CHAPTER 19

RIVER TO RIM

PUTTING ALL THE PIECES TOGETHER

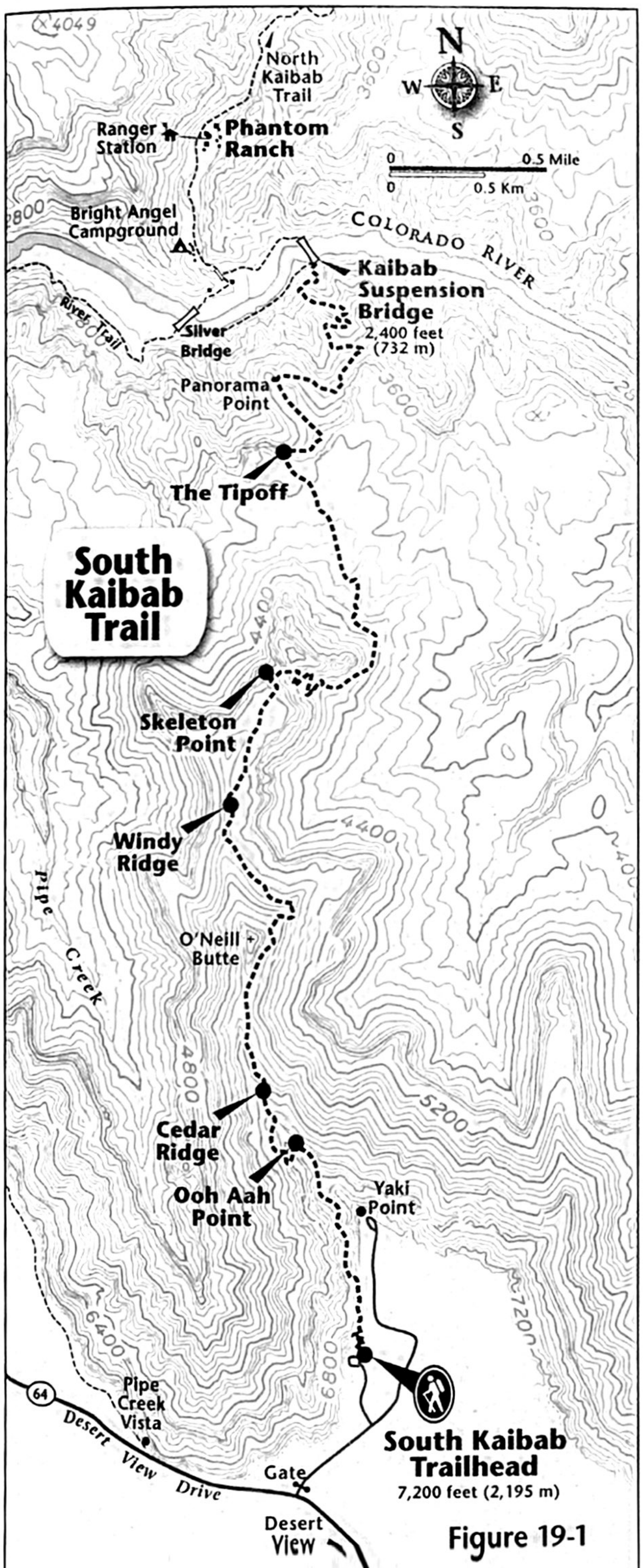


Figure 19-1

by **Gregg Davidson** and **Wayne Ranney**

The Grand Canyon is the single best place in the world to observe the broad span of Earth history, and the South Kaibab Trail is one of the best places within the canyon to see its spectacular geology (Fig 19-1). The South Kaibab is a very popular trail that is easy to access by a free shuttle service from Grand Canyon Village. Most of this chapter will describe what can be seen specifically along this trail, but occasional references will be made to what is observed at the same level on other trails. The South Kaibab Trail is unusual in the Grand Canyon because it was created by

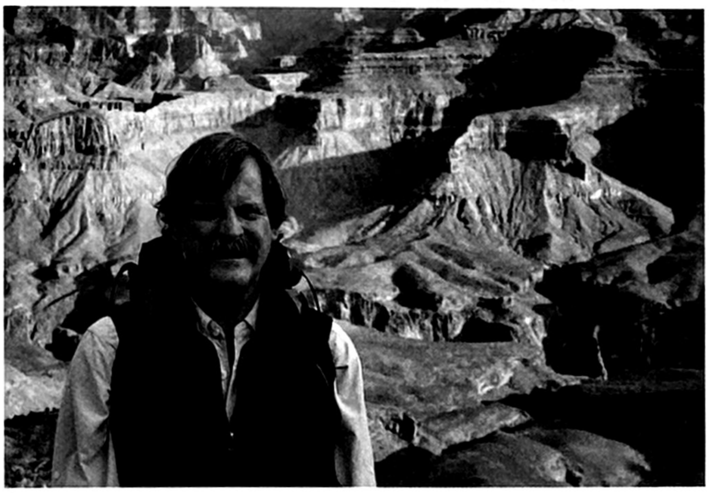
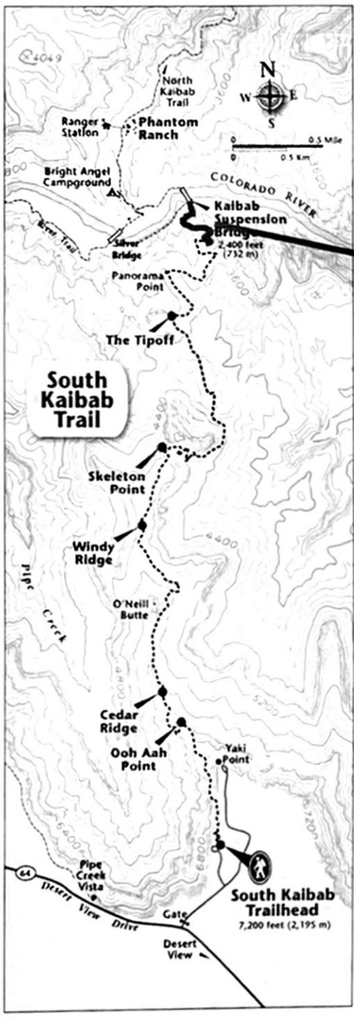


Figure 19-2. Wayne Ranney on the South Kaibab Trail. Ranney has taken more than 400 trips into the Grand Canyon, with at least 250 of those on the South Kaibab Trail. Many of the photos in this chapter are from Wayne's personal collection, spanning nearly four decades of exploration, photography, and writing about the canyon. *Photo by Helen Ranney.*

dynamiting into a high ridge rather than by following along the bottom of a side canyon, like most other trails in the canyon. For this reason, the views east and west from the trail are tremendous, and the canyon's geologic story is on dramatic display. But enough introduction – let's hike!

1. Vishnu Schist and Zoroaster Granite *(mile 0 to 0.4)*



Our trip begins along the banks of the Colorado River near Phantom Ranch – a small resort and common hiking destination at the bottom of the Grand Canyon. The South Kaibab Trail starts at the Colorado River just south of the ranch, where the Kaibab Suspension Bridge crosses the river (Fig 19-3). Standing at the bridge (mile 0 in our hike), we are surrounded by the Vishnu Schist, a rock riddled with bands of pink Zoroaster Granite (Fig 19-4, and page 186 photo). A few quick observations tell us much about the history of this rock. The schist contains altered minerals that form under high temperatures and pressures typically found only at great depths – on the order of 10 miles or more beneath the surface. These rocks are also folded and contorted. Rapid bending and folding shatters rock, but the schist shows little evidence of shattering – which indicates that it deformed very gradually. The granite that crisscrosses through the schist contains large crystals, which indicates that the rate of cooling was also slow (Fig 19-5).

All of these features are consistent with rock that formed over a long period of time, deep below the surface – much deeper than where this rock is exposed today. Samples of the crisscrossing granite have been radiometrically dated to about 1.7 billion years old. The granite intrudes into the schist, which means the age of the schist – the time when sedimentary and volcanic rocks were buried deeply enough to experience metamorphism and alteration to schist – is even older.

Flood geologists claim a recent and rapid origin for these rocks, with formation, intrusion, alteration, and cooling all between the creation week and Noah's flood (only about 1,650 years). But none of this fits with what we see in the rocks. From lab experiments, we know it takes a tremendous amount of time for large masses of heated and deeply buried rocks to cool. Given the immense volume of rock in the Zoroaster Granite, a recent pre-flood origin

