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The Uinta Mountains and the Flood

Part I. Geology

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Abstract

The geology of the Uinta Mountains can be explained in four phases. The first phase was the development of a deep basin that was infilled by sediments. The second phase was the deposition of a thick sequence of horizontal, undeformed sedimentary layers on top of the basin fill. The third phase was one of massive uplift, erosion, and the formation of unique geomorphological features. The final phase was the development of valley glaciers. Features representing all four phases are explained by biblical earth history, and it appears that almost the entire rock record of the Uinta Mountains is the result of the Flood.

Introduction

The Uinta Mountains in northeast Utah are only one of three major east-west ranges in the Western Hemisphere. The Uinta range is one of about 100 mountain ranges that combine to form the Rocky Mountains of the United States. The Uintas are similar to other mountain ranges in the Rockies, exhibiting significant uplift adjacent to deep basins.

The Uinta Mountains are located about 100 miles (160 km) east of Salt Lake City and range in elevation from 11,000 to 13,500 feet (3,400 to 4,100 m). Kings Peak is the highest at 13,528 feet (4,123 m) and is also the highest point in Utah. The mountains extend about 125 miles (200 km) east-west and 40 miles (60 km) north-south in northeastern Utah and extreme northwestern Colorado. The northern boundary is on the southern border of Wyoming (Figure 1). The Uinta Mountains are broadly arc-shaped, concave to the south (Hansen, 1986, 2005). They are composed of a western, higher dome and an eastern lower dome (Figure 2). At some point, the eastern dome collapsed and formed Browns Park. The resulting basin is infilled with about 2,000 feet (600 m) of sandstone with interbedded volcanic tuff and conglomerate (Hansen, 1986). High peaks surround most of Browns Park, but it is open to the southeast. The southeastern Uinta Mountains extend out from the main axis and are composed of several anticlines, synclines, and thrust and reverse faults (Figure 2). On the extreme southeast edge of the Uinta Mountains a steeply dipping bed (to the south) on the Split Mountain anticline forms Dinosaur National Monument, a dinosaur graveyard in sandstone (Untermann and Untermann, 1969).

Geology of the Uinta Mountains

An examination of the geology of the area suggests that the history of the Uinta Mountains can be explained by four phases: (1) the formation and filling of a deep basin; (2) rapid deposition of thick, undeformed strata on top of the deep basin fill; (3) massive uplift of the area accompanied by folding, faulting, massive erosion, and the formation of unique landforms; and (4) the development of alpine glaciers. These geological phases provide insight into the Flood and evidence against uniformitarianism.

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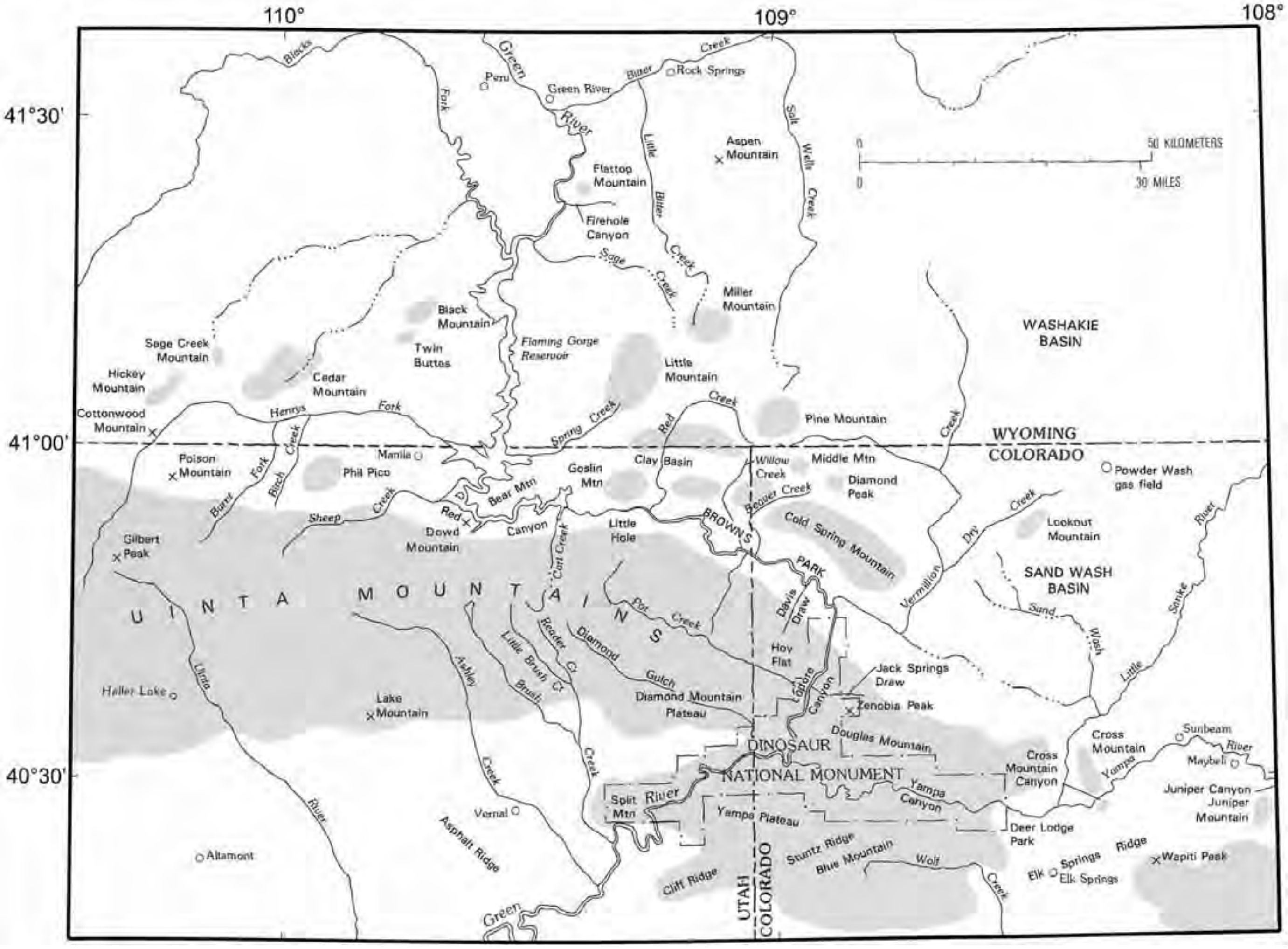


Figure 1. Regional setting of the Uinta Mountains with principal features. Grey represents mountainous areas (from Hansen, 1986, p. 4).

