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Groundwater Sapping Does Not Support Millions of Years

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Abstract

Groundwater sapping, or simply *sapping*, is a slow process of erosion by which some canyons form. It is thought to take tens of thousands to millions of years; however, several classic examples of sapping are found to have been eroded by overland water transport. Examples of these include Box Canyon and Malad Gorge in south central Idaho, basalt canyons in Hawaii, canyons in the Atacama Desert and parts of the Colorado Plateau, including the Grand Canyon area. Overland flow can erode canyons rapidly, in harmony with the biblical timescale.

Introduction

Uniformitarian scientists have made a cottage industry over the past two centuries of finding geological processes that they claim require more time than the 6,000-year biblical timescale. Old-age processes include the formation of coal, oil, and natural gas and uniformitarianism became an established doctrine of earth science, even though the purported evidence was not compelling. Since that time, nearly all geological research follows that paradigm (Rudwick, 2005). Along with uniformitarianism came deep time, and the need for ever-increasing ages for the universe and Earth and its rock record. Geologists interpreted the rocks as products of long ages for that reason.

Creation scientists have demonstrated that most of these challenges have credible alternatives from a Flood perspective (Oard and Reed, 2009). For example, the Ice Age—once considered a challenge to creation science—is better explained as a natural consequence of the Flood (Oard, 2004a, 2013). Similar challenges remain, typically because we lack data or because creation scientists have not yet addressed them. Other problems are difficult to explain for both creationists and secular scientists. Secular research often highlights problems in older ideas. One example is the origin of canyons. For many years, vertically walled, amphitheater-headed canyons or box canyons have been attributed to slow groundwater sapping. New research suggests other origins, less dependent on long ages.

Sapping and the Origin of Large Canyons

Uniformitarian scientists believe that many vertically walled canyons formed by sapping, not by flowing water. Sapping (Figure 1) is a form of erosion and is defined as:

> The natural process of erosion along the base of a cliff by the wearing-away of softer layers, often involving weakening by groundwater conducted along the contact between rock strata, and thus removing the support for the upper mass which breaks off into large blocks falling from the cliff face. (Neuendorf et al., 2005, p. 574)

This process is too slow to create large canyons within the biblical timespan (Baker et al., 1990; Dunne, 1975). It relies on the rate of groundwater flow and physical weathering and erosion at seepage points. When this discharge of groundwater occurs at or near the base of a slope, it weakens the "foundation" of the wall. It is similar to water moving

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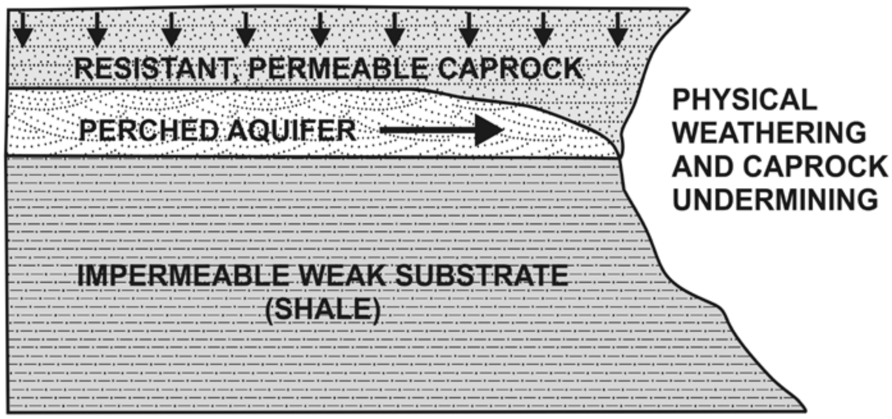

Figure 1. Diagram showing groundwater sapping. Groundwater flows above an impermeable layer and seeps out along a cliff face. As water seeps out, it erodes the sediment or sedimentary rock, weakening the caprock, which falls as blocks down the cliff.

Figure 2. Sapping features in wet sediment along the Colorado River in Grand Canyon (Courtesy of Tom Vail).

below the surface of sand at the beach (Figure 2). Sapping is very effective in soft, unconsolidated sediment (Lamb et al., 2006); however, it has yet to be shown that sapping is significant in hard rock.

