Chapter 24

The Rim Gravel in Arizona

In Arizona, quartzites and other exotic rocks have been transported from their sources, but not nearly as far as those from the northern Rocky Mountains. These rocks are called the Rim Gravel, and they are found on top the Mogollon Rim in central and northern Arizona, which is the southwest edge of the Colorado Plateau.[1] The Mogollon Rim is a general northwest-southeast escarpment that extends from northwest Arizona

Figure 24.1. Mogollon Rim in background east northeast across the Verde Valley from the Black Hills, west of the old mining town of Jerome, northeast of Prescott. The San Francisco Mountains are the snow-capped mountains just left of center.

into east-central Arizona (Figure 24.1). It is the edge of a broad plateau-like feature to the northeast of the escarpment rim and is the highest area in the region, except for the volcanic San Francisco Mountains that erupted on top of the plateau. Figure 24.2 shows the locations of the major deposits of Rim Gravel, which are erosional remnants of a once continuous blanket of gravel (see in-depth section at the end of the chapter). The characteristics of Rim Gravel are described in Appendix 13.

1 Oard, M.J. and P. Klevberg, 2005. Deposits remaining from the Genesis Flood: Rim Gravels in Arizona. *Creation Research Society Quarterly* 42(1):1–17.

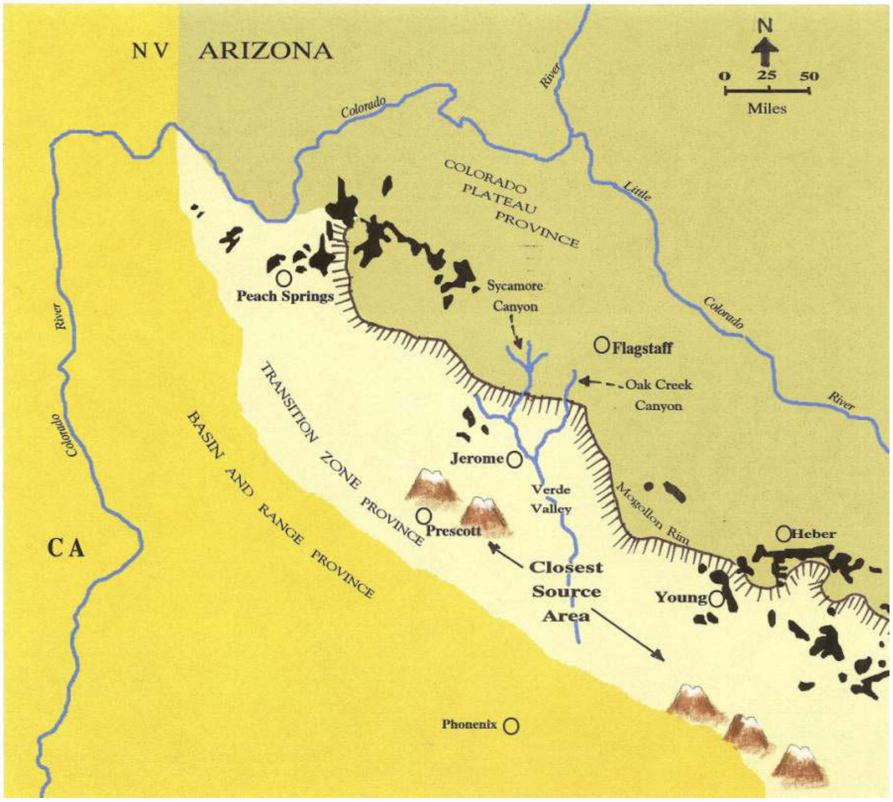

Figure 24.2. Location of Rim Gravel in Arizona in black, including gravel southwest of the Mogollon Rim which may not be true Rim Gravel (redrawn by Mark Wolfe after Elston and Young, 1991, figure 1). Physiographic provinces of Arizona are also shown. Nearest sources for the large erosional remnants of Rim Gravel along the northwest and east-central location of the Mogollon Rim are from the southwest.