Phase 1. Formation and Filling of a Deep Basin

Early in its geologic history, the Uinta Mountains region was the site of a large extensional basin. This is shown by the thick sequence of Proterozoic sedimentary and metamorphic rocks at the core of today's Uinta Mountains. The origin of the basin is not clear, but it is thought to have been an extensional rift basin, mainly because there are no associated volcanic rocks (Dehler et al., 2010). In fact, there are no igneous rocks of any type associated with the Uinta Mountains, which is a unique feature of this range as compared with most other ranges in the Rocky Mountains (Marsell, 1969).

Sediments were deposited in this extensional basin or trough. Uniformitarian geologists believe the basin, like so many others, slowly subsided so that it maintained a shallow marine setting. The principal researcher on the Uinta Mountains, Wallace Hansen, stated:

> Throughout most of recorded geologic time, long before mountains themselves appeared, the Uinta Mountains region was occupied by a slowly subsiding basin—a broad elongate trough flooded much of the time by shallow-marine waters (Hansen, 2005, p. 77).

He further elaborated: "The trough subsided slowly, and its rate of subsidence was counterbalanced almost exactly by the accumulation of sediment" (Hansen, 2005, p. 79). The idea of a shallow sea or lake is based on ripple marks, mudcracks, and raindrop imprints in the strata (Hansen, 2005), but it is hard to envision a setting where such a delicate

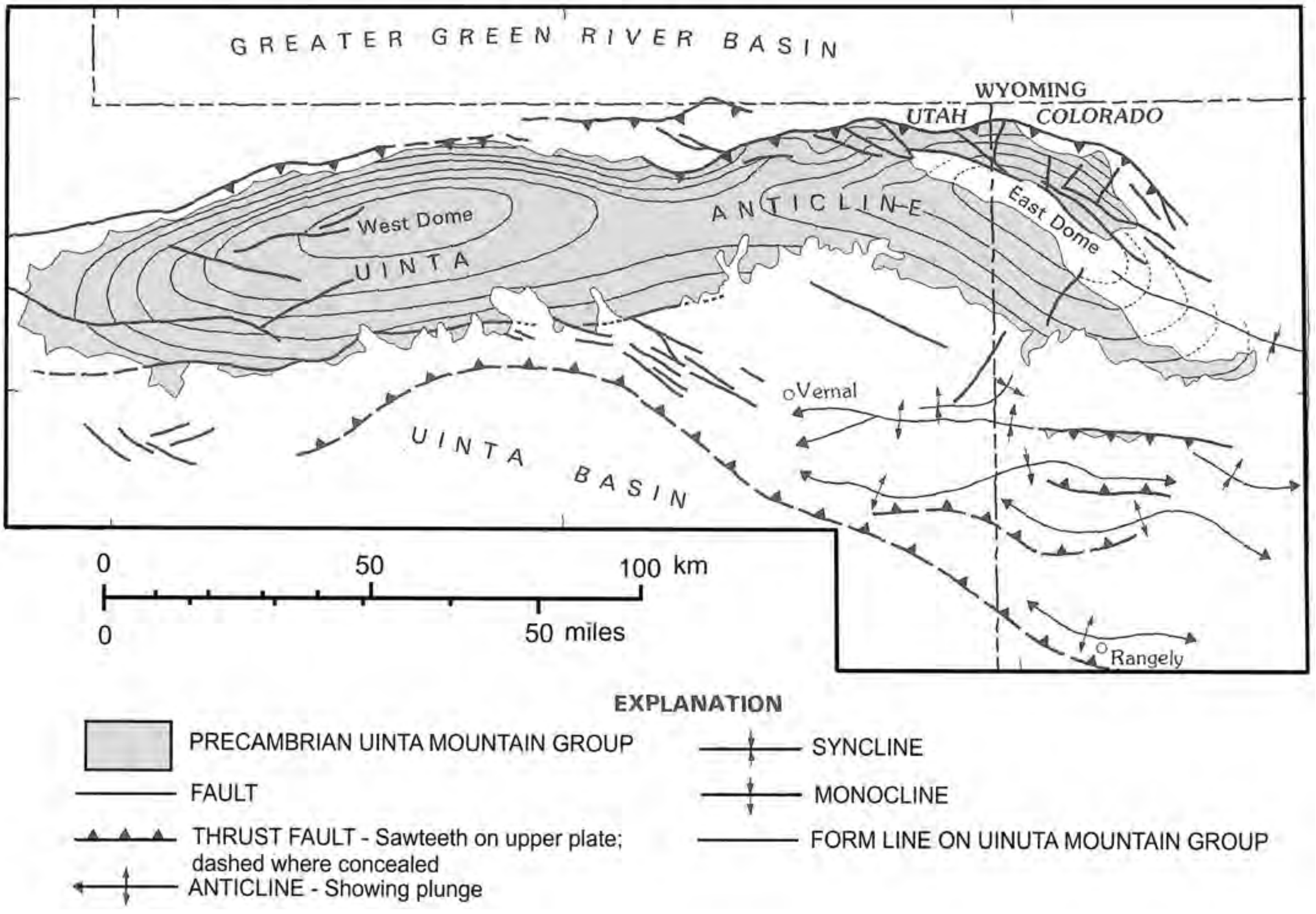


Figure 2. Generalized structural map of the large-scale anticline of the Uinta Mountains showing two domes. The east dome collapsed to form Browns Park (from Hansen, 1986, p. 6).

balance could be maintained for millions of years.