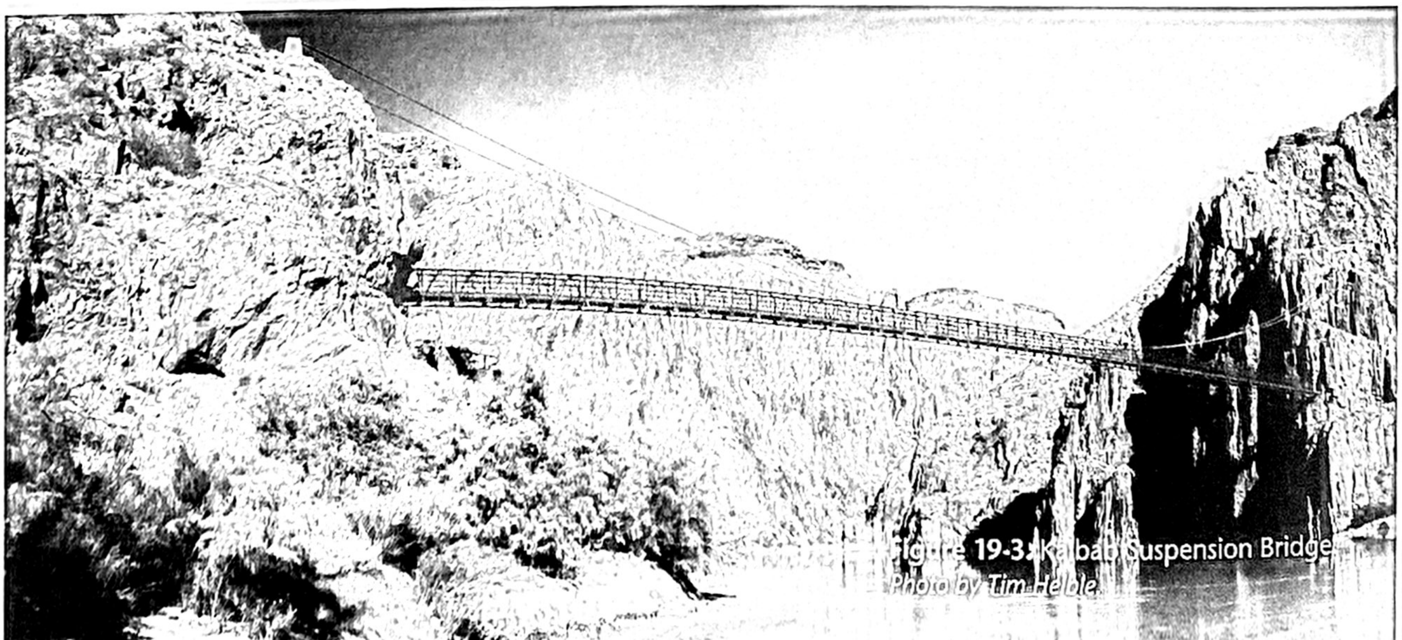


Figure 19-3: Kaibab Suspension Bridge
Photo by Tim Helble

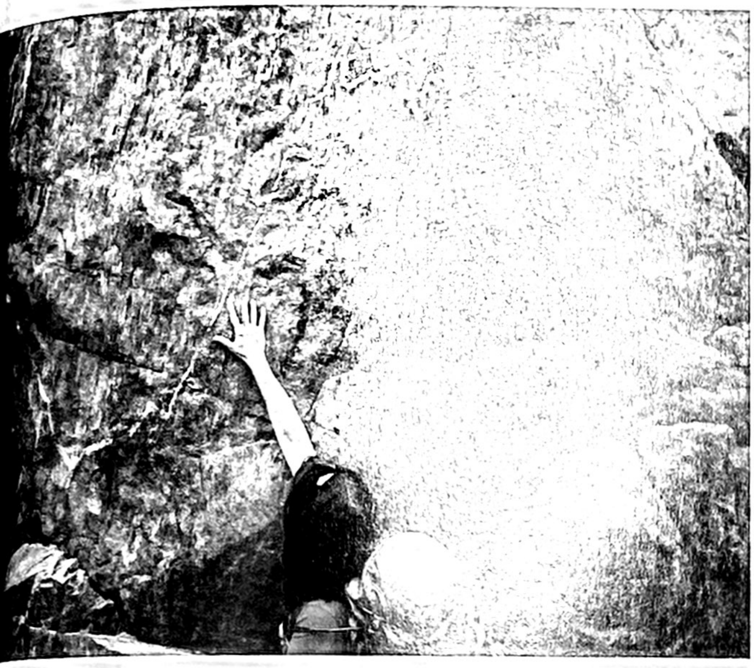


Figure 19-4. Wavy bands in the Vishnu Schist. *Photo by Wayne Ranney.*

Figure 19-5. Large crystals in the Zoroaster Granite. *Photo by Debbie Buecher.*

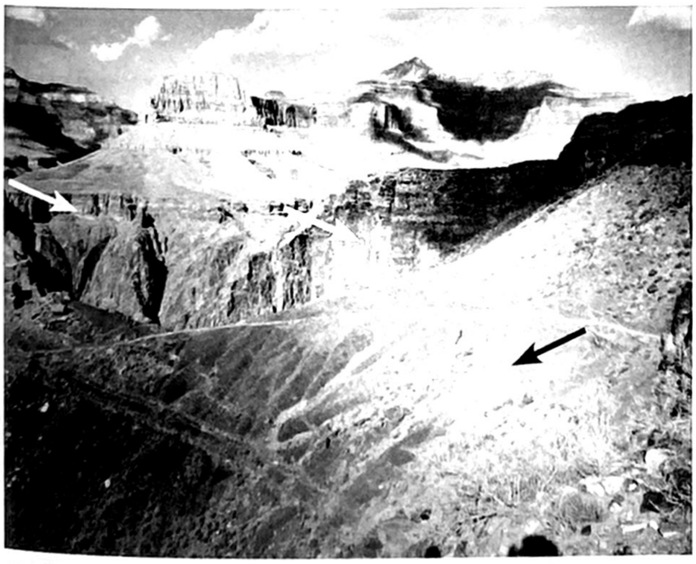
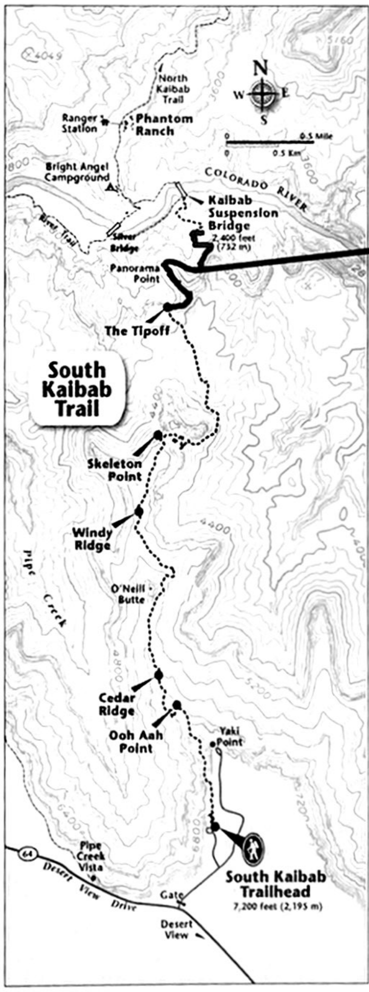


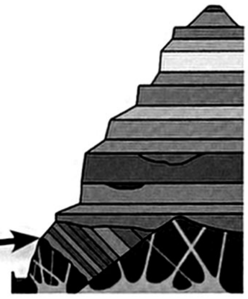
Figure 19-6. South Kaibab Trail descends through Supergroup layers (black arrow, Hakatai Shale; yellow arrow, Shinumo Quartzite), but upstream, the Supergroup layers (white arrow) are absent. *Photo by Gregg Davidson.*

would have required the action of some unknown mechanism to achieve ultra-rapid cooling. Flood geologists also claim that radiometric dates are unreliable. But no alternative for dating these rocks is offered – other than one based, not on the Bible, but on a particular interpretation of the Bible.

Remember that flood geologists say natural processes can account for all the Earth's layers that formed after the close of the creation week, yet the very start of the Grand Canyon's story requires reliance on never-before-encountered natural mechanisms and ignores all evidence of great age. We'll revisit this subject again later in our hike.

2. Grand Canyon Supergroup and the Great Unconformity *(mile 0.4 to 1.9)*





If you are exploring the geology of the Grand Canyon for the first time, the rocks along this stretch of the South Kaibab Trail might seem confusing. For the next mile, we pass through tilted rock layers belonging to the Grand Canyon Supergroup. Along the trail we see three formations: the Bass Formation, Hakatai Shale, and Shinumo Quartzite, with the Vishnu Schist below and the horizontal Tapeats Sandstone above (Fig 19-6). However, if we look up or down the river canyon, we see cliff faces where the Vishnu Schist terminates directly against the Tapeats Sandstone – the

Figure 19-7. *top:* Hotauta Conglomerate at the base of the Supergroup, containing pieces of schist and granite. *bottom:* Cut and polished Hotauta Conglomerate. *Photos by Wayne Ranney.*

Supergroup layers are entirely absent. There is clearly a complex history here that would require a lengthy discussion to fully describe. For the purposes of this chapter, we will limit our observations to those most pertinent to comparisons between the expectations of conventional geology and flood geology.

The Grand Canyon Supergroup includes nine formally named rock formations, with a combined total thickness in excess of 12,000 feet, but we find only the lowest three formations along the South Kaibab Trail. In some parts of the canyon (such as along the New Hance Trail), the lowest Supergroup layer contains chunks of the underlying schist and granite (Fig 19-7). The presence of such chunks reveals much about the history at this location. A very specific sequence of events was required in order for pieces of schist and granite to be encased within the lowest Supergroup layer: the crust had to be uplifted, miles of overlying rock had to be eroded away to expose the schist at the surface, fragments of the eroded rock had to be collected in low spots, and, finally, sediments had to be deposited over and around the weathered chunks of schist and granite. None of this requires any unusual processes to accomplish – unless you need it all to have happened in just a few hundred years, without the benefit of a great cataclysm (recall that flood geologists identify all these rocks as pre-flood).

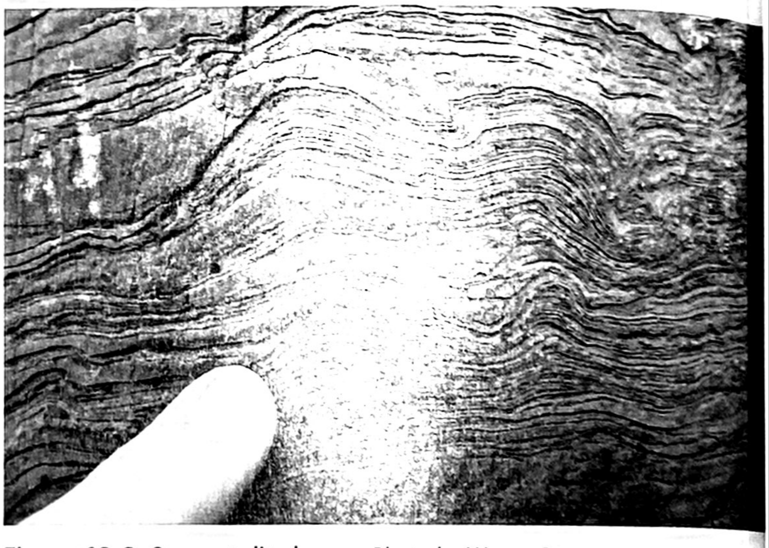


Figure 19-8. Stromatolite layers. *Photo by Wayne Ranney.*

About a mile up the trail in the Bass Formation, we encounter our first visible fossils – colonies of single-celled organisms called stromatolites (Fig 19-8). No multicellular fossils are found in the Bass Formation or in any of the overlying Supergroup layers – nor do we find multicellular fossils in rock layers of similar age anywhere in the world. If multicellular life did not exist at the time these deposits formed, what we find makes perfect sense. On the other hand, if the pre-flood Earth was filled with all manner of life forms that were similar to those we see today, and the Grand Canyon Supergroup was deposited before the start of the flood, at least some of these layers should contain a mix of all these types of life.