Moderate Transport Distance

One of the most surprising characteristics of the Rim Gravel are paleocurrent indicators that show the water transporting the exotic rocks flowed from the south or west.[2,3] Current directions are based mainly on the location of probable source areas, sand cross-beds within the gravel, oblong rock imbrication, and the orientation of some of the canyons and valleys,[4] mainly the canyon and valley with a northeast orientation.[5,6]

[2] Peirce, H.W., P.E. Damon, and M. Shafiqullah, 1979. An Oligocene (?) Colorado Plateau edge in Arizona. *Tectonophysics* 61:1–24.

[3] Elston, D.P. and R.A. Young, 1991. Cretaceous-Eocene (Laramide) landscape development and Oligocene-Pliocene drainage reorganization of transition zone and Colorado Plateau, *Arizona. Journal of Geophysical Research* 96(B7):12,389–12,406.

[4] McKee, E.D. and E.H. McKee, 1972. Pliocene uplift of the Grand Canyon region—time of drainage adjustment. *GSA Bulletin* 83:1,923–1,932.

[5] Young, R.A., 1966. *Cenozoic Geology along the Edge of the Colorado Plateau in Northwestern Arizona*, PhD Thesis, Washington University, St. Louis, MO.

[6] Young, R.A. and W.J. Brennan, 1974. Peach Springs Tuff: its bearing on structural evolution of the Colorado Plateau and development of Cenozoic drainage in Mohave County, Arizona. *GSA Bulletin* 85:83–90.

The closest source for quartzite and other igneous and metamorphic exotic rocks of the Rim Gravel in the northwest Mogollon Rim is from around the Prescott, Arizona, area, about 50 miles (80 km) to the south.[7,8] Apparently, the closest source for the east-central Rim Gravel is not too distant to the south. However, it could be from a number of locations farther to the south and west where the exotic types of rocks also outcrop extensively, especially in the mountain ranges.[9,10,11,12,13] Assuming some of the rocks were weathered before transport, a minor amount of heavily-weathered granitic rocks in the Rim Gravel may indicate the source was fairly close. If the weathering happened after transport, the granite may have been transported a long distance. We can at least conclude that the Rim Gravel has been transported at least a moderate distance, on the order of 25 to 100 miles (40-160 km).

Figure 24.3. Oak Creek Canyon just south of the Mogollon Rim (view south). The east side of canyon (left) is covered by a basalt flow with gravel below. The west side (right) has been faulted upward over 330 feet (100 m).

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[7] Koons, D., 1948. High-level gravels of western Grand Canyon. *Science* 107:475–476.

[8] Koons, D., 1964. Structure of the eastern Hualapai Indian Reservation, Arizona. *Arizona Geological Society Digest* 7:97–114.

[9] Conway, C.M. and L.T. Silver, 1989. Early Proterozoic rocks (1710-1615 Ma) in central and southeastern Arizona. In, Jenney, J.P. and S.J. Reynolds (editors). *Geologic Evolution of Arizona, Arizona Geological Society Digest 17*, Arizona Geological Society, Tucson, AZ, pp. 165–186.

[10] Anderson, J.L., 1989. Proterozoic anorogenic granites of the Southwestern United States. In, Jenney, J.P. and S.J. Reynolds (editors). *Geologic Evolution of Arizona, Arizona Geological Society Digest 17*, Arizona Geological Society, Tucson, AZ, p. 211–238.

[11] Wrucke, C.T., 1989. The middle Proterozoic Apache Group, Troy quartzite, and associated diabase of Arizona. In, Jenney, J.P. and S.J. Reynolds (editors), *Geologic Evolution of Arizona, Arizona Geological Society Digest 17*. Arizona Geological Society, Tucson, AZ, pp. 239–258.

[12] Williams, E.L., J.R. Meyer, and G.W. Wolfrom, 1992. Erosion of Grand Canyon Part II—Review of river capture, piping and ancestral river hypotheses and the possible formation of vast lakes. *Creation Research Society Quarterly* 28:138–145.

[13] Williams, E.L., G.F. Howe, and J.R. Meyer, 1999. An introduction to the geology of Verde Valley, a different perspective. *Creation Research Society Quarterly* 36:81–88.