Paleocurrent indicators suggest that sediment in the deep basins migrated from the east and northeast (Dehler et al., 2010). Uniformitarians believe that zircon crystal dates in the sedimentary particles suggest that some of the sand originated in the Appalachian Mountains and flowed approximately 1,200 miles (2,000 km) in a single broad river or a fluvial system to the Uinta area, as well as other areas of the southwest United States (Froede, 2004; Mueller et al., 2007; Oard, 2009a). These rivers are thought to have transported Appalachian sand as far as Antarctica, Australia, and South America, which were then supposedly abutting western North America (Dehler et al., 2010).

The basin fill is largely sand with some conglomerate and mud. These clean quartz sands were cemented into sandstones and then later metamorphosed to quartzite, called the Uinta Mountain Group, which is at least 23,000 feet (7 km) in thickness, with no exposed lower contact (Dehler et al., 2010). The quartzite is brick red to purplish-red. In the eastern Uintas, it is an orthoquartzite (Figure 3). However, its metamorphic grade increases in the western Uintas and is typically white or gray (Figure 4). The Uinta Mountain Group contains a wealth of microfossils (Dehler, et al., 2005). It has abundant colonial bacteria and supposedly records the first appearance of vase-shaped microfossils (Dehler et al., 2010). The Uinta Mountain Group is dated at about 750 Ma old (late Precambrian), according to the geologic timescale. There is supposed to be an older quartzite, called the Red Creek Quartzite, dated about 2 billion years old, confined to a few square miles in the northeastern part of the range (Hansen, 2005, p. 76).

Figure 3. Red quartzite of the Uinta Mountain Group from the eastern Uinta Mounains. Notice that the quartzite has small pebbles and is low grade, more like a coarse, hard-cemented sandstone or orthoquartzite.

Figure 4. White and grey quartzite boulder from the western Uinta Mountains.

Phase 2. Rapid Deposition on Top of the Basin Fill

After the basin was infilled by the sand that became the Uinta Mountain Group, the area was covered by a blanket of horizontal sediment, approximately 25,000 feet (7.6 km) thick (Hansen, 2005). These sediments are dated as Paleozoic, Mesozoic, and early Tertiary, with the Tertiary particularly represented by the conglomerate of the Wasatch Formation (Figure 5), which could represent a syntectonic debris apron shed at the beginning of uplift. There are few if any tectonic or deformation structures of any significance within the sedimentary rocks of this second phase. Similar sequences are found across the Rocky Mountain and High Plains regions, and beyond: "Many of the rock formations that crop out in the Uinta Mountains are recognized throughout much of the western interior of the United States" (Hansen, 2005, p. 75). The Paleozoic strata are especially extensive.

It is interesting to note that this thick sedimentary rock sequence is missing any rocks dated from the Ordovician, Silurian, and most, if not all, of the Devonian, approximately 150 million years (Hansen, 2005). These strata are also largely absent in sequences as far apart as Grand Canyon and Montana (Alt and Hyndman, 1986; Beus, 1990). The Cambrian is also missing from the north flank of the Uintas (Hansen, 2005); there, the Mississippian directly overlies the Precambrian.

The thick horizontal sediments of Phase 2 contain two interesting marker beds. One is the late Paleozoic Park City Formation, which contains a high proportion of phosphate that is mined for fertilizer on the south side of the Uinta Mountains. This phosphate-rich bed is regionally extensive, found in southwest Montana, western Wyoming, eastern Idaho, and northeast Utah (McKelvey et al., 1956; Piper, 2001). It is also called the Phosphoria or the Shedhorn Formation in other states. It has six times the concentration of P_2O_5 as is found in seawater and a high organic content (Stephens and Carroll, 1999).

The second marker bed is the distinctive Mowry Shale. It is thought to have formed largely from settling volcanic ash and is noted for its abundant fish scales easily found in most outcrops (Hansen, 2005). Despite the Mowry's broad extent over areas of the Rocky Mountains and High Plains, including Montana and Wyoming (Coffin et al., 2005), there

Figure 5. An erosional remnant of the Wasatch Formation conglomerate tilted at a high angle down toward the north on the north side of the Uinta Mountains. The early Tertiary Wasatch Formation probably represents coarse gravel first deposited at the beginning of uplift of the Uinta Mountain anticline that resulted in northward dipping strata on the north side.

are few other fish remains found. The bed was evidently deposited quite rapidly (volcanic settling and preserved fish scales), but it is difficult to explain how the fish scales were separated from other skeletal or organic remains and then preserved in the Mowry Shale.

Phase 3. Formation of Unique Landforms

After the deposition of this thick, relatively undisturbed, widespread, horizontal sedimentary sequence, a period of intense regional deformation marks the beginning of Phase 3. Most geologists think that the area was fairly flat prior to this Cenozoic episode. The typical uniformitarian interpretation of nearby areas in Wyoming is shown in Figure 6.