> For example, groundwater sapping is a key process in forming amphitheater-headed canyons in *unconsolidated sand* … but its importance is controversial in rock. (Lamb et al., 2014, p. 57, emphasis mine)

Therefore, sapping as the primary canyon-forming process in hard rock areas should be questioned. Other mechanisms may better explain their origin, especially in a short time frame. For example, many large canyons have been formed by overland flow during large floods, like those of the Channeled Scablands. Sapping may contribute to further erosion, but canyons once considered classic examples of sapping may have been formed entirely by overland flow or other processes.

Many geologists, however, still believe that many canyons were formed by sapping, including many on the Colorado Plateau (Howard et al., 1988; Laity and Malin, 1985), deep canyons carved in basalt in Hawaii (Kochel and Piper, 1986), and even some of the canyons on Mars (Malin and Carr, 1999). Ongoing, slow sapping today is taken as evidence that it was the primary cause of canyon formation.

Some small canyons, such as the one shown in Figure 3, likely were enlarged by sapping (Froede and Williams, 2004; Williams, 1995). But the major canyon-forming process was probably another process, such as overland flow. Lamb et al. (2006, p. 3, emphasis mine) state: "It is difficult to observe seepage erosion in bedrock because, *if it occurs*, it requires long timescales."

Box Canyon, Idaho, Not Formed by Sapping

Box Canyon is a tributary canyon to the Snake River, carved into the hard, impermeable Snake River basalt flows in south central Idaho (Lamb et al., 2008; Oard, 2010). Box Canyon has vertical walls 35 m high, a width of 120 m, and is 2.68 km in length (Figure 4). Today, a

Figure 3. A small canyon in northeast Arizona probably enlarged by sapping.

Figure 4. A view of Box Canyon, just off the Snake River in Idaho, which may have formed by a Flood according to Michael P. Lamb. (Google Earth image).

Figure 5. Malad Gorge (Google Earth image).

stream flows through the canyon with a discharge of 10 m^3/second. Box Canyon is thought to be a classic example of long, slow erosion by sapping; however, this interpretation has many problems.

First, talus, expected where groundwater undercut cliffs, is scarce at the head of the canyon. Second, the canyon also has waterfall plunge pools and waterfall spill points on the headwall rim, showing that overland flow has occurred in the past. Third, the upper kilometer of the canyon is scoured, not undercut and collapsed. Finally, the present-day large spring that feeds the stream is not causing visible erosion. Therefore, a better interpretation of Box Canyon is that it formed rapidly during a megaflood of either the Little River or Big Wood River to the north, or on the Big Lost River (Cerling et al., 1994). Such a flood could have been caused by catastrophic Ice Age melting or the upstream breaching of an ice dam.

Malad Gorge, Idaho, Not Formed by Sapping

Malad Gorge is also a tributary of the Snake River, carved into the nearly flat Snake River basalt plain of south central Idaho (Lamb et al., 2014). Many geologists think it is another classic example of slow erosion by sapping, but the gorge was carved through multiple basalt flows. It has three distinct canyon heads; two are 50 m high, vertical amphitheater-shaped heads, and the third has a 7% grade or "knickzone," composed of multiple steps. A *knickzone* is a series of knickpoints causing an interruption in the slope of a stream. The two amphitheater canyons rarely experience any overland flow, and a small spring issues from the side of one canyon. The canyon with the knickzone carries the small Wood River, which originates in the mountains of central Idaho. There is substantial evidence of another origin for Malad Gorge.

Erosional scour is present upgradient of the two amphitheater canyons, indicating overland *megaflooding* in the past. Malad Gorge is only 18 km north of Box Canyon (Figure 5), and the same megaflood could have carved both. Canyon headwalls at Malad Gorge display notches that suggest *plucking*, an erosional process that removes large blocks from the substrate in a powerful current. Large plunge pools, found at the bottom of the canyon heads, are similar to those found at the base of "dry

Figure 6. The Potholes, plunge pools created by a receding waterfall 100 m high when the Lake Missoula flood overtopped a ridge west of Ephrata, Washington.

Figure 7. Upper Grand Coulee and Banks Lake with its 275 m high, vertical cliffs and flat bottom was carved during the Lake Missoula flood.

falls" produced by the Lake Missoula flood (Figure 6) (Oard, 2004b, 2014). Large boulders, up to 3 m in diameter, were transported along the low gradient of the canyon bottom. This would require a minimum discharge of 1,250 m^3/s, flowing at a depth of 9 m—seven times the highest flow measured on Wood River.