Tremendous Erosion of Southern and Central Arizona

It is amazing that the altitude of the land south and west of the Mogollon Rim is *much lower* than where the gravels are found. This means that the area to the south and west was significantly higher than the Mogollon Rim at one time. This difference is *not* due to significant faulting near the Mogollon Rim, as some would at first suspect, since the rim is considered *erosional*.[13,14] While faults with minor vertical offsets are present in the Verde Valley area (Figure 24.3), Elston and Young stated:[15]

> The northern margin of the Transition Zone in central Arizona is an essentially unfaulted, south facing erosional escarpment known as the Mogollon Rim … Faulting is not responsible for most of this escarpment.

The present low elevations of the source area demonstrate tremendous erosion occurred south of the Rim during the uniformitarian "Cenozoic" Era.[16] This postulated higher terrain south of the Mogollon Rim has been called the Mogollon Highlands. These highlands are thought to have since been eroded to mountains and valleys at a much lower elevation than the Mogollon Rim.[17,18]

Figure 24.4. Coarse gravel on ridge just north of Mogollon Rim forming a flat surface. The surface is extensive but has been dissected by valleys since deposition. Picture taken about 2.5 miles (4 km) southwest of Arizona Highway 260, southwest of Heber, Arizona.

The size and location of the large quartzites on the highest terrain—the remnants of an erosion surface (Figure 24.4)—implies powerful currents swept *downhill* from the south and west. The relatively common percussion marks on quartzite boulders (Figures 24.5 and 24.6) indicate that mostly torrential currents, not landsliding processes, transported the rocks at high velocity. The more resistant rocks ended up as a boulder lag on the present Mogollon Rim, while softer rocks were either swept away or pulverized, contributing

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[14] Holm, R.F., 2001. Cenozoic paleogeography of the central Mogollon Rim-southern Colorado Plateau region, Arizona, revealed by Tertiary gravel deposits, Oligocene to Pleistocene lava flows, and incised streams. *GSA Bulletin* 113:1,467–1,485.

[15] Elston and Young, Ref 3, p. 12,393.

[16] Dumitru, T.A., I.R. Duddy, and P.F. Green, 1994. Mesozoic-Cenozoic burial, uplift, and erosion history of the west-central Colorado Plateau. *Geology* 22:499–502.

[17] Cooley, M.E. and E.S. Davidson, 1963. The Mogollon Highlands: their influence on Mesozoic and Cenozoic erosion and sedimentation. *Arizona Geological Society Digest* 6:7–35.

[18] Scarborough, R., 1989. Cenozoic erosion and sedimentation in Arizona; in, Jenney, J.P. and S.J. Reynolds (editors), *Geologic Evolution of Arizona, Arizona Geological Society Digest 17*, Arizona Geological Society, Tucson, AZ, pp. 515–537.

Figure 24.5. Well-rounded quartzite boulder 24 inches (60 cm) in long dimension and 20 inches (50 cm) in the intermediate dimension with abundant percussion marks. Location is about 0.6 miles (1 km) south of the junction of forest roads 512 and 291, southwest of Heber, Arizona.

Figure 24.6. Abundant percussion marks on a quartzite boulder from just south of the Mogollon Rim, 4.5 miles (7 km) south of Arizona Highway 260 on Forest Service Road 512, southwest of Heber, Arizona.

to the fine-grained matrix that surrounds the boulders. The likelihood that Rim Gravel was first deposited as a sheet during the erosion of the Mogollon Highlands implies deposition during the Sheet Flow Phase of the Genesis Flood.

The velocity of the water current was estimated for the deposition of the Rim Gravels. The calculations were based on the largest rocks, estimated slope of transport, and other variables.[1] Minimum current speeds of 25 to 50 mph (40 to 80 kph) were obtained, which is significantly faster than the fastest flash floods observed today (see Appendix 14).