With the onset of tectonism, the Uinta Mountains buckled into an im-

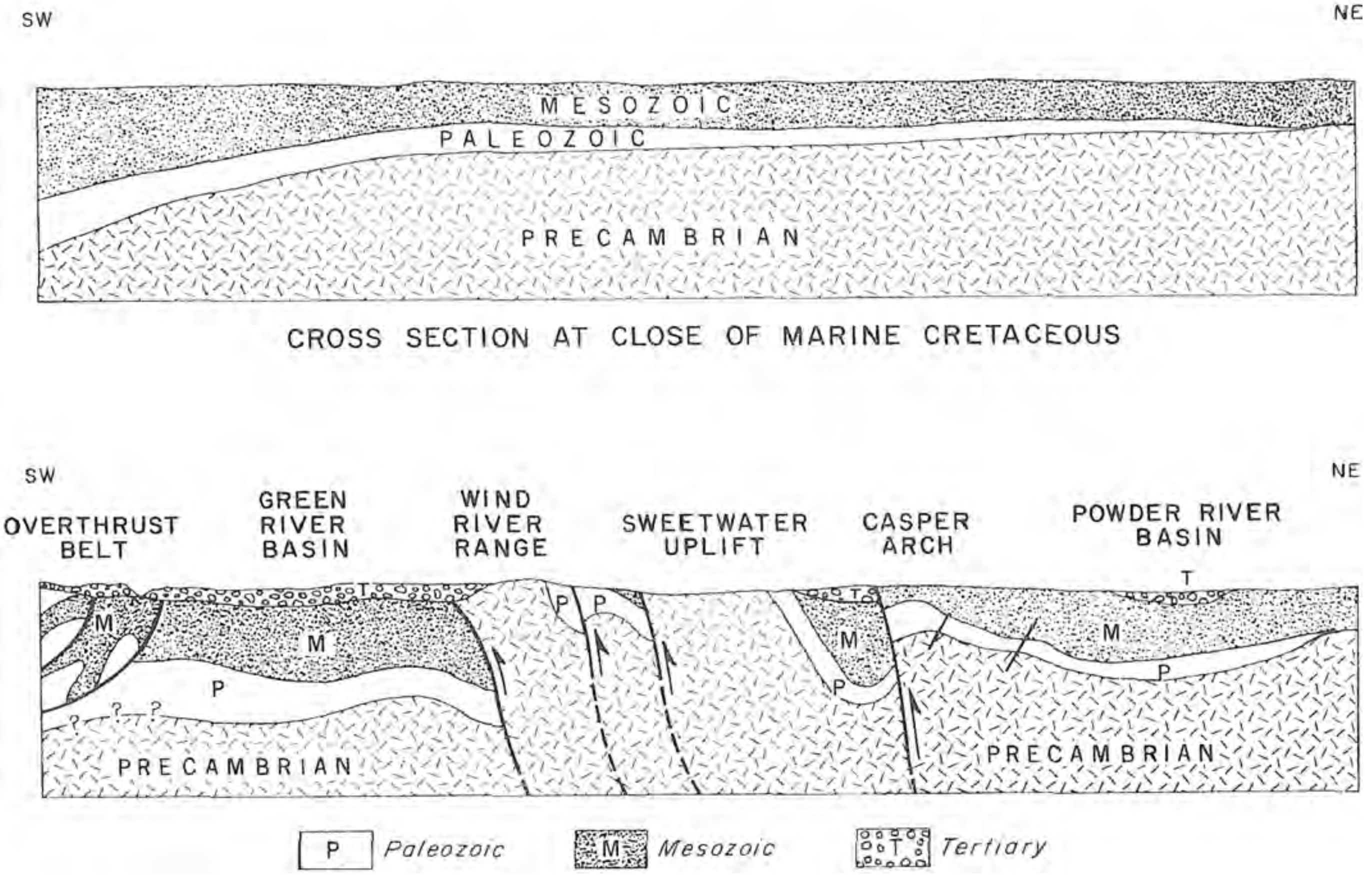


Figure 6. The uniformitarian view of the sedimentary rocks on top of generally horizontal Precambrian granite in Wyoming right after the Mesozoic, followed by huge differential vertical tectonics during the Tertiary (from Glass and Blackstone, 1994, p. 3).

mense anticline (Hansen, 2005) that was also thrust northward by a large reverse fault (Figure 7). At the same time, basins adjacent to the uplifting Uintas formed and subsided; the total differential movement exceeded 40,000 feet (12 km).

> The upbuckling that produced the mountains was accompanied by comparable downbuckling under the basins. *As the mountains rose, the basins subsided*, so that deposits once near sea level throughout the region are now 12,000–13,000 feet high in the mountains but are as much as 30,000 feet below sea level beneath the Green River and Uinta Basins (Hansen, 2005, p. 104; emphasis added).

Notice how Hansen essentially quotes Psalm 104:8, which describes differential vertical tectonics while the Floodwater drained. The differential tectonics of the Uinta Mountains and these late-forming basins is similar to that described in Wyoming, where a total of 45,000 feet of differential motion between the uplifting mountains and sinking basins is deduced (Love, 1960).

Another result of this deformation was the creation of extensive faulting within the Uinta Mountains (Hansen, 2005). The uplift was also responsible for the collapse of the crest of the east dome, which was then partially infilled by sand, volcanic tuff, and gravel of the Browns Park Formation (Hansen, 2005).

With uplift came erosion. The thick strata deposited during Phase 2 were eroded off the top of the anticline, initially forming an extensive planation surface on the quartzite called the Wild Mountain upland surface (Hansen, 1986; Munroe, 2006). It is possible that this planation surface is

Figure 7. High angle reverse fault in the northeastern Uinta Mountains. Uinta Group quartzite on the left and Paleozoic sedimentary rocks on the right.

Figure 8. Eroded, steeply dipping strata on the southeast edge of the Uinta Mountains at Split Mountain.

Figure 9. Much-eroded strike ridges and valleys with dip of the strata down to the north (view east across Flaming Gorge Reservoir).

Figure 10. Strike valleys and ridges on the north side of the Uinta Mountains (view northeast). In the background is Little Mountain representing a large erosional remnant of the Gilbert Peak erosion surface capped by Bishop Conglomerate.

Figure 11. The Gilbert Peak erosion surface southeastern Uinta Mountains

Figure 12. Bishop Conglomerate on top of the Gilbert Peak erosion surface on the Diamond Mountain Plateau just south of the main axis of the eastern Uinta Mountains.

an exhumed surface, formed before the sedimentary rocks were laid on top and only exposed due to subsequent erosion. This planation surface will be discussed in another article on the geomorphology of the Uinta Mountains (Oard, in press). Strata that were once flat and horizontal are now tilted up on the north and south sides of the Uinta Mountains and have been greatly eroded (Figure 8). Differential erosion in places created strike valleys and ridges (Figures 9 and 10). Debris eroded from the mountains filled the surrounding basins with a thick sedimentary sequence.