We mentioned earlier that the view up or down the river corridor here yields a very different view from the one along the trail. The Supergroup layers up and downstream are entirely missing, and the Tapeats Sandstone is sitting directly on the Vishnu

Schist (Fig 19-9). The dramatic difference is a testament to the work of faulting. This section of our trail crosses two faults, the Cremation and Tipoff Faults. During past tectonic activity, the block of rock between these faults, including layers of the Supergroup, slid downward several hundred feet and came to rest below the surrounding rock. Later erosion removed all of the Supergroup layers from the higher adjacent blocks, exposing the underlying schist and granite. The block crossed by the South Kaibab Trail (between the Cremation and Tipoff Faults) sat much lower, shielding the lowest Supergroup layers from erosion. Later, renewed deposition covered the region with blankets of new sediments, starting with the Tapeats. A simplified sequence of events is illustrated in Fig 19-10.

Once again, normal Earth processes can readily explain these observations, with shifting tectonic plates rupturing crust and moving blocks upward and downward. No never-before-seen mechanisms or mysterious forces are necessary to create the rock formations that we see today. The same cannot be said for the flood geology viewpoint. Most flood geologists place the deposition of all these rocks between Day 3 of the creation week and the flood. The tilting and faulting is attributed to violent tectonic activity initiated at the start of the flood, erosion of entire blocks of the Supergroup to mega-tsunamis, and deposition of the overlying layers to ensuing flood surges. Inconsistencies abound. We'll consider four topics that highlight these inconsistencies.

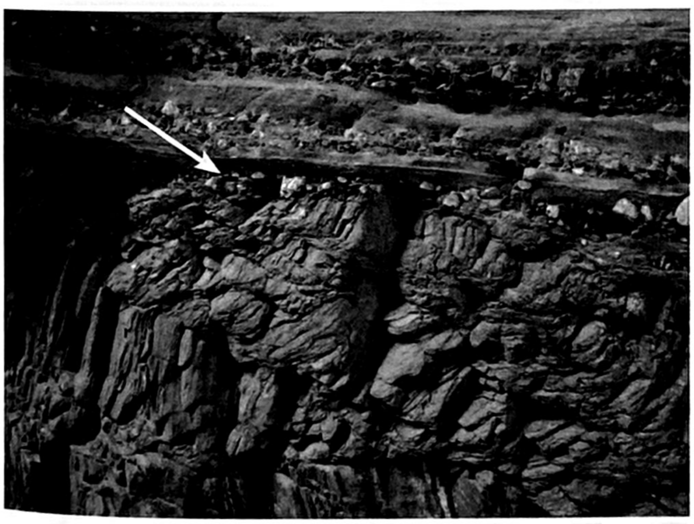


Figure 19-9. Vishnu Schist–Tapeats Sandstone contact, Supergroup missing. *Photo by Wayne Ranney.*

Thickness

Flood geologists claim that Noah's flood deposited all of the flat-lying Grand Canyon strata that sit above the Great Unconformity, including the Tapeats Sandstone and much of the Grand Staircase

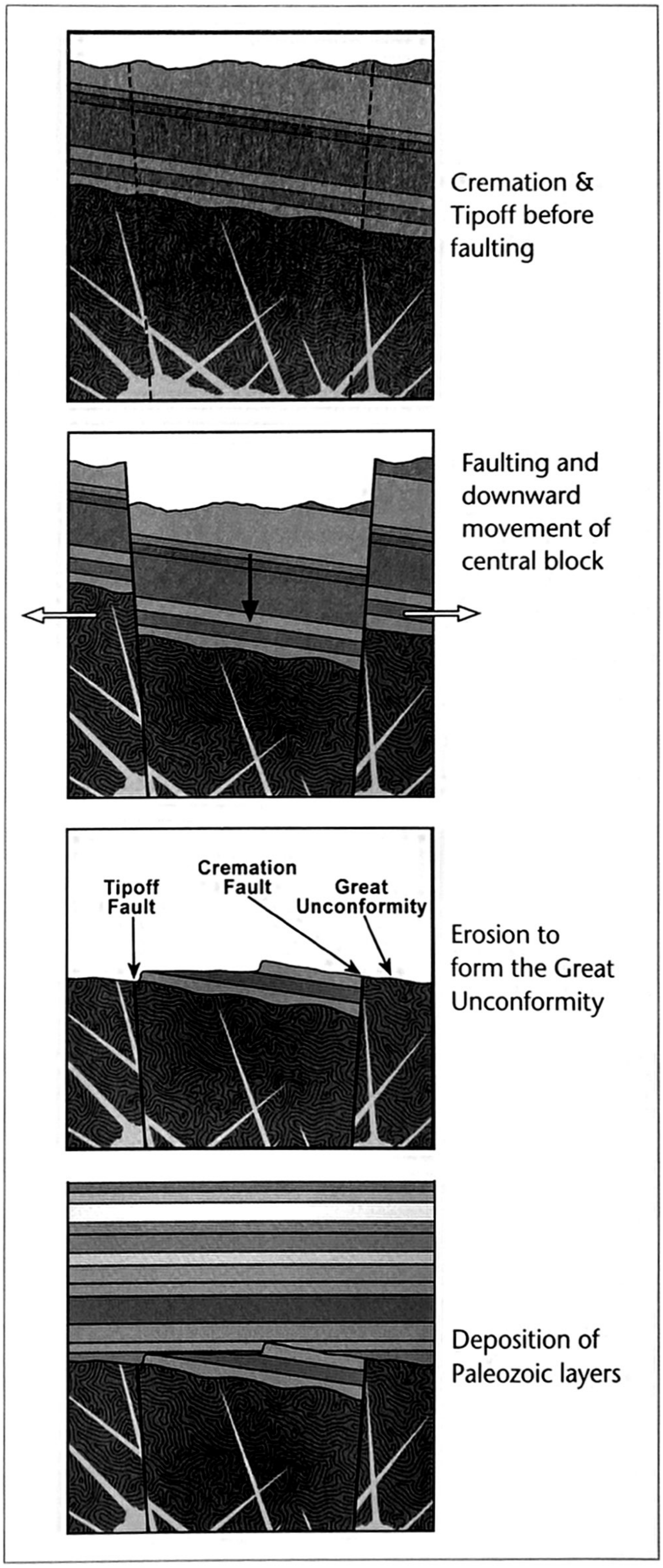


Figure 19-10. Time Sequence of movement on the Cremation and Tipoff Faults, erosion, and deposition.

rocks. These strata have a combined thickness of about 15,000 feet. If it required a cataclysmic flood to deposit 15,000 feet of sediment above the Great Unconformity, how did over 12,000 feet of Supergroup sediments accumulate before the flood? Is a second, earlier catastrophe required? Similarities between the layers above and below the Great Unconformity mean that either two global cataclysms occurred at different times (the first of which is missing from the biblical record), or that layers both above and below formed by normal Earth processes.

Erosion along top and bottom of Supergroup

Flood geologists argue that a violent global flood eroded away rock at the top of the Supergroup to form an unconformity. Yet the erosional surface between the Vishnu Schist and the base of the Supergroup is not fundamentally different from the one at the top of the Supergroup. Why is a global catastrophe needed to explain the unconformity at the top of the Supergroup but not the equally extensive unconformity at its base? Also, how was the schist beneath the Supergroup rocks uplifted and eroded before the flood? Recall that erosion first requires that the rock be lifted up so that it can be worn down. According to flood geologists, plate tectonics began when the fountains of the deep burst open and the Earth's crust was set violently into motion. With no mechanism to uplift the schist, the only option is to stuff it all into Day 3 of the creation week, when land was separated from the waters. Translation: the only plausible explanation is that everything in the schist, plus its uplift and erosion, is of miraculous origin.

Sediment types and structures

The alternating layers of conglomerate, limestone, shale, and sandstone in the Supergroup – including features like ripple marks, mud cracks, and cross bedding – look remarkably similar in nature to the alternating layers of conglomerate, limestone, shale, and sandstone in the overlying Paleozoic layers. The only substantial difference is the type of fossil organisms found. Why would layers deposited by a global flood look so similar to layers deposited by normal processes? Sediments and specific sedimentary features that are said to support a violent flood history for the Paleozoic layers appear convincing only by ignoring the presence of the same types of sediment and features in the Supergroup layers.

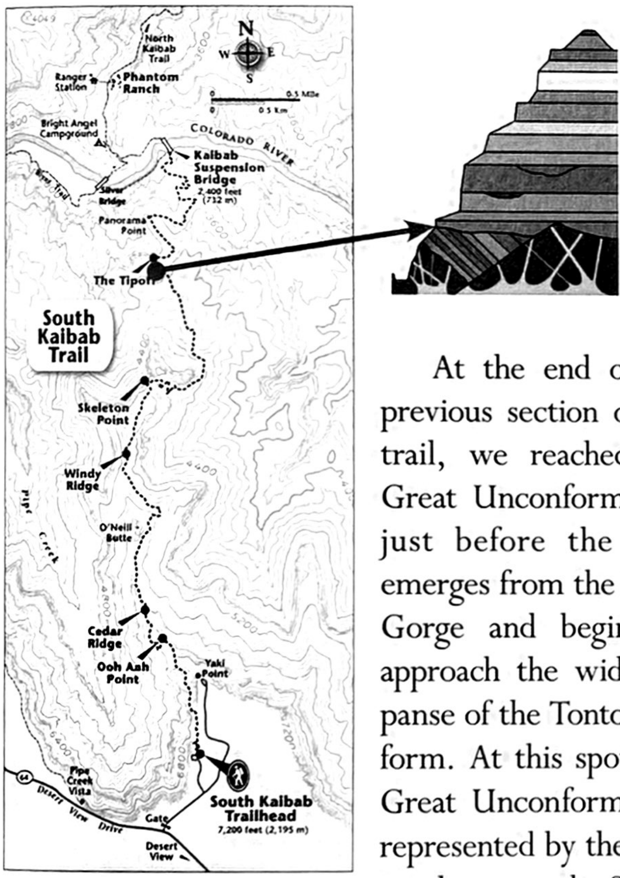
Fossils (or the lack thereof)

According to flood geologists, death began at a specific point in time between the creation week and Noah's flood, only a few thousand years ago. The first layers that contain visible fossils are in the Supergroup Bass Formation (of the Unkar Group), so all layers there and above represent deposition while organisms were dying. According to Genesis, Chapter 1, all the major categories of modern organisms were present prior to the flood, which means layers in and above the Bass Formation should contain a representative sampling of life forms reflective of the modern array

Figure 19-11. Tapeats Sandstone, containing boulders of Shinumo Quartzite. Arrows point to quartzite boulders, roughly 10-12 inches in size. *Photo by Wayne Ranney.*

of organisms. Many of these rock layers appear to have been deposited in marine settings, so at the very least, we should find fossils of shelled organisms, fish, coral, lobsters, and an occasional marine reptile or mammal. But in the entire 12,000 feet of Supergroup rock, there are no complex organisms at all. Not a single fish, clam, snail, coral, tooth, or bone. Fossilization was obviously occurring, so how did all but single-celled varieties escape preservation – over the entire planet?