A wide flow toward the northeast deposited the Rim Gravel as a sheet on top of the erosion surface of the Mogollon Rim. Shortly after deposition about 90% of the Rim Gravel was swept off by the current, probably because of an increase in speed, leaving only erosional remnants, as shown in Figure 24.2.[19]

The sheet currents that flowed toward the northeast shifted and flowed west and became more channelized. These westerly directed currents scrubbed the Mogollon Rim down to around 7,000 feet (a few thousand m). Whereas the "Mogollon Highlands" were high during deposition of the Rim Gravel, erosion in channelized currents probably flowing toward the west subsequently reduced the highlands to well *below* the elevation of the Mogollon Rim. The Mogollon Rim probably survived erosion because erosion was likely confined in valleys to the north and south.

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[19] Billingsley, G.H., K.J. Wenrich, and P.W. Huntoon, 2000. Breccia-pipe and geologic map of the southwest part of the Hualapai Indian Reservation and vicinity, Arizona. *U. S. Geological Survey Geologic Investigation Series I-2643 pamphlet*, Washington, D.C.

Uniformitarian Difficulties

Uniformitarian scientists have known about the Rim Gravel on top of the Mogollon Rim for at least 80 years.[7] Since this time, there have been many observations and reports done. However, there are conflicting interpretations of the ages and origins of the deposits.[14] Even the exact definition of Rim Gravel is confusing and somewhat controversial, as discussed further in the in-depth section at the end of the chapter.

The Rim Gravel is considered one key to understanding the geology of the Colorado Plateau, including its erosional history, the origin of the Grand Canyon, and the origin of the Mogollon Rim.[3,14]

An extensive gravel capping an erosion surface is difficult to accommodate in any uniformitarian scenario because that style of erosion and deposition on a large-scale is not seen in the modern world.[20] So, the Rim Gravel and its implications present a uniformitarian problem. Uniformitarian scientists sometimes appeal to terrain inversion in which mountains and ridges become valleys and river valleys become ridges (see Chapter 15). The old valleys supposedly were protected from erosion due to the armoring of the Rim Gravel. In this hypothetical concept, the gravel should end up as a veneer or lag with rock touching rocks. However, some of the gravel on the Mogollon Rim has finer particles completely surrounding the rocks. It is as if the cobbles and boulders are floating in the matrix. One would expect these gravels would erode easily if terrain inversion actually occurred. So, the Mogollon Rim should have eroded as much as the Mogollon Highlands. Furthermore, if the Rim gravel was deposited by rivers, we should detect the rough outlines of paleochannels, yet this does not appear to be the case. Finally, at today's erosion rate, all of North America should have been eroded to sea level in 10 to 50 million years,[21] but uniformitarian scientists consider the Rim Gravel a little older. So, why hasn't the whole area been reduced to near sea level in all those millions of years?

Genesis Flood Solution

The deposition of the Rim Gravel is a crucial clue pointing to the Flood history of the area. The uniformitarian concept of an historical "Mogollon Highlands," which were later eroded, is a sound deduction from the types of rocks and the paleocurrent directions in the Rim Gravel. A global Flood can explain the erosion and deposition. We can soundly deduce how it happened from the geomorphology.[1,21]

As the global Flood waters retreated, sheet currents early in the Retreating Stage of the Flood would deposit the Rim Gravel. The currents would have been flowing down slope from the south and west towards the north and east. As the southern and central Rocky Mountains uplifted the northeasterly current would have become blocked causing currents to shift toward the west and became more channelized with time. Therefore, there was a *reversal* of drainage. The Mogollon Highlands were then highly eroded. During all this activity, the Rim Gravel on the Mogollon Rim was also substantially eroded, leaving behind erosional remnants. The Mogollon Rim eventually became one of the highest terrains in the area. As base level dropped due to the rising terrain of the

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[20] Oard, M.J., 2008. *Flood by Design: Receding Water Shapes the Earth's Surface*, Master books, Green Forest, AR.

[21] Roth, A.A., 1998. *Origins: Linking Science and Scripture*, Review and Herald Publishing Association, Hagerstown, MD., pp. 263–266.