The axis of the Uinta Mountains lies in generally horizontal Precambrian quartzite (Bradley, 1936), and this quartzite was eroded, leaving behind deep valleys and high mountains on the axis of the mountains. The eroded rounded-to-subrounded quartzite lies mostly on an erosional surface called the Gilbert Peak erosion surface (Figure 11) and is called the Bishop Conglomerate (Figure 12).

Phase 4. Glaciation

Following the tectonism, with its differential uplift and basin formation, and the deformation of the Phanerozoic strata, the Uinta Mountains were extensively glaciated. Glaciers occurred predominantly in the valleys, not on the generally flat mountaintops (Munroe, 2007).

Flood Explanation

The phases of Uinta Mountain geology can be readily explained by the stages and phases of the Genesis Flood (Walker, 1994, Figure 13). We can use his criteria to interpret the phases of the Uinta Mountains using the outline of biblical earth history.

Phase 1

In Walker's model, there are two periods of intense tectonism (cf., Reed et al., 1996), the very early Flood and the

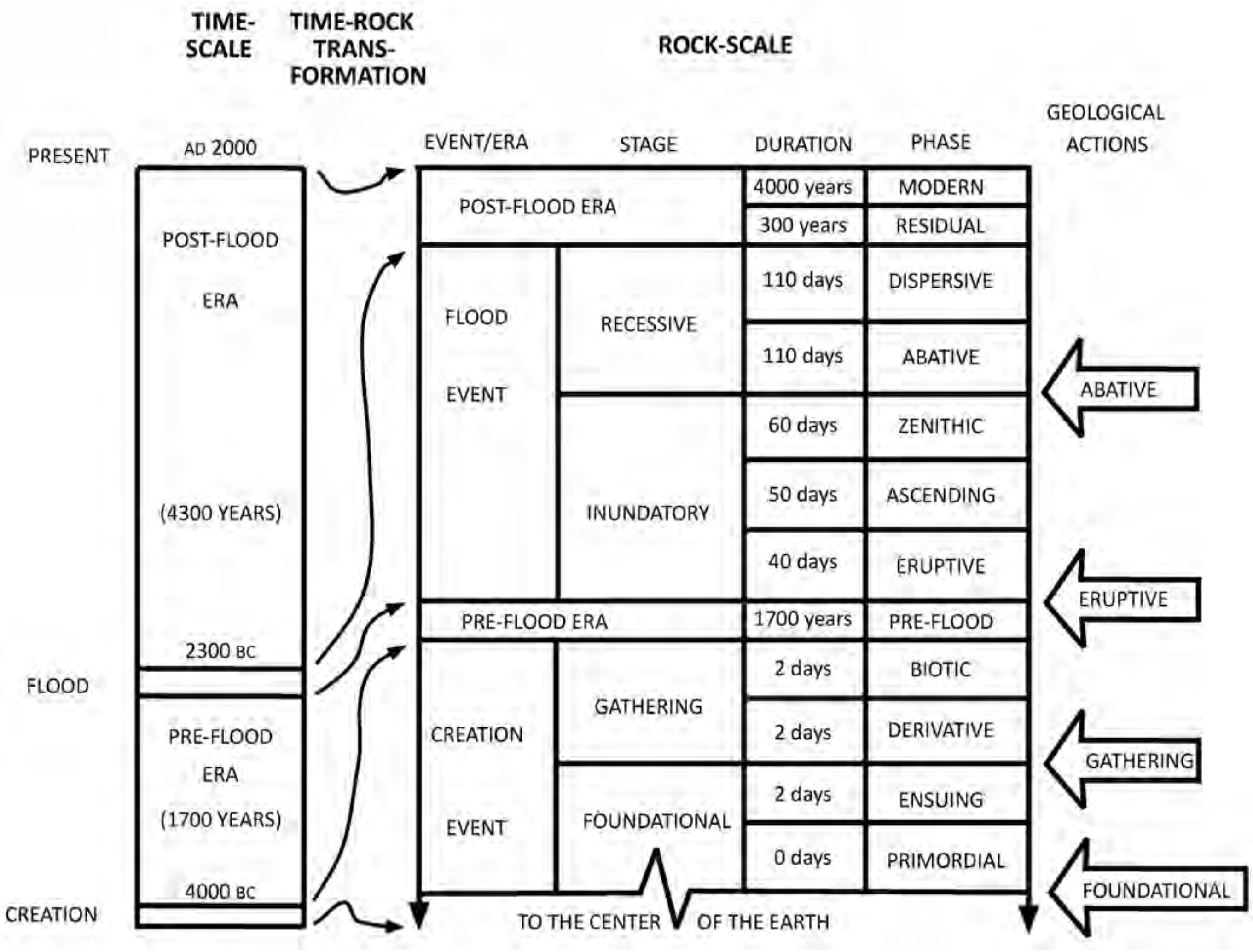


Figure 13. Walker's biblical geological model showing the Flood with its two stages and five phases.

beginning of the Flood retreat after Day 150: "The Eruptive [very early Flood] and Abative [early Recessive Stage] actions probably involved tectonic activity and may have been spread over weeks or months" (Walker, 1994, p. 587). Phases 1 and 3, described above, fit with this defining criterion very well.

The deep basin or trough formed during Phase 1 would correspond to the eruptive phase of the inundatory stage. Extensive rift and extensional troughs and basins are found throughout the basement of North America (Reed, 2000). Accumulation of mostly sand-sized particles in the trough indicates relatively high energy that was constant over a large area or originated from a sediment source restricted to quartz sand. Both the energy requirements and the lack of mud or carbonate facies in the basin suggest rapid deposition occurring simultaneously with the trough's subsidence and the absence of carbonate mud in the source area.