3. An Eroded Cliff along the Great Unconformity *(mile 1.9 to 2.0)*

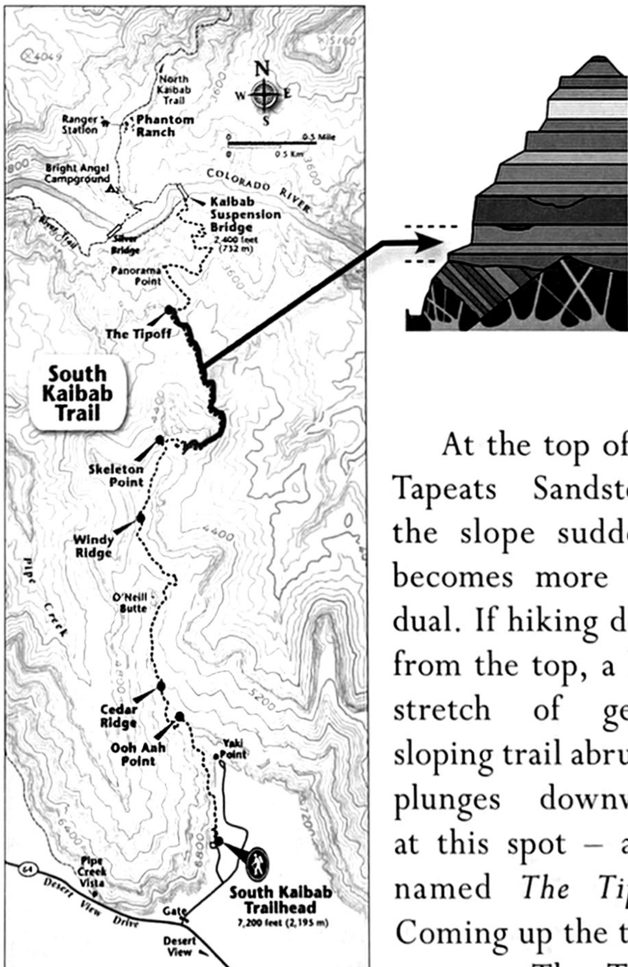


At the end of the previous section of the trail, we reached the Great Unconformity – just before the trail emerges from the Inner Gorge and begins to approach the wide expanse of the Tonto Platform. At this spot, the Great Unconformity is represented by the contact between the Supergroup's Shinumo Quartzite and the overlying Tapeats Sandstone. But the contact here is not horizontal. In fact, the Great Unconformity at this point becomes nearly vertical, with Shinumo Quartzite on one side and the Tapeats Sandstone on the other. Upon closer examination, we find that large angular blocks of the quartzite are encased within the sandstone, forming a conglomerate at the base of the Tapeats (Fig 19-11).

These observations testify to a time when the Tapeats Sea was encroaching on land and eroding into a cliff face of Shinumo Quartzite. Blocks of quartzite periodically fell into the water and lodged in soft layers of sand, accumulating at the base and eventually being covered by new deposits of Tapeats sand. The angular shape of the quartzite blocks means the quartzite was hard at the time of erosion of the cliff face, and we can see evidence of disrupted sand directly beneath some of the fallen blocks. Eventually, sea level rose high enough to deposit sand over the entire cliff and accumulate rubble of Shinumo Quartzite boulders.

At first pass, this history of crashing waves and rapidly buried chunks of broken rock could be argued to fit within the flood model, but only if viewed in isolation from all the underlying and overlying layers that have their own histories – histories that do not fit well with a single catastrophic event.

4. Tonto Group: Tapeats Sandstone, Bright Angel Shale, Muav Limestone *(mile 2.0 to 3.0)*



At the top of the Tapeats Sandstone, the slope suddenly becomes more gradual. If hiking down from the top, a long stretch of gently sloping trail abruptly plunges downward at this spot – aptly named *The Tipoff.* Coming up the trail, we pass The Tipoff and step onto the Tonto Platform – a broad ledge hosting panoramic views of the canyon (Fig 19-12).

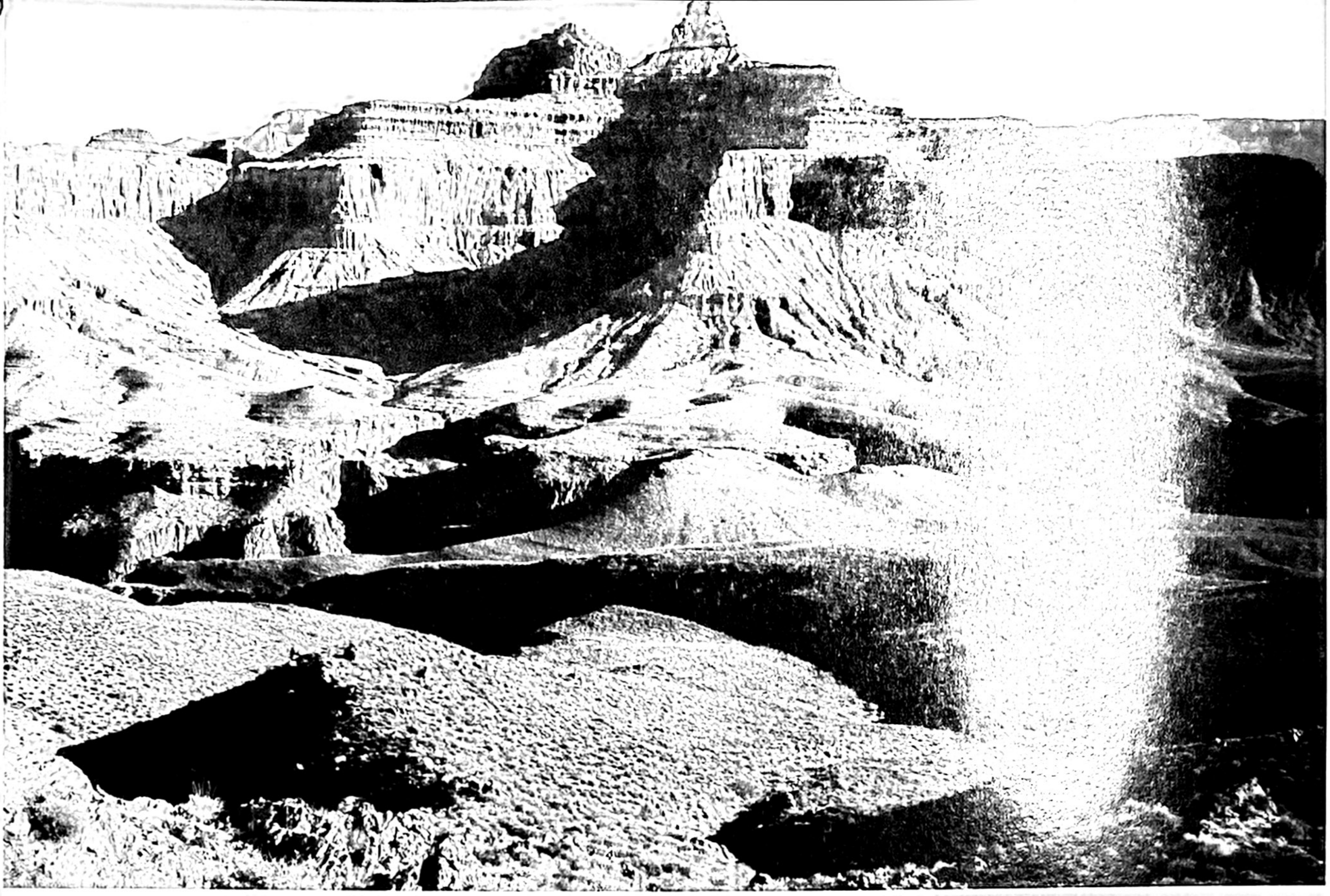


Figure 19-13. Alternating layers of the Muav Limestone (seen from the Tanner Trail). *Photo by Gregg Davidson.*

Figure 19-12. Tonto Platform, viewed from the South Kaibab Trail. *Photo by Wayne Ranney.*

The platform owes its existence to the exposure of the easily eroded Bright Angel Shale. The shale's relatively fast rate of erosion has undercut the harder layers of Muav Limestone above it, causing collapse. It is these alternating layers of hard and soft rock that give the Grand Canyon its classic alternating cliff-and-bench profile (see Fig 16-4, page 166 for a reminder of how this process works).

Farther up, the South Kaibab Trail again inclines steeply through the debris-covered slopes of the remaining Bright Angel Shale and the cliff-forming Muav Limestone. The Tapeats Sandstone, Bright Angel Shale, and Muav Limestone, all of Cambrian age, together comprise the Tonto Group. These layers share a natural association, because the transition from sand to silt and clay and then to limestone fits well with what we would expect from a gradually subsiding coastline or rising sea (see Fig 5-13, page 62).