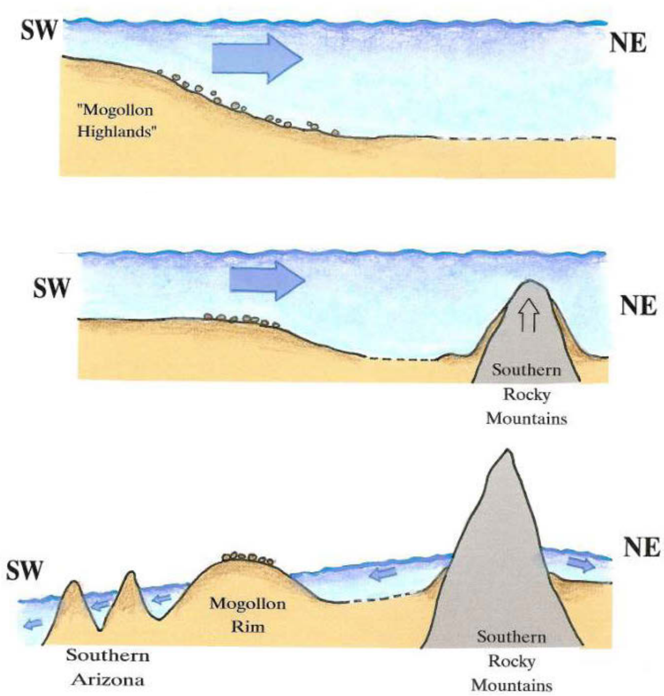

Figure 24.7. Schematic of Flood interpretation of the sheet erosion of the "Mogollon Highlands," deposition of Rim Gravel on top of the Mogollon Rim, and flow reversal caused by the uplifting southern Rocky Mountains resulting in channelized erosion (drawn by Mrs. Melanie Richard). Dashed line on the bottom indicates a greatly expanded distance scale.

southwest United States and the sinking of the ocean basins,[20] the channelized flow off the highest land to the east of the area would have rapidly eroded canyons and valleys to the north and south of the Mogollon Rim. The eroded Rim Gravel would have been re-deposited along with local rocks into the valleys and onto pediments, at lower elevations. Figure 24.7 shows a schematic of these Flood events.

All this activity occurred late in the uniformitarian timescale—mainly during the "Cenozoic," a time of great tectonic activity all across the Rocky Mountains.[3,14] This correlates with the Retreating Stage of the Flood when the region was still submerged below the Floodwater (Psalm 104:6-9).[22,23] Erosion would have greatly diminished after areas emerged above the Floodwaters. This implies rapid vertical uplift of the southwestern United States, probably accompanied by the subsidence of the Pacific Ocean basin.

What is Rim Gravel? (in-depth section)

Rim Gravel in northern and central Arizona occupies a unique location. It is often found on the highest terrain of the Mogollon Rim, generally on ridge crests at elevations of 6,900 to 7,900 feet (2,100 to 2,400 m).[18] Koons estimated the Rim Gravel on the Mogollon Rim was up to 250 feet (76 m) thick within the extensive surficial outcrops east of the Hualapai Indian Reservation.[8] The gravels are up to 200 feet (60 m) thick in other places.[2] Based on these observations, it is believed that the Rim Gravel was much thicker and more continuous at one time. Most of the Rim Gravel has been eroded since deposition, probably around 90%, leaving behind erosional remnants (Figure 24.2). Uniformitarian scientists believe the erosion happened mainly during "Cenozoic" uplift of the southwest united States. Elston and Young stated:

[22] Oard, M.J., 2001. Vertical tectonics and the drainage of Floodwater: a model for the middle and late diluvian period—Part I. *Creation Research Society Quarterly* 38 (1):3–17.

[23] Oard, M.J., 2001. Vertical tectonics and the drainage of Floodwater: a model for the middle and late diluvian period—Part II. *Creation Research Society Quarterly* 38 (2):79–95.