If so, this would place the pre-Flood/Flood boundary below the Precambrian Uinta Mountain Group. This is supported by the presence of subariel mudcracks and raindrop imprints in the sediments of the Uinta Mountain Group, assuming these features have been correctly identified. However, caution is warranted because mudcracks also can form in subaqueous conditions (Whitmore, 2009). But even if the Uinta Group features are subariel mudcracks, they can form within days (Whitmore, 2009), which would imply that the rain of the first 40 days was not everywhere heavy and continuous. The raindrop imprints indicate that the quartzite is younger than Creation Week, since Genesis 2:5–6 states that there was no rain until after man was created. Walker uses raindrop imprints as a criterion in placing strata at the beginning and middle of the inundatory stage.

> Raindrops [imprints] have been reported in rock formations. Raindrops are significant for the Biblical model because the surface must be exposed to rain. This would rule out the Foundational Rocks of the Creation Event. Also there would be some period of time during the Flood toward the end of the Inundatory Stage and the beginning of the Recessive stage when raindrops could not form because the surface was covered by water (Walker, 1994, p. 589).

The raindrop imprints and mudcracks can readily be explained the same way as dinosaur tracks, eggs, and scavenged bonebeds early in the Flood (Oard, 2011). The BEDS hypothesis proposes that in areas of rapid accumulation, the top of the sediments would approach the surface of the Floodwater and become briefly exposed during a local lowering of sea level. Mudcracks and raindrop imprints can quickly form. A subsequent rise in sea level would bury and preserve the delicate features.

Moreover, there are abundant microfossils in the quartzite, which would also indicate their formation during the Flood. There is still the possibility of placing the Uinta Mountain Group between the Creation and the Flood, but this is unlikely because of the huge volume of rapidly deposited sediments and the catastrophic tectonics, erosion, and deposition that occurred, requiring an energy budget far in excess of any antediluvian processes.

Phase 2

Phase 2 was a widespread, rapid depositional event notable for its lack of extensive sediment deformation. Sedimentation must have occurred either in very deep water or during a period of rapid subsidence, since over 25,000 feet (7.6 km) of sediments was deposited. Another indication of rapid, ongoing deposition is the absence of significant erosion within and between strata. These physical indications of continuous deposition contradict the biostratigraphic conclusion that the 150 million years of the Ordovician, Silurian, and Devonian periods are not present. It is likely that the fossils that define those periods simply were not deposited in this region.

Mesozoic rocks in the Rocky Mountains contain millions of dinosaur tracks and thousands of dinosaur eggs (Oard, 2011), and these suggest deposition between Day 40 and about Day 120 of the Flood. Dinosaur tracks are a very good criterion for the inundatory stage of the Flood (Walker, 1994). The tracks early in the Flood can be explained by the same way the mudcracks and raindrop imprints can be explained—with pulses of rapid deposition covering sediments that were briefly exposed to subariel conditions. Therefore, dinosaur tracks and eggs were incorporated into the rock record on an Earth not yet totally flooded. The absolute latest day for these features was Day 150, but they probably formed days or weeks earlier. Since there are few instances of raindrop imprints with eggs and tracks, then the rain between Days 40 and 150 may have been greatly reduced and may have been more local than global.

Phase 3

Geologic conditions then changed significantly, marking the beginning of a third phase. Rather than rapid deposition with little deformation, this period of time was marked by large-scale differential tectonics and erosion (see Hansen quote above). Deep basins subsided next to the rising mountains, and heavy erosion filled them with sediments, as well as formed different types of surficial landforms. These processes fit well with the recessive stage of the Flood, mainly the abative phase. According to uniformitarians, practically all the uplift occurred during the Cenozoic with adjacent basins sinking and collecting sediments; even early Tertiary beds are tilted at high angle along the north flank of the mountains (Bradley, 1936). This vertical tectonic movement was typical of this stage of the Flood all over the earth (Oard, 2008) and verifies Psalm 104:6–9 (as noted above, Hansen nearly quoted Psalm 104:8). Figure 14 is a schematic of this phase during the recessive stage of the Flood.

The final phase of the Flood in Walker's (1994) scheme is the dispersive phase, in which Flood currents became channelized as relative sea level continued to drop. The large-scale tectonic movements of the early abative stage decreased, though vertical movement continued on a broad scale (Oard, 2008). It was during this phase that the Gilbert Peak erosional surface was greatly eroded and divided into erosional remnants (Figure 15) as the channelized flow created the numerous water gaps in the area (Oard, in press). Therefore, it is likely that the Flood/post-Flood boundary in this region corresponds with the late Cenozoic.

Physical characteristics of the strata deposited in Phase 3 indicate rapid sedimentation under energetic conditions. For example, large rounded-to-subrounded quartzite boulders are found on the Gilbert Peak erosion surface. The sandstone underlying the erosional surface was thus consolidated and even metamorphosed before the abative phase of the Flood. Rapid lithification is also suggested by shale chips containing fish scales of the Mowry Shale (Hanson, 2005). In one case, an 11-foot-long (3.4 m) limestone boulder was transported at least 8 miles (13 km) (Hansen, 1965), implying that the limestone was lithified before the recessional stage of the Flood.

Figure 16 is a summary of the secular explanation of these three phases. Many physical processes would be similar to a Flood explanation, although the scale and rate would differ, since interpretation is driven by the same physical data. Note that many secular geologists believe the original basin was a rift, but Dehler et al. (2010) disagree because of the absence of volcanics. The massive nature of the quartzite, along with the scarcity of shale or argillite interbedding, renders the fluvial/deltaic scenario untenable because there are no discernible facies changes as expected in such a model. The sand dunes in the fourth schematic from the top left are based on the belief that the Navajo Sandstone is a wind-blown deposit, despite contrary evidence (Oard et al., 2010).

Phase 4

The final phase was marked by glaciation that probably occurred during the post-Flood ice age (Oard 2004). However, it is interesting that the valleys were preferentially glaciated and the uplands were not. A possible explanation for glaciated valleys but unglaciated uplands might be persistent high winds in the heights, scouring the high elevations and depositing the blowing snow into the surrounding valleys.