Looking a bit closer, we see that the transition from shallow to deep water was not uniform. Though the overall change from sandstone to shale to limestone is obvious, there are numerous alternating layers that identify multiple episodes of small-scale increases and decreases in relative water depth (Fig 19-13). If we were to venture off the trail and follow the layers westward, we would find grain sizes becoming finer, consistent

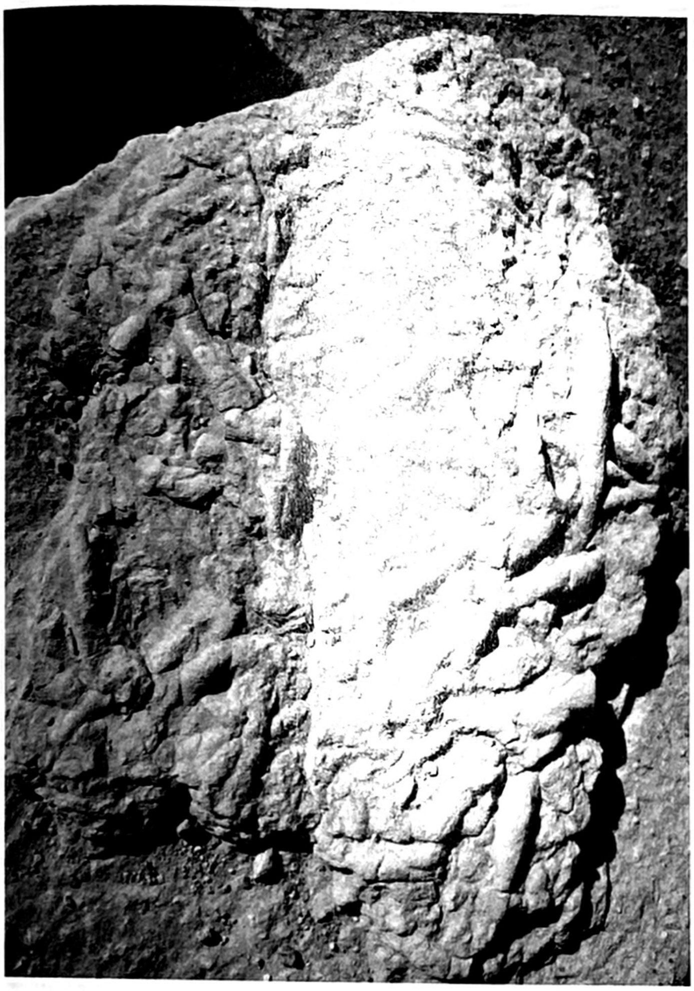


Figure 19-14. Fossil worm trails in Bright Angel Shale. *Photo by Gregg Davidson.*

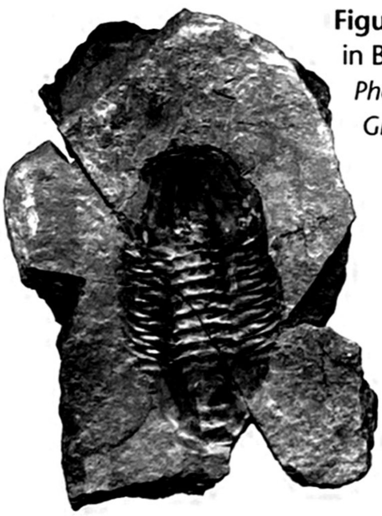


Figure 19-15. Trilobite in Bright Angel Shale. *Photo by Mike Quinn, Grand Canyon National Park.*

with deepening water in that direction. From this information, we can tell that the shoreline was advancing toward the east as sea level rose, with many back-and-forth fluctuations over shorter periods of time.

Fossils found in these layers are typical of those of the Cambrian Period in many other parts of the world. Forty-seven different species of trilobites have been identified in the Tonto Group alone, but none of these species are found in any layer above or below the Tonto Group (Figs 19-14, 19-15). Multiple layers of tracks and burrows provide evidence of a long succession of established ecosystems, one on top of the other. The fact that organisms such as trilobites appear and disappear from the Grand Canyon fossil record in the same order as they do in strata around the rest of the world tells us that each layer of the Grand Canyon represents a distinct time period in Earth history.

As with the flood geologists' explanations for the Supergroup, there are many problems and inconsistencies with their explanations for the Tonto Group. We'll once again consider just a few examples.

Sorting

Particles can become arranged by size (sorted) when flowing water gradually slows down; larger particles begin settling out first and smaller ones later. Flood geologists see the general sorting of particles to form sandstone, shale, and limestone as evidence of the floodwaters deepening and slowing. Their argument assumes that the limestone at the top of the Tonto Group did not originate from the shells of organisms (as with most limestone formation), but was washed in as lime sediment from some distant source. Even if we ignore the improbability of lime particles surviving transport without dissolving (see Chapter 5), there is still a serious problem. The flood model also assumes that the lime particles must have been exclusively smaller (or less dense) than the clay particles for them to settle out into separate, relatively unmixed layers as the water slowed. But, in actuality, the size and density of lime and clay particles overlaps substantially, meaning that the flood model should expect these layers to be *highly* mixed. When we look within the layers of shale and limestone of the Tonto Group, the degree of mixing is very small, contrary to expectations from deposition by a great flood.

In other words, none of the flood-geology arguments for layering are supported by the actual evidence found in the Grand Canyon.

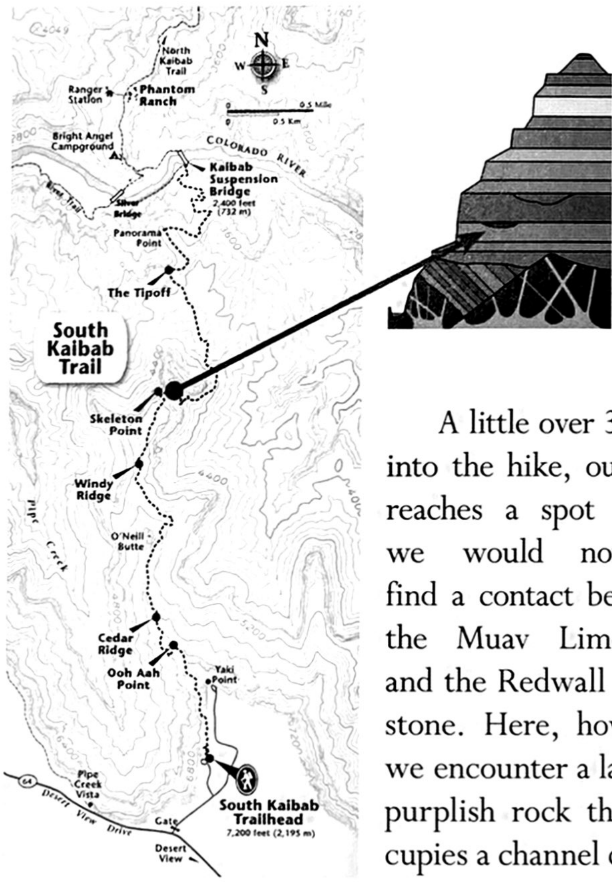
Limestone

No flood of any size, including the colossal floods of the Channeled Scablands, has ever been found to leave behind limestone or salt deposits around the world. The explanation that these deposits arose from the release of hot, mineral-rich fluids from the floodgates of the deep requires that separate pockets of calcite-rich and salt-rich subterranean waters were created during Day 3 of the creation week (when the land was separated from the waters) and were set in reserve for the coming flood. Upon release, separate calcite-rich and salt-rich fluids had to somehow avoid mixing with each other, avoid dilution by mixing with seawater, and form mineral precipitates without mixing with sediment stirred up by the churning flood waters – each step requiring a separate miracle. Limestone precipitation likewise would have required a miracle, for any hot, mineral-rich water released into the ocean would have *dissolved* calcite as it cooled – limestone could not have precipitated out of the water without violating basic laws of chemical thermodynamics.

Fossils

The ordering of fossils could be discussed with any number of fossil types, but here we'll limit the conversation to trilobites. The 47 species of trilobites known from the Tonto Group come in a variety of sizes and shapes. As ocean-dwelling creatures, trilobites should have had widespread distribution and are, in fact, found in Cambrian layers all over the world. How did every variety, large and small, stubby and elongated, get sorted into the same group of layers in the same sequence around the world, without a single case of mixing with a jawed fish? And why don't at least a few of these 47 species occur in layers between the Cambrian and the canyon rim, if all of these layers were deposited in the short duration of 150 days?

5. Temple Butte Formation *(mile 3.0)*



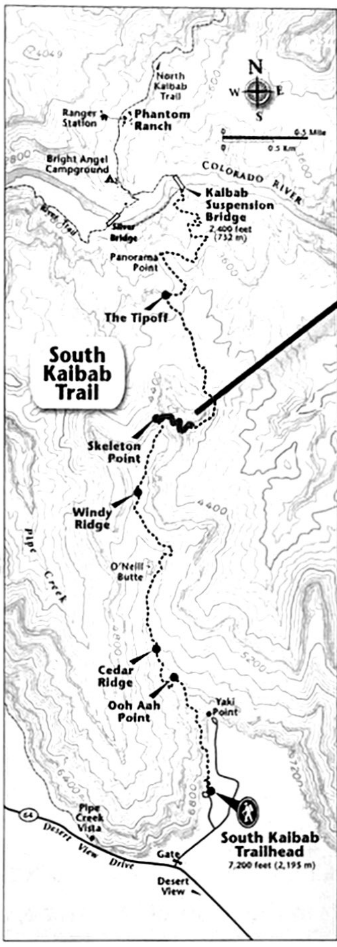
A little over 3 miles into the hike, our trail reaches a spot where we would normally find a contact between the Muav Limestone and the Redwall Limestone. Here, however, we encounter a layer of purplish rock that occupies a channel carved

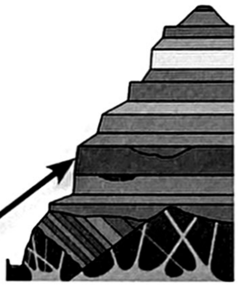
Figure 19-16. A pocket of Temple Butte rock along the South Kaibab Trail. *Photo by Wayne Ranney.*

out of the top of the Muav (Fig 19-16). This is an outcrop of the Temple Butte Formation. This formation is not found everywhere in the canyon, and it varies considerably in thickness. It gets its own name because it contains a unique assemblage of fossils compared with those of the Muav or Redwall, and it sits in low spots (channels) carved into the top surface of the Muav. Recall that Muav fossils are typical for the Cambrian Period. If channels were carved out soon after deposition and then quickly refilled, we should expect more Cambrian fossils, or at least fossils from the following Ordovician period. The fossils actually found, however, such as placoderm fish and various corals, come from the much later Devonian Period. This tells us that some time after the Muav Limestone formed, erosion removed whatever layers might have been deposited above, eventually scouring channels down into the Muav surface. Still later, new deposits filled in the channels. The total gap between deposition of the Muav and deposition of the Temple Butte represents about 135 million years.

Flood geologists call upon submarine currents during the flood carving channels into soft Muav lime, which subsequently refilled with fresh lime sediment, all within a few days. Under such a scenario, why would a unique set of organisms (all Devonian), including both bottom-dwelling corals and free-swimming placoderm fish, settle out exclusively into these channels and nowhere else?