> To obtain the existing stratigraphic and topographic distribution of Rim gravels across the Colorado Plateau and adjacent Transition Zone, the gravels must have once formed a *thick, virtually continuous regional blanket* that buried much, if not all, of the Mogollon Rim, the irregular erosion surface south of the rim, and the relatively smooth erosion surface developed on resistant strata north of the rim (emphasis added).[24]

Geologists have noted that the Rim Gravel lies on top of an erosion surface (erosion surfaces will be discussed in Volume II) that usually truncates the "Paleozoic" rocks of the Mogollon Rim area.[2,3,25,26] The erosion surface is bevelled the same way across both hard and soft rocks the same, at least in the Sycamore Canyon area.[27] This erosion surface was later dissected by water currents forming several canyons and valleys.

The Rim Gravel was re-eroded from the Mogollon Rim into the canyons and valleys, as well as on pediments (pediments will be defined and discussed in volume III) and lava-capped mesas on the Colorado Plateau.[14] Some areas of Rim Gravel have been covered by lava flows.[4] For example, basalt covers an outcrop of gravel in Oak Creek Canyon, a deep canyon perpendicular to the Mogollon Rim (Figure 24.3) where the city of Sedona is located.[28] The re-eroded gravel has been given a bewildering array of names. Some researchers call them Rim Gravel. There is some question of whether gravel deposits below the Mogollon Rim should be considered true Rim Gravel.[2] For the sake of simplicity, Rim Gravel is the gravel capping only the Mogollon Rim.

The types of rocks in the gravels vary considerably. There is a significant proportion of exotic quartzite. The quartzites are well rounded, large, and display percussion marks. The largest one I observed was 24 inches (60 cm) long and 20 inches (50 cm) across with abundant percussion marks (Figure 24.5). Along with the exotic rocks, there are also a large percentage of local "Paleozoic" rocks, especially sandstone rocks. Basalt lava outcrops at many locations along and near the Mogollon Rim, but very few if any basalt rocks are found in the Rim Gravel, implying that the agency that spread the Rim Gravel did so *before* the widespread volcanism and surficial basalt flows of the region. Uniformitarian geologists attribute the volcanism to the uplifting of the Colorado Plateau and Basin and Range Province in southwest Arizona.[29] So, the Rim Gravel was most likely spread *before* the area was uplifted.

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24 Elston and Young, Ref. 3, p. 12,396.

25 Lucchitta, I., 1972. Early history of the Colorado River in the Basin and Range Province. *GSA Bulletin* 83:1,933–1,948.

26 Young, R.A., 1979. Laramide deformation, erosion and plutonism along the southwest margin of the Colorado Plateau. *Tectonophysics* 61:25–47.

27 Price, W.E., 1950. Cenozoic gravels on the rim of Sycamore Canyon, Arizona. *GSA Bulletin* 61:505.

28 Holm, R.F. and R.A. Cloud, 1990. Regional significance of recurrent faulting and intracanyon volcanism at Oak Creek Canyon, southern Colorado Plateau, Arizona. *Geology* 18:1,014–1,017.

29 Young, R.A. and E.H. McKee, 1978. Early and middle Cenozoic drainage and erosion in west-central Arizona. *GSA Bulletin* 89:1,745–1,750.

In some areas of northwest and east central Arizona the gravel is widespread.[2,3,30,31,32] There is even mention in the scientific literature of Rim Gravel *north* of the Grand Canyon,[3,32] indicating that the Rim Gravel was deposited *before* the Grand Canyon was eroded. This, however, is disputed, especially since there are sources of quartzite in the mountains of Nevada and western Utah that could have been the source for the quartzite gravels north of the Grand Canyon.

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[30] Koons, D., 1948. Geology of the eastern Hualapai [sic] Reservation. *Museum of Northern Arizona Bulletin (Plateau)* 20(4):53–60.

[31] Lucchitta, I., 1979. Late Cenozoic uplift of the southwestern Colorado Plateau and adjacent lower Colorado River region. *Tectonophysics* 61:63–95.

[32] Lucchitta, I., 1989. History of the Grand Canyon and of the Colorado River in Arizona; in, Jenney, J.P. and S.J. Reynolds (editors), *Geologic Evolution of Arizona, Arizona Geological Society Digest 17*, Arizona Geological Society, Tucson, Arizona, pp. 701–715.