Erosion by megaflooding eliminates the need for long periods of sapping, and the abrupt catastrophic formation of the landscape suggests that uniformitarian perspectives are deficient in this area of geomorphology. It also suggests greater unpredictability in the rock record and less certainty in geologic history.

Box Canyon and Malad Gorge Carved by Megaflood after Noah's Flood

The rapid formation of Box Canyon and Malad Gorge by megaflood erosion, rather than by sapping, eliminates another objection of secular science to biblical history. Although these canyons may have formed during late-Flood channelized erosion (Oard, 2008), it is more likely they formed during the Ice Age, possibly after the Lake Bonneville flood, given the depth and direction of the canyons entering the Snake River.

Box Canyon and Malad Gorge are downstream from post-Flood Lake Bonneville, formed by ponding of Flood runoff and deepened by high precipitation during the Ice Age (Oard, 1993). It was a large, deep lake in Utah, about six times the area of Great Salt Lake and up to 345 m deep, nearly a hundred times more than the 3.5 m-deep Great Salt Lake. As Lake Bonneville rose, it overflowed Red Rock Pass at the southeast Idaho/Utah border, creating a breach that deepened the pass by about 100 m (O'Connor, 1993) during the Lake Bonneville flood. This event carved the channel of the Snake River Valley and formed local scabland features similar to those in eastern Washington. Since the tributary canyons of Malad Gorge were eroded to the same level as the Snake River and are not hanging valleys, the Snake River had to have been initially deepened by the Bonneville flood. This places the formation of Malad Gorge and Box Canyon well after Noah's Flood.

What, then, was the source of the water that carved Box Canyon and Malad Gorge? Their vertical walls, eroded into hard basalt, indicate significant volume and energy, like the Lake Missoula flood (Figure 7) (Oard, 2004b, 2014). At present, we cannot constrain the exact timing of this flood without a more detailed analysis of the area north of the canyon. One plausible uniformitarian explanation is that a flood broke a lava dam across the Wood River. Some basalt flows on the Snake River plain erupted after the Genesis Flood, and one of them could have created a dam. The Snake River basalts are thick and extensive, like the Columbia River Basalts. But the angular, rough lava at the Craters of the Moon and similar features indicate later volcanic activity on the Snake River basalt plain (Figure 8). It is also possible that Malad Gorge was carved by an arm of the Big Lost River flood (Cerling et al., 1994) when a glacial dam broke, flooding the area east of Wood River. In either case, erosion would have been within the biblical timescale.

Figure 8. Relatively recent basalt flow at the Craters of the Moon National Monument and Preserve.

Hawaiian Canyons Not Formed by Sapping

One of the most cited examples of sapping in basalt is the formation of spectacular amphitheater-headed valleys on the Hawaiian Islands (Howard et al., 1988). Lamb et al. (2007) analyzed four of them on the northeast side of Kohala Volcano on the island of Hawaii (Figure 9). Kohala is a small volcanic cone about 1,600 m high. Valleys between 300 and 750 m deep have been eroded into its sides. These extend to the northeast and terminate at a seaside cliff.

Although thought to have formed by sapping, these valleys show no evidence of intensely weathered rocks or alcoves around springs flowing from the valley headwalls. Springs are common due to high precipitation, but they often occur high on the valley walls, not at the intersection of the walls and valley floors. Springs have also emerged from the sea cliff that have not produced valleys. Moreover, plunge pools indicate overland flow. It is more likely that the canyons originally formed by the retreat of waterfalls (like the Niagara Falls) or from overland flooding during heavy rains. The same would be true of many other valleys on the Hawaiian Islands and is supported by their location on the *wet* side of the islands. This further suggests that the amphitheater morphology is *not* diagnostic of sapping. If so, the uniformitarian model is flawed.

Atacama Desert Canyons Not Formed by Sapping

Amphitheater-headed canyons in the hyper-arid Atacama Desert of northern Chile have been ascribed to sapping, based on analysis of the shape of their headwalls from satellite images (Hoke et al., 2004). These canyons range from V-shaped to trapezoidal in cross section, possess few tributaries, have low sinuosity, undergo little downstream widening, and are flanked by uplands that show little dissection, indicating that they were carved into a large planation surface (Mortimer and Sarič, 1975; Irwin et al., 2014). These large canyons are kilometers wide and hundreds of meters deep. Intermittent runoff from

Figure 9. Panorama of the Kohala Volcano with its deep canyons on the island of Hawaii (USGS, Wikipedia Commons PD USGS).

the high Andes is the only apparent significant water source for most of the valleys.