Summary

This interpretation of the geology of the Uinta Mountains is a straightforward application of Walker's (1994) biblical geological model (Figure 13). Phase 1 suggests intense activity, consistent with the eruptive phase. This includes the Precambrian extensional basin and thick sand. Phase 2, the deposition of massive amounts of eroded debris, would be expected with the decrease of the early Flood violence. Dinosaur tracks and eggs in Mesozoic sediments bracket this deposition between the eruptive phase and Day 150. Deposition was nonlinear; most occurred early in the Flood. The recessive stage was predominantly erosional in this location, with concomitant deposition in basins between rising mountains and along the continental margins. The Flood/post-Flood boundary would thus be late Cenozoic, and, with the exception of minor glacial

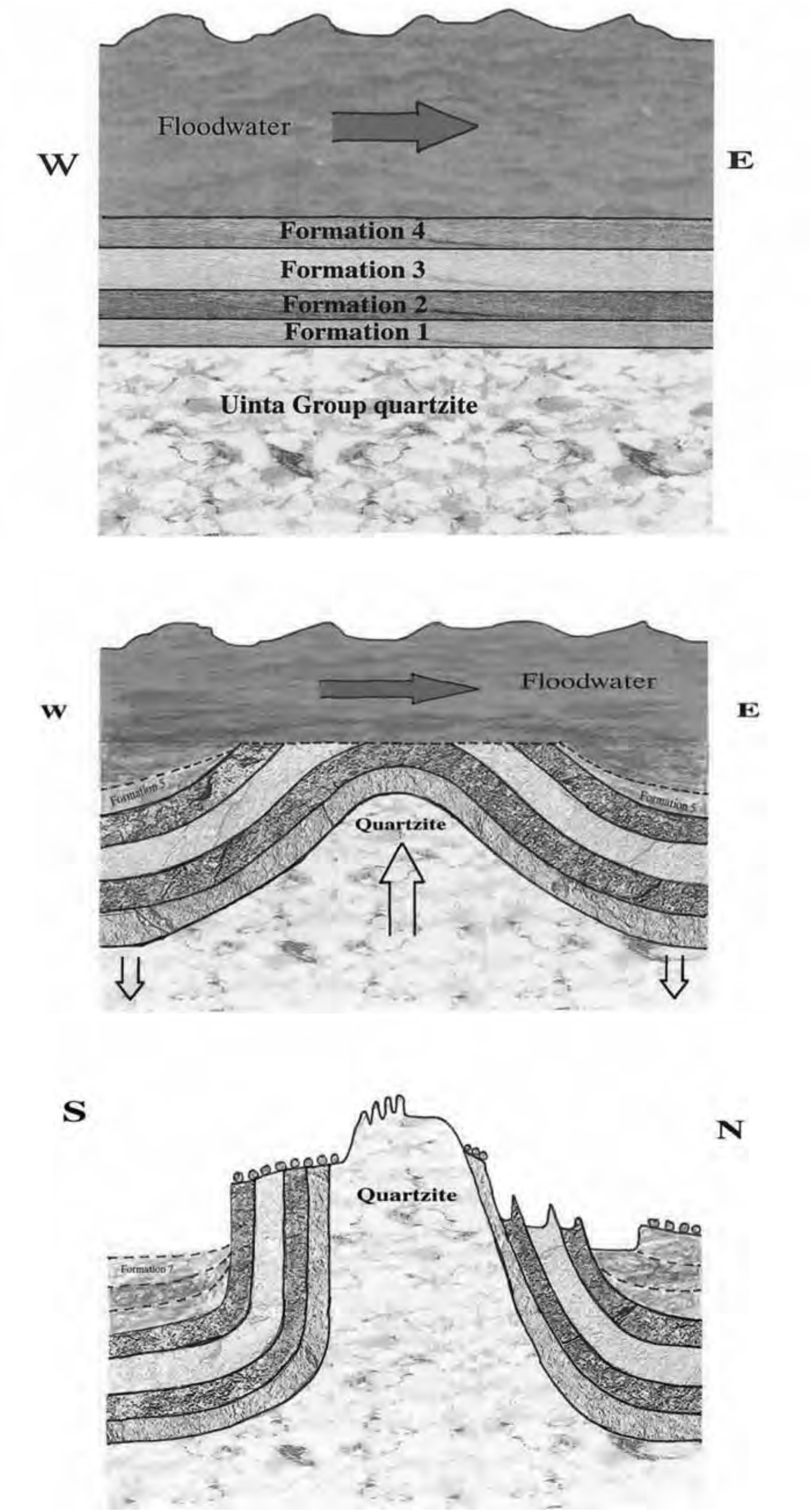
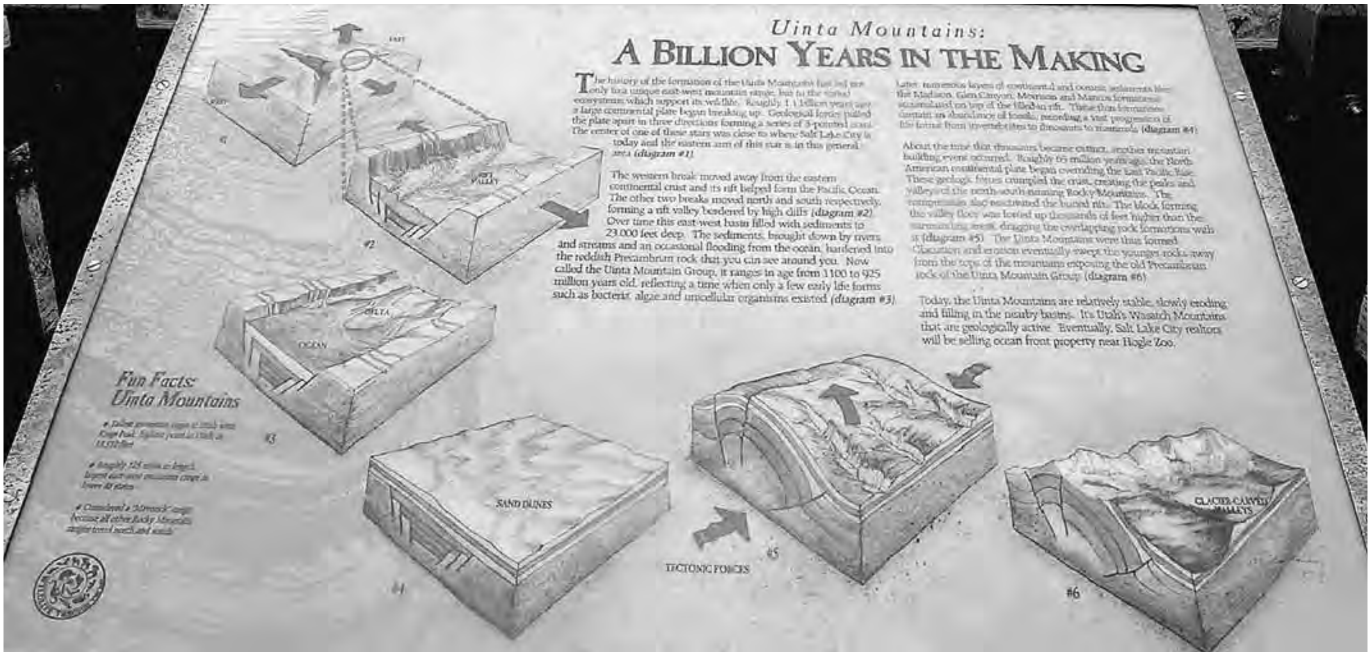


