred is discussed in Appendix 1.

### **How the Bighorn Basin Filled with Sediments (in-depth section)**

The fact that the northern Bighorn Basin is filled with over 15,000 feet (4,750 m) of sedimentary rock, once even thicker, indicates that the tectonic movements started when the Floodwater was deep in this area. The sedimentation of the Bighorn Basin likely started *before* uplift, since sedimentary rocks at the edge of both the Beartooth (Figure 6.5) and Bighorn Mountains is tilted up at a steep angle. These sedimentary rocks often form flatirons, triangular shaped bedding planes with a pointed apex and a broad base that resembles a flatiron for ironing clothes.

The few erosional remnants that are left on top of the granitic mountains give proof that sedimentary rocks once covered the area of the current mountain range before it was uplifted (Figure 6.3). The differential vertical tectonics likely initiated the erosion of the Beartooth and Bighorn Mountains, as well as adjacent mountain ranges. Some of the eroded sediment ended up settling in the Bighorn Basin. Sediment was also transported from some distance upstream by the powerful Flood currents (remember that most of the area was still underwater) and deposited in the Bighorn Basin. So, the Bighorn Basin and probably most basins of the Rocky Mountains received sediment directly from the erosion of sedimentary rocks that once overlaid the adjacent mountain ranges and from currents flowing through the area. These currents would also have carried some of the eroded sediment from the Beartooth and Bighorn Mountains out of the area to the east.

<sup>13</sup> Love, Ref. 12, p. 205.

<sup>14</sup> Thornbury, W. D., 1965. *Regional Geomorphology of the United States*, John Wiley & Sons, New York, NY, p. 354.