A field analysis of two of these canyons revealed *no* signs of sapping. There were no alcoves, no springs, no spring-watered vegetation, or any salt-weathering. However, signs of runoff erosion were evident. Canyon floors have been sculpted by fluvial channels, and boulders up to 2 m in diameter have been rounded by flowing water. Although sapping may have occurred in the past, it does not appear to be a major factor in their formation. Another valley, not analyzed in the field, is so wide that it likely originated by mass wasting, similar to that which formed the "Little Grand Canyon" at Mount St. Helens. Today, Little Grand Canyon is a 25 m deep canyon with a small stream running through it (Morris and Austin, 2003). It demonstrates rapid formation—in one day.

Colorado Plateau Canyons Not Formed by Sapping

The Colorado Plateau is rightly famous for its many long, amphitheater-headed canyons, including Grand Canyon. Many of these are assumed to have formed by sapping (Howard et al., 1988; Laity and Malin, 1985). This area is considered one of the best locations to see sapping:

> Excellent examples of sapping valleys have been described: (1) on the Colorado Plateau, where massive sandstone units are eroded by perched water emerging from bedding-plane boundaries; and (2) in the Hawaiian Islands, where basalt flows flanking shield volcanoes are dissected by both runoff and sapping valleys. (Baker et al., 1990, p. 235)

As with many forensic theories of earth history, however, much of the interpretation revolves around fitting observations into preconceptions of mechanisms. "Almost all the literature on landforms produced by groundwater sapping is descriptive" (Howard et al., 1988, p. 3). They continued to discuss the Colorado Plateau:

> From the preceding discussion it should be evident that our understanding of the processes involved in sapping erosion is fragmentary, and that it is difficult to make conclusive statements about the past and present roles of sapping processes in scarp evolution on the Colorado Plateau. (Howard et al., 1988, p. 49)

Sapping erosion is real and probably contributes to the present-day, small-scale formation of features in canyons. It is a major factor in the rapid growth of Providence Canyons in Georgia, which began with erosion from overland flooding (Froede and Williams, 2004; Williams, 1995). However, the more obvious cause of canyon erosion is that of overland flow, especially during flooding (Lamb et al., 2006). One of the indicators of this mechanism is the absence of talus in canyons. Flooding would remove the talus; sapping would leave many signs of activity:

> While some seepage weathering due to salt precipitation clearly takes place in the Colorado Plateau, spring flow is not able to remove boulders and gravel that tumble onto the canyon floor.… Precipitation-induced runoff is probably necessary to remove these gravels. (Lamb et al., 2006, pp. 2, 3)

Furthermore, there are many examples of groundwater flow in locations that could produce sapping but no evidence of actual erosion. Also, the presence of plunge pools is a clear indication of high volumes of overland flow. At Grand Canyon, the tributaries on the north side are longer, as would be predicted if formed by overland water:

> Although seepage erosion may play a minor role in valley extension within the Kaibab and Redwall Limestones, the main processes of canyon erosion and extension are runoff erosion and debris flow incision.… The tributaries on the north side of the Colorado River have eroded farther due to extensive drainage from the highlands north of the Grand Canyon passing over the canyon rim. (Lamb et al., 2006, p. 14)

The canyons on the Colorado Plateau probably were first eroded by late Flood-channelized flow when Grand Canyon formed (Oard, 2011, 2016). Greater Flood runoff would be expected from the Grand Staircase to the north. Canyons probably increased in size during heavy Ice Age precipitation (Oard, 1993) and summer flash floods after the Ice Age.

Conclusion

Although sapping may be a minor mechanism of erosion in hard rock, evidence demonstrates that large canyons were more likely formed by overland flow. Classic examples are cited because of the shape of the amphitheater-headed canyons, but clear field evidence of significant erosion by overland flow is ignored. Although uniformitarians consider sapping a major factor in canyon erosion, it is possible that it contributes very little to erosion processes in hard rock locales:

> The latter studies suggest that a ground-water sapping origin of bedrock valleys may not have been uniquely demonstrated *anywhere* on Earth, and that a positive relationship between spring discharge and weathering rate similarly lacks empirical support. (Irwin et al., 2014, p. 297, emphasis mine)

Uniformitarians continue to offer objections to biblical history based on mechanisms that require deep time. But once again, the evidence shows that the time is not necessary and that the explanatory model is distorted by the presumption of deep time and the need to find processes to fit that template.

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