6. Redwall Limestone *(mile 3.0 to 4.0)*





The trail gets quite steep as we ascend the famous "Red and White" switchbacks through the Redwall Limestone (Fig 19-17). The Redwall is 98% pure calcite, with sheer cliffs reaching 500 feet in thickness. Together with the Muav and Temple Butte Limestones, these layers form massive cliffs that can rise more than 1,500 feet. Although the Muav, Temple Butte, and Redwall are all limestones, the contacts between them are striking because of the dramatic changes in fossil organisms. In the Redwall we find fossils of bony fish, shark teeth, and other organisms typical of the Mississippian Period. A closer look at the Redwall reveals that much of it is composed of crinoids – marine animals that resemble flowers with tentacles – that are attached to the ocean floor by long segmented stalks or stems. Because some crinoid species still exist, we know that when they die, the segmented stems easily come apart and litter the ocean floor with their remains (Fig 19-18).

The Redwall Limestone extends laterally into several states beyond Arizona (given different formation names

Figure 19-17. Switchbacks through the Redwall Limestone. *Photo by Wayne Ranney.*

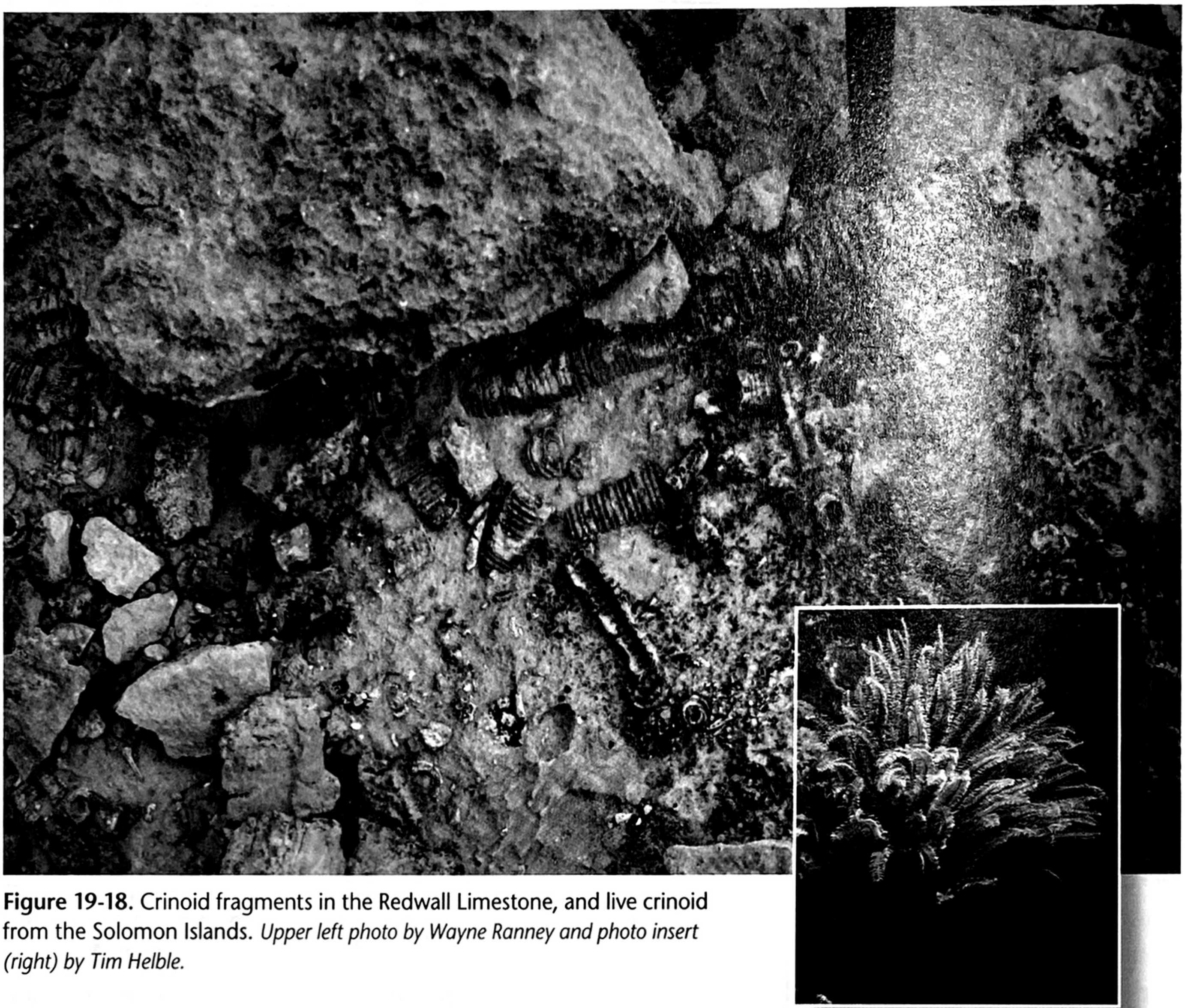


Figure 19-18. Crinoid fragments in the Redwall Limestone, and live crinoid from the Solomon Islands. *Upper left photo by Wayne Ranney and photo insert (right) by Tim Helble.*

in other places). Such an expansive layer of crinoid remains, with virtually no intermixed sand or clay, indicates a vast, shallow, warm sea with submarine colonies of crinoids blanketing the seafloor. The absence of any significant clay or silt means that the crinoids must have lived far from where sediment-laden streams discharged to the ocean. This thickness of fossil remains is easily accounted for by a succession of generations of crinoids, each growing on top of the remains of older ones. Similar processes are at work today where modern reef systems grow on top of the remains of their ancestors and produce limestone hundreds of feet in thickness.

Flood geologists argue that the crinoid stems in nearly pure calcite formed as the result of hot, calcite-rich fluids being released from the fountains of the deep and arriving at the same time that the crinoids were stripped from a distant ocean floor and dashed into pieces, ultimately to be mixed with the precipitating calcite.

Imagine what is required by this explanation. At this stage in Noah's flood, mega-tsunamis have been ravaging the planet, scouring sediment and transporting it vast distances to accumulate in beds hundreds of feet thick across what is now the American West. Mineral-rich water, released when the tectonic plates broke apart (the "floodgates of the deep"), had to travel across the continent to this location without mixing with seawater (cooling and mixing would work against precipitation) and without mixing with any churned-up sediment. Meanwhile, gargantuan submarine communities of fragile crinoids, covering thousands of square miles, had to survive the early weeks (or even months) of violence without being ripped up or buried, only to be abruptly torn from the seafloor and transported hundreds of miles – also without mixing with any churned-up clay or sand. Finally, the undiluted mineral-rich water had to meet the flow of crinoid stems (free of mixed silt or clay) and precipitate around the crinoids as virtually pure calcite.

As unbelievable as this scenario is, there is more. If a single generation of crinoids living at the time had been buried in place, the disseminated parts would have coated the ocean floor with a few inches of crinoid remains. To get deposits 500 feet thick over multiple western states, the crinoid communities would have had to initially cover a vastly larger area – tens of thousands of square miles in size – that were ripped up and stacked within a smaller area – all in clear, un-muddied water.

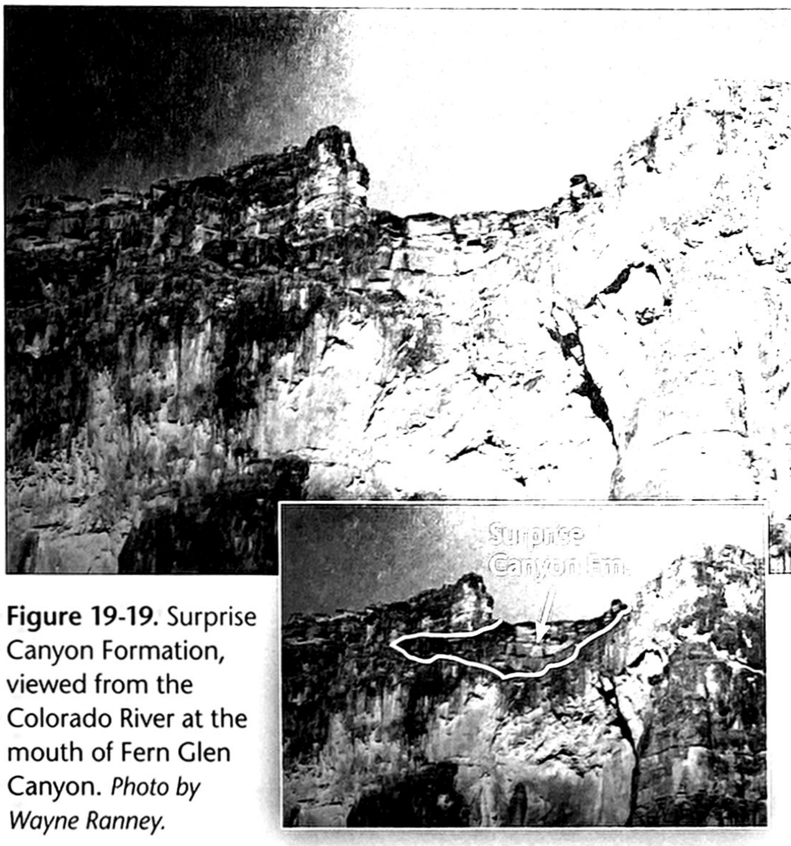
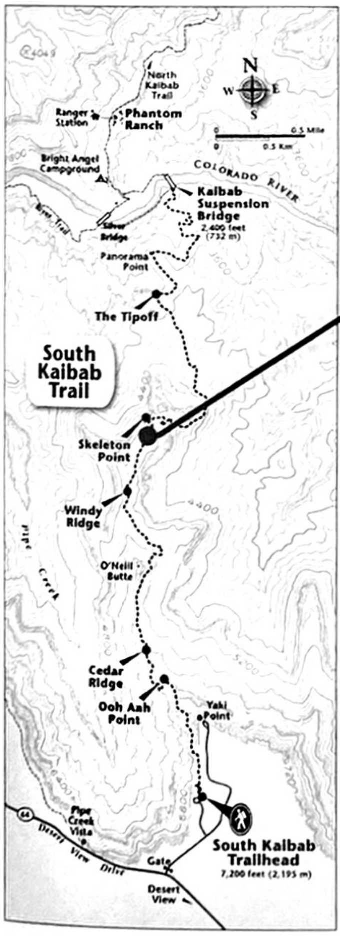


Figure 19-19. Surprise Canyon Formation, viewed from the Colorado River at the mouth of Fern Glen Canyon. *Photo by Wayne Ranney.*

7. Surprise Canyon Formation *(mile 4.0; not exposed on the South Kaibab Trail)*



At the top of the arduous ascent up the trail in the Redwall Limestone, four miles from the river, we come to the contact with the Supai Group. In other parts of the canyon, however, another formation is nestled in low spots on top of the Redwall – the Surprise Canyon Formation (Figs 19-19, 19-20). When the low spots are mapped, they form connecting conduits that look like a stream network, with channels that become wider and deeper in a westerly direction. The largest reaches a depth of 400 feet.