Figure 14. Schematic of phase 3 during the Recessive Stage of the Flood (drawn by Mrs. Melanie Richard).

Figure 15. A remnant of the Gilbert Peak erosion surface on Pine Mountain northeast of the Uinta Mountains (view southeast from Miller Mountain, a much larger erosional remnant of the erosion surface).



Uinta Mountains:

A BILLION YEARS IN THE MAKING

The history of the formation of the Uinta Mountains has led not only to a unique east-west mountain range, but to the varied ecosystems which support its wildlife. Roughly 1.1 billion years ago a large continental plate began breaking up. Geological forces pulled the plate apart in three directions forming a series of 3-pointed stars. The center of one of these stars was close to where Salt Lake City is today and the eastern arm of this star is in this general area *(diagram #1)*.

The western break moved away from the eastern continental crust and its rift helped form the Pacific Ocean. The other two breaks moved north and south respectively, forming a rift valley bordered by high cliffs *(diagram #2)*. Over time this east-west basin filled with sediments to 23,000 feet deep. The sediments, brought down by rivers and streams and an occasional flooding from the ocean, hardened into the reddish Precambrian rock that you can see around you. Now called the Uinta Mountain Group, it ranges in age from 1100 to 925 million years old, reflecting a time when only a few early life forms such as bacteria, algae and unicellular organisms existed *(diagram #3)*.

Later, numerous layers of continental and oceanic sediments like the Madison, Glen Canyon, Morrison and Mancos formations accumulated on top of the filled-in rift. These thin formations contain an abundance of fossils, recording a vast progression of life forms from invertebrates to dinosaurs to mammals *(diagram #4)*.

About the time that dinosaurs became extinct, another mountain building event occurred. Roughly 65 million years ago, the North American continental plate began overriding the East Pacific Rise. These geologic forces crumpled the crust, creating the peaks and valleys of the north-south running Rocky Mountains. The compression also reactivated the buried rift. The block forming the valley floor was forced up thousands of feet higher than the surrounding areas, dragging the overlapping rock formations with it *(diagram #5)*. The Uinta Mountains were thus formed. Glaciation and erosion eventually swept the younger rocks away from the tops of the mountains exposing the old Precambrian rock of the Uinta Mountain Group *(diagram #6)*.

Today, the Uinta Mountains are relatively stable, slowly eroding and filling in the nearby basins. It's Utah's Wasatch Mountains that are geologically active. Eventually, Salt Lake City realtors will be selling ocean front property near Hogle Zoo.

Fun Facts: Uinta Mountains

Figure 16. The three phases of the geology of the Uinta Mountains as displayed on a kiosk in the northeastern Uinta Mountains

sediments, all the sedimentary rocks in the Uinta Mountains were deposited by the Flood.

The sequence of the geological timescale is generally followed in the Uinta Mountains and surrounding basins. I subscribe to such a general geological column with many exceptions (Oard, 2006, 2010a, 2010b). So, I think the general sequence of Precambrian-Paleozoic-Mesozoic-Cenozoic is valid in the Uinta Mountains area and large areas of the Rocky Mountains and High Plains. I would not want to argue for any of the finer details of the geological column, such as the basis for the uniformitarian periods of Cambrian, Ordovician, Silurian, etc. However, this sequence cannot be related to absolute time. It may reflect instead sequences defined in part by vertical ecological zonation. The presence of microfossils in the rift basin quartzite without any macrofossils in the same sequence could be due to the destruction of larger organisms by the intense erosion, turbulence, and heat or could be due to their absence during deposition. There is a general vertical fossil sequence of marine organisms followed by more terrestrial organisms in the Mesozoic and Cenozoic. Since these organisms lived at higher elevations than marine creatures, they would likely have been killed later. Other factors that might influence fossil distribution include lateral ecological zonation, hydrodynamic sorting, the differential ability of an animal to swim or float, the differential ability of an animal to run toward higher land, and preservation potential.

As an aside, the late-Flood tectonic uplift suggests a solution for the oft-repeated pseudo-problem of the Flood having insufficient water to cover Mount Everest (e.g., Walton, 2001). If over 40,000 feet (12.2 km) of differential uplift occurred in the Uinta Mountains and 45,000 feet (13.7 km) in Wyoming, it is likely that much of Mt. Everest's current elevation probably also resulted from late Flood uplift (Oard, 2009b).

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