The bottom layers of the Surprise Canyon Formation contain fragments of the underlying Redwall Formation, complete with fossils from the Redwall – a clear sign of exposure and erosion of the Redwall surface following retreat of the ocean. Sediments filling these channels contain a rich assortment of fossils. In the lower sediments, the fossils are of land-dwelling organisms, including trees. Such information speaks of uplift, or of falling sea level, that left the area above

Figure 19-20. Fragments of the Redwall Limestone in a conglomerate boulder from the Surprise Canyon Formation. The boulder is about 1.5 feet wide. *Photo by Erin Whitakker, National Park Service.*

water long enough for stream systems and terrestrial ecosystems to develop before the region was again submerged. The fossils here are distinct from what is found in the underlying Redwall and are typical of organisms from the Late Mississippian Period.

Many Young Earth authors and speakers simply overlook the Surprise Canyon Formation. Others acknowledge its presence, but fail to mention its abundant terrestrial fossils. One might possibly imagine some land organisms being swept into the ocean and settling in a low spot or two, but the prevalence of these fossils in the bottom deposits of the Surprise Canyon layers – without marine fossils mixed in – speaks loudly of a prolonged period during which rivers coursed through these channels and land ecosystems thrived.

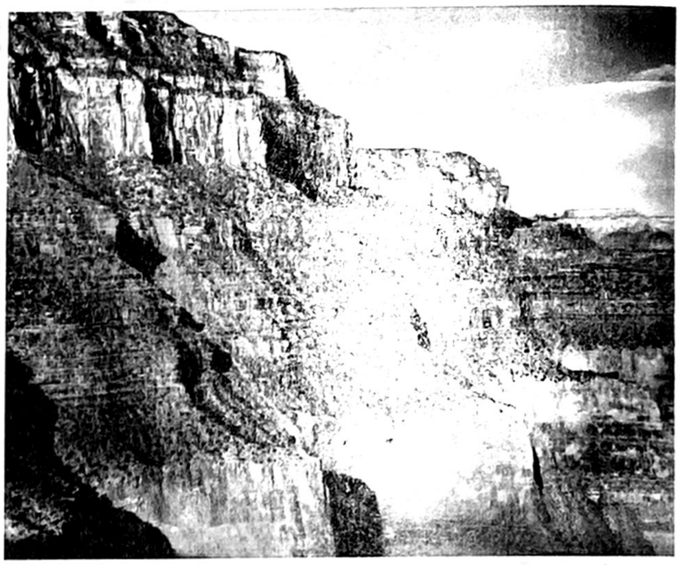
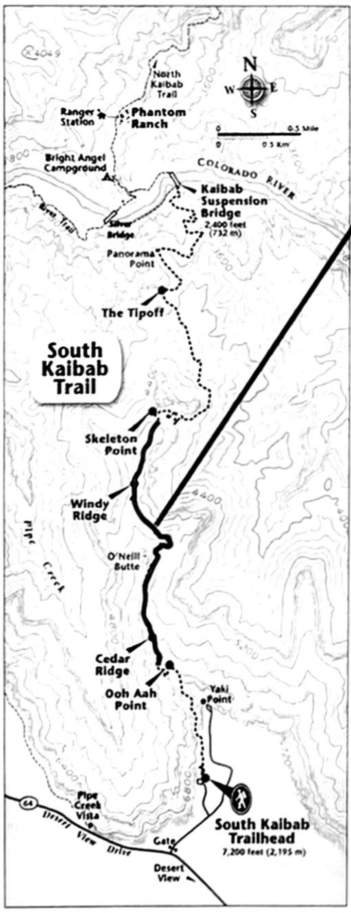
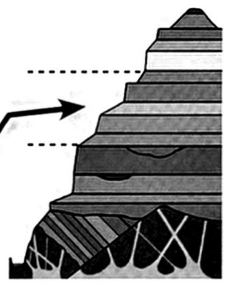


Figure 19-21. Alternating layers of the Supai Group and the Hermit Formation, above the vertical Redwall Limestone and beneath the vertical, lighter-colored Coconino Sandstone. *Photo by Wayne Ranney.*

8. Supai Group and Hermit Formation *(mile 4.0 to 5.8)*





There is a brief respite from steep hiking past Skeleton Point, but soon the trail climbs rapidly again through the Supai Group and the Hermit Formation. Along the way we find alternating layers of sandstone, shale, limestone, and conglomerate (Fig 19-21). Myriad alternating layers are again consistent with many cycles of rising and falling sea levels, interspersed with periods of deposition and erosion. Filled-in low spots, like

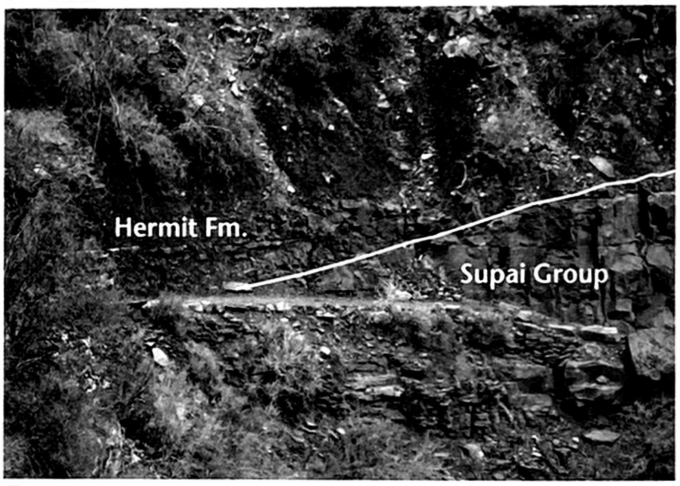


Figure 19-22. Edge of channel in the top of the Supai Group, filled in with Hermit Formation sediments (at the 1.5 mile Rest House, Bright Angel Trail). *Photo by Wayne Ranney.*

Figure 19-23. Channel within the Supai Group (in the Wescogame Formation) near 27 Mile Rapid in Marble Canyon. *U.S. Geological Survey photo by E.D. McKee.*

Figure 19-24. Reptile trackway in the Supai Group. *Photo by Wayne Ranney.*

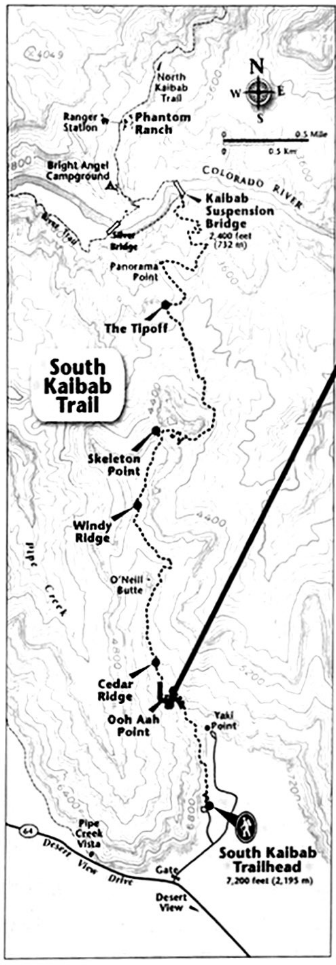
Figure 19-25. Fern fossils in the Hermit Formation. *Photo by Michael Quinn, National Park Service.*

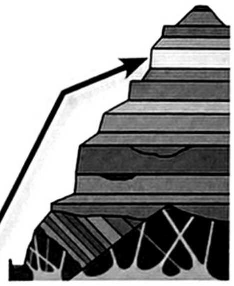
those described for the Temple Butte and Surprise Canyon Formations, also appear where Hermit Formation sediments fill in ancient channels in the upper sandstones of the Supai Group (Fig 19-22). Additional channels are found within formations in the Supai Group (Fig 19-23). Some of the sandstone layers of the Supai also show cross bedding that is characteristic of wind deposition.

The first occurrences of tracks from vertebrate animals (those with backbones) are found in the Supai Group (Fig 19-24). Some rock horizons in the Hermit Formation contain terrestrial fossils, such as dragonfly wings (Fig 13-12, page 139) and fern plants (Fig 19-25). The fact that terrestrial and marine fossils are not found intermingled within the same layers is clear evidence of distinct intervals of time when the region was sometimes above sea level and other times below it.

Flood geologists insist that all these layers are marine in origin – not because all the layers actually contain evidence of deposition in a sea, but because their model requires it.

9. Coconino Sandstone *(mile 5.8 to 6.5)*





After the trail climbs through the red mudstone of the Hermit Formation and passes through the picturesque scrub trees along Cedar Ridge, it crosses into the Coconino Sandstone. A sharp unconformity is easily seen here, where the red beds below give way to the white Coconino above (Fig 19-26).

Figure 19-26. *right:* Coconino Sandstone-Hermit Formation contact (Bright Angel Trail). The Coconino is the lighter rock above the reddish Hermit rock. *Photo by Gregg Davidson.*

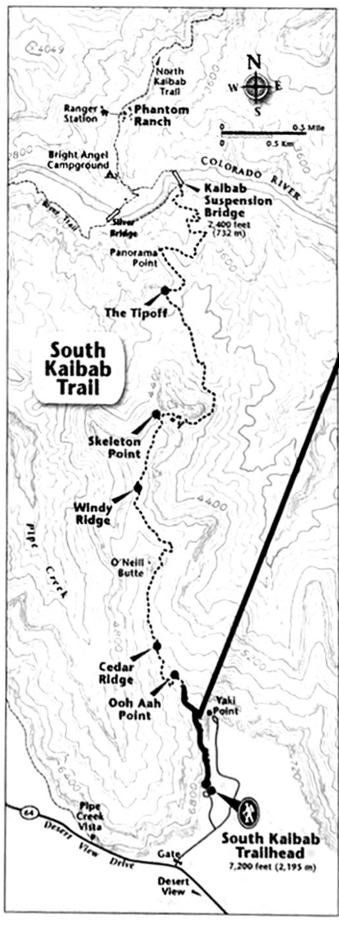
Figure 19-27. Reptile tracks in the Coconino Sandstone. *Photo by Wayne Ranney.*

Not far above that contact is a boulder that contains the trackway of a small reptile (Fig 19-27). Here we can see the detailed preservation of each footprint – pad and claw marks – as well as avalanche impressions imparted as the animal's weight pushed on the loose sand. Trackways are much more important than single footprints, for they give information about the stride, weight, size, and gait of the animal. To the west, along the Hermit Trail, tracks are found that were left by scorpions and spider-like creatures. These tracks, coupled with the absence of any fossils of bone, speak of a time when desert sands covered the local landscape. Few organisms would have been present in such an environment, and conditions would have been unfavorable to the preservation of skeletons.

On ahead, the trail winds steeply up Windy Ridge – a spectacular section of trail that falls away on both sides. From here, we have a sense that we are nearing the top, though it will take a good measure of sweat to finish the trip. Cross bedding is abundant in the mostly quartz-sand layers. The etched grains and the cross-bed angles up to 30° are typical for a desert, sand-dune environment. The abrupt transition in color and composition between the Coconino Sandstone and the underlying Hermit Formation, together with fissures within the Hermit that are filled with sand, suggest a period of erosion down into the Hermit, with weathered cracks later filling in with sand from advancing dunes (more easily seen along the Bright Angel Trail; Fig 19-26).

For flood geologists, the flood was still raging at this time, so to them the Coconino *must* be a marine deposit. The tracks are said to have formed underwater, and tank studies with living amphibians are cited as evidence that tracks can be formed this way. The flood geologists fail to mention, however, that these studies were done in water with a weak current, yet a violent flow would be needed to transport the massive layers of sand that their model requires. Even modest flow velocities would quickly erase underwater tracks, such as the reptile and arthropod varieties found in the Coconino.

10. Toroweap and Kaibab Formations *(mile 6.5 to 7.0)*



Near the top of the Coconino Sandstone, a spectacular view awaits us at Ooh-Aah Point – a worthwhile rest and admiration stop (Fig 19-28). Once we resume our hike, we climb through alternating limestone, shale, sandstone, and evaporites of the Toroweap and Kaibab Formations.

Figure 19-28. View from Ooh-Aah Point. *Photo by Wayne Ranney.*

DOES A DASH OF MARINE SEDIMENT MAKE THE WHOLE DEPOSIT MARINE?

Some isolated zones of *dolomite* (limestone with lots of magnesium – typically a marine deposit), have been found in the Coconino Sandstone. Flood geologists insist that the presence of dolomite means the *whole* system is marine. Given the proximity of the Coconino dunes to an ancient sea, it would not be surprising for some of the dune sands near the coastline to become cemented with dolomite. However, to say the entire Coconino is marine because of a pocket of dolomite is like finding a Swede living in Tokyo and declaring that all Japanese must be of Nordic stock!

The variable durability of the different layers produces a mixed terrain of steep and gradual slopes. The alternating layers reflect the return of cyclic sea level advance and retreat. With roughly half a mile to go, we encounter layers of rock that have tepee shapes, most likely created by the evaporites underneath buckling the rock upward (Fig 19-29). Such behavior is common when the weight of overlying rocks squeezes pliable underlying evaporites, like salt or gypsum, up through weak spots in the overlying strata. Evaporites provide strong testimony to periods of exposure during which intensive evaporation and drying occurred – no other mechanism is known to produce evaporite deposits. Fossil types change considerably as we move up from one set of layers to the next, which tells us that significant time must have passed while these layers formed – enough time to allow new ecosystems to replace older ones.

For flood geologists, the uppermost layers of the canyon bring us through only the first half of the flood (150 days, see Fig 3-2, pages 32-33). Though the flood is said to have been extraordinarily violent, sediment layers repeatedly formed with little mixing of different types or sizes of particles. Evaporites mysteriously formed underwater, and entire classes and orders of organisms waited until the second half of the flood to all be buried together.

Figure 19-29. Tepee structures in the Toroweap Formation. *Photo by Wayne Ranney.*

11. The Rim *(mile 7)*

Arriving at the rim, typically with aching legs and a great feeling of accomplishment, we have a fresh appreciation for the great depth of this canyon (Fig 19-30). As we catch our breath, we'll relate some final thoughts on what we have seen. The canyon's many layers, structures, and faults certainly represent powerful forces at work, but each is easily accounted for by normal Earth processes – some slow and some fast – but all normal. More importantly, the explanations for each individual layer or feature fit together into a larger story of rising and falling sea levels, and of slowly shifting tectonic plates lifting and lowering the crust. Fossils encountered along the trail in the canyon, and found around the world, communicate a consistent story as well – a story that makes sense only if the types of organisms present varied considerably at different times in the Earth's history. The fact that not a single fossil bird, dinosaur, mammal, or flowering plant can be found anywhere along this 7-mile hike is of great significance.

Flood geology arguments often have a ring of plausibility to them when they are applied to one layer or one feature in isolation, but there is no way to piece together all the individual explanations into a coherent whole. Flood geologists insist that God employed natural processes, open to scientific investigation, to lay down the Earth's myriad layers, but their explanations repeatedly require reliance on never-before-seen and mutually exclusive mechanisms. Radioactive decay had to be faster in the past, which would have required miraculous removal of heat to avoid melting the crust. Rapid plate tectonics likewise would have needed a miraculous

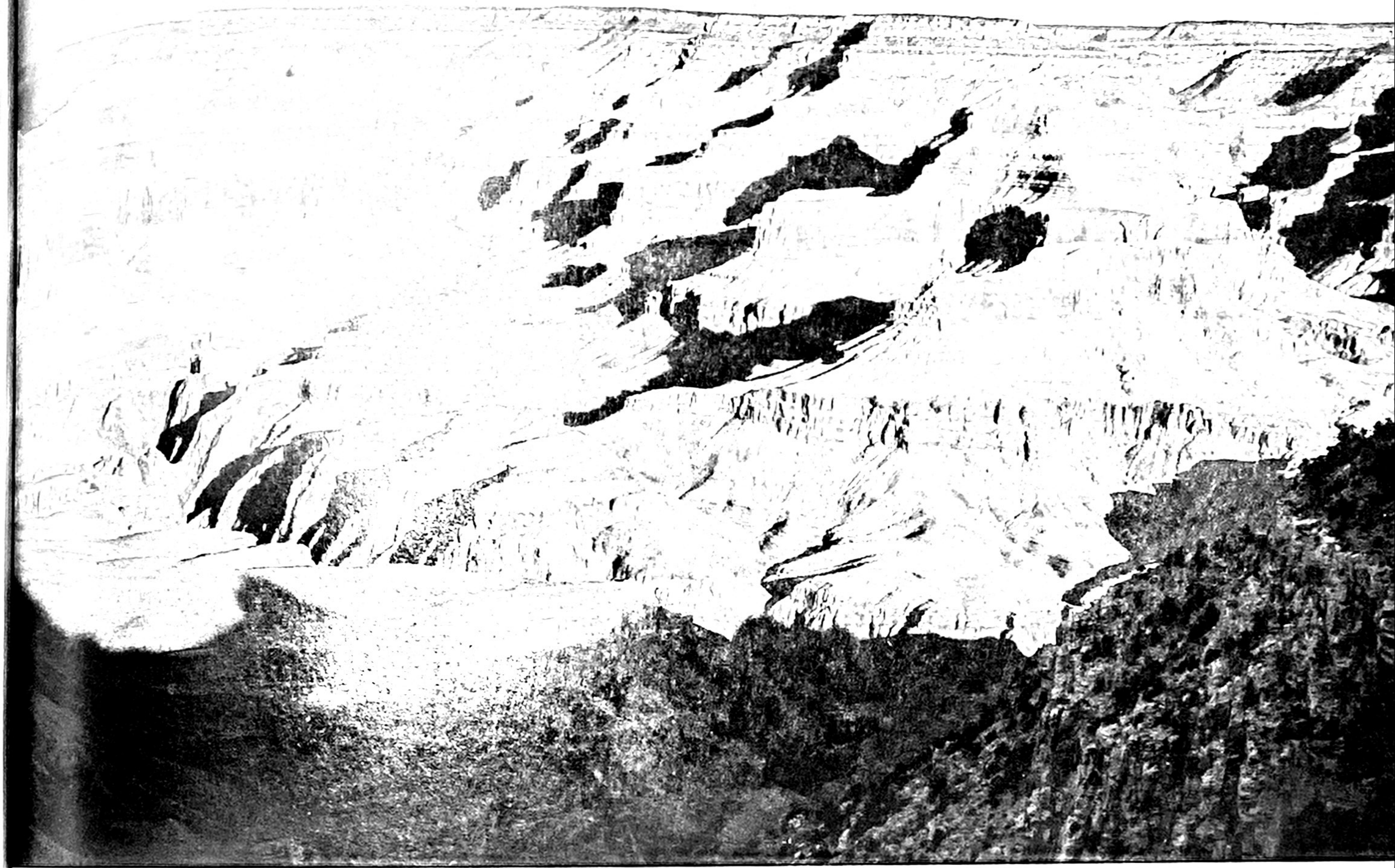


Figure 19-30. View from the South Rim at the South Kaibab Trailhead. *Photo by Wayne Ranney.*

dissipation of frictional heat. Mineral-rich fluids bursting through fissures at the start of the flood had to remain unmixed with seawater or mud or sand, and then violate basic laws of chemistry to precipitate limestone from a cooling fluid. Oriented fossils like nautiloids in one location are said to testify to deposition by a global flood, but nonoriented fossils everywhere else (which is the norm) are somehow not considered to be evidence of deposition in calm waters.

Earthquakes are called upon by some to explain separation of flood sediments into thin layers of differing particle sizes, while somehow allowing conglomerates to stay totally unsorted and fine features in delicate animal tracks to be unscathed. The immense record of fossil life is said to be evidence of a global flood that swept across entire continents, yet that flood somehow failed to capture a single mouse, seagull, whale, frog, tulip, or lobster in the entire Grand Canyon sequence.

The conventional geologic understanding of the Grand Canyon is not just better than the flood geology view. The conventional model works; the flood model does not.

WHERE DID ALL THIS COME FROM?

All explanations by flood geologists are said to be based on the Bible. So where in Scripture do we find references to Noah's flood linked with earthquakes, shifting continents, rising mountains, tsunamis, and mineral-rich ocean vents? The number of verses is much like the number of bird or dinosaur fossils found in the canyon. The answer is zero. Exactly how, then, is flood geology a biblical model?